Skip Richards Catalyst Consulting
Submitted 2016-05-12 as testimony to Whatcom County Planning Commission re CAO

Table of Contents

0.0 Executive Summary

This document explores questions surrounding the apparent failure to apply Best Available Science (BAS) to natural resource management. The GMA requires protection of natural resources and critical areas, which in turn requires their effective management. Yet even the most basic elements of the best available *management* science, together with *systems* science, is not apparent in current policies and regulations, nor in the proposed updates of the Comp Plan or CAO.

The traditional top-down regulatory paradigm suffers from various weaknesses when applied to complex interrelated natural systems, which are in turn involved in complex interrelationships with the human economy. This document illustrates that the net compound effect of the application of the currently regulatory regime has not only failed to adequately protect natural resources; rather, to the contrary, in many cases the regulatory regime has made the situation worse, by setting up a self-defeating feedback loop.

This document shows that the relaxation of regulatory requirements in order to make them less onerous and more fair to the regulated, or, the reverse, the tightening of those requirements to make them more protective of natural resources, are both doomed to fail because the underlying basic approach is fatally flawed. Both those who favor stronger protection for natural systems, and those who seek better outcomes for landowners, should be motivated to take heed of this conclusion.

Finally, a suggested method of curing the problem, based on management and systems science, is briefly outlined.

The current draft of WCC 16.16.262 appears to encourage the approach advocated herein. Unfortunately, however, it has at least two problems. First, because the requirements must all be met prior to any relief being granted under the CAO, the initial investment creates a barrier to exploring this alternative – the full costs of the alternative must be paid without knowing the outcome. A step-wise approach wherein both the county and the landowners would make incremental commitments would more likely encourage interested parties to take the risk. Second, section A, by limiting this alternative approach only to governments, adds to the up-front cost burden noted in the first problem, plus, it is discriminatory against private parties who may wish to form voluntary organizations to achieve the same result. If an entity of whatever sort can meet the criteria, why not grant it the same relief?

We know there these barriers are significant because the previous version of the same code, 260 E, has been on the books for ten years but has never been taken advantage of by any entity.

NOTE: This document is an early version of a book-length work in progress, working title *Programming Public Policy for Accountability, Transparency, Effectiveness and Efficiency*, wherein the references cited here from wikipedia are replaced with extensive original source references, including the applicable national and international standards as promulgated by the Project Management Institute, the American National Standards Institute (ANSI), and the International Organization for Standardization (ISO). This more in-depth research has found nothing, however, to undermine the theses of this document; in fact, it has done nothing but provide additional support.

1.0. Introduction to Best Available Science (BAS)

1.1. First, what is science? Links and the initial text of Wikipedia's introduction to science and the scientific method are provided in Appendix 1.

The distinction between science as a body of knowledge and science as a rigorous, objective process of acquiring such knowledge is critical to the understanding of the legitimate intent behind the notion of BAS.

As Thomas Kuhn has documented in ***The Structure of Scientific Revolutions***, as the process of scientific exploration goes forward, the discovery of hitherto unknown facts can alter even the most basic tenants of a field of inquiry, its 'dominant paradigm' as Kuhn calls it. Such a shift in the dominant paradigm can be relatively gradual or sudden. The shift from the Ptolemaic view of the cosmos, with the Earth at its center, to the Copernican view of the sun as the center of the solar system, marked such a 'scientific revolution.' For more on Kuhn's work, see Appendix 2.

Whatever criticism might justly apply to the finer points of Kuhn's work, the fact remains that the history of scientific inquiry is one marked by changes in many of even the most basic assumptions, beliefs, and bedrock theories that at one time not only were accepted parts of scientific 'truth,' but that as such also played a role in forming the mindset of and informing decisions made by people in all walks of life: academia, business, government, and everyday people.

Thus, what is scientifically valid today might not be tomorrow, and that 'meta-fact' applies to both venerable fields of inquiry like cosmology and physics as it does to relatively new fields like wetlands science.

Objectivity, an ideal not always realized: The commonly accepted view of the scientific method is that is an objective, dispassionate process that determines facts and tests theories without regard to the emotional, philosophical, or social impacts of its findings. As Kuhn has documented, however, such is not the case. Science is supposed to be value-free, but scientists are not – they are subject to the same biases as are other humans, due to the intrusion of feelings, values, core beliefs, and other predilections, and those biases can color their scientific work. The scientific method, like everything else, takes place in a cultural and socio-economic context. The recent flap over the 'climategate' email fiasco is just the latest of a long history of the contamination of science by human emotions, beliefs, and socio-political agendas. Esteemed members of academia joined in the call to burn Galileo at the stake. The shameful treatment of Hungarin physician Ignaz Semmelweis, (http://en.wikipedia.org/wiki/Ignaz_Semmelweis) among the first doctors to postulate the usefulness of disinfection in preventing disease, is perhaps an even more telling example, as it was primarily his scientifically trained medical peers who condemned his findings.

1.2. What constitutes Best Available Science (BAS)?

There is no legally binding definition of the term BAS. While the state legislature requires the use of BAS in designating and protecting critical areas, it did not provide a precise definition of what constitutes "best available science." The state Department of Community, Trade, and Economic Development (now called Department of Commerce), charged by the legislature with the responsibility to administer the GMA, set forth its attempt to define and describe procedures for employing BAS in Section 5 of WAC 365-195-900 as follows: (Link: http://apps.leg.wa.gov/wac/default.aspx?cite=365-195-905):

(5) Scientific information can be produced only through a valid scientific process. To ensure that the best available science is being included, a county or city should consider the following:

(a) **Characteristics of a valid scientific process.** In the context of critical areas protection, a valid scientific process is one that produces reliable information useful in understanding the consequences of a local government's regulatory decisions and in developing critical areas policies and development regulations that will be effective in protecting the functions and values of critical areas. To determine whether information received during the public participation process is reliable scientific information, a county or city should determine whether the source of the information displays the characteristics of a valid scientific process. The characteristics generally to be expected in a valid scientific process are as follows:

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 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.

(b) **Common sources of scientific information.** Some sources of information routinely exhibit all or some of the characteristics listed in (a) of this subsection. Information derived from one of the following sources may be considered scientific information if the source possesses the characteristics in Table 1. A county or city may consider information to be scientifically valid if the source possesses the characteristics listed in (a) of this subsection. The information found in Table 1 provides a general indication of the characteristics of a valid scientific process typically associated with common sources of scientific information.

Table 1:

	CHARACTERISTICS					
Table 1 **SOURCES OF SCIENTIFIC INFORMATION**	Peer review	Methods	Logical conclusions & reasonable inferences	Quantitative analysis	Context	References
A. Research. Research data collected and analyzed as part of a controlled experiment (or other appropriate methodology)	**X**	**X**	**X**	**X**	**X**	**X**

to test a specific hypothesis.						
B. Monitoring. Monitoring data collected periodically over time to determine a resource trend or evaluate a management program.		**X**	**X**	**Y**	**X**	**X**
C. Inventory. Inventory data collected from an entire population or population segment (e.g., individuals in a plant or animal species) or an entire ecosystem or ecosystem segment (e.g., the species in a particular wetland).		**X**	**X**	**Y**	**X**	**X**
D. Survey. Survey data collected from a statistical sample from a population or ecosystem.		**X**	**X**	**Y**	**X**	**X**
E. Modeling. Mathematical or symbolic simulation or representation of a natural system. Models generally are	**X**	**X**	**X**	**X**	**X**	**X**

used to understand and explain occurrences that cannot be directly observed.						
F. Assessment. Inspection and evaluation of site-specific information by a qualified scientific expert. An assessment may or may not involve collection of new data.		**X**	**X**		**X**	**X**
G. Synthesis. A comprehensive review and explanation of pertinent literature and other relevant existing knowledge by a qualified scientific expert.	**X**	**X**	**X**		**X**	**X**
H. Expert Opinion. Statement of a qualified scientific expert based on his or her best professional judgment and experience in the pertinent scientific discipline. The opinion may or			**X**		**X**	**X**

may not be based on site-specific information.						

