



Citizens' Alliance for Property Rights

June 8, 2004

King County Council Members:

We submit the following as official testimony from our organization on the changes being proposed to the King County Comprehensive Plan, Critical Areas Ordinance, Stormwater Ordinance, and Clearing and Grading Ordinance. We may submit additional testimony in the future. This is the first testimony that Citizens' Alliance for Property Rights has given on these amendments.

Many of us as individuals go all the way back to the original focus groups. Most of our objections along the way seem to have been used to find ways to "spin" the objections while not substantively changing the actual impacts of the ordinances. We have only had the final text of the proposed ordinances since late March. Ron Sims has saddled everyone not on his staff with the task of making sense of his proposal in a very abbreviated time frame. You are being asked to make decisions with devastating financial and quality-of-life impacts to a minority of King County property owners to achieve questionable public benefits. The alleged public benefits will be covered in-depth in a later section but there is no consensus on the actual benefits that might be achieved. Even if there were consensus about those benefits, the cost should be born by those who receive the benefit in proportion to the value of the benefit to them.

The matters being considered are far too important to be rushed through your legislative arm of King County government. The Executive has had years to concoct his proposals. If you rush to rubber stamp them, we will spend years and countless millions of dollars while the judicial branch sorts out the mess. You need to slow this process through the Council. King County will not be in violation of the GMA if you do not make any changes by December 1, 2004. You simply must recognize that wise regulations take time and thoughtful input from all sides, not just the side currently represented by the Executive. The Sensitive Areas Ordinance

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was rammed through the King County Council by executive departments and special interests, and it has been an absolute disaster for rural King County. The land use regulations currently in place in King County are the most restrictive in the state. There is no emergency that mandates that you rush the next 500 pages of regulations into place. You must simply review them, make no changes, and then take the time to do the job you are being paid to do. Find the creative way to meet the needs of **all** of the people of King County. The current proposals will continue to rip us apart at the seam called the urban growth boundary. There are only 130,000 people in rural King County. **It is simply wrong to make those few pay for the benefits of the many.** The 1,600,000 in urban King County have benefited enormously from the development of and ongoing use of their properties. Why must the rural few now provide further benefits to them by giving up what the urban many are unwilling to give up — the use of their property?

Governments by their very nature have no integrity. The definition of integrity that we refer to is “steadfast adherence to a strict moral or ethical code” and can only be achieved by humans, not their institutions. We therefore must rely on the personal integrity of individual politicians, judges and bureaucrats for ethical behaviour as they run the institution we call government. Without personal integrity the greed and self interest of a controlling majority, or a vocal minority, can easily overwhelm the basic principles of honesty, fairness and the rule of law. That may, indeed, be what is happening in King County and the State of Washington as you contemplate these massive new regulations that will continue to enforce a vocal minority’s vision on an even smaller minority, the rural landowners.

This is not the first time that government would be the willing accomplice in unethical acts. The federal government side-stepped well-developed common law principles with a series of treaties that effectively stole land from Native Americans. In the South, state and local governments created voting laws specifically designed to withhold voting rights and political power from African Americans. Washington State’s Growth Management Act that is the force behind these new rules strips most of the rights of property ownership from rural property owners, making them second class citizens. All these acts have occurred because individual men and women running the government have been willing to lay aside their personal integrity and make an unethical choice.

Because of the schizophrenic way that the government of King County is organized, you as individuals find yourselves asked to codify into law what is, in fact, extremely unethical

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treatment of one small portion of your constituency. These proposals only effect the unincorporated areas of King County, unlike most of your legislation that is regional in nature. Most of you have few, if any, unincorporated constituents. It would be easy to put your integrity aside for a moment and vote for these new proposals. Your constituency will not be affected and most don't care or don't even know what is being proposed. Those of you who are Democrats are being asked to lay aside your integrity and vote with Ron Sims, the head of your political party, and his special interests.

If you do that, you will be continuing the Culture of Control and Conflict that has been tearing this county apart for years. The Cedar County movement was the result of the unethical bullying of rural King County by the urban King County elite. The merger of Metro and King County has only exacerbated the problems. The residents of unincorporated King County virtually have no local government. Incorporations and annexations have been happening at a rapid rate as people bail out of King County so that they have a local government that looks out for their interests. The rift becomes wider each day that King County departments such as DNRP and DDES force their urbancentric rules down the throats of rural residents at the point of the sheriff's gun.

The committee that reviewed the King County Charter in the mid 1990s recognized the enormous disconnect of King County's local government function from its unincorporated citizens. Three new things were thrown into that gap. Several existing community groups were brought under the County wing as "Unincorporated Area Councils." Not all of the unincorporated area is represented by an area council and the councils have no authority or responsibilities. They have served primarily as a way for King County to pretend that the unincorporated areas have some actual voice in their local affairs.

Unincorporated referendum and initiative were added to the charter at that time. They can be used when dealing with matters that only affect unincorporated King County. A referendum to undo these new proposals, should you pass them, would be a slam dunk in unincorporated King County. Unfortunately, the Washington Supreme Court has ruled that the GMA trumps local referendum rules for land use regulations. Since land use regulations are really the only matters that apply only in the unincorporated areas, unincorporated referendum and initiative are rendered impotent and are just one more wound to fester.

Who benefits from this adversarial environment and these massively inequitable new laws? Only the bureaucrats, lawyers, and consultants. How many additional permit dollars and

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new bureaucrats will be generated by these ordinances? What is the estimated increase in the budget of DDES, the principal author of and benefactor of these regulations? Why is the executive branch of government drafting law instead of the legislative branch? That violates the concepts of separation of powers that governments in this country are built around. DDES's budget is whatever they can extort from the citizens in fees for permission and fines for not obtaining permission to use our property. To have them crafting the regulations is lunacy. We are amazed that they have only come up with 500 or so pages. It benefits them directly, and no one else, to have a permit fee tied to every use of property in rural King County. Personal integrity at DDES has disintegrated steadily since they were taken off budget and allowed to spend whatever they can take in. DNRP collects hundreds of millions of dollars in surface water management fees and spends those dollars on staff, not flood control or wetlands purchase or conservation easements.

You have before you the issue that will have the largest impact on King County in this decade. It falls to you to decide if the Culture of Control and Conflict will continue in this County. We implore you to keep a firm grasp on your integrity and do what is right for the constituency affected by these rules. We agree that the current rules need to be changed, as they are in large part the cause of the existing conflicts. We would like you to take your time and actually repair this county, not continue to tear it apart.

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We begin our exploration of the details of these ordinances with some excerpts from Washington State's Growth Management Act that we believe that you should keep foremost in your mind as you consider and then vote on the ordinances before you.

RCW 36.70A.020 — Planning goals

- 1) **Urban growth.** Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.
- 2) **Reduce sprawl.** Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.
- 3) **Transportation.** Encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.
- 4) **Housing.** Encourage the availability of affordable housing to all economic segments of the population of this state, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.
- 5) **Economic development.** Encourage economic development throughout the state that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and for disadvantaged persons, promote the retention and expansion of existing businesses and recruitment of new businesses, recognize regional differences impacting economic development opportunities, and encourage growth in areas experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.
- 6) **Property rights.** **Private property shall not be taken for public use without just compensation having been made. The property rights of landowners shall be protected from arbitrary and discriminatory actions.**
- 7) **Permits.** Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability.
- 8) **Natural resource industries.** Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forestlands and productive agricultural lands, and discourage incompatible uses.
- 9) **Open space and recreation.** Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities.
- 10) **Environment.** Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.
- 11) **Citizen participation and coordination.** Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.

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- 12) **Public facilities and services.** Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.
- 13) **Historic preservation.** Identify and encourage the preservation of lands, sites, and structures, that have historical or archaeological significance.

These goals call for the management of our state's [private](#) natural resources and land primarily for the public's benefit. That is a dramatic shift in policies from those of the founders of the United States and Washington as reflected in the Constitutions written by those founders. These goals reflect the will of the 1990 Washington legislature and governor, not the people. Initiative 547, upon which the GMA was based, was defeated 3 to 1 by the people. Only goals 4, 6 and 8 address any benefits of the actual landowner. While all of the GMA goals are supposed to guide comprehensive plans, there are no overt references to individuals' property rights in the mandatory elements for these plans. As a goal of growth management, protecting property rights has taken a backseat to attempting to contain sprawl and enhancing wildlife habitat. There is a clear tension between some of these goals and protection of the rights of individual property owners. It is your job to see that the legislation that you pass meets the intentions of the state law as set out in all the goals as well as meet the explicit statutory requirements of the law. You must also factor in the private property guarantees of both the federal and state constitutions as those guarantees take precedence over the GMA. We implore you to also do what is fair and just.

The GMA mandates that the Attorney General publish annually a guideline for local governments to use in reviewing GMA plans and, hopefully, avoid unconstitutional takings of private property. These guidelines assist "agencies which exercise regulatory authority impacting private property rights" through the identification of "warning signals" that can "determine whether a proposed regulatory action may violate a constitutional requirement." [See Appendix 1 for the complete text of that document.] The latest guideline was published in 1995. So much for state mandates! We ask that you pay special attention to paragraphs numbered 3, 4 and 11 in the "Warning Signals" section. Dedications of property such as 300-foot wetland buffers and 65% set-asides must be reasonable and proportional to the impacts from use. It does not seem to us that a variance of 300%, in wetland buffers for instance, from urban (100 feet) to rural (300 feet) is reasonable or proportional when applied to identical use of property.

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Please recognize that these regulations would be imposed upon property owners who, in many cases, have already been down-zoned out of 95% of their “reasonable investment-backed development expectations” when their zoning went from 1 unit per 9800 square feet to 1 unit per 5 acres. Pile on another 65% reduction and can we really say that they have not had a “Severe Impact” on their economic interest? While it may be possible for Ron Sims et al to morally justify anything that can be sneaked past the courts, are you ready to help him commandeer the moral low ground?

Recognize that there have been substantive rulings since the Attorney General’s document was prepared that narrow the scope of acceptable regulations. [See Appendix 2.] Also recognize that, though mostly ignored, the Washington Constitution does call for payment for damages to private property by government, not just outright physical takings as the Attorney General would lead you to believe. Property rights are guaranteed by our constitutions for valid reasons that have not changed in the years since those constitutions were drafted. Property rights are the bedrock upon which our other rights rest and without which we are simply pawns to be sacrificed by whomever has the power to rule us. Pragmatically, strong property rights are a key prerequisite for economic development in a market economy. Businesses only invest where the expected rate of return is sufficiently high to compensate for the risks that they face. Insecure property rights increase risks and decrease willingness to invest. Property rights in Washington State have been evaporating at a high rate in the last couple of decades. Businesses are leaving this state and taking their jobs with them. It is not an accident that we have our high unemployment rate while other states are rebounding.

You need to be aware that much of the “best available science” that the executive staff is using to justify these proposals is not seen as “best available science” by equally qualified independent scientists. That should concern you both personally and as a member of the Council. Any regulations that are based on faulty science are a violation of due process which is a violation of the Civil Rights Act which provides for serious penalties to those who enact the regulations. You can face prosecution personally for knowingly enacting laws, rules and regulations based on faulty science. Serious monetary consequences as well as jail time are possible. It is you, not executive staff, that will be held accountable for faulty science.

We understand that your job is not easy. The majority of you have very few constituents that own land that will be directly affected by the new regulations. We understand the pressure that you are under to provide possible benefits to your constituents via regulation of the land

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uses of those outside your districts. We call upon you to look for guidance from those Council members that have many constituents that are directly affected, just as they look to you for guidance in matters that mostly affect your district. It will take much moral and political courage for you to stand up to the special urban interests arrayed against rural landowners and make wise decisions concerning these ordinances.

RCW 36.70A.130 — Comprehensive plans -- Review -- Amendments.

- (1)(a) *Each comprehensive land use plan and development regulations shall be subject to continuing review and evaluation by the county or city that adopted them. A county or city shall take legislative action to review and, **if needed**, revise its comprehensive land use plan and development regulations to ensure the plan and regulations comply with the requirements of this chapter according to the time periods specified in subsection (4) of this section. A county or city not planning under RCW 36.70A.040 shall take action to review and, if needed, revise its policies and development regulations regarding critical areas and natural resource lands adopted according to this chapter to ensure these policies and regulations comply with the requirements of this chapter according to the time periods specified in subsection (4) of this section. **Legislative action means the adoption of a resolution or ordinance following notice and a public hearing indicating at a minimum, a finding that a review and evaluation has occurred and identifying the revisions made, or that a revision was not needed and the reasons therefore.** The review and evaluation required by this subsection may be combined with the review required by subsection (3) of this section. The review and evaluation required by this subsection shall include, but is not limited to, consideration of critical area ordinances and, if planning under RCW 36.70A.040, an analysis of the population allocated to a city or county from the most recent ten-year population forecast by the office of financial management.*
- (3) *Each county that designates urban growth areas under RCW 36.70A.110 shall review, at least every ten years, its designated urban growth area or areas, and the densities permitted within both the incorporated and unincorporated portions of each urban growth area. In conjunction with this review by the county, each city located within an urban growth area shall review the densities permitted within its boundaries, and the extent to which the urban growth occurring within the county has located within each city and the unincorporated portions of the urban growth areas. The county comprehensive plan designating urban growth areas, and the densities permitted in the urban growth areas by the comprehensive plans of the county and each city located within the urban growth areas, shall be revised to accommodate the urban growth projected to occur in the county for the succeeding twenty-year period. The review required by this subsection may be combined with the review and evaluation required by RCW 36.70A.215.*
- (4) *The department shall establish a schedule for counties and cities to take action to **review and, if needed, revise** their comprehensive plans and development regulations to ensure the plan and regulations comply with the requirements of this chap-*

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ter. The schedule established by the department shall provide for the reviews and evaluations to be completed as follows:

- (a) **On or before December 1, 2004**, and every seven years thereafter, for Clallam, Clark, Jefferson, King, Kitsap, Pierce, Snohomish, Thurston, and Whatcom counties and the cities within those counties;

The GMA excerpts printed above clearly outline what you must do. The GMA requires a review but does not mandate an upgrade. You must make revisions only if the current regulations do not comply with the requirements of the chapter. You need only look to other counties and cities in the state, which must meet the exact same requirements, to understand that the current regulations of King County are in excess of what is required. There is no reason to rush to judgment.

The Art of Distraction

Modern politics is the art of creating a perceived crisis and then pretending that whatever you want to happen is the only possible solution. The nice thing about jousting imaginary windmills is that it distracts the voters from the fact that you are ignoring more difficult real problems. "Growth Management" is a perfect example. King County has been a very nice place to live and work and as that news spread around the country, people moved here. Growth is good for business and the economy boomed bringing even more immigrants. The increased population brings with it increased demand for the services that government is charged with providing.

Unfortunately, as fast as King County has grown, its bureaucracy has grown even faster and that bureaucracy is not organized to provide the necessary new services. It is geared towards pretending to fix perceived problems via study and meetings and the production of words on paper. The largest bureaucracy in King County, the Department of Natural Resources and Parks, is a prime example. Instead of providing service, they are busy divesting themselves of County Parks. One of their divisions, Water and Land Resources, receives many millions of dollars in surface water management fees to manage surface water. They spend most of the money they receive on bureaucrats and paper, not on-the-ground projects that would help manage the increased amounts of water from new development. When citizen pressure forced them to actually clean a clogged stretch of May Creek, the work cost \$141,000 to clean 256 feet of ditch. That is \$550 per foot compared to private sector estimates of \$3 per foot.

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Instead of using tax dollars to build roads and schools and sewers or pay for police and fire protection, we now use those dollars to pay for evermore bureaucrats. Human instincts for self-preservation are very strong. The bureaucrats have figured out that the way to keep the money themselves instead of paying contractors to do actual work is to simply force the work to be done by the citizens via regulation. Roads are no longer built by government but by those who develop property. It has gotten so bad that the bureaucrats and politicians have made it illegal for government to build infrastructure in King County. That is like making it illegal for the sherriff to arrest criminals or firefighters to put out fires!

Now that the bureaucracy has made it illegal to do part of what they were invented to do, how do they solve the problem of demand for those services? What is needed is a distracter to draw attention away from the fact that the bureaucrats are keeping all the money intended for services. The "smart growth" folks have conveniently manufactured the perfect distracter. By manipulating science and promoting a series of little green lies, they have managed to create the great green whopper that "sprawl" is destroying King County. The "smart growth" folks are trying hard to get their trains built so that they don't have to shell out the money for a car. As they get older, it gets harder and harder to pedal their bicycle to all the places they want to go. By legislatively forcing growth to where they live, they hope to some day have the density that justifies their trains.

As you consider the pros (there are only a few) and cons of these new regulations, keep in mind that the manufactured problem here is "growth" whereas the real problem is the unwillingness of the bureaucracy to provide the services required by that growth. The pretense of "saving" the environment has been manufactured to achieve what cannot be achieved directly. By accusing the rural citizens of destroying "nature" the focus is shifted away from the urban areas where the real destruction of nature has taken place. That may be good for those of you with a large urban constituency but it is patently unfair to the rural minority. Tyranny by the majority is not the vision of most who live in this county. Most people's reaction upon learning of the proposed ordinances is that these ordinances can't happen because we have laws against such blatant abuse of power. Unfortunately, many said that in 1990 when the current laws were imposed. The current ordinances were imposed and continue to destroy lives, property values and the environment in rural King County.

Lest you pass that last sentence off as an exaggeration, let us put some real faces with those claims. One life those laws have literally destroyed is that of young Summer Stone who

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was drowned when swept under a King County-placed large woody debris installation on the Cedar River. The efficacy of large woody debris has not been proven. Recent studies even indicate that it may do harm to fish habitat. It certainly is not worth the lives of our children. The loss of property values can be illustrated by the story of Marshall Brenden who owns property in the highlands east of Renton. Mr. Brenden purchased three lots totaling 18 acres. At the time of purchase, they were zoned for 9800-square-foot lots. In hindsight, Mr. Brenden should have subdivided immediately and created 80 lots but he did not. He decided to wait until he retired and had more time and his children were older and ready to build their own homes on the property. He mistakenly thought that King County would honor and protect the zoning that they had created. When the urban growth boundary was invented, it was gerrymandered around Mr. Brenden's property. His land touches that boundary but is on the rural side of the line. Mr. Brenden recently had to fight hard to get permission to build a house on his eight-acre lot. He was forced to set aside 4½ acres of that lot in order to get permission to build. Meanwhile, undeveloped five-acre lots within sight of Mr. Brenden's property but on the other side of the urban growth boundary are selling to developers for one million dollars. Mr. Brenden has lost three million dollars he was counting on for his retirement. He was planning on having land available for his children to build homes on. His American dream was sacrificed so that the smart growth proponents can attempt to justify their train and the bureaucrats can have an excuse for not providing any services. The May Valley Environmental Council has extensively documented the environmental destruction of May Creek due to the restrictions of the Sensitive Areas Ordinance. Agricultural land that began production in the late 1800s has been converted to swamp. Homes have been destroyed by the encroaching floodwaters that rise ever higher each year that May Creek is not maintained. The once-vibrant coho run is gone, victim of the clogged and silted channel. Erosion is rampant in the lower canyon area of May Creek. The bottom of the channel in the section that passes through Cliff Brousard's property has been lowered five feet in the fifteen years the Sensitive Areas Ordinance has been in place after having been stable in the forty preceding years.

Make no mistake: these new ordinances that purport to "save" rural King County have a very real destructive effect on the lives of rural property owners and the very environment they pretend to be saving.

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65% - 35% - 10%

The requirement forcing rural property owners to leave 65% of their land untouched and unmanaged is easily the most egregious of the proposed changes and the most blatant violation of private property rights. In his classic text *The Common Law*, Oliver Wendell Holmes describes property as having two fundamental aspects. The first is possession, which can be defined as control over a resource based on the practical inability of another to contradict the uses of the possessor. The second is title, which is the expectation that others will recognize rights to control a resource, even when it is not in immediate possession. He elaborates the differences between these two concepts, and proposes a history of how they came to be attached to individuals, as opposed to families or entities such as the church or the state.

According to Adam Smith, the expectation of profit from "improving one's stock of capital" rests on private property rights, and it is central to capitalism that property rights encourage the property holders to develop the property, generate wealth, and efficiently allocate resources based on the operation of the market. From this evolved the modern conception of property as a right, which is enforced by positive law, in the expectation that this would produce more wealth and better standards of living. You need only compare the United States to the rest of the world to understand how well that concept has worked. It is sad that as Russia and China work rapidly towards free-market capitalism, King County is working just as rapidly to institute its own brand of collectivism, at least in the rural areas of the County.

Socialism's fundamental belief is centered on a critique of private property rights, stating, in effect, that the cost of defending property is higher than the returns from private property ownership. This is a modern theory of property whose arguments are based on superior utility of result. Those superior results are yet to be achieved for any appreciable time or scale.

Communism argues that only collective ownership through a polity, though not necessarily a state, will assure the minimization of unequal or unjust outcomes, and that therefore all, or almost all, private property should be abolished. The results of that grand experiment are well documented. Two equal standards of living are established; a relatively high standard is achieved for the bureaucracy and ruling class while a much less robust standard is achieved for the majority of common folks. Hardly the desired outcome for a system promoted to minimize unjust outcomes.

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If you pass these ordinances with their 65% set-aside in place, you are removing ownership from the current landowner as surely as if you occupied the property and built a wall around it. Instead of guaranteeing the title (the construct that establishes ownership and control) to the property, which is supposed to be county governments' primary responsibility, [see the paragraph below that begins "We formed governments"] **you are bastardizing the concept of "title" to become the construct that removes ownership and control.** The landowner is left with no positive benefits of ownership of 65% of their property, only liabilities. The landowner must still pay property tax on property she cannot use. The landowner must carry liability insurance in case someone is injured on property over which she has no control. The landowner is left liable to implement whatever scheme the regulatory agencies concoct in the future. Since there is effectively no owner of the 65% portion, there is no way to prevent harm to the 35% portion emanating from the set aside area. We are referring to things like wildfires, flooding from blocked channels, noxious weeds, clandestine methamphetamine labs and homeless squatters. If the 65% were truly privately owned, common law would provide remedies to such problems. Landowners would, in fact, be better off if you simply expropriated the 65% and removed their liability for it.

We formed governments — federal, state, and local — in the United States in large part to provide for the common defense of property. Our Washington State Constitution begins:

ARTICLE I — DECLARATION OF RIGHTS

SECTION 1 — POLITICAL POWER

All political power is inherent in the people, and governments derive their just powers from the consent of the governed, and are established to protect and maintain individual rights.

"... governments ... are established to protect and maintain **individual rights.**" Protection of Individual rights, not collectivist rights, is government's job. That is your job as our elected representatives. If you are not going to do that job, but rather be the very entity from which we need protection, then we are better off with no government. The five hundred pages of new attacks on our uses of our properties fly in the face of the fundamental premise that this country, state, and county were built upon.

Do you really have enough faith in the intelligence, knowledge and good intentions of Ron Sims' bureaucrats to throw away 200 years of superior results and opt instead for a collectivist system? What if your ideological opponents should gain control of that system and

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suddenly say that “for the public good” Seattle and the other urban areas should be leveled and returned to 1850 conditions? The best available science argument for that solution is much stronger than the one that proposes “saving” just the rural area. The urban area is larger than the rural area and has a much more devastating effect on fish and wildlife.

The “smart growth” concept that says it is okay to live in cities and destroy “critical areas” as long as you force someone else to “save” their pristine critical areas is infantile rationalization and incredibly hypocritical. Forced environmentalism at the point of government’s gun is no different than state-mandated religion. There is probably more disagreement by scientists about the best available science of environmentalism than there is among theologians about mainstream religions. You are being asked to set policy for a few of us based on the faith of “scientists” employed by the bureaucracy, most of whom do not have property that will be affected. You are being asked to dramatically change the policies of ten years ago that were based on the faith of those same scientists. You will be asked in another seven years to once again change the rules based on changes in the faith of scientists within the bureaucracy. Real science is predictable and repeatable. It puts men on the moon, doubles life expectancy in a mere century, and finds the replacements for candles, whale oil and petroleum.

Most of environmental science, as it is currently practiced, is not repeatable and therefore cannot be predictive. It requires faith, primarily in statistics. Joel Best, author of the book *Damned Lies and Statistics*, gives us an interesting perspective of statistics:

“There are cultures in which people believe that some objects have magical powers; anthropologists call these objects fetishes. In our society, statistics are a sort of fetish. We tend to regard them as though they are magical, as though they are more than mere numbers. We treat them as powerful representations of the truth; we act as though they distill the complexity and confusion of reality into simple facts. We use statistics to convert complicated social problems into more easily understood estimates, percentages, and rates. Statistics direct our concern; they show us what we ought to worry about and how much we ought to worry. In a sense, the social problem becomes the statistics as true and incontrovertible; they achieve a kind of fetish-like, magical control over how we view social problems. We think of statistics as facts we discover, not as numbers we create.”

The estimates, percentages, and rates of statistics are the “ranges” that King County staff tell you in briefings are the message of science. They are not. They are the messages of statistics. They are no substitute for the facts themselves. Statistical analysis can be a useful tool to figure out where effort might be best placed in the search for scientific fact. Statistical analysis can identify possible correlation between events and actions, but only re-

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peatable, predictive science and true understanding should be considered when setting policy that will be enforced at the point of government's gun.

One problem with statistics is that the same set of statistics can be viewed from more than one perspective. During the Cold War, a two-car race (one American, one Soviet) took place. An American headline read "American car beats out Soviet competitor." A Russian newspaper headline read "Soviet car finishes second; American car is next-to-last." Much of the bureaucrats "best available science" is really just statistics with the Soviet slant applied.

Another problem that can creep into popular use of statistics is inappropriate extrapolation. Just because modern technology can identify solutions containing a few parts per trillion of some questionable compound, we cannot automatically extrapolate a crisis that requires more government intervention to solve. Mark Twain pointed out the problem rather humorously in his book *Life on the Mississippi*:

"Now if I wanted to be one of those ponderous scientific people, and 'let on' to prove what had occurred in the remote past by what had occurred in a given time in the recent past, or what will occur in the far future by what has occurred in the last year, what an opportunity here! In the space of one hundred seventy six years the Lower Mississippi has shortened itself two hundred forty five miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi River was upward of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing rod. And by the same token any person can see that seven hundred and forty two years from now, the Lower Mississippi will only be a mile and three-quarters long. **There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.**"

We regret to inform you that, if anything, statistics are more misused now than they were in Mark Twain's day. They certainly proliferate at a higher rate. While listening to staff tell you what science says and what it dictates that you force others to do, you might ask yourself whether they are relaying scientific fact or merely their spin of the best available statistics that support their point of view. You might also ask if they are living their life based on the statistics they are promoting. Those who really believe in saving the rural area will have purchased five or ten acres and be well on their way to saving it via the policies they promote. When they tell you that they can't afford to do that, see item 6 of the list of Warning Signals of unconstitutional takings in Appendix 1.

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It is somehow ironic that those who live in the concrete jungle of Seattle and surrounding cities would demand that their rural neighbors have no more than 10% impervious surface. We are currently allowed 20% on 5-acre lots. If the urban area lived by the rules they promote, a typical one quarter acre building lot would be allowed 1,089 square feet of house, driveway, access easements, etc. That's about the size of a small three-car garage. Some people move to the country so that their neighbors will not hassle them if they have more cars than will fit in that three-car garage. DDES soon informs them that any and all vehicles must be parked on impervious surface. We think it has something to do with ensuring that the oil that might drip from the vehicle moves to the nearest stream as quickly as possible when it rains. Evidently the experts that thought up the rule don't want the oil broken down by the microbes that inhabit our lawns. It is all a neat Catch-22. The only way to have and enjoy cars is to be able to afford to house them indoors in the urban area on the 50% of the lot that has both impervious concrete and impervious roof. Cars are anathema to "smart growth" so we guess that it makes as much sense as forcing all the people into the city.

Buffers

Sixty-five percent set-asides are the camel's nose under the tent. Buffers are the whole camel. As you read this section, remember that buffers are not wetlands, aquatic areas, steep slopes, landslide hazard areas, or channel migration zones. They are the perfectly useable and productive lands that happen to be near such critical areas. They are being condemned not because of what they are but where they are.

The aquatic area and wetland buffers get most of the press but the real sleepers are the wildlife buffers. Imagine, if you will, owning a ten-acre rural lot on which a spotted owl chooses to procreate. Most rural folks (in the absence of stupid laws) would be very happy that Mrs. Owl had chosen to accept their hospitality and raise her kids in their tree. But, at the insistence of King County, Mrs. Owl will prevent their use of any of their ten acres. The prescribed buffer for a spotted owl nest is 986 acres. The only pragmatic solution for most landowners faced with such a situation is "shoot, shovel, and shut up." The actual effect of the regulation then becomes the exact opposite of what was intended as far as the owl is concerned. Entire valleys or hillsides will be made off limits to humans by a single bird. The same bird, by the way, nests in power line towers in New Mexico with nary a tree in sight.

The wildlife buffers range from the absurd 986 acres of the spotted owl to a mere 7.6 acres for a rural red-tailed hawk. Urban red-tailed hawks, such as Pale Male who has lived and

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raised his kids at 927 5th Avenue, New York City for the past 12 years, must get along without any buffers. Peregrine falcons such as the pair that have been nesting on the Washington Mutual Tower in Seattle since 1994, get 72 acres. That poor old osprey family that is nesting in the cell phone tower in Bellevue gets a piddling 3.8 acres.

Where rural landowners really start losing ground (no pun intended) is when King County starts connecting all the isolated buffers together into “wildlife corridors.” That concept is straight out of the Wildlands Project, a concept being pushed by former Earth First! leader Dave Foreman and Dr. Reed Noss. We quote directly from their web site:

“We are providing a science-based agenda for establishing large-scale wildlands networks. We’ve distilled the vast body of science generated by the disciplines of landscape ecology and conservation biology into their essence—if the goal of conservation action is to sustain Nature in all its buzzing, blossoming, howling glory, then: Bigger is better. Connected is critical. Carnivores are key. But even **large wilderness cores are not enough; to facilitate the flow of life across the entire landscape, these cores must be linked by corridors of wild habitat that allow the unimpeded movement of wildlife and natural processes such as wildfire and spring floods.**”

The science director of the Wildlands Project is Reed Noss. His writings are included in the volume of Best Available Science provided by King County bureaucrats as justification for their proposals. He is defended vigorously by them in the “Official King County Response to Comments For Critical Area Ordinances, 2nd Round,” page 54. Dr. Noss has designed the science of the Wildlands Project to be consistent with their mission statement:

“The mission of the Wildlands Project is to protect and restore the natural heritage of North America through the establishment of a connected system of wildlands. The idea is simple. To stem the disappearance of wildlife and wilderness we must allow the recovery of whole ecosystems and landscapes in every region of North America. Recovery on this scale will take time—100 years or more in some places. This vision for continental renewal rests on the spirit of social responsibility that has built so many great institutions in the past and acknowledges that the health of our society and its institutions depends on wildness. The land has given much to us; now it is time to give something back—to allow nature to thrive once more and to restore the links that will sustain both wilderness and the foundations of human communities.”
[http://www.twp.org/inside_wp/index_mission.html]

Key to the implementation of the Wildlands Project is the return of large meat-eating predators to the landscape as stated in their “Vision”:

“We are ambitious: we live for the day when grizzlies in Chihuahua have an unbroken connection to grizzlies in Alaska; when wolf populations are restored from Mexico to the Yukon; when vast forests and flowing prairies again thrive and support their full as-

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semblage of native plants and animals; when humans dwell with respect, harmony, and affection for the land; when we come to live no longer as conquerors but as respectful citizens in the land community.”

Dr. Noss himself has said, "Many ecologists (myself included) would just as soon see huge areas of land kept off limits to human activities of any kind." (Noss, R. 1995. Maintaining Ecological Integrity in Representative Reserve Networks, World Wildlife Fund Canada Discussion Paper. p. 12.) "The **only hope of the Earth** is to withdraw huge areas as inviolate natural sanctuaries from the depredations of modern industry and technology. **Move out the people and cars. Reclaim the roads and the plowed lands.**" [Dave Foreman in his 1990 book, *Confessions of an Eco-Warrior*] "**Does all the foregoing mean that Wild Earth** [the official magazine of The Wildlands Project] **and The Wildlands Project advocate the end of industrialized civilization? Most assuredly. Everything civilized must go...**" [John Davis, editor of Wild Earth magazine]

Is The Wildlands Project also the "Vision" of King County? It may be the vision of the bureaucrats and Mr. Sims, but we don't believe it is the vision of the majority of the voters in King County. We know for sure it is not the vision of the residents of rural King County where these rules will actually apply.

Viewed against the backdrop of the wildlife buffers, the aquatic areas and wetland buffers of 165 feet and 300 feet respectively, seem almost innocuous. That is hardly the case. Consider that a typical one-acre bog or fen will consume an additional 11.5 acres of perfectly useable land for its buffer. A two-foot wide fish-bearing stream will consume an additional 330 feet of buffer plus two additional 15-foot no-development zones.

The disparity between the size of the buffers in the rural areas as opposed to the urban areas is criminal. King County bureaucrats would like you to believe that the Growth Management Act's requirement for Best Available Science (BAS) to be used when setting land use regulation is responsible for the disparity. That is not true and they even admit it in the fine print. See page 39 of the Official King County Response to Comments For Critical Areas Ordinances, 2nd Round (KCRC) for the following quote, "Best available science is the process of identifying the current, most applicable (to King County conditions) science from a wide range of literature and its findings. Best available science (**BAS**) **does not differentiate between rural and urban areas.**" The truth is that science does indeed differentiate between poor quality watersheds as commonly found in urban areas and better quality watersheds as commonly

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found in rural areas. "Critical area protection is particularly necessary in watersheds of poor environmental quality," – KCRC page 18. "... **for wetlands in general within an urbanizing area, BAS suggests that wetland functions will definitely decline** with only fixed buffers of 25 to 100 ft." – Best Available Science, Volume II, page 2-55.

The proposed ordinances include a map of King County Basin Conditions. The map shows that the basin conditions of the far western portions of King County are low. These are generally the urban areas. The basin conditions of the eastern portions of King County are high. These are generally rural areas. If the intent of the ordinances were to protect and enhance the environment, restrictions would be strengthened on the urban areas where the condition of the basins is low. Restrictions would be maintained constant, or relaxed, on the rural areas where the condition of the basins is high. Instead the ordinances keep restrictions in urban areas essentially constant and greatly increase the restrictions in rural areas.

From the King County web site news for May 27, 2004 we read:

"Among smaller monitored lakes, the rural lakes were in the best condition, with 62.5 percent of them classified in very good condition, and just 37.5 percent in moderate condition. None were in poor condition. About 20 percent of city and non-city "urban" lakes were in poor condition, while half were classified in moderate condition, and one-third were in very good condition."

So the urban areas where the worst environmental damage has occurred get the least costly regulations while the rural areas where the landowners have taken the best care of their land get stuck with the regulations that cost the most. If BAS didn't decide that, who did? **It was decided by** the Critical Areas Ordinance Policy Group – **Stephanie Warden**, Director, DDES; **Wally Archuleta**, Managing Engineer, DOT; **John Briggs**, Deputy Prosecutor; **Linda Dougherty**, Division Director, DOT; **Daryl Grigsby**, Division Director, DNRP; **Mark Isaacson**, Assistant Director, DNRP; **Joe Miles**, Division Director, DDES. Guess where they live? The rules certainly won't affect their properties.

While property owners in the rural area are forced to give up 65% of their property and live with massive regulation of the rest, the urban majority of this democracy enjoy the fruits of the environmental destruction of their critical areas. Their house values continue to rise, their businesses and industries continue to thrive, and taxes paid by rural residents help them to build new infrastructure. People from around the world flock to the cities of King County where they can enjoy all the benefits of urban life while being only steps away from communing with

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nature in the wonderful open space their rural servants are forced to provide. Seattle is the only city in the world where you can move to the city to enjoy the country.

It is a sad day to be in the rural minority in King County. After a long history of providing the food, coal, and timber to make Seattle and its sister cities of King County what they are, rural residents are being made to appear the villains in order to assuage the environmental guilt of the urban elite and justify the malfeasance of the bureaucracy. It makes us yearn for a good king or benevolent dictator.

Meanwhile, the currently evolving science of buffers is finding that no-touch buffers are, in fact, harmful. If you don't have time to read the review of best available science in Appendix 4 of this document, make the short drive out to May Valley. Fifteen years of no-touch buffers there have obliterated the once plentiful run of coho salmon that were planted there in 1939 by the Issaquah hatchery. Dredging of that valley by the WPA in 1939-40 changed May Creek into a year-around stream and uncovered the gravel necessary to support spawning. The fish flourished while the landowners were able to manage their riparian areas. The Sensitive Areas Ordinance in 1990 and the no-touch buffers mandated by that law have turned May Creek into a vegetation- and sediment-choked swamp that no longer supports a coho run of more than a handful. No-touch means noxious weeds such as reed canary grass and blackberries dominate. Wet areas become willow swamps. The willow grows in and across the channel, traps any sediment coming downstream and turns the cool flowing stream needed by salmon into a warm-water swamp. The preceding is not conjecture or hypothesis. It is exactly what has happened in numerous watersheds in King County as a result of the current regulations. The bureaucrats are correct when they say the regulations need to be changed, but the restrictions need to be eased to allow better management, not added to, as proposed. No-touch in the drier areas means voluminous scrub/shrub growth interspersed with noxious, invasive weeds and the increased likelihood of wildfires.

Science: The Good, The Bad and The Quasi

When governments make traditional uses of private property illegal, organizations such as ours are born. The executive departments would like you to believe that science is on their side. The Growth Management Act requires counties and cities to "include" the best available science in developing policies and regulations that deal with critical areas.

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“RCW 36.70A.172

Critical areas -- Designation and protection -- Best available science to be used.

(1) In designating and protecting critical areas under this chapter, counties and cities shall include the best available science in developing policies and development regulations to protect the functions and values of critical areas. In addition, counties and cities shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries.”

It does **not** require that such science be the only substantive item used in developing those regulations. Social, economic, political, and legal considerations should carry as much or more weight than science and are in fact required by the same law. Those other aspects are conspicuously absent in King County’s currently proposed Critical Areas Ordinance.

“**Science** \Sci"ence\, n. [F., fr. L. scientia, fr. sciens, -entis, p. pr. of scire to know. Cf. Conscience, Conscious, Nice.] 1. Knowledge; knowledge of principles and causes; ascertained truth of facts.

“2. Accumulated and established knowledge, which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws; knowledge classified and made available in work, life, or the search for truth; comprehensive, profound, or philosophical knowledge.

“3. Especially, such knowledge when it relates to the physical world and its phenomena, the nature, constitution, and forces of matter, the qualities and functions of living tissues, etc.; -- called also natural science, and physical science.

“Note: Science is applied or pure. Applied science is a knowledge of facts, events, or phenomena, as explained, accounted for, or produced, by means of powers, causes, or laws. Pure science is the knowledge of these powers, causes, or laws, considered apart, or as pure from all applications. Both these terms have a similar and special signification when applied to the science of quantity; as, the applied and pure mathematics. Exact science is knowledge so systematized that prediction and verification, by measurement, experiment, observation, etc., are possible. The mathematical and physical sciences are called the exact sciences.”

Source: *Merriam-Webster Medical Dictionary*, © 2002 Merriam-Webster, Inc.

“Real science” to most of us is knowledge and understanding gained via the formal procedure known as the scientific method. It proceeds in an orderly fashion from observation to hypothesis to experiments. The results of the experiments lead either to a changed hypothesis or to the hypothesis becoming theory and thus a usable basis for human management or applied technology. Real science is predictive and testable and repeatable. It puts men on the moon and food on our tables.

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There is simply not enough real science available to make relevant land use decisions based solely on science. There is neither the time nor the money to develop that science. The very nature of land uses and the infinite variety of variables involved make repeatability impossible. Data gained from one area under one set of circumstances may not be relevant in similar but different areas. Often the variables that cause the disconnect are obvious even to laymen and cause the original science to be labeled “junk science” when it is indiscriminately applied.

Since there isn't much applicable real science, land use planners are left using a second level of science based upon observational studies and surveys. Such observational studies can prove helpful but caution must be used when writing regulations based upon them as they can never be truly predictive of outcomes. King County **loves** studies. We have heard Pam Bissonette expound at length to the state legislature about how much money DNRP spends to commission them.

Because observational science is not good at predicting outcomes, any regulations based on that science must be reviewed regularly and modified appropriately to have any chance of success. King County is proposing massive new regulation in the Critical Areas Ordinance without even pretending to review the effects and outcomes of the current law.

The limitations of available real science are bad enough without ignoring the good science that is available. The Washington State Office of Community Development publishes a document called “Citations of Recommended Sources of Best Available Science” for cities and counties to use when complying with the GMA. Dr. James Buell reviewed the latest edition and had this to say. “Of more than 80 annotated sources having to do with fresh water and riparian systems and wildlife habitats, including uplands, a mere handful would qualify as ‘science’.

However, there are many valid and applicable scientific studies ‘out there’, which should have been included in this annotated bibliography. This list is anything but a comprehensive collection of Best Available Science”. Other credible scientists have made similar statements about the science listed as the basis for the CAO. The people who work for King County are human and have agendas of their own. They obviously have been unable to resist the temptation to wrap themselves in the cloak of scientific credibility in order to achieve their personal political agendas.

One of the traps that King County seems to have fallen into is the use of reviews and compendiums as their science instead of using the source documents of those who actually did the research. The Washington Department of Fish and Wildlife publishes a document enti-

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tled "Management Recommendations for Washington's Priority Habitats: Riparian" which illustrates this problem well. This document is the buffer bible. It contains a table that purports to give the buffer widths needed to accomplish various desirable outcomes and lists the source documents used. Unfortunately, it has three major problems:

It averages the buffer widths from the various source documents. There is no scientific or technical basis for the use of averaging. The best way to use the research is to choose one or more scientific studies which apply particularly well to the site-specific resources involved and use those studies for guidance.

The title of the table is "Riparian habitat buffer widths needed to retain various riparian habitat functions." But the values in the table are actually the maximum distances studied, and are nearly always significantly in excess of that required for complete or nearly complete protection of 100% of fish and wildlife needs.

The majority of studies relied upon in the table focused on old-growth and late successional forests, but the riparian buffer restrictions in the CAO will apply almost entirely to second- and third-growth wooded lands or agricultural, urban, or industrial areas. Even properly arrived at conclusions from such studies would only be applicable if the objective is that the regulated lands ultimately evolve into old-growth areas; the forest primeval, if you will. Is that how you envision our land ending up?

King County's misuse of the science is blatantly political. It does not stand up to even cursory examination by private sector experts. As Dr. Teresa Zeitler says in her technical review of the CAO: "'Best Available Science' does not mean indiscriminate application of scientific studies to situations where they don't apply. That's 'Bad Science'" She further states that King County's efforts at Best Available Science "truly represent no more than the equivalent of a high school or undergraduate book report."

Dr. Michael Crichton, who arguably writes and speaks better than most scientists, presented a lecture on January 17, 2003, that outlines his observations of how hard science and public policy have degenerated to the sad state they find themselves in today. His lecture is titled "Aliens Cause Global Warming" and should be read at this point as it will be referred to in future text. It is included in Appendix 3.

Perhaps a look at "Best Available Science, Volume I, A Review of Science Literature" would be instructive. The large wetland buffers being proposed for rural King County are one

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of the more contentious points. Open BAS, Volume I to page 9-5 and start reading as we pull a few quotes from that and succeeding pages.

“In general, the scientific literature on buffers is clear and consistent in that there are three primary factors that are critical in determining adequate buffer widths: (1) type of wetland and functions it provides; (2) type of adjacent land use; and (3) characteristics of the buffer (McMillan 2000, per. com.). Consequently, **wide ranges of buffer widths are recommended by scientists** and engineers for the protection of wetlands and respective functions (Brown et al. 1990; Castelle et al. 1992a; Castelle et al. 1994; McMillan 2000).

“Recent literature **suggests** that buffers alone, although important to help minimize impacts, might be **insufficient to fully safeguard** all the varied functions (Correll 1997; McMillan 2000; Thom et al. 2001). Buffer **effectiveness and benefits also have been found to vary** depending on their widths, vegetation, wetland functions, and geographic context (Castelle et al. 1992). Specifically, wetland hydrology, groundwater re-charge/discharge and plant and animal habitat functions may not be well protected by buffers alone because these functions are in large part driven by adjoining area and larger watershed conditions (Reinelt et al. 1998; Azous and Cooke 2001; Richter and Azous 2001b).

“Under some rare circumstances in which buffers have erosive soils and little or no vegetation, **buffers may even be detrimental**, in that they may provide sediment sources to lakes, ponds, and wetlands as opposed to removing them (Dillaha and Inamdar 1997).

“Also, **not all wetland species benefit from buffers that are wooded**. Most shorebirds, for example, shun small wetlands surrounded by trees (Adamus pers. com.) although other species indigenous to the local area would benefit from forested buffers.

“**Many questions remain unanswered regarding the appropriate width, use, and adequacy of buffer zones** (Addiscott 1997). Most **wetland buffers implemented through development regulations** assume that a given type of wetland will support a mix of functions. This assumption **may result in homogenizing wetlands, making it unlikely individual wetlands will continue to sustain any superior or unique functions over time**. Moreover, fixed buffer protection freezes current wetland conditions (or historic conditions) rather than acknowledging that wetlands are dynamic evolving systems in which both short and long-term natural processes combine to create an array of functions that vary over time.

“Currently there are no guarantees of transitional areas between buffers and surrounding land use to minimize “edge effect.” Abrupt edges therefore enable predators (of woodland birds such as cowbirds) to access nests etc.” [What is a buffer if not a transitional area between land uses?]

Does this material sound like it backs up the words of staff when they say to you, “The science says 300-foot buffers are the minimum for category 1 wetlands?” They don’t even have the consensus that Dr. Crichton ridiculed, let alone the repeatable, predictive attributes

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demanded by real science! Let's look somewhere else in case this section is just a big mistake. Turn to page 8-28 and follow along as we quote some of the verbiage about red-tailed hawks. Remember that the buffer for a rural red-tailed hawk nest is 7.6 acres.

“The red-tailed hawk is the most frequently seen large hawk in the Pacific Northwest. Red-tailed hawks **occur and breed in every county in Oregon and Washington** (Gabrielson and Jewett 1940; Jewett et al. 1953; Larrison and Sonnenberg 1968; all as cited in Jackman and Scott 1975). It is the only large buteo regularly found west of the Cascades and is the most abundant one east of them (Jackman and Scott 1975). However, **there are no estimates of population numbers or densities for these regions.**

“Robbins et al. 1986 (as cited in Preston and Beane 1993) report that **breeding populations of redtailed hawks increased during the period 1965-1979 in nearly all regions of North America**, especially Ohio, Kentucky, Wisconsin, Minnesota, California, and British Columbia.

“Nest site characteristics for this species vary widely with vegetation and topography. Preston and Beane (1993) note that “common characteristics of all sites include an unobstructed access to nests from above and a commanding view of the adjacent environment.” **Nest sites are often tall and in open areas** and often close to water. They also note that “typically, several nests from previous years are visited by both members of the pair. Two or more nests are often repaired, and greenery may be placed on these before a single nest is finally chosen (Bent 1937).” **[So rural property owners are going to be asked to give up 7.6 acres for a nest that is not being used!]** Janes (1994) found that “red-tailed hawks abandoned areas with perches at moderate densities (0.3-0.6 perch/ha) more often than expected by chance while preferentially retaining areas with greater perch densities.”

“Stout et al. (1998) described and compared red-tailed hawk nesting habitat in urban, suburban, and rural locations in southeast Wisconsin. They found that **productivity** (defined as one or more fledglings that survive to bandable age, or 20-35 days) **did not differ among urban, suburban, or rural nest sites used by breeding red-tails.**

“Janes (1984b) evaluated the effects of human activity on red-tailed hawks nesting in north-central Oregon by classifying territories as (1) with and without dwellings, (2) with and without paved roads, and (3) with nests placed within 656.2 ft (200 m) of roads, or not so placed. **He reported that “normal human activity” (defined as the presence of dwellings or frequently traveled roads) did not affect red-tailed hawk reproductive success, that the presence of dwellings or frequently traveled roads or the location of nests near roads had no significant effects.** He did not, however, study the effects of more obtrusive activities such as clearing and grading.” [So we are to assume that he would have found significant effects from those activities? Come on. That last sentence is pure deceit.]

“Few studies have documented the response of red-tailed hawks to development, especially in the Pacific Northwest.

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“A study in New York by Minor et al. (1993) showed that nesting densities of red-tailed hawks in an urban/suburban area did not differ statistically from nesting densities in other studies from non-urban areas. Furthermore, there was no significant difference between the mean productivity of the non-urban studies and the mean productivity in this study. The implication of these two sets of statistics is that with adequate nest sites, red-tailed hawks can maintain populations alongside human-made habitat conditions.

“Unpublished data by an informal [Why even read any further?] King County monitoring study indicate that buffers of 25-150 ft are not adequate to protect nesting red-tailed hawks. Eleven nests were observed prior and subsequent to clearing and grading with buffer establishment. The fate of two nests went undetermined, one nest was destroyed during building, and two nests remained successful where construction plans were abandoned. The six remaining nests were all deserted.” **[Would it be possible to infer that maybe the hawks are simply smart enough to move to a new neighborhood while theirs is under construction?]** “In five of these instances, a buffer ranging between 25 and 150 ft was set, and in two of those cases, the actual buffer was significantly smaller (81 versus 150 ft, and 50-75 versus 150 ft). The sixth nest had no development activity within 650 ft; as with the other nests, it is unknown if the construction activities were the sole cause of nest abandonment. It is also unclear at what time frame construction activities were occurring; however, best times for construction tend to coincide with nesting.”

Are you starting to see a pattern? If you don't read the words, staff will be happy to tell you something that isn't supported even by the quasi-science being used. They are really proposing a multi-billion dollar science project funded by rural landowners in the hopes that they can somehow find some real science to support their coercive utopian vision for rural King County.

UW professor Dr. Robert G. Lee, in his book *Broken Trust, Broken Land: Freeing Ourselves from the War over the Environment*, states the following, “This book is a search for truths about how Americans are losing themselves in their attempt to solve environmental problems...I want to show how values and beliefs are embedded in much that passes as ecology, environmental science, or social science. I also want my readers to understand that conflicts over the environment are primarily moral and political issues...”

Environmental land use regulation is about governmental abuse of our property rights, not science. Forbidding our use of 65% of our land is not science, it is government gone crazy. There is no science exception to the Fifth Amendment or Article 1, Section 16 of the Washington State Constitution.

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If you want to read about science that actually meets the criteria of WAC 365-195-905 "Criteria for determining which information is the 'best available science'," we have included a literature review and bibliography as Appendix 4. If you pass these ordinances as written, you will not be able to claim you did not have access to appropriate science when the lawsuits rain down.

The WAC provides for the possibility of inadequate scientific information to support regulations.

“WAC 365-195-920 Criteria for addressing inadequate scientific information.

Where there is an absence of valid scientific information or incomplete scientific information relating to a county's or city's critical areas, leading to uncertainty about which development and land uses could lead to harm of critical areas or uncertainty about the risk to critical area function of permitting development, counties and cities should use the following approach:

“(1) A "precautionary or a no risk approach," in which development and land use activities are strictly limited until the uncertainty is sufficiently resolved; and

“(2) As an interim approach, an effective adaptive management program that relies on scientific methods to evaluate how well regulatory and nonregulatory actions achieve their objectives. Management, policy, and regulatory actions are treated as experiments that are purposefully monitored and evaluated to determine whether they are effective and, if not, how they should be improved to increase their effectiveness. An adaptive management program is a formal and deliberate scientific approach to taking action and obtaining information in the face of uncertainty. To effectively implement an adaptive management program, counties and cities should be willing to:

“(a) Address funding for the research component of the adaptive management program;

“(b) Change course based on the results and interpretation of new information that resolves uncertainties; and

“(c) Commit to the appropriate timeframe and scale necessary to reliably evaluate regulatory and nonregulatory actions affecting critical areas protection and anadromous fisheries.”

King County has been following option number 1 with disastrous consequences. It is time to follow option number 2. You could, in fact, treat rural King County as the large science project that Mr. Sims and his staff seem to be promoting. That experiment should be paid for by all the residents of the County, not just the landowners whose property uses are being confiscated in the name of science.

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Farm and Rural Stewardship Plans

Farm and rural stewardship plans are being touted by Staff as the way around the onerous fixed regulations. They are touted as being highly flexible, allowing substantial reductions in buffer width, for example, or providing the ability to clean a ditch without a Clearing and Grading permit. As with most things, the devil is in the details. And we don't have any; details that is!

The details of the requirements for such plans will only be determined after the ordinances are passed. They will be in the form of "public rules" that will be written by DNRP and DDES. That is in direct violation of state law.

"D. Except for other agencies with authority to implement specific provisions of this title, the department shall have the sole authority to issue official interpretations ((~~of~~)) and adopt public rules to implement this title, ((~~pursuant to~~)) in accordance with K.C.C. chapter 2.98."

The paragraph quoted above is from the top of page 8, "CAO Transmittal Package Part 1." DDES has added a significant underlined phrase to the text that is located in Section 2 – Administration and Review Authority:

The chapter 2.98 compliance wording has not, in the past, prevented DDES' public rules from, in actuality, being new official land use controls. The executive's new proposals offer unlimited scope for DDES to completely control private land use in unincorporated King County, particularly in the Rural Area.

You should read carefully the Planning Enabling Act, RCW.36.70.020.11 and 36.70.550 through 670 [reprinted below]. These RCW sections specifically state that anything and everything that constitutes land use management is an "official control", and that all such controls must be legislatively adopted. And, that legislative responsibility can not be delegated to anyone, including the administrative branch. Official controls must be adopted by ordinance, not by public rule. Public rules are valid only when adopted under the oversight of the legislative body.

"RCW 36.70.020 - Definitions

2 "Board" means the board of county commissioners.

4 "Commission" means a county or regional planning commission.

8 "Department" means a planning department organized and functioning as any other department in any county.

11 "Official controls" means legislatively defined and enacted policies, standards, precise detailed maps and other criteria, all of which control the physical development of a county or any part thereof or any detail thereof, and are the means of translating into

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regulations and ordinances all or any part of the general objectives of the comprehensive plan. Such official controls may include, but are not limited to, ordinances establishing zoning, subdivision control, platting, and adoption of detailed maps.

“RCW 36.70.550 - Official controls.

From time to time, the planning agency may, or if so requested by the board shall, cause to be prepared official controls which, when adopted by ordinance by the board, will further the objectives and goals of the comprehensive plan. The planning agency may also draft such regulations, programs and legislation as may, in its judgment, be required to preserve the integrity of the comprehensive plan and assure its systematic execution, and the planning agency may recommend such plans, regulations, programs and legislation to the board for adoption.

“RCW 36.70.560 - Official controls — Forms of controls.

Official controls may include:

- 1 Maps showing the exact boundaries of zones within each of which separate controls over the type and degree of permissible land uses are defined;
- 2 Maps for streets showing the exact alignment, gradients, dimensions and other pertinent features, and including specific controls with reference to protecting such accurately defined future rights of way against encroachment by buildings, other physical structures or facilities;
- 3 Maps for other public facilities, such as parks, playgrounds, civic centers, etc., showing exact location, size, boundaries and other related features, including appropriate regulations protecting such future sites against encroachment by buildings and other physical structures or facilities;
- 4 Specific regulations and controls pertaining to other subjects incorporated in the comprehensive plan or establishing standards and procedures to be employed in land development including, but not limited to, subdividing of land and the approval of land plats and the preservation of streets and lands for other public purposes requiring future dedication or acquisition and general design of physical improvements, and the encouragement and protection of access to direct sunlight for solar energy systems.

“RCW 36.70.570 - Official controls — Adoption.

Official controls shall be adopted by ordinance and shall further the purpose and objectives of a comprehensive plan and parts thereof.

“RCW 36.70.580 - Official controls — Public hearing by commission.

Before recommending an official control or amendment to the board for adoption, the commission shall hold at least one public hearing.

“RCW 36.70.590 - Official controls — Notice of hearing.

Notice of the time, place and purpose of the hearing shall be given by one publication in a newspaper of general circulation in the county and in the official gazette, if any, of the county at least ten days before the hearing. The board may prescribe additional methods for providing notice.

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“RCW 36.70.600 - Official controls — Recommendation to board — Required vote.

The recommendation to the board of any official control or amendments thereto by the planning agency shall be by the affirmative vote of not less than a majority of the total members of the commission. Such approval shall be by a recorded motion which shall incorporate the findings of fact of the commission and the reasons for its action and the motion shall refer expressly to the maps, descriptive and other matters intended by the commission to constitute the plan, or amendment, addition or extension thereto. The indication of approval by the commission shall be recorded on the map and descriptive matter by the signatures of the chairman and the secretary of the commission and of such others as the commission in its rules may designate.

“RCW 36.70.610 - Official controls — Reference to board.

A copy of any official control or amendment recommended pursuant to RCW [36.70.550](#), [36.70.560](#), [36.70.570](#) and [36.70.580](#) shall be submitted to the board not later than fourteen days following the action by the commission and shall be accompanied by the motion of the planning agency approving the same, together with a statement setting forth the factors considered at the hearing, and analysis of findings considered by the commission to be controlling.

“RCW 36.70.620 - Official controls — Action by board.

Upon receipt of any recommended official control or amendment thereto, the board shall at its next regular public meeting set the date for a public meeting where it may, by ordinance, adopt or reject the official control or amendment.

“RCW 36.70.630 - Official controls — Board to conduct hearing, adopt findings prior to incorporating changes in recommended control.

If after considering the matter at a public meeting as provided in RCW [36.70.620](#) the board deems a change in the recommendations of the planning agency to be necessary, the change shall not be incorporated in the recommended control until the board shall conduct its own public hearing, giving notice thereof as provided in RCW [36.70.590](#), and it shall adopt its own findings of fact and statement setting forth the factors considered at the hearing and its own analysis of findings considered by it to be controlling.

“RCW 36.70.640 - Official controls — Board may initiate.

When it deems it to be for the public interest, the board may initiate consideration of an ordinance establishing an official control, or amendments to an existing official control, including those specified in RCW [36.70.560](#). The board shall first refer the proposed official control or amendment to the planning agency for report which shall, thereafter, be considered and processed in the same manner as that set forth in RCW [36.70.630](#) regarding a change in the recommendation of the planning agency.

“RCW 36.70.650 - Board final authority.

The report and recommendation by the planning agency, whether on a proposed control initiated by it, whether on a matter referred back to it by the board for further report, or whether on a matter initiated by the board, shall be advisory only and the final determination shall rest with the board.

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“RCW 36.70.660 - Procedures for adoption of controls limited to planning matters.

The provisions of this chapter with references to the procedures to be followed in the adoption of official controls shall apply only to establishing official controls pertaining to subjects set forth in RCW 36.70.560.

“RCW 36.70.670 - Enforcement — Official controls.

The board may determine and establish administrative rules and procedures for the application and enforcement of official controls, and may assign or delegate such administrative functions, powers and duties to such department or official as may be appropriate.”

Years ago one of our members was involved in a hearing examiner case in which what was then called BALD [Building and Lands Development – now DDES] admitted to not following correct procedure in the adoption of public rules. She was also involved in a Court of Appeals case in which King County’s ability to deny short plats unless the applicants constructed a mile of public road, was denied. BALD was so anxious that the case not set a precedent, due to a footnote by the court about an unconstitutional taking, that they asked the landowners to join with the county and ask for non-publication of the case so that no precedent could be set. In return the county would not appeal to the Supreme Court and would go ahead and process the short plats. Since the landowners just wanted their short plats, they agreed. The point is, in the past BALD/DDES has not been punctilious about following rules. The Council should keep the control it is allocated by state law.

Force DNRP and DDES to publish the full text of the requirements that farm and stewardship plans will have to comply with now. Let there be debate. If the plans really are an improvement over the fixed regulations, have them prove it. If they are the giant “Gotcha” requiring 85% native vegetation retention as reported by Harry Reinert, you need to know that before you vote.

Critical Aquifer Recharge Areas (CARA)

Official research discloses no significant environmental impacts from hundreds of years of indiscriminate, unsupervised land uses in unincorporated King County. King County's Comprehensive Plan states that, with the exception of a stretch of the Duwamish River, which still supports one of the state’s major salmon runs, "All rivers and streams in the County are classified either A (excellent) or AA (extraordinary)." The area's water quality meets all the primary

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and secondary state and federal drinking water standards, according to the Redmond-Bear Creek Ground Water Management Plan (RBC), which also says that "There has not been a reported incident of groundwater contamination related to pesticides or fertilizer practices in King County". After all those years of unregulated land practices that resulted in no contamination, now - with extreme downzoning and massive regulation - this new Critical Areas Ordinance drops this huge load on us.

At the ag hearing on the CAO, responsibility for regulatory requirements was attributed to state and federal government regulations. The RBC is very enlightening as to the role King County plays in higher-level government requirements: "King County and cities will jointly petition Ecology to designate Ground Water Management Areas as Environmentally Sensitive Areas. . ." Since CARA includes home heating oil tank super-controls, another RBC quote is pertinent: "Local jurisdictions are prohibited by Chapter 90.76 RCW from assessing additional annual tank fees unless an Environmentally Sensitive Area is designated." So now King County will have a new sensitive, or critical, area to slap us with. And slap it does, even though it ignores another state law, RCW 36.36.020, which **requires resident citizens to vote to create aquifer protection districts:**

“RCW 36.36.020

Creation of aquifer protection area -- Public hearing -- Ballot proposition.

The county legislative authority of a county may create one or more aquifer protection areas for the purpose of funding the protection, preservation, and rehabilitation of subterranean water.

“When a county legislative authority proposes to create an aquifer protection area it shall conduct a public hearing on the proposal. Notice of the public hearing shall be published at least once, not less than ten days prior to the hearing, in a newspaper of general circulation within the proposed aquifer protection area. The public hearing may be continued to other times, dates, and places announced at the public hearing, without publication of the notice. At the public hearing, the county legislative authority shall hear objections and comments from anyone interested in the proposed aquifer protection area.

“After the public hearing, the county legislative authority may adopt a resolution causing a ballot proposition to be submitted to the registered voters residing within the proposed aquifer protection area to authorize the creation of the aquifer protection area, if the county legislative authority finds that the creation of the aquifer protection area would be in the public interest. The resolution shall: (1) Describe the boundaries of the proposed aquifer protection area; (2) find that its creation is in the public interest; (3) state the maximum level of fees for the withdrawal of water, or on-site sewage disposal, occurring in the aquifer protection area, or both; and (4) describe the uses for the fees.