X = characteristic must be present for information derived to be considered scientifically valid and reliable

Y = presence of characteristic strengthens scientific validity and reliability of information derived, but is not essential to ensure scientific validity and reliability

How do we know that the criteria set forth in the WAC cited above are themselves scientifically valid? Within a legal context, the answer is, because the agency is presumed to have expertise in the subject area. In a procedural context, if the WAC was promulgated by rule, following the requirements of the state Administrative Procedures Act (APA), RCW 34.05 (Link: http://apps.leg.wa.gov/rcw/default.aspx?cite=34.05), which requires the opportunity for public input, that public input might have included scientific peer review of the agency's findings and rules … although such is not required by the APA.

In Subsection C of Section 5 of the same WAC the agency also addresses what is NOT scientific, in its judgment:

(c) **Common sources of nonscientific information.** Many sources of information usually do not produce scientific information because they do not exhibit the necessary characteristics for scientific validity and reliability. Information from these sources may provide valuable information to supplement scientific information, but it is not an adequate substitute for scientific information. Nonscientific information should not be used as a substitute for valid and available scientific information. Common sources of nonscientific information include the following:

(i) Anecdotal information. One or more observations which are not part of an organized scientific effort (for example, "I saw a grizzly bear in that area while I was hiking").

(ii) Nonexpert opinion. Opinion of a person who is not a qualified scientific expert in a pertinent scientific discipline (for example, "I do not believe there are grizzly bears in that area").

(iii) Hearsay. Information repeated from communication with others (for example, "At a lecture last week, Dr. Smith said there were no grizzly bears in that area").

Thus, using the example in the code cited above, a detailed daily journal of grizzly bear sightings kept by a local resident, including dates, times, and specific locations of each such sighting, might 'supplement' but could not 'substitute' for the findings in an academic paper, based upon a walk-through of the same area performed by a recent Huxley College wildlife biology graduate. Presumably the results of the two efforts would be similar, but what is local government to do if they are not? Fund more scientifically valid studies to resolve the differences, or just accept the academic study because it is 'scientific?'

The interest group Futurewise has attempted explore a definition and the proper use of BAS by culling from Growth Management Hearings Boards rulings and court decisions. The document is found here: http://futurewise.org/resources/publications/CAO%20Updates%20What%20is%20Needed%20May%209%202005.pdf

The document attempts to clarify the term BAS by examining each word of it through a legal lens, as follows:

Best …

"'Best' means that within the evidence contained in the record a local government must make choices based upon the scientific information presented to it" and the characteristics of a valid scientific process.[36] The board has specifically rejected the "contention that 'best' under RCW 36.70A.172(1) includes one, and only one, scientific document."[37] The broader the range of valid science, "the broader the range of discretion allowed to a" city or county.[38] Where a city or county incorporates scientific conclusions of equal validity to the other science in the record into its policies or regulations, the city's or county's choice will not be disturbed.[39]

What the foregoing discussion seems to suggest is that local government decision makers are free to pick and choose from among a range of studies to aid them in the proper determination of say, wetland buffer widths, even if those studies arrive at differing conclusions, just so long as each of those studies meets the minimum criteria of scientific validity. From the previous discussion of the nature of science and the scientific method, and the influences that the socio-cultural matrix in which science is practiced exerts upon its practitioners and, consequently, upon its results, the question that the above discussion of the meaning of 'best,' does not address is, what are local government decision makers to do when scientific studies generated by the 'dominant paradigm' limit their options and contradict common sense based on the experience of landowners and natural resource managers who operate outside the academic context?

That there is a dominant paradigm in critical areas science is suggested by the narrow range of sources of BAS and their fairly close agreement, at least as referenced in such documents as the Whatcom County BAS Report, found here: http://co.whatcom.wa.us/pds/naturalresources/criticalareas/updates/downloads/pdf/bas-rpt_publicreviewdraft-may-06-05.pdf

Some Issues Arising from the preceding discussion of Best Available Science:

Selective picking and choosing from among all the available studies: There are approximately 150 references provided in the Wetlands section of the County's BAS report, cited above. On its face, that seems like sufficient information upon which to base the County's CAO update. There is no information provided, in the BAS Report, however, about the total number of such studies that make up the entire body of scientific research on the subject, so we don't know what percentage that 150 documents represents out of the entire body of such work. Even if the number constitutes a substantial percentage of all available studies, the opportunity for the consultant to select those studies that supported a given agenda or point of view was present … especially since neither the County, the Citizen Advisory Committee nor the Technical Advisory Committee undertook an independent comprehensive review of the entire body of work to verify that the sampling was representative of the entire spectrum of perspectives, conclusions and results that would be found therein.

Further, many of the documents were generated by, or on behalf of, or supported by, state or federal agencies. It is not clear if those studies were peer reviewed. It is not clear the extent to which the political agenda of the agency drove or influenced the outcome of the studies. Nine of the references are directly authored by Department of Ecology, two of them authored directly by Department of Fish and Wildlife.

Two of the most critical works cited in the development of the last 'update' of Whatcom County's CAO were developed by the same consultant the County used for that effort, and were funded by Department of Ecology:

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, and M. Witter. 1992a. Wetland buffers: An annotated bibliography. Publ. 92-11. Prepared by Adolfson Associastes Inc. for Shorelands and Coastal Zone Manage. Program, Washington Department of Ecology, Olympia, Washington.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Mauermann, M. Bentley, D. Sheldon, and D. Dole. 1992b. Wetland mitigation replacement ratios: Defining equivalency. Prepared by Adolfson Associates, Inc. for Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia, Washington. Publ. #92-08.

Two other publications that played a substantial role in the consultant's BAS report include the following, both authored by Department of Ecology personnel:

Gersib, R. 1997. Restoring wetlands at a river basin scale. A guide for Washington's Puget Sound. Washington State Department of Ecology. Publication No. 97-99. 198 pp.

Gersib, R. 2000. Whatcom County wetlands GIS mapping by hydrogeomorphic classification. Washington State Department of Ecology.

A more fundamental problem; passive observation versus active experimentation: Much of the research performed on critical areas, especially wetlands and habitat, is limited to the passive observation type of research. That is, the investigator systematically collects observations of the conditions of, say, certain types of wetlands, and then from those observations draws conclusions regarding the nature and extent of wetland functions and appropriate buffer size to protect those functions. The other approach, active experimentation, in which various types of wetland management regimes are established, and their results monitored, in the same or similar areas, is less frequently employed. There are good reasons for the lack such active experimentation, but the problems it poses are significant, as the opportunity to test hypotheses regarding the relative efficacy of a range of management options is absent when research is limited to passive observation. Since management always involves coping with varying levels of uncertainty, and the evaluation of complex payoff matrices (tradeoffs in outcomes between protecting one wetland function versus another, for example), it would be useful for those responsible for natural resource management to know the kinds of "what ifs" that active experimentation would permit.

In addition, the passive observation method would appear to have a built-in bias in favor of conclusions such as, for example, the larger the buffer the better, since wetlands undisturbed by human activity are highly likely in most instances to appear to provide more habitat and other functions than those closer to developed areas. The question a natural resource manager faced with the need to comply with the GMA's critical areas requirements and yet do so with minimum economic loss of land might need to know, however, is, how close to a wetland can the development be and still retain the minimum level of its functions that is acceptable in the context of the role(s) it is playing in its ecosystem? Or, what best management practices (BMP) could be employed to minimize buffer size and still protect the wetland functions? Which BMP provides the best 'bang for the buck' in that regard? An active experimental approach could answer those questions in a decisive way that the passive observation method simply cannot do.

Available

"'Available' means not only that the evidence must be contained in the record, but also that the science must be practically and economically feasible[]" to be implemented as shown by evidence in the record.[40]

Because the science must be "available," if a local government is faced with the rare circumstance that there is no science, the city or county is not required to conduct original scientific research. WAC 365-195-920 recommends that a city or county in this circumstance adopt a precautionary or no risk approach and an adaptive management program.[41] However WAC 365-195-920 only recommends this approach and these regulations, as was documented above, only need to be considered. To some degree this makes sense since while some local governments, such as King County and Snohomish County, have done important original scientific research, most local governments lack the capability to do so. Fortunately, state agencies have worked hard to fill information gaps and compile scientific information for cities and counties to use.

Yes, indeed, the state agencies have been hard at work conducting studies and compiling studies from other sources, all of which support and reinforce the critical areas dominant paradigm. So if a local government lacks scientific information relevant to critical areas protection issues it faces, it can either pay for such studies, or, rely on state-sponsored studies that might or might not adequately address the issue at hand.

Science

"[S]cience is a process involving methods used to understand the workings of the natural world. This process consists of four stages: 'making observations, forming hypotheses, making predictions from these hypotheses, and testing those predictions.'"[42] The characteristics of a valid scientific process include: findings that have been critically reviewed by qualified scientific experts in the field, the methods used are standard in the field or peer reviewed, the conclusions are logical and the inferences reasonable given the data and methods, the data have been analyzed using standard or peer reviewed quantitative or statistical methods, the data and findings are placed in their proper context, and the assumptions, analytical techniques, and conclusions are well referenced to the relevant, credible scientific literature.[43] Not all forms of science have all of these characteristics of a valid method, but the more characteristics incorporated, the more reliable the science is likely to be.[44] WAC 365-195-905 Table 1 shows the types of scientific information and the characteristics of a valid method that are characteristic of that type of scientific information. The characteristics of science are useful for cities and counties to determine if offered evidence is science. As was documented under the analysis of "available" above, cities and counties are not required to do original scientific research.

The initial description above of the experimental method, if applied strictly, would disqualify much of what appears in the academic literature as critical areas science, as it is based upon the passive observation method rather than the active experimental method.

Include

RCW 36.70A.172(1) requires that BAS shall be included "in developing policies and development regulations to protect the functions and values of critical areas." This court held "that evidence of the best available science must be included in the record and must be considered substantively in the development of critical areas policies and regulations."[45]

The courts and Growth Boards have rejected the argument that including best available science is procedural; rather, as the above quote shows, it is also a substantive requirement.[46] However, the scientific evidence alone does not require a particular policy outcome.[47] But best available science is essential to an accurate decision on critical areas policies and regulations.

The policies at issue here deal with critical areas, which are deemed "critical" because they may be more susceptible to damage from development. The nature and extent of this susceptibility is a uniquely scientific inquiry. It is one in which the best available science is essential to an accurate decision about what policies and regulations are necessary to mitigate and will in fact mitigate the environmental effects of new development.[48]

The Court of Appeals also wrote that best available science would not only protect the environment, but also the rights of property owners. "If a local government fails to incorporate, or otherwise ignores the best available science, its policies and regulations may well serve as the basis for conditions and denials that are constitutionally prohibited.

Given the procedural and substantive elements of the best available science requirement, the boards analyze best available science issues by considering the following questions:

1. The scientific evidence contained in the record;
2. Whether the analysis by the local decision-maker of the scientific evidence and other factors involved a reasoned process; and
3. Whether the decision made by the local government was within the parameters of the Act as directed by the provisions of RCW 36.70A.172(1).[50]

An issue related to best available science is whether the legislature should define the term. In the 2004 legislative session there was an unsuccessful attempt to pass a definition. This issue was recently addressed by a committee of the National Research Council of the National Academy of Sciences for the federal analogue to best available science. The Committee on Defining Best Scientific Information Available for Fisheries Management wrote: "**A statutory definition of what constitutes 'best scientific information available' for fisheries management is inadvisable because it could impede the incorporation of new types of scientific information and would be difficult to amend if circumstances warranted change.**"[51]

Thus, even an assembly of the most prominent experts in the nation cannot provide, nor would they be willing to stand behind, a definition of the term "best available science," yet the GMA mandates its use. Thus, by default, Hearings Boards rulings and court decisions have defined and will continue to define the sideboards within which cities and counties have to operate to remain in compliance with the GMA. While it makes sense for local jurisdictions to try their best to avoid legal challenges, because the GMA provides no clear definition of BAS, and not all circumstances have necessarily been addressed by case law, the ambiguity baked into the BAS process means that locals cannot be sure of achieving compliance no matter what choices they make in attempting to comply with the requirements of RCW 36.70A.060 and RCW 36.70A.170, and RCW 36.70A.172.

2.0 The Growth Management Act (GMA) requires the use of Best Available Science

[Return to Table of Contents]

The GMA requires the application of Best Available Science (BAS) to designate and protect critical areas, as provided RCW 36.70A.172, found here: http://apps.leg.wa.gov/rcw/default.aspx?cite=36.70A.172, which reads as follows:

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.

(2) If it determines that advice from scientific or other experts is necessary or will be of substantial assistance in reaching its decision, a growth management hearings board may retain scientific or other expert advice to assist in reviewing a petition under RCW 36.70A.290 that involves critical areas.

Section 2 of RCW 36.70A.060, found here, http://apps.leg.wa.gov/rcw/default.aspx?cite=36.70A.060, reads as follows:

(2) Each county and city shall adopt development regulations that protect critical areas that are required to be designated under RCW 36.70A.170. For counties and cities that are required or choose to plan under RCW 36.70A.040, such development regulations shall be adopted on or before September 1, 1991. For the remainder of the counties and cities, such development regulations shall be adopted on or before March 1, 1992.

Thus, presumably, BAS is to be used not only in the designation of critical areas, but also in their protection. Indeed, that is what Futurewise found in their work on BAS, as seen in this excerpt from the material quoted above: " … the best available science is essential to an accurate decision about what policies and regulations are necessary to mitigate and will in fact mitigate the environmental effects of new development."

NOTE: The 2005 CAO provided a document on BAS, and the current update includes a revised version. Unfortunately there appears to be no recognition of relevant management science or systems science. The updated BAS document continues to rely on the standard approach, based on static academic research on subject matter areas such as wetlands and habitat – all necessary and valuable, no doubt, but unless tied together in a management system, incomplete.

[Return to Table of Contents]

3.0. The role of management science in protecting Critical Areas. [Return to Table of Contents]

The GMA requires that critical areas be protected as well as designated. To accomplish the goal of protecting critical areas requires managing major projects involving massively complex and highly interdependent natural systems spread over thousands of acres of varied terrain, along with related land use issues as well as a wide range of human behavioral issues across the same landscape. Yet, little if any sign of the proper use of management science appears in the references included in BAS reports, nor in the GMA's RCW or WAC, nor in local regulations that implement the GMA, including critical areas ordinances.

3.1. What is management science?

First, what is a system? W. Edwards Deming, a pioneer in management science, defined human-created systems thus: *"What is a system? A system is a network of interdependent components that work together to try to accomplish the aim of the system. A system must have an aim. Without an aim, there is no system. The aim of the system must be clear to everyone in the system. The aim must include plans for the future. The aim is a value judgment. …*

Generally, management science consists of a body of research and methodologies derived from the mathematical disciplines of statistics and systems analysis to develop, and monitor the performance of, a given process (be it a plan, program, or project [including regulatory regimes]) that seeks to establish, maintain, or repair a system or systems. Based on the data collected during the monitoring, tools developed from the science of management helps the manager(s) evaluate the effectiveness of the process in managing the system(s0, and to take whatever corrective action might be required to close the gap between the established objective of the process and the actual performance of the process.