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“An aquifer protection area shall be created by ordinances of the county if the voters residing in the proposed aquifer protection area approve the ballot proposition by a simple majority vote. The ballot proposition shall be in substantially the following form:

"Shall the . . . (insert the name) aquifer protection area be created and authorized to impose monthly fees on . . . (insert "the withdrawal of water" or "on-site sewage disposal") of not to exceed . . . (insert a dollar amount) per household unit for up to . . . (insert a number of years) to finance . . . (insert the type of activities proposed to be financed)?

“Yes.
No”

“If both types of monthly fees are proposed to be imposed, maximum rates for each shall be included in the ballot proposition.

“An aquifer protection area may not include territory located within a city or town without the approval of the city or town governing body, nor may it include territory located in the unincorporated area of another county without the approval of the county legislative authority of that county.”

Note that this is a fund-raising scheme. The RCW says nothing about actually protecting any aquifers!

“The majority of county land is probably a groundwater recharge area.” (BAS Vol.I, p.6-1) State law and former King County policy limited "protection" to SOLE SOURCE AQUIFERS and WELLHEAD PROTECTION DISTRICTS. Section 23 of CAO's Part 1 deliberately has removed significant wording, thereby allowing DDES/DNRP the ability to exercise their land management to a much greater extent than intended by state law or current county wording. The statement made at the March 23, 2004, Growth Management and Unincorporated Areas Committee meeting that, “a net loss of groundwater recharge with the removal of forest cover,” is refuted by a 1988 Island County aquifer hearing at which three DOE scientists testified “When you remove the trees you get more water - it’s been demonstrated all over the U.S.” Yet CARA requires maximum tree retention even though tree clearing, properly done, contributes to maximum aquifer recharge because trees' canopies prevent rain from reaching the ground, and trees transpire [To evaporate (moisture) from living cells] large amounts of water.

It’s interesting that the very brief CARA assessment on p. 4-8 of BAS Vol. II speaks of stormwater being “transported horizontally”, while BAS Vol. I, Chapter 6, which has 29 pages

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of analysis, speaks only of "downward" and "upward", which is emphasized by the following quote from the Redmond/Bear Creek Valley Groundwater Management Plan of 1994 p. 3-16....."recharge only occurs where water reaches an aquifer by surface water infiltration, and where there is a downward component of hydraulic head. However, the presence of a downward component of hydraulic head cannot be determined without extensive research on water levels...Therefore....a downward component of hydraulic head is assumed to be present in all areas." Are we to assume, therefor, that every inch of King County should be a CARA?

Despite Ecology's saying "No problem" when Metro buses have accidentally spilled hundreds of gallons of fuel, CARA requires both underground, and in many instances above-ground home heating oil tanks, to be removed or decommissioned when "any development proposal in a critical aquifer recharge area" is applied for.

On-site septic systems of less than one acre - this should be 35,000 square feet due to the large number of previously and currently legal vacant unsewered lots of that size outside the urban areas - are prohibited if you can't meet specific requirements for nitrate-nitrogen, even though the government is encouraging throwing thousands of fish carcasses into streams to build up nitrogen.

CARA calls for us landowners to pay for a special, expensive critical areas report, including a hydrogeologic site evaluation, in order to request a removal from the encompassing, non-scientific, blanketing CARA critical area designation. Once again, we private landowners are forced to pay for the science the county skipped or ignored. DDES should hold new hearings later, after all designations are made, maps attached, all reports' criteria set forth, and the public has had time to absorb this over-size new regulatory ordinance.

When executive staff member Karen Wolf said, during the March 18, 2004, meeting of the Natural Resources and Utilities Committee, that the Executive's water policies/regs are "to discourage growth in the Rural Area . . .", she should have said "to discourage growth that complies with Council-adopted Rural Area zoning densities in the Comprehensive Plan." It was also misleading to speak of "allowing" an Exempt Well (under State law) in the Rural Area "to serve up to six homes" without mentioning that the landowner must do that - he must set up a public water system to serve any new rural subdivision - and DDES counts short plats as subdivisions despite short plats being exempt under SEPA, which is one of the drivers for these new policies. That's a huge impact to a rural landowner who, for instance, must pipe water to a new short plat with 10-acre lots.

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The water policies' ambiguous wording is exemplified by the sewer/water ordinance's Section 3.B., which says that new development in the Rural Area may be served by individual private wells, followed by 2½ pages of hard-to-understand prohibiting conditions. Plus there are complan policies F-227b and F-227c and the text preceding those two policies, which talk about exempt wells "creating more holes in the ground that can lead to contamination of entire aquifers." Whoever wrote that knew very well that all new wells must be SEALED and protected by do-nothing recorded radiuses.

During the March 23, 2004 GMUAC committee meeting both Staff and the Prosecuting Attorney cited the case of Ecology v. Campbell and Gwinn (3/28/01) No. 70279-9, as a reason for not allowing short plats (which Karen Wolf includes in the term "subdivisions") to use more than one exempt well when dividing property. Developers Campbell and Gwinn notified Ecology of their intent to drill 20 individual wells for their Rambling Brooks Estates. Upon arrival at the Supreme Court, the court said no. (Page 3) However, FN4 on Page 7 says the following:

"FN4. "... it does make a difference whether the exemption from the permitting requirements is sought by an individual homeowner or a developer. . . . Use of the exemption by developers will predictably and greatly expand unpermitted water use in this state. Individual, single family residential use of the exemption (or group uses not exceeding 5,000 gpd in total) is simply not comparable to what can occur if the exemption is rewritten to allow for multiple wells in large developments."

The Supreme Court's distinction certainly allows a 4-lot short plat in the Rural Area by a landowner of 20 acres who wishes to allow each individual 5-acre purchaser to drill his own well. This represents current practice and should be allowed to continue. The cited case should not be used as an excuse to prevent the continuance.

Ron Sims' Executive Staff has incorrectly interpreted RCW 90.44.050 (exempt wells) to suit itself. It ignores the exemptions in WAC 173-507 through 515. Staff also ignores WAC 365-195: GMA PROCEDURAL CRITERIA FOR ADOPTING COMPREHENSIVE PLANS AND DEVELOPMENT REGULATIONS. Section 510(3)(b) says: "Levels of service should be set to reflect realistic expectations consistent with the achievement of growth aims. Setting levels too high could... result in no growth. As a deliberate policy this would be contrary to the act." Executive Staff admits they are deliberately trying to prevent rural area growth through transportation and water policies that prevent even the rural-density growth that has been adopted by the Legislative Branch which is you, the King County Council!

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Forestry in King County

[This "Forestry in King County" section of testimony has been provided by Preston Drew. Mr. Drew is a Snoqualmie Valley land and timber owner. He has been in the logging business over 30 years and currently serves on the Snoqualmie Valley Land Use Advisory Group.]

The King County Council is looking at a tough new set of rural land regulation known as the Critical Areas Ordinance. (CAO) The voluminous document defines most of rural east King County as a critical or hazardous area of one sort or another, and proposes dramatically increased buffers, setbacks and restrictions for the benefit of open space, fish, wildlife and other amenities.

The Council should consider the CAO carefully. Much of the rural economy is connected to land use. This economy is in a state of stress. Each new regulation, with the increased associated cost, means that much less activity. The economic "buffer" has been used up. More cost can no longer be absorbed.

Other counties and the state as a whole should pay close attention to what happens as the CAO is pondered. In a state with 39 counties, King County alone has one third of the state population and 44 per cent of its total economy. What happens in King County usually has ramifications for the rest of Washington State.

Forestry is mentioned frequently and is heavily supported throughout the Growth Management Act, Countywide Planning Policies, King County Comprehensive Plan and the CAO. Forestry is the practice of growing and maintaining forests. For purposes of this testimony, I will add to that definition—harvesting and marketing of forest products.

1990 Growth Management Act: "Healthy and robust rural economy. Goal 8: Maintain and enhance natural resource based industries."

To understand forestry in King County, it has to be separated into two categories. Industrial forestry is that practiced on a large scale in the eastern part of the county by companies and government on large acreage like the 105,000 acre Snoqualmie tree farm or the Mt. Baker-Snoqualmie National Forest. This portion of the county has been designated the Forest Production District (FPD) by King County planners. King County land use policies, rules and regulations have little to say about these operations. Even if King County were to outlaw all logging in the county, as Seattle has done on the city-owned Cedar River Watershed, it would

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not affect industrial operations. They are governed by a different set of rules by the traditional logging authority, the Washington State Department of Natural Resources (DNR). This testimony will deal with forestry issues King County does govern, which are in the rural areas (RA) generally west of the FPD, east of suburbia, and privately owned. This second category of forestry I will call private forestry.

1992 Countywide planning policy FW9b: "RESOURCE-BASED INDUSTRIES... Commercial and non-commercial farming, forestry, primary forest products manufacturing, mining and fisheries activities shall be encouraged to continue and expand as possible."

Most properties are five-, ten- or twenty-acre parcels. The owner generally lives on the property, and he purchased it on the residential real estate market. That market is currently fifteen to twenty thousand dollars per acre for larger parcels; five-acre lots are about thirty thousand per acre. One high-end five-acre lot at Blakely Ridge on the west basin wall of the Snoqualmie Valley is priced at \$74,000 per acre. Contrast this with the recent sale of the Snoqualmie Tree Farm to Hancock Forest Resources. They paid about \$1750.00 per acre.

King County Comprehensive Plan (KCCP) Policy R-104: "Farming and forestry are vital to the preservation of the rural areas and should be encouraged throughout the rural area."

This value differential makes it obvious that landowners don't buy and own land to conduct private forestry. Trees are a desirable part of the landscape, but people want and pay for land to live on. Logging that is conducted in the rural area is almost always the result of some other activity, mostly construction or property maintenance related. I spent a lot of time prior to 1985 knocking on doors buying timber. Today it would be a total waste of time trying to buy timber in the East King County rural area. Timber values alone are insufficient to interest most owners; but my phone rings often from people looking for a logger or land clearer because they want to build something, remove dangerous trees or clear for a bigger yard.

KCCP intro statement to 'Rural Economy': "It is critically important for the rural area to sustain the farming and forestry industries"

King County planners act like the rural area is an open space resource area. They emphasize farming and forestry to save us all from development. But the reality is that landowners paying big bucks for property want some development and a whole lot less restriction.

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Most small-scale private forestry activity is not even permitted because the process, time and cost make it impossible to conduct business in any reasonable manner. A landowner called me last year after applying for a permit to log two acres of his elderly mother's place prior to selling the property. The county estimated the permit cost at \$1400.00. When I first talked to him, he had already paid \$1600.00, had a current bill for another \$1400.00 and paperwork calling for two expensive studies. He wanted to know what he should do before spending any more of his mother's money. I advised him to forget the whole thing. Timber revenue wouldn't even pay for the permits and studies.

This is a typical story and it illustrates the big disconnect from the wonderful policy statements and the way the Department of Development and Environmental Services (DDES) conducts business. They never think about whether or not the permit cost can be sustained by the economic activity.

KCCP policy R106a: "King County shall develop and implement a rural economic development strategy, which shall be consistent with the character and the service levels of the rural area... This strategy is to include the following components: Identification of rural economic development policies, goals, objectives and implementation tools necessary to bring income to businesses... Establishment of a plan-of-action to produce desired results... -Assessment of strengths, weaknesses, threats and opportunities faced by the King County rural economy.... Identification of the types of businesses that should be encouraged in the rural areas... Determination of current obstacles to overall rural economic development as well as impediments to the location or expansion of favored industries that are consistent with rural character."

The worst element of the CAO is the 65/10 rule. King County planners want to restrict the clearing of 65% of a property while imposing 10% maximum impervious surface limit on that property whenever a landowner must get a permit. The property owner, in order to get a building permit, has to surrender control of 65% of his property in perpetuity. He then has to ask the county for permission when he may want to use the remaining 35% of that property. Uses would be very limited.

One question that has been asked by the Snoqualmie Valley Land Use Advisory Group is about what uses would be allowed. The county asserts that best available science dictates the need for 65% preservation of forest cover for environmental requirements. The 13-member advisory group has asked if logging would be an allowable use. Is this a 'no touch' open space, or a management zone? The wording in the ordinance is confusing.

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My own take on this is that it is 'no touch'. I reach this conclusion based on a careful reading of the proposed ordinance, best available science documents, the knowledge that a logger friend of mine was denied a logging permit in the Bear Creek drainage zone because more than a certain percentage of the land had already been cleared, and the amount of time that has gone by waiting for the county to not answer the question. This is an interesting dilemma for the county. If they restrict logging on 65% of private land in the rural area, how can they possibly be supporting the economic requirements of forestry activities in all the policy statements?

A logging ban of this magnitude also creates a public safety problem. Forest fire potential due to excessive fuel loadings per acre in Western Washington is a growing problem. Carnation had a scare last summer when a fire got started that burned about ten acres and a shed. The fire threatened a neighborhood but there was minimal loss due to a great fire department response. Forestry professionals have long been advising homeowners about the need to think about defensible perimeters with regard to fire or hazardous trees. People love their trees and it is sometimes hard to change minds, but certain events often bring about almost instantaneous mind change. A 150-foot fir tree crashing through a house or hot cinders descending on a cedar shake roof are life- and property-threatening events.

The 65/10 rule should be completely eliminated from the CAO proposal. It does not support required economic policies, it creates a public safety problem and it abrogates private property rights.

I have an example of a forestry project that has gone very well. The 21-acre property is heavily timbered with one house and an access road. The main environmental issue is a category 1 wetland along one border of the property. I contacted a county forester with a short description of the project and the issues involved. He responded in a timely manner and we had a very short meeting on the site; professional forester and professional logger. Due to technical reasons with regard to the property segregation, the permitting options were favorable. The thinning project (take some trees while leaving most) will reduce forest fuels, it will allow the remaining trees to grow better while maintaining forest environmental functions. It creates jobs and revenue for the owner, contractor, trucker, mills and taxman. This project is a winning deal all around.

The project requires a 100-foot buffer from the wetland. Under the proposed CAO, that buffer would be increased to 300 feet. With that requirement, this job suddenly becomes a

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non-job. The owner's house is in the 300 feet. How do we address fire issues? If the owner had built after the 65/10 rule were in effect, the job becomes a non-job. Take 65% and/or the 300 foot buffer and there isn't enough volume. And why is a landowner treated so much differently when a lot was created one way or another? The environment doesn't know the difference.

County employees writing rules and regulations have to be held accountable by our elected representatives. The on-the-ground rules have to reflect economic as well as environmental values reflected in policies to achieve a reasonable balance.

Tent Cities, Here We Come

On September 23, 2003, an article by Ron Sims was placed on the King County web site at <http://www.metrokc.gov/exec/news/2003/092303.htm>. The bulk of the article was a self-promotion piece about what a wonderful job Mr. Sims' growth management policies are doing in King County. It also contained the following section:

"King County report reflects solid growth management

"WORKFORCE HOUSING IS STILL IN SHORT SUPPLY

"Creating sufficient housing affordable to the King County workforce continues to be a difficult challenge. There is an adequate supply of rental housing for those above 50 percent of median income, but below that level there are too few affordable units.

"Rental vacancy rates have increased to 7.4 percent, indicating that the supply of rental housing is easing, and that rents are likely to stabilize.

"Buying a first home remains extremely difficult for those under 120 percent of median household income, making less than \$78,500 in 2002. The median price for a single family home or condominium was \$256,000 in 2002. " [the average price is currently \$338,000]

"21 percent of households earn less than half of the \$65,000 median income, but only about 15 percent of King County's housing stock, rental or ownership, is affordable to that group. Only 10 out of King County's 40 jurisdictions have sufficient housing for those earning under 50 percent of median household income. "

This section leads to the obvious question, "For whom are Mr. Sims' policies doing such a good job?" It would seem that only those making in excess of \$78,500 and are thus able to

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buy a home would agree with Mr. Sims. Only 40% of households in King County are at that level; fully 60% of households in King County cannot afford to buy their first home. For a significant portion of those making \$32,500 or less there is **no** affordable housing of any kind. Mr. Sims should be apologizing, not bragging about the wonderful job he is doing.

How did we get to this sad state of affairs? A 2002 study by the Harvard Institute of Economic Research may help us understand the problem. Professors Edward Glaeser and Joseph Gyourko compared the effect of zoning and other land use regulations on housing prices in 26 U.S. metropolitan areas, including Seattle. They used a clever method to figure out the cost of what they call the “zoning cost.”

First, they compared the prices of houses on quarter-acre lots to the cost of similar homes on half-acre lots. The difference gave the “raw” market value of a quarter acre of land. Next, they subtracted the cost of constructing a house from the sales prices of homes on quarter-acre lots. This gave them the value of a quarter-acre of buildable land. The difference in price between the two lots is the zoning tax on a quarter acre of land. The study found that in over 60% of the United States there is no zoning tax. The cost of homes is simply the cost of land plus the actual cost of construction. **In the Seattle area that zoning tax is \$207,000!**

The average home cost in King County is now \$338,000, of which 61% is the cost of government regulation. The cost of \$207,000 over 30 years at 7% interest is \$492,908. If you buy a home in King County today you will pay an extra half million dollars because of Mr. Sims' fine growth management policies. The really bad news is that 60% of the people in King County will pay that extra cost to their landlords and not even have a house at the end of the 30 years. A significant amount will, of course, pay nothing. They will have lived in one of Mr. Sims' tent cities.

There are 443,405 single-family homes in King County with an average value of \$338,000. Their total value is therefore \$149 billion with \$91 billion of that value being the zoning tax. Can anyone, with a straight face, argue that we have gotten \$91 billion dollars of value from the regulations extracting that tax? That money would run the current bloated government of King County for 30 years! Interest alone on that money would fund King County's current expense fund! But instead, we spend it on bureaucrats and studies and pretending to “save the environment.” Who will save us from Mr. Sims and the proponents of “smart” growth?

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The average annual catch of the Pacific commercial salmon fishery is 13,100 metric tons valued at \$22 million at dockside. The value of the sportfishing catch at \$20 per fish is \$13 million. [catch data from "Pacific Coast Salmon" chapter on the NOAA website at <http://spo.nwr.noaa.gov/unit12.pdf>] The \$91 billion dollars of zoning tax would pay for the annual salmon catch for 260 years! But this is not about fish, of course. Saving fish is just a convenient distracter provided by the environmental evangelists. The zoning tax doesn't go to help the fish or the environment. It goes to support the bureaucracy, a welfare system of enormous magnitude. We could pay fishermen, both sport and commercial, the commercial value of their entire Pacific salmon catch to stop fishing with the salaries of Water and Land Resources, a small division of King County DNRP.

The following cost benefit analysis of salmon recovery on the Columbia may serve to put this in perspective. The Columbia fishery is much larger than the Puget Sound fishery. The reviewer repeats commonly held, but scientifically questionable, beliefs about the causes and cures of the salmon's ills which wouldn't change the economic questions significantly even if they are wrong.

"Title: Saving Salmon Stocks: Cost Benefit Analysis

Focal Question: Is saving salmon populations in the Columbia River Basin worth the cost?

Reviewer: Tully Blalock, Washington and Lee University, '00

Note: Unless otherwise noted, all data come from Huppert 1999.

"The Columbia River Basin once supported 10 to 16 million salmon. By 1999 this number had declined to 2 million or fewer. Of the 214 salmon stocks inhabiting rivers in the Pacific Northwest, 101 are at high risk of extinction, and 58 are at moderate risk [27 are actually listed under ESA]. The population of salmon in the Columbia River basin continues to decline, and the six species of salmon found here are in danger of extinction. Economic activities on and around the Columbia and Snake rivers have greatly impacted fish habitats and impaired the ability of fish to move up and down stream to spawn. Hydroelectric dams have hindered access to salmon spawning grounds, water levels have been reduced due to irrigation and municipal water use, and channels dug for irrigation often trap juvenile fish. Overfishing has also resulted in a decrease in salmon populations. A program has been designed to recover the salmon populations of the Columbia River Basin, but with it comes a heavy financial cost. Some question whether the value generated from the program justifies the expense.

"Historically, federal efforts to sustain the salmon population have been limited. Efforts were confined to the installation of "fish ladders" on dams so that the fish could return upstream to spawn and to the creation of fish hatcheries to augment the population of wild salmon. It was not until the Northwest Power Plant Planning Council was formed in

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1980 that the salmon populations were given equal consideration to power generation. In 1990 the river basin's fish and wildlife budget (which largely focuses on salmon) had risen to \$127 million dollars. In 1987 it had been only \$400 thousand. Despite the increase in funds allocated to salmon preservation, the population has continued to decline. Salmon ecologists argue that recovering salmon populations will require the "4 H's" to be addressed: habitat, harvest, hatcheries, and hydropower. In order to improve salmon habitat, cattle must be prevented from destroying vegetation along the river banks, irrigation must be reduced to improve water flow and temperature, and mining and timber cutting must be curtailed in order to reduce sediment concentrations in the water. Harvest recovery involves the reduction of fishing and a decrease in fish harvests. The third "H", hatcheries, refers to the danger which farm raised salmon impose on the natural wild salmon population. Farm raised salmon compete with wild fish for resources and breed with them, damaging the genetic fitness of the population. Finally, the flow of water through hydroelectric dams must be adjusted so that the disruption of spawning runs is minimized. One possible solution to this problem involves removing the earthfill portions around the four dams on the lower Snake River, allowing the river to return to its natural level.

“None of these salmon recovery measures are without economic costs. The direct costs of these measures are fairly easy to estimate, but gauging their opportunity costs is more difficult. There are costs associated with the decline in cattle grazing, agricultural production (due to irrigation restrictions), mining, recreational fishing, and power production that are difficult to measure but which must be accounted for in any decision making process.

“The opportunity costs of the salmon recovery program may be measured by the replacement costs associated with the project. For example, should the water flow through the dams be decreased, the replacement cost would be the cost of alternative power sources. Because most of the costs associated with hydroelectric power generation are one time fixed costs, shutting down the dams would result in little savings. The opportunity cost of shutting down the dams would be the cost of power production using the lowest cost alternative—in this case natural gas. If natural gas could produce electricity at the same price as the dams, the aggregate demand for electricity would remain unchanged, and there would be no loss of consumer surplus. However, if the price of electricity increased by using natural gas, the wholesalers of electricity would produce less due to the higher cost of production. The supply curve would shift upward, the price would rise, the quantity demanded would decrease, and consumer surplus would be lost.

“The replacement cost may also be used to determine the opportunity cost of irrigation regulations. Should restrictions be placed on water usage from the Columbia and Snake rivers, farmers would either have to use less or pay more for to receive water from different sources. If the farmer decided to use less water, he may choose to retire marginal lands. The cost of this could be calculated as a loss of revenue. If the farmer chose to pay more for water, producer surplus would decline due to an increase in production costs. This would also result in a loss of net revenue. This replacement cost method may be used to measure the opportunity costs of all aspects of the salmon recovery program.

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The habitat protection and restoration are estimated to cost between \$11.0 and \$31.6 million a year. The direct costs of this program include construction of fences to prevent cattle from reaching the rivers, shoreline protection, addition of structures in streams to create more habitats, and planting programs to increase vegetation in and around the streams. The opportunity costs of [this] would also be high, resulting from the reduction in timber harvests, mining, and cattle grazing as well as a reduction in recreation.

“The recovery plan proposes to decrease the number of fishing permits for offshore salmon fishing by 50%. Currently, a fixed number of permits are available, resulting in a market for the permits. The price of these permits is roughly equivalent to the annual net revenues which fishermen can expect to receive. Therefore, the costs of reducing the number of available permits through a buy-back program would be equal to half of the total revenues taken in from offshore commercial salmon fishing. This cost is estimated at \$3.2 million dollars a year. When this cost is added to the enforcement costs and administrative costs of harvest management, the total cost reaches an estimated \$4.8 million a year.

“In order to preserve the genetic fitness of the salmon, the hatchery programs would have to be altered. Costs would be associated with research and tagging programs and are estimated at \$6.7 million annually. When this cost is combined with the cost of the habitat program, the harvest management program, and a \$2.3 million a year administrative cost the total cost is approximately \$29.6 million a year. However, this is only a fraction of the cost of the total salmon recovery program. The majority of the program's cost lies in hydropower recovery measures.

“The dams along the Columbia and Salmon Rivers pose the greatest threat to the salmon populations, and dealing with this problem will undoubtedly be the most costly aspect of the salmon recovery program. There are many available options, but the option with the greatest likelihood of success also carries the heaviest cost. This option entails disabling four dams on the lower Snake River. This would lower the water level of the Snake River and adjust the flow of the river to natural levels. Juvenile salmon would have the highest chances of survival under this plan, but the cost of replacing the lost hydroelectric power and the loss of recreational value would be extremely high. This program would cost an estimated \$283.9 million a year.

“The total cost of the salmon recovery program may be up to \$359.4 million a year. Even at this price, the **success of the program is uncertain.** Is this cost excessive for the protection of a species of fish? It may be difficult to determine whether the salmon recovery program would be worth the cost. **The net increase in use value to commercial and recreational fisherman is estimated to be between \$0 and \$20 million.** (Huppert et al., 1996) Change in use value does not come close to covering the cost of the program, but nonuse values may cover the difference.

“Estimates have been made of the gain in nonuse value that would be generated by the salmon recovery program. According to a recent poll, 79% of Puget Sound residents indicated that they would be willing to water their lawns less frequently in order to help restore salmon populations. However, 60% said that they were unwilling to pay higher

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utility rates or accept restrictions on their property rights to accomplish this goal (Harkinson 2000). **Another survey of residents in the Pacific Northwest indicated that households would be willing to pay between \$26.5 and \$60 a year for the recovery of salmon populations.** As there are approximately 3.4 million households in the Pacific Northwest, we may assume the existence value of the salmon populations to these residents to be between \$86.7 and \$204 million/year. However, this value is the existence value of salmon throughout the Pacific Northwest—not just the Columbia River basin. “The existence value of the salmon in the Columbia and Snake Rivers may be remarkably less. It must also be noted that the survey does not take into account the existence value of salmon for the rest of the nation.

“Determining whether the salmon recovery program is worth the cost is a difficult task. More scientific research needs to be conducted to eliminate some of the uncertainties associated with the program. Economic research needs to be furthered in order to determine the full use and nonuse value that we as a society place on the salmon populations of the Columbia River basin. Saving these fish would result in great costs that may exceed the value that is generated from the program. However, extinction of any of the six species of salmon in the Columbia River basin is irreversible. Once they are gone, we cannot get them back.

“Sources:

Anonymous. "Fisheries Service Salmon: Plan Targets Snake River System." *Engineering News Board*, volume 242, issue 17, May 1999: 13.

Harkinson, Josh and Elissa Reiling. "Sacrificing to Save Salmon." *E: the Environmental Magazine*, volume 11, issue 1, January/February 2000: 16-18.

Huppert, Daniel D. "Snake River Salmon Recovery: Quantifying the Costs." *Contemporary Economic Policy*, volume 17, Issue 4, October 1999: 476-491.

Huppert, Daniel D., David L. Fluharty, Eric E. Doyle, and Amjoun Benyounes. "Economics of Snake River Salmon Recovery: A Report to the National Marine Fisheries Service." School of Marine Affairs, University of Washington, Seattle, 1996. “
[http://home.wlu.edu/~caseyj/sustainable_development/tully.htm]

The survey of residents of Puget Sound indicated a willingness to pay up to \$60 per year for salmon recovery. If the 443,405 single family households each paid \$60, that would be \$26,604,300 for salmon recovery. Just the 5,962 new single family homes built in 2002 in King County paid \$1,234,134,000 in environmental zoning taxes. That is \$26 million and \$1.2 billion respectively. The zoning tax from just 5,962 new homes was over 1/3 the entire King County budget which includes the cost of transit and the court system. We only spend \$1.7 billion for education at all levels in King County which includes the state's largest university. By shifting the zoning tax on new houses to education we could nearly double educational spending. Would that have a better return on investment than the \$35 million Pacific fishing industry?

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To existing home owners, the artificial inflation of house prices often looks like a positive result of growth management. We wonder if those owners are ready to cash in that equity to keep their children and grandchildren out of the tent cities or will their kids simply live with them forever? King County is not very business friendly now; how can we expect the lower-skilled workers to stay here if they cannot afford housing? How can we expect businesses to stay if there are no available workers? That certainly would solve the "growth" problem. King County can become the exclusive playground of Ron Sims, his independently wealthy friends and their servants.

Fee In Lieu Of Mitigation

We have saved the most blatant bureaucratic boondoggle of all for last.

The entire CAO is based on the premise that it will prevent harm to "critical areas." In instances where harm cannot be prevented, "mitigation" will be required. The basic concept is that if you harm the function of a critical area you must recreate that function several times over somewhere else. That almost makes sense if you don't know that, no matter what the foul, the mitigation is always to plant lots of trees, even when too many trees are causing the problem. Talk to the May Valley folks for the full story on that.

Meanwhile, the new rules say that developers who damage or destroy "critical" areas can simply pay into a mitigation fund instead of having to fix the problem. Nowhere does it say that the money must be spent on mitigation. That reinforces our idea that there is no problem that DDES cannot resolve with enough money. Especially when the ordinances (written by Harry Reinert of DDES) specifically say that the money can be used for enforcement!

Up to this point, King County has been abiding by a Washington State law that says the code enforcement officers cannot be paid from the fees and fines collected by DDES. Due to the budget problems of King County, of which you are well aware, code enforcement staff is way down. Having these additional funds will cure that problem nicely.

So the scenario is this. If you want to harm a "critical" area but not mitigate, you pay into the mitigation fund which pays the salary of the person who is supposed to make you mitigate. Most of us out here in the RA zone think that is the definition of bribery, which we also think is against the law. Just to be sure, we looked it up.

"Bribery \Brib"er*y), n.; pl. Briberies. [OE. brybery rascality, OF. briberie. See Bribe, n.] 1. Robbery; extortion. [Obs.]

2. The act or practice of giving or taking bribes; the act of influencing the official or political action of another by corrupt inducements."

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We think definition 2 fits best. Definition 1 is closer to the permits we must pay for to get permission to use our property. We also checked the RCW and discovered that bribery is a class B felony.

“RCW 9A.68.010

Bribery.

(1) A person is guilty of bribery if:

“(a) With the intent to secure a particular result in a particular matter involving the exercise of the public servant's vote, opinion, judgment, exercise of discretion, or other action in his official capacity, he offers, confers, or agrees to confer any pecuniary benefit upon such public servant; or

“(b) Being a public servant, he requests, accepts, or agrees to accept any pecuniary benefit pursuant to an agreement or understanding that his vote, opinion, judgment, exercise of discretion, or other action as a public servant will be used to secure or attempt to secure a particular result in a particular matter.

“(2) It is no defense to a prosecution under this section that the public servant sought to be influenced was not qualified to act in the desired way, whether because he had not yet assumed office, lacked jurisdiction, or for any other reason.

“(3) Bribery is a class B felony.”

We think the entire population of King County is best served by keeping code enforcement of officers' salaries coming out of the budget. It is proper that you decide how much code enforcement is needed compared to, say, sheriff's department staffing. In fact, we would encourage you to put all of DDES back on the budget.

If you are going to let developers pay a fee in lieu of mitigation, use the money to mitigate something.

Good Changes

Ditch cleaning without a permit is a good step in the right direction. Much of the damage being done by the current regulations comes from clogged waterways. You should take two additional steps. Apply it to all waterways so that we don't have to pay DDES and private consultants to argue about what constitutes an “agricultural ditch” and remove the farm plan requirement. The State already requires HEPA permits for any work in any waterway. The Corps of Engineers has refined downward the size of waterways that they cover to anything

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larger than the sweat off your brow. Between them, they have the situation well in hand and King County should simply let them handle it.

The Transfer of Developments Rights program change that allows all acreage to be included in the transfer makes a lot of sense. If we are trying to save critical areas, why exclude them from the acreage to be protected?

Removal of the regulation that prevented you from farming if you didn't farm for 5 years is good. Recognizing that fallow ground is a necessary part of farm management is also a good change.

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We Propose The Following:

Vote NO on the proposed ordinances.

And then:

A truly independent study of Best Available Science should be initiated to identify the most efficient and effective methods to conserve, enhance or restore truly critical areas in King County. It should be reviewed by a panel of impeccable experts such as the one being promoted to King, Pierce, and Snohomish counties by Sara Hemphill and Scott Wallace. Based on the real BAS derived from that review, an independent inventory of environmentally critical sites in King County shall be developed and prioritized. The cost of outright purchase of, or conservation lease of, those sites at fair market value would be determined. Equitable sources of funds for those lease payments and purchases shall be identified and presented to the citizens for a vote. Available money should be used to enter into voluntary lease or purchase agreements with property owners in the order the areas were prioritized. If property owners with critical areas choose not to sell or lease but wish to develop, they must submit a farm or stewardship plan that is based on the identified BAS and that follows predetermined general guidelines. If their critical areas are low on the priority list, then their development restrictions would be less than if they are high on the priority list.

This method would allow voters to indicate how badly they want to “save” each critical area by how many new taxes/bonds they approve. An intellectually honest public discussion of the issues will happen because then everyone in King County will have skin in the game, not just the rural minority.

In order to succeed, environmental policies must be intellectually honest and fair. King County departments must rid themselves of self-promoting, manipulative and coercive acts. Utopia cannot be coerced. You must restructure the departments to remove the temptations to act in their own best interests instead of the best interests of the citizens of King County, even the minorities. Enhancement and preservation must be transferred to the community organizations and non-profits that can most efficiently handle the task at the lowest cost.

Local management of environmental features and systems is preferred. We are referring to the township level, not county level, as local. The processes must be positive and community-building, not divisive.

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All those who benefit from open space and a quality environment must pay in proportion to the benefit received. It is simply wrong to ask those who have yet to develop their land or who want to change its use to shoulder enormous additional expense without also asking those who developed first—and have reaped the most benefits from that development—to share the burden. Do we really want to live by the credo that **“The First to the Trough Gets All the Swill?”** That is the very thing that causes the Tragedy of the Commons! The decision you are being asked to make is really, “Who should pay for the destruction caused by the urbanization of King County?” Before you answer that question, ask yourself the following questions:

- ◆ Where are the major sources of pollution and the primary locations of environmental damage in King County?
- ◆ Where are the “Super Fund” sites in King County?
- ◆ Where are the areas with impervious surfaces greater than 10% of the property?
- ◆ How many gallons of contaminated water run off of impervious surfaces in urban King County each year as compared to rural King County?
- ◆ How many gallons of raw sewage have been discharged by urban cities?
- ◆ How many gallons of partially treated effluent are discharged by cities each year?
- ◆ Where are the primary sources of chemical and oil spills?
- ◆ Where are the sources of air pollution?
- ◆ How many acres of saltwater mudflat and estuaries have been lost in urban areas?
- ◆ How many acres of wetlands have been destroyed in urban areas as compared to rural areas?
- ◆ How many acres of floodplains have been filled in urban areas?
- ◆ How many miles of creeks and streams have been enclosed in culverts?
- ◆ Where do water quality studies show impacted water quality?
- ◆ What percentage of water resources are used by the urban areas?
- ◆ How much wealth has been generated by urban development and how much has been used for mitigation?
- ◆ How do these ordinances reward individuals for environmental protection?
- ◆ How much do these ordinances demand from those same individuals?
- ◆ **Which message do you want to send? First to the trough gets the goodies or everyone pays according to how they have benefited?**

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STATE OF WASHINGTON ATTORNEY GENERAL'S RECOMMENDED PROCESS AND ADVISORY MEMORANDUM FOR EVALUATION OF PROPOSED REGULATORY OR ADMINISTRATIVE ACTIONS TO AVOID UNCONSTITUTIONAL TAKINGS OF PRIVATE PROPERTY – MARCH 1995

The Office of the Attorney General is required under the Growth Management Act to advise state agencies and local governments on an orderly, consistent process that better enables government to evaluate proposed regulatory or administrative actions to assure that such actions do not result in unconstitutional takings of private property. RCW 36.70A.370.

This process must be used by state agencies and local governments that are required to or choose to plan under RCW 36.70A.040. A private party, however, does not have a cause of action against an agency for failure to utilize the recommended process. The Act also provides that "[t]he process used by government agencies shall be protected by attorney client privilege". See RCW 36.70A.370(4).

The Attorney General's recommended process and advisory memorandum was initially published and circulated in February 1992, with a subsequent edition in April 1993. This memorandum has been updated to reflect recent court decisions.

Attorney General's Recommended Process

1. The Attorney General's Office prepares and distributes an advisory memorandum to all government agencies which exercise regulatory authority impacting private property rights. This advisory memorandum includes discussions of the most recent Supreme Court decisions, along with examples of specific types of situations which raise constitutional questions.
2. Local governments and state agencies should review the advisory memorandum with their legal counsel and distribute it to all decision makers and key staff. Government sensitivity regarding private property rights can be further increased if agency decision makers at all levels of government have consistent, authoritative guidance on the applicable constitutional limitations. This is particularly important for potential property uses which may be subject to the regulatory jurisdiction of multiple agencies.
3. Local governments and state agencies should use the warning signals in the advisory memorandum as a checklist to determine whether a proposed regulatory action may violate a constitutional requirement. The warning signals are phrased as questions. If there are affirmative answers to any of these questions, the proposed regulatory action should be reviewed in detail by staff and approved by counsel.
4. State agency and local government actions implementing the Growth Management Act programs, such as planning under the Growth Management Act, should be assessed by both staff and legal counsel. Examples of these actions include the adoption of development regulations and designations for natural resource lands and critical areas, and the establishment of policies or guidelines for conditions, exactions, or impact fees incident to permit approval. This assessment should also be used for the issuance or denial of permits for land use development.
5. The assessment should be incorporated into the agency's review process. Since the extent of the assessment necessarily depends on the type of regulatory action and the specific impacts on private property, the agency should have some discretion to determine the extent and the form of the as-

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assessment. For some types of actions, the assessment might focus on a specific piece of property. For others, it may be useful to consider the potential impacts on types of property or geographic areas. It is strongly suggested, however, that any government regulatory actions which involve warning signals be carefully and thoroughly reviewed by legal counsel. As mentioned above, the Legislature has specifically indicated that the process used shall be protected by attorney client privilege. The agencies, therefore, have the discretion to determine the extent of distribution and publication of reports developed as part of the recommended process.

STATE OF WASHINGTON ATTORNEY GENERAL'S ADVISORY MEMORANDUM FOR EVALUATION OF PROPOSED REGULATORY OR ADMINISTRATIVE ACTIONS TO AVOID UNCONSTITUTIONAL TAKINGS OF PRIVATE PROPERTY

The purpose of this advisory memorandum is to provide a tool to assist state agencies and local governments in evaluating whether proposed administrative or regulatory actions may violate constitutional limitations. Government agencies, exercising regulatory authority which impacts the use of property, must be sensitive to the constitutional limits on their authority, and thereby respect private property rights. The failure to recognize these constitutional limits erodes public confidence in government. It may also subject the government agency to liability for costs and damages associated with the invalidation of the government regulatory action, or the imposition of an obligation to pay compensation for the taking of the property.

The memorandum outlines some general legal principles derived from cases which have interpreted the constitutional provisions in specific fact situations. Most of the cases involving regulatory takings issues have discussed the takings clause of the United States Constitution. Some opinions also refer to a substantive due process right under the Constitution. Both constitutional provisions are discussed. The memorandum also includes a list of warning signals, i.e., situations which may involve constitutional issues and should be further assessed by staff and legal counsel.

This memorandum is intended as an internal management tool for agency decision makers. It is not a formal Attorney General's Opinion under RCW 43.10.030(7), and should not be construed as an opinion by the Attorney General on whether a specific action constitutes a taking or a violation of substantive due process. Legal counsel should be consulted for advice as to any particular action which may involve a constitutional taking or due process violation.

I. GENERAL PRINCIPLES

Government has the authority and responsibility to protect the public health, safety, and welfare. This is an inherent attribute of sovereignty. Pursuant to this authority, the government may properly regulate or limit the use of property.

Accordingly, government may abate public nuisances, terminate illegal activity, and establish building codes, safety standards, or sanitary requirements. The government may limit the use of property through land use planning, zoning ordinances, setback requirements, and environmental regulations.

The government may also establish conditions or requirements for potential uses of property which may have adverse impacts. Conditions may include the granting of easements or donation of property for public use.

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Courts have recognized, however, that if government regulation goes "too far", it may constitute a taking of property. The next section of the memorandum outlines the general principles courts use to determine whether a given government regulation effects a "taking" under the Constitution.

A. Takings Clause

The Fifth Amendment to the United States Constitution provides that private property shall not be taken for public use without just compensation. Article 1, section 16 of the Washington State Constitution provides that "[n]o private property shall be taken or damaged . . . without just compensation". The government may not, therefore, take property except for public purposes within its constitutional authority and only upon payment of just compensation.

When the government seeks to use private property for a public building, a highway, or some other public purpose, it must compensate the property owner. Government historically acquires property and compensates landowners through a condemnation proceeding.

The government may also become liable for the payment of just compensation to private property owners whose land has been either physically occupied or invaded by the government on a permanent basis. This is generally referred to as an inverse condemnation.

Most comprehensive land use regulation does not, in itself, constitute a taking of property. Zoning and other comprehensive regulations are a legitimate exercise of the government's police power. The regulation, however, must advance a legitimate public interest and not deprive the owner of all economic or beneficial use of the property. Also, a regulation which destroys a fundamental property right, such as the right to possess, exclude others from, or dispose of property, could, on its face, constitute a taking.

A regulation which prohibits all economically viable or beneficial uses of property is not a taking if the government can demonstrate that the proposed uses are prohibited by laws of nuisance or other preexisting limitations on use of property. Limitations on the use of tidelands under the public trust doctrine would be an example of a preexisting limitation on use of property which might insulate government from takings liability.

When government may deny a land use, it may condition a permit to engage in that use. For example, the government may condition a development permit on measures to mitigate adverse impacts of the development. However, a permit condition which imposes substantial costs or limitations on property use could be a taking. In assessing whether a regulation or permit condition constitutes a taking in a particular circumstance, the courts will consider the public purpose of the regulatory action along with the extent of reduction in use of and economic impact on the property. The burden on the property owner must be roughly proportional to the adverse public impact sought to be mitigated.

One factor in assessing the economic impact of a permit condition is the extent of interference with a property owner's reasonable investment-backed development expectations. For instance, in determining whether a taking has occurred, a court would, among other things, weigh the extent of a condition's impact on vested development rights against the government's interest in promulgating the regulation.

B. Substantive Due Process

The Fourteenth Amendment to the United States Constitution has been interpreted by courts to include a right of substantive due process which protects an individual's property from arbitrary regulation. There

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is also a due process clause in article 1, section 3 of the Washington State Constitution. Recent Washington Supreme Court decisions state that, in addition to the takings clause, the substantive due process limitation protects landowners from unduly oppressive regulation. The court described a balancing test similar to the takings analysis involving the nature of the government interest and the extent of the impact on private property rights.

C. Remedies

The violation of constitutional limits on the scope of regulatory authority may have financial consequences to government agencies. The specific remedy depends on the nature of the government action and the impact on the property owner.

The government must pay just compensation to the property owner if property has been taken and used for a public purpose. In determining just compensation, the court will consider the impact on the value of the property.

If a court determines there has been a regulatory taking, the government has the option of either paying just compensation or withdrawing the regulatory limitation. Even if the regulation is withdrawn, the government might be obligated to compensate the property owner for the temporary taking of the property before the regulation was withdrawn.

The remedy for a violation of the substantive due process requirement is the invalidation of the regulation. The government agency should be aware that if the regulation is invalidated under this constitutional provision and the landowner proves that the agency's actions were irrational or invidious, damages and reasonable attorney's fees may be recovered under the Federal Civil Rights Act.

Government agencies should also be aware that, under state law, a property owner who has filed an application for a permit has a cause of action for damages to obtain relief from agency actions which were arbitrary, capricious, or made with the knowledge that the actions were in excess of lawful authority. *See* RCW 64.40. This state law also provides relief for failure to act within the time limits established by law.

A person challenging an action or ordinance generally must exhaust available administrative remedies before seeking court review and has the burden of proving that the action or ordinance violates the constitutional provision.

II. WARNING SIGNALS

The following warning signals are examples of situations which may raise constitutional issues. The warning signals are phrased as questions which agency staff can review regarding the potential impact of a regulatory action on specific property.

Agencies should use these warning signals as a checklist to determine whether a regulatory action may raise constitutional questions and require further review.

The fact that a warning signal may be present does not automatically mean that there has been a taking. It means only that there could be a constitutional issue and that agency staff should carefully review the proposed action with legal counsel. If property is subject to regulatory jurisdiction of multiple government agencies, each agency should be sensitive to the cumulative impacts of the various regulatory restrictions.

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1. Does the Regulation or Action Result in a Permanent Physical Occupation of Private Property?
2. Regulation or action resulting in a permanent physical occupation of all or a portion of private property will generally constitute a taking. For example, a regulation which required landlords to allow the installation of cable television boxes in their apartments was found to constitute a taking. *See* *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 419 (1982).
3. Does the Regulation or Action Require a Property Owner to Dedicate a Portion of Property or to Grant an Easement?
4. Regulations requiring the dedication of property or granting an easement should be carefully reviewed. The dedication of property must be reasonable and proportional, specifically designed to prevent or compensate for adverse impacts of the proposed development. A court will also review whether the action in question substantially advances a legitimate state interest.
5. For example, the United States Supreme Court determined in *Nollan v. California Coastal Comm'n*, 483 U.S. 825 (1987), that compelling an owner of waterfront property to grant a public easement which does not substantially advance the public's interest in beach access constitutes a taking. Similarly, the Washington Court of Appeals determined in *Unlimited v. Kitsap Cy.*, 50 Wn. App. 723, 750 P.2d 651, review denied, 111 Wn.2d 1008 (1988), that compelling the landowner to dedicate strips of property to allow commercial access to a public road from private property and to extend the road, constituted a taking. The Court held that the requirement of commercial access served no public purpose and that the acquisition of the land for an extension for which the County had no immediate plans to build was not necessitated by Unlimited's development. *See* *The Luxembourg Group, Inc. v. Snohomish Cy.*, 76 Wn. App. 502 (1995) (cannot require developer to grant easement for land-locked property). On the other hand, state statutes require local governments to assure that adequate provisions have been made for the public health, safety and welfare before approving subdivisions. *Miller v. Port Angeles*, 38 Wn. App. 904, 909, 691 P.2d 229 (1984). The Court in *Miller* approved of the exaction of land to widen roads necessary to handle traffic generated by the proposed development.
6. Does the Regulation or Action Deprive the Owner of All Economically Viable Uses of the Property?
7. If a regulation or action prohibits all economically viable or beneficial uses of the land, it will likely constitute a taking. In this situation, the agency can avoid liability for just compensation only if it can demonstrate that the proposed uses are prohibited by the laws of nuisance or other preexisting limitations on the use of the property. *See* *Lucas v. South Carolina Coastal Coun.*, 505 U.S. ___, 120 L. Ed. 2d 798, 112 S. Ct. 2886 (1992).
8. Unlike the impact of a physical invasion or other limitation on the right to exclude others, it is important here to analyze the regulation's impact on the property as a whole, and not just on a portion of the property. It is also important to assess whether there is any profitable use of the remaining property available. *See* for instance *Florida Rock Industries, Inc. v. United States*, 791 F.2d 893 (Fed. Cir. 1986). The remaining use does not necessarily have to be the owner's planned use, a prior use, or the highest and best use of the property. One factor in this assessment is the extent of interference with a property owner's reasonable investment-backed development expectations.
9. Regulations or actions requiring that all of a particular parcel of land be left substantially in its natural state should be carefully reviewed. A prohibition of all economically viable uses of the property could be vulnerable to a takings challenge. In some situations, however, there may be preexisting limitations on the use of property which could insulate the government from takings liability. Limitations on the use of tidelands under the public trust doctrine probably constitute a preexisting limi-

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tation on use of property such as to insulate government from takings liability. *See* Orion Corp. v. Washington, 109 Wn.2d 621, 747 P.2d 1062 (1987), cert. denied, 486 U.S. 1022 (1988).

10. Does the Regulatory Action Have a Severe Impact on the Landowner's Economic Interest?
11. A regulatory action, such as conditioning or denying a permit, which has a significant impact on the owner's economic interest, should be carefully reviewed. Courts will often compare the value of property before and after the impact of the challenged regulatory action. Although a reduction in property value alone may not be a taking, a severe reduction in property value often indicates a reduction or elimination of reasonably profitable uses. Another economic factor which courts will consider is the extent to which the challenged action impacts any development rights of the owner. As with warning signal 3, these economic factors are normally applied to the property as a whole.
12. Does the Regulation or Action Deny a Fundamental Attribute of Ownership?
13. Regulations or actions which deny the landowner a fundamental right of ownership, including the right to possess, exclude others, and dispose of all or a portion of the property are potential takings.
14. The United States Supreme Court has held that requiring public access along a stream bank as a condition to obtaining a development permit is a taking. *Dolan v. Tigard*, 512 U.S. ___, 129 L. Ed. 2d 304, 114 S. Ct. 2309 (1994). The Washington Supreme Court has considered regulations which precluded houseboat moorage owners from terminating leases to regain possession as a taking. *See* *Granat v. Keasler*, 99 Wn.2d 564, 663 P.2d 830 (1983).

III. APPENDIX

Appendix A is a list some of the principal cases dealing with regulatory takings issues and a summary of the result in each case. These cases provide examples of how courts have resolved specific questions and may be helpful for assessing how courts might resolve analogous situations. There are, of course, a number of other cases which have discussed or resolved regulatory takings issues and some excellent law review articles on the subject.

Appendix A includes a brief summary of the recent United States Supreme Court decision in *Dolan v. Tigard*, 512 U.S. ___, 129 L. Ed. 2d 304, 114 S. Ct. 2309 (1994). This opinion should be carefully read in light of other United States Supreme Court opinions on the subject: *Lucas v. South Carolina Coastal Coun.*, 505 U.S. ___, 120 L. Ed. 2d 798, 112 S. Ct. 2886 (1992), and *Nollan v. California Coastal Comm'n*, 483 U.S. 825, 97 L. Ed. 2d 677, 107 S. Ct. 3141 (1987). Also summarized are several State Supreme Court decisions issued since the last edition of this memorandum.

[Appendix A is not available on the Attorney General's web site from which the text of the document was retrieved. We have substituted the following analysis of the evolution of takings law since *Nollan* and *Dolan*.]

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The Evolution of the "Essential Nexus": How State and Federal Courts Have Applied *Nollan* and *Dolan* and Where They Should Go from Here

J. David Breemer*

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I. Introduction

In *Nollan v. California Coastal Commission*¹ and *Dolan v. City of Tigard*,² the Supreme Court imposed federal constitutional limits on governments that attempt to exact property from landowners in return for development approval.³ In *Nollan*, the Court ruled that these exactions violate the Takings Clause of the Fifth Amendment unless there is an "essential nexus" between the required concessions and the public impact of the proposed development.⁴ The Court held that the California Coastal Commission violated the new nexus standard when it demanded that the Nollans give up a lateral beachfront easement in exchange for a building permit.⁵ In *Dolan*, the Court added to the nexus test, declaring that an exaction of property must be "roughly proportional" in nature and extent to the impact of the proposed land development.⁶ The Court again found a taking when a landowner was required to give up an easement in land in exchange for a development permit.⁷

Although there always has been some disagreement about the crux of these decisions – whether it was the fact that government engaged in a physical invasion of land,⁸ the potential abuse of government permitting

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1. 483 U.S. 825 (1987).
 2. 512 U.S. 374 (1994).
 3. See *Nollan v. Cal. Coastal Comm'n*, 483 U.S. 825, 841-42 (1987) (finding government's ability to extract concessions from landowners limited by Fifth Amendment Takings Clause); see also *Dolan v. City of Tigard*, 512 U.S. 374, 391 (1994) (stating that Fifth Amendment requires "rough proportionality" between property exaction and developmental impact).
 4. *Nollan*, 483 U.S. at 837.
 5. *Id.* at 841-42.
 6. *Dolan*, 512 U.S. at 391.
 7. See *id.* at 394-95 ("We conclude that the findings upon which the city relies do not show the required reasonable relationship between the floodplain easement and [Dolan's] proposed new building.").
 8. See Frank I. Michelman, *Takings, 1987*, 88 COLUM. L. REV. 1600, 1608 (1988) (suggesting that "talismanic force of 'permanent physical occupation' is the cornerstone of *Nollan*"). Interestingly, Michelman later characterizes *Nollan* as a case involving a "regulatory restriction on use." See Frank I. Michelman, *Tutelary Jurisprudence and Constitutional Property*, in LIBERTY, PROPERTY & THE FUTURE OF CONSTITUTIONAL DEVELOPMENT 127, 140 (Jennifer Nedelsky ed., 1990).

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power,⁹ or a simple desire on the part of the Court to elevate property rights in the constitutional hierarchy¹⁰ – the cases at least seemed to call for increased judicial scrutiny of land use conditions.¹¹ Yet, while some post- *Dolan* federal and state cases indeed reflect a more skeptical stance toward the permitting process,¹² many others have discovered exceptions to the essential nexus rule¹³ that preclude its application to many, if not most, of the exactions commonly imposed by government. In particular, there is great confusion over the applicability of the essential nexus to exactions that amount to a demand for money¹⁴ and to exactions that originate from a legislative act.¹⁵ Many courts have concluded that both types of land use conditions fall outside the scope of *Nollan* and *Dolan*.

This Article contends that courts misread *Nollan* and *Dolan* and undermine the purposes of the Takings Clause when they hold that the essential nexus does not apply to monetary or legislative exactions. Part II briefly reviews *Nollan* and *Dolan* and summarizes the rules that flow from

9. See *Lambert v. City & County of San Francisco*, 529 U.S. 1045, 1048 (2000) (Scalia, J., dissenting from denial of certiorari) (noting that "the object of the Court's holding in *Nollan* and *Dolan* was to protect against the State's cloaking within the permit process 'an out-and-out plan of extortion'").

10. See Otto J. Hetzel & Kimberly A. Gough, *Assessing the Impact of Dolan v. City of Tigard on Local Governments' Land-Use Powers*, in TAKINGS: LAND-DEVELOPMENT CONDITIONS AND REGULATORY TAKINGS AFTER *DOLAN* AND *LUCAS* 219, 219 (David L. Callies ed., 1996) (stating that Court's takings cases, including *Nollan* and *Dolan*, "clearly signaled the Court's determination to provide greater protection for private property rights").

11. See Mark W. Cordes, *Legal Limits on Development Exactions: Responding to Nollan and Dolan*, 15 N. ILL. L. REV. 513, 534 (1995) (noting that *Dolan* "Court's analysis demonstrated a seriousness of review to protect unjustified intrusions on property interests"); Hetzel & Gough, *supra* note 9, at 232 (commenting that *Nollan* applied "intermediated level of scrutiny"); Douglas W. Kmiec, *The Original Understanding of the Takings Clause Is Neither Weak Nor Obtuse*, 88 COLUM. L. REV. 1630, 1649 (1988) (noting that parts of *Nollan* call for "heightened intermediate scrutiny of [government's] means").

12. See David L. Callies, *Regulatory Takings and the Supreme Court: How Perspectives on Property Rights Have Changed from Penn Central to Dolan and What State and Federal Courts Are Doing About It*, 28 STETSON L. REV. 523, 568-71 (1999) (reviewing post-*Dolan* cases that find taking due to impermissible exaction).

13. The term "essential nexus" is used throughout this Article to refer to both the *Nollan* nexus test and the *Dolan* rough proportionality standard, unless clearly noted. The conjunction is appropriate here because both prongs are applied in the context of impact fees and legislative exactions. It is important to keep in mind, however, that it is misleading to address the rough proportionality and nexus tests in the same breath in the permit denial context because only *Nollan* applies there. See *City of Monterey v. Del Monte Dunes, Ltd.*, 526 U.S. 687, 703, 721

(1999) (holding "rough proportionality" test inapplicable to permit denial, but affirming jury's right to consider whether denial substantially advanced legitimate state interests).

14. See *infra* notes 86-89 and accompanying text.

15. See *infra* note 114-48 and accompanying text.

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each of those decisions. Part III surveys post-*Dolan* lower court decisions dealing with monetary exactions and explores the judicial debate over relevance of the source of the exaction. Part IV argues that the purposes underlying *Nollan* and *Dolan* and the Takings Clause compel application of the essential nexus to both monetary and legislative exactions. Finally, Part V concludes that courts should apply the essential nexus test equally to all land use conditions, not only because the thrust of the cases requires this application, but also because the most narrow holdings of *Nollan* and *Dolan* are rendered meaningless without an integrated and consistent takings doctrine in the exaction context.

II. A Brief Review of *Nollan* and *Dolan*

Nollan burst onto the scene in 1987 as part of a "trilogy" of regulatory takings cases decided that year.¹⁶ The case had its genesis, however, in a land use process that dated to the 1970s.¹⁷ Since that time, the California Coastal Commission required coastal landowners to dedicate easements across their property when seeking permission to improve their land.¹⁸ In the early 1980s, the Commission set its sights on James and Marilyn Nollan after they applied to replace a dilapidated 504 square-foot beach "bungalow" that had fallen into such disrepair that it could no longer be rented out¹⁹ with a new "three-bedroom house in keeping with the rest of the neighborhood."²⁰

The Commission informed the Nollans that they could have the necessary permits as long as they agreed to dedicate a public access easement across the dry sand area of their lot.²¹ In the Commission's view, the easement was proper because the Nollan's house "would increase blockage of the view of the ocean, thus contributing to the development of 'a "wall" of

16. See *First English Evangelical Lutheran Church v. County of Los Angeles*, 482 U.S. 304, 318-19 (1987) (holding that compensation is always remedy for regulatory taking regardless of whether government removes offending regulation and thus makes taking "temporary"); *Keystone Bituminous Coal Ass'n v. DeBenedictis*, 480 U.S. 470, 501-02 (1987) (finding no taking when state of Pennsylvania denied coal company right to extract its coal from beneath occupied land); *Nollan v. California Coastal Comm'n*, 483 U.S. 825 (1987) (finding that attempt to extort easement for building permit violates Takings Clause unless compensation is paid). For a general discussion of all three cases, see Kmiec, *supra* note 11.

17. *Nollan*, 483 U.S. at 859 (Brennan, J., dissenting) (noting that "regulation to ensure public access to the ocean had been directly authorized by California citizens in 1972").

18. *Id.* (Brennan, J., dissenting) (observing that "[t]he specific deed restriction to which the Commission sought to subject them had been imposed since 1979 on all 43 shoreline new development projects" in Nollan's vicinity).

19. *Id.* at 827.

20. *Id.* at 828.

21. *Id.* at 828-29.

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residential structures' that would prevent the public 'psychologically . . . from realizing a stretch of coastline exists nearby that they have every right to visit.'"²² It also found that the house was likely to jeopardize public access by increasing "private use of the shore-front."²³ Disagreeing with the Commission's conclusions, the Nollans turned to the courts in an effort to bar the Commission from imposing the dedication condition and to have the condition declared a taking without just compensation in violation of the Takings Clause of the Fifth Amendment. After an extended foray through the California courts,²⁴ the Nollans appealed to the United States Supreme Court.²⁵

The issue before the High Court in *Nollan* was whether the Takings Clause allowed the Commission to require an "uncompensated conveyance" as a condition for issuing a land-use permit when it could not do so outright.²⁶

In the Court's view, this question depended on whether the condition "substantially advances legitimate state interests."²⁷ Disposing of the "legitimate state interest" prong by assuming that the provision of public beach access was a proper purpose,²⁸ the Court focused on the lack of congruence between the easement demanded of the Nollans and the purposes articulated by the Commission.²⁹ A "lack of nexus between the condition and the original

22. *Id.*

23. *Id.* at 829.

24. "On June 3, 1982, the Nollans filed a petition for a writ of administrative mandamus asking the Ventura County Superior Court to invalidate the access condition." *Id.* at 828. The superior court subsequently issued an order requiring the Commission to hold an evidentiary hearing to determine if the proposed house "would have a direct adverse impact on public access to the beach." *Id.* After this hearing resulted in findings adverse to the Nollans, they returned to superior court to attack the merits of the Commission's findings and to assert the constitutional challenge. *See id.* at 829 (arguing that condition violated Takings Clause of Fifth Amendment). The superior court agreed with the Nollans that the condition was unwarranted because the evidence failed to show that the house would actually have a "direct or cumulative burden" on beach access. *Id.* The victory was short-lived, however, because the California Court of Appeals reversed and additionally held that the dedication requirement did not amount to a taking. *Id.* at 830-31.

25. *Id.* at 831.

26. *Id.* at 834. The Court explained:

Had California simply required the Nollans to make an easement across their beachfront available to the public on a permanent basis in order to increase public access to the beach, rather than conditioning their permit to rebuild their house on their agreeing to do so, we have no doubt there would have been a taking. *Id.*

27. *Id.*

28. *Id.* at 834-36.

29. *See id.* at 837 (stating that "constitutional propriety disappears, however, if the condition fails to further the end advanced as the justification").

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purpose of the building restriction,"³⁰ was critical because: "[U]nless the permit condition serves the same governmental purpose as [a] development ban, the building restriction is not a valid regulation of land use but an 'out-and-out plan of extortion.'"³¹

Having laid the legal framework, the Court quickly determined that the lateral beach access exaction imposed on the Nollans did not advance the Commission's stated purposes:

It is quite impossible to understand how a requirement that people already on the public beaches be able to walk across the Nollans' property reduces any obstacles to viewing the beach created by the new house. It is also impossible to understand how it lowers any "psychological barrier" to using the public beaches, or how it helps to remedy any additional congestion on them caused by construction of the Nollans' new house.³²

As a result, the Commission's exaction could not be treated as a proper exercise of the police power.³³ In the end, California "was free to advance" public access along the coast, but if it wanted "an easement across the Nollans' property, it must pay for it."³⁴

Nollan thus established that an "essential nexus" must exist between a development condition and the amelioration of a legitimate public problem arising from the development.³⁵ Although the Court does a poor job of defining the parameters of the test, suggesting that it simply requires a correspondence between the government's purposes and its means,³⁶ its reasoning and holding clearly show that the raw nexus test requires (1) a legitimate state interest or purpose; (2) a connection between that interest and the land use exaction chosen to address it; and (3) a minimal connection between the impacts of the proposed development and the land use exaction.³⁷

30. *Id.*

31. *Id.*

32. *Id.* at 838-39.

33. *Id.* at 839.

34. *Id.* at 841-42.

35. *Id.* at 837-39. For an exceptional discussion of the bifurcated nature of the nexus test, see *Burton v. Clark County*, 958 P.2d 343, 356-57 (Wash. Ct. App. 1998). See also Jan G. Laitos, *Causation and the Unconstitutional Conditions Doctrine: Why the City of Tigard's Exaction Was a Taking*, 72 DENV. U. L. REV. 893, 904-08 (1995) (explaining bifurcated analysis of *Dolan*).