Quality Management, from wikipedia (http://en.wikipedia.org/wiki/Quality_management): **Quality Management** can be considered to have three main components: quality control, quality assurance and quality improvement. Quality management is focused not only on product quality, but also the means to achieve it. Quality management therefore uses quality assurance and control of processes as well as products to achieve more consistent quality.

Total Quality Management, from wikipedia (http://en.wikipedia.org/wiki/Total_quality_management): **Total Quality Management** (or **TQM**) is a management concept coined by W. Edwards Deming. The basis of TQM is to reduce the errors produced during the manufacturing or service process, increase customer satisfaction, streamline supply chain management, aim for modernization of equipment and ensure workers have the highest level of training. One of the principal aims of TQM is to limit errors to 1 per 1 million units produced. The application of TQM can vary tremendously from business to business, even across the same industry.

While management science was first applied to large-scale industrial manufacturing systems, its principles have been found to be generally applicable to all human enterprises, including government.

For more information on management science, see Appendix 4.

At the very least, management science requires periodic measurement of the conditions of the system that is being addressed by the process in question. In the case of the CAO, aquatic systems (rivers, streams, and associated wetlands and habitat) would be among the systems the conditions of which (water quality parameters, frequency and duration of flood events, species counts, etc.) would need to be monitored in order to determine the effectiveness (quality of output) of the CAO as a regulatory instrument.

3.2. The use of 'adaptive management' in protecting critical areas

At least two GMA WACs recommend the application of 'adaptive management,' in implementing critical areas protection, as follows:

Section 6 of WAC 365-195-905 (Link: http://apps.leg.wa.gov/wac/default.aspx?cite=365-195-905) reads as follows:

> (6) Counties and cities are encouraged to monitor and evaluate their efforts in critical areas protection and incorporate new scientific information, as it becomes available.

In addition, WAC 365-195-920 (http://apps.leg.wa.gov/wac/default.aspx?cite=365-195-920) recommends that a city or county facing uncertainty in what methods for protecting critical areas under its jurisdiction would yield the best results should adopt a precautionary or no risk approach and an adaptive management program, as follows:

> 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 time frame and scale necessary to reliably evaluate regulatory and nonregulatory actions affecting critical areas protection and anadromous fisheries.

Since the term 'adaptive management' is not found in the definitions section of the GMA, RCW 36.70A.030 (http://apps.leg.wa.gov/rcw/default.aspx?cite=36.70A.030), the description provided in the WAC cited above is presumably the primary guidance from the state upon which local government officials may rely in implementing the concept of adaptive management.

For more on adaptive management, see Appendix 5.

Notice how the description of adaptive management in the WAC cited above is congruent with, if not identical to, the general characteristics of management science, cited in Section 3.1 above, in that it emphasizes the use of 'scientific methods to evaluate how well regulatory and nonregulatory actions achieve their objectives" and "[m]anagement policy and regulatory actions are treated as experiments that are purposefully monitored and evaluated to determine whether they are effective … ." Notice that Deming's Plan-Do-Check-Act cycle (as described in Appendix 4) is virtually identical in basic structure and intent as the CMP cycle depicted at the end of Appendix 5.

3.3. Has Whatcom County complied with the requirements of RCW 36.70A.172, to use Best Available Science in the protection of critical areas?

Baselines and benchmarks: Were any performance benchmarks established in the current version of the CAO? Does the staff monitor, for example, the goal of "no net loss" of wetlands functions and values? If there are such benchmarks, is there a progress report on how well they have been met? Are there such benchmarks established in the draft CAO update? Without such benchmarks, how can adaptive management be accomplished. In plain English, how can we tell if the regulations are working as they are designed to do, so that next time the update is due, we can know for sure whether we need to do more or do less?

Even if the County has based its critical areas designations and protection regulations on those documents that the state has blessed as the 'best available science,' does the County face sufficient uncertainty, as described in WAC 364-195-920, cited above, to warrant the application of adaptive management to its regulatory regime? As set forth in Appendix 6, as the procedural history of the adoption of the CAO indicates, the ordinance was first adopted in 1992. The ordinance was subsequently modified by local referendum and by various administrative policies, before being replaced by an amended version in late 1997; it was further amended in 2005. At no time during the initial phases of the development of the CAO, nor at any subsequent time, were any system baselines or benchmarks of progress established to guide the evaluation of its effectiveness, nor has any monitoring been done across that time period to provide the data points necessary to perform such an evaluation.

During the entire period that the County has had a CAO in place, water quality and habitat conditions have apparently continued to deteriorate, but because there has been no monitoring of the CAO's effectiveness, no one can whether the CAO has made these conditions better than they might otherwise have been, or has made them worse, or has had little or no effect. It is simply presumed, based on studies conducted in other areas that have been blessed as the best available science by state agencies and mercenary, opportunistic consultants, that conditions would be worse if the CAO were not in place, and that an even more restrictive ordinance would cause conditions to improve, or at least deteriorate at a slower pace than they would otherwise.

Since the level of restriction as embodied in the 1993 referendum version of the CAO has been raised in each subsequent version, it is not reasonable to ask why the conditions the CAO is supposed to remedy have not improved? If the best available management science, of which the techniques of adaptive management as set forth in WAC 365-195-920, are but one subset, could improve the outcome of our natural resource regulations, should it not be used in order to comply with the requirements of RCW 36.70A.172?

Arguably, the massive geographic extent and complexity of the natural systems known as critical areas, especially riparian habitats, is sufficient to *require* the use of the best available management science in order to have even a prayer of achieving the GMA's mandate to protect those natural systems. Inarguably, use of the best available management science has not even been considered.

3.4. Would employment of management science have been the wisest course? Is it still?

Even if there is no obligation under the GMA to apply adaptive management to the regulatory regime that the County is using to protect critical areas, would it be wise to do so?

Consider the purpose statement of the CAO, the 1997 version of which has been reproduced in Appendix 3. Is it fair to say that the CAO has succeeded, in any measure, in "maintain[ing] harmonious relationships between human activity and the natural environment."? Aside from the false presupposition that there was any such harmonious relationship in existence at the time those words were written worth maintaining (in which case there would have been no need for a CAO, if there had there been a 'harmonious relationship' in the first place), certainly the continuing political frustration, the economic impacts, and the continuing decline in the condition of critical areas, when taken together, suggest that a different approach of some kind would be warranted.

There are substantial obstacles in the way of taking a different course of any kind. First, expertise in management science is not typically included in the job description of planners and code enforcers. Application of management science is not unheard of in government (See the links to Erie County, New York, in Appendix 4, for example), but it not widespread by any means. The mindset of most planners tends toward the dominant regulatory paradigm, of top-down, command-control proscriptive regulations in which the experts make the rules and force obedience to those rules, heedless of the cost to the regulated and to society as a whole, and, of equal importance, heedless of the results in terms of the goals of the regulations.

If the CAO is failing to fulfill its stated purposes, should not some consideration be given to alternative approaches?

Today's big problem: funding.

WAC 365-195-920, promulgated at least 10 years ago, pointed the finger at one valid practical problem that Whatcom County now faces, that it did not have during the boom times that preceded the 2008 economic downturn:

> 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 time frame and scale necessary to reliably evaluate regulatory and nonregulatory actions affecting critical areas protection and anadromous fisheries.

Performance monitoring is not politically sexy, and it is expensive, so it was not even considered when the CAO was first passed, nor, as an element of the CAO per se, has it been since then.

Belatedly, some long-term monitoring plans were developed as part of the WRIA 1 Watershed Management Plan, and some monitoring is taking now, as water quality reports are now posted on the Natural Resources pages of the County's PDS website (http://www.co.whatcom.wa.us/pds/naturalresources/criticalareas/updates/downloads/index.jsp).

Yet, the opportunity has been lost forever to establish baselines by which the performance of the various versions of the CAO could be evaluated and compared with one another. When it comes to the basics of applying management science to our natural resources, we'll almost be starting from scratch.

Sadly, while the health of the local economy remains in doubt, the resources necessary to fully employ the necessary tools of management science may be limited for some time to come.

3.5. Management Options: The structure of a scientific revolution in natural resource management?

There is a potential for a major paradigm shift in natural resource management, that could well qualify as a scientific revolution (see Appendix 2).

Innovative Solutions: The current "blame the victim" regulatory regime provides no incentive to innovate fair and effective solutions to our natural resource management challenges. But they're out there if one would only look for them. Here, for example, is a"Smart Farm" idea, similar to those employed in Smart Homes, that relies on creative uses of ever-less-expensive information technologies, that could be implemented with gear that is either in the process of being developed, or easily could be:

> Imagine cattle equipped with GPS transponders, linked to a computer in the farmer's office. A computer program tracks the location of each cow, relative to streams, wetlands, etc. When a cow

wanders too close to a protected terrain feature, software automatically sends a signal to the cow's transponder that triggers a small shock, similar to that provided by an electric fence – the results: instant invisible electric fences and buffers; no steel posts in the ground that cost a bundle to install, maintain, and replace. A prototype of this device already exists and a company is in the process of seeking capital to begin manufacturing and distributing a production-grade model.

Proscriptive versus performance-based code: Expanding reliance upon performance-based standards where possible could go a long way to improving results. Performance-based standards minimize the subjectivity of administration of the CAO and at the same time maximize both the flexibility of its application as well as its effectiveness. Performance-based standards includes such items as "no net loss of functions and values" of critical areas, and "post-development runoff [or impact or whatever] shall not exceed pre-development runoff [or impact or whatever]." The means are left up to the permit applicant, with the burden on the applicant to demonstrate (using best available science, of course), that the means are likely to achieve the end.

Drainage-Based Management: The parcel-by-parcel, passive (in that enforcement takes place only when someone complains or applies for a permit), top-down proscriptive regulatory approach can be replaced by a more flexible system where landowners within a drainage basin get together and develop their own plans for water supply, water quality and habitat management, and enter into a contract with the state to meet standards by whatever means they find most cost-effective. The Bertrand Creek Watershed Improvement District is a leading-edge model of this kind of natural resource management paradigm.

[Return to Part 3] [Return to Table of Contents]

3.6. Best Available Science reveals limitations of the traditional top-down approach to natural systems protection

[Return to Part 3] [Return to Table of Contents]

The Transactional or Interactive Model of Economy-Environment Systems

General principles of systems connectivity: Natural systems and the human economy, including the regulatory process, are all interconnected. As a corollary, you can't do just one thing. Every action within one element of the system reverberates, causing higher order effects, in all the other elements.

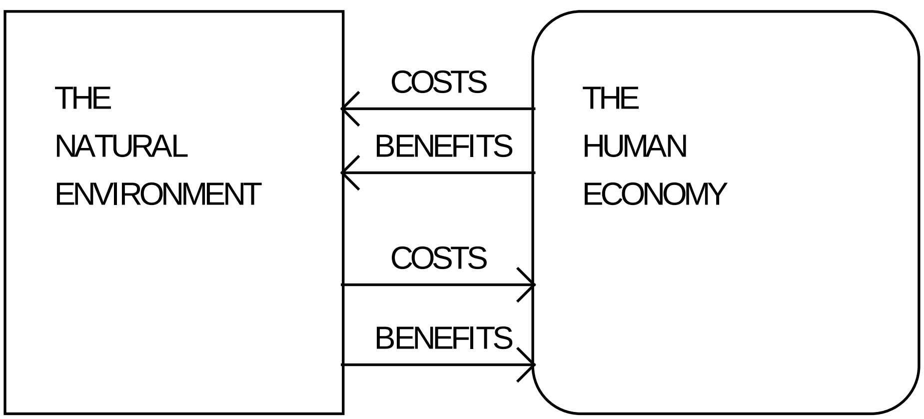
The Interactive or Transactional Model

The "environmentalist" model vastly improved our understanding by establishing that there is a relationship between the environment and the economy. That model also has had tremendous impacts on our decision making in the last thirty years, which has seen the passage of the National Environmental Policy Act, the Clean Water Act, the Clean Air Act, and so on. [For the full text of the article on systems modeling of the economy and environment, go here.]

Further reflection, combined with the experience we have gained in the process of implementing that legislation, has led to a realization that this model requires significant refinement.

First of all, while it is true that economic activity can and does have negative impacts on the natural environment, the natural environment has negative impacts on people and the economy, such as wide ambient temperature swings, flooding, pest infestations, and so on, against which people must take steps to protect themselves if an orderly society and productive economy is to be maintained.

Second, the natural environment can only be restored from past harm and protected from future harm by the investment of capital generated from surplus-creating (i.e., profit-making) economic activity. These two observations lead to the development of an interactive model, in which both negative and positive impacts flow both ways, that is, from the economy to the environment, and from the environment to the economy. The interactive model is represented graphically below [next page]:



Notice that while conceptually the interactive model might only be a refinement of the "environmentalist" model, the policy consequences of this model can be profound. The main theme of the interactive model is that the health of the economy and the environment are mutually dependent, and therefore one cannot simply chose to "err on the side of the environment" in decision making without risking significant negative impacts -- not only to the economy, but to the environment as well.

The model also implies that the appropriate overall public policy goal with respect to the environment is to redesign the existing interfaces between human activity and the natural environment so as to bring the negative impacts of each upon the other below the threshold of sustainability.

Empirical support for the validity of this model can be found in the high positive correlation between the health of national economies and their respective environments. Only wealthy countries can afford to restore and protect their environments.

Role of the regulatory system:

It is commonly believed the regulatory system somehow stands apart from other human activity. To the contrary, it is simply yet another component of human institutional activity, a subsystem with inputs and outputs into both the human economy, as well as to the natural systems it is intended to protect, and subject to the same laws and constraints as all other such subsystems. These inputs and outputs have their own set of impact, including adverse impacts.

Design flaws of the current regulatory system generate adverse impacts to natural systems they are intended to protect:

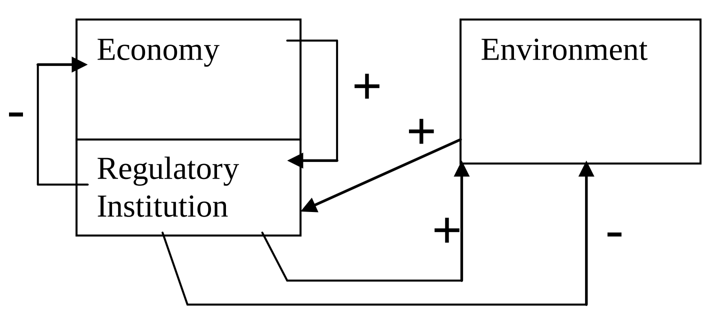
The regulatory system has a fundamental design flaw: some outputs of the regulatory process are improperly hooked into the input of the problem, so the regulations make the problems worse. That is so because as currently designed the regulatory system has the following characteristics:

One: It gives a competitive advantage to the bigger, well-heeled players, because they have superior access to regulators and legislators, and they face relatively less percentage overhead to comply with regulations, which means compliance costs them less. Result is consolidation, where the big fish eat the little fish; the small farmer and other landowner gets squeezed out of the game, gobbled up by the larger players, and economic diversity diminishes.

Two: There is no impact on regulators' bottom line for impact on the regulated, no direct feedback loop from the general economy into the regulatory institutions. Thus insulated from the impact of their decisions, regulators heedlessly destroy landowner equity and productive capacity, with no direct consequence to their "bottom line." By contrast, if a private sector business trashes its customers, they don't stay in business long.