36. *Nollan v. Cal. Coastal Comm'n*, 483 U.S. 825, 837 (1987). The Court observed that, without a nexus, a "condition . . . utterly fails to further the end advanced as the justification for the prohibition."

37. *Id.* at 838-39. In this regard, it is important to remember that the Court struck the easement condition imposed on the Nollans in part because it did not reduce "any obstacles to viewing the beach created by the new house." *Id.* at 838. The centrality of the requirement that

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The Court left unanswered the question of just how close a connection there must be between development exaction and development impact, as the beachfront easement demanded of the Nollans failed to meet even the loosest standard.³⁸

In *Dolan*, the Court set out to finish what it started in *Nollan*. In *Dolan*, the City of Tigard required Florence Dolan to submit to several exactions in return for permission to expand a plumbing and electrical supply store and to pave an enlarged parking area.³⁹ Citing concerns that Dolan's development would lead to more storm water runoff and flood potential,⁴⁰ the local Planning Commission demanded that Ms. Dolan "dedicate the portion of her property lying within the 100-year floodplain for improvement of a storm drainage system."⁴¹ In addition, the Commission required Ms. Dolan to dedicate a fifteen-foot strip of land along the floodplain as a pedestrian/bicycle pathway, over and above that which was needed for the storm water system.⁴² The Commission justified its decision on the ground that it "could offset some of the traffic demand on [nearby] streets and lessen the increase in traffic congestion."⁴³

In considering whether the dedication conditions were consistent with *Nollan*,⁴⁴ the Court explained that it was necessary first to determine "the

a land use condition address a problem traceable to the proposed development is seen by considering several hypothetical situations. As the Court noted, the Commission permissibly could have required the Nollans to supply a viewing area on their property in return for a building permit. *Id.* at 836. This condition would pass constitutional muster because it would advance the state's interest in protecting views of the ocean by addressing a problem (loss of view) directly caused by construction of the Nollans' house. *Id.* But a different outcome would result if the Commission were to require the Nollans to give up a vertical access easement across their lot so that the public could get from a road fronting the house to the public beach beyond. Although this condition undoubtedly would promote beach access and, therefore, "further the [public access] end advanced," it still would fail the nexus test because construction of the house could not cause the public access problem. Regardless of whether the lot was improved by just a "bungalow," or nothing at all, it would remain private property and, therefore, off-limits to the general public at pain of criminal trespass. Thus, it would be difficult to see how the requirement of a vertical access easement "reduces any obstacles" to beach access "created by the house."

38. *Id.* at 838. The Court stated, "[W]e find that this case does not meet even the most untailed standards." *Id.*

39. *Dolan v. City of Tigard*, 512 U.S. 374, 379 (1994).

40. *Id.* at 382. The western and southwestern portions of the lot in which the expansion was to take place bordered a creek, the year round low of which rendered "the area within the creek's 100-year floodplain virtually unusable for commercial development." *Id.* at 379.

41. *Id.* at 380.

42. *Id.*

43. *Id.* at 381-82 (quoting Commission findings).

44. *Id.* at 383. The U.S. Supreme Court granted certiorari after both the Oregon Court

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required degree of connection between the exactions and the projected impact of the proposed development."⁴⁵ After concluding that a minimal nexus existed between the city's interest in flood prevention and reduced traffic congestion and the land dedications it sought from Ms. Dolan,⁴⁶ the Court turned to state courts for guidance on the question of the "required degree of connection."⁴⁷ Noting that a "reasonable relationship" test was "closer to the federal constitutional norm,"⁴⁸ the court adopted this intermediate standard.⁴⁹

However, to avoid confusion with the "rational basis" test central to Equal Protection analysis, the Court held that "'rough proportionality' best encapsulates what we hold to be the requirement of the Fifth Amendment."⁵⁰

The Court summarized the new standard as follows: "No precise mathematical calculation is required, but the city must make some sort of individualized determination that the required dedication is *related both in nature and extent to the impact of the proposed development*."⁵¹

When it applied the "rough proportionality" test to the facts at hand, the Court concluded that the City of Tigard failed to meet its requirements when it "demanded more" from Ms. Dolan than an open space reservation:

"[The City] not only wanted petitioner not to build in the floodplain, but it also wanted petitioner's property along Fanno Creek for its greenway system. The City has never said why a public greenway, as opposed to a private one, was required in the interest of flood control."⁵²

The Court continued: "It is difficult

of Appeals and the Oregon Supreme Court held that the bikeway and floodplain dedications demanded of Ms. Dolan were "reasonably related to the impact of the expansion of [her] business," and, therefore, permissible under *Nollan*. Thus, in granting certiorari, the Court intended to resolve "an alleged conflict between the Oregon Supreme Court's decision and our decision in *Nollan*." *Id.*

45. *Id.* at 386. The Court stated: "If we find that a nexus exists, we must then decide the required degree of connection between the exactions and the projected impact of the proposed development. We were not required to reach this question in *Nollan*, because we concluded that the connection did not meet even the loosest standard." *Id.*

46. *Id.* at 387-88.

47. *Id.* at 386. According to the Court, states accepted "very generalized statements as to the necessary connection" between an exaction and a development; a "very exacting correspondence," under which the exaction fails if it is not "directly proportional to the specifically created need"; or a "reasonable relationship" test, described as an "intermediate" standard. *Id.* at 389-90.

48. *Id.* at 391.

49. *Id.*

50. *Id.* (emphasis added).

51. *Id.* (emphasis added). An open space reservation condition would comport with the essential nexus test because it would "likely confine the pressures on Fanno Creek created by petitioner's development." *Id.* at 393.

52. *Id.*

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to see why recreational visitors trampling along petitioner's floodplain easement are sufficiently related to the city's legitimate interest in reducing flooding problems along Fanno Creek, and the city has not attempted to make any individualized determination to support this part of its request."⁵³ On the other hand, while the city's demand for a pedestrian/bicycle pathway was sufficiently related, in theory, to an increase in traffic that might arise from the new store,⁵⁴ the Court refused to uphold that exaction because there was no clear showing that it was indeed roughly proportional to the impacts of Ms. Dolan's development.⁵⁵

Dolan thus refined the *Nollan* nexus test in two important ways. First, it held that exactions must be roughly proportional in nature and extent, not merely related, to the impacts of a proposed development.⁵⁶ Second, it shifted the burden of showing the required degree of connection to the government.⁵⁷

III. The Search for the Limits of the Essential Nexus Requirement

In the years since *Dolan*, lower courts consistently have applied the essential nexus test to land use exactions similar to those challenged in *Nollan* and *Dolan*.⁵⁸ Indeed, they have had surprising little difficulty applying the dual aspects of the test to strike down exactions when presented with facts similar to those in *Nollan* and *Dolan*.⁵⁹ Thus, unlike the Court's other regula-

53. *Id.*

54. *Id.* at 395. The Court stated:

[W]e have no doubt that the city was correct in finding that the larger retail sales facility proposed by petitioner will increase traffic on the streets of the Central Business District Dedications for streets, sidewalks, and other public ways are generally reasonable exactions to avoid excessive congestion from a proposed property use.

55. *Id.* at 395-96. The city's conclusion "that the creation of the pathway 'could offset some of the traffic demand . . . and lessen the increase in traffic congestion,'" was not specific enough to pass the rough proportionality test: "No precise mathematical calculation is required, but the city must make some effort to quantify its findings in support of the dedication for the pedestrian/bicycle pathway beyond the conclusory statement that it could offset some of the traffic demand generated." *Id.*

56. For an excellent summary of the requirements of the *Dolan* test, see Callies, *supra* note 12, at 549-50.

57. *Dolan v. City of Tigard*, 512 U.S. 374, 391 n.8 (1994).

58. See *Culbro Corp. v. Town of Simsbury*, CV 960559508, 1999 Conn. Super LEXIS 551 at *9 (Conn. Super. Ct. Mar. 1 1999) (reviewing twenty percent open-space dedication requirement under *Dolan*); *River Birch Ass'n v. City of Raleigh*, 388 S.E.2d 538, 550 (N.C. 1990) (applying *Nollan* to forced conveyance of recreational area to home owner's association); *Trimen Dev. Co. v. King County*, 877 P.2d 187, 194 (Wash. 1994) (applying *Dolan* to open-space dedication requirement).

59. See generally *Goss v. City of Little Rock*, 151 F.3d 861 (8th Cir. 1998) (holding

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tory takings tests, particularly the economically viable use standard articulated in *Lucas v. South Carolina Coastal Council*,⁶⁰ the essential nexus standard is routinely enforced beyond the halls of the High Court, at least with respect to dedications of real property.⁶¹

The test is hardly as healthy, however, when challenged land use regulations arise from a factual context distinct from that in *Nollan* and *Dolan*. In these situations, there is only agreement that the "rough proportionality" prong of the essential nexus test does not apply when there is no conditioned permit at issue.⁶² When a permit condition is implicated, courts have split along two key issues, namely whether *Nollan* and *Dolan* apply to monetary exactions, and whether they are relevant to land use conditions imposed by general legislation.

highway dedication condition unconstitutional); *Walz v. Town of Smithtown*, 46 F.3d 162 (2d Cir. 1995) (applying essential nexus test to strike down requirement that landowners deed portions of their property in return for water service); *Christopher Lake Dev. Co. v. St. Louis County*, 35 F.3d 1269 (8th Cir. 1994) (applying *Nollan* and *Dolan* to strike down requirement that land developer build drainage system for county); *Isla Verde Int'l Holdings, Inc. v. City of Camas*, 990 P.2d 429 (Wash. Ct. App. 1999) (holding exaction of open space reservation unconstitutional under *Nollan* and *Dolan*); *Burton v. Clark County*, 958 P.2d 343, 354 (Wash. Ct. App. 1998) (holding exaction of "right-of-way" unconstitutional under *Nollan* and *Dolan* because "exacted road lacks any tendency to solve or even alleviate the public problems that the county identifies"); *LuxembourgGroup, Inc. v. Snohomish County*, 887 P.2d 446, 448 (Wash. Ct. App. 1995) (noting that dedication requirement is unconstitutional if unrelated to development problem).

60. 505 U.S. 1003 (1992). In *Lucas*, the Court held that a per se regulatory taking occurs when the government denies all "economically viable use." Unfortunately, some lower courts have burdened this rule with expansive and controversial exceptions. See R.S. Radford & J. David Breemer, *Great Expectations: Will Palazzolo v. Rhode Island Clarify the Murky Doctrine of Investment-Backed Expectations in Regulatory Takings Law?*, 9 N.Y.U. ENVTL. L.J. 449, 472-531 (2001) (discussing *Lucas* decision and post-*Lucas* doctrine).

61. See Callies, *supra* note 12, at 567 ("Courts since *Dolan*, both state and federal, appear to have adopted completely both the nexus and proportionality tests . . .").

62. See *City of Monterey v. Del Monte Dunes*, 526 U.S. 687, 703 (1999) (declaring that *Dolan* was "inapposite" to *Del Monte Dunes*' challenge of denial of development application); *Clajon Prod. Corp. v. Petera*, 70 F.3d 1566, 1578-79 (10th Cir. 1995) (refusing to apply *Nollan* and *Dolan* to statute limiting hunting on private land); *Santa Monica Beach, Ltd. v. Superior Court*, 968 P.2d 993, 1002 (Cal. 1999) (holding *Nollan* and *Dolan* inapplicable to rent control challenge); *Brenner Ass'n v. City of Del Mar*, 69 Cal. App. 4th 166, 175-76 (1998) (holding *Nollan* and *Dolan* inapplicable to denial of building permit); *Largent v. Klickitat County*, No. 18231-2-III, 2000 Wash. App. LEXIS 1166, at *15 (Wash. Ct. App. July 6, 2000) (refusing to apply *Dolan* to denial of road construction variance). But see *Steel v. Cape Corp.*, 677 A.2d 634, 641, 651 (Md. Ct. Spec. App. 1996) (applying *Dolan* to open space zoning). For a more extensive summary of cases refusing to apply *Dolan* to a permit denial, see Richard J. Ansson, Jr., *Dolan v. Tigard's Rough Proportionality Standard: Why This Standard Should Not Be Applied to an Inverse Condemnation Claim Based upon Regulatory Denial*, 10 SETON HALL CONST. L.J. 417 (2000).

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A. The Tenuous Application to Monetary Exactions

The most contentious and most litigated issue to arise from *Nollan* and *Dolan* is whether the essential nexus requirement applies to monetary exactions. Monetary exactions are often characterized as either "impact fees" or "in lieu" fees, depending upon whether government initially demands money or actual capital facilities,⁶³ but the effect is the same: a prospective developer must hand over cash in exchange for government approval and permits.⁶⁴ In the period between *Nollan* and *Dolan*, federal and state courts consistently refused to extend *Nollan* to monetary exactions⁶⁵ most often by simply pointing to the fact that *Nollan* involved an exaction of real property.⁶⁶ All this changed, however, with the Court's decision in *Dolan*

63. See *Bd. of County Comm'rs v. Bainbridge, Inc.*, 929 P.2d 691, 698-99 (Colo. 1996) (describing differences between impact fees and in lieu fees); see also Hetzel & Gough, *supra* note 10, at 237-39 (discussing various characterizations and uses of monetary exactions).

64. *Id.* The question of the applicability of *Nollan* and *Dolan* to these conditions is of great practical importance to landowners, for in recent years governments increasingly have turned to them as a way to raise capital for public improvements. See generally James Berger, Note, *Conscripting Private Resources to Meet Urban Needs: The Statutory and Constitutional Validity of Affordable Housing Impact Fees in New York*, 20 FORDHAM URB. L.J. 911 (1993).

65. See *Commercial Builders of Northern Cal. v. City of Sacramento*, 941 F.2d 872, 875 (9th Cir. 1991) (holding *Nollan* inapplicable to impact fee designed to provide low-income housing); *Adolph v. Fed. Emergency Mgmt. Agency*, 854 F.2d 732, 737 (5th Cir. 1988); *Naegele Outdoor Advertising, Inc. v. City of Durham*, 844 F.2d 172, 178 (4th Cir. 1988); *Blue Jeans Equities West v. City & County of San Francisco*, 4 Cal. Rptr. 2d 114, 115 (Cal. Ct. App. 1992) (holding *Nollan* inapplicable to San Francisco's Transit Impact Development Fee); *McCarthy v. City of Leawood*, 894 P.2d 836, 845 (Kan. 1995) (refusing to apply *Dolan* to traffic impact fee).

66. See, e.g., *Commercial Builders*, 941 F.2d at 874 (noting that no previous cases "have interpreted [*Nollan*] as changing the level of scrutiny to be applied to regulations that do not constitute a physical encroachment on land"). *Commercial Builders* is a good example of early judicial attitudes toward monetary exactions. There, the City of Sacramento enacted an ordinance that required commercial developers to pay a fee "into a fund to assist in the financing of low-income housing," prior to receiving a building permit. *Id.* at 873. The ordinance was premised on a city-commissioned study that found that nonresidential development created "a need for additional housing in the city" because it tended to attract new employees to the area. *Id.* The court agreed "with the City that *Nollan* does not stand for the proposition that the exaction ordinance will be upheld only where it can be shown that the development is directly responsible for the social ill in question." *Id.* at 875. It subsequently upheld the fee ordinance despite the "indirectness of the connection between the creation of new jobs and the need for low-income housing," because "nothing in *Nollan* or any other authority . . . requires the nexus to be more direct than that achieved through the legislative process that the city here employed." *Id.* at 876.

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⁶⁷ and the California Supreme Court's decision in the 1996 case of *Ehrlich v. City of Culver City*.⁶⁸

In *Ehrlich*, the California Supreme Court clearly endorsed the applicability of *Nollan* and *Dolan* to monetary exactions.⁶⁹ The case arose in 1988 when Richard Ehrlich, owner of a failing private tennis and recreational club in Culver City, California, attempted to amend the city's general plan and zoning scheme so that he could replace the club with a "30-unit condominium complex."⁷⁰ Concerned about the impact of the proposal on recreational space within its boundaries, the city assured Ehrlich that it would oppose his project "unless he agreed to build new recreational facilities for the city."⁷¹

Ehrlich subsequently indicated a willingness to build tennis courts for the city, which prompted the city council to approve his project conditioned on a payment of \$280,000. This money was to be provided in-lieu of four new tennis courts, and was to be used "for additional [public] recreational facilities as directed by the City Council."⁷² The council also required Ehrlich to provide

"art work," valued at one percent of the project, on the project site, or a payment of an equivalent amount into a "city art fund."⁷³ Ehrlich protested, but when it became clear that the city would not budge, he "agreed to pay the

\$280,000 recreation fee under protest in exchange for the necessary building and grading permits for the project."⁷⁴ However, as soon as the property was securely developed, Ehrlich initiated suit to have the fees declared unconstitutional under the Fifth Amendment.⁷⁵ So began an extended journey up and down the judicial ladder, with the case ending up in the California

67. After *Dolan* was decided, several courts concluded that the essential nexus requirement could not be limited to exactions of real property. See *City of Portsmouth v. Schlesinger*, 57 F.3d 12, 17-18 (1st Cir. 1995) (striking down \$1,792,960 impact fee imposed on residential housing developer); *Northern Illinois Home Builders Ass'n v. County of DuPage*, 649 N.E.2d 384, 387-90 (Ill. 1995) (applying essential nexus test to traffic impact fee); *Castle Homes Dev., Inc. v. City of Brier*, 882 P.2d 1172, 1178 (Wash. Ct. App. 1994) (holding monetary exaction invalid because it was not linked to charged development).

68. 911 P.2d 429 (Cal. 1996).

69. See *Ehrlich v. City of Culver City*, 911 P.2d 429, 433 (Cal. 1996) (holding that *Nollan* and *Dolan* "apply under the circumstances of this case, to the monetary exaction imposed by Culver City").

70. *Id.* at 433-34.

71. *Id.* at 434. In the meantime, Ehrlich went ahead and demolished the recreational facility, donating the left-over recreational equipment to the city. *Id.*

72. *Id.* at 435 (quoting from minutes of city council meeting).

73. *Id.*

74. *Id.*

75. *Id.*

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Supreme Court only after a California Court of Appeal appeared to ignore the U.S. Supreme Court's command that it consider the constitutionality of the fees in light of *Dolan*.⁷⁶

When the case finally came before it, the California Supreme Court conducted an extensive review of *Nollan* and *Dolan* and concluded that they were meant to apply anytime "the individual property owner seeks to negotiate approval of a planned development."⁷⁷ This type of bargaining process triggered the essential nexus because it put government in position to use its permitting power to appropriate property it would otherwise have to pay for.

[S]uch a discretionary context presents an inherent and heightened risk that local government will manipulate the police power to impose conditions *unrelated* to legitimate land use regulatory ends, thereby avoiding what would otherwise be an obligation to pay just compensation. In such a context, the heightened *Nollan-Dolan* standard of scrutiny works to dispel such concerns by assuring a constitutionally sufficient link between ends and means. It is the imposition of land-use conditions in individual cases, authorized by a permit scheme which by its nature allows for both the discretionary deployment of the police power and an enhanced potential for its abuse, that constitutes the *sin qua non* for application of the intermediate standard of scrutiny formulated by the court in *Nollan* and *Dolan*.⁷⁸

The court subsequently concluded that the distinction between physical dedications and monetary exactions was inconsistent with the underlying

76. *Id.* The trial court upheld the \$33,200 art fee, but agreed with Ehrlich that the larger recreational fee violated the Takings Clause because it was not reasonably related to the condominium project. This judgment was initially affirmed on appeal, but was later reversed on rehearing. In its second opinion, the California Court of Appeal held that both fees were sufficiently related to the project to satisfy the Constitution. The California Supreme Court then denied Ehrlich's petition for review, prompting him to look for relief in the United States Supreme Court. That court granted Ehrlich's petition for a writ of certiorari and promptly returned the case to the California Court of Appeal for reconsideration "in light of *Dolan*." The appellate court was unmoved by the Court's remand, upholding the fees in a third opinion. Ehrlich petitioned the California Supreme Court once more, and this time the court granted Ehrlich's petition to consider the applicability of *Nollan* and *Dolan* to monetary exactions. *Id.* at 436.

77. *Id.* at 438.

78. *Id.* at 439. The court later summarized as follows:

The essential nexus test is . . . intended to limit the government's bargaining mobility in imposing permit conditions on individual property owners – whether they consist of possessory dedications or the exaction of cash payments – that, because they appear to lack any evident connection to the public impact of the proposed land use, *may* conceal an illegitimate demand – *may* in other words, amount to "out-and-out . . . extortion."

Id. at 444 (emphasis in original).

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rationale of *Nollan* and *Dolan*: "In a context in which the constraints imposed by legislative and political processes are absent or substantially reduced, the risk of too elastic or diluted takings standard – the vice of distributive justice in the allocation of civic costs – is heightened in either case."⁷⁹ Rejecting previous cases that limited the essential nexus to exactions of real property, the court explicitly held that monetary exactions are subject to essential nexus review "when such exactions are imposed – as in this case – neither generally or ministerially, but on an individual basis"⁸⁰

Applying these principles, the court determined that the city's justifications for the \$280,000 recreation fee were insufficient to establish the constitutionally required "fit" between exaction and development impact.⁸¹ The court was particularly distressed by the city's belief that it could base a fee intended to fund *public* tennis courts on the loss of the *private* courts that would have existed on Ehrlich's land.⁸² In the court's view, this equation failed the proportionality standard because it required the landowner to supply

79. *Id.*

80. *Id.*

81. *Id.* at 447-50. The court determined that the art fee was not a development exaction at all, but "more akin to traditional land-use regulations imposing minimal building setbacks, parking and lighting conditions, landscaping requirements, and other design conditions such as color schemes, building materials and architectural amenities." *Id.* at 450. *Nollan* and *Dolan* were, therefore, inapposite not because the art fee was a monetary exaction, but because such design controls traditionally have been upheld as "valid exercises of the city's traditional police power." *Id.* The court was of a different mind, however, when it considered the recreational fee. Because this monetary exaction was one of the "special, discretionary permit conditions on development by individual property owners," it triggered *Nollan* and *Dolan*. *Id.* at 447.

Applying the nexus test to the recreational fee, the court found that the basic nexus was "plain" because "the \$280,000 fee, which the city has committed to the purchase of additional recreation facilities, will substantially advance its legitimate interest in correcting a demonstrated deficiency in municipal recreational resources." *Id.* at 448. It was troubled by the "rough proportionality" component of the test, though, because the record failed to show

"individualized findings to support the required 'fit' between the monetary exaction and the loss of a parcel zoned for commercial recreational use." *Id.* The private nature of the tennis courts demolished by Ehrlich meant that the public always had less than full rights in them and, therefore, could not expect full reimbursement for their loss under the "rough proportionality" test:

[U]nder the city's formula, the public would receive, ex gratia, \$280,000 worth of recreational facilities the cost of which it would otherwise have to finance through membership fees. Plaintiff is being asked to pay for something that should be paid for either by the public as a whole, or by a private entrepreneur in business for a profit. The city may not constitutionally measure the magnitude of its loss, or of the recreational exaction, by the value of facilities it had no right to appropriate without payment.

Id. at 449.

82. *Id.* at 448-49.

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free and open facilities to a public that had lost only the ability to access member financed facilities.⁸³ This did not mean, however, that the city could impose no fee, or even that it was barred from charging \$280,000, only that the fee "must be tied more closely to the actual impact of the land-use change the city granted plaintiff."⁸⁴ After suggesting several alternatives, the court remanded the case to the city to "reconsider its valuation of the [recreational] fee in light of the principles we have articulated."⁸⁵

The decision in *Ehrlich* lent credence to the few courts that had anticipated a broader and logically consistent application of *Nollan* and *Dolan*,⁸⁶ and thus altered the constitutional terrain surrounding monetary exactions. Although a slight majority of post-*Ehrlich* courts continue to hold the essential nexus test inapplicable to monetary exactions,⁸⁷ recently several tribunals have come to the opposite conclusion.⁸⁸ The disagreement rests primarily on the importance the courts place on the facts in *Nollan* and *Dolan* and sometimes on language in the 1999 case of *City of Monterey v. Del Monte Dunes*.⁸⁹

83. *Id.* at 449.

84. *Id.*

85. *Id.*

86. *See supra* note 67 (citing cases in which courts had concluded that *Dolan* had expanded essential nexus requirement).

87. *See Henry v. Jefferson County Planning Comm'n*, 148 F. Supp.2d 698, 709 (N.D.W. Va. 2001); *Home Builders Ass'n of Central Ariz. v. City of Scottsdale*, 930 P.2d 993, 1000 (Ariz. 1997) (refusing to apply essential nexus to water district impact fee in part because district "seeks to impose a fee, a considerably more benign form of regulation" than exaction of real property); *Lambert v. City & County of San Francisco*, 67 Cal. Rptr. 2d 562, 568-69 (Ct. App. 1997) (refusing to apply essential nexus to \$600,000 hotel conversion fee), *cert. denied*, 529 U.S. 1045 (2000); *Loyola Marymount Univ. v. Los Angeles Unified Sch. Dist.*, 53 Cal. Rptr. 2d 424, 435 (Ct. App. 1996) (holding Supreme Court cases inapplicable "in California cases involving development fees"); *Krupp v. Breckenridge Sanitation Dist.*, 19 P.3d 687, 695 (Colo. 2001) (requiring "essential nexus" and "rough proportionality").

88. *See Home Builders Ass'n of Dayton v. City of Beavercreek*, 729 N.E.2d 349, 356 (Ohio 2000) (applying dual rational nexus test to monetary exaction); *Clark v. City of Albany*, 904 P.2d 185, 189-90 (Or. Ct. App. 1995) (applying *Dolan* to monetary exaction); *Town of Flower Mound v. Stafford Estates Ltd., P'ship*, 2002 Tex. App. LEXIS1209, at **27-28 (Feb. 14, 2002) (applying essential nexus test to road improvement exaction); *Honesty in Envtl. Analysis & Legislation (HEAL) v. Cent. Puget Sound Growth Mgmt. Hearings Bd.*, 979 P.2d 864, 871 (Wash. Ct. App. 1999) ("We decline to adopt the dicta that *Nollan* and *Dolan* may be applied only to dedications of land required to allow a development to proceed.").

89. *See Henry*, 148 F. Supp. 2d at 709 (noting Court's limit of *Dolan* test to exactions and refusal to extend to denials of development proposals); *Krupp*, 19 P.3d at 697. The relevant language from *Del Monte Dunes* is: "Although in a general sense concerns for proportionality animate the Takings Clause. . . we have not extended the rough-proportionality test of *Dolan* beyond the special context of exactions – land-use decisions conditioning approval of development on the dedication of property to public use." *Del Monte Dunes*, 526 U.S. at 702 (citations omitted).

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In *Krupp v. Breckenridge Sanitation District*,⁹⁰ the Colorado Supreme Court utilized both considerations in refusing to apply *Nollan* and *Dolan* to a District's imposition of a \$4000 per unit "plant investment fee" (PIF) on a residential townhouse project.⁹¹ The court, observing that *Nollan* and *Dolan* dealt with the physical dedication of property, initially relied on the traditional avenue for avoiding application of *Nollan* and *Dolan*⁹² – that most courts have limited the essential nexus test to that context, and consequently, that the essential nexus did not in any way limit the PIF at issue.⁹³ The court explained:

There was no physical taking here. The PIF is not an exaction of land; rather it is a generally applicable service fee designed to defray the costs of expanding the wastewater treatment system directly caused by the new development. Because *Nollan*, *Dolan*, and their progeny applied heightened scrutiny only where the government demanded real property as a condition of development, we find that they are not applicable to a general development fee.⁹⁴

To buttress this conclusion, the court turned to the Supreme Court's statement in *Del Monte Dunes* that "we have not extended the rough-proportionality test of *Dolan* beyond the special context of exactions – land-use decisions conditioning approval of development on the dedication of property to public use."⁹⁵ The *Krupp* court declared that this language "made explicit the conclusion that other jurisdictions had been reaching for years," namely, that the essential nexus requirement is limited to real property exactions.⁹⁶ Although it later backtracked from this expansive reading of the *Del Monte Dunes* dicta,⁹⁷ the court ultimately concluded that, as a "generally applicable service fee" which was "neither a land use regulation nor an exaction of property as a condition of development," the PIF "does not fall into the

90. 19 P.3d 687 (Colo. 2001).

91. *Id.* at 691-92.

92. *Id.* at 695-98.

93. *Id.* at 697-98.

94. *Id.* at 697.

95. *Id.*

96. *Id.* (stating that "[t]he plain language of *City of Monterey* suggests that a *Nollan/ Dolan* analysis is appropriate in the narrow circumstance where the government conditions development on the forfeiture of private property for public use").

97. *Id.* at 698. The Court appeared to recognize that the context of the language in *Del Monte Dunes* and the holding in *Ehrlich* left room for application of the essential nexus standard to certain monetary exactions. *Id.*

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relatively narrow category of development exactions addressed by *Nollan* and *Dolan*.⁹⁸

In reaching its holding, the *Krupp* court minimized the importance of contemporaneous state court decisions, such as *Home Builders Ass'n of Dayton v. City of Beavercreek*,⁹⁹ that have applied *Nollan* and *Dolan* to monetary exactions. In *Beavercreek*, the Ohio Supreme Court faced a question almost identical to that considered in *Krupp* – whether the essential nexus test should be applied to an ordinance imposing impact fees on certain developments for the purpose of funding new roads.¹⁰⁰ The court reviewed the standards of scrutiny applied by other courts and, like the *Dolan* court, opted for the intermediate reasonable relationship test ultimately incorporated into federal takings law by *Dolan*.¹⁰¹ Although it recognized that the essential nexus, or as it termed it, the dual rational nexus test,¹⁰² evolved from cases dealing with exactions of real property, the court gave little weight to this factual distinction:

Although impact fees do not threaten property rights to the same degree as land use exactions or zoning laws, there are similarities. Just as forced easements or zoning reclassifications can inhibit the desired use of property, an unreasonable impact fee may affect the manner in which a

98. *Id.*

99. 729 N.E.2d 349 (Ohio 2000).

100. *Home Builders Ass'n of Dayton v. City of Beavercreek*, 729 N.E.2d 349, 353 (Ohio 2000).

101. *See id.* at 355-56 ("This [dual rational nexus] test applies a middle level of scrutiny that balances the prospective needs of the community against the property rights of the developer.").

102. *Id.* at 356. Noting its origins in *Nollan* and *Dolan*, and a Florida case, *Hollywood, Inc. v. Broward County*, 431 So. 2d 606 (Fla. Ct. App. 1983), the court described the "dual rational nexus test" as follows:

The dual rational nexus test requires a court to determine (1) whether there is a reasonable connection between the need for additional capital facilities and the growth in population generated by the subdivision; and (2) if a reasonable connection exists, whether there is a reasonable connection between the expenditure of the funds collected through the imposition of an impact fee, and the benefits accruing to the subdivision.

Id. at 354-55.

The first prong of the above test is a reasonable rendition of the *Nollan* nexus standard. However, it is notable that second prong differs from *Dolan's* rough proportionality test by asking whether the fees benefit the development rather than whether they are proportional to the development's impact. This difference shows the influence of *Hollywood, Inc.*, in which the Florida Court of Appeals established that monetary exactions must be used so as to benefit the charged development in some way. *See Hollywood, Inc.*, 431 So. 2d at 612.

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parcel of land is developed. Further, impact fees are closer in form to land exactions than to zoning laws.¹⁰³

Thus, in stark contrast to *Krupp*, the *Beavercreek* decision placed the imposition of excessive and arbitrary impact fees upon the same constitutional plane as demands for physical dedications.¹⁰⁴ To get around the implications of this holding, the *Krupp* court blithely dismissed *Beavercreek* as a case that

"discussed *Nollan* and *Dolan* in the context of service fees but ultimately articulated a 'reasonable relationship' test."¹⁰⁵ Apparently, the Colorado court did not realize that *Dolan* specifically adopted the exact same standard in the guise of "rough proportionality."¹⁰⁶

In the 2002 case of *Town of Flower Mound v. Stafford Estates, Ltd.*,¹⁰⁷ the Texas Court of Appeals sided with the *Beavercreek* court, holding that there is no basis for applying the heightened scrutiny required by *Nollan* and *Dolan* to exactions of real property, but not to demands for money.¹⁰⁸ In *Town of Flower Mound*, the Town required a developer to demolish and replace an existing asphalt street with a concrete road and three-foot high concrete shoulders at the developer's expense in return for permission to build a 247-unit residential subdivision.¹⁰⁹ Treating the Town's demands as a monetary exaction, the court concluded that these exactions present the same dangers as demands for real property and thus that the essential nexus test logically applies to both situations.¹¹⁰ In so doing, the court rejected the assertion, accepted by the *Krupp* court, that *Del Monte Dunes* limited *Nollan* and *Dolan* to dedications of real property.¹¹¹ It ultimately held that the Town failed to satisfy the "rough proportionality" test because it did not demonstrate that "the additional traffic generated by the Subdivision bears a sufficient relationship to the requirement that Stafford demolish a nearly new, two land asphalt road that was not in disrepair and replace it with a two-land concrete road."¹¹² Thus, while consensus on the applicability of the nexus test to monetary exactions continues to allude courts, there is growing recognition that

103. *Beavercreek*, 729 N.E.2d at 355.

104. See *Krupp v. Breckenridge Sanitation Dist.*, 19 P.3d 687, 698 (Colo. 2001).

105. *Id.*

106. See *Dolan v. City of Tigard*, 512 U.S. 374, 391 (1994).

107. 2002 Tex. App. LEXIS 1209 (Feb. 14, 2002).

108. *Town of Flower Mound v. Stafford Estates, Ltd.*, 2002 Tex. App. LEXIS 1209, at **31-32 (Feb. 14, 2002).

109. *Id.* at **4-6.

110. *Id.* at **30-31.

111. *Id.* at **26-27.

112. *Id.* at **59-61.

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the logic of *Nollan* and *Dolan* apply in such a context and that the Supreme Court has not otherwise precluded courts from moving in that direction.¹¹³

B. Legislative vs. Adjudicative Exactions

Evan as the split over monetary exactions begins to favor applying *Nollan* and *Dolan*, a controversy over the applicability of the nexus test to legislative acts continues to retard judicial consistency in application of that test. Indeed, when courts hold the essential nexus test inapplicable to monetary exactions, the result is occasionally justified not only by the nature of the exaction, but also by the fact it emanated from a legislative, rather than an administrative, body.¹¹⁴ The source of an exaction is, in fact, an important factor in exactions cases in general, with courts as deeply divided over the issue as they are over the standard to be applied to monetary exactions.¹¹⁵

The disagreement over legislative exactions traces largely to comments made by the *Dolan* Court suggesting that the adjudicative nature of the exaction was a relevant factor in its decision.¹¹⁶ *Dolan* twice drew attention to the adjudicative nature of the challenged exactions – once in rejecting a deferential standard normally reserved for "essentially legislative determinations classifying entire areas of the city"¹¹⁷ and, later, in justifying the

113. See, e.g., *id.* at **26-27; *Benchmark Land Co. v. City of Battleground*, 14 P.3d 172, 173 (Wash. Ct. App. 2000), *rev. granted*, 2001 Wash. LEXIS 352 (May 2, 2001).

114. See *Krupp*, 19 P.3d at 698 (concluding that "plant investment fee" was not subject to the essential nexus test in part because fee "is not imposed adjudicatively in the *Nollan/Dolan* sense"); *Arcadia Dev. Corp. v. City of Bloomington*, 552 N.W.2d 281, 286 (Mn. Ct. App. 1996) (holding *Dolan* inapplicable to requirement that mobile home park owners pay "relocation costs" to displaced tenants because fee flowed from city-wide ordinance).

115. See Callies, *supra* note 12, at 572 (noting that courts are unclear on "whether to apply the tests from [*Nollan* and *Dolan*] to 'legislative' determinations").

116. See *Tex. Manufactured Housing Ass'n, Inc. v. Nederland*, 101 F.3d 1095, 1105 (5th Cir. 1996) (citing distinction noted in *Dolan* about land use regulations that are legislative in character); *Harris v. City of Wichita*, 862 F. Supp. 287, 294 (D. Kan. 1994) (noting *Dolan* Court's comments on legislative nature of *Dolan* regulations and determining that *Dolan*'s rough proportionality test does not apply in instant case due to legislative nature of regulations at issue); *Parking Ass'n of Ga., Inc. v. City of Atlanta*, 450 S.E.2d 200, 203 n.3 (Ga. 1994) (distinguishing Atlanta ordinance from *Dolan* because Atlanta ordinance was "a legislative determination"); *Curtis v. Town of S. Thomaston*, 708 A.2d 657, 660 (Me. 1998) (relying on *Dolan* language about legislative nature of regulation to support conclusion that South Thomaston's regulation, as example of legislative rule, "more likely represents a carefully crafted determination of need tempered by the political and legislative process"); see also *Garneau v. City of Seattle*, 897 F. Supp. 1318, 1325 (W.D. Wash. 1995) (noting that *Dolan* emphasized adjudicative nature of exaction struck down in that case).

117. *Dolan v. City of Tigard*, 512 U.S. 374, 385 (1994). The court stated:
The sort of land use regulations discussed in the cases just cited, however, differ in two relevant particulars from the present case. First, they involved essentially

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placement of the burden to show rough proportionality on the city.¹¹⁸ While the Court left its implied deference to legislative exactions unexplained, lower courts often cite the lower danger of extortion present in generally applicable lawmaking. *Ehrlich* is the leading example.¹¹⁹

In *Ehrlich*, the California Supreme Court held that *Nollan* and *Dolan* apply to monetary exactions imposed on a discretionary, individual basis because they present "a heightened risk that local government will manipulate the police power to impose conditions unrelated to legitimate land use regulatory ends."¹²⁰ The court subsequently suggested that exactions imposed

"generally or ministerially" were likely to be free of such manipulation: "Fees of this nature may indeed be subject to a lesser standard of judicial scrutiny than that formulated by the court in *Nollan* and *Dolan* because the heightened risk of the 'extortionate use' of the police power to exact unconstitutional conditions is not present."¹²¹

legislative determinations classifying entire areas of the city, whereas here the city made an adjudicative decision to condition petitioner's application for a building permit on an individual parcel.

118. *Id.* at 391 n.8. The court further noted:

[Justice Stevens] is correct in arguing that in evaluating most generally applicable zoning regulations, the burden properly rests on the party challenging the regulation to prove that it constitutes an arbitrary regulation of property rights. Here, by contrast, the city made an adjudicative decision to condition petitioner's application for a building permit on an individual parcel. In this situation, the burden properly rests with the city.

Id. (citation omitted).

119. *See supra* notes 69-85 and accompanying text (discussing *Ehrlich*).

120. *Ehrlich v. City of Culver City*, 991 P.2d 429, 439 (Cal. 1996).

121. *Id.* at 444. The court additionally noted that "it is not at all clear that the rationale (and the heightened standard of scrutiny) of *Nollan* and *Dolan* applies to cases in which the exactions takes the form of a generally applicable development fee or assessment." *Id.* at 447.

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The concurring opinion of Justice Stanley Mosk¹²² forcefully elaborated on the same theme, as did the court's later opinion in the case of *Santa Monica Beach, Ltd. v. Superior Court*.¹²³ This trend was further solidified in the recent case of *San Remo Hotel v. San Francisco*,¹²⁴ in which the Supreme Court of California held that the City of San Francisco did not engage in a taking when requiring the owner of a residential hotel to pay \$567,000 in return for permission to convert sixty-two residential units to tourist rooms.¹²⁵ In determining that the fee was subject to deferential review, rather than the essential nexus test, the court focused on the fact that the fee was imposed pursuant to a "generally applicable" city ordinance that required all residential hotels wishing to convert to tourist uses to build replacement units or pay an in-lieu fee sufficient to cover the cost of such units.¹²⁶

When state courts outside California reject exaction challenges, they also tend to point to the general applicability of the condition.¹²⁷ In *Parking Ass'n of Georgia, Inc. v. City of Atlanta*,¹²⁸ for instance, the Georgia Supreme Court relied on the general applicability of a zoning ordinance that required individuals who owned parking lots of thirty spaces or more to bear all the

122. See *id.* at 459-61 (Mosk, J., concurring) (advocating heightened scrutiny for development fees imposed by land use regulations). In his concurring opinion, Justice Mosk explained:

This risk [of extortion] diminishes when the fee is formulated according to preexisting statutes or ordinances which purport to rationally allocate the costs of development among a general class of developers or property owners But when the fee is ad hoc, enacted at the time the development application was approved, there is a greater likelihood that it is motivated by the desire to extract the maximum revenue from the property owner seeking the development permit, rather than on a legislative policy of mitigating the public impacts of development or of otherwise reasonably distributing the burdens of achieving legitimate government objectives.

Id. at 459-60.

123. See *Santa Monica Beach, Ltd. v. Superior Court*, 968 P.2d 993, 1002 (Cal. 1999) (holding *Nollan* and *Dolan* inapplicable to rent control challenge).

124. 117 Cal. Rptr. 2d 269 (2002).

125. See *San Remo Hotel v. San Francisco*, 117 Cal. Rptr. 2d 269, 273-74 (2002) (holding that trial court "properly denied . . . the demurrer as to the [taking] action").

126. *Id.* at 288-89.

127. See, e.g., *Home Builders Ass'n of Cent. Az. v. City of Scottsdale*, 930 P.2d 993, 1000 (Az. 1997) (noting general applicability of Scottsdale's water fee as one reason supporting court's decision to uphold water fee); *Parking Ass'n of Ga., Inc. v. City of Atlanta*, 450 S.E.2d 200, 203 (Ga. 1994) (upholding parking lot regulations that apply to lots with thirty or more spaces); *Curtis v. Town of S. Thomaston*, 708 A.2d 657, 660 (Me. 1998) (supporting decision to uphold regulation with argument that conditions on land use were imposed by "a legislative rule of general applicability").

128. 450 S.E.2d 200 (Ga. 1994).

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costs of providing "minimum barrier curbs and landscaping areas equal to at least ten percent of the paved area within a lot, ground cover (shrubs, ivy, pine bark or similar landscape materials) and at least one tree for every eight parking spaces," as a basis for its decision.¹²⁹ The court refused to apply *Dolan* because "[h]ere the city made a *legislative determination with regard to many landowners* and it simply limited the use the landowners might make of a small portion of their lands."¹³⁰

Most courts go one step further and, following *Ehrlich*, cite the lower probability of extortion in general legislative acts. In *Home Builders Ass'n of Central Arizona v. City of Scottsdale*,¹³¹ the Arizona Supreme Court turned back a takings challenge to a "water resources development fee" because the danger of improper "leveraging [of the police power] does not exist when the exaction is embodied in a generally applicable legislative decision."¹³²

Similarly, in *Curtis v. Town of South Thomaston*,¹³³ the Supreme Judicial Court of Maine dismissed a challenge under *Dolan* to an ordinance requiring subdivision developers to build "a 250,000 gallon fire pond" and then convey a "right of way or easement" to the town "[b]ecause the Town's dedication requirement is a legislative rule, this requirement more likely represents a carefully crafted determination of need tempered by the political and legislative processes rather than a 'plan of extortion' directed at a particular land owner."¹³⁴ Not all courts find merit in the legislative distinction, however, or its purported theoretical basis.¹³⁵ Oregon courts are particularly skeptical. In *Shultz v. City of Grants Pass*,¹³⁶ the Oregon Court of Appeals rejected the city's argument that a land dedication condition imposed by ordinance was not subject to *Nollan* and *Dolan*, stating:

129. *Parking Ass'n of Ga., Inc. v. City of Atlanta*, 450 S.E.2d 200, 201-02 (Ga. 1994); *see id.* at 203 (refusing to apply *Dolan* because of general applicability of zoning ordinance).

130. *Id.* at 203 n.3 (emphasis added). It, therefore, applied a test that "weighs the benefit to the public against the detriment to the individual." *Id.* at 202. The court found that there was no significant detriment to the parking lot owners and, thus, no taking. *Id.* at 202-03 (quoting *Gradous v. Bd. of Comm'rs*, 349 S.E.2d 707, 709 (Ga. 1986)).

131. 930 P.2d 993 (Az. 1997).

132. *Home Builders Ass'n of Cent. Az. v. City of Scottsdale*, 930 P.2d 993, 994, 1000 (Az. 1997).

133. 708 A.2d 657 (Me. 1998).

134. *Curtis v. Town of S. Thomaston*, 708 A.2d 657, 660 (Me. 1998).

135. *See J.C. Reeves Corp. v. Clackamas County*, 887 P.2d 360, 365 (Or. Ct. App. 1994) (noting that "the nature, not the source" of land use regulations is what matters in constitutional analysis irrespective of whether regulation emanated from legislative or case-specific formulations); *Trimen Dev. Co. v. King County*, 877 P.2d 187 (Wash. 1994).

136. 884 P.2d 569 (Or. Ct. App. 1994).

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The city insists that, because the relevant ordinances *require* the imposition of such conditions, the decision to do so is, in reality, a legislative one. The city misses the point. Even if that were so, the character of the restriction remains the type that is subject to the analysis in *Dolan*. In drawing its distinction between the legislative land use decisions that are entitled to a presumption of validity and the exactions that are not, the Supreme Court noted that what triggers the heightened scrutiny of exactions is the fact that they are "not simply a limitation of the use" to which an owner may put his or her property, but rather a requirement that the owner deed portions of the property to the local government.¹³⁷

The court went one step further in *J.C. Reeves Corp. v. Clackamus County*,¹³⁸ concluding that the legislative/adjudicative distinction was irrelevant in the context of monetary as well as real property exactions.¹³⁹ There, the court considered whether a condition requiring a prospective developer to pay all of the costs of road improvements adjacent to his land violated the Takings Clause.¹⁴⁰ Quoting *Shultz*, the court stated, "[T]he character of the [condition] remains the type that is subject to the analysis in *Dolan*,⁷ whether it is legislatively required or a case-specific formulation. The nature, not the source, of the imposition is what matters."¹⁴¹ To make sure it was being clear, the court emphasized that "[a] condition on the development of particular property is not converted into something other than that by reason of legislation that requires it to be imposed."¹⁴² The court subsequently concluded that the road improvement fees could not be reconciled with *Nollan* and *Dolan*.¹⁴³

Several courts outside of Oregon also have refused to adopt the distinction between legislative and administrative exactions. In *Amoco Oil Co. v. Village of Schaumburg*,¹⁴⁴ an Illinois appellate court refused to give any

137. *Shultz v. City of Grant Pass*, 884 P.2d 569, 573 (Or. Ct. App. 1994) (citation omitted).

138. 887 P.2d 360 (Or. Ct. App. 1994).

139. *Id.* at 365.

140. *Id.* at 361-62.

141. *Id.* at 365 (citation omitted).

142. *Id.* at 365 n.1.

143. *See id.* at 365 (reversing and remanding on issue of road improvements).

144. 661 N.E.2d 380 (Ill. App. Ct. 1995). Illinois courts typically apply a higher standard of scrutiny to land use exactions than that adopted by the Supreme Court in *Nollan* and *Dolan*. *See Dolan v. City of Tigard*, 512 U.S. 374, 389-90 (1994). However, the court's rejection of the legislative/adjudicative distinction in *Amoco Oil* was premised largely on Justice Thomas's dissent to a denial of a petition for certiorari in *Parking Ass'n of Ga., Inc. v. City of Atlanta*, 515

U.S. 1116, 1117-18 (1995) (Thomas, J., dissenting from denial of certiorari). *See Amoco Oil Co. v. Vill. of Schaumburg*, 661 N.E.2d 380, 390 (Ill. App. Ct. 1995) ("Although not binding as precedent, we find Justice Thomas's comments particularly persuasive and consonant with

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credence to the city's argument that it could "skirt its obligation to pay compensation when taking private property for public use merely by having the Village Board of trustees pass an 'ordinance' rather than having a planning commission issue a permit."¹⁴⁵ Accordingly the court held that the city affected a taking when it conditioned a zoning change on the landowner's dedication of twenty percent of its property for use in the redesign of an inter-section.¹⁴⁶ The Washington Supreme Court¹⁴⁷ and a Washington state appeals court also have applied the essential nexus requirement to a legislative exaction.¹⁴⁸

IV. The Case for Jettisoning Judicial Exceptions to the Essential Nexus Requirement

When one looks beyond the bare facts of *Nollan* and *Dolan* and examines the purposes underlying the essential nexus standard, it becomes apparent that the test cannot easily be limited to exactions of real property and/or exactions imposed administratively. Indeed, those purposes logically call for an integrated doctrine that recognizes the constitutional equivalency of monetary exactions. Statements from the Supreme Court are consistent with and, in fact, support such a reading. Indeed, given the lack of a clear basis for distinguishing money from real property for takings purposes, a harmonized exaction doctrine is a rather unremarkable proposition.¹⁴⁹

the rationale underlying *Dolan* and similar cases.").

145. *Amoco Oil*, 661 N.E.2d at 389.

146. *Id.* at 381, 391-92.

147. See *Trimen Dev. Co. v. King County*, 877 P.2d 187, 194 (Wash. 1994) (citing *Dolan v. City of Tigard*, 512 U.S. 374 (1994) and applying "rough proportionality" test). In *Trimen*, the Washington Supreme Court ignored the legislative/adjudicative distinction in applying *Dolan* to an ordinance that made subdivision approvals "contingent upon reservation or dedication of land for the open space and recreational needs of its residents, but which ultimately required a developer to pay a fee of more than fifty thousand dollars "in lieu of providing open space." *Id.* at 189-90.

148. See *Honesty in Env'tl. Analysis & Legislation (HEAL) v. Cent. Puget Sound Growth Mgmt. Hearings Bd.*, 979 P.2d 864, 871 (Wash. Ct. App. 1999) (concluding that *Nollan* and *Dolan* apply to Seattle ordinance that clarified policies to be considered in designating critical environmental areas).

149. The applicability of the Takings Clause to money is not fully settled. This is illustrated by the ongoing battle over the constitutionality of state interest on lawyer trust fund account (IOLTA) programs, which require lawyers to deposit some client funds into interest bearing bank accounts and then facilitate the transfer of the generated interest to certain groups providing legal services to the indigent. See generally J. David Breemer, Comment, *IOLTA in the New Millennium: Slowly Sinking Under the Weight of the Takings Clause*, 23 U. HAW. L. REV. 221 (2000) (arguing that IOLTA programs are unconstitutional takings of private property). In 1998, the Supreme Court rejected the time-worn, and often successful, argument

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EVOLUTION OF THE "ESSENTIAL NEXUS"

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A. The Essential Nexus Test Should Apply to Monetary Exactions

1. The Purposes of the Essential Nexus Requirement Compel Its Application to Monetary Exactions

The essential nexus test is grounded primarily in a concern for protecting individuals from bearing public burdens that should be borne by the public as a whole.¹⁵⁰ The nexus test reflects that concern by requiring a strong causal link between development and exaction, thus ensuring that the landowner rectifies only those public problems that flow from the development. Once she is required to solve (pay for) problems or a portion of a problem not arising from her development, a nexus and "rough proportionality" are absent, and the

that IOLTA interest was not subject to the Takings Clause because it was public rather than private property. See *Phillips v. Wash. Legal Found.*, 524 U.S. 156, 165-72 (1998) (citing rule that interest follows principle in concluding that IOLTA interest income is private property). After remand, the Fifth Circuit held that the per se takings analysis that applies to physical invasions of real property applied to, and required the invalidation of, IOLTA's confiscation of private funds. *Wash. Legal Found. v. Tex. Equal Access to Justice*, 270 F.3d 180, 185-86 (5th Cir. 2001). The Ninth Circuit originally came to a similar conclusion in an IOLTA case arising out of Washington State, but then reversed itself upon rehearing the case en banc, thus setting up a conflict that may prompt resolution by the Supreme Court. See *Wash. Legal Found. v. Legal Found. of Wash.*, 271 F.3d 835, 841 (9th Cir. 2001) (en banc) (holding that there is "no taking of property without just compensation in violation of the Fifth Amendment" for funds that lawyers deposit in client trust accounts), *petition for cert. filed*, 70 U.S.L.W. 3580 (Mar. 7, 2002) (No. 01-1325).

The Supreme Court has sent mixed signals on the applicability of the Takings Clause to "a general [monetary] liability." See *E. Enters. v. Apfel*, 524 U.S. 498, 537 (1998) (plurality opinion) (holding for plaintiff that application of Coal Act to Eastern "effects an unconstitutional taking"). In *Eastern Enterprises*, a plurality found that a congressional act requiring a defunct coal company to contribute money to a private pension fund violated the Takings Clause, *id.* at 537, even as the remaining justices indicated that the monetary liability was more properly challenged under the Due Process Clause. *Id.* at 556 (Breyer, J., dissenting). However, in other contexts, a majority of the Court consistently has portrayed money as a form of property that is protected by the Fifth Amendment. See *Phillips v. Wash. Legal Found.* 524 U.S. 156, 172 (1998) (holding that interest generated by IOLTA accounts is private property for purposes of Takings Clause); *Webb's Fabulous Pharmacies, Inc. v. Beckwith*, 449 U.S. 155 164-65 (1980) (holding that government's attempt to confiscate interest accruing on interpleader fund amounted to taking). Lower federal courts also have reviewed appropriations of money under traditional takings standards. See, e.g., *Student Loan Mktg. Ass'n v. Riley*, 104 F.3d 397, 402 (D.C. Cir. 1997) (applying ad-hoc takings inquiry to "straightforward mandate [] of cash payment to the government"), *cert. denied*, 522 U.S. 913 (1997); *LTV Steel Co. v. Shalala (In re Chateaugay Corp.)*, 53 F.3d 478, 493 (2d Cir. 1995) (applying multi-factor takings inquiry to act "requiring direct transfer[s] of funds to the government"), *cert. denied*, 516 U.S. 913 (1995).

150. See *Kmiec*, *supra* note 11, at 1651-52 (stating that one key to understanding *Nollan* is its emphasis on preventing societal burdens from being borne by only one landowner); *Laitos*, *supra* note 35, at 905 (explaining one premise behind Takings Clause as being to prevent individuals from solely bearing societal burdens).

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government has overstepped its authority.¹⁵¹ The causation requirement also weeds out exactions that are motivated by a "plan of out-and-out extortion" rather than by considerations of public health, welfare, and safety.¹⁵² Those exactions that are not needed to offset the actual impact of development are presumed to flow from an improper desire to obtain property without paying for it and, thus, must be treated as an exercise of condemnation power.¹⁵³

When courts reject the applicability of the essential nexus test to monetary exactions, they would have us believe that the concerns underlying *Nollan* and *Dolan* alter with the nature of property in danger of appropriation. But this is clearly not so. A monetary exaction can be used to force a landowner to shoulder a disproportionate share of a public burden just as easily as a demand for a dedication of real property; all that is required is that the appropriated money be designed to address a problem unrelated to the owner's use of property¹⁵⁴ or be in an amount that is excessive for addressing the problems that do arise from the property.¹⁵⁵ For instance, in *Ehrlich*, the city wanted Ehrlich to pay to solve a deficiency in public recreational facilities that existed before he ever sought a zoning reclassification.¹⁵⁶ Further, it is impossible to see how monetary exactions are immunized by their nature from

151. See Laitos, *supra* note 35, at 905-06 (citing *Dolan* as example of government over-reaching that resulted in taking because government sought to single out Ms. Dolan to bear burden for greenway construction when government's only "legitimate interest" was in "reducing flooding").

152. See *Ehrlich v. City of Culver City*, 911 P.2d 429, 444 (Cal. 1996) (noting that exactions require heightened scrutiny under *Nollan* and *Dolan*). The court explained:

The essential nexus test is . . . intended to limit the government's bargaining mobility in imposing permit conditions on individual property owners – whether they consist of possessory dedications or the exaction of cash payments – that, because they appear to lack any evident connection to the public impact of the proposed land use, may conceal an illegitimate demand – may, in other words, amount to "out-and-out . . . extortion."

Id.

153. See *Nollan v. Cal. Coastal Comm'n*, 483 U.S. 825, 837 (1987) (stating "the lack of nexus . . . converts that [police power] purpose to something other than what it was. The purpose then becomes, quite simply, the obtaining of an easement to serve some valid governmental purpose.").

154. See Laitos, *supra* note 35, at 905 (noting that when "condition or restriction is imposed on a property owner who has not caused the problem that the government action is designed to correct, then the owner is being singled out and the Takings Clause might be violated").

155. See, e.g., *Dolan*, 512 U.S. at 393 (holding that public easement was excessive means to address flood problems that might arise from landowner's proposed development).

156. *Ehrlich*, 911 P.2d at 434. The city recognized it had a deficit of recreational facilities in 1974, a year before Ehrlich even opened the private club that he later hoped to replace with condominiums. *Id.*

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acting as a vehicle of government extortion.¹⁵⁷ The law identifies extortion by looking at the characteristic pattern of behavior, not by examining the specific content of the extortionist's demands. In *Nollan*, the Court implicitly made this point when it observed that, as a measure of extortion, the essential nexus test would preclude government from conditioning the right to shout "fire" in a theater upon payment of a \$100 tax.¹⁵⁸

2. The Supreme Court Has Not Limited the Essential Nexus Requirement to Real Property Exactions

As we have seen, some courts like to justify the preclusion of the essential nexus test from monetary exactions on the ground that this "extension" is disfavored by the High Court.¹⁵⁹ In reality, the Supreme Court has sent the opposite signals, even though it has not yet given definitive word on the subject. *Ehrlich* was, after all, remanded to the California court to be reconsidered in light of *Dolan*.¹⁶⁰ The only reasonable conclusion to be drawn from this event is that at least some members of the Court viewed the essential nexus test as being relevant to impact fees at that time. A recent dissent to a denial of certiorari in *Lambert v. City & County of San Francisco*¹⁶¹ suggests that at least three justices still adhere to that view – even in the context of permit denials.¹⁶²

In the *Lambert* dissent, Justices Scalia, Kennedy, and Thomas expressed regret that the Court chose not to review a case in which the City of San

157. See *San Remo Hotel v. San Francisco*, 2002 Cal. LEXIS 623 at *55 ("[L]egislatively mandated fees do present some danger of improper leveraging."); *Honesty in Envtl. Analysis & Legislation (HEAL) v. Cent. Puget Sound Growth Mgmt. Hearings Bd.*, 979 P.2d 864, 871 (Wash. Ct. App. 1999) ("Other [nonreal property] conditions exacted to obtain development permits may differ in degree of burden short of a taking, but do not differ in kind."); see also *Cordes, supra* note 11, at 542 ("[T]he primary concern behind the *Dolan* test – that local governments will use their monopoly power to seek exactions unrelated to the impact of development – applies equally to impact fees as well as to physical exactions.").

158. *Nollan*, 483 U.S. at 837. The court stated: "[E]ven though, in a sense, requiring a \$100 tax contribution in order to shout fire is a lesser restriction on speech than an outright ban, it would not pass constitutional muster." *Id.*

159. See, e.g., *Krupp v. Breckenridge Sanitation Dist.*, 19 P.3d 687, 697 (Colo. 2001) ("Recent pronouncements by the United States Supreme Court strongly indicate that the *Nollan/Dolan* test is limited to exactions involving the dedication of property.").

160. *Ehrlich v. City of Culver City*, 512 U.S. 1231, 1231 (1994).

161. 529 U.S. 1045 (2000).

162. See *Lambert v. City & County of San Francisco*, 529 U.S. 1045, 1048-49 (2000) (Scalia, J., dissenting from denial of certiorari) (criticizing Court's decision to refuse to hear case involving demand by government that developer pay \$600,000 to obtain permit to convert apartments).

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Francisco denied a hotel owner the right to convert some residential hotel rooms to commercial use after he refused to pay \$600,000 to the city.¹⁶³ The critical issue was whether a California appellate court erred in refusing to apply *Nollan* and *Dolan* to the permit denial. While Justice Scalia saw the case as presenting an important unanswered question as to whether the essential nexus test indeed applies to a permit *denial* premised on an unpaid exaction,¹⁶⁴ there is no suggestion that the issue hinged on the nature of the exaction. On the contrary, the dissent clearly assumes that *Nollan* and *Dolan* are applicable to monetary exactions, if not permit denials:

When there is uncontested evidence of a demand for money or other property – and still assuming that denial of a permit because of failure to meet such a demand constitutes a taking – it should be up to the permitting authority to establish *either* (1) that the demand met the requirements of *Nollan* and *Dolan*, or (2) that denial would have ensued even if the demand had been met.¹⁶⁵

In fact, the dissent ultimately concludes that summary reversal and "remand for conduct of the *Nollan-Dolan* analysis" would be warranted if the appellate court's decision was based on a finding that the owner's refusal to pay the \$600,000 fee played a minimal or negligible role in the permit denial.¹⁶⁶ On the other hand, Scalia would have granted the petition and scheduled argument if the lower court premised its decision on the distinction "between the grant of a permit subject to an unlawful condition and the denial of a permit when an unlawful condition is not met."¹⁶⁷ In any case, the three dissenting justices assume that the essential nexus requirement applies to monetary exactions when a landowner is granted a permit subject to such a condition.

Although the Colorado Supreme Court thinks otherwise,¹⁶⁸ *Del Monte Dunes* does not undermine the conclusion that the essential nexus test applies to monetary exactions.¹⁶⁹ In fact, it is completely inapposite. This is clear

163. *Id.* at 1045-46, 1049 (Scalia, J., dissenting from denial of certiorari).

164. *See id.* at 1048 (Scalia, J., dissenting from denial of certiorari) (noting that lower court's "refusal to apply *Nollan* and *Dolan* might rest upon the distinction that it drew between the grant of a permit subject to an unlawful condition and the denial of a permit when an unlawful condition is not met").

165. *Id.* at 1047-48 (Scalia, J., dissenting from denial of certiorari).

166. *Id.* at 1049 (Scalia, J., dissenting from denial of certiorari).

167. *Id.* at 1048-49 (Scalia, J., dissenting from denial of certiorari).

168. *See supra* notes 90-98 and accompanying text (noting Colorado Supreme Court's use of *Del Monte Dunes* dicta to support conclusion in *Krupp* that *Nollan* and *Dolan* do not apply to monetary extractions).

169. *See* Honesty in Envtl. Analysis & Legislation (HEAL) v. Cent. Puget Sound Growth Mgmt. Hearings Bd., 979 P.2d 864, 871 (Wash. Ct. App. 1999) (declining to adopt dicta of *Del*

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when the Court's statement that it had "not extended the rough-proportionality test of *Dolan* beyond the special context of exactions – land-use decisions conditioning approval of development on dedication of property to public use [citations]"¹⁷⁰ is read in context.