Three: Worst of all, the requirements of the regulations themselves often undermine their intent. Example: the big dumb buffer "hands off " approach to protecting aquatic terrain features such as streams and wetlands prevents or discourages "hands on" active management. When big dumb buffers are imposed, to be in compliance all the landowner has to do is stay out of them and the critical area they are supposed to protect. But Nature is not static; blackberry vines, reed canary grass and other noxious weeds keep growing, clogging up the watercourse, and degrading habitat and water quality. So conditions get worse, and in turn those who are slavishly devoted to rules on paper call for more of the same, which only serve to make the problem even worse. It's a vicious cycle, compounding over time.

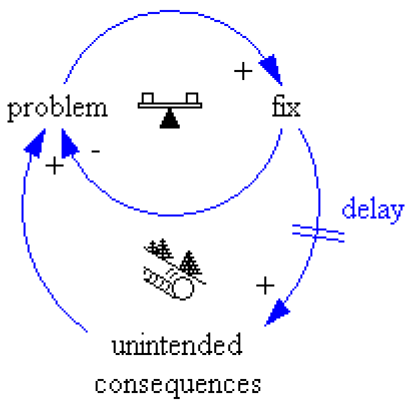
Graphic depiction of systems analysis of regulatory process:



The arrows signed "-" indicate a reduction in value the originating process causes the receiving process; the arrows signed "+" indicate an increase in value from the origination process to the receiving process. From this figure it can readily been seen that the net effect of the current regulatory system upon the economy and the environment has the potential to be net negative, a potential all too often realized in current circumstances. Worse yet, the regulatory process grows in proportion to the magnitude of its failure.

A similar analysis is common in systems literature, thus:

Fixes that fail
In the fixes that fail archetype, the problem is solved by some fix (a specific solution) with immediate positive effect. Nonetheless, the “side effects” of this solution turn out in the future. The best remedy seems to apply the same solution. Example: saving costs on maintenance, paying interest by other loans (with other interests)[1]



http://en.wikipedia.org/wiki/System_Archetypes

[Return to Part 3] [Return to Table of Contents]

4.0 Toward a new paradigm of natural resource management

[Return to Part 3] [Return to Table of Contents]

NOTE: This material is based on program and project management standards as found here:
http://www.pmi.org/PMBOK-Guide-and-Standards/foundational-standards.aspx
A work of particular value from the above source:
http://www.pmi.org/~/media/PDF/learning/translations/2015/capture-value-decision-making.ashx

Step One: **Define, re-define, or refine statement of purpose**. The CAO purpose statement includes the following language: "… to maintain harmonious relationships between human activity and the natural environment." At WCC 16.16.100 A.

Note the presumption: that such harmony existed at the time the CAO was passed. It did not. Natural systems were degrading and landowners felt abused by regulations long BEFORE the CAO, and if anything, that code has done just the opposite of its purpose; it has increased the disharmony.

Proposed restatement of purpose: to achieve and maintain harmonious relationships between human activities and natural systems, including surface and ground water resources and fish and wildlife habitat. To do that will require nothing less than the building of a continuous interface between productive lands and aquatic features, between human activity and the natural environment, so that adverse impacts are minimized and productivity of both is maximized.

Looking more carefully at the purpose step: Most public policy making goes wrong right at the first step, establishing the purpose or goal of the policy. While each piece of legislation may have a well meaning statement of purpose, rarely do policymakers bother to look at existing laws and rules to see if they are intended to accomplish the same or a similar purpose, and, if there are such, why new legislation is needed. Moreover, policymakers tend to ignore legislation that is failing to accomplish its purpose, that is, they do not apply the feedback loop accountability mechanism as outlined in Figure One.

Rather, new legislation is proposed, and, after the interminable interest-group tug-of-war, the legislation pops out of the pork sausage grinder, morphed into something unrecognizable from the initial proposal. The final text often contradicts its intended purpose or hamstrings it in a variety of ways, primarily by handing off its implementation to agencies that have perpetual employees with no incentive to solve problems. That's why for example, while there is only one set of rivers, streams, wetlands, habitat areas and so forth in any given area, there are a multitude of federal, state and local laws, rules, and agencies that address those areas. The resulting duplication, conflict, and redundancy results in massive waste of time, money, and effort, as well as the perpetual failure to achieve meaningful progress on the ground.

Since there is already so much legislation on the books, the first thing any competent manager would do would be to look over all legislation with the same or similar purposes addressing the same subject matter, and consolidate it into one coherent policy statement, and then recast all of the various sections of code into one comprehensive set that might stand a reasonable chance of accomplishing the stated purposes. Such an approach would prove anathema to the Political Class, whose very existence is based upon feeding an ever-growing bureaucracy that continues to identify new problems while never solving the existing ones. It would not suit the agencies, because they would be consolidated and trimmed to become something far different than what they are today.

Step Two: **Establish *Measurable* Objectives**, metrics to measure accomplishment of purpose.

Economic: unit productivity of land; permit application time; permit cost; permit approval time; jobs created per unit land use; etc.

Environmental: water quality standards; habitat conditions; species counts, etc. To measure the effectiveness of the management and/or regulatory regimes will require establishment of baselines. While notions like “no net loss of wetlands functions and values” sound nice, in practice it would like prove far too expensive in most cases to inventory all of the wetlands in a given area, to establish the baseline, but without that baseline, how is one to know if the objective is being achieved? Measuring more global results, like water quality parameters at the outfall of a drainage, is still expensive but a lot less so than delineating all the wetlands in a drainage.

Regardless of whether a parcel-based regulatory system is used, or a multi-parcel management planning approach is used, some valid measures of results must be taken to enable proper evaluation of program performance and the application of adaptive management.

Regulatory: ratio of total regulatory cost to measures of objectives achieved; count impacts on productivity as regulatory costs, as well as permitting costs.

It is critical to include regulatory performance metrics among the programs’ objectives. The bureaucracies have no incentive to work with the folks they regulate; if a regulation causes financial loss to an industry, or society as a whole, the regulators don’t feel the pain directly, in the same way that if a private business abuses or disappoints its customers it rapidly feels a hit to its bottom line. If the manager of a private business does not take the key metrics of the business into account when making decisions, such as unit costs, gross revenues, net revenues, employee morale, and the like, even a business that sells a popular product or provides a needed service can lose money, or fail to capitalize on opportunities to expand sales or improve profit margin, or suffer in many other ways. Such are the inherent risks in any enterprise, private or public. If such failures accumulate, at some point the business itself fails. So the manager has to ask, before implementing a decision, what will be the consequences across all aspects of this business of making the decision? Top-down command-control bureaucracies, by contrast, have no incentive to look at how their rules impact the rest of the economy, or society, let alone the entities they regulate. They can flaunt the impacts of unintended consequences, collateral damage, and such other regulatory externalities, which are as real as economic externalities. Agencies can, in effect, kill the goose that lays the golden egg, without immediate consequence to *their* bottom line.

The determination of multi-variable point of diminishing returns: The determination of the point of diminishing returns for such measures as buffers is properly a multi-variable exercise, where the returns curves for the environment and the economy are superimposed, and the point of diminishing returns is thus the intersection of the two curves. For more on this topic, see excerpt from supplemental testimony submitted to County Council during the last CAO update.

Step Three A: Develop criteria for selecting solutions

Some of the standard candidates: technical feasibility; providing fairness; ensuring effectiveness; simple; safe; quick; least cost to all affected parties. Many other criteria can be developed driven by the specific circumstances of the situation being addressed.

Draft list of proposed criteria follows:

Legal:

1. The proposal shall satisfy the obligations and requirements of the state Growth Management Act RCW 36.70A.

Financial:

2. The proposal must be affordable to those who are asked to pay for it, where affordable means that the party or parties in question is capable of bearing the cost throughout the life cycle of the proposed solution. In cases at issue, the cost should lie within the range identified by the fairness criterion (see Criterion 11, Equity Considerations).

Consistency with rest of County Comprehensive Plan and other county natural resource policies and plans:

3. The CAO's provisions shall be consistent with the provisions of the rest of the County's natural resource management policies, programs, and ordinances.