The *Del Monte Dunes* Court made this statement about *Dolan* while reviewing the Ninth Circuit's decision to allow application of the rough proportionality test to Del Monte Dunes' claim that *denial of a development permit* resulted in a compensable taking. Exactions contemplated by the City of Monterey were left unchallenged by Del Monte Dunes and were never an issue before the Supreme Court. Consequently, the Court's allusion to *Dolan* cannot be read as creating a rule precluding heightened scrutiny of monetary exactions. As the Texas Court of Appeals explained, "The fact that the Supreme Court has not yet applied the Dolan test to a development exaction of fees or public improvements, as opposed to a dedication of land, does not mean that the *Dolan* test does not apply."¹⁷¹ Indeed, *Del Monte Dunes* simply articulates the unremarkable principle that *Dolan*'s "rough proportionality" test does not apply to outright permit denials.¹⁷² As a result, the Court's remand of *Ehrlich* and the dissent to denial of certiorari in *Lambert* are the only viable indicators of the Court's thinking on the applicability of the essential nexus test to monetary exactions. These actions declare what the purposes of the test clearly imply: the nexus standard does not vary in applicability according to whether the government chooses to appropriate real property or money.

B. Courts Should Apply the Essential Nexus Requirement to Legislative Exactions

There is as little to support a lower level of scrutiny for exactions levied pursuant to legislative acts as there is to justify an exception from essential nexus review for monetary exactions.¹⁷³ As one commentator puts it,

Monte Dunes that *Nollan* and *Dolan* apply "only to dedications of land required to allow a development to proceed").

170. *City of Monterey v. Del Monte Dunes at Monterey, Ltd.*, 526 U.S. 687, 702 (1999).

171. *Town of Flower Mound v. Stafford Estates, Ltd.*, 2002 Tex. App. LEXIS 1209, at *26 (Feb. 14, 2002).

172. *Id.* at *25 ("The *Del Monte Dunes* holding is logical. If no exaction, i.e., no action or concession is required of the landowner, a determination cannot be made about whether the action or concession . . . is roughly proportional to the public consequences of the requested land use.").

173. See Callies, *supra* note 12, at 567-68 (noting that "there appears to be little doctrinal basis beyond blind deference to legislative decisions to limit [the essential nexus and proportionality doctrines] application only to administrative or quasi-judicial acts of government regulators"); Cordes, *supra* note 11, at 539 ("The better view is that *Dolan* should

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"[a]lthough the distinction between legislative and adjudicative functions of government has important procedural implications, it is not at all clear that the distinction should have any relevance with respect to the substantive protection of property rights."¹⁷⁴ In fact, the distinction is not only meaningless from the landowner's point of view, but also inconsistent with the principles underlying *Nollan* and *Dolan* and the Takings Clause in general. It is also an impracticable standard for courts to apply.

I. Nollan and Dolan Apply to Legislative Acts as Part of the Unconstitutional Conditions Doctrine

In *Dolan*, the Court suggested that its decision sprang from the broader "unconstitutional conditions" doctrine,¹⁷⁵ which, to simplify, holds that government may not seek a waiver of a constitutional right in return for a discretionary governmental benefit.¹⁷⁶ Although there are reasons for believing that *Nollan* and *Dolan* should not be viewed as unconstitutional conditions cases,¹⁷⁷ the question is clearly open to debate.¹⁷⁸ In any case, to the extent that *Nollan* and *Dolan* flow from the unconstitutional conditions doctrine, courts should not limit the essential nexus test to administrative exactions because no distinction between legislative and administrative conditions exists in unconstitutional conditions cases involving other

apply to permit conditions even when imposed pursuant to legislative requirements.").

174. James L. Huffman, *Dolan v. City of Tigard: Another Step in the Right Direction*, 25 ENVTL. L. 143, 150 (1995).

175. See *Dolan v. City of Tigard*, 512 U.S. 374, 385 (1994). The Court introduced the issue in *Dolan* with the following statement:

In *Nollan* . . . we held that governmental authority to exact such a condition was circumscribed by the Fifth and Fourteenth Amendments. Under the well-settled doctrine of "unconstitutional conditions," the government may not require a person to give up a constitutional right – here the right to receive just compensation when property is taken for a public use – in exchange for a discretionary benefit conferred by the government where the benefit sought has little or no relationship to the property.

Id.

176. See Thomas W. Merrill, *Dolan v. City of Tigard: Constitutional Rights as Public Goods*, 72 DENV. U. L.REV. 859, 859 (1995) ("The unconstitutional conditions doctrine directs courts not to enforce certain contracts that waive constitutional rights.").

177. See Laitos, *supra* note 35, at 904 (arguing that *Dolan* rests on purposes of Takings Clause rather than on unconstitutional conditions doctrine).

178. See RICHARD A. EPSTEIN, *BARGAINING WITH THE STATE* 179-84 (1993) (arguing that *Nollan* implicates doctrine of unconstitutional conditions); Merrill, *supra* note 176, at 886-88 (arguing that *Dolan* can be viewed as unconstitutional conditions case grounded in concern for positive externalities associated with strong Fifth Amendment).

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constitutional provisions.¹⁷⁹ On the contrary, in many of these decisions, courts have held generally applicable legislation unconstitutional.¹⁸⁰ If the Fifth Amendment is as much a part of the unconstitutional conditions doctrine as the First Amendment,¹⁸¹ the essential nexus test must be equally relevant to suspect legislative conditions.

2. Generally Applicable Takings Are Still Takings

The notion that legislative exactions are generally applicable, rather than directed toward particular individuals, is not a sufficient basis for diminishing the potency of the Fifth Amendment and of the Takings Clause. The assumption that exaction legislation is generally applicable is itself dubious,¹⁸² but even if true, that trait logically cannot alter the constitutional nature of the underlying acts. From the landowner's point of view, there is nothing magical about the fact that a law that takes property applies equally to a large number of people. Justice Thomas drove home this point in his dissent from a denial of certiorari in *Parking Ass'n of Georgia*:

It is not clear why the existence of a taking should turn on the type of governmental entity responsible for the taking. A city council can take property just as well as a planning commission can. *Moreover, the general applicability of the ordinance should not be relevant in a takings analysis. If Atlanta had seized several hundred homes in order to build a freeway, there would be no doubt that Atlanta had taken property.* The distinction between sweeping legislative takings and particularized

179. Many federal unconstitutional conditions cases deal with challenges to statutorily imposed conditions. *See, e.g.,* *Rust v. Sullivan*, 500 U.S. 173, 203 (1991) (permitting Congress to condition health care funding on restrictions on speech encouraging abortion); *Regan v. Taxation with Representation*, 461 U.S. 540, 550-51 (1983) (upholding power of Congress to condition tax-exempt status for nonprofit groups on their willingness to give up lobbying).

180. *See* *United States v. Nat'l Treasury Employees Union*, 513 U.S. 454, 457 (1995) (striking down federal statute that banned certain government employees from making speeches or writing articles); *Metro. Washington Airports Auth. v. Citizens for Abatement of Aircraft Noise, Inc.*, 501 U.S. 252, 272-77 (1991) (striking down federal law conditioning disposal of federal property in way that undermines executive branch power); *FCC v. League of Women Voters*, 468 U.S. 364, 402 (1984) (holding that Congress may not condition broadcasting grants on agreement not to broadcast editorials).

181. *See* *Dolan v. City of Tigard*, 512 U.S. 374, 392 (1994) ("We see no reason why the Takings Clause of the Fifth Amendment, as much a part of the Bill of Rights as the First Amendment or the Fourth Amendment, should be relegated to the status of a poor relation in these comparable circumstances.").

182. *See infra* notes 195-98 and accompanying text (explaining difficulties in determining whether exaction is product of legislative or adjudicative action, as well as noting that most local land use decisions involve individual development and thus are individualized to some degree).

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administrative takings appears to be a distinction without a constitutional difference.¹⁸³

The assertion that legislative or generally applicable exactions are immune from the extortionate impulse¹⁸⁴ adds nothing to support the legislative/adjudicative distinction. Courts rarely explain in depth the idea that legislators are less likely to abuse landowners via an exaction, but the implicit justification seems to be that an open legislative process affords greater protection against governmental abuse than the insular adjudicative process.¹⁸⁵

While this may be true as a general proposition, it too cavalierly dismisses the fact that procedural mechanisms designed to protect the minority often break down in the legislature as well as in the administrative context.¹⁸⁶ Indeed, as the branch most accountable, and thus most responsive, to the majority, the legislature may be especially prone to extort disproportionate amounts of property from under-represented groups.¹⁸⁷ As California Supreme Court Justice Brown explained in a dissenting opinion in *San Remo*:

[T]he majority's exception for legislatively created permit fees is mere sophism, particularly where the legislation affects a relatively powerless group and therefore the restraints inherent in the political process can

183. *Parking Ass'n of Ga., Inc. v. City of Atlanta*, 515 U.S. 1116, 1117-18 (1995) (Thomas, J., dissenting from denial of certiorari) (emphasis added).

184. *See supra* notes 138-48 and accompanying text (noting courts that found legislative/adjudicative distinction irrelevant).

185. *See, e.g., San Remo Hotel v. San Francisco*, 2002 Cal. LEXIS 623, at *55 (Mar 4, 2002) ("[S]uch generally applicable legislation is subject to the ordinary restraints of the democratic political process. A city council that charged extortionate fees for all property development, unjustifiable by mitigation needs, would likely face widespread and well-financed opposition at the next election."); *Curtis v. Town of St. Thomaston*, 708 A.2d 657, 660 (Me. 1998) ("Because the Town's dedication requirement is a legislative rule, this requirement more likely represents a carefully crafted determination of need tempered by the political and legislative processes rather than a 'plan of extortion' directed at a particular land owner."); WILLIAM A. FISCHER, *REGULATORY TAKINGS: LAW, ECONOMICS, AND POLITICS* 329 (1995) (arguing that "state legislatures that create general police-power laws should receive great deference" because this type of regulation is "more like an exogenous event . . . and more subject to logrolling of pluralistic politics," both of which reduce "the demoralization of apparently being singled out").

186. *See FISCHER, supra* note 185, at 100-39 (proposing a sliding scale of judicial scrutiny of property regulation that increases as level of government authority decreases). This framework is premised on the idea that smaller legislatures "would discount the welfare of under-represented outsiders. Local insiders can use regulation in a way that subverts the Constitution's clear commands not to take property without compensation." *Id.* at 139.

187. *See FISCHER, supra* note 185; Huffman, *supra* note 174, at 152 (observing that "even properly functioning democracies can abuse power at the expense of individuals and minorities. The [T]akings [C]ause, like the equal protection clause, protects against this majoritarian tyranny").

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hardly be said to have worked. If the agency in *Nollan* had passed a rule requiring all beachfront property owners to dedicate an easement as a condition of developing their properties, those easements would have no better mitigated the effects of development (and they would have been no less objectionable) than the easement that the agency exacted adjudicatively.¹⁸⁸

The founding fathers also recognized and feared the threat to minority rights presented by the legislative power:

It would be a dangerous delusion were a confidence in the men of our choice to silence our fears for the safety of our rights Confidence is every where the parent of despotism. Free government is founded in jealousy, and not in confidence. It is jealousy and not confidence which prescribes limited constitutions, to bind down those whom we are obliged to trust with power¹⁸⁹

Their answer was, of course, the Constitution¹⁹⁰ and, more specifically, the Takings Clause: "In a constitutional system which values both democracy and liberty, *the beauty of the takings clause is that it provides a solution to the difficult problem of protecting individual rights in the face of legitimate government actions* which often impact arbitrarily and unevenly on isolated individuals."¹⁹¹

It is unclear why courts believe human nature or legislators have changed so much that an invasion of property rights by "men and women of our choice" should be scrutinized with more "confidence" today. Today's democratic legislative process is entirely conducive to forcing a landowning minority to shoulder an unfair portion of a general public burdens, in accordance with the will of a non-landowning majority.¹⁹² Thus, in *San Remo*, San Fran

188. *San Remo*, 2002 Cal. LEXIS 623, at **122-23 (Brown, J., dissenting) (citation omitted).

189. THOMAS JEFFERSON, DRAFT KENTUCKY RESOLUTIONS (Mem'IED.17:388)(1798).

190. *Id.* ("Our Constitution has accordingly fixed the limits to which, and no further, our confidence may go *In questions of power, then let no more be heard of confidence in man, but bind him down from mischief by the chains of the Constitution.*" (emphasis added)).

191. Huffman, *supra* note 174, at 145 (emphasis added).

192. See James D. Gwartney & Richard E. Wagner, *Public Choice and the Conduct of Representative Government*, in PUBLIC CHOICE AND CONSTITUTIONAL ECONOMICS 4 (James D. Gwartney & Richard E. Wagner eds., 1988) ("At least with regard to economic functions and rights, we no longer possess a constitutionally limited government. Congressional majorities are now largely free to legislate as they choose, with government being limited only by the requirements of electoral competition."); Inna Reznik, Note, *The Distinction Between Legislative and Adjudicative Decisions in Dolan v. City of Tigard*, 75 N.Y.U. L. REV. 242, 271 (2000)

("[L]egislative land use decisions made at the local level may reflect classic majoritarian oppression. And developers, whose interests judicial rules like *Dolan* aim to protect, are pre-

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cisco's elected officials legislated the burden of ameliorating a city-wide housing shortage – and the associated homelessness – upon approximately 500 hotel owners.¹⁹³ Because the risk of government extortion is present in the legislative setting, the essential nexus test cannot reasonably be limited to exactions imposed pursuant to an adjudicative process.¹⁹⁴

3. *The Legislative-Adjudicative Distinction Is Difficult to Apply in Any Meaningful Way*

Even if there were some valid reason to uphold the principle of special deference to general legislative exactions – which there is not – the rule is extremely difficult to apply in the land use context.¹⁹⁵ An initial problem is that there is no logically consistent way to pinpoint the source of an exaction because they typically reach the landowner only after the involvement of both legislative and adjudicative bodies.¹⁹⁶ Moreover, little can be implied even when the source of an exaction is clear; in the land use process, legislative bodies often act in an administrative capacity and vice versa.¹⁹⁷ Focusing on

cisely the kind of minority whose interests might actually be ignored."). See generally TOWARD A THEORY OF THE RENT SEEKING SOCIETY (James M. Buchanan et al. eds., 1980) (describing process by which individuals and groups use the legislative process to effect transfers of wealth from one group to another).

193. See *San Remo Hotel v. San Francisco*, 2002 Cal. LEXIS 623, at **134-35 (Mar. 4, 2002) (Brown, J., dissenting).

194. See CAL. GOV. CODE §§ 66000-66020. In providing a procedure by which a landowner may challenge – under the "reasonable relationship" test – any type of monetary exaction, "whether established for a broad class of projects by legislation of general applicability or imposed on a specific project on an ad hoc basis," the California legislature has recognized that there is no meaningful basis for distinguishing among exactions based on their place of origin.

195. See Reznik, *supra* note 192, at 257-66 (surveying proposed methods to apply legislative/adjudicative distinction in exaction arena and concluding that all are "difficult to use in practice").

196. See, e.g., *Loyola Marymount Univ. v. Los Angeles Unified Sch. Dist.*, 53 Cal. Rptr. 2d 424, 430 (Cal. Ct. App. 1996) (upholding imposition of fee on university by school district when legislature granted school district power to decide amount of fee based on findings of school board).

197. See, e.g., *Amoco Oil Co. v. Vill. of Schaumburg*, 661 N.E.2d 380, 390 (Ill. App. Ct. 1995) (refusing to recognize legislative/adjudicative distinction). In *Amoco Oil Co.*, a legislatively adopted ordinance directed a single zoning applicant to deed a portion of its property to the Village in return for favorable zoning. *Id.* at 381. The court's response to this fact is instructive:

[W]e also note that *the so-called "ordinance" at issue here did not itself reflect a uniformly applied legislative policy. Indeed, the dedication requirement was clearly site-specific and adjudicative in character.* As such, even if we were to recognize the distinction between legislative and adjudicative actions, which we are not

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the extent to which a decision is discretionary as a means to identify adjudicative exactions provides no solution because most local land use decisions, including exactions, must be tailored to fit an individual development at some point and, therefore, necessarily involve a certain amount of discretion.¹⁹⁸

Lambert exemplifies the foregoing principles.¹⁹⁹ Like *San Remo*, *Lambert* involved a generally applicable law requiring hotel owners to pay a fixed percentage (raised in 1990 from forty percent to eighty percent) of the cost of replacing residential rooms as a condition of obtaining a permit to convert such rooms to tourist units.²⁰⁰ However, the law allowed local government administrators to determine the underlying "replacement" value on a case-by-case basis.²⁰¹ Under this framework, an administrative board set Mr. Lambert's portion of the cost of replacing thirty-one residential rooms at \$600,000, even though the city's appraisers had differed substantially in their estimates of the likely actual cost.²⁰² Thus, although the exaction could rightfully be described as legislative, the fee ultimately was imposed pursuant to the exercise of administrative discretion.

There will, of course, be a few cases in which exactions are clearly legislative in nature. The art fee imposed in *Ehrlich* comes to mind. That fee arose under an ordinance that required all

new residential development projects of more than four units, as well as all commercial, industrial, and public building projects with a building valuation exceeding \$500,000 . . . to provide "art work" (as defined by the ordinance) for the project in an amount equal to 1 percent of the total building valuation, or to pay an equal amount in cash to the city art fund.²⁰³

inclined to do under the circumstances of this case, we would still apply the two-part approach set forth in *Dolan*

Id. at 390 (emphasis added).

198. See Reznik, *supra* note 192, at 264 ("[T]he legislative/adjudicative test is misplaced in a land use system where development proceeds mainly on a piecemeal, individualized basis in response to developer requests, and therefore few decisions, by the terms of the [discretionary] test, can be categorized as legislative.").

199. *Lambert v. City & County of San Francisco*, 67 Cal. Rptr. 562, 564-68 (Cal. Ct. App. 1997) (concluding that ordinance and planning code amendment restricting landowner from converting residential hotel units to tourist hotel units was not taking), *cert. denied*, 529 U.S. 1045 (2000).

200. *Id.* at 564.

201. See *id.* at 570 (Strankman, P.J., dissenting) (noting that replacement value was determined by appraisals through Department of Real Estate).

202. *Id.* The appraisers estimated the actual cost to be between \$484,584 and \$612,887.
Id.

203. *Ehrlich v. City of Culver City*, 911 P.2d 429, 435 (Cal. 1996).

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Yet, broadly applicable and discretion-free laws are rarities in the exaction context. As such, they are exceptions that tend to prove the rule, rather than a norm that might justify a special exemption from the essential nexus standard.

V. Conclusion

Courts are increasingly rejecting the idea that *Nollan* and *Dolan* can be limited to their facts, and rightly so. The principles underlying the essential nexus requirement are as relevant to monetary exactions as they are to exactions of real property and as necessary to protect against legislative abuses of power as against administrative extortion.²⁰⁴ There is, therefore, no compelling reason to avoid applying *Nollan* and *Dolan* to all exactions.²⁰⁵ At the same time, a robust essential nexus test is necessary to facilitate both the broadest purposes of the Takings Clause and the narrowest holding of *Nollan* and *Dolan*. Without a strong essential nexus test, individuals often will be forced to bear burdens that properly should be borne by the public as a whole.²⁰⁶ At the same time, the Court's widely accepted prescription against

204. See *Manocherian v. Lenox Hill Hosp.*, 643 N.E.2d 479, 483 (N.Y. 1994) (applying *Nollan* and *Dolan* to a rent control law and stating that "the Supreme Court refrained from placing any limitations or distinctions or classifications on the application of the 'essential nexus' test. This suggests and supports a uniform, clear and reasonably definitive standard of review in takings cases.").

205. Judicial willingness to expand *Nollan* and *Dolan* to their logical limits could, of course, founder on the "slippery slope." The fear that stronger scrutiny of legislative monetary exactions will bring the courts perilously close to opening the door to attacks on the current system of property taxation is a potential psychological bar. See, e.g., *San Remo Hotel v. San Francisco*, 2002 Cal. LEXIS 623, at *57 (Mar. 4, 2002). It should not be. Unlike monetary exactions, which typically flow from statutory authority, general ad valorem property taxes are almost always authorized by a constitution. In part for this reason, it is well settled that the basic form of property taxation is not subject to a takings claim unless it is arbitrary or overtly discriminatory. See *Steward Mach. Co. v. Davis*, 301 U.S. 548, 584-85 (1937) (upholding taxation scheme of Social Security Act against Fifth Amendment challenge); *Brushaber v. Union Pac. R.R.*, 240 U.S. 1, 24-26 (1916) (determining that federal tax laws do not infringe of Fifth Amendment, as long as taxation is not "arbitrary . . . confiscation of property"). On the other side of the coin, it is important to recognize that some species of property taxation are already subject to a crude version of the essential nexus and rough proportionality tests. In particular, courts generally require special benefit assessments on property to be related to and proportional to an increase in property value flowing from expenditure of the assessments. See *McNally v. Township of Teaneck*, 379 A.2d 446, 451 (N.J. 1977) (stating that "[e]xaction of more than the special benefit to the property owner would constitute a taking of private property for public use without compensation"). The extension of the essential nexus requirement to its natural extremes simply would put property exactions in the same class, for constitutional purposes, as other, similar burdens on real property while in no way jeopardizing more general forms of taxation.

206. See *supra* notes 150-51 (explaining that Takings Clause is in place to prevent individ-

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EVOLUTION OF THE "ESSENTIAL NEXUS"

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unrelated and excessive demands for physical dedications of land is one small step away from becoming meaningless if a local government can bypass the essential nexus test simply by "utilizing a different bureaucratic vehicle."²⁰⁷

Similarly, if government may exact exorbitant sums of money freely, only the Legislature's good will can stop it from imposing such demands to raise cash to buy the same land that it could not otherwise get directly under *Nollan*. The essential nexus cannot survive long when riddled with these loopholes. Application of *Nollan* and *Dolan* to monetary exactions and legislative exactions is not only the logical end of the evolution of the essential nexus, it is also the necessary beginning to ensuring that their core outcomes are the constitutional legacy of all landowners, not just the Nollans and Ms. Dolan.

uals from bearing societal burdens alone).

207. See *Amoco Oil Co. v. Vill. of Schaumburg*, 661 N.E.2d 380, 390 (Ill. App. Ct. 1995) ("Certainly, a municipality should not be able to insulate itself from a takings challenge merely by utilizing a different bureaucratic vehicle when expropriating its citizen's property.").

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Supreme Court of the State of Washington
Opinion Information Sheet

Docket Number: 69475-3
Title of Case: Isla Verde International Holdings, Inc., et al.
v.
City of Camas, Washington
File Date: 07/11/2002
Oral Argument Date: 12/06/2000

SOURCE OF APPEAL

Appeal from Superior Court,
Clark County;
95-2-03438-5
Honorable John F. Nichols, Judge.

JUSTICES

Authored by Barbara A. Madsen
Concurring: Charles Z. Smith
Faith E Ireland
Bobbe J. Bridge
Visiting Judge Charles W. Johnson
Dissenting: Richard B. Sanders
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IN THE SUPREME COURT OF THE STATE OF WASHINGTON

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ISLA VERDE INTERNATIONAL HOLDINGS,)	NO. 69475-3
INC., a foreign corporation; and CONNAUGHT)	
INTERNATIONAL HOLDINGS, INC., a foreign)	
corporation,)	
)	
Respondents,)	
)	
v.)	EN BANC
)	
CITY OF CAMAS, WASHINGTON, a)	
Municipal corporation of the State of Washington,)	
)	
Petitioner.)	
)	Filed July 11, 2002

MADSEN, J. -- This is an action brought under the Land Use Petition Act by a developer challenging the legality of conditions imposed by the City of Camas for approval of a preliminary plat for a residential subdivision. The challenged conditions include a 30 percent 'open space' set aside and provision of a secondary limited access road into the proposed development for emergency vehicles. The Clark County Superior Court ruled on constitutional and statutory grounds that both conditions are unlawful. The Court of Appeals affirmed as to the open space requirement, holding that it constitutes an unconstitutional taking, but reversed as to the secondary access road, upholding this condition. We affirm the Court of Appeals, although in part on different grounds. We conclude that the open space set aside condition violates RCW 82.02.020, and thus do not reach arguments respecting the constitutionality of this requirement. We hold that the developer has failed to establish unconstitutionality or other invalidity of the secondary access road condition.

FACTS

In March 1995, the developer, Isla Verde International Holdings, Inc. and Connaught International Holdings, Inc. (together Isla Verde), submitted a preliminary plat application for a proposed 32-lot subdivision, Dove Hill, on 13.4 acres located in the City of Camas (City), in Clark County. The Director of Public Works for the City issued a determination of nonsignificance for the project. The plat application was later amended to include 51 lots.

Isla Verde planned to extend an existing road, Sierra Lane, into the new subdivision to provide the only access. Sierra Lane would be 'stubbed' at the north edge of the development, with plans that it be extended when property to the north of Dove Hill was developed.

The Camas Planning Commission considered Isla Verde's application for preliminary plat approval at several meetings. A number of local residents testified that Sierra Lane often becomes impassable in winter conditions, and that residents of a subdivision south of the proposed subdivision have to park their vehicles at the bottom of the hill because the road becomes impassable. Several residents expressed concerns about fire safety issues. The Camas Fire Marshal also spoke about fire protection. He described the steep-sloped nature of the property, and the danger of wildfires in the area.¹ He asked for a secondary access road for emergency vehicles, describing access into Dove Hill as a very bad situation.

The Planning Commission considered how the proposed subdivision would satisfy the City's 'open space' ordinance, former Camas Municipal Code (CMC) 18.62.020 (1991) (repealed Mar. 2002),² which

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requires that every proposed subdivision in the city must retain 30 percent of its area as open space. A June 16, 1995, staff report presented at the June 20, 1995, Planning Commission meeting included findings that, due to its location and configuration, the developer would meet only 37 percent of the total required acreage for open space. The remainder would be satisfied by a 'buy down,' i.e., a payment partially in lieu of the set aside, as permitted within the discretion of the Camas City Council by CMC 17.12.090(E) (1991).³ The report said that wildlife would be affected by the development, but a notation added that this comment was made with regard to the original 32-lot proposal. The report also included a notation that a concern had arisen about permitting a 'buy down' in lieu of a full 30 percent open space set aside. This is evidently a reference to a June 12, 1995, letter from the City Administrator to the Assistant City Engineer/City Planner recommending that the Planning Commission approve a plat design with a full 30 percent open space set aside. The open space would largely consist of steep wooded slopes. The City Administrator explained that the City Council's recent decisions on proposed subdivisions had generally preferred the open space set aside rather than the optional 'buy down.' He said that a 30 percent set aside would add about four acres to the City's open space network, would be consistent with the objectives of the open space network, and would be consistent with past council decisions.

The Planning Commission approved the application, subject to a number of conditions, including construction of a secondary temporary access road from the end of NW Sierra Lane to an acceptable point to the east. The recommended conditions also contemplated that a homeowner's association would be required and that it would be responsible for maintenance of the open space areas.

On June 26, 1995, Isla Verde's application came before the Camas City Council for a final decision. The Council permitted local residents to comment on the application, and, with regard to a secondary access road, the same concerns regarding fire protection and access that were raised in the Planning Commission's meetings were voiced before the Council. The Fire Marshal again expressed concerns about fire protection and access to the proposed development. He also pointed out that the Uniform Fire Code required more than one access road for fire fighting equipment when a determination was made by the fire chief 'that access by a single road may be impaired by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.' Clerk's Papers (CP) at 107. The neighbor to the east of the proposed subdivision stated that she would not grant an easement for a secondary access road over her property.

With regard to the open space set aside, several people spoke about wildlife at the site. Local resident Richard Palmer (the president of the homeowners' association for the subdivision just south of Dove Hill) presented a letter from an area habitat biologist with the Washington State Department of Fish and Wildlife addressed to Mr. Palmer. The biologist's letter stated that adequate open space within the Dove Hill subdivision was critical to survival of wildlife species. The biologist referred to a conversation with Palmer where Palmer told the biologist that several wildlife species had been seen at the site, including the pileated woodpecker, a candidate for listing as threatened, endangered or sensitive,⁴ and the ringneck snake, which had been found in Clark County only at one other location and was classified as a monitored species. The letter stated that Fish and Wildlife recommended that the full 30 percent set aside be required. Another resident also referred to this letter, and urged that the full 30 percent set aside for open space be required.

Isla Verde objected to the secondary access road requirement, stating that satisfying the condition was impossible because Isla Verde would be unable to obtain easements over neighboring property to construct the road. As to open space, as noted, Isla Verde proposed less than a 30 percent set aside,⁵ with a 'buy down' to make up the difference. Isla Verde also objected to any separate impact fees for parks and open spaces. Chapter 3.88 CMC provides for imposition of impact fees to help pay for the

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cost of public facilities to serve new growth and development, and CMC 3.88.070 specifically allows impact fees for park and recreational facilities and open space.

The City Council decided to delay its decision until after an on-site visit, which occurred July 5, 1995. The Council then initially voted to deny Isla Verde's application because of fire safety concerns, but on July 24, 1995, reconsidered. It approved the preliminary plat application subject to the condition recommended by the Planning Commission for a secondary limited access road. It did not, however, specify where this road must be constructed. The City Council also required a full 30 percent open space set aside, with no 'buy down.' The City's decision on the application does not mention any impact fees imposed pursuant to chapter 3.88 CMC.

Isla Verde petitioned for review of the City's decision under the Land Use Petition Act (LUPA), chapter 36.70C RCW. Following review, the Clark County Superior Court entered an order holding that the secondary access road condition violates substantive due process and chapter 64.40 RCW, because the condition is impossible to satisfy, unduly burdensome, arbitrary and capricious, and denies all viable use of the property. The court held that the open space set aside constitutes a taking under the state constitution and a violation of RCW 82.02.020 and chapter 64.40 RCW, because the City made no individualized determination that the 30 percent set aside requirement is necessary to mitigate an impact of the development, the condition is disproportionate to the impact caused by the subdivision, and the City has not established a need for additional open space within the city limits as a result of the proposed development. Finally, the court held that the City's imposition of a parks impact fee and an open space impact fee was also unlawful, despite the lack of any such condition in the City's written decision. The City sought reconsideration, offering evidence to show the reason for enactment of the open space ordinance with its 30 percent requirement. The superior court declined to consider the additional evidence, and denied a motion for reconsideration.

The Court of Appeals affirmed the superior court's ruling that the open space set aside condition constitutes an unconstitutional taking.⁶ The Court of Appeals upheld the secondary access road condition, however. Finally, that court concluded that since the City had not assessed any impact fees under chapter 3.88 CMC, the issue of whether they could lawfully be imposed was not ripe for adjudication. *Isla Verde Int'l Holdings, Inc. v. City of Camas*, 99 Wn. App. 127, 990 P.2d 429 (1999). The City then sought discretionary review by this court.

ANALYSIS

Review is under the LUPA, chapter 36.70C RCW. This court stands in the same position as the superior court. *Wenatchee Sportsmen Ass'n v. Chelan County*, 141 Wn.2d 169, 176, 4 P.3d 123 (2000). Review is limited to the record before the City Council. *Citizens for Responsible & Organized Planning v. Chelan County*, 105 Wn. App. 753, 758, 21 P.3d 304 (2001); *Kahuna Land Co. v. Spokane County*, 94 Wn. App. 836, 841, 974 P.2d 1249 (1999). The potentially relevant standards of review in this case are set forth in RCW 36.70C.130(1), which authorize invalidation of the City's decision to impose the disputed conditions if that decision (1) is an erroneous interpretation of the law; (2) is not supported by substantial evidence; (3) is a clearly erroneous application of the law to the facts; or (4) violates the constitutional rights of the party seeking relief.⁷ The court may grant relief only if Isla Verde, the party seeking relief from the land use decision, has carried the burden of establishing that one of these standards has been met. RCW 36.70C.130. Statutory construction is a question of law reviewed de novo under the error of law standard. *Wenatchee Sportsmen*, 141 Wn.2d at 176. In order to conclude that substantial evidence supports the factual findings, there must be a sufficient quantity of evidence in the record to persuade a reasonable person that the declared premise is true. *Id.* *Open Space Set Aside Condition*

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The first issue is whether the 30 percent open space set aside condition is valid. As noted, the superior court determined that the open space set aside condition on preliminary plat approval violates state constitutional and statutory provisions, including RCW 82.02.020. The Court of Appeals held that the condition violates the takings clause of the Fifth Amendment to the United States Constitution. Although the Court of Appeals decision rests on constitutional grounds, the condition violates RCW 82.02.020, as the superior court determined. Accordingly the Court of Appeals should not have reached the constitutional question.

We adhere to the fundamental principle that if a case can be decided on nonconstitutional grounds, an appellate court should refrain from deciding constitutional issues. See *State v. Speaks*, 119 Wn.2d 204, 207, 829 P.2d 1096 (1992) (although Court of Appeals decided constitutional issue, this court declined to reach constitutional issue where case was resolvable on statutory grounds); *Tunstall v. Bergeson*, 141 Wn.2d 201, 210, 5 P.3d 691 (2000) (where issue may be resolved on statutory grounds, court will avoid deciding issue on constitutional grounds); *Tommy P. v. Bd. of County Comm'rs*, 97 Wn.2d 385, 391, 645 P.2d 697 (1982) (where case can be resolved on other grounds, court will not reach constitutional issue); *Senear v. Daily Journal-Am.*, 97 Wn.2d 148, 152, 641 P.2d 1180 (1982) (same); *Ohnstad v. City of Tacoma*, 64 Wn.2d 904, 906, 395 P.2d 97 (1964) (same); see also *Skagit Surveyors & Eng'rs, LLC v. Friends of Skagit Valley*, 135 Wn.2d 542, 546, 958 P.2d 962 (1998) (because the case was decided on statutory grounds, constitutional issues were not reached); *State v. Faford*, 128 Wn.2d 476, 481, 910 P.2d 447 (1996) (same); *In re Dependency of J.B.S.*, 123 Wn.2d 1, 7, 863 P.2d 1344 (1993) (same); *In re Pers. Restraint of Moore*, 116 Wn.2d 30, 32, 803 P.2d 300 (1991) (same).

RCW 82.02.020 generally provides, with some exceptions, that the state preempts the field of imposing certain taxes. The statute then states, in relevant part: 'Except as provided in RCW 82.02.050 through 82.02.090, no county, city, town, or other municipal corporation shall impose any tax, fee, or charge, either direct or indirect, on . . . the development, subdivision, classification, or reclassification of land.' RCW 82.02.020.8 There are, besides the involuntary impact fees permitted under RCW 82.02.050 through RCW 82.02.090,⁹ three exceptions to the prohibition against direct or indirect taxes, fees or charges on the development or subdivision of land (or classification or reclassification). RCW 82.02.020 'does not preclude dedications of land or easements within the proposed development or plat which the county, city, town, or other municipal corporation can demonstrate are reasonably necessary as a direct result of the proposed development or plat to which the dedication of land or easement is to apply.' RCW 82.02.020. RCW 82.02.020 also permits voluntary agreements that allow a payment in lieu of dedication of land or to mitigate a direct impact that is a consequence of a proposed development, subdivision or plat. In both instances, payment may be required as part of a voluntary agreement only where the county, city, town, or other municipal corporation establishes it is reasonably necessary as a direct result of the proposed development or plat.¹⁰

RCW 82.02.020 requires strict compliance with its terms. *Trimen Dev. Co. v. King County*, 124 Wn.2d 261, 270, 877 P.2d 187 (1994); *R/L Assocs., Inc. v. City of Seattle*, 113 Wn.2d 402, 409, 780 P.2d 838 (1989). A tax, fee, or charge, either direct or indirect, imposed on development is invalid unless it falls within one of the exceptions specified in the statute. *Henderson Homes, Inc. v. City of Bothell*, 124 Wn.2d 240, 247, 877 P.2d 176 (1994) (citing *R/L Assocs.*, 113 Wn.2d at 409).

The superior court held that the open space set aside condition violates RCW 82.02.020 because there has been no individualized determination that the 30 percent set aside requirement is necessary to mitigate an impact of the development, the condition is disproportionate to the impact caused by the subdivision, and the City has not demonstrated any need for additional open space arising from the development. In his oral ruling, the superior court judge noted that the statute permits dedications of land or easements provided the City can establish that they are reasonably necessary as a direct result of the

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proposed development. He also noted the statutory requirement that payments in lieu of dedication also must be reasonably necessary as a direct result of the proposed development. The judge said, 'I didn't find anything in the record that showed that there was any consideration of the direct effect of this development to serve as a basis for imposing the 30 percent.' Verbatim Report of Proceedings (June 28, 1996) at 102.

As noted, the burden of proof under RCW 36.70C.130(1) is on Isla Verde, while under RCW 82.02.020 the burden of establishing that a condition is reasonably necessary as a direct result of the proposed development is on the City. Keeping these burdens in mind, we address the arguments advanced by the City, the petitioner here, as to why the open space condition is a lawful condition. The City argues that the open space set aside does not violate RCW 82.02.020 because it does not impose a tax, fee or charge on development. Instead, the City maintains, the set aside is a police power based condition imposed pursuant to RCW 58.17.110.11 The City says that RCW 82.02.020 recognizes the authority of cities to require dedication for police power purposes, provided they are reasonably necessary as a direct result of the proposed development or plat. The City says that the necessary connection between a required dedication and the impact of Isla Verde's proposed subdivision has been established legislatively and by evidence in the record.¹²

Initially, although some of the City's argument equates the open space set aside condition to a dedication for purposes of RCW 82.02.020, it maintains that the set aside is not actually a dedication.¹³ However, the question we must answer is whether the set aside constitutes a tax, fee or charge within the meaning of the statute. The meaning of RCW 82.02.020 is a question of law reviewed de novo. *Wenatchee Sportsmen*, 141 Wn.2d at 176; see also *State v. Breazeale*, 144 Wn.2d 829, 837, 31 P.3d 1155 (2001); *State v. J.M.*, 144 Wn.2d 472, 480, 28 P.3d 720 (2001). The court's fundamental objective is to ascertain and carry out the Legislature's intent, and if the statute's meaning is plain on its face, then the court must give effect to that plain meaning as an expression of legislative intent. *J.M.*, 144 Wn.2d at 480. The question whether a tax, fee or charge is involved also involves application of the law to the facts.

For a number of reasons we disagree with the City's assertion that the set aside condition is not a tax, fee, or charge within the meaning of RCW 82.02.020. The exclusionary language of the statute demonstrates that the prohibited charges are not limited to monetary charges. Specifically, the statute provides that a dedication of land or easement is excluded from the statute's prohibitions if reasonably necessary as a direct result of the proposed development. The statute thus contemplates that a required dedication of land or easement is a tax, fee or charge. Further, this court has recognized that for purposes of RCW 82.02.020 a tax, fee, or charge can be in kind as well as in dollars. *San Telmo Assocs. v. City of Seattle*, 108 Wn.2d 20, 24, 735 P.2d 673 (1987) (requirements that owners of low income rental units provide relocation notice and assistance, and replacement of a specified percentage of the low income housing with other suitable housing or contributing to the low income housing replacement fund in lieu thereof, when residential units are demolished or redeveloped to other use violated RCW 82.02.020 as indirect charge on development).

The open space condition here is comparable to conditions in a number of cases analyzed under RCW 82.02.020. E.g., *Vintage Constr. Co. v. City of Bothell*, 135 Wn.2d 833, 959 P.2d 1090 (1998) (RCW 82.02.020 applicable where ordinance required dedication of five percent of land for parks or payment of \$400 per lot in lieu thereof; developer entered a 'voluntary agreement' to pay in lieu fees) (adopting opinion of the Court of Appeals in *Vintage Constr. Co. v. City of Bothell*, 83 Wn. App. 605, 922 P.2d 828 (1996)); *Trimen*, 124 Wn.2d 261 (RCW 82.02.020 applicable where ordinance required dedication of land for open space or payment of fee in lieu thereof; developer paid in lieu fees under voluntary agreement); *Henderson Homes*, 124 Wn.2d 240 (RCW 82.02.020 applicable where condition

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required payment of \$400 per lot park mitigation fee); *United Dev. Corp. v. City of Mill Creek*, 106 Wn. App. 681, 698-99, 26 P.3d 943 (RCW 82.02.020 applicable where condition required frontage improvements for drainage along adjacent boulevard) review denied, 145 Wn.2d 1002 (2001); *Castle Homes & Dev., Inc. v. City of Brier*, 76 Wn. App. 95, 882 P.2d 1172 (1994) (RCW 82.02.020 applicable where voluntary agreement required payment of \$3,000 per lot or provision of offsite traffic improvements); *View Ridge Park Assocs. v. City of Mountlake Terrace*, 67 Wn. App. 588, 839 P.2d 343 (1992) (RCW 82.02.020 applicable where ordinance required developers to construct onsite recreational facilities or pay a fee in lieu thereof). Indeed, the Camas ordinance authorizing the set aside condition is quite similar to the ordinance at issue in *Trimen*, which required a dedication or reservation of open space, or a fee in lieu thereof. We conclude that the open space set aside condition is an in kind indirect 'tax, fee, or charge' on new development.

The next question is whether the 30 percent set aside is unlawful under RCW 82.02.020 or whether it falls within an exception. It is, as explained, *Isla Verde's* burden to show that one of the standards in RCW 36.70C.130(1) applies and requires invalidation of the open space condition. Under RCW 82.02.020, however, the City has the burden of showing that one of the statute's exceptions applies. With these principles in mind, we address the City's justifications for imposing the open space condition. As mentioned earlier, the City maintains that the open space condition does not require an actual dedication of land to public use. Nevertheless, the City argues that the exception allowing dedication where reasonably necessary as a direct result of the proposed development of plat does apply in this case, and thus no violation of RCW 82.02.020 exists. The City more directly argues that the open space condition is authorized to mitigate direct impacts of the proposed development.

We need not decide whether the set aside provisions require a dedication of land for purposes of the exceptions in RCW 82.02.020 because the City has failed to establish that the 30 percent open space set aside is reasonably necessary as a direct result of the proposed subdivision or reasonably necessary to mitigate a direct impact that is a consequence of the proposed subdivision. We note, however, the possibility that just as a tax, fee, or charge on development may be, in kind, a required set aside of the sort required under CMC 18.62.020 and might be deemed equivalent to a dedication for purposes of the statute, given the Legislature's obvious intent to allow charges on development where the need for them is a direct result of the development.¹⁴

The City first urges that its set aside requirement falls within the statutory exception because it has made a valid legislative determination of the need for subdivisions to provide for open space set asides to mitigate consequences of subdivision development. The City relies on *Trimen* for the proposition that such a determination in and of itself satisfies its burden of proving the required connection between the development and the open space condition. The City misreads *Trimen*. In *Trimen*, the county conducted a comprehensive assessment of park needs in a report predating the developer's applications for subdivision approval. *Trimen*, 124 Wn.2d at 274. That report showed a deficit of park acres in the area of the proposed developments, and projected a greater deficit as population expanded. *Id.* A dedication or reservation of open space at the figure negotiated by the parties would have resulted in an amount of park land roughly proportional to that which the report showed would be needed for the developments' estimated population. *Id.* The fees in lieu of dedication were thus upheld by this court. Importantly, and contrary to the City's argument here, we said that the county's 'fee in lieu of dedication is calculated based on zoning, projected population, and the assessed value of the land that would have been dedicated or reserved. {The county's} assessment of fees in lieu of dedication are specific to the site.' *Id.* at 275. Thus, in *Trimen* the fees imposed were reasonably necessary as a direct result of the proposed subdivisions, i.e., the need for park land was directly attributable to the projected population of the developments and the fees were calculated based upon the value of land that would otherwise be required to

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be dedicated or reserved for parks to serve the developments' populations. Trimen does not support the City's argument that a legislative determination of the need for open space satisfies the exceptions in RCW 82.02.020.

Nor does RCW 82.02.020. The statute mandates that a municipality must demonstrate that a dedication is 'reasonably necessary as a direct result of the proposed development or plat,' and also mandates that, in the case of a payment in mitigation of a 'direct impact that has been identified as a consequence' of the proposed development, a municipality must establish that the payment is 'reasonably necessary as a direct result of the proposed development or plat.' RCW 82.02.020 (emphasis added). We have repeatedly held, as the statute requires, that development conditions must be tied to a specific, identified impact of a development on a community. *Vintage Constr. Co.*, 83 Wn. App. at 611-12, opinion adopted in *Vintage Constr. Co.*, 135 Wn.2d 833; *Trimen*, 124 Wn.2d at 275; *Henderson Homes*, 124 Wn.2d at 242-44. RCW 82.02.020 does not permit conditions that satisfy a 'reasonably necessary' standard for all new development collectively; it specifically requires that a condition be 'reasonably necessary as a direct result of the proposed development or plat.' (Emphasis added.) We reject the City's argument that it satisfies its burden under RCW 82.02.020 merely through a legislative determination 'of the need for subdivisions to provide for open space set asides . . . as a measure that will mitigate a consequence of subdivision development.' *Am. Br. of Appellant* at 38.

The City also contends, however, that its steep slopes ordinance supports imposition of the open space condition as a mitigation measure. Under the steep slopes ordinance, if a development site has steep slopes it is an environmentally sensitive area, a geotechnical report is required, and mitigation measures may be required. Former CMC 18.61.020(D), (E), (F), (I). The City points out that the open space ordinance states that open space areas should include 'environmentally sensitive areas.' Former CMC 18.62.020(C). *Isla Verde's* property has steep slopes.

One difficulty with the City's contention is that the record does not establish that under the steep slopes ordinance any of the steep slopes here are greater than allowed for development. Former CMC 18.61.050(B)(1). In addition, the geotechnical report prepared for the proposed development concludes that the 'property is not within nor part of a potentially unstable slope area.' *Dove Hill Subdivision File Records* at 277. We note that a determination of nonsignificance was issued under the State Environmental Policy Act, chapter 43.21C RCW.15 Most importantly, while there may be some negative impact on environmentally sensitive areas, the record does not reveal the extent or significance of such an impact. There is no showing on this record that as to this property a 30 percent open space set aside is reasonably necessary to mitigate development impacts on environmentally sensitive steep slopes.

The City next asserts that the record shows a proposed conversion of wooded property to developed property, impact on wildlife, and the City's recent past practice to favor the full 30 percent set aside over 'buy downs' justify the 30 percent open space condition for subdivision approval. The City also refers to the City Administrator's letter that describes a 30 percent set aside as conforming to the City's open space network (since the property is wooded, has steep slopes, and wildlife habitat). None of the evidence to which the City refers shows any relation between a 30 percent open space requirement and impacts or effects of *Isla Verde's* proposed development. Again, it is arguable that there will be some impact on wildlife habitat, and certainly clearing wooded land to build houses will affect the wooded nature of the site. However, there is no showing that a 30 percent open space set aside is required to address these impacts. The fact that the City has recently imposed the full 30 percent set aside rather than allowing 'buy downs' is irrelevant; it says nothing about why an open space set aside is necessitated by a particular proposed subdivision.

Instead, the open space condition to obtain plat approval is uniformly applied, in the preset amount, regardless of the specific needs created by a given development. The fees or charges authorized

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under the exceptions in RCW 82.02.020, whether direct or indirect, may not be imposed automatically, but must be tied to a direct impact of the proposed development. See *Henderson Homes*, 124 Wn.2d 240 (payment of a preset \$400 per lot fee as a park mitigation fee invalid); *Vintage Constr. Co.*, 83 Wn. App. 605, opinion adopted in *Vintage Constr. Co.*, 135 Wn.2d 833 (condition requiring dedication of five percent of land for park or payment of \$400 per lot invalid). Aside from the ordinance requiring a flat 30 percent set aside for every proposed subdivision, there is nothing in the record explaining why 30 percent was chosen as the amount of open space needed in this case.¹⁶

Finally, the City's claim that RCW 58.17.110 provides police power authority to impose the open space condition does not validate the condition. RCW 58.17.110 requires local governments to ensure that proposed plats make appropriate provisions for the public health, safety and welfare, including open spaces. Although local governments are encouraged to require developers to set aside open space under this statute, nowhere does the platting statute authorize an across the board 30 percent set aside for open space. Recognizing that local governments have the authority to adopt regulations or to withhold plat approval if appropriate provisions have not been made, courts have interpreted RCW 58.17.110 as allowing such conditions only where the purpose is to mitigate the problems caused by the particular development. *Southwick, Inc. v. City of Lacey*, 58 Wn. App. 886, 892-93, 795 P.2d 712 (1990). Indeed, the City agrees that conditions imposed in accord with RCW 58.17.110 must be necessary as a direct result of the development. RCW 58.17.110 does not authorize the City's condition in this case.¹⁷

We conclude that the open space set aside condition does not fall within any exception in RCW 82.02.020.

The City also relies on RCW 35A.63.100 as authority for its 30 percent open space condition. That statute provides municipal authority to code cities to divide the municipality into appropriate zones within which specific standards, requirements, and conditions may be provided for regulating the use of public and private land, buildings, and structures, and the location, height, bulk, number of stories, and size of buildings and structures, size of yards, courts, open spaces, density of population, ratio of land area to the area of buildings . . . setbacks RCW 35A.63.100(2) (emphasis added). As the statute states, ordinances enacted under its authority are 'zoning ordinance{s}.' *Id.* Although its preamble states that Camas Ordinance 1820 (1991), which includes former CMC 18.62.020, amends the zoning code to provide for an overlay zone, the body of the ordinance does not simply treat the open space requirement as a zoning requirement. Former CMC 18.62.010(A) first states that the open space condition will be required in areas shown on the zoning map with a use classification of 'P'. However, it then states, '{i}n addition, the standards and requirements of this chapter shall apply to any application or proposal involving a planned unit development, subdivision or short subdivision, or any site with a portion of the site designated for the Open Space Network.' *Id.* (emphasis added). The open space ordinance thus applies to any subdivision, regardless of zoning, as a condition for subdivision approval, and, as explained, its application here burdens development in the way that is proscribed under RCW 82.02.020.

We hold that the 30 percent open space set aside condition for approval of Isla Verde's plat application violates RCW 82.02.020 and is therefore invalid.

Secondary Access Road Condition

In its answer to the petition for review, Isla Verde contends that the Court of Appeals erred in upholding the constitutionality of the City's conditioning approval of Isla Verde's plat application on provision of a secondary access road for emergency vehicle use. Isla Verde contends that the condition is impossible to perform and illegally delegates a veto power to the neighbors, and therefore its imposition violates substantive due process. Isla Verde's argument rests on the premise that the access road must be constructed on property to the east of the proposed development, and the owner of that property has

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stated that she will never grant an easement for a secondary access road. Isla Verde also says that the condition constitutes a taking, because the property is not suitable for any other purpose and therefore imposing a condition on subdivision development that is impossible to perform deprives it of any economically viable use for the property. We agree with the Court of Appeals that the record does not support Isla Verde's claim of impossibility, and therefore its constitutional challenges to the secondary access road condition fail.

Initially, we emphasize that the City's decision does not mandate that the secondary access be provided by a road over the property to the east, as Isla Verde has claimed. While a city staff report proposed that condition, the City Council's final decision provides only that 'the applicant provide a secondary access to the subject real property that is sufficient to permit utilization by emergency vehicles and that satisfies the standards of the Uniform Fire Code for fire apparatus access roads.' Dove Hill Subdivision File Records at 149.

Before approving a subdivision development, a local governmental entity must consider the adequacy of access to the proposed development, and may condition approval of a plat on provision of adequate access. *Lechelt v. City of Seattle*, 32 Wn. App. 831, 835, 650 P.2d 240 (1982); see RCW 58.17.110. However, while a municipality has authority to make appropriate provisions for the public health, safety, and welfare, and to condition plat approval accordingly, it does not have authority to require a developer "to shoulder an economic burden, which in justice and fairness the public should rightfully bear." *Weden v. San Juan County*, 135 Wn.2d 678, 706, 958 P.2d 273 (1998) (quoting *Orion Corp. v. State*, 109 Wn.2d 621, 648-49, 747 P.2d 1062 (1987)).

The burden of proving a violation of substantive due process is on Isla Verde. *Christianson v. Snohomish Health Dist.*, 133 Wn.2d 647, 659-61, 946 P.2d 768 (1997). A land use regulation is not violative of substantive due process where (1) the regulation aims to achieve a legitimate public purpose; (2) the means adopted are reasonably necessary to achieve that purpose; and (3) the regulation is not unduly burdensome on the property owner. *Presbytery of Seattle v. King County*, 114 Wn.2d 320, 331, 787 P.2d 907 (1990).

Isla Verde concedes that a secondary access road for emergency vehicles serves a legitimate public purpose. The concession is appropriate. See, e.g., *Kahuna Land Co. v. Spokane County*, 94 Wn. App. 836, 843, 974 P.2d 1249 (1999) (a requirement that there be adequate access to a subdivision serves a legitimate public purpose). Isla Verde contends, however, that the means to achieve the public purpose are unreasonable. Isla Verde characterizes the decision to require a secondary access road as the City's 'mere desire' to have a second road. Moreover, Isla Verde argues, it is not reasonable to require an impossible or oppressive condition. The record demonstrates that an additional access route is reasonably necessary to provide fire protection for the residents of the new Dove Hill subdivision. Testimony established that Dove Hill is located in a hazardous fire area and Sierra Lane alone would provide inadequate access to the proposed subdivision in the event of a fire. The testimony of the Camas Fire Marshal and that of a number of local residents was that Sierra Lane can become impassable in inclement weather. The Camas Fire Marshal also testified that Sierra Lane is inadequate under current code requirements for emergency vehicle access. Dove Hill, with its proposed 51 lots, will certainly add to the need for adequate fire and other safety protection; Isla Verde's proposed development will significantly increase the population that must be served. Fire and other rescue vehicles must have adequate access for emergency purposes, and Sierra Lane is not adequate to provide such access to the proposed subdivision.

Although Isla Verde complains that the condition is impossible to satisfy, it relies solely on the testimony of one neighbor to the east who has stated that she will not grant an easement for construction of a secondary access road over her property. There is no evidence that Isla Verde has made any at-

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tempts to secure this or any other property prior to filing this suit. Even if this particular property is unavailable, Isla Verde has not shown that all reasonable efforts to meet the secondary access road condition would be frustrated. Moreover, while Isla Verde also cites testimony that it says supports its conclusion that there is no access from the north, it fails to note that the testimony actually indicates a possible alternate route. CP at 252-53.

Thus, Isla Verde has not established that the selected means of achieving a legitimate public purpose--a secondary access road for emergency vehicles--is unreasonable, either as a mere desire for a second road or as an impossible condition to meet.

As to the third factor in the substantive due process analysis, we consider the (a) nature of the harm to be avoided; (b) the availability and effectiveness of less drastic measures; and (c) the economic loss suffered by the property owner. *Presbytery of Seattle*, 114 Wn.2d at 331. Other nonexclusive factors that may be helpful in the balancing required under the third factor include the seriousness of the public problem, the extent to which the landowner's property contributes to the problem, the degree to which the regulation solves the problem, and the feasibility of less burdensome solutions. *Id.*

The harm to be avoided is an uncontrolled fire within the proposed subdivision or the need for a rescue or other emergency assistance. The problem is serious because, as the record establishes, Sierra Lane is inadequate and human life and property are at risk. Isla Verde maintains, though, that the problem of inadequate access via Sierra Lane existed prior to its proposed development, and it has not contributed to the need for a secondary access road. As explained above, however, the increased population of the proposed subdivision exacerbates the problem, creating a greatly increased risk of harm. The record does not show any less drastic solution that would be as effective as providing a secondary access road.¹⁸

Isla Verde also contends that the condition is economically fatal to its development. As noted, Isla Verde claims that the condition is impossible to comply with because the neighbor to the east has said she will grant no easement, and thus, Isla Verde maintains, it cannot satisfy the condition and cannot develop its property. As explained, the record does not support Isla Verde's claim of impossibility. While Isla Verde has also argued that any alternate route would be excessively expensive, it cites to no evidence that backs this claim.

Finally, because the condition does not specify any particular access, it clearly does not grant a veto to the neighbor to the east, contrary to Isla Verde's contention. We therefore do not reach the question of the validity of a condition that did grant a 'veto.'

We conclude, after balancing the various factors, that the secondary road access condition does not violate substantive due process.

Isla Verde also argues that the condition is arbitrary and capricious because it cannot be performed and all uses on the property are therefore denied. In addition to arguing that substantive due process is thus violated, Isla Verde also argues that chapter 64.40 RCW is violated.

RCW 64.40.020(1) states that '{o}wners of a property interest who have filed an application for a permit have an action for damages to obtain relief from acts of an agency which are arbitrary, capricious, unlawful, or exceed lawful authority.' As the Court of Appeals held, the City's act in imposing the secondary access road condition was not arbitrary or capricious. An act is arbitrary or capricious if it is "'wilful and unreasonable action, without consideration and regard for facts or circumstances.'" *Landmark Dev., Inc. v. City of Roy*, 138 Wn.2d 561, 573, 980 P.2d 1234 (1999) (quoting *Teter v. Clark County*, 104 Wn.2d 227, 237, 704 P.2d 1171 (1985) (quoting *Miller v. City of Tacoma*, 61 Wn.2d 374, 390, 378 P.2d 464 (1963))). "Where there is room for two opinions, action is not arbitrary or capricious when exercised honestly and upon due consideration . . ." *Landmark Dev.*, 138 Wn.2d at 573 (quoting *DuPont- Fort Lewis Sch. Dist. No. 7 v. Bruno*, 79 Wn.2d 736, 739, 489 P.2d 171 (1971)).

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As explained above, the record does not support Isla Verde's contention that the secondary road access condition is impossible to comply with, and thus the City's action in imposing the condition is not arbitrary or capricious on that ground. Further, when making its decision, the City visited the development site, considered all the evidence, including the Fire Marshal's testimony and recommendations, and the testimony of residents about the poor road conditions of Sierra Lane during winter weather, and additionally considered the problems posed by the topography of the site. The record shows that the City's concerns about public safety in the absence of a secondary access road are legitimate. The City made a reasonable decision when it required Isla Verde to provide a secondary access road for emergency vehicles. We conclude that chapter 64.40 RCW was not violated.

Our analysis makes it unnecessary to address Isla Verde's summary contention that the secondary road access condition constitutes a taking. Because Isla Verde has not supported its claim that compliance is impossible, it has not shown that it is left with no viable economic use of the property.

Finally, we agree with the Court of Appeals that because the City has not actually imposed any parks and open space impact fees, Isla Verde's challenges to the imposition of any such fees is not ripe for judicial review. There is no land use decision reviewable under the LUPA. See RCW 36.70C.020; see also *Rhod-A-Zalea & 35th, Inc. v. Snohomish County*, 136 Wn.2d 1, 959 P.2d 1024 (1998) (insofar as constitutional challenge is made). Therefore, we do not address the propriety of any such fees.

CONCLUSION

The City's condition on plat approval that Isla Verde set aside 30 percent of its property as open space violates chapter 82.02.020 RCW and is therefore invalid. Isla Verde has failed to establish that the City's condition that Isla Verde provide secondary access for emergency vehicles violates substantive due process or is arbitrary and capricious in violation of RCW 64.40. Accordingly, we uphold that condition. The Court of Appeals' decision as to these conditions is affirmed, and this matter is remanded for further proceedings.

1 Isla Verde identified the steepest as having about a 30 percent slope.

2 Former Camas Municipal Code (CMC) 18.62.020 provides in part:

- A. Proposals for lands within the city have {sic} a P suffix zoning designation or being developed as a planned unit development or a subdivision or short plat shall retain a minimum of thirty (30%) percent of the site as open space.
- B. For the purpose of this section, 'open space(s)' shall be defined to mean areas set aside and suitable for active or passive recreation; and areas maintained in a natural state, providing habitat for wildlife, and/or containing significant trees and vegetation. This requirement shall be in addition to any area required to be dedicated to meet standards for the provision of parks, schools, open space or other facilities except that the city may allow up to half of the required open space to be credited toward the open space network.
- C. To the extent possible, open space areas on a site should contain forested areas, significant trees, wildlife habitat for protected species, and any environmentally sensitive areas located on the site as identified on the city sensitive areas maps or discovered in the field. Where possible, individual open space areas should be contiguous to other existing or planned open spaces so as to permit creation of a larger contiguous area or a continuous corridor. Except where developed for active recreation, open space areas are to be maintained in a natural and undisturbed state.
- D. Open space areas shall be protected and preserved through a permanent protective mechanism acceptable to the city. This may include placing the open space area in a separate tract; execu-

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tion of a protective easement; or dedication to a public agency or public or private land trust. The mechanism or agreement shall provide for maintenance.

3 CMC 17.12.090(E) provides:

- E. Location of required project open space and open space network, if applicable. If the city determines that the location, quality or extent of the required project open space, particularly on smaller plats or short plats, would not fulfill the intent or purpose of useful common open space, that requirement may be waived. If the requirement is waived, no increase in density can occur unless the city determines that a payment of an equivalent fee in lieu of the required project open space is appropriate. Such fee will be placed in the city's impact fee fund for open space acquisition and will not be subject to refund.

4 The June 16, 1995, staff report states that the question regarding the status of the pileated woodpecker had been resolved and that the species is considered a candidate species and is neither threatened nor endangered according to state and national species lists.

5 At the time the preliminary plat application came before the City Council, the proposed 51-lot plat map stated on its face that it provided .4 acres of open space, while the City Council's findings were that a 1.49-acre set aside was provided for. Both figures are considerably less than the 4-acre set aside necessary to meet the 30 percent requirement of former CMC 18.62.020.

6 Although the superior court had found a taking under our state constitution, the Court of Appeals found a taking in violation of the Fifth Amendment to the United States Constitution.

7 RCW 36.70C.130(1) provides in relevant part: (b) The land use decision is an erroneous interpretation of the law, after allowing for such deference as is due the construction of a law by a local jurisdiction with expertise; (c) The land use decision is not supported by evidence that is substantial when viewed in light of the whole record before the court; (d) The land use decision is a clearly erroneous application of the law to the facts. . . . (f) The land use decision violates the constitutional rights of the party seeking relief.

8 Although some earlier cases, including *San Telmo Associates v. City of Seattle*, 108 Wn.2d 20, 735 P.2d 673 (1987), turned on whether a payment was an unauthorized tax as opposed to a valid regulatory fee or charge, it has been clear since *R/L Assocs., Inc. v. City of Seattle*, 113 Wn.2d 402, 780 P.2d 838 (1989) that this court interprets the statute according to its plain terms, thus including all charges without regard to whether the payment is a tax or not.