Technical feasibility:

4. Proposed solutions shall be scientifically and technically sound and be based upon the best available science.

Overall Effectiveness:

5. The proposal shall achieve the objectives for which it is designed, as measured by the appropriate established objective numerical indices or other applicable objective criteria.

Cost-effectiveness.

6. The cost of implementation of the proposal shall be the least total impact to all affected parties and natural systems of Whatcom County.

Flexibility over time.

7. Proposals shall be capable of being modified in response to changing conditions.

Potential Side Effects

8. A proposal shall not have a reasonable probability of causing a significant new, or exacerbating an existing, natural resource management problem.

Equity Considerations (Fairness).

9. Proposals shall be fair, where fairness is defined as a distribution of costs and benefits that ensures that no party, or, where it proves too difficult to ascertain the impacts to specific parties, then no economic sector, pays significantly more in project costs than the sum of what that party (or economic sector) receives in direct and indirect benefits from the project and causes in terms of direct and indirect adverse impacts that the project is designed to address.

Step Three B: Generate as many possible solutions as time permits

Collect all proposed solutions in a catalog. Evaluate each against the established criteria. Note the status of each proposed solution, such as: conceptual stage; evaluation completed; under implementation; tested and worked; tested and failed, etc.

All of the Best Management Practices (BMPs) accumulated by NRCS and the Conservation District would make up one chapter in such a catalog. Planning tools like density bonuses, clustering, and purchase and transfer of development rights would form another.

With respect to habitat, specific incentives should be created and disincentives removed. Why don't we put money into learning how to develop habitat capacity, rather than into paperwork and bureaucracy that so far has led to many listings but few de-listings, that is, that is a miserable failure by any reasonable measure?

While it is beyond the scope of a county land use regulation to effect, or even affect, the way federal and state funds are allocated to species programs, why not consider property tax credits or other such incentives for landowner who provide wildlife habitat? Given that the county is strapped for money, the basic idea might be OK but as a practical matter, the amount of available tax credit the county could afford at this point might not amount to much, but at least it would be a start.

Other such incentives suggest themselves. For example, why not offer a transferable density bonus to anyone who hosts or supports productive habitat? Rather than force huge one-size-fits-all buffers that remove land that might best be used more productively for human activity, let the landowners figure out the best way to achieve and maintain productive wildlife capacity and still do what they want with their property, within performance-based standards. In a Watershed Improvement District or other local management entity, many options could be put in place to improve habitat capacity. The transferable density bonus is just one option. It might work like this: In a case where an area of valuable wildlife habitat exists on a parcel zoned for housing, the property owner would have several options. One, the parcel owner could leave the habitat in place, and transfer the density otherwise allowed on that parcel (plus a bonus of more housing in some portion to the value of the habitat) to some other parcel(s) in the same drainage basin, with similar zoning, and be compensated by the owner(s) of the receiving parcel(s). Another option would be to allow the subdivision platting (with clustering if appropriate) to take place on the parcel with the habitat, but make the actual building activity contingent upon maintaining the level of species population levels and diversity at the same or higher levels than before. The infrastructure and buildings would go up a piece at a time, while habitat would be monitored to ensure that target species were continuing to do OK. If the species began a downturn, then the project would have to halt and the density would have to be transferred to less sensitive parcels. If the parcel owner were unwilling to shoulder such risk, or lending institutions would not be flexible enough to allow financing of such a venture, then they could do the density transfer without even starting the building process.

These notions are not offered as turn-key solutions, just as starting points for a discussion of creative, win-win solutions that is long overdue.

Step Four: Select Action(s) to be taken: note all reasons for, against, and identified uncertainties

The selection process should be explicit, and a written rationale developed and archived for each element thereof.

Step Five: Implement Action(s)

A detailed report should be made of the details of each step of each action implemented.

Step Six: Monitor Results

Monitor all relevant metrics to determine if objectives are being met, and, if so, if the purpose(s) are being achieved.

Step Seven: Evaluate Result and decide if corrective action is needed. If so, determine which process to return to.

There are many possible outcomes to the analysis that must be performed at this step.

If the results monitoring shows that the objectives are not being met, then the cause of that problem could be that the prescribed measures have not been implemented properly, or that, having been implemented properly, they are not working well enough to get the job done. If the former, corrective action should be taken to ensure the implementation is being done correctly. If the latter, one must return to the catalog of proposed solutions, pick another, and try it.

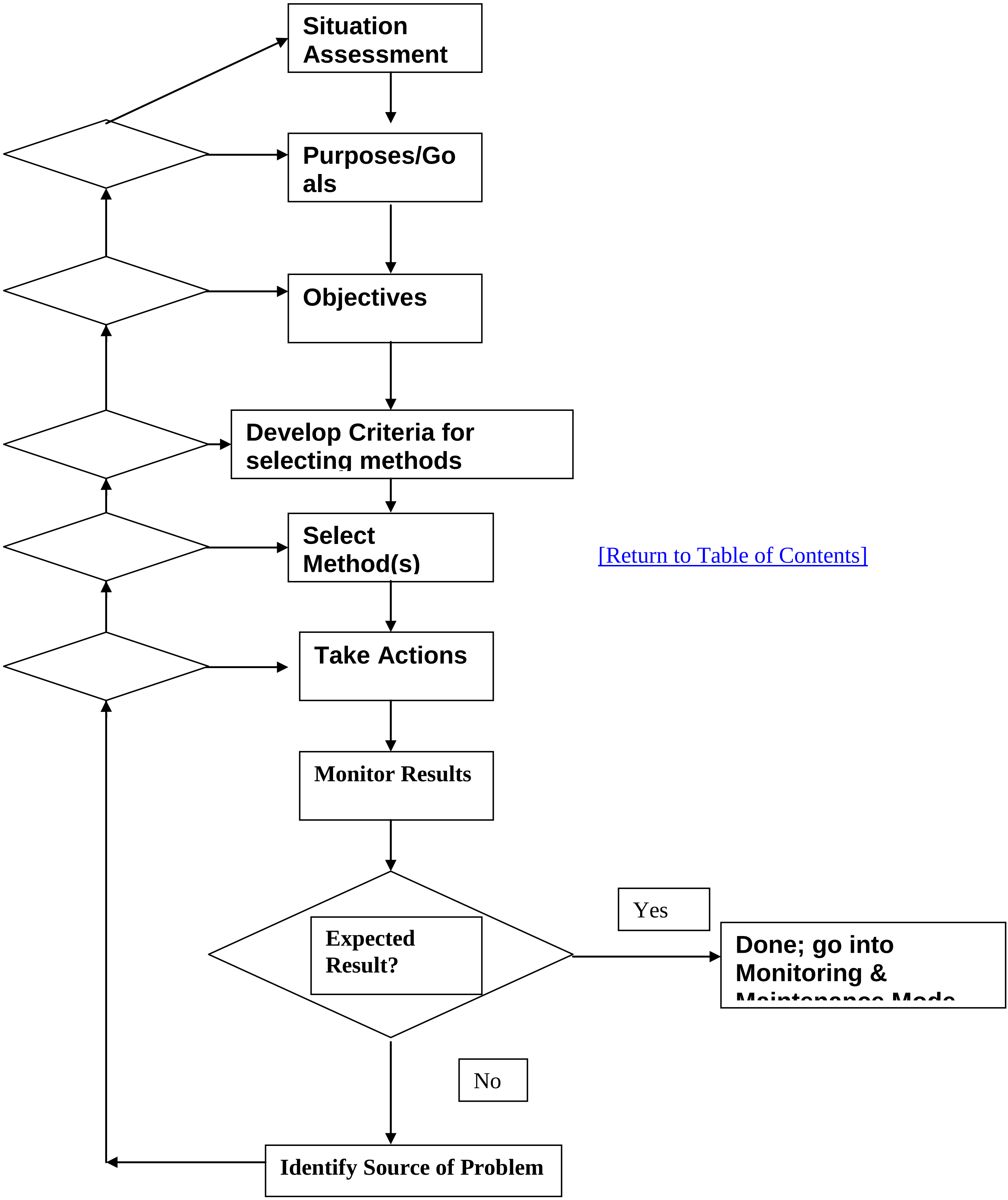
Wrong Objectives: It is also possible that the wrong measures are being taken to assure the accomplishment of the stated purpose. For example, if the goal is to maintain water quality standards at Point X, but the water samples are being taken at Point W, the correction is obvious. But it is also possible that the metric itself is flawed, or the wrong one to use. The issue of source typing for fecal coliform contamination provides a case in point. There are many types of such tests, and it is not clear which ones, if any, are the most effective for a given circumstance.