9 RCW 82.02.020 was amended, and RCW 82.02.050 through .090 were enacted, as part of the Growth Management Act of 1990. Laws of 1990, 1st Ex. Sess., ch. 17, sec.sec. 42-44, 46-48. Most cases concerning RCW 82.02.020 involved prior versions of the statute, and do not concern the involuntary fees that may be imposed. E.g., *Henderson Home, Inc. v. City of Bothell*, 124 Wn.2d 240, 877 P.2d 176 (1994); *Trimen Dev. Co. v. King County*, 124 Wn.2d 261, 877 P.2d 187 (1994). The fact that RCW 82.02.050 through .090 create another exception to the general prohibition in RCW 82.02.020 has been recognized, however. *View Ridge Park Assocs. v. City of Mountlake Terrace*, 67 Wn. App. 588, 596, 839 P.2d 343 (1992); see generally 17 William B. Stoebeck, *Washington Practice, Real Estate: Property Law* sec. 5.5, at 277-78 (1995). Impact fees under RCW 82.02.050 through .090 may be imposed on development activity by counties, cities, and towns that are required to or choose to plan under RCW 36.70A.040 as part of public facilities financing. RCW 82.02.050(2). The impact fees may be imposed only for system improvements reasonably related to the new development, shall not exceed a proportionate share of system improvements reasonably related to the new development, and the improvements must reasonably benefit the new development. RCW 82.02.050(3)(a), (b), (c). 'System improvements' are public facilities included in the capital facilities plan to provide service to service areas within the community at large, in contrast to project improvements. RCW 82.02.090(9). 'Service area {s}' are de-

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defined geographic areas in which a defined set of public facilities provide service to development within the area. RCW 82.02.090(8). 'Public facilities' are capital facilities owned or operated by government entities: public streets and roads, publicly owned parks, open space, and recreation facilities, school facilities, and fire protection facilities unless they are part of a fire protection district. RCW 82.02.090(7). 'Project improvements' are site improvements and facilities for a particular development project, and are needed for the use and convenience of the occupants and users of the project. RCW 82.02.090(6). No improvement or facility in an approved capital facilities plan shall be considered a project improvement. Id. RCW 82.02.060(1)(c) states the Legislature's intent that impact fees are imposed through established procedures and criteria so that a development does not pay arbitrary or duplicative fees for the same impact.

10 RCW 82.02.020 provides in relevant part: Except only as expressly provided in chapters 67.28 and 82.14 RCW, the state preempts the field of imposing taxes upon retail sales of tangible personal property, the use of tangible personal property, parimutuel wagering authorized pursuant to RCW 67.16.060, conveyances, and cigarettes, and no county, town, or other municipal subdivision shall have the right to impose taxes of that nature. Except as provided in RCW 82.02.050 through 82.02.090, no county, city, town, or other municipal corporation shall impose any tax, fee, or charge, either direct or indirect, on the construction or reconstruction of residential buildings, commercial buildings, industrial buildings, or on any other building or building space or appurtenance thereto, or on the development, subdivision, classification, or reclassification of land. However, this section does not preclude dedications of land or easements within the proposed development or plat which the county, city, town, or other municipal corporation can demonstrate are reasonably necessary as a direct result of the proposed development or plat to which the dedication of land or easement is to apply.

This section does not prohibit voluntary agreements with counties, cities, towns, or other municipal corporations that allow a payment in lieu of a dedication of land or to mitigate a direct impact that has been identified as a consequence of a proposed development, subdivision, or plat. A local government shall not use such voluntary agreements for local off-site transportation improvements within the geographic boundaries of the area or areas covered by an adopted transportation program authorized by chapter 39.92 RCW. Any such voluntary agreement is subject to the following provisions:

- (1) The payment shall be held in a reserve account and may only be expended to fund a capital improvement agreed upon by the parties to mitigate the identified, direct impact;
- (2) The payment shall be expended in all cases within five years of collection; and
- (3) Any payment not so expended shall be refunded with interest at the rate applied to judgments to the property owners of record at the time of the refund; however, if the payment is not expended within five years due to delay attributable to the developer, the payment shall be refunded without interest.

No county, city, town, or other municipal corporation shall require any payment as part of such a voluntary agreement which the county, city, town, or other municipal corporation cannot establish is reasonably necessary as a direct result of the proposed development or plat.

11 RCW 58.17.110 provides in part:

- (1) The city, town, or county legislative body shall inquire into the public use and interest proposed to be served by the establishment of the subdivision and dedication. It shall determine:
 - (a) If appropriate provisions are made for, but not limited to, the public health, safety, and general welfare, for open spaces, drainage ways, streets or roads, alleys, other public ways, transit stops, potable water supplies, sanitary wastes, parks and recreation, playgrounds, schools and schoolgrounds, and shall consider all other relevant facts, including sidewalks and other plan-

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ning features that assure safe walking conditions for students who only walk to and from school; and (b) whether the public interest will be served by the subdivision and dedication.

- (2) A proposed subdivision and dedication shall not be approved unless the city, town, or county legislative body makes written findings that: (a) Appropriate provisions are made for the public health, safety, and general welfare and for such open spaces, drainage ways, streets or roads, alleys, other public ways, transit stops, potable water supplies, sanitary wastes, parks and recreation, playgrounds, schools and schoolgrounds and all other relevant facts, including sidewalks and other planning features that assure safe walking conditions for students who only walk to and from school; and (b) the public use and interest will be served by the platting of such subdivision and dedication. If it finds that the proposed subdivision and dedication make such appropriate provisions and that the public use and interest will be served, then the legislative body shall approve the proposed subdivision and dedication. Dedication of land to any public body, provision of public improvements to serve the subdivision, and/or impact fees imposed under RCW 82.02.050 through 82.02.090 may be required as a condition of subdivision approval. Dedications shall be clearly shown on the final plat. No dedication, provision of public improvements, or impact fees imposed under RCW 82.02.050 through 82.02.090 shall be allowed that constitutes an unconstitutional taking of private property. The legislative body shall not as a condition to the approval of any subdivision require a release from damages to be procured from other property owners.

12 The briefing to this court principally concerns constitutional issues. The City's argument respecting RCW 82.02.020 appears in its appellant's brief to the Court of Appeals.

13 Although there has been some dispute about the nature of the set aside, the City Council's written findings and decision expressly provide that Isla Verde must comply 'with all standard and special conditions set forth in the staff report {of June 16, 1995} that are not inconsistent with these findings, conclusions and decision.' Clerk's Papers (CP) at 9. The staff report includes recommended conditions, including, as noted, that a homeowners' association be required and that 'the open space area within this development will be owned and maintained by the homeowner's association.' Dove Hill Subdivision File Records at 114. These conditions are consistent with the City Council's written decision, and thus they apply.

14 See *Southwick, Inc. v. City of Lacey*, 58 Wn. App. 886, 893-94, 895, 795 P.2d 712 (1990) (RCW 82.02.020's voluntary agreement exceptions show 'legislative intent to stop the imposition of general social costs on developers, while at the same time allowing the continued imposition of costs that are directly attributable to the development;' (it would be anomalous to allow a municipality to charge a fee to pay for improvements necessitated by developer but not to allow the municipality to require that the developer make the improvements as a condition of site approval).

15 The evidentiary importance of this fact should not be overemphasized. Whether a determination of nonsignificance has or has not been issued is not dispositive. Moreover, insofar as the record shows, a determination of nonsignificance was issued with respect to the 32-lot proposal, not the 51-lot proposal.

16 The concurrence criticizes the majority for deciding this case under RCW 82.02.020 on what it calls an 'inadequate' and an 'insufficient' record; the concurrence even goes so far as to say the majority concedes that the record is inadequate. Concurrence at 1, 3. The concurrence misreads the majority. The record is sufficient to decide the issue presented. The problem to which the criticism is more appropriately addressed is the City's failure to establish a record that justifies its imposition of the set aside condition on Isla Verde. That is a matter of the City failing to meet its burden of proof, not a matter of an inadequate record on which to make a decision under RCW 82.02.020.

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17 We also note that by its express terms the City's open space ordinance set aside condition is in addition to any dedications under RCW 58.17.110: 'This requirement shall be in addition to any area required to be dedicated to meet standards for the provision of parks, schools, open space or other facilities; except that the city may allow up to half of the required open space to be credited toward the open space network.' Former CMC 18.62.020(B). We do not understand the City to have imposed any other open space requirement in this case than the 30 percent set aside, however.

18 As the Court of Appeals noted, one alternative was mentioned in testimony, i.e., a combination of sprinkler systems and fire-resistant building materials. However, as that court also noted, the record does not contain any evidence that this would be either less expensive or as effective as a limited access road. There is no basis for concluding it would be an available, less drastic, but still effective alternative. (Isla Verde did not agree to this alternative, and does not mention it in appellate briefing.)

Isla Verde does maintain that it proposed a looped road system as a viable alternative. However, while Isla Verde did suggest this possibility in oral comments, it never submitted a proposal to the City with this alternative design. We do not foreclose the possibility that a looped road system could be approved by the City as an alternative. We do conclude, however, that there is insufficient evidence to find on this record that a looped system would provide an effective less drastic measure. statistics

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Aliens Cause Global Warming

By Michael Crichton

Caltech Michelin Lecture

January 17, 2003

My topic today sounds humorous but unfortunately I am serious. I am going to argue that extraterrestrials lie behind global warming. Or to speak more precisely, I will argue that a belief in extraterrestrials has paved the way, in a progression of steps, to a belief in global warming. Charting this progression of belief will be my task today.

Let me say at once that I have no desire to discourage anyone from believing in either extraterrestrials or global warming. That would be quite impossible to do. Rather, I want to discuss the history of several widely-publicized beliefs and to point to what I consider an emerging crisis in the whole enterprise of science-namely the increasingly uneasy relationship between hard science and public policy.

I have a special interest in this because of my own upbringing. I was born in the midst of World War II, and passed my formative years at the height of the Cold War. In school drills, I dutifully crawled under my desk in preparation for a nuclear attack.

It was a time of widespread fear and uncertainty, but even as a child I believed that science represented the best and greatest hope for mankind. Even to a child, the contrast was clear between the world of politics-a world of hate and danger, of irrational beliefs and fears, of mass manipulation and disgraceful blots on human history. In contrast, science held different values-international in scope, forging friendships and working relationships across national boundaries and political systems, encouraging a dispassionate habit of thought, and ultimately leading to fresh knowledge and technology that would benefit all mankind. The world might not be a very good place, but science would make it better. And it did. In my lifetime, science has largely fulfilled its promise. Science has been the great intellectual adventure of our age, and a great hope for our troubled and restless world. But I did not expect science merely to extend lifespan, feed the hungry, cure disease, and shrink the world with jets and cell phones. I also expected science to banish the evils of human thought---prejudice and superstition, irrational beliefs and false fears. I expected science to be, in Carl Sagan's memorable phrase, "a candle in a demon haunted world." And here, I am not so pleased with the impact of science. Rather than serving as a cleansing force, science has in some instances been seduced by the more ancient lures of politics and publicity. Some of the demons that haunt our world in recent years are invented by scientists. The world has not benefited from permitting these demons to escape free.

But let's look at how it came to pass.

Cast your minds back to 1960. John F. Kennedy is president, commercial jet airplanes are just appearing, the biggest university mainframes have 12K of memory. And in Green Bank, West Virginia at the new National Radio Astronomy Observatory, a young astrophysicist named Frank Drake runs a two-week project called Ozma, to search for extraterrestrial signals. A signal is received, to great excitement. It turns out to be false, but the excitement remains. In 1960, Drake organizes the first SETI conference, and came up with the now-famous Drake equation:

$$N=N*fp\ ne\ fl\ fi\ fc\ fL$$

[where N is the number of stars in the Milky Way galaxy; fp is the fraction with planets; ne is the number of planets per star capable of supporting life; fl is the fraction of planets where life evolves; fi is

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the fraction where intelligent life evolves; and f_c is the fraction that communicates; and f_L is the fraction of the planet's life during which the communicating civilizations live.]

This serious-looking equation gave SETI a serious footing as a legitimate intellectual inquiry. The problem, of course, is that none of the terms can be known, and most cannot even be estimated. The only way to work the equation is to fill in with guesses. And guesses-just so we're clear-are merely expressions of prejudice. Nor can there be "informed guesses." If you need to state how many planets with life choose to communicate, there is simply no way to make an informed guess. It's simply prejudice.

As a result, the Drake equation can have any value from "billions and billions" to zero. An expression that can mean anything means nothing. Speaking precisely, the Drake equation is literally meaningless, and has nothing to do with science. I take the hard view that science involves the creation of testable hypotheses. The Drake equation cannot be tested and therefore SETI is not science. SETI is unquestionably a religion. Faith is defined as the firm belief in something for which there is no proof. The belief that the Koran is the word of God is a matter of faith. The belief that God created the universe in seven days is a matter of faith. The belief that there are other life forms in the universe is a matter of faith. There is not a single shred of evidence for any other life forms, and in forty years of searching, none has been discovered. There is absolutely no evidentiary reason to maintain this belief. SETI is a religion.

One way to chart the cooling of enthusiasm is to review popular works on the subject. In 1964, at the height of SETI enthusiasm, Walter Sullivan of the NY Times wrote an exciting book about life in the universe entitled WE ARE NOT ALONE. By 1995, when Paul Davis wrote a book on the same subject, he titled it ARE WE ALONE? (Since 1981, there have in fact been four books titled ARE WE ALONE.) More recently we have seen the rise of the so-called "Rare Earth" theory which suggests that we may, in fact, be all alone. Again, there is no evidence either way.

Back in the sixties, SETI had its critics, although not among astrophysicists and astronomers. The biologists and paleontologists were harshest. George Gaylord Simpson of Harvard sneered that SETI was a "study without a subject," and it remains so to the present day. But scientists in general have been indulgent toward SETI, viewing it either with bemused tolerance, or with indifference. After all, what's the big deal? It's kind of fun. If people want to look, let them. Only a curmudgeon would speak harshly of SETI. It wasn't worth the bother.

And of course, it is true that untestable theories may have heuristic value. Of course, extraterrestrials are a good way to teach science to kids. But that does not relieve us of the obligation to see the Drake equation clearly for what it is-pure speculation in quasi-scientific trappings.

The fact that the Drake equation was not greeted with screams of outrage-similar to the screams of outrage that greet each Creationist new claim, for example-meant that now there was a crack in the door, a loosening of the definition of what constituted legitimate scientific procedure. And soon enough, pernicious garbage began to squeeze through the cracks.

Now let's jump ahead a decade to the 1970s, and Nuclear Winter.

In 1975, the National Academy of Sciences reported on "Long-Term Worldwide Effects of Multiple Nuclear Weapons Detonations" but the report estimated the effect of dust from nuclear blasts to be relatively minor. In 1979, the Office of Technology Assessment issued a report on "The Effects of Nuclear War" and stated that nuclear war could perhaps produce irreversible adverse consequences on the environment. However, because the scientific processes involved were poorly understood, the report stated it was not possible to estimate the probable magnitude of such damage.

Three years later, in 1982, the Swedish Academy of Sciences commissioned a report entitled "The Atmosphere after a Nuclear War: Twilight at Noon," which attempted to quantify the effect of smoke from burning forests and cities. The authors speculated that there would be so much smoke that a large

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cloud over the northern hemisphere would reduce incoming sunlight below the level required for photosynthesis, and that this would last for weeks or even longer.

The following year, five scientists including Richard Turco and Carl Sagan published a paper in Science called "Nuclear Winter: Global Consequences of Multiple Nuclear Explosions." This was the so-called TTAPS report, which attempted to quantify more rigorously the atmospheric effects, with the added credibility to be gained from an actual computer model of climate.

At the heart of the TTAPS undertaking was another equation, never specifically expressed, but one that could be paraphrased as follows:

$$Ds = Wn Ws Wh Tf Tb Pt Pr Pe \text{ etc}$$

(The amount of tropospheric dust = # warheads x size warheads x warhead detonation height x flammability of targets x Target burn duration x Particles entering the Troposphere x Particle reflectivity x Particle endurance, and so on.)

The similarity to the Drake equation is striking. As with the Drake equation, none of the variables can be determined. None at all. The TTAPS study addressed this problem in part by mapping out different wartime scenarios and assigning numbers to some of the variables, but even so, the remaining variables were-and are-simply unknowable. Nobody knows how much smoke will be generated when cities burn, creating particles of what kind, and for how long. No one knows the effect of local weather conditions on the amount of particles that will be injected into the troposphere. No one knows how long the particles will remain in the troposphere. And so on.

And remember, this is only four years after the OTA study concluded that the underlying scientific processes were so poorly known that no estimates could be reliably made. Nevertheless, the TTAPS study not only made those estimates, but concluded they were catastrophic.

According to Sagan and his coworkers, even a limited 5,000 megaton nuclear exchange would cause a global temperature drop of more than 35 degrees Centigrade, and this change would last for three months. The greatest volcanic eruptions that we know of changed world temperatures somewhere between .5 and 2 degrees Centigrade. Ice ages changed global temperatures by 10 degrees. Here we have an estimated change three times greater than any ice age. One might expect it to be the subject of some dispute.

But Sagan and his coworkers were prepared, for nuclear winter was from the outset the subject of a well-orchestrated media campaign. The first announcement of nuclear winter appeared in an article by Sagan in the Sunday supplement, Parade. The very next day, a highly-publicized, high-profile conference on the long-term consequences of nuclear war was held in Washington, chaired by Carl Sagan and Paul Ehrlich, the most famous and media-savvy scientists of their generation. Sagan appeared on the Johnny Carson show 40 times. Ehrlich was on 25 times. Following the conference, there were press conferences, meetings with congressmen, and so on. The formal papers in Science came months later.

This is not the way science is done, it is the way products are sold.

The real nature of the conference is indicated by these artists' renderings of the effect of nuclear winter.

I cannot help but quote the caption for figure 5: "Shown here is a tranquil scene in the north woods. A beaver has just completed its dam, two black bears forage for food, a swallow-tailed butterfly flutters in the foreground, a loon swims quietly by, and a kingfisher searches for a tasty fish." Hard science if ever there was.

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At the conference in Washington, during the question period, Ehrlich was reminded that after Hiroshima and Nagasaki, scientists were quoted as saying nothing would grow there for 75 years, but in fact melons were growing the next year. So, he was asked, how accurate were these findings now?

Ehrlich answered by saying "I think they are extremely robust. Scientists may have made statements like that, although I cannot imagine what their basis would have been, even with the state of science at that time, but scientists are always making absurd statements, individually, in various places. What we are doing here, however, is presenting a consensus of a very large group of scientists"

I want to pause here and talk about this notion of consensus, and the rise of what has been called consensus science. I regard consensus science as an extremely pernicious development that ought to be stopped cold in its tracks. Historically, the claim of consensus has been the first refuge of scoundrels; it is a way to avoid debate by claiming that the matter is already settled. Whenever you hear the consensus of scientists agrees on something or other, reach for your wallet, because you're being had.

Let's be clear: the work of science has nothing whatever to do with consensus. Consensus is the business of politics. Science, on the contrary, requires only one investigator who happens to be right, which means that he or she has results that are verifiable by reference to the real world. In science consensus is irrelevant. What is relevant is reproducible results. The greatest scientists in history are great precisely because they broke with the consensus.

There is no such thing as consensus science. If it's consensus, it isn't science. If it's science, it isn't consensus. Period.

In addition, let me remind you that the track record of the consensus is nothing to be proud of. Let's review a few cases.

In past centuries, the greatest killer of women was fever following childbirth. One woman in six died of this fever. In 1795, Alexander Gordon of Aberdeen suggested that the fevers were infectious processes, and he was able to cure them. The consensus said no. In 1843, Oliver Wendell Holmes claimed puerperal fever was contagious, and presented compelling evidence. The consensus said no. In 1849, Semmelweiss demonstrated that sanitary techniques virtually eliminated puerperal fever in hospitals under his management. The consensus said he was a Jew, ignored him, and dismissed him from his post. There was in fact no agreement on puerperal fever until the start of the twentieth century. Thus the consensus took one hundred and twenty five years to arrive at the right conclusion despite the efforts of the prominent "skeptics" around the world, skeptics who were demeaned and ignored. And despite the constant ongoing deaths of women.

There is no shortage of other examples. In the 1920s in America, tens of thousands of people, mostly poor, were dying of a disease called pellagra. The consensus of scientists said it was infectious, and what was necessary was to find the "pellagra germ." The US government asked a brilliant young investigator, Dr. Joseph Goldberger, to find the cause. Goldberger concluded that diet was the crucial factor. The consensus remained wedded to the germ theory. Goldberger demonstrated that he could induce the disease through diet. He demonstrated that the disease was not infectious by injecting the blood of a pellagra patient into himself, and his assistant. They and other volunteers swabbed their noses with swabs from pellagra patients, and swallowed capsules containing scabs from pellagra rashes in what were called "Goldberger's filth parties." Nobody contracted pellagra. The consensus continued to disagree with him. There was, in addition, a social factor-southern States disliked the idea of poor diet as the cause, because it meant that social reform was required. They continued to deny it until the 1920s. Result-despite a twentieth century epidemic, the consensus took years to see the light.

Probably every schoolchild notices that South America and Africa seem to fit together rather snugly, and Alfred Wegener proposed, in 1912, that the continents had in fact drifted apart. The consensus sneered at continental drift for fifty years. The theory was most vigorously denied by the great

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names of geology-until 1961, when it began to seem as if the sea floors were spreading. The result: it took the consensus fifty years to acknowledge what any schoolchild sees.

And shall we go on? The examples can be multiplied endlessly. Jenner and smallpox, Pasteur and germ theory. Saccharine, margarine, repressed memory, fiber and colon cancer, hormone replacement therapy. The list of consensus errors goes on and on.

Finally, I would remind you to notice where the claim of consensus is invoked. Consensus is invoked only in situations where the science is not solid enough. Nobody says the consensus of scientists agrees that $E=mc^2$. Nobody says the consensus is that the sun is 93 million miles away. It would never occur to anyone to speak that way.

But back to our main subject.

What I have been suggesting to you is that nuclear winter was a meaningless formula, tricked out with bad science, for policy ends. It was political from the beginning, promoted in a well-orchestrated media campaign that had to be planned weeks or months in advance.

Further evidence of the political nature of the whole project can be found in the response to criticism. Although Richard Feynman was characteristically blunt, saying, "I really don't think these guys know what they're talking about," other prominent scientists were noticeably reticent. Freeman Dyson was quoted as saying "It's an absolutely atrocious piece of science but who wants to be accused of being in favor of nuclear war?" And Victor Weisskopf said, "The science is terrible but---perhaps the psychology is good." The nuclear winter team followed up the publication of such comments with letters to the editors denying that these statements were ever made, though the scientists since then have subsequently confirmed their views.

At the time, there was a concerted desire on the part of lots of people to avoid nuclear war. If nuclear winter looked awful, why investigate too closely? Who wanted to disagree? Only people like Edward Teller, the "father of the H bomb."

Teller said, "While it is generally recognized that details are still uncertain and deserve much more study, Dr. Sagan nevertheless has taken the position that the whole scenario is so robust that there can be little doubt about its main conclusions." Yet for most people, the fact that nuclear winter was a scenario riddled with uncertainties did not seem to be relevant.

I say it is hugely relevant. Once you abandon strict adherence to what science tells us, once you start arranging the truth in a press conference, then anything is possible. In one context, maybe you will get some mobilization against nuclear war. But in another context, you get Lysenkoism. [A biological doctrine developed by Trofim Lysenko that maintains the possibility of inheriting environmentally acquired characteristics] In another, you get Nazi euthanasia. The danger is always there, if you subvert science to political ends.

That is why it is so important for the future of science that the line between what science can say with certainty, and what it cannot, be drawn clearly-and defended.

What happened to Nuclear Winter? As the media glare faded, its robust scenario appeared less persuasive; John Maddox, editor of Nature, repeatedly criticized its claims; within a year, Stephen Schneider, one of the leading figures in the climate model, began to speak of "nuclear autumn." It just didn't have the same ring.

A final media embarrassment came in 1991, when Carl Sagan predicted on Nightline that Kuwaiti oil fires would produce a nuclear winter effect, causing a "year without a summer," and endangering crops around the world. Sagan stressed this outcome was so likely that "it should affect the war plans." None of it happened.

What, then, can we say were the lessons of Nuclear Winter? I believe the lesson was that with a catchy name, a strong policy position and an aggressive media campaign, nobody will dare to criticize

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the science, and in short order, a terminally weak thesis will be established as fact. After that, any criticism becomes beside the point. The war is already over without a shot being fired. That was the lesson, and we had a textbook application soon afterward, with second hand smoke.

In 1993, the EPA announced that second-hand smoke was "responsible for approximately 3,000 lung cancer deaths each year in nonsmoking adults," and that it "impairs the respiratory health of hundreds of thousands of people." In a 1994 pamphlet the EPA said that the eleven studies it based its decision on were not by themselves conclusive, and that they collectively assigned second-hand smoke a risk factor of 1.19. (For reference, a risk factor below 3.0 is too small for action by the EPA. or for publication in the New England Journal of Medicine, for example.) Furthermore, since there was no statistical association at the 95% confidence limits, the EPA lowered the limit to 90%. They then classified second-hand smoke as a Group-A Carcinogen.

This was openly fraudulent science, but it formed the basis for bans on smoking in restaurants, offices, and airports. California banned public smoking in 1995. Soon, no claim was too extreme. By 1998, the Christian Science Monitor was saying that "Second-hand smoke is the nation's third-leading preventable cause of death." The American Cancer Society announced that 53,000 people died each year of second-hand smoke. The evidence for this claim is nonexistent.

In 1998, a Federal judge held that the EPA had acted improperly, had "committed to a conclusion before research had begun", and had "disregarded information and made findings on selective information." The reaction of Carol Browner, head of the EPA was: "We stand by our science; there's wide agreement. The American people certainly recognize that exposure to second hand smoke brings a whole host of health problems." Again, note how the claim of consensus trumps science. In this case, it isn't even a consensus of scientists that Browner evokes! It's the consensus of the American people.

Meanwhile, ever-larger studies failed to confirm any association. A large, seven-country WHO study in 1998 found no association. Nor have well-controlled subsequent studies, to my knowledge. Yet we now read, for example, that second-hand smoke is a cause of breast cancer. At this point you can say pretty much anything you want about second-hand smoke.

As with nuclear winter, bad science is used to promote what most people would consider good policy. I certainly think it is. I don't want people smoking around me. So who will speak out against banning second-hand smoke? Nobody, and if you do, you'll be branded a shill of RJ Reynolds. A big tobacco flunky. But the truth is that we now have a social policy supported by the grossest of superstitions. And we've given the EPA a bad lesson in how to behave in the future. We've told them that cheating is the way to succeed.

As the twentieth century drew to a close, the connection between hard scientific fact and public policy became increasingly elastic. In part this was possible because of the complacency of the scientific profession; in part because of the lack of good science education among the public; in part, because of the rise of specialized advocacy groups which have been enormously effective in getting publicity and shaping policy; and in great part because of the decline of the media as an independent assessor of fact. The deterioration of the American media is dire loss for our country. When distinguished institutions like the New York Times can no longer differentiate between factual content and editorial opinion, but rather mix both freely on their front page, then who will hold anyone to a higher standard?

And so, in this elastic anything-goes world where science-or non-science-is the hand maiden of questionable public policy, we arrive at last at global warming. It is not my purpose here to rehash the details of this most magnificent of the demons haunting the world. I would just remind you of the now-familiar pattern by which these things are established. Evidentiary uncertainties are glossed over in the unseemly rush for an overarching policy, and for grants to support the policy by delivering findings that are desired by the patron. Next, the isolation of those scientists who won't get with the program, and the

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characterization of those scientists as outsiders and "skeptics" in quotation marks-suspect individuals with suspect motives, industry flunkies, reactionaries, or simply anti-environmental nut-cases. In short order, debate ends, even though prominent scientists are uncomfortable about how things are being done.

When did "skeptic" become a dirty word in science? When did a skeptic require quotation marks around it?

To an outsider, the most significant innovation in the global warming controversy is the overt reliance that is being placed on models. Back in the days of nuclear winter, computer models were invoked to add weight to a conclusion: "These results are derived with the help of a computer model." But now, large-scale computer models are seen as generating data in themselves. No longer are models judged by how well they reproduce data from the real world-increasingly, models provide the data. As if they were themselves a reality. And indeed they are, when we are projecting forward. There can be no observational data about the year 2100. There are only model runs.

This fascination with computer models is something I understand very well. Richard Feynmann called it a disease. I fear he is right. Because only if you spend a lot of time looking at a computer screen can you arrive at the complex point where the global warming debate now stands.

Nobody believes a weather prediction twelve hours ahead. Now we're asked to believe a prediction that goes out 100 years into the future? And make financial investments based on that prediction? Has everybody lost their minds?

Stepping back, I have to say the arrogance of the model-makers is breathtaking. There have been, in every century, scientists who say they know it all. Since climate may be a chaotic system-no one is sure-these predictions are inherently doubtful, to be polite. But more to the point, even if the models get the science spot-on, they can never get the sociology. To predict anything about the world a hundred years from now is simply absurd.

Look: If I was selling stock in a company that I told you would be profitable in 2100, would you buy it? Or would you think the idea was so crazy that it must be a scam?

Let's think back to people in 1900 in, say, New York. If they worried about people in 2000, what would they worry about? Probably: Where would people get enough horses? And what would they do about all the horseshit? Horse pollution was bad in 1900, think how much worse it would be a century later, with so many more people riding horses?

But of course, within a few years, nobody rode horses except for sport. And in 2000, France was getting 80% its power from an energy source that was unknown in 1900. Germany, Switzerland, Belgium and Japan were getting more than 30% from this source, unknown in 1900. Remember, people in 1900 didn't know what an atom was. They didn't know its structure. They also didn't know what a radio was, or an airport, or a movie, or a television, or a computer, or a cell phone, or a jet, an antibiotic, a rocket, a satellite, an MRI, ICU, IUD, IBM, IRA, ERA, EEG, EPA, IRS, DOD, PCP, HTML, internet. interferon, instant replay, remote sensing, remote control, speed dialing, gene therapy, gene splicing, genes, spot welding, heat-seeking, bipolar, prozac, leotards, lap dancing, email, tape recorder, CDs, air-bags, plastic explosive, plastic, robots, cars, liposuction, transduction, superconduction, dish antennas, step aerobics, smoothies, twelve-step, ultrasound, nylon, rayon, teflon, fiber optics, carpal tunnel, laser surgery, laparoscopy, corneal transplant, kidney transplant, AIDS. None of this would have meant anything to a person in the year 1900. They wouldn't know what you are talking about.

Now. You tell me you can predict the world of 2100. Tell me it's even worth thinking about. Our models just carry the present into the future. They're bound to be wrong. Everybody who gives a moment's thought knows it.

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I remind you that in the lifetime of most scientists now living, we have already had an example of dire predictions set aside by new technology. I refer to the green revolution. In 1960, Paul Ehrlich said, "The battle to feed humanity is over. In the 1970s the world will undergo famines-hundreds of millions of people are going to starve to death." Ten years later, he predicted four billion people would die during the 1980s, including 65 million Americans. The mass starvation that was predicted never occurred, and it now seems it isn't ever going to happen. Nor is the population explosion going to reach the numbers predicted even ten years ago. In 1990, climate modelers anticipated a world population of 11 billion by 2100. Today, some people think the correct number will be 7 billion and falling. But nobody knows for sure.

But it is impossible to ignore how closely the history of global warming fits on the previous template for nuclear winter. Just as the earliest studies of nuclear winter stated that the uncertainties were so great that probabilities could never be known, so, too the first pronouncements on global warming argued strong limits on what could be determined with certainty about climate change. The 1995 IPCC draft report said, "Any claims of positive detection of significant climate change are likely to remain controversial until uncertainties in the total natural variability of the climate system are reduced." It also said, "No study to date has positively attributed all or part of observed climate changes to anthropogenic causes." Those statements were removed, and in their place appeared: "The balance of evidence suggests a discernable human influence on climate."

What is clear, however, is that on this issue, science and policy have become inextricably mixed to the point where it will be difficult, if not impossible, to separate them out. It is possible for an outside observer to ask serious questions about the conduct of investigations into global warming, such as whether we are taking appropriate steps to improve the quality of our observational data records, whether we are systematically obtaining the information that will clarify existing uncertainties, whether we have any organized disinterested mechanism to direct research in this contentious area.

The answer to all these questions is no. We don't.

In trying to think about how these questions can be resolved, it occurs to me that in the progression from SETI to nuclear winter to second-hand smoke to global warming, we have one clear message, and that is that we can expect more and more problems of public policy dealing with technical issues in the future-problems of ever greater seriousness, where people care passionately on all sides.

And at the moment we have no mechanism to get good answers. So I will propose one.

Just as we have established a tradition of double-blinded research to determine drug efficacy, we must institute double-blinded research in other policy areas as well. Certainly the increased use of computer models, such as GCMs, cries out for the separation of those who make the models from those who verify them. The fact is that the present structure of science is entrepreneurial, with individual investigative teams vying for funding from organizations that all too often have a clear stake in the outcome of the research-or appear to, which may be just as bad. This is not healthy for science.

Sooner or later, we must form an independent research institute in this country. It must be funded by industry, by government, and by private philanthropy, both individuals and trusts. The money must be pooled, so that investigators do not know who is paying them. The institute must fund more than one team to do research in a particular area, and the verification of results will be a foregone requirement: teams will know their results will be checked by other groups. In many cases, those who decide how to gather the data will not gather it, and those who gather the data will not analyze it. If we were to address the land temperature records with such rigor, we would be well on our way to an understanding of exactly how much faith we can place in global warming, and therefore with what seriousness we must address this.

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I believe that as we come to the end of this litany, some of you may be saying, well what is the big deal, really. So we made a few mistakes. So a few scientists have overstated their cases and have egg on their faces. So what?

Well, I'll tell you.

In recent years, much has been said about the post-modernist claims about science to the effect that science is just another form of raw power, tricked out in special claims for truth-seeking and objectivity that really have no basis in fact. Science, we are told, is no better than any other undertaking. These ideas anger many scientists, and they anger me. But recent events have made me wonder if they are correct. We can take as an example the scientific reception accorded a Danish statistician, Bjorn Lomborg, who wrote a book called *The Skeptical Environmentalist*.

The scientific community responded in a way that can only be described as disgraceful. In professional literature, it was complained he had no standing because he was not an earth scientist. His publisher, Cambridge University Press, was attacked with cries that the editor should be fired, and that all right-thinking scientists should shun the press. The past president of the AAAS wondered aloud how Cambridge could have ever "published a book that so clearly could never have passed peer review." (But of course, the manuscript did pass peer review by three earth scientists on both sides of the Atlantic, and all recommended publication.) But what are scientists doing attacking a press? Is this the new McCarthyism-coming from scientists?

Worst of all was the behavior of the *Scientific American*, which seemed intent on proving the post-modernist point that it was all about power, not facts. The *Scientific American* attacked Lomborg for eleven pages, yet only came up with nine factual errors despite their assertion that the book was "rife with careless mistakes." It was a poor display, featuring vicious ad hominem attacks, including comparing him to a Holocaust denier. The issue was captioned: "Science defends itself against the *Skeptical Environmentalist*." Really. Science has to defend itself? Is this what we have come to?

When Lomborg asked for space to rebut his critics, he was given only a page and a half. When he said it wasn't enough, he put the critics' essays on his web page and answered them in detail. *Scientific American* threatened copyright infringement and made him take the pages down. Further attacks since, have made it clear what is going on. Lomborg is charged with heresy. That's why none of his critics needs to substantiate their attacks in any detail. That's why the facts don't matter. That's why they can attack him in the most vicious personal terms. He's a heretic.

Of course, any scientist can be charged as Galileo was charged. I just never thought I'd see the *Scientific American* in the role of Mother Church.

Is this what science has become? I hope not. But it is what it will become, unless there is a concerted effort by leading scientists to aggressively separate science from policy. The late Philip Handler, former president of the National Academy of Sciences, said that "Scientists best serve public policy by living within the ethics of science, not those of politics. If the scientific community will not unfrock the charlatans, the public will not discern the difference-- science and the nation will suffer." Personally, I don't worry about the nation. But I do worry about science.

CRICHTON, (John) Michael. American. Born in Chicago, Illinois, October 23, 1942. Educated at Harvard University, Cambridge, Massachusetts, A.B. (summa cum laude) 1964 (Phi Beta Kappa). Visiting Lecturer in Anthropology at Cambridge University, England, 1965. Henry Russell Shaw Travelling Fellow, 1964-65. Entered Harvard Medical School, M.D. 1969; spent one year as a post-doctoral fellow at the Salk Institute for Biological Sciences, La Jolla, California 1969-1970. Visiting Writer, Massachusetts Institute of Technology, 1988.

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**LITERATURE REVIEW OF
BEST AVAILABLE SCIENCE
for
Statistics
River Systems
Water Science and the Physical Laws
Livestock use of Riparian Communities
Nutrients & Sediments in the Riparian Communities
Fish**

Prepared by: Pat Larson
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March, 2003

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Appendix 4 OVERVIEW

The Earth is two-thirds water and one-third land. Oceans surround the continents that have formed throughout geologic time and continue to form and erode. Members of both the Plant and Animal Kingdoms have evolved and become extinct as shifts in their habitat changed or were destroyed due to climatic or geologic events.

Oceans and atmospheric conditions interact and as air currents move over land various climates form. Throughout time a series of mountains and valleys of variable sizes have developed due to geologic events in combination with localized climate events. As a result mountains and valleys have become areas where precipitation is captured, stored in the soils, and the excess water through paths of least resistance moves off the land and back to the ocean.

Watersheds and river systems are the result of very long periods of events caused by geologic and hydrologic forces influenced by climate. At different scales both are defined areas where time, geologic, hydrologic and climatic events are recorded.

Geologists observe land forms from a perspective of time. Geologic events can be characterized as change over hundreds of years or in some cases a large area may have changed over thousands of years. Geology relies on Physics and Chemistry principles to reconstruct the order and causes of the event that have formed Earth's landscape.

Hydrologists study waterways and river systems in terms of time. Daily and seasonal events of the water cycle are often seen as important or insignificant when compared to periodic effects grouped by decades or centuries. The physical laws are used to describe and predict river and land interactions during changes that take place constantly.

Climatologists study climate in terms of periodic events at large scales. Trends in wet periods or dry periods, cold or warm cycles are viewed from a perspective of patterns established over time. Climate is described using laws in the fields of Physics and Chemistry

In a river system, Hydrologists and Geomorphologists study the time and space where geologic and climatic forces interact. Under the force of gravity the land surface has been sculpted by water, wind, and ice. The time involved in the process may be over hundreds of years and is recognized as a system in constant change.

Excess water from precipitation continues to carve paths through mountains, erode land in one area and depositing the load on another. River form and fluvial processes take place simultaneously and the system adjusts to the volume of water, erosional debris taken on as a load within the water column, and drainage area contributing to the channel.

Excess water from precipitation after saturating land (soil) can enter waterways carrying loose particles of soil and plant material. Natural erosion of soils takes place in this manner. River deposition has played a role in forming new soils where rivers and streams have carried materials from uplands to valley floors.

Soils are biochemical weathered products of nature formed through time and are a habitat for the growth of plants. The soils have been formed from a variable mixture of broken and weathered minerals and organic matter. Soils, with the proper amount of air and water provide a mechanical support and sustenance for plants.

Plant ecologists examine plant life based on boundaries established by water and/or soil formation influenced by local climatic factors. Plants species have adaptive characteristics placing them in variable spaces across the Earth. Generally ecological studies describe communities in terms of periodic events that have allowed or discouraged species of plants to become established over years, decades and possibly

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a century. Changes in plant community composition occur continuously due to disruptions of other earth processes such as fire, wind, precipitation in the form of rain, snow or ice, as well as volcano and earthquake activities. These events have prevented landscapes from becoming a monoculture of a single family, genus, or species.

Plant communities are used by members of the Animal Kingdom. Organisms of microscopic size to very large species take advantage of the varying landscapes to find food and shelter. Animal species are studied as populations within a habitat while observing their adaptive survival skills within a habitat. Nutrition for growth and reproduction takes place through interactions with plants or other organisms over life spans which can be from a few days, weeks, years or decades. Different species use different habitat. Specialized fields within the biological sciences have developed, to focus on species that occur on the land or in the water. Wildlife Biologists focus on terrestrial and aquatic animals that use plant communities and display interactions with both the habitat as well as other terrestrial or aquatic life. Fish biologists study aquatic life and specialize in fresh or marine water inhabitants.

The fisheries during the last half century have examined questions of how fish exist and adapt to the variable aquatic habitats. Fresh water habitats of rivers and lakes are of particular interest in North America regarding the group of fish, Salmonids, as they take advantage of a marine environment during their adult, mature lives and seek fresh water to begin the reproduction of the species. Fisheries physiological studies describe internal adaptations that allow the species to make the switch as having formed through many generations during hundreds or thousands of years. In current events, the phenomenon is viewed within the time period of human settlement on the continent into the present day.

It is because of the recognition of scale and interaction that in 1941 H. Jenny (Father of Soil Science) proposed in Factors of Soil Formation that soil formation was the cumulative interaction of parent material, climate, biota topography and time. Similarly A.G. Tansly (Tansly, H. 1936. The use and abuse of vegetational concepts and terms. Ecology 16:284-307) proposed the term ecosystem to describe the structure and interaction of climate, topography soils, plants and animals.

Members of the Animal Kingdom live and use habitat for food and shelter and use adaptive features of the species to nudge nature or seek new habitat favorable to their survival and future existence. Humans and Salmonids exist in different habitats as opportunists with limited abilities to manipulate and control the ecosystem which has been formed at scales of time and force beyond individual capabilities.

It is imperative that man's ability to manipulate a system be viewed with a realistic understanding of scale and the interactions that occur in natural systems. It is equally imperative that Salmonids be viewed with a realistic understanding that their existence is dependent on two very different environments: the ocean and fresh water river systems. Reproduction takes place in fresh water and survival has come about due to both adaptations and mobility which allows the species to relocate when specific water column conditions become unsuitable.

To study Salmonid increases or declines being caused solely by man's manipulation of the terrestrial habitat is an error. Biological processes and population dynamics require observance of scale in both the time and events that resulted in the creation of a specific environment.

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Appendix 4 INTRODUCTION

This literature review is arranged using a literature citation by authors, date, journal name, with volume and page number. A short abstract and summary of the study follows each manuscript reviewed. For most of the literature, the abstract provided in the published manuscript written by the authors has been included. Some manuscript summaries also include reported findings, descriptions of methods, and concluding statements if an abstract was missing or was abbreviated and did not capture detail important to the topic.

Issues currently facing natural resource management are: fish, fish habitat, water temperature, sedimentation of streams due to forest and agriculture non point source erosion from runoff, the role of nitrate in the riparian areas, and riparian buffers. The following questions were used to provide categories as guidance for the selections of literature to be reviewed :

1. What is temperature and what is heat?
2. What governs water temperatures in watersheds?
3. What do we know about the interaction of livestock with salmon in riparian areas?
4. What do we know about livestock use of the plant community of a riparian area?
5. What is the role of nitrogen in the riparian area and stream water?
6. How does a riparian area filter sediments out of runoff from non point source erosion?
7. What do we know about "filter strips" in riparian areas?
8. What water temperatures are important to salmon, and when are water temperatures critical for their survival?

Within each topic, hundreds of published articles (and possibly thousands in some categories) are available in professional scientific journals, government documents, reports, and University extension bulletins. This literature review was conducted using six criteria found in Washington Administrative Code, Growth Management. Act (WAC 365-195-905).

These criteria provided guidance to determine what is "best available science". The criteria are a close representation of the criteria used during manuscript review at professional journals. Reviewed articles that did not include each of the criteria were excluded from this literature list.

1. Peer review. The information has been critically reviewed by other persons who are qualified scientific experts in that scientific discipline. The criticism of the peer reviewers has been addressed by the proponents of the information. Publication in a refereed scientific journal usually indicates that the information has been appropriately peer-reviewed.
2. Methods. The methods that were used to obtain the information are clearly stated and able to be replicated. The methods are standardized in the pertinent scientific discipline or, if not, the methods have been appropriately peer-reviewed to assure their reliability and validity.
3. Logical conclusions and reasonable inferences. The conclusions presented

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are based on reasonable assumptions supported by other studies and consistent with the general theory underlying the assumptions. The conclusions are logically and reasonably derived from the assumptions and supported by the data presented. Any gaps in information and inconsistencies with other pertinent scientific information are adequately explained.

4. Quantitative analysis. The data have been analyzed using appropriate statistical or quantitative methods.

5. Context. The information is placed in proper context. The assumptions, analytical techniques, data, and conclusions are appropriately framed with respect to the prevailing body of pertinent scientific knowledge.

6. References. The assumptions, analytical techniques, and conclusions are well referenced with citations to relevant, credible literature and other pertinent existing information.

Statistics and Science

Snedecor, G.W. and William Cochran. 1967. Statistical methods. Iowa State University Press. Ames, IA.

This text is a standard reference for researchers in designing and analyzing data collected on projects. The theories of math are used to provide an objective result in determining when numbers are different due to patterns occurring within a population that are not due to chance.

Steel, R.G. and J.H. Torrie. 1980. Principles and procedures of statistics. McGraw-Hill. New York, NY.

This text is a standard reference for researchers in designing and analyzing data collected on projects. The theories of math are used to provide an objective result in determining when numbers are different due to patterns occurring within a population that are not due to chance.

Romesburg, H.C. 1981. Wildlife science: gaining reliable knowledge. J. Wildl. Manage. 45(2):293-313.

Two scientific methods called induction and retrodution form the basis for almost all wildlife research. Induction is used to establish reliable associations among sets of facts, whereas retrodution is used to establish research hypotheses about the fact-giving processes driving nature. A 3rd method, the hypothetico-deductive (H-D) is a means for testing research hypotheses for gauging their reliability. The H-D method is rarely used in wildlife science. Instead research hypotheses are proposed, and either made into a law through verbal repetition or lose favor and are forgotten.

Knowledge, the set of ideas that agree or are consistent with the facts of nature, is discovered through the application of scientific methods. There is no single all purpose scientific method; instead there are several, each suited to a different purpose. When the set of methods is incomplete, or when one method is used for the purpose better fit by another, or when a given method is applied without paying strict attention the control of extraneous influences, then these errors of misuse cause knowledge to become unreliable.

Unreliable knowledge is the set of false ideas that are mistaken for knowledge. If we let unreliable

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knowledge in then others accepting these false laws, will build new knowledge on a false foundation. At some point an overload will occur, then a crash, then a retracting to the set of knowledge that existed in the past before the drift toward unreliability started. Every field that loses quality control over its primary product must undergo this kind of tracing if it is to survive. Of course, some unreliable knowledge inevitably creeps in – a researcher makes a systematic error here, or fails to do enough replications there. All science is prone to human error, and minor retracing continually occurs. Part of wildlife science's knowledge bank has become grossly unreliable owing to the misuse of scientific methods, and major retracing is inevitable.

Consider the question of how salmon find their way upstream to their home spawning grounds. The answer, "salmon navigate by vision alone," is a research hypothesis (H), a conjecture about a process of navigation. A test consequence (C) is a "a group of salmon that has been captured and blinded as they begin their upstream migration and will not reach their home tributary spawning grounds in numbers greater than expected by chance, whereas a non blinded control group of equal size that was spawned in the same tributary as the blinded fish will return to their tributary in numbers greater than expected by chance." The fact of the test consequence must then be obtained by experiment, e.g. tagging smolts before their migration to the lake or ocean, recapture of those returning to spawn, and subsequent recapture of blinded and control-group salmon after they have swum upstream.

The more certain a researcher is that the background conditions are indeed true, the more certain he will be in announcing H to be confirmed when C is true, and H to be falsified when C is false.

Hurlbert, Stuart H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecological Monographs*. Ecological Society of America. 54(2).

Pseudoreplication is defined as the use of inferential statistics to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates are not statistically independent. In ANOVA terminology, it is the testing for treatment effects with an error term inappropriate to the hypothesis being considered. Scrutiny of 176 experimental studies published between 1960 and the present revealed that pseudoreplication occurred in 27% of them, or 48% of all such studies that applied inferential statistics.

Some specific actions to take to combat pseudoreplication and related errors are provided as guidance for editors.

Insist that the physical layout of an experiment either be presented in a diagram or be described so that the reader can sketch a diagram for himself.

Determine from the above if the experiment involves true replication and interspersions of treatments.

Question and pass judgment as to the likelihood that the procedures for assigning treatments to experimental units may have introduced bias or generated spurious treatment effects.

Insist that the statistical analysis applied be described in detail. Insist on disclaimers and explicit mention of the weaknesses of the experimental design. Be liberal in accepting good papers that refrain from musing inferential statistics when these cannot validly be applied. Many papers, both descriptive and experimental, fall in this category.

It is often easier to get a paper published if one uses erroneous statistical analysis than if one uses no statistical analysis at all.

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On science and planning, discussion is presented separating the science domain and the planning exercise as different kinds of decision-making. Man's imperative to plan is so strong that planning routinely goes on even when scientific knowledge is totally absent from the planner's images. Science on the other hand uses relatively absolute and tight tolerances for deciding which theories and hypotheses should be called law. Planning does not use tolerances for deciding what is the best plan, but instead defines "best" as relative to the set of alternative images.

Computer simulation modeling as a science is discussed also. The model is a hypothesized process and its predictions of the state variables are the test consequences. Modelers call the process of comparing predicted and observed test consequences "verification" or "validation" and a valid model is one whose predictions are within a designated tolerance.

The model is an informed guess, a mixture of knowledge and error about a process of nature. Models are often tuned or calibrated, a process in which some of the model parameters are "fiddled with" to force better agreement between predicted and observed consequences (also Innis 1978, Savia and Roberston 1979). This serves as feedback for what is called model validation which is not the modeler's ability to hypothesize but rather his ability to fiddle.

Modeling was never intended to function as a means to scientific knowledge. Its use in science is limited because it usually cannot predict to within established tolerances. Wildlife science must try the H-D method. Without an ability to detect errors in pronouncement of laws, the self-correcting feature science must have, is lacking. All learning takes place in a feedback system in which ideas and reality interplay. The H-D method is such a feedback system. Uncouple them and the ability to learn, to tell error from truth is hindered, if not destroyed.

Csuros, M. 1994. Environmental sampling and analysis for technicians. CRC Press Inc. Information needed to design sampling plots and guidance for determining the statistical analysis procedures.

Cochran, W.G. and G.M. Cox. 1957. Experimental Design. Wiley and Sons. New York.

This text is a standard reference for researchers in designing and analyzing data collected on projects. The theories of math are used to provide an objective result in determining when numbers are different due to patterns occurring within a population that are not due to chance.

Cook, C.W, and J. Stubbendieck. 1986. Range Research: basic problems and techniques. SRM. Denver, CO.

Information needed to design sampling plots and guidance for determining the statistical analysis procedures.

Wilson Jr., E. Bright. 1990. An introduction to scientific research. Dover Inc. Mineola, NY. From a practical standpoint this book is intended to assist scientists in planning and carrying out research. Mathematical treatments have been kept as elementary as possible to make the book accessible to a broad range of scientists. It's principles and rules can be absorbed by most in the physical sciences. The topics include research design, execution of experiments, analysis of experimental data, errors of measurements, and discussions of probability and randomness as well as logic.

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Appendix 4 River Systems

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology Books. Pagosa Springs, CO.

A companion field book for Rosgen, D. and L. Silvey. 1998.

Rosgen, D. and L. Silvey. 1998 Field Guide for stream classification. Wildland Hydrology Books. Pagosa Springs, CO.

A discussion of prediction--a key to prevention, traditions, natural stability concepts and efforts to improve the river. Emphasis is made to learn from observation of the river response to treatments and understand what caused the problem, how the river responded, determine consequences and ultimately determine how to remedy the problem and prevent the problem from recurring. Control reaches must be used when changes are being made because not all streams respond the same to a given set of imposed changes. "One size fits all" management scenarios are not appropriate for river systems.

It is imperative that management and research intensify their efforts to put research principles into practice. Mathematical relations exist to illustrate a stratification of river systems by unique morphological forms, that provide meaning to an otherwise random appearing, complex set of interrelated variable. Ignoring the rules of the river can cause diverse channel adjustments and damage to property and life.

Rarely do we see rivers with the same set of morphological characteristics. We should not impose common forms and practices to meet site specific objectives. Fish habitat enhancement projects that attempt to change the sequence of pools must recognize that riffle/pool sequences rarely occur in nature at 50-50 or at spacing of convenience. The nature, type, sequence, and function of riffle/pool features are well known among fluvial geomorphologists and they need to be consulted if biologists and others working with the river are unfamiliar with these determinations.

LWD (large woody debris) reintroduction using chainsaws to return debris to the stream must consider how many, how high and in what sequence the woody debris is needed in each stream. Aiming at a "desired future condition" leaves confusion between ecological potential and a natural stable channel form to be achieved. It is critical that prescribed fisheries habitat improvement guidelines such as desired width/depth ratios; riffle/pool and step/pool sequences; and debris spacing be established as functions of slope and stream width. These can be mathematically described for specific morphological stream types.

Leopold, Luna B., M.G. Wolman, J.P. Miller. 1964. Fluvial Processes in Geomorphology. Dover Pub. Inc. New York.

Leopold et al (1964) discussions of fluvial processes describes scouring caused by debris in a stream varying by levels of discharge. Debris load is a factor sometimes overlooked in assessing the scour and fill mechanics. In some cases scour occurs with immediate fill taking place rather than continued transport downstream.

Leopold et al provide basic river morphological principles including water and sediment in channels, fluid force and its relation to debris movement, and hydraulic characteristics. Bankfull discharge in many rivers is one that occurs about every 1.5 years. Leopold et al clearly discuss the geologic time involved in all these processes. A flood plain is a depositional feature of a river valley associated with a particular climate or hydrologic regimen of the drainage basin. Sediment is

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stored and averaged over years and alterations of the conditions of equilibrium through tectonic changes or by changes in the hydrologic regimen results in an alteration of the flood plain to degradation and terrace formation or aggradation. These processes are a result of stream power and forces over geologic time and are not processes that are manipulated on any broad scale through current activities.

Calame, E., G. Holden (compiled). 1981. Hydrometeorological data bank: water year 1978-79. USDA Forest Service. Umatilla National Forest Region 6.

Monitoring of the Umatilla River Barometer Watershed and its sub-basins started 1965.

The objective was to provide a representative instrumented watershed in the Blue Mountains to aid in providing needed information to protect and improve soil water and dependent resources. The harvesting and fuel treatments, erosion control, precipitation and runoff data are presented for the area during the 1978-79 water year. Water temperature, water quality data, sediment loads, and flow data are included for the Mill Creek and High Ridge watersheds. A number of research projects were conducted in this watershed to address grazing impacts and forest management techniques while monitoring of the watershed took place. This paper is fundamental as a basic inventory of the watershed and its environment.

SUMMARY OF WATER SCIENCE AND THE PHYSICAL LAWS

What is temperature and what is heat?

What governs water temperatures in watersheds?

The water science literature reviewed for this document was selected from papers on the topic of water. Many of the papers reviewed discussed streams and stream water heating, but data was absent in the paper that supported the discussions. Some of the popular papers cited in recent government and state agency documents have been excluded if they failed to meet the criteria outlined earlier. Some manuscripts describe mechanistic models without field verification, other speculate about stream heating processes but fail to provide data and analysis to validate discussions. Many contained assumptions about stream water conditions and fail to test the hypothesis using statistical methods. Many papers assumed a cause and effect that shade would cool water, but failed to provide data supporting the theory.

Some papers relied on citations of works that examined fish (salmon, steelhead, trout etc.) physiological responses to warm or cool water in laboratory experiments while reporting results of ocular observations of riparian components on a stream. These papers failed to provide a logical link between the riparian plant community function, the water column heating process, and the fish survival at the study site. Many supplied thermometer records that displayed water temperatures greater than laboratory results cited in other literature, and assumed the temperatures were caused by direct solar radiation on the stream surface. Thermometers record the amount of energy in a system when the temperature is read. They do not also report what caused the change in temperature. Temperature changes captured by the instruments can only be interpreted as a change in energy and the cause of the change requires other instruments as well as other physical law applications.

This review includes manuscripts that examine the characteristics of water, the physical laws that govern heat, provide onsite applications of the laws, or are basic research describing the physical

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laws themselves.

The chronological sequence of the publications is provided to put into context work by one scientist that is supported in work conducted by other scientists at a later date. The process of science is not one conducted by an individual, isolated from other work or other studies. The products are the evolution of manuscripts by many scientists that provide a systematic arrangement of our knowledge of the physical or material world.

We know from Physic textbooks that the heat theory described in the Physics literature is the theory that applies to everything in the Universe. Dr. Richard Feynman, a Nobel prize winner delivered a series of lectures at California Institute of Technology that revolutionized the teaching of physics around the world. The lectures are cited as **Feynman, R.P., R. B. Leighton, and M. Sands. 1963.**

Dr. Feynman in one of his lectures on heat, describes the “thermal ratchet” which is a classic description for Physics students during their courses about the Laws of Thermodynamics. Halliday and Resnick as well as Wheeler and Kirkpatrick are basic Physic college textbooks that provide a clear description of these laws and how they apply to our everyday lives.

In 1999 von Baeyer explained the history of the heat theory and how it interacts with other Laws of Physics. The history of heat began with the Greeks who perceived heat as being something that was measured by a human’s response after touching an item that was hot or cold. From there it was examined by many scientists for hundreds of years. Following the history it becomes clear that the scientific principles that govern the Universe have been founded through the work of many and no one individual can be credited for work without recognition that they benefited from discoveries of their predecessors.

The history of the search to understand heat and energy is a chapter in the history of science. The Laws of Thermodynamics were written in the mid 1800s, have been tested through experimentation time and time again always to be confirmed. Faucheux et al (1995) constructed an optical thermal ratchet along the same design as Feynman used to explain to students at Cal Tech. This experiment describes “thermal” noise in the data that previously had not been accounted for but had been estimated. The Laws of Thermodynamics were again confirmed as proper theory and no adjustments to the theory were made.

In natural resource management the issue of stream water heating during the summertime has become a contentious issue between different fish biologists, range and forest managers, landowners, government, and anyone involved in the problem of salmon population declines since the Endangered Species Act listings of the early 1990’s. It has been established in some federal and state regulations that in order to protect fish and other aquatic life, stream water temperatures throughout entire watersheds need to be cooled. The prescription being offered as a way to cool stream waters has been to increase shade over the streams to prevent solar radiation from striking the stream surface directly. Literature citations supporting the concepts are numerous but most fail to meet the criteria described above (see Introduction) to be considered “best available science” for the topic.

Edinger et al. (1968) indicated that the rate of heat exchange is a function of the difference between actual water temperature and an equilibrium temperature at which the net rate of heat exchange would be zero. Cluis (1972) modeled water temperatures from ambient air temperatures rather than using the “heat budget” technique which examines the water in a static environment and made inaccurate predictions for natural streams. Walker et al (1976) described a method to determine water temperatures using the site topographic altitude and ambient air temperatures. Recognition

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that the natural thermal cycle could be described with these two variables is a proper application of the Thermodynamic Laws.

Bohren (1987) describes heating and cooling events through atmospheric science and gives many examples of "optical" illusions people experience in their lives, and erroneously believe what they see or feel by failing to examine the processes properly. Bohren's work was published for a broad audience and the author explains the fundamentals of solar radiation and how it affects Earth in everyday terms. Coupled with the college Physics textbooks mentioned above, radiation, wavelengths, the importance of following how different wavelengths are absorbed and reflected, and how energy is dispersed on Earth can be established according to the principles of science.

McRae (1994) et al, Larson et al (1996), and Stoneman and Jones (1996) examined the science of water heating and cooling in watersheds as it occurs in streams and rivers using air temperatures as an influence on the stream water temperature increases and decreases. McRae et al found beaver ponds were responsible for increasing stream water temperatures. Stoneman et al (1996) found streams heated differently as they moved downhill. Larson et al (1996) described the Laws of Thermodynamics and how the law influences the rate of heating and cooling of water. Larson et al (1997) applied physical laws to streams at different elevations to explain the differences between stream temperatures at different locations.

From 1963 to 1996 the Laws of Physics are applied to descriptions of stream water heating and cooling by addressing air temperatures and elevation gradients. The reviewed and selected literature focus on the science of heat when applied to stream temperatures as a natural response of increasing or decreasing due to the physical laws. Each work confirms the findings of previous authors and ultimately are applications of physical law in a watershed. These studies are especially important to natural resource managers as they pursue the issue of stream water temperature increases.

Larson and Larson (1997) described how to assess water temperatures on streams to identify the natural rates expected in a watershed using air temperature and topographic elevation and stream velocity. Larson and Larson (2001, 2003) provided a mathematical methodology to statistically validate differences between rates of heating and cooling on streams at different topographic locations using the Thermodynamic thermal gradients.

Many of the mythical and factual concepts about heating and cooling are well explained in Bohren (1998) through atmospheric science and the application of the Thermodynamic Laws. Atmospheric science must apply the same laws as other science disciplines to describe air and land thermal cycles as well as water heating and cooling.

Mohseni (1999) provides regression equations that describe the association between air temperature and stream water and equilibrium principles in a stream system. Meays (2000) provided an examination of streams in a watershed and how the mean air, water, and soils responded to the adiabatic heating and cooling at each 500 foot drop in elevation.

Zwieniecki et al (1999) studied forested areas that had been clear-cut or thinned and compared stream segments through the project areas to determine differences and if the forest practices had influenced the stream temperatures. They did not find differences due to forest harvesting treatments.

Larson et al (2001) measured and analyzed data collected in 4 different watersheds in Northeastern Oregon and compared the rates of heating and cooling by examining the data through a gradient analysis between air and water temperature data collected at different elevations. A mathematical

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methodology is provided for land managers to determine the natural rate of heating and cooling in order to assess the value of revegetation projects intended to cool stream water.

Larson et al (2002) describe the use of FLIR (forward looking infrared) systems currently used in the Pacific Northwest to determine stream heating. FLIR (infrared) photos cannot determine the temperature of a stream and the technology has been misrepresented as a tool to determine the influence of shade across stream channels. The article presents an application of known processes that describe how a stream cools due to the influence of the air mass. Shade, whether viewed on an infrared photo or measured with a thermometer, did not influence the stream temperature.

Statements throughout cited literature during the 1990s published by fish biologists and natural resource disciplines have produced speculative statements such as: streams are warmer today than in historical times, livestock grazing and forest harvesting have reduced riparian vegetation which has caused stream temperatures to increase, and major reasons for fine sediment loading and temperature increases as well as fish habitat declines are due to agriculture development, forest harvesting and road development.

Of particular interest in addressing the question of what governs water temperatures in watersheds is how water temperatures increase or decrease. It cannot be assumed that stream temperatures are currently greater than or less than any other year without approaching a study designed to test the water temperatures. Many studies investigate fish habitat, population densities, or the availability of food within the habitat and either assumed at the onset or speculated at the conclusion that their results were being influenced by human activities and a lack of shade.

These kinds of statements and papers are well described by Romesburg, 1981. What Romesburg noted continues to be a prevalent problem today regarding water temperature literature in the wildlife sciences that describe the decline of fishery habitat and their populations.

No studies were located that in fact measured water temperatures and then linked the study to the salmon population studies. Fish biology and water temperature science are not the same. Fish physiology must be studied and interpreted from the position of how a fish survives through adaptive techniques. A fish body heats internally, they live in a cool water environment, and the questions about water temperature harm to fish is not necessarily a factor human activity can correct outside of obvious point source discharges.

Stream temperatures are best studied from a position that water in a stream is governed by physical laws. The specific heat of water governs how long it takes water to heat and cool and that time is controlled by the thermal gradient that establishes around the body of water within the watershed. Water cannot be assumed to be heating too much or little based on how a fish responds. Stream temperatures cycles are well understood through the Physics laws. There is nothing about water that is so special or so different from other objects that it responds differently than rocks or trees or paper for that matter when solar radiation is present. The specific heat capacity of each object on earth is what determines the time it takes to increase in temperature and the time it takes to decrease temperatures.

WATER SCIENCE LITERATURE

American Public Health Association, et al. 1971. Standard methods for the examination of water and waste water. American Public Health Association. Washington, D.C. p 874.

This book is a standard handbook used to ensure proper use of methods for water quality testing

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procedures. Most water quality labs and agencies involved in the work to monitor water quality cite this handbook as their reference for standard testing.

Allen, J. David. 2001. Stream Ecology. Kluwer Academic Publishers. Netherlands. p 23-43. This book provides some of the basic fundamentals of the physical processes acting on river systems. Chapter 1 and 2 are references for channel flow and stream water chemistry respectively.

Raphael, Jerome M. 1962. Prediction of temperature in rivers and reservoirs. J. of the Power Division, Proceedings of the American Society of Civil Engineers 88:157-181.

Raphael (1962) observed that for most streams in the western United States, water temperatures at their source are nearly at freezing temperature because the flow originates from snow melt at high altitude. As the water moves downstream, whether it flows through a natural channel or through an artificial reservoir, it is affected at its surface by the sun and air mass, which raise the temperature of the water during the summer. Raphael visualized that the greater the temperature difference between air and water, the greater the surface area of the water, and the more slowly it moves, then the greater will be the heating of the water. Raphael's (1962) observations suggest that the thermal environment as well as stream characteristics are important in determining the amount of heating that will occur.

Feynman, R.P., R. B. Leighton, and M. Sands. 1963. The Feynman Lectures on Physics, Volume I. Addison-Wesley Publishing Co. Reading, MA.

Edinger, John E., D.W. Duttweiler, J.C. Geyer. 1968. The response of water temperatures to meteorological conditions. Water Resources Research. 4(3); 1137-1143. Temperature difference and exposure time influence this process. In the study of water temperature the concept of an equilibrium temperature is used to describe the response of water temperature to meteorological conditions. Edinger et al. (1968) indicated that the rate of heat exchange is a function of the difference between actual water temperature and an equilibrium temperature at which the net rate of heat exchange would be zero. They noted that the equilibrium temperature changes in response to varying meteorological conditions and that water temperature moves continuously toward the equilibrium temperature. Edinger et al. (1968) indicated that a lag time approaching 6 hours can occur between maximum equilibrium temperature and maximum water temperature.

Cluis, Daniel A. 1972. Relationship between stream water temperature and ambient air temperature: a simple auto regressive model for mean daily stream water temperature fluctuations. Nordic Hydrology, 3:65-71.

The water temperature of streams and rivers is required for various practical purposes and is frequently obtained by calculating the heat budget. This method is tedious and yields rather inaccurate values of the water temperature. This paper presents an alternative approach using cheap and simple means to measure air temperatures, which are believed to be a major factor influencing the water temperature. It is demonstrated that a useful separation can be made between the seasonal cyclic variations and the daily stochastic fluctuations of these temperatures.

Walker, J.H. and J.D. Lawson. 1976. Natural stream temperature variations in a catchment. Water Research. Vol 11, pp. 373-377. Pergamon Press 1977. Great Britain.

In order to establish water temperature criteria or limits for reaches of streams downstream from thermal discharges, a knowledge of the natural water temperature is necessary. To overcome the situation where no historical records are available a simple method of predicting natural water

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temperature in a catchment is presented.

The only data required for computation are the site altitude and the air temperature at a station in the catchment or the natural water temperature in an upstream reach or other tributary in the catchment. The time scale of the predicted water temperature is a function of the frequency of measurement of the independent variables.

Bohren, C.F. 1987. Clouds in a glass of beer. John Wiley and Sons, Inc. New York, NY. Page 81-81

Radiative equilibrium of the earth is described. The planet is bathed in solar radiation and is always bathed as one half of the earth always has sun shining on it. Absorbed radiation gives up its energy to whatever absorbed it, thereby causing its temperature to increase. The earth does not get hotter and hotter because the earth also emits radiation in a spectra distribution different from the incoming solar radiation. Everything emits infrared radiation. If the atmosphere absorbed no infrared radiation the ground would be intolerably cold and so would the air in contact with it.

Halliday, D. and R. Resnick. 1988. Fundamentals of physics. 3rd ed. John Wiley & Sons Inc., New York.

Standard college Physics textbook. Chapter 22 covers Entropy and the Second Law of Thermodynamics. The directions in which natural events happen is governed by the second law of thermodynamics. The second law can be expressed in several equivalent forms two of which involve simple statements about heat and work. The Second law--first form states: It is not possible to change heat completely into work, with no other change taking place and the second form states: It is not possible for heat to flow from one body to another body at a higher temperature, with no other change taking place. In a third form in terms of entropy it states: In any thermodynamic process that process from one equilibrium state to another, the entropy of the system + environment either remains unchanged or increases. All three forms are equal.

Many events do not occur even though they would not violate the first law of thermodynamics. The spontaneous flow of heat from a cold to a hot body is an example. The second law of thermodynamics sets up a criterion for identifying such "forbidden" processes.

Kirkpatrick, Larry D., G.F. Wheeler. 1995. Physics a world view. Harcourt Brace College Publishers.

Chapter 9: Thermal Energy. Heat and temperature are not the same thing. Heat is a flow of energy and temperature is a macroscopic property of the object. Two objects can be the same temperature and yet transfer different amounts of energy to a third objects. EXAMPLE: a swimming pool of water and a coffee cup of water at the same temperature can melt very different amounts of ice.

The amount of heat it takes to increase the temperature of 1 gram of any material by 1 °C is known as the specific heat of the material. This is an intrinsic property of the material and is not dependent on the size of shape of the object made from the material. The specific heat of water is numerically 1. The specific heat of air is 0.24. When two different materials are brought into thermal contact with each other, they reach thermal equilibrium, but do not experience the same changes in temperature because of their different specific heats and masses. The heat lost by the hotter object is equal to the heat gained by the colder object.

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“The specific heats of the materials on the surface of the earth account for the temperature extremes lagging behind the season changes. The first day of summer in the Northern Hemisphere usually occurs on June 21. On this day the soil receives the largest amount of solar radiation because it is the longest day of the year and the sunlight arrives closest to the vertical. And yet, the hottest days of summer occur several weeks later. It takes time for the ground to warm up because it requires a lot of energy to raise its temperature each degree.

Faucheux, L.P., L.S. Bourdieu, P.D. Kaplan, and A.J. Libchaber. 1995. Optical Thermal Ratchet. *Physical Review Letters*. 74:9: 1504(4)

The authors experimentally demonstrated the principle of a thermal ratchet. They presented an optical realization by directing motion of Brownian particles in water and induced by modulating in time a spatially periodic but asymmetric optical potential. The experimental results agree with a simple theoretical model based on diffusion. Similar models of engines that extract work from random noise have been recently proposed under the denomination of “thermal ratchets” (**Feynman, R.P., R. B. Leighton, and M. Sands. 1963.**) Thermal noise can be a tool rather than a physical limit to the efficiency of motors.

McRae, G. and Clayton J. Edwards. 1994. Thermal characteristics of Wisconsin headwater streams occupied by beaver: implications for brook trout habitat. *Transactions of the American Fisheries Society*. 123-641-656. American Fisheries Society.

Expansion of beaver populations raised concerns of warming water due to the mammal impoundment. Hourly water, air and soil temperatures on four headwater streams occupied by beaver were measured. Stream temperatures followed air temperatures, even near groundwater sources. Removal of beaver dams did not generally reduce the difference between upstream and downstream temperatures. In some cases dam removal increased the warming rate. Direct thermal benefits of dam removal in headwater streams may be outweighed by the potentially disruptive effects on the fish and invertebrate communities downstream.

Larson, L.L. and S.L. Larson. 1996. Riparian shade and stream temperature: a perspective. *Rangelands*, 18(4) 149152).

The capacity of a stream to buffer against temperature increase is directly influenced by water volume and the size of the surface area that is exposed to the energy source. Overnight low air temperature will modify the daily temperature range of a stream by influencing predawn water temperature.

The specific heat of water allows water to absorb considerable amounts of energy before its temperature will increase. A warmed stream must release significant amounts of energy before cooling can take place. The minimum temperature that water can be cooled will be the lowest temperature in the local environment. It will be difficult to cool a stream in a warm environment whether the stream is shaded or not. Streamside vegetation can improve bank stability, increase habitat for some species of wildlife, and serve as a component in the system as a whole, but shade does not control stream temperature.

Feynman, R.P. 1996. Six easy pieces. Addison-Wesley Publishing Co. MA. p 64-67.

Dr. Feynman lectures discuss Physics as well as the relationship of Physics to other sciences. He discusses the problem that the analysis of circulating or turbulent fluids, such as water, has not

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been described satisfactorily using math. He describes the problem in terms of being able to analyze turbulent fluids if water flows very slowly (thick goo like honey) in order for us to describe it. The complexity is enormous. Water running through a pipe cannot be analyzed entirely because of the large number of molecules and their interactions with each other.

Relative to the science of running water, such as a river system, the complexity of the problem is even greater. Modeling efforts to describe a heat budget for stream are weakened due to this problem. Modeling efforts at best use a static lab environment in order to account for a quiet water body reaction to heat input.

Feynman conducted a classic experiment in thermodynamic known as the thermal ratchet problem. Richard Feynman received the Nobel Prize in Physics in 1965 along with Sin-Itero Tomanaga and Julian Schwinger, for work in quantum electrodynamics. He played a role in the Manhattan Project at Los Alamos during World War II and taught at Cornell and at California Institute of Technology. Feynman introduced basic new computational techniques and notations into physics, above all the ubiquitous Feynman diagrams that have changed the way in which basic physical processes are conceptualized and calculated. The Feynman Lectures on Physics is the guide for teachers along with his other publications have become classic references for researchers and students.

Richard Feynman was one of the most influential physicist of modern times. The first 7 lectures delivered at Cornell University discuss the Law of Gravitation and the interaction of mathematics and physics. He explores the principles of conservation and symmetry and the irreversibility of time.

Stoneman, C.L. and Michael L. Jones. 1996. A simple method to classify stream thermal stability with single observations of daily maximum water and air temperatures. *North American Journal of Fisheries Management* 16:128-131.

The relationship between instream water temperature and ambient air temperature at 6 stream sites in southern Ontario was examined. At two sites, maximum summer water temperatures never exceeded 17°C; at two others, temperatures remained below 23°C; and at the remaining two, temperatures reached 28°C. The relationship that best distinguished the three pairs of sites was the regression of water temperature measured at 1600 hours on maximum air temperature. Analysis of covariance indicated that the regression slopes for the first (cold) and second (cool) pairs of sites were non homogeneous; those for the second (cool) and third (warm) pairs were homogeneous, and the adjusted means were significantly different. Where data were available analysis of covariance indicated that the relationship did not differ between years. Graphical analysis of the data indicated little overlap of 95% confidence intervals at air temperatures greater than 25°C. The regression results were used to develop a nomogram to determine the thermal stability of stream sites from a single observation of water temperature at 1600 hours on a warm summer day and a maximum air temperature estimate for the same day.

Larson, L. and P.A. Larson. 1997. The natural heating and cooling of water. *Rangelands* 19:6-8.

The ability of woody vegetation to shade a stream for any reason decreases with increasing stream width. Larson and Larson cited basic Physics text and other works addressing thermodynamic principles and demonstrated on a stream at 3000 ft. elevation in northeastern Oregon that water temperature responds to air temperature.

At any point along the stream the gradient between air temperature and water temperature will

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vary from hour to hour. Maximal heat transfer occurs when the gradient is steepest.

Generally water at higher elevations accumulates energy at a different rate than those at lower elevations. Higher elevations have lower water temperatures at sunrise and greater average gradients during the day. This might suggest that the water temperatures would be higher than a similar body at lower elevations. This is not the case. Water heating at higher elevations is restricted to a short time period. This is due to a rapid thermal cycling of the local environment which results in less energy accumulation. Given this, water temperatures at lower elevations will have a greater increase in temperatures than those at higher elevations.

When all these processes are combined (elevation, rates of heating and cooling, and the difference between air temperature and water temperature) the framework of the thermal environment in which a stream is flowing is described. However, as recognized in the principles of thermodynamics and the examples provided in this paper, modification of one or more of the thermal sources will result in a different rate of heating or cooling.

1. Climates produce weather systems that determine the patterns of heating and cooling within a watershed environment.
2. Water temperatures are influenced by the thermal reservoir that surrounds the water body. Air temperature can be used as an index of that thermal environment. Air and stream temperatures, at a minimum, must be measured at each data collection site to establish the relationship between the stream and its environment.
3. A portion of stream temperature change can be associated with the thermal environment and rates of adiabatic temperature change. The lower elevations not only have warmer water, but they have warmer air temperatures on a daily basis. The adiabatic rates of air mass temperature change is 3.2°F to 5.5°F difference for each 1000 ft. of elevation.
4. The difference between the air temperature and the water temperature influences the rate at which the water will warm or cool. The smaller the differences are between air and water temperature the longer it will take for the water to heat or cool.
5. The rate of flow of a stream must be determined to understand the entire process of how a stream heats and cools. Flow determines how long a body of water is influenced by a particular thermal environment. Downstream air temperatures are warmer than upstream because of lower elevations. Flow rates must be monitored during each sample period, between each monitoring site to establish how long the water is exposed to a thermal environment.
6. Two measurements are required at a minimum to estimate the thermal evolution of a stream: 1) the flow rate and, 2) the gradient between air and water temperature. The rate of flow determines how long the water is exposed to a particular air mass (at a specific temperature). The gradient determines the rate at which heat energy is transferred between the air and water.

Bohren, C.F. 1998. Atmospheric Thermodynamics. Oxford University Press. New York, NY Page 45 describes temperature scales and thermometers. It discusses the subjectivity of a human's perception of temperature which is not a reliable measure of temperature. Thermometers are based in the Zeroth law of Thermodynamics.

Page 233-237 discusses Henry's Law: air in water. Molecules that strike water from air will be captured by it and retained for at least a brief time before possibly returning to the air. Because of

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this at the surface of water, their concentration increases above that in the air. This is known as adsorption. Eventually molecules dissolved in water will come into equilibrium with those in the air.

Page 346-347 discusses energy transfer and thermal conductivity in water and gases such as the atmosphere.

Page 381 provides a problem and solution to demonstrate that humans are not reliable thermometers.

Dong, J. , J. Chen, K.D. Brosofske and R.J. Naiman. 1998. Modeling air temperature gradients across managed small streams in western Washington. *Journal of Environ. Management.* 53: 309-321.

J.Dong, et al, 1998 collected air temperatures on 20 buffered stream in western Washington . Five streams were sampled before and after harvesting of the forest. The data were analyzed to examine the effects of harvesting riparian buffer strips. Buffer width was not a significant variable in predicting stream air temperature, suggesting that even a 72 meter buffer was not sufficient to maintain a stream environment due to greater depth of the edge influences. The forest buffers provided minimal protection for stream air temperature during the middle of summer at the stream. Little is known about the degree of protection achieved when buffers are used and the authors state that 70 meter wide buffers do not offer good protection to the stream and efforts to preserve the vegetation are costly because of economic competition for high quality timber. Social assessments are necessary along with ecological assessments to determine the costs of maintaining buffer strips.

Maloney, S.B., A.R. Tiedemann, D.A. Higgins, T.M. Quigley and D.B. Marx. 1999. Influence of stream characteristics and grazing intensity on stream temperatures in eastern Oregon. Gen. Tech. Rep. PNW-GTR-459, Portland, OR :U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 19 p.

Stream temperatures were measured during summer months, 1978-1984, at 23 forested watersheds near John Day, Oregon to determine temperature characteristics and assess effects of three range management strategies of increasing intensity. Maximum temperatures in streams of the 12 watersheds ranged from 12.5 to 27.8 °C. Maximum stream temperatures on four watersheds exceeded 24 °C the recommended short term maximum for rainbow trout and Chinook salmon. Streams with greater than 75 percent stream shade maintained acceptable stream temperatures for rainbow trout and Chinook salmon. Lowest temperatures were observed in streams from ungrazed watersheds. Although highest temperatures were observed in the most intensely managed watersheds the effect of range management strategy was not definitive. It was confounded by watershed characteristics and about 100 years of grazing use prior to initiation of this study.

Mohseni, O. and H.G. Stefan. 1999. Stream temperature/air temperature relationship: a physical interpretation. *Journal of Hydrology* 218 (1999) 128-141.

Linear regressions of stream temperature versus air temperature are attractive because they require only one input variable (air temperature) which can be simulated by General Circulation Models. The equilibrium temperature concept introduced by Edinger was used. In stream reaches with large drainage area, stream temperature can be approximated by equilibrium temperature. At elevated air temperature the vapor pressure deficit above a water surface increases drastically causing strong evaporative cooling and hence a flatter stream temperature / air temperature relationship. At low air temperatures, stream temperatures often reach 0°C as an asymptote. If an upstream flow control (dam, reservoir release) or a waste heat input is present, the lower asymptotic value can be larger

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than 0° C. As a result of these upper and lower constraints for stream temperatures, the stream temperature/air temperature relationship resembles an S-shaped function rather than a straight line. The authors made a physical interpretation of the relationship between stream and air temperature. They observed a strong association between air and stream temperature and that the upper and lower constraints of the relationship tended to form an S-shaped function due to changing factors such as vapor pressure deficit.

von Baeyer, Hans C. 1999. Warmth disperses and time passes: the history of heat. The Modern Library. NY

Today we know that warmth or heat is nothing but motion, a palpable manifestation for the ceaseless, random, chaotic agitation of the invisible atoms and molecules that compose all matter. Temperature, a measure of the intensity of heat, turns out to be related to the speed of those particles - - the faster they jiggle, the hotter they seem to the touch. These insights in turn suggest new more difficult questions. Why doesn't a warm cup ever heat up spontaneously, and come to a rolling boil, while the vast reservoir of motion vested in the air of even a cool kitchen is imperceptibly reduced?

In the middle of the nineteenth century, this question occupied center stage of scientific research. In the language of thermodynamics, the science of heat that was then emerging, the question became: When a hot body is in contact with a cool body, why does heat always flow from hot to cold and never the other way around? Why does heat only flow downhill, which in time led to the theories of universal gravitation and general relativity and today inspires the search for a quantum theory of gravity.

The puzzle of the teacup also affects our lives in a more personal and philosophical way. It turns out that the flow of heat from the tea into the air or from any body into a cooler one for that matter defines the flow of time itself.

In 1995 the Second Law of Thermodynamics was confirmed again in the paper by Faucheaux et al (1995). The Second Law is not in jeopardy. The purpose of the experiment was to demonstrate the fundamental mechanism for detecting thermal noise.

Zwieniecki, M.A. and M. Newton, 1999. Influence of streamside cover and stream features on temperature trends in forested streams of Western Oregon. West. J. Am. For. 14(2) 106-112. Clear-cut harvesting along low-elevation streams in western Oregon with forest buffers (8.6 to 30.5 m wide) was followed by little direct local effect on water temperature. A study of 14 streams demonstrated that all have a tendency to warm with downstream direction even under full forest cover. After the natural warming trend of the stream water was accounted for, water at slightly higher temperatures within the buffered clear-cut zones cooled to the trend line for temperature by 150 m downstream.

Different levels of buffering were compared and there was no basis for a cumulative effect on temperature from multiple harvest units interspersed with forested stream sections. The warming trend signature occurring within a natural forest cover is a product of the sum radiant energy inputs and exposure to air warmer than water.

Larson, L. and P.A. Larson. 2000. Topographic Classification of stream temperature patterns. SRM. 53rd Annual Meeting.

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Discriminant analysis of stream temperature data collected at elevations of 3000 feet to approximately 7000 feet in Northeastern Oregon over a 3 year period indicated that elevations could be used to stratify the data. Elevation was found to be an important factor in determination of the rate of heating and cooling.

Meays, Cynthia L. 2000. Elevation, Thermal Environment, and Stream Temperatures on Headwater Streams in Northeastern Oregon. Master of Science thesis, Oregon State University. This study showed a strong association between water temperature and atmospheric conditions. Elevation, a factor shown to have a strong association with the thermal environment of this study, represents an indirect measure of vertical atmospheric conditions and its influence on the thermal environment. Similarly, monthly associations represent exposure to annual, monthly, and daily patterns of atmospheric conditions. Stream temperature is a function of the thermal environment to which it is exposed.

Larson, L. and P.A. Larson. 2001. Influence of thermal gradients on the rates of heating and cooling of streams. *Journal of Soil and Water Conservation*. 56:1:38-43

The study addressed the influence of thermal gradients on rates of stream heating and cooling. 4 watersheds in Northeastern Oregon were studied using air temperature as an index of the thermal environment to estimate the rate of stream heating or cooling in different thermal environments. Rates were tested to evaluate a means of quantifying and evaluating rates of water heating through the application of scientific principles. There were no significant differences between rates of heating or cooling at similar elevations between watersheds during any of the study years. Days with similar thermal gradients had similar rates of heating and cooling.

Larson, S.L., L.L. Larson, P.A. Larson. 2002. Perspectives on water flow and the interpretation of FLIR Images. *Journal Rng. Mgmt.* 55 (2): 106-111.

Airborne infrared thermal radiography (infrared photography) has been proposed as a tool which may be used to monitor the water temperature along the network of stream and rivers. The proponents correlate vegetative shadows on a stream channel with the reduced infrared radiation (IR) reception in the data to suggest that the water temperature is reduced in such areas due to the shade on the water surface.

The fundamental principles of thermodynamics are employed and if the stream is in fact flowing, the water affected by any cooling process cannot remain in the vicinity where it was cooled. Second, temperature data taken from a stream channel are used to show that the water flowing in the channel is essentially unaffected by the patterns of vegetative shaded on the surface of the water. The paper considers the time it takes a body of water to cool, explores how the temperature change should manifest itself in a monitoring system such as FLIR. The effect of the flow rate on water is analyzed to show that the coolest temperatures in the FLIR images should not correspond exactly with the shaded regions when compared to aerial photos. Examples of using the theory are given, data is presented from a partially shaded stream, and speculation is offered as to the cause of the misinterpretation of the FLIR data. A mathematical derivation is also presented.

Borman, M. and L. L. Larson. (2003). A case study of river temperature response to agricultural land use and environmental thermal patterns. *Journal of Soil and Water Conservation*. JSWC. 58:1:8-12.

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Water temperature standards are being implemented in various states. This may impact agricultural land management. We evaluated the association between river temperature patterns, existing agricultural land uses, and the thermal equilibrium condition of the surrounding environment. This case study was conducted on irrigated hay (meadow and wet meadow ecological sites) and pasture (sodic meadow ecological site) land in northeastern Oregon. Shading over the river channel was estimated at 1 to 5% based on site characteristics. Daily mean and maximum stream temperature increases along approximately 1 mile reach lengths were 0 to 0.2 and 0.2 to 0.4 °F respectively and were not different between existing land uses/ecological sites. Mean air and water temperatures were approximately 2 °F apart indicating that an equilibrium condition existed during the study.

P.A. Larson and L. L. Larson. 2003. Landowner monitoring of stream temperature and bottom sediments. *Journal of Soil and Water Conservation*. (In Press).

A 3-year study was designed to capture the temperature signature and substrate sediments of individual stream segments. The study was conducted with rancher cooperation through the Oregon Cattlemen's Watershed Ecosystem Education and Training (WEST) program. The daily pattern of temperature change (4h periods between 5 am and 5 pm) in both air and water were examined based on elevation and were classified as cold, cool, and warm stream segments. Thermal gradients and heating rates at the study sites were different when compared by elevation. Data compared across elevation showed cold water sites had the greatest temperature changes occurring between 1 and 5 pm and cool and warm water sites changed most between 9 am and 1 pm. Adiabatic stratification of the watershed environment has an influence on the thermal pattern of stream temperature and should be considered when assessing daily maximum water temperatures. Channel substrate measurement of "fines" was between 0.03% and 4% in 2000 and no substrate sediments were found in quantities > 20%. Overall, thermal and sediment pollution were undetected once natural and/or background conditions were established.

SUMMARY OF LIVESTOCK AND RIPARIAN COMMUNITY PUBLICATIONS

What do we know about the interaction of livestock with salmon in riparian areas? What

do we know about livestock use of the plant community in a riparian area?

Issues regarding livestock and salmon in riparian areas are generally misrepresented in the current writings by fish biologists and wildlife specialists as well as other natural resource authors. The misquoted and misguided statements about livestock use of riparian vegetation has apparently stemmed from literature reviews that are too narrow in their scoping of the available literature.

To determine if livestock use of riparian areas is harmful to fish, both the fish and the livestock must be studied at the same time. Understanding how livestock use an area is important coupled with identification of whether they are grazing grasslands, sagebrush, forest, or meadow sites. The available best science is ample. Structured science and replicated experimentation have been conducted in the Animal Science profession for many decades. The body of work encompassed through the years establish a firm foundation about the livestock use and misuse of vegetation communities across the country.

Schepers 1982 studied the water chemistry in pastures with and without livestock. The results did not indicate that when chemical composition of water was high that the livestock were a problem, because there were factors such as plant decomposition and wildlife use that contributed to high

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numbers where cattle weren't present.

Biskie et al 1981 studied fecal coliforms and how they moved in a stream system as flows changed. This study is important to note that the investigators studied fecal coliforms separate from livestock use. The study is focused on a single topic which is relevant in determining how fecal coliforms survive and when they die in a watershed. Many studies associate fecal coliforms with livestock but do not establish whether the coliforms were from the cattle or if they were from wildlife such as deer, beaver, or waterfowl living in the same areas.

Larsen et al 1994 present a study that measured the movement of coliforms across land due to runoff patterns. The analysis of data did not indicate significant differences of bacteria transport in relation to rainfall intensities at distances of less than 1 meter., at 1-37 or 2-13 meters. Any suggestions that speculate that livestock presence adjacent to a stream in fact establishes fecal coliform in water would be in error. Yet, many papers include such statements.

The Larsen et al 1994 paper has not been repeated nor shown to have errors that make it invalid. Based on other research the runoff and fecal coliform in streams have not been found to be a problem across the landscapes. Porath et al 2002 tested for fecal deposits and tracked cattle distance from a riparian meadow stream and documented their use of the area. Grazing activity, fecal deposit distribution, and travel distance of cattle were not found to have a significant affect on the study site. The study indicated that careful management of livestock to ensure uniform distribution throughout grazing areas is a better way of protecting streams and fish than fencing streams or excluding grazing altogether and this is consistent with other studies conducted throughout the last 20-30 years.

Livestock use of grass and shrub browsing is generally misquoted as being a cause of riparian vegetation missing from sites or that livestock have caused damage to riparian plants due to grazing, browsing and trampling. Management of grasslands, shrub communities and forest sites using cattle are well documented and too numerous to list in a single literature review. Silvertown 1993, Shaw 1982, and Heitschmidt and Stuth 1991 are textbooks for reference to establish a foundation of knowledge regarding practices and systems used for livestock management. Assessing the cause of riparian vegetation missing from sites requires an investigation based on site potential analyses that include soil types, rainfall, and plant ecology. Other topics necessary to understand herbivores behavior and eating habits are covered in the citations already mentioned as well as Tiedemann 1987, Smith 1992 & 1993, and Clary 2000 under the topic: River Systems and Riparian Management.

Fisheries studies often claim human activities have caused streams to fail in providing habitat for salmon and trout but they are merely claims. It is not possible from the standpoint of science given the Best available science in the literature using criteria 1-6 (see Introduction), to tie fish physiological responses in water to all watershed components such as vegetation on the streambank. Many plants have evolved under a grazing/browsing system and respond to use in a beneficial manner. Nutrients and sediments present in a watershed reach the water column through many processes none of which occur in a response to the fish needs, but are chemical and natural events occurring before human activities began. Fish may or may not have physiological responses to different levels of nitrates, phosphates, or sediments. Some adaptations in the fish are due to an ability to adjust to a changing water habitat where they live their entire life. Fish have adaptive physiological responses to varying habitat conditions encountered as they swim up and down river systems and migrate from fresh water to salty ocean conditions.

To determine the impact of human activities or livestock impacts on a stream the scientist must first determine what part of the current stream condition was formed through hundreds or thousands of

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years of geologic time. They must also account for variability of water volume that under natural climatic events erodes banks and scours stream bottoms. Best available science criteria in this literature review, found no published material where a stream had been measured and data analyzed to be able to qualify as sufficient to make the statements that human activity near streams had caused fish populations to decline. Generally one might observe that within the works of Leopold and Rosgen that the impact from daily human activity is somewhat minimal, simply due to the power of geologic time and the dynamics of water on the formation of river systems. Coupled with the fishery literature selected, the Salmonid species can be seen as a survivor of events most of us were not present to experience while other species of the plant and animal Kingdoms became extinct.

Also important are publications by Leopold 1964, and Rosgen 1996 and 1998. River morphology studies describe a stream's characteristics, through geology and hydrologic responses while applying many of the physical laws that help explain the river systems of the watersheds throughout the world. Leopold and Rosgen are stream specialists who have spent many years studying river systems based on physical laws. Their works are helpful in providing a foundation about the types of mountain and valley terrain where water drains via a river channel and how the river systems can be described using geologic land form as a classification.

Literature, Livestock and Riparian Communities

Dickey, Elbert C., and Dale H. Vanderholm. 1981. Vegetative filter treatment of livestock feedlot runoff. *J. Environ. Qual.* 10:3:279-284.

Four vegetative filters were installed on feedlots in central and northern Illinois. Channelized flow and overland flow configurations were used. Runoff was applied directly to the filters with results reported as influent, effluent, and surface flow. Filters removed as much as 95% of nutrients and oxygen demanding materials from the applied runoff on a weight basis and 80% on a concentration basis. Removal was directly related to flow distance or contact time with the filter. Channelized flow with greater flow depths required greater contact time or flow distance than shallow overland flow to achieve the same level of treatment. Discharge from adequate size vegetation filters occurs only during large runoff events, which coincide with periods of high stream flows. The overall impact of multiple vegetative filter systems on receiving streams appeared to be negligible, but needs to be evaluated in more detail before these can be widely recommended and used. Vegetative filters can provide a satisfactory alternative to zero-discharge systems and result in reduced pollution problems associated with feedlot runoff.

This study provides insight about runoff from an area with 500 confined animals, the use of vegetative filter strips, and the effectiveness as a means of reducing pollution from runoff. Analysis of the data showed no difference in runoff content during periods of runoff due to rainfall. They found a relationship between the concentrations and the distances developed that provide the overland flow and time for filtration of the discharge. Channelized flow with greater flow depths required greater contact time or flow distance than shallow overland flow to achieve the same level of treatment.

This study uses a "control" plot. The study was conducted over 2 years and plots were replicated. No recommendations were made for size of buffer with trees of any type or height. It is important to understand that while some differences were indicated, the number of bacterial analyses was not large enough to analyze statistically. This suggests no differences were found between the treatment plots and the control plots. The authors stated that additional research is needed to accurately define bacterial quality for agricultural runoff. Other than very large precipitation events or spring high water levels, which were not tested water quality was the same between treatments on

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4 feedlots located at 4 different sites.

Schepers, J.S., D.D. Francis. 1982. Chemical water quality of runoff from grazing land in Nebraska: I. Influence of Grazing Livestock. *J. Environ.Qual.* 11(3):351-358.

The chemical quality of runoff water from a 32.5 hectare (81 acres) cow-calf pasture area was determined over a 3 year period. Runoff events from the grazed pasture were separated into those occurring while livestock were grazing and when no livestock were present. Grazing livestock increased by 52% the total solids concentration, but only increased total organic carbon and chemical oxygen demand by 11 and 7% respectively and decreased the nitrogen concentration by 19%.

Concentrations nitrate, ammonia, total phosphate, soluble phosphate, and chlorine were 6, 45, 37, 48 and 78.5% greater, respectively, when livestock were grazing. Runoff from an ungrazed control area within the pasture contained chemical concentrations that ranged from 1.94 and 10.8 times greater than those from an adjacent pasture under grazed conditions. These elevated concentrations were attributed to concentrations of wildlife and decomposition of plant material

Tiedemann, A.R., D.A. Higgins, T.M. Quigley, et al. 1987. Responses of fecal coliform in streamwater to four grazing strategies. *J. Range Management.* 40:322-329.

This study was conducted at the Umatilla River Barometer Watershed.

Concentrations of fecal coliform (FC) and fecal streptococcus (FS) were measured weekly during summer 1984 in streamwater of 13 wildland watersheds managed under four range management strategies. The strategies were (A) no grazing; (B) grazing without management for livestock distribution; (C) grazing with management for livestock distribution; and (D) grazing with management for livestock distribution and with cultural practices to increase forage. Counts were compared to Oregon water quality standards. Data for FS were used for determining the ratio of FC to FS to assess origin of FC organisms. Counts of FC were significantly lower under strategies A and C than under strategy D, but no significant differences were apparent among other strategy comparisons. Two strategy D watersheds violated the Oregon water quality 30-day log₁₀ standard of no more than 200 FC/100 mL; one watershed was in violation for the major part of the sampling period. Ratios of FC to FS indicated that wildlife was the major source of FC bacteria in strategies A, B, and C watersheds. Cattle were the primary source of FC bacteria on strategy D watersheds when combined with the background wildlife contribution.

Biskie, Howard A., Brett A. Sherer, James A. Moore, John C. Buckhouse, and J. Ronald Miner. 1988. Behavior of indicator bacteria in rangeland streams- manure spike experiments. *Society of Agriculture Engineers. ASAE. Paper #88-2082.*

Cattle grazing on public and private rangelands typically have access to streams as a source of water. The most significant impact of this grazing has been shown to be increased concentrations of indicator organisms of fecal origin (Darling and Cothorp, 1973). The organisms typically measured are fecal coliforms and fecal streptococci. This work documents that when fresh manure enters a rangeland stream under summertime flow conditions, approximately 95% of the indicator organisms settle out of the flow in the first 50 m.

Peak FC and FS could be noted 50 m downstream of a manure slurry injection. The peak arrived at the same time as the plume of a soluble constituent would be expected. Peaks at 100 and 300 m downstream showed a wider distribution. 95% of the FC and FS introduced into a stream did not reach a sampling station 50 m downstream within 20 minutes. Additional settling was noted between 50 and 300 m and between 10 and 300 m. Following the passing of the FC and FS

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plumes, the bacterial counts returned to near the background levels but generally remained noticeably higher, indicating the continuing resuspension of previously settled microorganisms.

Sherer, Brett M., J. Ronald Miner, James A. Moore, John C. Buckhouse. 1988.
Resuspending Organisms from a Rangeland Stream Bottom. *ASAE, St. Joseph, Michigan. Transactions of the ASAE.* 41:4:1217-1222.

Bacteria from livestock wastes enter streams with run-off and are deposited directly when animals have access to the stream. While the exact fate of all of the organisms is not known, some of the bacteria settle out into the sediment on the stream bottom. This study examined resuspending organisms from the stream bottom. The extent of increases reflects water temperature and recent animal access to streams. Low water temperature may have been responsible for the numbers of viable bacteria that were resuspended in the study. The data suggest that the fecal streptococcus tend to move downstream more freely and survive longer under adverse temperatures than fecal coliforms. Stream velocity appears to play an important role in the equilibrium between the bottom sediments and the overlying water. The magnitude of the resuspension will vary with the intensity of the discharge rate.

Sedgwick, James A., and Fritz L. Knopf. 1991. Prescribed grazing as a secondary impact in a western riparian floodplain. *Journal of Range Management* 44:4:369-373.

The effect of late-autumn cattle grazing on plant biomass was examined in a western Great Plains cottonwood riparian zone prone to catastrophic flooding every 5-8 years. Five hectare pastures were grazed from 1982-1984 were compared to control pastures within the South Platte River floodplain in northeastern Colorado. At a prescribed grazing level of .46 ha/AUM (1.15 Acre/ AUM), riparian vegetation proved to be resilient to the impacts of grazing. Yearly changes in aboveground biomass, especially dramatic following a severe flood in 1983, suggest that periodic, catastrophic flooding is a major perturbation to the ecosystem, and in conjunction with our results on grazing impacts, indicate that the dormant season grazing within SCS (Natural Resource Conservation Service) guidelines is comparatively minor impact within the floodplain. Grazing impacts were further mitigated by a major forage supplement of cottonwood leaves which was available at the time of cattle introductions. The local forage supplement ultimately created a lighter grazing treatment than that originally prescribed.

1. Smith, M.A., J.D. Rodgers, J.L. Dodd, Q.D. Skinner. 1992. Habitat selection by cattle along an ephemeral channel. *J. Range Manage.* 45:385-389.

2. Smith, M.A., J.D. Rodgers, J.L. Dodd, Q.D. Skinner. 1993. Habitat selection by cattle along an ephemeral channel. *Rangelands.* 15(3):120-122.

Habitat preferences were similar in a small pasture compared to the large allotment. The study emphasized the applicability of small pasture studies versus larger areas of similar vegetation and land forms and the importance of water developments to grazing management. Water location influenced cattle selection of habitats in the large allotment. A slightly greater proportion of cattle selected channel and flood plain habitats near water, and fewer cattle used uplands than in the small seasonal pastures.

Use of the channel where water was present increased in summer and declined in the flood plain. Similar changes did not occur in seasonal pastures. When no water was available at upland reservoirs, cattle reduced selection of uplands from 46% to 14%.

When controlled number of cattle and length of time in the pasture were tested, increased selection

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of a site did not result in increased utilization in the preferred areas. Limited water distribution in large allotments may influence use of forage closer to water. No season of grazing in this study resulted in more detrimental utilization of channels when water was not limited. Vegetation in or near channels can be best protected by developing water sources in adjacent uplands while monitoring utilization of channel areas.

Larsen, Royce E., J. Ronald Miner, John C. Buckhouse, and James A. Moore. 1994.

Water-quality benefits of having cattle manure deposited away from streams. *Bioresource Technology*. 48(1994) 113-118.

A series of runoff and infiltration studies with bovine feces were used to assess effectiveness of vegetative filter strips. Effectiveness was evaluated on the ability of the separation distance to reduce the number of fecal coliform bacteria being transported from the manure to the edge of the plots. 17% of the FC in the manure were present at the edge of the manure pile. The analysis of data did not indicate significant differences of bacteria transport in relation to rainfall intensities at distances of less than 1 meter., at 1-37 meters or 2-13 meters.

Green, Douglas M. and J. Boone Kauffman. 1995. Succession and livestock grazing in a northeastern Oregon riparian ecosystem. *Journal of Range Management*. 48:4:307-313. Comparisons of vegetation dynamics of riparian plant communities under livestock use and exclusions over a 10 year period were quantified in a Northeastern Oregon riparian zone. Livestock grazed from late August until mid September at a rate of 1.3 to 1.8 ha/AUM (3.2-4 acres/ AUM). Ungrazed dry and moist meadow communities had significantly lower species richness and diversity when compared to grazed counterparts. In heavily grazed communities, ruderal and competitive ruderal species were favored by grazing disturbance. In exclosures of the same communities, competitive or competitive stress tolerant species were favored. Both height and density of woody species were significantly greater in ungrazed gravel bar communities. The results indicate that influences of herbivore on species diversity and evenness varies from 1 community to another and basing management recommendation on 1 component ignores the inherent complexity of riparian ecosystems.

Allen-Diaz, Barbara, R.D. Jackson, J.S. Fehmi. 1998. Detecting channel morphology change in California's hardwood rangeland spring ecosystems. *J.Range Manage*. 51:514-518.

Permanent channel cross-sectional transects perpendicular to flow were used to estimate changes in spring and resultant creek channel morphology. Three cattle grazing treatments (none, light, and moderate) were applied to a 2.5 ha pastures containing a perennial spring and resultant creek cohort for 5 years. Grazing effects on the total change in channel morphology were not detected, nor did our method detect channel morphology change over the 5 year study period. Ungrazed springs and creeks were observed to change more than grazed springs and creeks although these differences were not statistically significant. Observed, but not significant, change over time appears related to rainfall patterns. Permanent channel cross-sections, one of the currently recommended methods for monitoring livestock grazing impacts on stream channels may not be adequate for detecting channel changes in low flow spring/creek systems.

Larsen, R.E., W.C. Krueger, M.R. George, M.R. Barrington, J.C. Buckhouse and D.E.

Johnson. 1998 provides a classification for published literature regarding livestock influences on riparian zones and fish habitat. The document uses a similar classification as the one described in criteria 1, 2, 3, 4, 5, and 6 of the Introduction "What is the best science?". They reported that of 2300 stream ecology papers reviewed by the group, only 1/3rd were scientifically based; 2/3rds

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were the "opinions" of the authors. Many of the opinion articles state that riparian buffers are necessary to shade streams and provide riparian buffers, but the articles do not meet criteria expected for science classification.

The scientifically based articles describe the scientific principles used to determine the best methods of grazing grass and riparian areas for maximum production. The study areas are descriptions of how grazing is used to ensure vigorous growth and production of the grasses and riparian vegetation in order to maintain a plant community as a viable component of the land management opportunities for wildlife and livestock. Fundamentals of "grass species" biology and physiology are incorporated in the articles and prescribe methods of grazing using livestock as a tool to maintain vigorous grass and riparian communities and avoid decadent grass stands and deterioration of winter range for wildlife.

Ballard, T.M. 1999. Interactions of cattle and chinook salmon. M.S. Thesis, OSU, Dept. of Rangeland Resources, Corvallis, OR.

The 2 year study had 3 objectives: determine cattle distribution and behavior within the riparian pasture, determine if cattle disrupt the spawning behavior of salmon by the presence near the redd, and determine the likelihood of a cow coming into direct contact with a redd.

The study took place on a 41 hectare(102 acres) riparian pasture in Eastern Oregon, cattle were stocked at a rate of 0.82 ha/AUM (2 acres/ AUM) with salmon spawning densities of 4.6 redds perimeter in 1996 and 6.1 redds per kilometer in 1997. 2.6 kilometers of stream is in the pasture and 50% of the area had been excluded from cattle since 1978.

Mid August through early September cattle and salmon distribution and behavior were recorded every minute for two out of three four-hour periods per day. 94% of the time, cattle preferred the terrestrial habitats, 5% was observed in the gravel bar habitats, and less than 1% of their time was in direct contact with the aquatic habitat. During observations of active salmon redds, cattle were visible from the redd location an average of 12% of the time. During the period of visibility, cattle spent 96% of the time out of the stream and 84% of the time greater than 3 meters from the redds.

Over the 2 years study period, of 50 cows over 56 days in the pasture a redd was contacted two different times which calculated to be less than 0.01% of the time that contact was made. When cattle were present during salmon spawning the salmon spent 64% of their time resting in the redd and 26% of tier time under cover. Typical behavior found in the literature indicates that salmon in other studies spent 45% of their time resting in the redd and 30% of their time under cover. Salmon carcasses surveyed during both years were 100% spawned which indicated that egg loss from retention due to harassment by cattle was not a problem.

Overall cattle were rarely close to a redd so there was very little opportunity for cattle to interact with salmon or step on redds.

Clary, Warren P. 1999. Stream channel and vegetation responses to late spring cattle grazing. J. Range Manage. 52;218-227.

A 10 year study in central Idaho in response to cattle grazing-salmonid fisheries conflicts. No grazing, light grazing, and medium grazing were tested. Stream channels narrowed, stream width- depth ratios were reduced, and channel bottom embeddedness decreased under all 3 grazing treatments. Many improvements were similar under all 3 treatments indicating these riparian habitats are compatible with light to medium late spring use by cattle. Changes in total herbaceous

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plant cover did not differ among treatments in the grazed years. The no grazed treatment ended in with a lower total plant cover than the initial reading. Litter tended to decrease in the moderately grazed pastures, gain in the no grazing treatment and change minimally in the light grazing treatment. No single management approach is best for all situations, nor perhaps is even required for a given situation. Grazing strategies employed in this study were designed to stay within the annual tolerance of the site for plant or stream bank/channel impacts each year. Potential changes in other riparian meadow situations will vary depending on past grazing management, streambank substrates, weather, and other factors.

Clary, Warren P. and Wayne C. Leininger. 2000. Stubble height as a tool for management of riparian areas. *J. Range Manage.* 53:562-573.

The effects of residual stubble height in riparian functions have received limited direct experimental examination. Consequently, much of the information is derived from studies indirectly related to the questions raised and to some extent from observations of experienced professionals. The authors identified areas of scientific investigation needed to improve understanding of the effects of stubble height on riparian function and grazing management.

Laliberte, Andrea S. , Douglas E. Johnson, Norman R. Harris and Grant M. Casady. 2000. Stream Change Analysis using Remote Sensing and Geographic Information Systems (GIS). *Journal of Range Management.* 54(2) (CD-Electronic Section).

Remote sensing and Geographic Information Systems (GIS) are common tools for time change analysis, however, in most cases satellite imagery or small-scale aerial photography is used. The increased resolution of large-scale aerial photos helps in identifying small features on the ground and is highly useful in the assessment of riparian areas. In this project, large-scale aerial photography from 1979 and 1998, GIS, Global Positioning Systems (GPS) and ground truthing were combined in a time change analysis of an eastern Oregon riparian area. The objectives of this study were: 1) to examine changes in stream morphology over 20 years, 2) to assess if changes were associated with management, topography or other factors, 3) to determine the feasibility of using large-scale aerial photography, GIS and GPS techniques as a tool for assessing change over time.

The 2.5 km long study area, consisting of the stream and riparian area was separated into exclosures and grazed areas in 1978. Aerial photos from 1979 and 1998 (scale of 1:4000) were geo-referenced using 102 ground control points for the 41 ha study site. In addition, older aerial photography and previously collected survey data were available for this study. Stream features, such as islands and stream channel, were digitized using a GIS. Stream length, stream width and areas of change were identified for both years. The width of the stream was extracted automatically every 0.5 m along the 2.5 km long stream section, yielding 5070 width measurements.

Although stream length remained the same over time, stream width decreased in both grazed and exclosed areas. The area of change (3.65 ha) was slightly larger than the area of no change (3.2 ha). Number of islands and island perimeter decreased, while the island area increased. Exclosures and grazed areas responded similarly, and it was concluded that the topography and stream dynamics had a greater impact than the grazing regime in this study. The use of large-scale aerial photography, GIS and GPS proved to be a powerful tool for detecting change and it is expected that these techniques will become more common in rangeland analysis in the future.

Allen-Diaz, Barbara, R.D. Jackson. 2000. Grazing effects on spring ecosystem vegetation of California's hardwood rangelands.

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Three watersheds at University of California's Sierra foothill Research and Extension Center were selected to study cattle grazing effects on the vegetation surrounding cold-water springs and their down slope creeks. Three spring-creek systems from each of 3 watersheds were randomly assigned to grazing treatments (9 total). Treatments were ungrazed, lightly grazed (1500 kg per hectare residual dry matter (1600 lbs/ acre)) and moderately grazed (1000 kg per hectare residual dry matter (1120 lbs/ acre)).

Total herbaceous cover varied significantly among the 6 years only once (greater in 1994 than all others) covarying with the previous years rainfall. With few exceptions stable plant communities persisted on sites regardless of grazing intensity or cover changes. Total herbaceous cover was sensitive to inter annual fluctuations, especially under increased grazing intensities. Cover is a more useful gauge of ecosystem health than plant composition as the latter may not provide evidence of potentially deleterious grazing by climate interactions until after soil erosion or water table characteristics are altered.

Porath, M.L., P.A. Momontt, T.De.Curto, N.R. Rimbey, J.A. Tanaka, M. McInnis. 2002. Off-stream water and trace mineral salt as management strategies for improved cattle distribution. *J. Anim. Sci.* 80: 1-11.

Scientists find cattle and salmonid streams compatible at the OSU Union Experimental Station in Northeastern Oregon. Livestock don't degrade riparian areas if they have other sources of water and trace mineral salt. Three treatments were randomly assigned to one pasture in each of three blocks. Sixty cow/calf pairs were allotted to the grazed pastures. The treatments included stream access and access to off stream water and trace mineral salt, stream access and no access to off stream water or trace mineral salt, and ungrazed control.

Properly managed cattle grazing can be compatible with healthy streams. The study found that livestock can be lured away from stream bottoms in the summer to avoid damage to the streams. Cattle and grazing in those streams may be difficult, by and large riparian areas can be grazed, and if managed properly, healthy streams will be present.

Cattle often prefer to graze away from streams in the early morning hours, then search for water in the late morning and seek shade or graze less intensively through the hot afternoon hours. No off stream cattle began the day further from the stream than cattle without offstream water but consistently moved closer to the stream after the morning grazing period. Cattle also tend to spend summer afternoons in the same areas where they last drank and move away from water sources in the evenings.

Grazing activity, fecal deposit distribution, and travel distance of cattle were not affected by the presence of off stream water and trace-mineral salt.

Livestock with a stream as their only water source were on average 150 feet to 200 feet away from the stream between 3 p.m. and 9 p.m., the researchers found. When tanks or other alternative water sources were available, cattle tended to move 350 feet to 400 feet away from the stream during the same hours. This study quantified what the cattle actually do as they graze, how far they go from the stream and how long they stay away." Luring cattle away from Eastern Oregon streams gets more difficult in late summer. In late summer, forage away from stream bottoms often has been cured by the sun and is less attractive to cattle, while some upland water sources are disappearing. The presence of cattle, or some cloven-hoof animal, may actually benefit low-elevation bunchgrass country and some other types of terrain. Periodic defoliation by cattle or fire eventually could prove

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healthy for such areas, although that has not yet been scientifically established. The study is indication that careful management of livestock to ensure uniform distribution throughout grazing areas is a better way of protecting streams and fish than fencing streams or excluding grazing altogether.

Parson, C.T., P.A. Momont, T. DelCurto, and J.L. Sharp. 2002. Effects of season of use on beef cattle distribution patterns and subsequent vegetation use in mountain riparian areas *Journal of Range Management*. (In Press)

To quantify the effects of season of use on cattle distribution relative to riparian areas fifty-two cow/calf pairs were randomly assigned to two years of 3 replications of treatments: 1) early season (ES) grazing (mid-June-mid-July, and 2) late season LS grazing (mid-August to mid-September). Based on previous years DM production estimates pasture were stocked to achieve 50 percent utilization after 28 days of grazing. Livestock observation points, livestock activities and ambient temperatures were recorded hourly during two 4 day periods in each season of use.

Locations were transcribed to a geographical information system for the study area on OSU's Hall Ranch in northeastern Oregon. Cow weight and body condition score (BCS), calf weight, ocular vegetation utilization estimates, forage quality, and fecal deposits within 1 meter of the stream were recorded pre- and post-grazing.

During ES, cattle were further from the stream ($p < .01$) than LS grazing averaging 161.41 and 99.4 m for ES and LS, respectively. Grazing distribution also displayed a diurnal response ($P < .01$) with increasing diurnal response resulting in decreased cattle distance from the stream. Fecal deposits within 1 m of the stream tended ($p = 0.13$) to be greater following LS than ES grazing. Forage quality varied between seasons with ES forage having lower DM, greater CP, lower fiber and greater IVDMD compared with LS forage. Livestock activity (grazing, ruminating or drinking) and grazing times, min/day were not affected by season of use. However forage utilization was influenced by season of use with ES grazing vegetation use as compared to LS grazing ($p < .05$). In summary the grazing season affected cattle distribution relative to the riparian area, with LS having more concentrated use of riparian vegetation.

Morrison, J.A., T. DelCurto, C.T. Parsons, G.D. Pulsipher and E.S. Vanzant. 2002. The influence of cow age on grazing distribution and utilization of mountain riparian areas and adjacent uplands. *Journal of Range Management*. (In Review)

In a 2 year study sixty cow-calf pairs were stratified by age into the treatments of first calf heifers, and mature cows (5, 6 and 7 years). The research was conducted on the Milk Creek drainage at Oregon State University's Hall Ranch in northeast Oregon from late July to early September. The analysis of 13,000 cattle location observations during the grazing time revealed a three way interaction between cow age, time of day and grazing bout. Mature cows were farther from the stream during the morning than the first-calf heifers. There were no significant differences between the distances of the first calf heifers and cows from the stream or in the percentage occupying the riparian vegetation type from noon until dark. During the later portion of the grazing bout no significant differences were observed between the distribution of the age classes from the stream or in the percentage of each age class in the riparian vegetation type. Forage utilization and utilization pattern were not different when comparing pastures grazed by the different age classes. Fecal deposits within one meter of the stream did not differ between mature cows and first calf heifer treatments during the entire grazing bout. In summary the mature cows distributed farther from water and spent more time outside the riparian vegetation zones early in the grazing period and during the morning hours as compared to first calf heifers.

SUMMARY OF NUTRIENTS, SEDIMENTS, AND RIPARIAN PLANT COMMUNITY

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Appendix 4 INTERACTIONS

What is the role of nitrogen in the riparian area and stream water?

How does a riparian area filter sediments out of runoff from non point source erosion? What do we know about “filter strips” in riparian areas and large woody debris (LWDs)?

An ample amount of literature is available through review of journal publications and can be found on topics that discuss riparian vegetation as being a filter for nutrients, sediments, and a general catchall for harmful elements to fishery habitat.

From a scientific approach a riparian area may or may not play as important a role in directly protecting aquatic habitats for fish as some have implied. Best available science doesn't make links that connect the nitrogen cycle or nitrogen sources to sediment deposits in streams and then to fish survival. Such concepts are foreign in the science disciplines that have the task of studying each process.

Nitrogen forms found in a riparian area such as nitrates are not harmful to the fish itself as far as the health of a fish is concerned. Sediments in a stream are only a concern in streams if they are a particularly small size and somehow able to drop out of the water column due to very low velocities of the water which allows the smallest particles be deposited into a fish egg nest called a redd. These “fines” would be a concern for fish egg survival if there were enough “fines” that the eggs became smothered.

Due to the lack of careful examination of the known facts about riparian area interactions within a watershed, a distorted picture of cause and effect was found in much of the available literature. For studies to determine all of the interactions that many speculate about, the authors Snedecor et al 1963, Herlbert 1987, and Romsberg 1981 lay out the steps necessary to make the links if it is possible. To date, most nutrient/salmon survival studies have not been conducted in a manner to allow a factual linkage and do not meet the criteria for “best available science”.

Listed below are studies reviewed and selected as “best available science” on the topics of sediment and runoff and plant communities. Eight studies were added that specifically studied the nitrogen cycle in near-stream plant communities. These studies did not speculate on how fish survive due to land conditions, because aquatic life survival is a topic unrelated to these processes. Fishery studies were not located that demonstrate fish populations are physically and directly affected by the presence of nitrates, sediments, and runoff from uplands into riparian areas. There are opinions about such cause and effects, but studies to document the links did not show up as “best available science” when using the 6 criteria provided in the Introduction.

Several textbooks have been listed as important in reviewing literature about plant communities if a person is not familiar with the science discipline of plant ecology. Also, in order to understand the process of nutrients and sediments, basics must be established about the interaction of the nutrients, soils, and plants on a site by accounting for specific variables that change with place and time.

The Fundamentals of Science Theory for Land and Plant Community Management

Schimper, A. F. W. 1903. Plant Geography upon a Physiological Basis. Clarendon Press, Oxford.

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Schimper's First Law states: The type of flora (species), insofar as it depends on existing factors, is determined primarily by heat.

Schimper's Second Law states: The local distribution of plants and of plant communities is determined chiefly by the nature of the soil, either directly, or in its relation to other factors.

Schimper's Third Law: The type of vegetation (life-form) in the tropical and temperate zones is determined by the amount and seasonal distribution of the rainfall and by the humidity of the air.

USDA Natural Resource Conservation Service. 1986. Major Land Resource Areas.

USDA Natural Resource Conservation Service. 1989 Soil Survey of (County name) County
USDA Soil Survey, 1989 and 1986 are records of investigations identifying soil series and land resource areas conducted by Soil scientists and compiled over many years. WAC 365-195-905 criteria 1, 2, 3,4, 5, and 6 are the basis for the report and make the report a reliable source of site specific knowledge. The USDA Soil Survey, 1989 creates a clear picture of where soils are present that can support vegetation and are the major function of sediment deposition.

There are soil surveys available for nearly every major county area in the country. They are considered standard reference books for research, land planning, and construction purposes. They are recognized as a valuable resource by the professional soil scientists.

Anderson, E.W., M. M. Borman, and W.C. Krueger. 1998. Ecological provinces of Oregon. SR 990. Oregon Agriculture Experiment Station. Corvallis, OR. (Book)

Zones of Oregon classified by geologic formation and plant communities. The Coastal Zone extends through Oregon into Washington to the North and into California to the South.

Nutrient Cycles & Nitrate Cycles

Burford, J.R. and J.M Bremner. 1975. Relationships between the denitrification capacities of soils and total, water-soluble and readily decomposable soil organic matter. Soil Biol. Biochem. &: 389-394.

The relationships between the denitrification capacities of 17 surface soils and the amounts of total organic carbon, mineralizable carbon, and water-soluble organic carbon in the soils were investigated. The soils used differed markedly in pH, texture, and organic matter content. Denitrification capacity was assessed by determining the N evolved as N₂ and N₂O on anaerobic incubation of nitrate treated soil at 20°C (68 °F) for 7 days. Mineralizable carbon was assessed by determining the C (carbon) evolved as CO₂ on aerobic incubation of soil at the same temperature for the same time period.

The work reported indicates that denitrification in soils under anaerobic conditions is controlled largely by the supply of readily decomposable organic matter and that analysis of soils for mineralizable carbon or water soluble organic carbon provides a good index of their capacity for denitrification of nitrate.

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Overcash, S. C. Bingham, P. W. Westerman. 1981. Predicting Runoff Pollutant Reduction in Buffer Zones Adjacent to Land Treatment Sites. American Society Of Agricultural Engineers. Transactions of the ASAE-1981

Overcash et al provides an example of how to assess the BMP for watersheds regarding the need for riparian buffers. This study presented the hydraulic continuity equation which takes into account runoff discharge per area, time, depth of flow, distance through the buffer and rainfall above the saturation of soil types. It becomes obvious that filter strips are not designed for entire systems as cure all for pollution capture. Factors between soil textures suggest that soil infiltration is an important consideration. Major influences on buffer length (rather than prescribed width) and performance are: dilution, infiltration, and pollution potential of the waste area.

Bormann, B.T. and D.S. DeBell. 1981. Nitrogen content and other soil properties related to age of red alder stands. Soil.Sci.Soc. Am. J. 45: 428-432.

In 1981 Bormann et al found soil characteristics beneath alder stands differed markedly from those beneath adjacent Douglas fir stands. They studied stands with tree ages of 5-41 years growing on the same soil type in the same general area. Soil nitrogen content had accumulated a nearly constant rate of about 35 Kg/ ha/ year in the soil measured beneath alder stands (0- 20 cm depth) They noted that after an apparently rapid buildup in the first decade, forest floor N (nitrogen) increased from 10 to 40 years old at a rate of 15 Kg/ha/year Other mineral soil characteristics beneath the alder stands differed markedly from those beneath adjacent Douglas-fir stands. organic matter content was 20% higher, pH and bulk density were much lower. The study found mixed stands offered opportunities for Douglas fir growth and that soil nitrogen regressed over stand age indicated an accumulation of N at a nearly constant rate in mineral soil.

Alder can fix appreciable amounts of N on wide range of sites varying from poorly productive to productive soils with high N content sampled in this study. Understanding the effects of alder- derived N and other changes in soil properties on site productivity will help determine the extent of future alder use. Economic feasibility of mixed and rotational cultures of alder in Douglas-fir managed forests needs further work in light of increasing energy costs. Addition of N fertilizers derived from fossil fuels is part of the economic feasibility considerations.

Bormann, B.T and J.C. Gordon. 1984. Stand density effects in young red alder plantations: Productivity, photosynthate partitioning, and nitrogen fixation. Ecology. 65(2) 394-402.

Red alder (*Alnus rubra*) is sometimes considered for use in intensive forest management in the Pacific Northwest primarily because of its rapid growth and ability to fix atmospheric nitrogen. Red alder has rapid juvenile growth with characteristics which are ideal for maximum fiber yield. Annual biomass production in 8-10 year old, naturally established stands can reach 29 Mg/ha. Growth characteristics had not been fully analyzed, and little is known about alder production in managed natural stands or plantations.

Red alder forms a symbiosis in which N₂ can be fixed. From previous studies it appeared that a great deal of energy was sacrificed for the process. Much is yet unclear about the processes involved.

Red alder spacing trials were established to estimate aboveground and below ground biomass and above-ground productivity and structural characteristics. Branch and bole measurements were made. Nodules and roots were also sampled.

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Bormann et al evaluated the effects of stand density on nitrogen fixation and canopy characteristics in a 5 year old red alder plantation. Stand and average tree dimensions were strongly affected by stand density. Average tree values for dbh, wood volume, branch surface area, and number of growth sites were greatest in trees growing in the open stands. Similar values for crown volume and live crown ratio were also greatest in open stands. Intermediate stands had the highest branch surface area and canopy volume per unit area. Tree height ($p=0.41$), crown shape intercept and slope, and leaf density were little affected by stand density.

The maximum aboveground net production was midrange compared with cool temperate zone estimates. Compared to the natural 8-10 year old alder stands measured in British Columbia the estimate on this study appeared low. The Oregon site may have been medium to poor for alder or from a seedling stock not adapted to the site. Freeze rings, aphids and black leaf mold were abundant during the growing season also stand age or methods may have accounted for some of the lower productivity estimates.

Low density stands had the highest mass, volume, and surface area components as well as nitrogen fixation. High density stands had the highest wood volume and above ground dry mass. The lack of correlation between leaf mass and nitrogen fixation per unit area suggested that high density stands allocated less photosynthate to the nodules for nitrogen fixation. These findings suggest that dense stands comprised of 85% older trees of 24"DBH which cannot mitigate nutrient uptake. Intermediate to wide spacing on a relative basis, maintained over a complete alder rotation will apparently result in near maximum cumulative fixation of atmospheric nitrogen and the most economic wood production (near maximum bole volume growth on the fewest stems).

Lowrance, R., R. Todd, L.E. Asmussen. 1984. Nutrient cycling in an agricultural watershed: I. Phreatic movement. *J. Environ. Qual.* 13(1): 22-27.

Runoff from agricultural fields in southeastern Coastal Plain is carried to a stream channel system in a shallow phreatic aquifer. The subsurface runoff often passes through a band of riparian forest before becoming streamflow. It is hypothesized that the riparian ecosystem acts as a nutrient sink and reduces the concentrations and loads of nutrients in the shallow aquifer before the nutrients reach the stream channel. The total water volume moving off the watershed at the study site in subsurface flow was less than 1% of the streamflow with corresponding small amounts of nutrients. Nitrate nitrogen, calcium and magnesium had significantly higher concentrations in field wells than in forest or streamside wells.

In 1979 thirty-seven wells were located along nine transects extending from the field/forest or field/pasture interface to the stream. 500 ml samples were taken after rainfall events or at least each 2 weeks between events. Darcy's equation was used to estimate water movement in the phreatic zone. The soils of the Atlantic and Gulf Coastal Plan are generally sandy and have high infiltration rates. The study area at Tifton Georgia in the Tipton Upland has permeable surface horizon underlain by a zone less permeable (0.9 to 1.5 meters below) where incident precipitation infiltrates and moves laterally as phreatic flow. The flow then enters the alluvial zones near the stream and eventually moves to the stream channels of the Tifton Upland which generally are bordered by a layer of mixed hardwood riparian forest. Water and nutrients from upland fields must flow through the forest as either subsurface or surface flow.

As shown in schematic representation of the units, Well 1 was located at the top of the unit just

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below a field with an agriculture crop, Well 2 was below a field, and Well 3 was located below the hardwood riparian at the interface with the stream channel.

Each season of 3 months long beginning with January in season 1 was tested. Streamflow nitrate nitrogen was generally highest in season 1 and lowest in season 3, but streamside wells showed little change between seasons. Decreases in nitrate nitrogen and SO₄-S during the summer months could have been due to increased microbial activity reducing more sulfate and nitrate to gaseous forms.

Nutrient loads and water volumes transported off the watershed in subsurface flow were small compared with volumes and loads transported in streamflow. Total water volume was only 0.07% of the streamflow volume. Total phosphorus, calcium, magnesium, potassium and sulfates as well as chlorine were all less than 0.075 of the streamflow load, indicating that they were relatively less concentrated in subsurface than in the streamflow. Organic nitrogen, nitrate, total nitrogen were all relatively more concentrated in subsurface flow than streamflow. In general, subsurface discharge through the watershed boundary carried negligible quantities of nutrients due to the small volume of water movement.

The riparian forest zone acted as a filter for nitrates, calcium, magnesium, potassium and sulfates. Nitrogen was transformed from inorganic to organic forms in the bottomland forest. Almost all water and nutrient movement from the watershed was in streamflow with subsurface discharge off the watershed accounting for less than 1% of the streamflow.

Lowrance, R., R. Todd, L.E. Asmussen. 1984. Nutrient cycling in an agricultural watershed: II. Streamflow and artificial drainage. *J. Environ. Qual.* 13(1): 27-32.

Runoff from agricultural fields in southeastern Coastal Plain is carried to a stream channel system in a shallow phreatic aquifer. The objective of this study was to examine seasonal variations of nutrients in streamflow and to quantify the effects of artificial drainage effluent on streamflow nutrients on an agricultural watershed.

Loads per hectare of organic N were lower from the drained fields, but loads of other elements were lower from the mixed cover watershed. In-stream and riparian zone processes apparently converted inorganic N to organic forms and removed N through denitrification. Annual streamflow N load was about 29% of the precipitation input of 12.2 Kg per hectare per year. Sediment associated N and P (phosphorous) loads in streamflow were 0.35 and 0.9 kg per hectare per year, respectively accounting for 9.0 and 8.5% of total N and P, respectively.

The two highest flow events for the year carried 19% of the total annual flow and 19% of the annual sediment load, but had 30 and 27% of the total annual sediment N and P loads. This indicated that part of the sediment load moved directly from upland areas.

Lowrance, Richard, Robert Todd, Joseph Fail, Jr., Ole Hendrickson, JR. , Ralph Leonard, Loris Asmussen. 1984 Riparian Forests as Nutrient Filters in Agricultural Watersheds. *BioScience.* 34:374-377.

Riparian vegetation may help control transport of sediments and chemicals to stream channels. Studies of a coastal plain agricultural watershed showed that riparian forest ecosystems are excellent nutrient sinks and buffer the nutrient discharge from surrounding agroecosystems. Nutrient uptake and removal by soil and vegetation in the riparian forest ecosystem prevented outputs from agricultural uplands from reaching the stream channel. The riparian ecosystem can apparently serve as both a short - and long-term nutrient filter and sink if trees are harvested

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periodically to ensure a net uptake of nutrients. Proper streamside forest management requires both periodic harvest of trees to maintain nutrient uptake and minimum disturbance of soil and drainage conditions.

Sexstone, A.J., T.B. Parkin, and J.M. Tiedje. 1985. Temporal response of soil denitrification rates to rainfall and irrigation. *Soil Sci. Soc. Am. J.*, 49:99-103.

The response of soil denitrification to increased soil moisture was compared in a non-aggregated sandy loam soil and an aggregated clay loam soil using a soil core technique and lab procedures. Elevated field denitrification rates were observed on 9 of 11 occasions on three sites following irrigation or rainfall of greater than 1 cm. Sandy loam soil increased immediately after water addition and reached a maximum rate within 3-5 hours and returned to pre-irrigation levels within 12 hours. Clay loam soil required 8-12 hours before a maximum rate was observed and 48 hours before the original background rate was restored.

Nitrogen losses from the clay loam soil were double that of the sandy loam although the sandy loam received almost twice the water input. The difference was apparently due to the longer duration of the enhanced denitrification rate in the clay loam soil following the increase in the soil moisture.

The study confirmed that significant denitrification losses can occur in bursts in response to rainfall, and illustrated that sampling schemes based on integration of denitrification rate measurements must include these episodes to obtain meaningful estimates of N loss. Denitrification response to rainfall was not always the cause suggesting that nitrate or carbon may also limit nitrogen loss.

Groffman, P.M., E.A. Axelrod, J.L. Lemunyon and W.M. Sullivan. 1991. Denitrification in grass and forest vegetated filter strips. *J. Environ. Qual.* 20:671-674.

Denitrification was measured in two grass and two forest vegetated filter strips (VFS) in Rhode Island. Grass plots were established on well drained soil and were planted to tall fescue or reed canarygrass. One forest site was on an excessively well drained soil and was dominated by oak, and the other was a poorly drained soil and was dominated by red maple.

Denitrification was measured using soil cores under aerobic and anaerobic conditions with a range of treatments: no amendment, acetylene, water, nitrate, and nitrate plus carbon.

Unamended rates of denitrification were low in all plots. Nitrates and NO₃ plus C amended rates were consistently higher in the grass plots than in the forest plots. Nitrate plus carbon amended rates were higher than NO₃ amended rates in all plots, but the differences were significant in the forest plots only. Denitrification enzyme activity was measured in 14 additional forest sites of varying natural drainage classes and was related to soil moisture at these sites. The results suggest that the ability of VFS to support denitrification varies strongly with vegetation, soil type and pH, and that denitrification of VFS may be amenable to management.

Groffman, P.M., A.J. Gold and R.C. Simmons. 1992. Nitrate dynamics in riparian forests: microbial studies. *J. Environ. Qual.* 21: 666-671.

Measurements were made from groundwater during growing and dormant seasons (reported in a companion study Lowrance et al (1984)) at two sites on stratified glacial drift and a third site on

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unstratified glacial drift to study nitrate removal from uplands due to uncertainty about the mechanisms of nitrate removal in these areas.

Poorly and very poorly drained soils had higher denitrification enzyme activity (DEA) than upland- wetland transition zones (moderately drained to somewhat poorly drained) surface soils. Microbial biomass C(carbon) and N (nitrogen) content were more variable but showed the same general pattern. Levels of denitrification enzyme activity were consistently low or undetectable at the band below the seasonal high water table. Surface soil DEA and microbial biomass were correlated with nitrate removal from groundwater reducing the growing season. Low levels of DEA and microbial biomass in the subsurface suggested that plant uptake was the dominant groundwater nitrate sink during the growing season. In the dormant seasons the water table levels were higher and groundwater nitrate was able to interact with the near surface soil and be removed by denitrification and/or microbial immobilization. The potential net denitrification was very low at most sites. The transition zone soils with a densely developed upland, which had high rates of nitrate production, suggested that the long term buffering potential of the site was limited.

The study took place on 3 sites using 4 soil types based on drainage classes of being moderately well drained, somewhat poorly drained, poorly drained and very poorly drained soil. The denitrification was higher in wetland portions of the riparian zone than in upland-wetland portions of the zone likely due to the presence of anaerobic conditions and higher levels of organic carbon in the wetland. Denitrification enzyme activity has been shown to be highly correlated with annual rates of denitrification in north temperate forest soils and is useful for site comparison studies. Microbial biomass and activity were also high in wetland areas relative to the transition zone due to favorable moisture conditions and high levels of organic C in the wetlands. The denitrification enzyme activity and microbial biomass and activity data measured suggests that wetlands have a greater potential for microbial nitrate attenuation than transition zones of uplands.

The high correlation during the growing season though does not prove that denitrification or microbial immobilization were responsible for the removal. The low level of the parameters in the subsurface may reflect interactions with the dominant nitrate sink, plant uptake. Soil DEA does not provide information on the actual rate of denitrification occurring at any point in time. A lack of detectable DEA is a strong indicator that denitrification is NOT occurring. The data indicates that there is significant spatial and temporal variations.

A major question when evaluating the water quality maintenance value of riparian zones relates to long term effectiveness. If a site receives high levels of subsurface nitrate inputs for many years, the ability of the site to attenuate nitrate may increase or decrease over time. It is possible that plant and microbial sinks can become saturated with nitrogen. Groundwater nutrient inputs have been shown to stimulate both plant and microbial populations increasing their potential to act as sink. One site in the study may have been an N-rich site susceptible to nitrate losses. The symptom of N enrichment was marked in the transition zone soils at the out wash site with a developed upland. The high nitrification rates may be indicative that a long-term buffering potential if the site is limited.

Lowrance, R. 1992. Groundwater nitrate and denitrification in a Coastal Plain riparian forest. J. Environ. Qual. 21:401-405.

Mechanisms of nitrate (NO₃) removal from groundwater in riparian forests are poorly understood. This study was conducted in the Georgia coastal plain to : (i) determine changes in NO₃ and CL concentrations within shallow groundwater moving from a row-crop field to a stream; (ii) determine the spatial and temporal distribution of denitrification potential relative to changes in

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NO₃ concentrations; and (iii) determine whether NO₃ or C supply was limiting denitrification potential. Nitrate and CL concentrations in groundwater were measured biweekly or monthly for October 1988 through May 1990. Denitrification potentials, indicated by the denitrification enzyme assay, were measured bimonthly from October 1988 through October 1989.

Denitrification potential was more than two orders of magnitude higher in the top 10 cm of soil than in the top 19 cm of the shallow aquifer. Denitrification potential was consistently highest in surface soil nearest the field and nearest the stream and was limited by NO₃ availability in all surface soil samples. Denitrification potential was highest in October and August, although NO₃ is definitely being removed from shallow groundwater, it is apparently not due to direct denitrification from the saturated zone. High denitrification potential in surface soils, especially near the field/forest interface, may contribute to NO₃ disappearance from shallow groundwater. Processes associated with intact riparian vegetation appear to play the primary role in N removal.

Lowrance, R., G. Vellidis, and R.K. Hubbard. 1995. Denitrification in a restored riparian forest wetland. *J. Environ. Qual.* 24:808-815.

Groundwater nitrate moving from upland areas toward streams can be removed by denitrification in mature riparian forests, but denitrification in restored riparian forests has not been quantified. We determined denitrification rates in a restored riparian wetland below a liquid mature application site. A riparian forest buffer consisting of hardwoods along the stream and pines above the hardwoods was established according to USDA specification. Denitrification was measured monthly using the acetylene inhibition technique on intact soil cores for 2 mo before mature application began and for 24 mo after mature application. Groundwater movement of nitrate nitrogen and total Kjeldahl N were estimated biweekly. Average annual denitrification rate was 68 kg N₂O-N ha/yr. Denitrification was significantly higher in a grassed area than in either of the forest areas. Denitrification did not differ significantly between the hardwood and pine areas. Denitrification was greater than a conservative estimate of groundwater input of total N. Denitrification rates were higher in April and May 1992 and 1993, after manure application to the upland began, compared with April and May 1991, before manure application began. These results indicate that riparian wetland, which has not undergone hydrologic modifications can have denitrification rates comparable to mature riparian forests. High denitrification rates in and adjacent grassed wetland and lack of difference in denitrification in hardwood and pine zones indicates that the high denitrification rates were due to factors other than the reforestation itself. Compared with groundwater inputs of N, denitrification was an important sink for N moving from the upland management system.

Lowrance R., G. Vellidis, R.D. Wauchope, P. Gay, and D.D. Bosch. 1997. Herbicide transport in a managed riparian forest buffer system. *Trans. ASAE* 40:1047-1057.

The effect of a riparian forest buffer system (RFBS) on transport of two herbicides, atrazine and alachlor, was studied during 1992-94. Herbicides were applied to an upland corn crop in March of each year. The buffer system was managed based on USDA recommendations and averaged 50m in width. The system included a grass buffer strip immediately adjacent to the field (Zone 3); a managed pin forest downslope from the grass buffer (Zone 2); and a narrow hardwood forest containing the stream channel system (Zone 1). After the first year of the study, the managed forest was clear cut to 1/3 and thinned in 1/2 of Zone 2. The other 1/3 of Zone 2 was left as a mature forest. Most of the herbicide transport in surface runoff occurred before 30 June with about 25 cm of cumulative rainfall after herbicide application. During this period of higher herbicide transport, atrazine and alachlor concentrations averaging 34.1 ug/Liter and 9.1 ug per liter at the field edge, respectively were reduced to 1 ug per liter or less as runoff neared the stream. There were generally no differences among the mature forest and the two treatment areas (clear cut and thinned) for either

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concentration or load in surface runoff. Using precipitation data collected on site, the effects of dilution versus other concentration reduction factors (infiltration, adsorption) was estimated for surface runoff. Concentration reduction was greatest per meter of flow length in grass buffer adjacent to the field. There was only minor transport of herbicides through the buffer system in shallow groundwater and little difference between the Zone 2 treatment areas. In 1992 and 1993, herbicide concentrations in shallow groundwater in the RFBS and at the edge of field were generally at or below detection limits. In 1994 well concentrations of both herbicides increased, probably in response to infiltration of surface runoff containing high herbicide concentrations. Average herbicide concentrations were at or below detection limits in groundwater near the stream for most of 1994.

Bosch, D.D., R.K. Hubbard, L.T. West, and R.R. Lowrance. 1994. Subsurface flow patterns in a riparian buffer system. *Trans. ASAE* 37:1783-1790.

Matric potential was measured in a grass and forest riparian buffer system adjacent to a cropped field in the Georgia Coastal Plain. The soil in the adjacent cropped field is a Tifton loamy sand, containing an argillic subsurface horizon with plinthite at approximately 1 m which has been shown to restrict vertical infiltration and induce lateral flow. Two years of matric potential data and measurements of soil hydraulic characteristics were examined to evaluate and quantify unsaturated water flow in the riparian buffer. The lowest soil matric potential occurred at the grass/forest interface and the greatest surface infiltration occurred within 10 m downslope of the same interface. The area of low matric potential was likely due to water uptake by trees. Water flowed laterally through the unsaturated soil into the riparian area from the upland field, apparently induced by low vertical conductivity in the subsurface and driven by the high water demand of the forest.

Bosch, D.D., J.M. Sheridan, and R.R. Lowrance. 1996. Hydraulic gradients and flow rates of a shallow coastal plain aquifer in a forested riparian buffer. *Trans. ASAE* 39:865-871.

Three years of water table measurements and estimates of saturated hydraulic conductivity were used to evaluate and quantify saturated water flow gradients, directions and rates for a hillslope consisting of a tilled upland field and a downslope riparian forest buffer system located in the Gulf- Atlantic coastal Plain Uplands. The gradient of the water table from the top of the landscape to the bottom varied from 0.9 to 9.2% less than the 1.5% land slope. The direction generally followed the land slope. During summer months the hydraulic gradient within the forested buffer reversed direction. Water table data indicate that riparian area was saturated from January through March. During this time, flow direction in the shallow aquifer is from the top of the field to the stream bottom. During summer months high rates of forest evapotranspiration created large water sinks in the shallow subsurface and large local hydraulic gradients. Examination of water table elevations indicates that seasonal water demand of the forest shifts the direction of shallow subsurface aquifer flow. During these periods flow direction within the riparian buffer was from the lowest landscape position to the riparian forest, reversed from winter months. Total subsurface flow within the hillslope was calculated as 35 mm per year, 3% of annual precipitation. Average groundwater linear velocity was calculated as 1.4 mm per hour. Evapotranspiration loss was estimated as 67% of average annual precipitation.

Groffman, Peter M., G. Howard, A.J. Gold, and W.M. Nelson. 1996. Microbial nitrate processing in shallow groundwater in a riparian forest. *J. Environ. Qual.* 25:1309-1316. Denitrification, immobilization, and respiration in microcosms that simulated groundwater conditions in a riparian forest were measured in Rhode Island. Rates were compared with rates of nitrate removal measured in a companion study using a groundwater monitoring well network.

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While there were significant variation in water table levels, dissolved oxygen, dissolved organic carbon and total carbon within the aquifer in the riparian forest, there was little spatial variation in denitrification or respiration rates.

Rates were higher in summer than in winter and were nearly always limited by a lack of organic C (carbon). Measured denitrification rates were much lower than rates of groundwater nitrate removal directly measured in a companion hydrologic study at the same time, suggesting that there is still considerable uncertainty about the mechanism of nitrate removal from groundwater in riparian forests.

Addy, K.L., A.J. Gold, P.M. Groffman and P.A. Jacinthe. 1999. Groundwater nitrate removal in subsoil of forested and mowed riparian buffer zones. *J. Environ. Qual.* 28:962-970.

Two similar riparian sites in Southern New England were examined for ground water nitrate removal in the subsurface of mowed vs forested vegetation. Soil cores were extracted from the study area. Substantial ground water removal and denitrification occurred at all locations. Ground water removal rates were significantly correlated with carbon enriched patches of organic matter. The correlation of the data supports previous work that patches function as hotspots of microbial activity in the subsoil. Our ability to manage the export of nitrates from coastal watersheds is limited by a lack of understanding of the various processes that retain or remove nitrate in terrestrial landscapes. There is considerable uncertainty regarding the site characteristics that promote substantial ground water nitrate removal in riparian zones and the influence of different types of vegetation cover on groundwater nitrate removal.

Similar patterns of soil morphology and hydrology existed at both sites. The depth to C horizon was greater at Site A than Site B. Both sites had low ambient nitrate concentrations. There was no significant differences in the percent of organic patch material between forested and mowed areas within each site. The percent of organic patch material was different between sites. Patch material ranged from 0.6 to 3.5% carbon where the matrix material ranged from 0.2 to 0.6% carbon. At site A there was no significant difference in the patch carbon between forested and mowed areas. Patch carbon was significantly correlated with ground water nitrate removal rates and denitrification gas production rates. Ground water nitrate removal rates and denitrification gas production rates were not significantly correlated with matrix carbon.

Roots in all soil samples were present. There was no significant difference in root biomass within or between sites. Root biomass was not significantly correlated with patch carbon, ground water nitrate removal rates or denitrification gas production rates.

The study found no significant difference in ground water nitrate removal rates within the subsoil of forested and mowed riparian areas. Second, they found significant differences in ground water nitrate removal rates between the two riparian sites with similar soil texture, drainage class, and morphology. Implications from management of riparian buffer zones for ground water nitrate removal are that lack of vegetation effect may be related to similarities in the subsoil root composition and biomass throughout each sampling site. Composition and distribution of roots may not directly reflect the above ground vegetation.

The authors caution against ascribing specific ground water nitrate removal rates to different above-ground riparian vegetation types without recognizing the importance of other site differences such as water table dynamics, land use legacy, and adjacent vegetation.

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Denitrification was the primary mechanism for ground water nitrate removal in this study. The study supports previous work demonstrating that patches of organic matter function as hotspots of microbial activity in the subsoil. Riparian zones composed of a mix of forested and mowed vegetation, common in agroforestry and suburban land uses, may remove substantial amounts of ground water nitrates. Reconciling this function with the other less robust functions such as sediment trapping and stream habitat maintenance is an ongoing challenge in riparian buffer zone management.

SEDIMENTS AND RUNOFF

Bisson, P.A. and R.E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. *North Am. J. of Fisheries Management.* 4:371-374.

Some state water quality standards established by the states permit minor increases in suspended sediment when background turbidity is low, allow greater absolute increases as background levels rise, and do not consider acclimation of stream biota to high turbidity. Juvenile coho salmon were subjected to experimentally elevated concentrations of suspended sediments and did not avoid moderate turbidity increases when background levels were low but exhibited significant avoidance when turbidity exceeded a threshold that was relatively high (>70 NTU) and was varied according to previous suspended sediment exposure.

Behavior of coho salmon fell into two categories - normal swimming behavior described as rapid darting movements, huddling, and attempting to hide in corners. The behavior response has been termed "fright huddle" by Mason and Chapman 1965). The authors did not know what elicited the fright response when acclimated to turbid water except to speculate that it was related to the sudden transfer into an environment where cover was lacking (the lab test containers). The study found no evidence of a significant preference for slightly turbid water (10-20 NTU) in any of the experiments, including fish acclimated to 2-15 NTU. In certain stances water having higher turbidity was sought for cover when the fish behavior response was the "fright huddle" position. The study suggests that release of coho fry during stream stocking activities should not take place when streams are carrying a high load of suspended sediment. Clear or slightly turbid water will allow fish time to adjust and raise their tolerance to periodic turbidity increases during storms. The authors also concluded that further testing of controlled, sediment-addition studies in natural streams are needed. Suspended sediment levels described in the state standards have been designed to protect both spawning and rearing periods and are intended to minimize impacts on periphyton and invertebrates. This study indicated that moderate turbidity increases over low background levels may not cause avoidance by juvenile coho salmon.

Alonso, Carlos V., Cesar Mendoza. 1992. Near-bed sediment concentration in gravel-bedded streams. *Am. Geophysical Union. Paper 92WR00915.* 0043-1397/92/92WR-00915. p 2459-2461.

This paper describes an analytical model for the concentration of suspended sediments in the proximity of the bed of gravel rivers. The model is applicable to high-gradient streams carrying sands and finer sediment particles in suspension over poorly sorted gravel beds. The equations were verified using available flume and river data and evaluated their responses for various combinations of bed roughness and suspended load characteristics.

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The results indicate the characterization for the near-bed concentration can be formulated in terms of a velocity defect representation for the mean turbulent velocity profile and sediment eddy diffusivity distribution developed for sand bed rivers.

Dabney, S.M., L.D. Meyer, W.C. Harmon, C.V. Alonso, G.R. Foster. 1995. Depositional patterns of sediment trapped by grass hedges. *Trans. ASAE.* 38(6):1719-1729.

Stiff grass hedges can resist, retard, and disperse concentrated flows of runoff; trap suspended sediment; and reduce ephemeral gully development. Flume experiments were conducted at a 5% grade using four grass species, four types of sediment and eight flow rates ranging from 0.33 to 2.66 m³ / minute - meter. Sediment trapped was initially deposited 1 to 2 meters downslope from a hydraulic jump transition that formed at the upper edge of the backwater. A delta of sediment then grew back toward the hydraulic jump until flow depth became shallow enough that bedload transport was initiated and the delta began to advance toward the grass. A steady state model was developed that underpredicted trapping of fine sediment and overpredicted trapping of coarse sediment in situations where the delta neared the grass.

The mechanisms of settling and filtration cause sediment to be trapped by grass hedges. although filtration is important in the removal of fine sediment grass hedges have relatively large flow spaces and thus filter only large particles such as fibrous plant residues. Settling is the primary mechanism for trapping sediment by grass hedges and most models of sediment trapping by grass strips consider only settling.

Sheridan, J.M., R. Lowrance, D.B. Bosch. 1999. Management effects on runoff and sediment transport in riparian forest buffers. *ASAE.* 42(1):53-64.

The project examined the effect of forest management within a Coastal Plain riparian forest buffer system (RFBS) on runoff and sediment transport over a four year period. The buffer conformed with the USDA Forest Service and USDA natural Resource Conservation Service best management recommendations, included a narrow strip of undisturbed forest located adjacent to the stream drainage system (Zone 1) , a wide managed pine forest downslope from the grass filter (Zone 2), and a narrow grass filter strip immediately downslope from an agricultural field (Zone 3).

To evaluate the effects of forest management within the RFBS, 3 management treatments were imposed within the Zone 2 pine forest. Forest treatments were clear-cutting, selective-thinning, and the mature forest as a reference. All merchantable timber was removed in the clear cut. Thinning treatments were conducted leaving a standing biomass removed from all size classes to target basal area of about 25 square meters per hectare. All woody debris greater than 60 mm diameter was removed during the timber harvest and remaining debris was distributed uniformly by hand. Little or no exposed soil remained in either the clear-cut or thinned plots. Zone 1 was not disturbed during the harvest and the mature forest was left uncut as a reference area.

Rainfall tipping buckets and flow samplers were installed. A total of 24 samplers were installed with two devices located at each zonal interface and at the Zone 2 midpoints for each of the management treatment plots.

Reductions in runoff across the RFBS were significant for all three treatment plots (99% level of confidence). There was less runoff measured on the clear-cut and selectively thinned plots than from the mature forest plot. This was consistent with a previous study that observed that rapid regrowth of herbaceous vegetation occurred within the harvested zones (Lowrance et al 1997).

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There was no evidence of concentrated flow or scour occurring within the grass filter portion of the RFBS over the four year record even for the highest rainfall year which included a 100 year, 24 hour storm event. Routine maintenance of mowing was performed on the site but no other was required over the study time. Even after harvest of Zone 2 forests, no period of recovery for this buffer system function was evident.

In the forest management treatments, sediment concentrations showed significant differences between years for the two upper landscape sampling positions. There were no differences in sediment at the two lower positions between years. When a cropped field was planted in peanuts during 1996 sediment concentrations entering and leaving the grass filter strip were significantly different than for other years. Despite higher field edge sediment loadings through the lower sites sediment concentrations were not significantly different than the other years. Seasonal trends were seen with reductions in sediment concentrations between wet and dry period. These trends were noted across the landscape for all seasons, and when tested by sampling position the loads were not significantly different between seasons.

Overall the study indicates that implementation of recommended forest harvest practices had little impact on the runoff and sediment load reduction function of the RFBS for the Coastal Plain Zone 2 forests.

Pearce, Robert A., Gary W. Frasier, M.J. Trlica, Wayne C. Leininger, John D. Stednick, and James L. Smith . 1998. Sediment filtration in a montane riparian zone under simulated rainfall. *Journal Range Management*. 51:309-304.

Sediment yields, measured at the outlet of small and large plots, did not decrease, or increase, as vegetation heights increased. Accurate prediction of sediment filtration from shallow flow in riparian zones required consideration of a combination of vegetation and soil surface characteristics.

Frasier, Gary W., M.J. Trlica, W.C. Leininger, R.A. Pearce, and A. Fernald. 1998. Runoff from simulated rainfall in 2 montane riparian communities. *Journal Range Management*. 51:315-322.

Riparian ecosystems are the final terrestrial zone before runoff water enters a stream. They provide the last opportunity to decrease nonpoint source pollution delivery to streams by removing sediments from overland water flow from uplands and roads. The study found there were lower equilibrium runoff percentages from dry runs in sedge communities compared to the grass community. The differences were less during wet runs. The organic layer on the soil surface exhibited signs of water repellence that reduced the water infiltration rate during the initial stages of rainfall simulation. These results indicated that runoff and infiltration processes in the surface organic horizon of riparian zones may not respond in the classical manner.

Corley, Carin J., Gary W. Frasier, M.J. Trlica, Freeman M. Smith, and E.M. Taylor, Jr. 1998. Technical Note: Nitrogen and phosphorus in runoff from 2 montane riparian communities. *Journal Range Management*. 52:600-605.

A rainfall simulator was used to evaluate 2 montane riparian communities as filters for removing N and P nutrients from sediment laden overland flow water. Communities were composed of Kentucky bluegrass, tufted hairgrass, water sedge, beaked sedge. There were no consistent differences among specific vegetation height treatments or communities in the removal of N and P nutrients.

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Weltz, Laura, Gary Frasier, and Mark Weltz. 2000 Hydrologic responses of shortgrass prairie ecosystems. *Journal Range Management*. 53:403-409.

Different prairie sites were evaluated to determine the hydrologic similarity within a single ecosystem at widely separated sites. There were no consistent patterns. Soil types showed differences in time-to-peak of the runoff event. Overall the study indicated that easily estimated factors such as biomass, cover and litter were not good indicators of hydrologic function. It is necessary to identify which portion of the runoff event is most important in the assessment. To estimate infiltration rates as a function of cover, biomass, soil properties and to stratify soils into the functional units are needed to accurately estimate runoff rates.

Mergen, D.E., M.J. Trlica, J.L. Smith, and W.H. Blackburn. 2001. Stratification of variability in runoff and sediment yield based on vegetation characteristics. *Journal of Am. Water Res. Assoc.* 37:3:617-628.

Runoff and sediment yield were collected from 100 plots during simulated rainfalls (100mm/hr for 15 minutes). A clustering technique was used to stratify the variability of a single data set within a sagebrush-grass community into four groups based on vegetation life form and amount of cover. The four groups were grass, grass/shrub, shrub, and forb/grass and were found to significantly different in plant height, surface roughness, soil bulk density and soil organic matter.

Runoff was found to be significantly less in forb/grass groups compared with the other vegetation cluster groups, but this was influenced by four plots that produced little or no runoff. Sediment yield was not found to be significantly different among any cluster groups. Discriminant analysis identified important variables and developed a model to classify plots into one of four cluster groups

The study was conducted at Sheep Creek in a temperate mountain zone with summer rainfall events recorded at the study site in 1993 and 1994. Two thunderstorms that produced more than 25 mm of precipitation occurred and events that produce more than 25 mm of rainfall are infrequent event in the study area, they produce runoff and sediment that can enter the creek.

Soil variables such as soil moisture content, soil organic matter, and silt content were found to be somewhat important. Surface cover variables explained 5 to 28% of the variability in sediment yield, whereas soil characteristics explained from 18 to 34% of the variation in sediment yield.

Davis, J.G., K.V. Iversen, and M.F. Vigil. 2002. Nutrient variability in manures: Implications for sampling and regional database creation. *J. Soil and Water Conservation*. 57:6: 473-478.

The variability of manure nutrient levels within and across farms makes manure sampling and development of reliable tabular values challenging. The chemical characteristics of beef, dairy, horse sheep and chicken solid manures in Colorado were evaluated by sampling six to ten different livestock operations for each manure type and comparing the results to values found in the literature. On average, about 25 sub-samples are necessary for nitrogen, phosphorus, and potassium characterization of solid manures, but determining ammonium and nitrate concentrations requires over 100 sub samples to form a representative sample, due to their relatively low concentrations.

Wu, J., W. Mesie, A. Atalay, and C.A. Seybold. 2003. Copper retention from runoff by switchgrass and tall fescue filter strips. *J. Soil and Water Conservation*. 58:1: 67-72. Vegetative filter strips are recommended to reduce the load of agricultural chemicals in surface

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runoff. Quantitative data however, is still needed on the performance of various grass species in filter strips and the effectiveness under different runoff flow rates. A study was conducted to compare the effectiveness of switchgrass and tall fescue filter strips in removing dissolved copper pesticide from runoff flowing at 2.7 L (0.7 gallon min) or 6 L (1.6 gallon min) over 0.9 m (3 ft) soil surface area. Runoff was simulated by applying 82 L (22 gallons) solutions containing 6.9 mg L (6.9 ppm) Copper (Cu) on aluminum tilted beds set at 3% slope, filled with Bojac soil, and planted to switchgrass or tall fescue.

Kucharik, C.M., J.A. Roth, R.T. Nabieiski. 2003. Statistical assessment of a paired-site approach for verification of carbon and nitrogen sequestration on Wisconsin Conservation Reserve Program land. *J. Soil and Water Conservation*. 58:1: 58-66.

The threat of global climate change has provoked policy makers to consider plausible strategies to slow the accumulation of greenhouse gasses especially carbon dioxide (CO₂) in the atmosphere. One such idea involves the sequestration of atmospheric carbon (C) in degraded agriculture soils as part of the Conservation Reserve Program. In this study 14 paired CRP and cropland sites in Dane County, WI were used to assess whether a paired site sampling design could detect statistically significant differences (ANOVA) in mean soil organic C and total nitrogen N storage. Soil bulk density and sampled soils at different depths were compared for textural differences and chemical analysis of organic matter, soil organic C and total N and pH. The CRP contributed to reducing soil bulk density by 13% and increased soil organic C and organic matter storage. The study tested the statistical power associated with ANOVA for measured soil properties and calculated minimum detectable differences. 40 to 60 paired sites and soil sampling in 5 cm (2 inch) increments near the surface were needed to achieve an 80% confidence level in soil C and N sequestration rates.

Because soil C and total N storage was highly variable among these sites only a 23% to 29% change in existing total organic C and N pools could be reliably detected. The study concluded that usage of statistical power analysis is essential to insure a high level of confidence in soil C and N sequestration rates that are quantified using paired plots. The study design did not statistically support the desired 80% confidence level.

Lee, K.H., T.M. Isenhardt, and R.C. Schultz. 2003 Sediment and nutrient removal in an established multi-species riparian buffer. *J. Soil and Water Conservation*. 58:1: 1-7.

Riparian buffers are widely recommended as a tool for removing nonpoint source pollutants from agricultural areas especially those carried by surface runoff. A field plot study was conducted to determine the effectiveness of an established multi-species buffer in trapping sediment, nitrogen, and phosphorus from cropland runoff during natural rainfall events. Triplicate plots were installed in a previously established buffer with a cropland source area paired with either no buffer, switchgrass buffer, or a switchgrass/woody buffer. The switchgrass buffer removed 95% of the sediment 80% of the total nitrogen, 62% of the nitrate nitrogen, 78% of the total phosphorus and 58% of the phosphate phosphorus. The switchgrass/woody buffer removed 97% of the sediment, 94% of the total N and 85% of the nitrate nitrogen and 80% of the phosphate. The 23 ft switchgrass buffer was effective in removing sediment and sediment bound nutrients and the added width of 53 feet switchgrass/woody buffer increased the removal efficiency of soluble nutrients by over 20%.

Riparian Communities and Large Woody Debris

Williams, Philip B. and Mitchell L. Swanson. 1989. A new approach to flood protection design and riparian management. USDA Forest Service Gen. Tech. Rep. PSW-110.

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Maintenance programs to improve flood conveyance and enhance levee stability such as clearing riparian vegetation in channels and on levees undergo little if any technical scrutiny. Such programs are prescriptive rather than based on actual performance standards. A multi objective hydrologic geomorphic and biologic approach is presented to consider factors that influence stream hydraulics. A failure to account for debris indicated that floods can carry large amounts of debris such as up-rooted vegetation and trees, fences, and parts of structures. Such items on smaller streams combined with sediment impedes and blocks hydraulic efficiency of small to medium size culverts. Bridges can also be obstructed causing increases in flood elevations upstream. The rise in water surface elevation due to backwater from an obstructed bridge can greatly exceed the reduction in water surface elevation due to stream channelization which can direct the main flood flow out of the channel.

Buer, Koll, Dave Forwalter, Mike Kissel, and Bill Stohler. 1989. The middle Sacramento River: human impacts on physical and ecological processes along a meandering river. USDA Forest Service Gen. Tech. Rep PSW-110.

The Dept. of Water Resources, monitored changes in the river using old survey maps, aerial photographs and field surveys. Studies indicate that bank protection had significantly reduced a source of salmon spawning gravel from freshly eroded banks and over time decreased the number of preferred spawning areas such as point bar riffles, chute, cutoffs, multiple channel areas, and areas near islands. Bank protection also increases the tendency of the confined river to deepen and narrow, further reducing spawning habitat. Flood control has interrupted the natural equilibrium between erosion and deposition, resulting in reduction in bank erosion rates and in over bank sediment deposition. Solutions to these problems will require a comprehensive river management program that incorporates the natural processes of meandering and bank erosion. The study makes the conclusion that floodplain deposition replaces silt lost by bank erosion. The study helps determine if the system is in balance. Bank erosion is necessary to maintain riparian succession, anadromous fish and wildlife habitat in the reach. Bank protection will have several negative effects since over 85 percent of the gravel provided to a river comes from bank erosion, it will prevent the recruitment of gravel to salmon spawning areas if banks are protected. Although the study was made regarding flood control structures, it has implications about discerning the contribution of natural bank erosion in a healthy, functioning stream system.

Beechie, T. E. Beamer, and L. Wassermann. 1994. Estimating coho salmon rearing Habitat and Smolt Production Losses in a Large River Basin, and Implications for Habitat Restoration. N.Am. J. of Fisheries Management 14:797-811.

Habitat types were identified based on 6 types found during field surveys, topographic maps, and the national Wetlands Inventory maps. The study assumed that a historical perspective was deemed crucial to the identification of attainable and feasible goals in habitat restoration and they assessed loss and degradation of summer and winter rearing habitats for coho salmon throughout the Skagit River basin. The investigators focused specifically on losses of physical rearing habitats and did not address spawning or other issues. They estimated the magnitude of loss habitat areas and coho salmon smolt production from each habitat type and related the magnitude of the habitat loss to broad categories of land ownership and types of impacts. They attempted to also quantify the amounts of summer and rearing habitat available in the basin and to identify critical elements and assumptions of limiting factors analysis for the salmon in the basin.

The Skagit basin has an area of 8,270 sq. km. Small tributaries were defined as streams with average summer wetted widths less than 6m and were classified based on topographic gradients of less than 2% or 2-4%. Side channels were described as branching from the mainstem typically

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abandoned river channels or overflow channels and further described them based on 90% having pools (sloughs). Channels with greater than 6m were classified as large tributaries. Lakes and ponds were arbitrarily distinguished according to size. Ponds have a surface area less than 5 ha and lakes had a surface area of 5 ha or more.

Quantification of the area of habitat in each of the units as well as rearing density and survival to smoltification was generated based on mapping techniques and appear to have been lifted out of articles published as Reeves et al (1989) as well as personal communication and unpublished data by Beechie and T. Sibley.

While no water temperature data was collected nor was the investigation focused on water temperature issues as stated in the introduction, a discussion of winter water temperatures in the Skagit basin was provided. Speculation was given as to the importance of the winter temperature influences used in the Reeves et al (1989) smolt production model, and presented but offered no identification of where the water temperature numbers were found nor how they were used in the overall final conclusions.

The authors suggested that their assessment used pool areas above 50 % for the basin as a whole, but that it would be more appropriate to evaluate the entire basin as a set of the interconnected sub basins. The statements were made in the discussion of the assumptions used regarding temperature and pools. It is unclear where this fits into the topic of estimating rearing habitat.

Smolt production estimate was made at a scoop trap nearby in 1990 and 1992. The data were compared to that in Reeves et al (1989) which estimated that slough areas should produce 0.4 smolts/m² to 0.8 during summer and winter respectively. The trap numbers were higher than Reeves et al (1989) (0.4 - 1.31m⁻²) and the authors state they accepted the Reeves et al (1989) estimates. The authors could not fully estimate the losses in habitat or smolt production from the mainstem river areas because coho salmon use of large rivers is not known reliably. However, through citations of various materials the authors selected to use 600 smolts / km to be appropriate for the river basin.

In conclusions the authors stated that the estimated reductions in coho salmon smolt production provide a clear indication of where efforts should be expended for habitat restoration and the largest benefits can be gained by restoring side channel and slough habitats. They suggest that their analysis provides a basis for pursuing restoration of habitats through culvert improvements.

Beechie, T.J., T.H. Sibley. 1997. Relationships between channels characteristics, woody debris, and fish habitat of Northwestern Washington streams. *Trans. Am. Fish. Soc.* 126:217-229. Regression analysis showed correlation between pool spacing and percent pools in the study area and by a surrogate term suggested that LWD abundance and channel slope influence pool formation changes with channel slope. They also suggest that low slope channels are less sensitive to LWD abundance because pools are formed by mechanisms other than LWD when LWD abundance is low. Streambed particles sizes were also addressed.

Twenty eight sites were located in four major watersheds of the North Cascades and Puget sound. The surveys focused on low gradient (<.04%) stream reaches as the common habitat for anadromous salmonids and were on channel widths less than 20m.

The authors state that the regression equations are only good on the study streams under the study conditions. There is no relationship between the interaction slope, LWD and pool area. The studied opted to use the slope-LWD interaction term as appropriate of the relationship between

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channel slope and width, LWD abundance and pool area. No relationship was found between gravel and LWD abundance. Problems in data collection using ocular measurements in identifying LWD pieces caused few actual samples to be collected than needed for the study. Also, ocular estimations contain an error for sampling bias. This likely caused the discussions to revolve around "probable" occurrences.

Management implications are discussed as possibilities. The authors state that studies of logging scenarios with decreased LWD abundance and reductions in number and area of pools "may affect" juvenile Salmonid abundance or species age-class distribution. The authors speculate on what they expect and provide an example of a riparian forest thinning "may benefit" larger streams and may take 75 years or more to begin recruiting LWD of pool forming size.

Wallerstein, N.P., C. Alonso, S.J. Bennett, C.R. Throne. 2001. Froude-scaled flume analysis of large woody debris. *Earth Surf Process. Landforms* 26: 1265-1283

This paper presents the results of a movable-boundary, distorted, Froude scaled hydraulic model. The model was used to examine the geomorphic and hydraulic impact of simplified large woody debris (LWD) elements. The channel model had bed and banks molded from 0.8mm sand and flow conditions were just below the threshold of motion so that any sediment transport and channel adjustments were the result of the debris element.

Field investigation in northern Mississippi has shown that streams are actively eroding their channel banks, introducing into the channel large numbers of fallen trees. These trees have been observed to accumulate at specific locations within the streams, thus causing an accumulation of large woody debris (LWD) and LWD jams. Jams generally form around a triggering element such as a large tree and they either grow over time as smaller debris piles up against the jam or become smaller as the jam breaks down through decay and dislodgment of its elements. It is difficult to separate cause and effect when assessing the actual geomorphic impacts of LWD. A flume model offers an excellent opportunity to determine more accurately the hydraulic forces exerted upon LWD elements and the geomorphic effects of LWD.

LWD can affect the direction and magnitude of the stream flow, and it can significantly increase river stage and channel geometry. Yet in an evolving stream system, it is difficult to separate a river's response to LWD from other possible causes such as channel straightening, bank stabilization, and anthropogenic effects. Thus a flume model study was constructed to examine the effects LWD can have on river flow processes. Using Abiaca Creek, Mississippi as the field case, an experimental model was constructed, and simple cylinders were used to simulate trees that have fallen into the creek.

As the debris elements neared the water surface, the drag forces acting on the elements increased dramatically due to the effects of wave formation. The velocity around an element decreased with time as the channel widened and deepened due to flow constriction and diversion, and channel erosion also caused the formation of new sediment accumulations downstream. Alluvial channel response within each experiment was relatively short, and these experimental results agreed well with observations within Abiaca creek. This new knowledge will enable action agencies to develop better tools to assess the impact of LWD accumulations on river flow conveyance and flood risk potential.

The results show that LWD has a distinct geomorphic impact upon highly erodible channels, causing both bed scour and bank erosion and the formation of mid-channel, lateral, alternate bars and pool-riffle formations. This finding highlights the need to differentiate the local impact of

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LWD formations from geomorphic processes acting at the river-basin scale, such as degradation. It should be noted, however, that extremely large debris rafts can have geomorphological impacts at larger scale than was represented in the model.

Hydraulic modeling can aid in determining cause and effect in the geomorphic evaluation of stream corridors impacted by LWD. The geomorphic results demonstrate that, while debris may be trapped by high points in the channel bed topography, it will also create a distinctive set of geomorphic features regardless of preexisting channel forms if the channel boundary can be eroded. The channel became progressively less disturbed with distance downstream from each element.

SUMMARY OF FISH BIOLOGY STUDIES

Literature reviews are useful to develop a foundation on specific topics of interest, but do not meet the criteria for "best available science". Reviews often do not include discussion about whether papers include methods, data collections, and the quantitative analysis required for BAS. The reviews present narratives across many topics to support what the authors intend to point out. If follow up isn't made to track and read the cited paper, literature reviews are of little value.

As an example, some of the cited and popular papers of today including literature reviews, regarding fisheries and stream temperature, do not use any criteria for "best available science". Many articles address buffers, how wide they should be, what their composition should be, and what plant species are important in river basins to prevent harm to the fish, using citations and appeals that are merely narratives themselves. The papers are topical or are studies addressing unrelated topics with insertions of a vast array of speculative statements in an attempt to link cause and effect. As an example there are no experimentally designed papers that give recommendations for 50 foot of trees and 25' of grass as a fenced buffer to improve water temperatures for aquatic life. These dimensions as well as most others are meaningless. To design an experiment that would link buffers to fish survival would be costly, time consuming, and possibly fruitless in the end. Prescriptions for plant communities are usually made on a site specific basis for specific purposes. Distinct science disciplines are needed to address the question: **What water temperatures are important to salmon, and when are water temperatures critical for their survival?**

The disciplines would include: fish physiology, water science, and plant physiology as well as silviculture practices, and livestock grazing impacts (if the area is to be fenced from all uses).

Brett in 1952 addressed a question about water temperatures needed for salmon before death when they were 2 months old. The ultimate upper lethal temperatures for each species were: spring 25.1 °C, coho - 25.0, sockeye - 24.4 C, pink - 23.9C, chum - 23.8C. These upper lethal temperatures were established by running the experiment in a tank in a lab while holding the fish for many hours without fluctuating the water temperatures.

The test posed the question: how long does it take for the 5 different species to die when held at a constant temperature under lab conditions? The test does not establish a threshold temperature expected in natural streams for all life stages. The experiment was established to address conditions for hatcheries rather than natural events in a watershed and addressed on 2-4 month old fish that had emerged from the eggs (January - March time period when referencing a natural stream system and life stage).

Combs conducted similar investigations using the newly emerged salmon. It is important to note that newly emerged salmon at 2-4 months old are in a stream during the January-April months.

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They are not instream during July and August when stream temperatures in the Pacific Northwest are above the generally repeated numerical threshold of 64°F.

The significance of Combs (1965) can not be overlooked. Mortality patterns and time of mortality were related to temperature increases as evidenced by high egg mortality occurring at the warmest temperatures. Mortality occurred primarily during a critical transition period at commencement of the active feeding stage. Once feeding, the fry mortalities decreased and remained low. The “warmest temperatures” were not summer temperatures but were expected winter to spring temperatures. Also, the temperatures were only relevant at a specific point in the embryonic development and not mortality of the salmon at all other ages.

Juvenile salmon of most species are 6 months and older during July and August. At this age, there are other questions about how the fish survives. The important questions for July and August periods center more on rearing temperatures, feeding opportunities, and predation. Brett in 1971 stated: both the prey of sockeye and the predators of sockeye are in a dynamic state of balance with their total environment while a major force in the evolving diurnal patterns are attributed to the energetic.

In 1977 trout were tested to determine if they preferred certain temperatures at 15 months old that differed from their body temperature after being acclimated to a specific temperature. The tested temperature range was 41°F to 77°F. Preferred temperature of the fish did not change more than 3-4 °C (5.4-7.2 °F) over a range of acclimation temperature. No significant differences were found in preferred temperature over the acclimation range studied.

The study by McCauley et al builds on the information provided by Bret and Combs for a different stage of life. At 15 months fish are migrating out of streams and they experience a variety of temperature regimes as they move from natal streams to the ocean.

Cherry et al (1977) studied avoidance temperatures of 15 fish species. They found that upper avoidance of fish tested at high acclimation temperatures between 30° and 36°C (86°F to 96.8 °F), either equaled or exceeded a 7 day upper lethal temperature limit of the species when tested at acclimation. Fish tended to avoid temperatures that increased when they were held in a higher acclimation environment where these temperature increased.

In this project avoidance only occurred above a 3°C (5.4 °F) increment increase which did not confirm Cherry's earlier 1975 study where the significant increment avoidance were 1°C (1.8 °F). Hicks et al (1991) wrote about evidence in studies which showed that stream side management zones minimize damage to habitat. The consistency was variable over time and places.

A study by Bilby and Bisson (1987) also indicated conflicting evidence of the benefits of stream side areas that are vegetated versus those that are not. Bilby and Bisson is further discussed in another section.

Anyone attempting to justify habitat requirements through published literature using studies that are not properly designed to address the specific question without using the criteria for “best available science” (provided in the Introduction) will likely make costly decisions that could be expensive for society and harmful to the aquatic life intended to be helped. Wildlife studies and experiments often lack a proper approach to data collection and then analysis. Many popular articles cited in reports and documents either speculate about links between salmon and habitat or do not fully analyze data in order to be able draw the conclusions that are made. Ultimately the published articles state an outcome that has not been examined and when the outcomes are restated in an appeal to authority by others, the errors become compounded and distorted.

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In Poe et al (1991) and Tabor et al (1993) a study was conducted to examine predation of salmon by other species of fish that occupy the same streams as the salmon. Authors often fail to discuss salmon and population declines in terms of the mortality due to predation by other fish species. Fish populations would be expected to have a natural population cycle that changes from high to low. Northern squawfish and smallmouth bass live in streams with salmon and take advantage of a plentiful food supply when the salmon smolts traverse their territories headed to the ocean.

Salmon losses due to predation by other fish species and other wildlife is rarely discussed when papers speculate on the causes of salmon declines. There are many predators within the salmon's water habitat as well as predators near the habitat edges. Habitat should be studied in the overall picture based on how many fish are in fact dead, injured, or harmed by the habitat itself or by predators associated with the habitat. The physical and chemical parameters of the salmon habitats must be separated from death, injury, or harm from natural predation.

Scriener et al (1994) studied salmon densities in a tributary of the Fraser River in Canada. This publication is of interest simply because the authors were able to observe fish moving into and out of the tributary. The fish took advantage of the stream for feeding and the water conditions while the larger Fraser River was experiencing the seasonal adjustments between the seasons of winter- spring and spring-summer.

In 1995 (40 years after the Bret (1952) study) Konecki et al posed the hypothesis, that a salmon group from a stream with lower and less variable temperatures would have a lower and less variable preferred temperature than a group from a stream with warmer and more variable temperatures. Bockman Creek which has flows derived from snowpack and were identified as being strongly influenced by local air temperatures. Bingham Ck. a tributary of the Chehalis river was described as a thermally buffered stream by groundwater inputs. Stock from these streams were used in the study.

Konecki et al (1995) also reported a study that investigated the critical thermal maximum (CTMs) for salmon. Tolerances varied among the populations and exceeded published data from some laboratory tests. After the salmon had been in the lab for 3 months under constant, common temperature regimes, the CTMs no longer differed, indicating that the population specific differences resulted from different acclimation regimes rather from genetic adaptations. This is an important concept as the literature often discusses the salmon species in terms of their genetic requirements for a specific water temperature threshold.

Dockray et al (1999) tested juvenile rainbow trout under conditions of a limited ration, low pH water and temperature increases. The study measured the metabolic and physiological response of the trout to changes in the control conditions. The study results describe the rainbow trout physiologic changes in terms of being able to compensate for low pH levels and increasing water temperatures if the fish is limited by food intake versus a trout response when the fish has a normal diet. This study makes no claim that humans therefore must control water temperatures and relies on the information of the study to report how the trout make metabolic changes to a changing environment.

Ingraham (1998) and Kaczynski (1998) both address the influences of the ocean conditions on the survival of salmon. Considering that salmon spend the majority of the life in the ocean and that the ocean climate influences the land climate, it is appropriate if not critical to examine these papers. The ocean influences on our lives can often be a challenge to our personal habitats when flooding and blizzard events take place. We are influenced a great deal by the interaction of the ocean and

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land mass as climate develops across the topography. The salmon species spends most of its life in the ocean environment and these papers are important contributions to the literature and knowledge about the salmon populations.

Each of the articles reviewed are studies that meet the criteria for “best available science” using criteria 1-6. The limited number of reviewed articles presented in no way indicates that they are the only articles read. These were selected from over 75 reviewed papers written and used as appeals to authority often used as references to facts regarding salmon requirements.

These selected few are important “best available science” to the fundamentals of salmon tolerances of warm water. None of the studies published after Bret 1952 contradicted his work. The work stands. Salmon emerging from the egg state are sensitive to temperatures more at a developmental stage than after emerging and feeding starts. Temperature variations likely do occur in natural settings, but an estimate of what ranges the fish responded to in 1952 are acceptable today.

There is no connection though between the life stage described by Bret and the requirements of salmon during the summer months. The fish were not at summertime rearing sizes nor were they present in streams ready for spawning. The test was investigating hatching temperatures for hatcheries and to add to the knowledge base about fish at that time. In 1995 Konecki increased our understanding of the difference between a genetic and an adaptive response to the temperatures. Science (best science) is progressed when a study is published and someone at a later time demonstrates through a second experiment whether the first was confirmed or found to contain an error. The studies presented have not been repeated with new results to establish a theory on fish mortality due to temperatures preferred by salmon up to approximately 4 months old. Salmon during summertime months are not sensitive to these same stream conditions identified as lethal to eggs and newly hatched juveniles, because the salmon in July and August are beyond the age limit when these temperatures are critical.

Fish Literature

Brett, J.R. 1952. Temperature tolerance in young Pacific salmon, genus *Oncorhynchus*. J. Fish Res. Bp. Can. 9(6), 1952.

In 1952 a laboratory study was conducted to assess the lethal limits of high and low temperatures for 5 species of Pacific salmon, the spring (*Oncorhynchus tshawytscha*), pink (*O. goriscus*), the sockeye (*O. nerka*), the chum (*O. keta*) and the coho (*O. kisutch*). Brett cited a study reported in Fry, 1947 that concluded the existence of a known upper and lower limit of temperature tolerance in fish that is extended through adaptation as well as resistance either separately or collectively to distinguish the fish species.

Brett reports that five species of Pacific salmon common the west coast were obtained as eyed eggs from three hatcheries in Washington and British Columbia, Canada. A transition from alevin to free-swimming, feeding fry included feeding which had to be encouraged by frequent presentation of small particles of food. The feeding was made of finely ground beef or hog liver, four times daily over periods of 15-20 minutes. The diet was a modification of a 1948 study which used 50 percent beef or hog liver together with 48 per cent ground “fish pack” (haddock and cod fillet waste) and 2 percent yeast through the second month.

The mortality in the stock tanks holding the fish had a constant temperature of 8.8 ± 0.2 °C (48.8 °F). At temperatures above 20°C Bret observed mortality rates of up to 5% mortality, and in two cases disease became significant with one group experiencing an apparent inability to derive

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nutrition from their diet at temperatures increased by increments up to 24°C.

The pH of the well water used to supply the lab tanks was 7.3 with total solids amounting to 254.3 parts per million. The study was conducted on fish 3 months after hatching and was continued for an additional two to three months. When tanks were loaded with the maximum number of fish (4) the oxygen concentrations were never reduced below 93% saturation. The tanks were 36 inches high, 36 inches in length, and 20 inches wide.

200 young spring chinook were held in troughs kept at a constant temperature. There were no significant losses in troughs of 24°C at which temperature they proved to be very active and to be good feeders, but had reduced growth rates when compared to groups in lower temperature. As a result, the constant 24°C was used as a standard to test the tolerance of the other species. Most species in 40% of the cases curtailed feeding and activity was reduced.

Mortality was tested on fish held at the constant high temperatures over 3.5 days or 5000 minutes. Brett discusses "lethal" temperature as the temperature at which 50% of the population is dead after indefinite exposure. His study observed that the duration can be as long as a 7 day period used for Pacific salmon and that it varies for different species and different acclimation. He distinguishes between a zone of resistance and a zone of tolerance.

Brett states that at each lethal level of temperature there is a characteristic rate of dying which may be influenced within limits by acclimation. He notes that in this study that the results apply to the stocks of salmon from which the eggs were collected which may be traced back to a comparatively few females. The possibility of variation both within and between local stocks cannot be disregarded.

Summary of findings:

1. No significant difference in response to upper lethal levels of temperature exists between spring and coho salmon.
2. Spring and coho salmon show a highly significant difference ($p > 0.01$) from that of sockeye, pink or chum there is a very highly significant linear fit of the logarithmic relation for data (log of the median time to death in relation to the temperature causing that death).
3. The slope of the lines relating log resistance time to temperature for the five species are not significantly different.
4. The ultimate upper lethal temperatures for each species were: spring 25.1 °C (77.2°F), coho - 25.0 (77 °F), sockeye - 24.4 C (75.9 °F), pink - 23.9 C (75 °F), chum - 23.8 C (74.8 °F).
5. An initial period of rapidly increasing resistance to low temperature was followed by relatively little change in resistance for 2 or 3 degrees (3.6 - 5.4 °F) increase in temperature (15-23°C) (59-73.4 °F) acclimation.
6. Mixed responses were noted in the lethal baths from acclimation temperature of 20°C (68 °F). A rapid death of all fish occurred at the lowest temperatures.

Temperatures slightly above 20°C (68 °F) caused rapid death in part of the sample followed by a long delay and then death of the remainder.

Temperatures somewhat higher, yet still low enough to cause death, did so only after prolonged exposure.

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The zones of thermal tolerance were determined and indicated that the high degree of sensitivity to low temperatures resulted in a comparatively low thermal tolerance rating. The spring and coho were almost identical, next sockeye, followed by the chum.

An intolerance to low temperatures particularly restricts Pacific salmon in their biokinetic range. For prolonged exposure up to one week to high temperatures, the spring and coho salmon were most resistant, the sockeye intermediate and the pink and chum salmon least resistant. These differences are in keeping with taxonomic conclusions and certain ecological distinctions.

Combs, Bobby D., R.E. Burrows. 1957. Threshold temperatures for the normal development of chinook salmon eggs. *The Progressive Fish-culturist*. 19:1:3-6. Combs and Burrows studied spring chinook salmon eggs during 1952-1956. The study related three but separate experiments were included in the study. The first tested high temperatures ranges, the second low range temperatures, and the third was designed to duplicate the middle range of temperatures tested in the two previous trials. The experiments were designed to test the effect of constant incubating temperatures on the development of chinook salmon eggs.

Eggs from the Entiat River salmon stock were incubated at constant temperatures of 35°F, 50, 55, 57.5, and 60°F. Complete mortality occurred in the 35°F lot which set 35 °F as the lower limit for future experiments. In 1953-54 two races of chinook salmon eggs (Skagit and Entiat River) were subjected to constant temperatures of 35, 37.5, 40, 42.5 and 45 °F. Again complete mortality occurred in the 35°F lot. Mortality was significantly higher in the 37.5 and 40°F than in the 42.5 and 45°F lots. The lower threshold temperature of normal development was established at a level of 40 to 42.5. The threshold temperature was the same for both reaches of chinook salmon. The Skagit eggs showed less mortality as a group when compared to the Entiat eggs, the significant difference between losses within both groups occurred between those incubated at 40 and those at 42.5°F.

During the 1955-1956 experiment which duplicated the middle range of temperatures tested in previous experiments confirmed that there was a significant difference between the lots incubated at 40°F and 42.5°F reaffirming the range as the lower threshold.

The established ranges in these experiments are for normal development and applies only to constant temperatures. The study found that the stage in development of the eggs when subjected to temperatures outside the range is more important than temperature alone.

Other results were that the pink and chinook salmon eggs could tolerate long periods of very low temperatures if the initial incubation temperature was above 42°F for a month. The cause of death due to adverse temperatures may be lack of coordination between growth and organic differentiation within the embryo or dislocations in the order of differentiation.

Combs, Bobby D. 1965. Effect of temperature on the development of salmon eggs. *Progressive Fish Culturist*. 134-137.

Combs conducted a study on the development of salmon eggs which concluded that sockeye eggs would tolerate water at a temperature of 35°F if they had developed beyond the 128-cell stage. He emphasized that the results of the threshold temperature experiments were derived from constant incubating temperatures. The conditions imposed on the salmon eggs would rarely be duplicated either in nature or in artificial propagation procedures at hatcheries. Combs referenced a study on the Fraser River of sockeye salmon indicating that if spawning conditions included abnormally high water temperatures due to the temporary and local conditions mortality of the unspawned adult

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sockeye was extensive. Fish that did survive to spawn at temperatures above 55°F incurred higher than normal losses.

Also noted was a study by Burrows (1960) on late spawning chinook salmon at the Entiat station study a race of chinook which normally spawned in the main Columbia River or lower reaches of large tributaries in October and November while in water above 40°F. At the Entiat holding pond, the water temperature abruptly dropped below 40°F early in November causing the female chinook salmon to lose inclination to spawn naturally. Using spring water at a favorable temperature excellent spawning and egg mortality were observed.

1. Combs results indicated that the lower temperature threshold for the normal development of sockeye salmon eggs was established as between 40 and 42.5°F.
2. The upper threshold temperature for sockeye salmon eggs occurred between 55°F and 57.5°F.
3. Chinook salmon eggs which had developed to the 128-cell stage in 42.5°F water could tolerate water at 35°F for the remainder of the incubation period. The 128-cell stage was attained in 144 hours of incubation. Sockeye salmon eggs reached the 128-cell stage in 72 hours, at 42.5°F but required an additional 24 hours of development at that temperature before they could withstand 35°F water.

Olson, P.A., R.E. Nakatani, and T. Meekin. 1970 Effects of thermal increments on eggs and young of Columbia River Fall Chinook. Battelle memorial Institute. USACE. Seattle, WA.

The Fisheries research Institute, University of Washington in Seattle and the Washington State Department of Fisheries in Olympia contracted with the Battelle Memorial Institute to study and determine more precisely the temperature response of eggs and young derived from local chinook salmon to different heat increments. The thermal effects were defined in terms of mortality and growth of developmental stages. The results provided biological data required for comprehensive guidelines to determine permissible standards for the addition of heat to the Columbia River water during fall, winter, and spring without significant damage to reproductive success of adult chinook. The population of salmon tested were *Onchorhynchus tshawytscha* which spawns each fall in the Priest rapids- Hanford section of the Columbia river, south-central Washington.

The study was conducted over 177 days using four series of spawn. Seven temperature increments differing by intervals of about 2°F were used which encompassed a test range of 12°F. Rearing temperatures paralleled the Columbia's normal seasonal pattern where the coldest test temperatures approximated the mean river temperature.

Due to falling river temperatures after the start of the experiment, successively later series tolerated greater thermal increments. Temperature of 7.0°F in excess of the base river temperatures resulted in large mortalities in the spawned salmon of Oct. 30 and 12.0°F resulted in a total mortality. However, a 12.5°F increment above the base river temperatures in salmon spawned at the December 8 date, had a mortality of only 12.4%. This was within the normal hatchery production.

Mortality patterns and time of mortality were related to temperature increases as evidenced by high egg mortality occurring at the warmest temperatures but when there was considerable embryonic development and deaths just prior to hatching. The increased losses occurred primarily during the critical transition period at commencement of active feeding. Once feeding the fry mortalities decreased and remained low.

Increased temperatures increased growth with fish in the warmest lots 8 times heavier than those in

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the coldest lot when exposed to similar thermal units at the conclusion of rearing. The study concluded that the developmental stages of fall chinook can safely withstand greater thermal additions during winter when temperatures are low. It also suggested that elevated temperatures would favor egg and fry survival of late spawners over those of earlier spawners when spawning temperatures were higher.

Brett, J.R. 1971. Energetic Responses of Salmon to Temperature. A Study of Some thermal Relations in the Physiology and freshwater Ecology of Sockeye Salmon (*Oncorhynchus nerka*). *Am.m. Zoologist*, 11:99-113.

Brett published a review of literature in 1971 on the relation of temperature tolerance, preference, metabolic rate performance, circulation, and growth of sockeye salmon. The author stated that most studies pointed to a physiological optimum in the region of 15°C (59 °F) for the young sockeye salmon during lake residence. Their natural occurrence is limited in time and space at temperatures above 18°C (64.4 °F) despite being able to tolerate 24°C (75.2 °F). Forms of physiological inadequacy can be demonstrated which account for restrictions in distribution.

In concluding comments Brett states that 15°C (59 °F) derived from physiological studies remains a very meaningful parameter for performance, metabolic rate, and cardiac function of sockeye. Sustained performance can confidently be expected to be maximum in the vicinity of 15°C (59 °F) no matter where the animal is. The field condition that dictated much of the energetic physiology of young sockeye was restricted rations. Few experiments had been performed where the biotic factor of ration had been coupled with the abiotic variable such as temperature (or light or salinity). The work concluded that it is the retention of a high food conversion efficiency over the full range of daily temperatures experienced which becomes most meaningful. He also observed that both the prey of sockeye and the predators of sockeye are in a dynamic state of balance with their total environment while a major force in the evolving diurnal patterns are attributed to the energetics. Pacific Northwest salmon rely on many interwoven factors to maintain their health, well being, population, and distribution. Abnormal conditions in a fish's environment may elicit a stress response. If a fish is already responding to one stressor, it is less likely to withstand another. Temperature can be a biological, physical, or chemical stressor. Biologically, temperature affects the metabolism of fish and their ability to resist disease. Physically, temperature affects properties of water and fishes' tolerance to suspended sediment. Chemically, temperature can change the concentration of substances in water and reduce a fish's ability to withstand chemical exposure. Not all these relationships are well understood.

A wide range of biological, chemical, and physical factors can challenge the physiological systems of fish. Thus, the success of fish and fish populations in acclimating to environmental changes depends on the compensatory abilities of individual organisms. To persist and ultimately reproduce, fish need to perform such necessary activities as obtaining oxygen, swimming, metabolizing, and resisting pathogens.

Cherry, D.S., K.L. Dickson, J.Cairns JR. 1977. Preferred, avoided, and lethal temperatures of fish during rising temperature conditions. *J. Fish Res.Board Can.* 34:239-246.

Fifteen fish species were tested in a laboratory acclimated to 3°C increments between 12 and 27°C and showed preferences that exceeded their acclimation temperatures except for the telescope shiner, yellow perch, rainbow trout, brown trout, and brook trout. At 30,33, or 36°C acclimation, preferred temperatures were less than the acclimation temperature. The highest temperature preferences were at acclamations of 27, 30 and 33°C (80.6°F, 86.0°F, and 91.4 °F). Bluegill, spotted bass, rockbass, and spotfin shiner consistently selected the highest temperatures while the

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lowest temperatures were preferred by the Salmonids. Final temperature preferences were less than 19°C (66.2 °F) for the trout species tested.

Preferred temperatures changed with the changes in season from winter to summer. The upper limit for temperatures that the fish avoided increased as their acclimation temperatures increased. Fish temperature responses are dependent upon their thermal history and some of the species tested have adapted to the thermal regimes resulting from the operation of power plants such as one located in South Carolina that had been in existence for 56 years.

Avoidance temperatures increased as acclimation temperature increased.

Upper avoidance's tested at high acclimation temperatures between 30° and 36°C either equaled or exceeded a 7 day upper lethal temperature limit of the species when tested at acclimation.

In this project avoidance's only occurred above a 3°C (5.4°F) increment increase which did not confirm Cherry's earlier 1975 study where the significant increment avoidance's were 1°C (1.8°F). Mortality did occur and absolute avoidance's were slightly lower than the statistical avoidance ranges.

McCauley RW, Elliot JR, L.A.A. Read. 1977. Influence of acclimation temperature on preferred temperature of rainbow trout, *Salmo gairdneri*. *Trans Am Fish Soc* 106:362-365.

The relation of preferred temperature to acclimation temperature of 29 rainbow trout 15 months old was examined during summer. Fish were acclimated to 5, 10, 15, 20, and 25°C (41°F, 50, 59, 68, and 77 °F), respectively and tested individually in an electrically controlled shuttle box device. Body temperatures monitored by a radio thermometer ingested by the fish closely approximated occupied temperatures to within 0.2 °C.

No significant differences were found in preferred temperature over the acclimation range studied. Fish regulated environmental and body temperature with precision as they selected temperature in a spatial gradient. The authors indicated that acclimation temperature exerts little or no effect on temperature preference of adult rainbow trout. Preferred temperature of the fish did not change more than 3-4 °C (5.4-7.2 °F) over a range of acclimation temperature. This study acclimated fish over a long 16 hour period compared to other studies and provided a progressive series of changing water temperatures until the final preferendum was attained. The results indicate that mean body temperature as determined by telemetry can provide a close approximation of preferred temperature. Salmon, trout, and bass have been studied in similar experiments which had similar results.

Meisner, J.D., J.S. Rosenfeld, and H.A. Regier. 1988. The role of groundwater in the impact of climate warming on stream salmonines (*Fisheries* 13:3:2-8)

Meisner, J.D. et al. adds further understanding of the complexities of energy transfers from the atmosphere to groundwater and to stream water. This paper provides many studies that have documented that groundwater temperature is strongly linked to air temperature. Mean surface soil temperature generally exceeds mean annual air temperature: a common rule of thumb holds that 1 °C be added to the mean annual air temperature to derive the mean surface temperature of the ground. Surface soil temperatures follow seasonal air temperature fluctuations with a time lag related to depth. This paper references known theories and understanding Earth's thermal systems. Solar radiation is the energy that affects all components throughout all the planet and the task in the study is to experiment and apply the thermal theories to the measurements within the project.

Data is provided that acknowledges the influence of adiabatic lapse rates with changes in

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topographic elevations. These components are part of the fundamental considerations given to all experiments conducted on-the-ground in natural resource science. They are components of the physical laws established in Physics. Elevated groundwater temperatures may depress dissolved oxygen concentrations in groundwater discharge due to decreased oxygen solubility and increased rates of microbial oxidation of dissolved organic matter. Suboptimal oxygen concentrations of groundwater may affect where trout build redds in streams. Current research involves the use of quantitative relationships such as the ratio of groundwater baseflow to average volume of stream flow over a given reach during critical warm periods.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J. R. Sedell. 1991. Responses of salmonids to habitat changes. IN: Influences of forest and rangeland management on salmonid 96-506.

Role of Streamside management zones section of Chapter 14 (IN Influences of forest and rangeland management on salmonid) discusses streamside management as a tool to protect fishery values. The evidence in the studies considered, indicated that streamside management zones minimize damage to habitat but the consistency was variable over time and places. The Alsea study was one cited in Oregon, but the study relied on speculation about the causes of observations between logged and unlogged stream reaches. Variability between treatments in studies conducted on Carnation Creek in Canada also occurred. On Carnation Creek it was observed that smolts of age 1 were fewer in logged areas, but adult salmonids grew faster in higher water temperatures on some reaches. Winter survival from age 0-1 should have been reduced by the decrease in the amount and stability of large woody debris in the logged area compared to old growth, forested riparian area but instead survival was better. Changes in abundance of fish populations in Carnation Creek have been difficult to attribute to specific streamside treatments due to flaw in the research design. As a result many of the data summaries indicate that a hypothesis of the direct influence of woody debris presence in a stream due to the old growth stands versus a logged riparian are could not be answered.

A study by Bilby and Bisson (1987) also indicated conflicting evidence of the benefits of streamside areas that are vegetated versus those that are not. Both clear-cut and vegetated streambanks offer benefits to fish at different stages of growth which indicates that variety in habitat and woody debris presence and/or absence each have a role in salmonid management. Climatic variation was discussed to indicate the difficulty in tracking logging-related habitat disturbances over time. Large floods have a significant influence on channel morphology. In evaluation of logging and vegetation removal as they relate to habitat, disturbance regimes imposed by management should be compared to natural disturbances in both frequency and amplitude. Salmonids have evolve in a landscape where they experience many environmental stresses: forest fires, floods, mass soil and ice movements, debris torrents, glaciation and volcanism. Their life history strategies enable them to withstand considerable environmental variations and unpredictability.

Focus on individual stream reaches has limited the accuracy of many studies. Study designs used have underestimated sampling error and have not addressed the comparative importance of different parts of a basin (Hankin, 1984). Reach analysis does not effectively assess cumulative effects and this is especially evident in short-term postharvest evaluations.

The authors caution that there is much to learn before we can predict with confidence the effects of activities that will provide habitat protection.

Vigg, Steven, T.P. Poe, L.A. Prendergast, H.C. Hansel. 1991. Rates of Consumption of

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Juvenile salmonids and alternative prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in the John Day Reservoir, Columbia River. *Trans Am Fish Soc* 120:421-438.

The study took place in four regions of the John Day reservoir from April to August 1983-1986 to quantify the consumption of 13 species of prey fish, particularly seaward-migrating juvenile Pacific salmon and steelhead. For each predator consumption rates varied by reservoir area, month, time of day and predator size or age. The technique used to establish prey/predator relationships reconstructed an average diel feeding pattern from pooled stomach contents of samples of predators collected from the natural environment. Several regressions were performed

The greatest daily consumption of Salmonids by northern squawfish and channel catfish occurred in the upper end of the reservoir below McNary Dam (0.7 to 0.5 prey/predator). Greatest daily predation by walleyes and smallmouth bass occurred in the middle and lower reservoir. Consumption rates of all predators were highest in July, concurrent with maximum temperature and abundance of juvenile Salmonids. Consumption rates varied with time of day; diel patterns were generally consistent throughout the season.

Poe T.P., H.C. Hansel, S. Vigg, D.E. Palmer, L.A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. *Trans Am Fish Soc* 120(4):405-419.

The study took place in four regions of the John Day reservoir from April to August 1983-1986 to study the diets of northern squawfish, smallmouth bass, walleye and channel catfish to determine the extent of predation on juvenile salmonids during seaward migrations of the salmonids. Juvenile Pacific salmon and steelhead were the most important food group by weight of the northern squawfish – about 67% - but made up smaller proportions of the food of the other predators: channel catfish, 33%; walleyes, 14%; smallmouth bass, 4%.

Squawfish preferred juvenile salmonids in May and August (generally the peak of the salmonid out-migration), and switched to prickly sculpin when numbers of salmon declined. Walleyes and smallmouth bass showed a preference only for prickly sculpin among the prey fishes analyzed. Walleyes and smallmouth bass were much less important predators on salmonids and appeared to select subyearling chinook salmon only in August when the distribution of the prey overlapped with that of the predators.

Size-selective predation by northern squawfish may also play an important role in reducing survival of the smaller individuals within each run of the out-migrating juvenile salmonids.

Fraser, N.H.C., N.B. Metcalfe, J.E. Thorpe. 1993. Temperature-dependent switch between diurnal and nocturnal foraging in salmon. *Proc. R. Soc. Lond. B* 252: 135-139.

The activity patterns of animals whether diurnal crepuscular or nocturnal are usually fixed. This study demonstrates that juvenile Atlantic salmon switch between diurnal and nocturnal foraging solely in response to environmental temperature and independently of photoperiod and season. At temperatures above 10°C juvenile fed predominantly during daylight, spending the night exposed in the water column but relatively quiescent. As temperatures dropped below 10° C they became increasingly nocturnal taking refuge by day but emergent to feed at night.

It has previously been shown that parallel physiological changes take place in the retinae of several species of Salmonids: the quantity and composition of the visual pigments change so as to make the fish more dark adapted at low temperatures. As the fish were found to be far less aggressive by night than by day all temperatures the switch to nocturnal activity was also accompanied by a

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change in social structure. The authors suggest that this temperature-dependent strategy maximizes feeding efficiency in summer but reduces predation risk in winter.

Tabor, R.A., R.S. Shively, T.P. Pie. 1993. Predation on juvenile salmonids by smallmouth bass, and northern squawfish in the Columbia river near Richland, Washington. *North American Journal of Fisheries Management* 13:831-838.

The importance of juvenile Salmonids in the diet of smallmouth bass and northern squawfish was examined at a 6 km stretch of the Columbia River.

The importance of juvenile Salmonids in the diet of smallmouth bass and northern squawfish was examined during 1990 during emigration of juvenile anadromous Salmonids. 62 smallmouth bass and 69 northern squawfish were sampled. Juvenile Salmonids made up 59% of the smallmouth bass diet, by weight and were present in 655 of the stomachs of the bass and were estimated to consume from 1.4 to 1 salmonids per predator daily. Crayfish were dominant prey consumed (41.4% by weight) of northern sawfish, but juvenile Salmonids were 28.8%. The squawfish consumed 0.55 to 0.34 salmonids per predator daily during two sampling periods of May 2-3 and June 20-21 respectively. Smallmouth bass and northern squawfish consumed mostly subyearling chinook salmon which may have been wild chinook salmon that emigrated downstream from the Hanford reach. The predation rates by smallmouth bass were estimated as high during spring and early summer because subyearling chinook salmon are abundant and of suitable forage size and their habitat overlaps with that of smallmouth bass.

24 transects along the shore, 500 m long, were established. 12 transects were located on each shore. Six random transects were sampled first each day, then additional transects were sampled to maximize catch of northern squawfish.

Stomach contents were sampled from bass of 200 mm fork length size. Samples were taken to a lab, magnified and identification of the contents took place.

92 bass with a mean length of 234 mm (range was 109-389 mm) fork length were used for stomach analysis. 8 had empty stomachs and 2 contained large prey that couldn't not be removed. All 69 squawfish collected were examined with 11 empty stomachs. Fork length of the squawfish averaged 385 mm and ranged from 261 to 495 mm.

Juvenile salmonids were the major prey items for all size classes of bass representing 59% of the diet by weight. Crayfish and other fish represented 19 and 18% of the diet respectively. Little other food was found except for various orders of insects. Overall for all size classes of the bass, juvenile salmonids were in 65% of the stomachs and constituted 84.2% of all consumed fishes. The mean number of salmonids per smallmouth bass stomach was 1.87. In May when 1.4 salmon per predator was consumed each day the average fork length of the ingested salmonid was 43.8 mm and in June they averaged 67.6 mm.

Squawfish consumed a variety of crayfish (dominant by weight of 41.4%) fish 28.8%plants 11.6%, insects 10.4% and mollusks. 29% of the squawfish digestive tracts contained salmon. The authors suggest their estimates of consumption rates of Salmonids by smallmouth bass are evidence that the bass may be a major predator on juvenile Salmonids in some situations especially in rearing areas of subyearling Salmonids. They also suggest that predator-prey relationships in other areas of the Columbia River system should be examined.

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Scriener, J.C., T.G. Brown, and B.C. Andersen. 1994. Juvenile Chinook salmon (*Oncorhynchus tshawytscha*) utilization of Hawks Creek, a small and nonnatal tributary of the Upper Fraser River. *Can. J. Fish. Aquat. Sci.* 51:1139-1145.

Scriener et al (1994) examined Hawks Ck. a small tributary of the upper Fraser River where there are no records of spawning salmonids during 1990 for the presence of juvenile salmonids. Chinook salmon have a variable life history strategy in freshwater. Some reside in or near their natal streams for a year after emerging from the streambed. Others reside for only a few days or months before migrating to the ocean. Both strategies are observed among most populations for chinook salmon from the Fraser River British Columbia. The ocean-type behavior is more prevalent in the lower tributaries described in other studies.

Hawks Ck. has a fish barrier 300 m (984 feet) upstream from the confluence with the Fraser River. The study area was within the 300 m long reach which has < 2% gradient and is shaded by poplar, birch and willow layers of trees 1-3 m in height and pine 15-25 m (49-82 feet) in height. Riffle/pool sequences were at 10 m (32.8 feet) intervals along the length. Irrigation use occurs above the fish migration barrier.

During the study period, winter flows were low and snow and ice built to a height of 3 m at the confluence of Hawks Ck. and the Fraser River. In April, peak stream flows and sediment loads breached the ice when the snow melted in Hawks Ck. watershed (water level = 1.2 m (3.9 feet) and sediment concentration - 689 mg/liter (0.04 lbs/ cu. ft.) in mid April). Hawks Ck. was clear by May while flows and sediment loads in the Fraser River were still increasing. Hawks Ck. increased a few days during rains storms and then cleared again.

Number and distribution of fish in the study reach were determined on 12 occasions between May 18 and November 1, 1990. Species were identified, counted, and released. All fishable areas were seined so that fish distribution in the study reach was determined. Fish were captured and marked at each sampling date, using a different mark each time. When loss of marks was not significant population size was estimated. Stream temperature and water level were determined for 14 occasions between May 18, 1990 and April 23, 1991. Sediment samples were collected from both the Fraser River margin near Hawks Creek and the study reach at Hawks Creek.

Abundance and area occupied by juvenile chinook salmon increased during the spring and decreased during the autumn in the Hawks Creek study reach. Abundance of age 0+ juveniles increased during May and June, declined in July after a storm, increased again in August and declined again during September and October. The area occupied increased, while total catch showed little variation between May 27 and July 6. The salmon use of Hawks Creek was limited almost exclusively to age 0+ fish from wild stocks. Hatchery chinook salmon did not appear to use the study area as marked adipose fins were never observed in a capture.

Average residence in Hawks Creek was 9 days for individual fish. Recapture was rare after 55 days. The maximum population size in the study reach was estimated with mark-recapture data from August 22 and 25. The chinook population peaked between 346 and 325 fish which averaged a peak density at 0.76 fish per meter for 443 square meters of stream.

Suspended sediment in Hawks Creek were lower than those of the Fraser River. A peak of 689 mg/L occurred during snow melt in April and < 25 mg/L from May to November. The Fraser river concentrations were > 150 mg/L during May and June and exceeded 60 mg/L throughout the summer.

Water temperature and water levels in Hawks Creek were also different from those of the Fraser

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River. Hawks Creek was $> 2^{\circ}\text{C}$ warmer during May, June and July and $>5^{\circ}\text{C}$ cooler during August and September than the Fraser River. By late August Hawks Ck. consisted of a series of pools that were connected by narrow (0.5m) and shallow (~ 10 cm) riffles. Water level in the Fraser River declined continuously after July 15.

Discussion of the results include descriptions of the overall patterns of use. The authors suggest that during May through August salmonids were attracted to the clearer and warmer waters of Hawks Creek. The high densities and changes in the habitat preferences might have caused them to remain only a short time. The change in densities during September and October were thought to be due to declining water levels, velocities, and temperatures in Hawks Creek and also declining sediment in the Fraser River which made it more attractive for that time period.

Other speculative remarks are made unrelated to the data testing. Finally, the use of small nonnatal tributaries of the upper Fraser River by juvenile chinook salmon appeared to be a rearing and growing habitat during times of high sediment concentrations in the Fraser River during periods of downstream fish migration. The authors felt feeding was probably less inhibited in the clear smaller stream but they observed it was a short-term and seasonal residency with high fish densities they felt supported the refuge concept.

Konecki, J.T., C.A. Woody, T.P.Quinn. 1995. Temperature preference in two populations of juvenile coho salmon, *Oncorhynchus kisutch*. *Environ. Biology of Fishes* 44: 417-421.

Konecki et al (1995) studied two groups of coho salmon raised under identical regimes to test the hypothesis that the group from a stream with low and less variable temperature would have a lower and less variable preferred temperature than a group from a stream with warmer and more variable temperatures.

The study was conducted using stock from two coastal Washington streams. Bingham Ck. a tributary of the Chehalis river is a thermally buffered stream by groundwater inputs. Hour temperature averages in 1993 were 11.3°C and varied by $\pm 5^{\circ}\text{C}$. Bockman Creek flows are derived from snowpack and were identified as being strongly influenced by local air temperatures. The average hourly temperatures were 12.5°C with a range of 10°C .

Eggs were collected, inseminated, and progeny incubated in trays maintained at around 6°C , juveniles were reared at 10°C well water and were fed a semi moist diet daily. At 4-5 months fish were tested for thermal preference.

The tests were conducted in a shuttle box with a boundary temperature of 2°C and 28°C . Results were reported as the temperature at which 70% of the observations were made. The range of temperatures where the fish spent 70% of their time were between $6-20^{\circ}\text{C}$ and $7-22^{\circ}\text{C}$ for the Bingham and Bockman Ck. respectively. The average temperatures during 70% of the observations were $8.4-12.5^{\circ}\text{C}$ and $9.2-13.7^{\circ}\text{C}$ for each group. There were no significant differences between the two groups.

In conclusions Konecki et al (1995) observed that in the literature salmon in general may prefer temperatures near those where their realized optimum growth occurs, even though they can more efficiently utilize food at higher temperatures and they can tolerate much higher temperatures.

Konecki, J.T., C.A. Woody, T.P.Quinn. 1995. Critical thermal maxima of coho salmon fry under field and laboratory acclimation regimes. *Can J. Zool.* 73:993-996.

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Juvenile coho salmon from three populations in Washington State were captured and tested for critical thermal maximum (CTM). Tolerances varied among the populations and exceeded published data from some laboratory tests. The population from one of the streams were from streams that are relatively cool and they had a lower CTM than the two populations from warmer streams. After the salmon had been in the lab for 3 months under constant, common temperature regimes, the CTMs no longer differed, indicating that the population specific differences resulted from different acclimation regimes rather from genetic adaptations.

Ingraham Jr. W.J., C.C. Ebbesmeyer, R.A. Hinrichsen. 1998. Imminent climate and circulation shift in northeast Pacific Ocean could have major impact on marine resources. EOS, Trans. Am. Geophys. Union. 79:16 197-199.

Ingraham et al (1998) describes an imminent climate shift. Based on ocean drift and tree ring records the most recent decadal phase appears to be one of the longest during the last five centuries. Tree ring intervals studied averaged 30, 30, and 31 years between growth troughs. The trajectories provide insight on the impacts ocean conditions have on salmon populations.

Kaczynski, V.W., J.F. Palmisano, J.E. Levin. 1998. Marine survival of opia hatchery Coho salmon related to marine temperatures. Proce. 49th Annual Pacific Northwest Fish Culture Conference. Boise, ID. P. 131-147.

Sea surface temperature information for the northeast Pacific Ocean were examined for annual trends (49,029 monthly records). The trends reveal that distinct temperature latitude differences are apparent for locations. Decade scale temperature trends are the same for all 4 locations between California and Alaska. The trend data shows how the warm ocean problem has progressively marched northward over the years first affecting California, then Oregon and Washington and then British Columbia.

Dockray, J.J., I.J. Morgan, S.D. Reid, C.M. Wood. 1998. Responses of juvenile rainbow trout, under food limitations to chronic low pH and elevated summer temperatures, alone and in combination. J Fish Biol 52:62-82.

Rainbow trout were exposed (90 days) in synthetic soft water to sub lethal low pH (5.2) and simulated climate warming scenario (2°C above the control summer temperature range of 16.5-21 °C) alone and in combination of limited food (~4% dry body weight).

The gradual increase in temperature over the 90 day exposure period, in combination with daily fluctuations and the fact that fish are able to acclimate more rapidly to increases than to decreases in temperature resulted in metabolic compensation. This effect was evident in an experiment Dockray et al, 1996. The continuous +2° C elevation was sufficient to reduce growth rates in the limited ration fish in these treatments. Similar effects of temperature on growth were obtained in 1996, although the effects were most obvious in the period during which temperatures increased rapidly towards incipient lethal levels. The similar metabolic rates, both over time and among treatments, throughout the 90 period indicated that there was no substantially increased cost of living in a warmer environment.

Chronic exposure of juvenile rainbow trout to warmer environmental temperatures and sublethal low pH under limited ration conditions did not result in more clear cut treatment effects on their physiology and energetics than previously seen under unlimited ration. The combination of warmer temperatures and sublethal low pH appeared to be slightly more costly than either stressor alone, in trout that have an unlimited or limited ration.

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The trout exposed to 5.2 pH exhibited no evidence of ionregulatory disturbance. High summer temperatures above the optimum temperature for growth, reduce conversion efficiency. These effects were more evident in limited ration fish because they were unable to increase their food intake to combat the subsequent high metabolic rates (relative to energy intake), resulting in low conversion efficiencies.

It appears that feeding trout would withstand low pH conditions and to some degree warmer environmental temperatures more effectively than starved trout. A further reduction in ration to the maintenance level, may uncover treatment effects. Trout in the wild would have such limitations on their diet, particularly under winter conditions. Further studies relevant to the wild should be aimed at determining the seasonal effects of these environmental stressors on fish.

Dickerson BR, Vineyard GL. 1999. Effects of high chronic temperatures and diel temperature cycles on the survival and growth of Lahontan cutthroat trout. *Trans Am Fish Soc* 128:516-521. Tests of chronic temperature tolerance indicated that the upper limit for survival and growth of Lahotan cutthroat trout was between 22°C and 24°C. Lahotan cutthroat trout experienced complete mortality within 2 days at 28°C and approximately 60% mortality over 7 days at 26°C (78.8 °F). Fish suffered no significant mortality at temperatures of 24°C (75.2 °F) and below. No significant differences in growth of fish held at 22°C (68°F) relative to fish held at cooler temperatures were found. Significant reductions in growth were observed at 24°C. When fish were subjected to fluctuating temperatures similar to field conditions which cycled daily from 20°C (68°F) to 26°C (78.8 °F), they still grew.

The upper temperature limit for growth and survival of Lahotan cutthroat trout under chronic elevated thermal stress appears to be between 22°C (71.6 °F) and 23 °C (73.4 °F), however responses were modified by exposure to fluctuating temperature conditions. The authors acknowledge that the study was site specific to the Truckee River and they used fish stock from a lacustrine environment. Additional studies of steam-derived fish from other areas would help elucidate whether there may be stock-related differences in thermal tolerances.

BOOKS

The following book list contains standard texts that can provide the basic fundamentals to many of the natural resource sciences.

Bedunah, Donald J., and Ronald E. Sosebee. 1995. *Wildland plants: physiological ecology and developmental morphology*. SRM. Denver, Colorado Pages 23-59.

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Heitschmidt, Rodney K. and Jerry W. Stuth. 1991. *Grazing Management, an ecological perspective*. Timber Press. Portland OR. Page 85-108.

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APPENDIX A

Hydrosphere and the hydrologic cycle

Hydrosphere - all water in all forms present at or near the earth's surface (including water in lithosphere, atmosphere and biosphere). Hydrosphere covers 71% of the surface of the planet.

Composition of hydrosphere

Water in hydrosphere is contained in the following reservoirs (by volume):

World oceans	97.2%
Fresh water	2.8%
Ice sheets and glaciers	2.15%
Ground water	0.63%
Water at or near surface and in the atmosphere	0.02%
Freshwater lakes	0.009%
Saline lakes and inland seas	0.008%
Soil water	0.005%
Water in streams and rivers	0.0001%
Water in atmosphere	0.001% A few

terms

* Subsurface water = Soil water + Ground water.

* Soil water - water contained in soils (within 1-5 meters from the surface), can be reached by plants

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- * Ground water - water below soil, cannot be reached by plants
- * Surface water = Lakes + Stream channels

Hydrologic cycle and global water balance Global water cycle

Global water cycle - processes involved in moving water around the globe. Cycle implies that water circulates between the global water reservoirs.

Inflows		Outflows
Continents Precipitation	=	Evapotranspiration + Runoff
Oceans Precipitation + Runoff	=	Evaporation

- * Precipitation - all processes by which water descends through the atmosphere reaching the surface.
- * Evapotranspiration = evaporation + transpiration. Water is evaporated from land by two processes:
 - o from open water, soil and other inanimate surfaces - evaporation
 - o by plants - transpiration (by far the more important of the two processes)
- * Runoff - rivers transporting water into oceans or closed inland basins. Global water balance - more specific notion than cycle - incoming and outgoing flows have to be balanced for globe as a whole and any part of it.

Average annual water balance

1. For continents and oceans:

Inflows		Outflows
Continents 110 km ³	=	70 km ³ + 40 km ³
Oceans 380 km ³ + 40 km ³	=	420 km ³

2. For the whole Earth:

Total annual precipitation:		
110 km ³ (land) + 380 km ³ (ocean)	=	490 km ³
Total annual evaporation:		
70 km ³ (land) = 420 km ³ (ocean)	=	490 km ³

Humidity

Humidity - amount of water vapor present in the air.

Air typically contains less water vapor than it can carry (except for very humid conditions => high humidity). Maximum humidity - maximum quantity of

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moisture that can be held in the air.

Two ways to measure humidity:

- * Specific humidity - actual mass of water contained in a given mass of air, g/kg (absolute measure)
- * Relative humidity - amount of water vapor present relative to maximum specific humidity, % (relative measure)

Specific humidity:

- * Maximum specific humidity increases sharply with air temperature;

This is the maximum possible quantity of water vapor, in reality air typically contains less water. It can't, however, contain more.

- * Since specific humidity is an absolute measure, it can be applied to compare air masses anywhere (polar, tropical, etc.)
- * Specific humidity can vary 100-200 times: cold & dry polar air mass vs warm & humid equatorial oceanic mass
- * If air is slowly cooled, it will reach saturation (maximum amount of air moisture possible for a given temperature); saturation temperature is known as dew point temperature. Moist air has higher dew point temperature than drier air.

Relative humidity:

- * Relative humidity is simply a ratio:

Specific humidity / Maximum specific humidity for this temperature

- * A change in relative humidity can happen in 2 ways:
 1. By direct gain or loss of water vapor (for example, air mass gains moisture from open water surface) - slow process because it involves diffusion of molecules)
 2. Through a change of temperature.
- * The effect of temperature on a daily relative humidity cycle
 - If temperature rises THEN relative humidity falls, and vice versa
 - Specific humidity typically remains almost the same; It changes when a different air mass arrives

Lapse Rate

Essentially, the lapse rate is a measure of how much air decreases in temperature as it rises through the atmosphere.

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Environmental Lapse Rate : (ELR)

This is the actual measured decrease in temperature with height above the ground (i.e. the rate which is actually occurring, not a theoretical rate). Generally this is about 6.5 C per 1000 m. This rate does vary and depends on local air conditions. There are several influencing factors:

- * Height: Lapse rates depend on ground temperature (and are normally less near the ground)
- * Time of Year: Lapse rates are lower in winter or during a rainy season.
- * Surface: Lapse rates are lower over land than sea.
- * Air masses: Different properties of air masses mean different lapse rates.

Adiabatic Lapse Rate :

This is a theoretical rate and can be calculated. Looking at Dry Adiabatic Lapse Rate : (DALR)

A dry parcel of air which does not mix at all with the surrounding air is considered. As this parcel does not mix it can be considered to be adiabatic (i.e. it does not lose any heat outside of the parcel in the process). As the parcel of air rises through the atmosphere the surrounding pressure is less and so the parcel expands. Expanding takes energy and so the parcel cools (i.e. heat energy used in expansion). The rate at which the parcel cools, the DALR (dry adiabatic lapse rate), stays constant at 9.8 c per 1000m.

The dry adiabatic lapse rate only applies when the relative humidity is less than 1000%. When the air cools to dew point (the temperature at which the air can hold no more water without condensing) water vapor condenses out leading to complications due to the energy introduced from the latent heat. This then means that the saturated lapse rate is used below this temperature.

Looking at Saturated Adiabatic Lapse Rate (SALR)

The saturated lapse rate has to take into account the fact the energy is released when water condenses (called the latent heat). This means that once the air has cooled to the dew point and water has started condensing the air parcel cools more slowly.. The SALR (saturated adiabatic lapse rate) range from 4 C per 1000m to as high as 9 C per 1000m. The average SALR is about 5.4 C per 1000m.

History of the Theory of Heat

In our everyday experience of heat our intuitive sense about hot tea and cold showers mirrors the Greek science theory of heat. In 300 BC Aristotle believed that heat is what produces the sensation of hotness. He believed observation was essential to science and derived the heat theory from personal observations. Aristotle's theory of heat stated : heat is what produces the sensation of hotness. The Greeks and others held to the theory for hundreds of years,that heat flows into our bodies creating a sense of hotness and flows out of our bodies and we sense coldness.

The Greeks were clever in their speculations and discovered many facts about nature, but they had no principles to guide them so science could grow (Motz and Weaver, 1991). Personal

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observation combined with a logical thought process was the common scientific methodology employed to make new discoveries. The idea that a sense of how hot or cold an object felt could determine how much "heat" it contained gave way when Galileo invented a thermoscope to investigate degrees of heat and cold. He used a glass bulb having a long tube extending downward into a container of colored water, although Galileo in 1610 is reported to have used wine (Quinn 1982). In 1714 Fahrenheit unveiled an instrument that used mercury sealed inside a bulb with a scale that measured the freezing point and boiling points of water. This development established that heat caused the column in the thermoscope to change height. In the late 1750s Joseph Black baked equal quantities of mercury and water in an oven and checked their temperatures. Black's results showed that mercury was hotter than the water after being heated by the same oven for the same amount of time which created a theory: that heat consists of a caloric fluid that is invisible, weightless, and indestructible (Gullen, 1995).

J. P. Joule published a paper in 1847 that described heat as a form of energy. Joule discovered the law of conservation of energy through relentless, painstaking experimentation for whom scientific research was a matter of measurement, not speculation (von Baeyer, 1999). Work of other scientists confirmed the paper's theory and the ideas of heat were again changed. Joule's experimentation was concerned with the heating of water, but once the gaseous state of air was appreciated the students of heat turned to this less familiar form of matter (von Baeyer, 1999). In the mid 1800s Rudolph Clausius described the heat theory using a mathematical foundation and established the Laws of Thermodynamics.

We no longer base heating laws on the Aristotelean "thought experiments" that the human can feel temperature as heat and our personal sensations can be transferred to everything around us. We now know that heat and temperature are not the same. Heat is energy that flows between a system and its environment by virtue of a temperature difference that exists between them. The Laws of Thermodynamics, established in the 1600s allow us to explain that when two different materials are brought into thermal contact with each other, they reach thermal equilibrium, but do not experience the same changes in temperature because of their different specific heats and masses. The heat lost by the hotter object is equal to the heat gained by the colder object. The goal of fundamental science is to discover the laws of Nature, which means we are interested in finding that few set of rules that apply to all objects and systems in the Universe. The Laws of Thermodynamics describe how the water heats in a watershed, as well as air and soil.

Thermodynamics states that If three or more systems are in thermal contact with each other and all in equilibrium together, then any two taken separately are in equilibrium with one another (Quinn 1982). Thermometers are based in the laws of Thermodynamics and humans are not reliable thermometers (Bohren 1998). The laws establish the principles of using a thermometer to indicate the quantity of accumulated energy in a substance and imply the irreversibility of certain processes. These concepts of temperature explain how heat (thermal energy) flows from one body to another. When two different materials are brought into thermal contact with each other, they reach thermal equilibrium, but do not experience the same changes in temperature because of their different specific heats and masses. The heat lost by the hotter object is equal to the heat gained by the colder object (Kirkpatrick, and Wheeler, 1995). Heat and temperature are not the same. Heat is energy that flows between a system and its environment by virtue of a temperature difference that exists between them (Halliday and Resnick 1988).

Classification of Pathogens including Fecal coliforms:

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1. PATHOGENS ARE ORGANISMS THAT ALWAYS CAUSE SPECIFIC DISEASE OR CONDITION

2. THE ABILITY OF PATHOGENS TO CAUSE A SPECIFIC DISEASE DEPENDS ON THEIR BEHAVIOR IN THE BODY:

- a. ABILITY TO ENTER THE BODY
- b. GROW AND INFECT
- c. PRODUCE TOXINS

3. REQUIREMENTS OF FECAL INDICATORS:

- a. APPLICABLE TO ALL TYPES OF WATER
- b. ALWAYS PRESENT IN WATER WHEN THERE IS CONTAMINATION FROM FECAL SOURCES

4. QUANTITATIVE TEST METHOD AVAILABLE

Simplified classification of the coliform bacteria group ENTEROBACTERIACEAE including the species Escherichia coli

TOTAL COLIFORM GROUP

FECAL COLIFORM GROUP Citro-
bacter sp.
Enterobacter sp. Kleb-
siella sp.

INCLUDING THE SPECIES: Es-
cherichia coli

Simplified classification of the Streptococcus groups

STREPTOCOCCUS
GROUP D
S. equinus
S. bovis
S. gallinarum ENTEROCOCCUS
GROUP E. faecium
E. faecalis
GROUP Q S.
avium

Includes species of the genus Enterococcus

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Appendix 4 COLIFORM BACTERIA

Looking at total coliforms, some are intestinal and indicate the quality of finished water

Looking at fecal coliforms, most are intestinal—indicate the quality of recreational and finished water and the possible presence of fecal contamination

ESCHERICHIA COLI

Strictly intestinal -- indicates the quality of finished water and fresh recreational water and is direct evidence of fecal contamination.

STREPTOCOCCUS AND ENTEROCOCCUS Groups

STREPTOCOCCUS SP., Most are intestinal and indicate the possible presence of fecal contamination.

ENTEROCOCCUS SP., Most are intestinal and indicates the quality of fresh and marine recreational waters and the probable presence of fecal contamination.

OTHER FECAL INDICATORS: SOMATIC AND F-SPECIFIC COLIPHAGES (viruses that infect coliforms)

These indicate the presence of sewage, and are present in only 5 percent of humans (unlike E. coli which is present in all humans and warm blooded animals), and are more persistent in the environment than E. coli

OTHER FECAL INDICATORS

CLOSTRIDIUM PERFRINGENS (a spore-forming bacterium)

Indicates the presence of human and animal waste, like protozoan parasites, and sewage and is very resistant to disinfection and environmental stressors

PATHOGENS

BACTERIAL:

Salmonella sp.

Shigella sp. Campylo-

bacter sp.

VIRAL

Polio virus

Norwalk virus

Rotavirus

PROTOZOAN

Cryptosporidium parvum

Giardia lamblia

SUMMARY

Concentrations of fecal bacteria are highly variable characterized many sources inputs difficult to model

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Appendix 4 Nitrogen

Forms:

N_2 = Dinitrogen

N_2O = Nitrous oxide

NO = Nitric oxide

NO_2^- = Nitrite

NO_3^- = Nitrate

NH_3 = Ammonia

NH_4^+ = Ammonium

Sources and Transformation: Most nitrogen on earth occurs in the atmosphere and in the rock mantle of the earth. Nitrogen used by plants, represents a small amount of the total nitrogen on earth and is found primarily in the soil. The amount of soil nitrogen available to plants is dependent on the amount of dead plant and animal tissue found in the soil, soil microorganisms, temperature, and moisture. Nitrogen can be found in the soil in all of the forms listed above. Plants use nitrate as their primary source of nitrogen.

Plant and animal protein contains nitrogen in the form of amino acids. When plant or animal tissue is decomposed and/or digested (animals, insects or microbes) a waste product of ammonia or ammonium results. Ammonia and ammonium serve as a food source for a group of soil bacteria (ie nitrosomonas) that convert it to nitrite. The nitrite is then quickly converted by a second group of bacteria (ie nitrobacter) into nitrate. The oxidation process of transforming nitrogen found in organic matter into nitrate is called mineralization or nitrification.

Denitrification occurs when nitrate is reduced by anaerobic bacteria (bacteria living in an environment lacking oxygen). In this case the nitrate is reduced in sequence to nitrite, nitric oxide, nitrous oxide and dinitrogen. Denitrification requires an organic source for anaerobic bacterial activity to occur and the reduced form of nitrogen escapes from the soil into the atmosphere. Leaching and Erosion: Nitrogen can be transported from the soil into groundwater and surface water by leaching or runoff. The principle form of nitrogen that is lost in this manner is nitrate. Nitrate has a negative electrical charge. This is the same charge as that found on clay and organic colloids found in the soil. As a result there is no electrical attraction to hold nitrate to these particles and excessive amounts of nitrate can migrate in the soil via soil water movement. Nitrate leaching is not a universal problem and is most likely to occur on sandy, well-drained soils with a shallow water table, in areas that receive high rainfall or intensive irrigation and frequent use of fertilizers, manures, or other nitrogen sources.

Runoff occurs when water accumulates on the surface of a soil at a faster rate than soil infiltration. Soil infiltration is influenced by soil texture, soil surface characteristics, soil moisture, and slope. In this case, nitrogen can be lost as soluble nitrate at the soil surface or organic sources moving in the runoff. Once again as in leaching, nitrogen loss by runoff is site specific and can be managed by managing the timing and rate of nitrogen application, avoiding situations when soil infiltration is reduced (ie frozen soil), and providing grassed buffers that filter sediment from runoff.

Nitrates & Phosphates and Turbidity from Ag Land via Non Point Sources

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A turbidity test indicates presence or absence of small, nearly microscopic particles in a water column without identification of the causes. Turbidity data are somewhat meaningless for agriculture land management if identification of suspended particles is not made.

When water temperatures are warm, sunlight is present, and soluble nitrogen and phosphorus is available in the water, an environment for algae growth is created. If the growth is excessive (algae bloom) the algae population will contribute excessive amounts of dead algae to the water. Microbes in the water digest the dead algae consuming oxygen through respiration. This can lower the oxygen level in the water to the point that fish are deprived of oxygen. This is one linkage between nitrogen, phosphorus, and fish that water quality regulators want to avoid. Sloughs and ponds are often found to have poor oxygen levels for fish because the waters are still, are not regularly receiving aerated fresh water, and are a good place for algae to grow thus starting the process and keeping it in a perpetual state of depleted oxygen supply for fish requiring a higher availability. There are documented slough areas that have elevated N and P present.

When monogastric digestive systems (man, pigs, etc.) digest organic material they breakdown and either absorb or excrete the nitrogen and phosphorus contained in the food. However, this digestive system is not particularly efficient and considerable amounts of the nutrients are lost in urine and feces (all mammal feces will contain fecal coliform).

Since monogastric mammals are the most likely source of excess nitrogen and phosphorus and concentrated fecal coliform, people conduct tests for N and P in the water. If there is a strong concentration of the two elements, then it is worthwhile to check for fecal coliform. The presence of all three suggests a concentrated sewage source (man or animal) is contributing in the area. City sewage treatment plants are regulated on how clean the treated water must be to reenter a stream or be placed on land for further filtering.

Ruminants have microbes in the stomach that digest organic materials and the microbe waste products and dead bodies are also digested and absorbed by the ruminant digestive system. This is done in a much more efficient manner than monogastric digestion and only small amounts of N and P are lost in the form of urine and feces by the ruminant group of animals.

When urine, feces, and vegetation are present in water, microbes and insects use them as nitrogen and phosphorus sources for their bodies and excrete excess as waste. In general none of the above processes is a problem for fish except under certain conditions.

A final way that nitrogen can enter the water is from an excessive source of nitrate in the soil. Most forms of Nitrogen are tied up by clay particles in the soil and cannot become soluble. Nitrate is a water soluble form of nitrogen important to agriculture. We test for it in the water. If nitrates are present in the soil, they are soluble, and if runoff is excessive the nitrates can be picked up in the runoff and eventually reach a stream in sufficient quantities and concentration to be detected. This is not likely though under normal land management. Areas that use large amounts of fertilization with nitrogen (farm crop areas) have been known to contaminate water with nitrates due to irrigation return flows as well as having it reach ground water sources. These areas and management techniques have been documented and different methods and rates commonly used to prevent the problem are well known.

Phosphorus like nitrogen is easily tied up in soils. It is extremely difficult to pick up out of the soil. P applications are made to land in many areas because crops cannot use it from one season to the next because it is unavailable and so little can be retrieved from the soil. When the form of phosphorus is soluble, phosphate, it is nearly always due to a natural background source or it is a sewer or septic system that is the source. Ag lands are the least likely to be contributing to a

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phosphate contamination. It's just not likely under normal land management.

In many areas of Oregon and Washington, the types and amounts of fertilization described above for Nitrogen and Phosphorus are not applied. Concern about nitrates and phosphates is minimal from agriculture land. It is a concern below Fish Hatcheries and sewer discharge areas, or other point source discharge permit sites, if they are discharging animal wastes. That's usually where the sources are and those sites are considered a part of the point source discharge regulations and must be under a permit to operate. Non point agriculture contributions to those levels have not been documented, and are usually lumped by EPA and the authorized state agency (authorized to handle water pollution under the Clean Water Act) with natural background conditions.

APPENDIX B

Management Practices for Agriculture

Adaptive management practices are practices that are the product of best available science which have come about through research and studies that meet the criteria described in WAC -365-195 900 through 925, Guidelines for Identifying best science available.

In many of the land grant university systems a Cooperative Extension System has been incorporated as an educational outreach program. The Extension Services provide a mechanism for University research programs to reach the general public for whom the research is being conducted. The Extension personnel act as the intermediary and a "translator" of research results so that those who will benefit from the new knowledge can apply tested theories to their operations.

Extension publications are valuable tools for people when assessing land management practices. The publications are guides for local activities based on a regional area. These guides are intended to be a tool so that a land manager can assess the value of the information for different sites. A management practice may be useful in one area, but not useful in another only a few miles away. A single practice is rarely suggested as being one that will work everywhere all the time. Instead "practices" are described as useful in a number of situations depending on the goals of the land manager. There are many practices that can be used in an area, which allows choices for a practice based on the objectives the manager wants to meet, as well as consideration of the site specific characteristics.

Extension Service information can be put into categories of practices recommended as being "sound" for the different kinds of management activities. The term "best management practices" is sometimes used to describe the information and sometimes it is published as a summary of the "state-of-the-art" knowledge on a specific topic. Following are some examples of practices published by Extension offices across the United States. While some refer to a specific situation in a state, the practices can be applied elsewhere.

GRASS AND PASTURE MANAGEMENT

M. J. Trlica. Grass growth and response to grazing. Colorado State University Extension. Ft. Collins, CO. #6.108.

Grazing strategies

Develop flexible grazing management strategies that allow plants a rest or deferment after grazing. This is necessary for regrowth and to maintain sufficient leaf area for growth and maintenance. Heavy grazing throughout the growing season usually is the least desirable grazing strategy. A

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management strategy that incorporates rest periods and movement of animals through different pastures usually is more desirable for grass growth than season-long grazing. If you know the amounts, kinds, and locations of available plants (cool- and warm-season grasses), and what grasses grazing animals prefer, you can develop a strategy that meets the needs of plants and animals.

Management plans should utilize the forage resource and maintain it through time. Grazing plans, however, must be flexible. Consider differences in growing conditions among years as a result of drought or wet cycles, depletion of forage supply by wildlife or insects, and other rapidly changing environmental conditions. Consider these along with the impacts of grazing livestock, to determine what effects the combined impacts will have on plants.

Try to avoid rigid plans that require moving animals from one pasture to another on given dates. Other environmental factors certainly will influence grass growth and utilization at any point in time. Base your decision to move stock on how much the grasses are used and how much green leaf material remains; not a predetermined date.

University of Maine Extension Service. This old hayfiled: a fact sheet on hayfield renovation. #2491. <http://www.umext.maine.edu/onlinepubs>.

The hayfield renovation process depends on many factors: site characteristics, goals for the site and resource available. To better understand what needs to be done to renovate a hayfield, a review of what happens to neglected land is provided.

Eck, Kenneth J. Vegetated Filter Strips for Improved Water Quality. Vegetated filter strips for improved water quality. AY-285.

Filter strips are areas of vegetation bordering a body of surface water. Seeded with close-growing plants, such as grasses or legumes, filter strips protect surface water from eroded soil, nutrients, chemicals, and organic materials. Plants in the filter strip slow water runoff, which reduces the water's ability to carry pollutants. Potential pollutants, especially those associated with sediment, are deposited before they reach surface water. Filter strips also preserve highly erodible ground often found near moving surface water.

Filter strips are a "best management practice" (BMP) near field boundaries or within fields near water sources or inlets. They are often used along with practices such as conservation tillage, pest scouting, crop rotations, strip cropping, soil testing, contour tillage, riparian zones, and proper nutrient and pest management to improve water quality. Many state and federal agencies recommend filter strips as an agricultural and urban best management practice because of their potential environmental benefits.

Benefits

Filter strips often provide unrealized economic benefits; possibly returning more than traditional field crop production. Filter strips planted to marketable hay or forest species, or used for very limited grazing, can easily recover much of the construction and maintenance expenses. Where good markets exist for alternative products, such as timber or hay, filter strips may prove more profitable than a corn/soybean rotation. Property taxes may be waived for filter strips located along legal drainage ways, although the filter strip can not be used for profit and must fall within a county's legal right-of-way (consult your local assessor's office for full details). Federal and state programs, such as the USDA Conservation Reserve Program, may increase the economic feasibility of filter strips in more environmentally sensitive locations.

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Additional benefits of filter strips:

- year-round access to land for farming operations
- improved drainage through access to ditches and tile outlets
- increased safety through more stable stream banks and ditches
- wildlife and hunting areas
- natural beauty

Franti, Thomas G. Bioengineering for hillslope, streambank and lakeshore erosion control. Nebraska Cooperative Extension, Institute of Agriculture and Natural Resources, U. Nebraska. Lincoln, Nebraska. #G96-1307-A.

The NebGuide describes bioengineering techniques for hillslope, streambank, and lakeshore erosion control. Tips for a successful bioengineering installation and demonstration project are described.

Borman, Michael. July 2001. INTERACTIONS BETWEEN WEEDS, NATIVE PLANT COMMUNITIES, AND GRAZING. Oregon State University Rangeland Resources. Grazier. OSU Extension. No. 309

Livestock exclusion does not stop weed encroachment. Appropriate, light to moderate, cattle grazing should not accelerate weed encroachment. Small ruminants, sheep and goats, can be used as tools to selectively graze and suppress weeds. Livestock provide a direct economic return. Other weed control measures do not. Any grazing program must be part of an overall integrated weed management program.

An excellent reference is: "Biology and Management of Noxious Rangeland Weeds" edited by Roger Sheley and Janet Petroff, available through Oregon State University Press, Corvallis, Oregon.

Borman, Michael, and Larry Larson. November, 2001. Cottonwood Establishment, Survival, and Stand Characteristics. Oregon State University Rangeland Resources. Grazier. OSU Extension. No. 310.

Cottonwood establishment is largely determined by reach type and stream flow. Thus, high flow along one reach of a stream may promote cottonwood establishment while an equivalent flow along a second reach may scour away established cottonwood (Everitt 1968, Bradley and Smith 1986). Differences in geology, elevation, climate, and tributary influence can exist between two reaches of the same stream (Frissell 1986). Because of the difference in dominant fluvial processes, cottonwood distribution will also be different along different reaches of the same stream.

The riparian corridor is a complex mosaic of moisture and disturbance patterns. Plants that form communities within those corridors survive on sites where their basic requirements for establishment, growth, and reproduction are being satisfied. It is obvious that restoration efforts in riparian areas require an understanding of both the environmental mosaic and the life history/adaptations of riparian species.

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be different along different reaches of the same stream.

Cottonwood can tolerate substantial flooding, but not to the same extent as many herbaceous riparian species. Cottonwood trees are often associated with soils that contain a layer of coarse substrate, which drains more quickly than fine-textured soils, providing a quick return to aerobic conditions. Cottonwood trees survive flooded environments through anaerobic respiration, the production of shallow adventitious roots, and the presence of lenticels along the stem and root crown.

SOILS AND NUTRIENTS

Karen Mancl. Nitrate in Drinking Water. University Outreach and Extension, University of Missouri.

Nitrate (NO₃) is the primary source of nitrogen (N) for plants; it is a nutrient they cannot live without. Nitrates are naturally occurring in soil and water. Extensive farming can rob the soil of its natural nitrogen source, so farmers often add nitrate fertilizers. Properly managed, nitrogen does not endanger health and can increase crop production. However, when more nitrogen is added to the soil than the plants can use, excess nitrate can leach into groundwater supplies and contaminate wells. On-site sewage systems (such as septic tanks and lagoons) also can be a source of nitrate pollution. Because nitrate is converted to a very toxic substance (nitrite) in the digestive systems of human infants and some livestock, nitrate-contaminated water is a serious problem.

Ruminant animals (such as cows and sheep) and infant monogastrics (such as baby pigs and chickens) also have nitrate-converting bacteria in their digestive systems. For this reason, nitrate poisoning affects them the same way it affects human babies. Because adult monogastrics generally do not have nitrate-converting bacteria, they are not affected by methemoglobinemia. Horses, however, are an exception. They are monogastric, but they also have a cecum, which is similar to a rumen. The nitrate-converting bacteria living in the cecum increase the risk of nitrate poisoning.

Barbarick, K.A. Soil: Nitrogen sources and transformations. Colorado State University Extension. Ft. Collins, CO. no. 0.550

Nitrogen in the air is the ultimate source of all soil nitrogen. Nitrogen may enter the soil through rainfall, plant residues, nitrogen fixation by soil organisms, animal manures and commercial fertilizers. There is no difference between the nitrogen that enters the plant from commercial fertilizers and that from organic products. Nitrogen may be lost from the soil by plant removal, volatilization, leaching or erosion. leaching of nitrate is a pollution hazard; control losses of nitrogen with proper management practices.

Nitrogen Loss

Nitrogen may be lost from the soil by plant removal, denitrification, leaching, volatilization and erosion.

The first alternative, absorption by crops, is the desired goal.

Erosion losses of N can be significant. The loss of 10 tons of soil/acre/ year with 2 percent organic matter can result in a loss of 20 pounds of N. Leaching can contribute to ground and surface water pollution problems.

Loss of nitrates by leaching is undesirable from all standpoints. The loss is minimized and crop utilization maximized by proper management practices:

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- Split the applications of nitrogen on sandy or shallow soils where leaching or erosion hazards are greatest and when heavy rates of nitrogen are required.
- Apply nitrogen during the growing season (not in the fall) on soil subject to leaching and erosion.
- Apply the proper amount of nitrogen and other plant nutrients for vigorous crop growth. Base this on a soil test.
- Use good soil conservation techniques to minimize erosion losses of topsoil.

Johnson, Gordon. Nitrates in Soil and water. Oklahoma Cooperative Extension Service. Division of Agricultural Sciences and Natural Resources. Oklahoma State University. #F-2242. It should be clear that fertilizer use and nitrate levels in groundwater are not associated by a direct cause and effect relationship. Present nitrate in groundwater may be a result of ancient, natural excesses of nitrate in soil as a result of disturbances of the biological nitrogen recycling. Modern technology has provided agriculture with the tools to safely manage nitrogen to minimize risk of polluting domestic water supplies. Nevertheless, efforts will continue to identify sources of pollution and management strategies to eliminate them.

Waskom, Reagan M. 1994. Best Management Practices For Phosphorus Fertilization. Colorado State University Cooperative Extension. Ft. Collins, CO. #XCM-175.

Water quality problems associated with phosphorus are generally confined to surface water. Phosphorus in most Colorado soils is tightly held to soil particles and does not leach. However, the P held in organic phases from residues such as manure can dissolve in water and be lost if improperly managed. Adsorbed P on soil particles can cause surface water contamination as P containing sediments move off the land in agricultural runoff. When large amounts of nutrients enter lakes and streams, they accelerate the natural aging process, or eutrophication, by enhancing the growth of algae and other aquatic weeds. As these plants flourish, depleted oxygen and light reduce the survival of more desirable species and the natural food chain declines. Eventually, impounded waters such as lakes, ponds, and reservoirs become overgrown with aquatic vegetation and, in a sense, die.

BMPs are recommended methods, structures, or practices designed to prevent or reduce water pollution. Implicit within the BMPs concept is a voluntary, site-specific approach to water quality problems. Development of BMPs in Colorado is being accomplished largely at the local level, with significant input from chemical applicators and other local experts. Many of these methods are already standard practices, known to be both environmentally and economically beneficial.

Lilley W.D. and R. Merchant. The Forest nutrient cycle: Forestry notes. University of Maine Cooperative Extension. #7029.

There are major factors required for plant growth---sunlight, water and nutrients. Each factor is also renewed: sunlight, daily; water, usually every week or two; and nutrients anywhere from several to hundreds of years. The key to an adequate supply of nutrients is the nutrient cycle, which store nitrogen, phosphorus, potassium (N,P,K) and other elements.

Schmidt, J.L. B.F. Wolfley. Protecting groundwater: managing livestock on small acreage. WSU Cooperative Extension. Pullman, WA. pp 11. eb1713. <http://cru.cahe.wsu.edu/CEPublications>.

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Management practices can reduce water pollution from farms and contribute to the overall improvement of water quality. Sound livestock management keeps contaminants such as sediments, fertilizers, animal waste, and pesticides out of water sources. Best Management Practices can improve or protect surface and groundwater quality. Farm owners can carry out BMPs on a long term basis to maintain the productive life of the farm.

LIVESTOCK & PASTURE MANAGEMENT

Adams, Edward B. Riparian Grazing. Clean Water for Washington. WA State Cooperative Extension. Pullman, WA. p 9. EB1775.

A discussion of Riparian areas, the use of the areas for grazing, practices and management tools, **Undersander, D., Beth Albert, Pamela Porter, Alan Crossley, N. Martin.** 1997. A3529 Pastures for Profit. Univ. of Minnesota and Wisconsin-Extension. Madison, WI. pp 35.

Under rotational grazing, only one section of pasture is grazed at a time while the remainder of the pasture "rests." To accomplish this, pastures are subdivided into smaller areas and livestock are moved from one pasture to another. rotational grazing allows forage to renew energy reserves, to rebuild plant vigor, and to give long-term maximum production.

Faries Jr. F.C., J.M. Seeten, and J.C. Reagor. 1998. Water quality: Its relationship to livestock. Texas Agricultural Extension Service. Texas A&M University System. L2374. To evaluate water quality in relation to livestock health problems it is imperative to obtain a thorough history, make accurate observations, ask intelligent questions and submit suspected water and properly prepared tissue specimens without delay to a qualified laboratory. Obtain assistance from a local veterinarian, county Extension agent or a Veterinary Medical Diagnostic Lab.

Baker, T.T., J.C. Boren, C.D. Allison. Strategies for Livestock management in riparian areas in New Mexico. Cooperative Extension Service, New Mexico State University. Guide B-119. The impact of cattle grazing on riparian ecosystems depends largely on the grazing management practices. It is important to remember that there is not one, single, grazing system because each situation is unique and requires its own management system. The only way to know if a management system is meeting the goals for a particular site is to monitor the effect of management activities. Therefore, riparian grazing plans should be site-specific and based upon available research and current monitoring.

Larry A. Redmon. Grazing Systems for Pastures. Oklahoma Cooperative Extension Service • Division of Agricultural Sciences and Natural Resources. F-2567

Thoughts on Grazing Systems

The key to proper grazing management is to obtain a balance between animal diet selectivity and harvest efficiency; the "right" system will vary between locations and producers. Close attention should also be paid to matching livestock nutrient requirements with forage availability. Using either a continuous or rotational grazing system can result in the optimum use of available forage, acceptable animal performance, and thus, a profitable livestock operation depending on the producer's managerial expertise.

Producers considering changing the type of grazing system of their operation, or producers who may just be getting into livestock production should:

1) Think through the process with respect to their expectations and inputs required for each system

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and,

2) Seek an optimum balance among harvest efficiency, resource conservation, individual animal performance, and, most importantly, the economic returns from the enterprise.

The most significant aspect of a grazing system, however, is to provide grazing livestock with an adequate amount of forage of high nutritive value. This requires choosing the proper forage species for grazing, a sound soil fertility program, and the proper stocking rate. If you require further information about which of the grazing systems offers the most potential for your livestock production operation, contact your local county agricultural agent.

Rayburn, Edward B. 1992. Forage management. Principles of grazing management. West Virginia University Extension Service. 5710-5711.

When managing a pasture, a producer needs to stem reserves for regrowth. In some grasses where reserves are stored in the lower leaf stem, close grazing will physically remove energy reserves and slow regrowth. On the other hand, in some plants the lower leaves at the base are older and inefficient in photosynthetic activity.

If these leaves are removed through close grazing, new more efficient leaves are allowed to grow. With some forage species low stubble or root reserves are maintained and leaves must be left to provide the energy for regrowth.

Larson, Larry and Michael Borman. July 2001. AN EXAMPLE OF A RIPARIAN VEGETATION MOSAIC. Oregon State University Rangeland Resources. *Grazier*. OSU Extension. No. 309

In the May 2000 and October 2000 issues of the *Grazier* we discussed factors that influence the establishment and survival of plants within riparian corridors. We observed that the periodic occurrence of flooding, erosion, deposition, and drought directly influence plant composition and that knowledge of plant adaptations will help interpret the site potential of a riparian corridor. The purpose of this article is to illustrate the geomorphic, soil, and vegetation patterns that occur along the Burnt River between Unity reservoir and Bridgeport, Oregon as an example.

McInnis, Michael L. March 1997. PRINCIPLES OF SUCCESSFUL LIVESTOCK GRAZING IN RIPARIAN ECOSYSTEMS. Oregon State University Rangeland Resources. *Grazier*. OSU Extension. Number 291.

Livestock production can be compatible with riparian ecosystem management. The key is to design and implement thoughtful management strategies that incorporate the following components: (1) clearly defined objectives; (2) implementation of management activities based on scientific principles to meet these objectives; (3) site-specific monitoring to appraise whether the objectives are being met; and (4) alteration of management activities if they are not meeting objectives.

The four key components of a successful livestock grazing plan are: (1) clear, specific and measurable objectives; (2) practical and science-based management activities to meet these objectives; (3) a monitoring program to evaluate effectiveness of management activities; and (4) willingness and ability to alter management strategies that do not result in desired outcomes. Livestock grazing can be compatible with riparian ecosystem management. Successful livestock grazing in riparian areas means implementing science-based management strategies to meet specific objectives; monitoring effectiveness of management activities; and changing management activities when they fail to yield desired results. Goals of successful livestock grazing should include

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maintenance or improvement of riparian ecosystem functions and meet production goals of commodity users. Management activities should be based on the principles of grazing management as they relate to plant ecology, plant growth, riparian geomorphology and hydrology, and animal behavior. As Krueger (1996) observed: "when this is done with full involvement of all the people affected by the management program, successful grazing programs can be developed, because people will support what they create themselves.

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