Unclear picture: The Situation Assessment step may need to be revisited if new facts come to light, models are refined, or errors in data collection or analysis are discovered.

Purpose out of reach: Finally, it may be that the purpose cannot be achieved with the available means and resources. While that is the worst-case outcome, it is better to face that fact than to continue to pour time and treasure into a hopeless task.

The entire process, including its feedback loop (Adaptive Management) is depicted below as a flow chart of its logic model.

A SIMPLIFIED LOGIC MODEL FOR NATURAL RESOURCE PUBLIC POLICY



[Return to Table of Contents]

Appendix 1: What is science?

[Return to Part 1] [Return to Table of Contents]

Description of science, from wikipedia: http://en.wikipedia.org/wiki/Science, followed by a description of the scientific method.

Science (from the Latin *scientia*, meaning "knowledge") is, in its broadest sense, any systematic knowledge-base or prescriptive practice that is capable of resulting in a correct prediction, or reliably-predictable type of outcome. In this sense, *science* may refer to a highly skilled technique, technology, or practice, from which a good deal of randomness in outcome has been removed.

In its more restricted contemporary sense, science refers to a system of acquiring knowledge based on scientific method, and to the organized body of knowledge gained through such research.[2][3] This article focuses on the more restricted use of the word. Science as discussed in this article is sometimes called experimental science to differentiate it from applied science, which is the application of scientific research to specific human needs—although the two are commonly interconnected.

Science is a continuing effort to discover and increase human knowledge and understanding through disciplined research. Using controlled methods, scientists collect observable evidence of natural or social phenomena, record measurable data relating to the observations, and analyze this information to construct theoretical explanations of how things work. The methods of scientific research include the generation of hypotheses about how phenomena work, and experimentation that tests these hypotheses under controlled conditions. Scientists are also expected to publish their information so other scientists can do similar experiments to double-check their conclusions. The results of this process enable better understanding of past events, and better ability to predict future events of the same kind as those that have been tested.

The ability of the general population to understand the basic concepts related to science is referred to as scientific literacy.

The scientific method, from Wikipedia: http://en.wikipedia.org/wiki/Scientific_method:

Scientific method refers to a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry must be based on gathering observable, empirical and measurable evidence subject to specific principles of reasoning.[1] A scientific method consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses.[2]

Although procedures vary from one field of inquiry to another, identifiable features distinguish scientific inquiry from other methodologies of knowledge. Scientific researchers propose hypotheses as explanations of phenomena, and design experimental studies to test these hypotheses. These steps must be repeatable in order to dependably predict any future results. Theories that encompass wider domains of inquiry may bind many independently-derived hypotheses together in a coherent, supportive structure. This in turn may help form new hypotheses or place groups of hypotheses into context.

Among other facets shared by the various fields of inquiry is the conviction that the process be objective to reduce biased interpretations of the results. Another basic expectation is to document, archive and share all data and methodology so they are available for careful scrutiny by other scientists, thereby allowing other researchers the opportunity to verify results by attempting to reproduce them. This practice, called *full disclosure*, also allows statistical measures of the reliability of these data to be established.

Appendix 2: The Structure of Scientific Revolutions [Return to Part 1] [Return to Table of Contents]

From wikipedia: http://en.wikipedia.org/wiki/The_Structure_of_Scientific_Revolutions

An academic study guide: http://www.des.emory.edu/mfp/Kuhn.html

[Return to Part 1] [Return to Table of Contents]

Appendix 3: Purpose Statement of the Critical Areas Ordinance, 1997 version

[Return to Part 3.4] [Return to Part 3] [Return to Table of Contents]

16.16.100 Purpose

A. The purpose of this chapter is to carry out the goals of the Whatcom County comprehensive land use plan by identifying and managing environmentally critical areas and ecosystems. This chapter seeks to maintain harmonious relationships between human activity and the natural environment.

B. By regulating development and alterations to critical areas, this chapter seeks to:

1. Protect the health, safety and welfare of the public;
2. Reduce potential losses to property and human life;
3. Protect the public from harm due to landslide, subsidence, erosion, seismic, flooding and other natural hazards;
4. Protect the public against losses from unnecessary maintenance of public facilities, property damage and cost for emergency rescue relief operations;
5. Minimize adverse impacts to the quality and quantity of water resources;
6. Alert appraisers, assessors, real estate agents, owners, potential buyers or lessees, and other members of the public to natural conditions which limit development of critical areas;
7. Prevent destruction to the natural resources necessary to maintain the viability of natural ecosystems;
8. Protect and restore critical areas, and/or mitigate impacts to critical areas by regulating their development;
9. Protect unique, fragile and valuable elements of the environment, including fish, shellfish, and wildlife habitat;
10. Protect the beneficial functions of wetlands, rivers and streams and avoid, minimize, or mitigate for damage to wetlands, rivers or streams whenever practicable;
11. Provide county officials with information to approve, condition, or deny project proposals.
12. Protect private property rights and allow for adequate and appropriate public services and facilities. Where property rights or public services are seriously compromised by the goal of critical area protection, adverse impacts may be permitted provided appropriate mitigation measures are taken.

[Return to Part 3.4] [Return to Part 3] [Return to Table of Contents]

Appendix 4: Management Science

[Return to Part 3.1]   [Return to Part 3]   [Return to Table of Contents]

Articles on two pioneers of management science:

Walter Shewhart: http://en.wikipedia.org/wiki/Walter_Shewhart; **Walter Andrew Shewhart** (pronounced like "shoe-heart", March 18, 1891 - March 11, 1967) was an American physicist, engineer and statistician, sometimes known as the *father of statistical quality control*.

W Edwards Deming: http://en.wikipedia.org/wiki/W._Edwards_Deming; **William Edwards Deming** (October 14, 1900 – December 20, 1993) was an American statistician, professor, author, lecturer, and consultant. Deming is widely credited with improving production in the United States during the Cold War, although he is perhaps best known for his work in Japan. There, from 1950 onward he taught top management how to improve design (and thus service), product quality, testing and sales (the last through global markets)[1] through various methods, including the application of statistical methods.

Deming made a significant contribution to Japan's later reputation for innovative high-quality products and its economic power. He is regarded as having had more impact upon Japanese manufacturing and business than any other individual not of Japanese heritage. Despite being considered something of a hero in Japan, he was only just beginning to win widespread recognition in the U.S. at the time of his death.

…

The Deming Cycle (or *Shewhart Cycle*): As a repetitive process to determine the next action, the Deming Cycle describes a simple method to test information before making a major decision. The 4 steps in the Deming Cycle are: Plan-Do-Check-Act (PDCA), also known as Plan-Do-Study-Act or PDSA. Dr. Deming called the cycle the *Shewhart Cycle*, after Walter A. Shewhart. The cycle can be used in various ways, such as running an experiment: PLAN (design) the experiment; DO the experiment by performing the steps; CHECK the results by testing information; and ACT on the decisions based on those results.

[The Shewhart/Deming PDCA cycle has been adopted by the International Organization for Standards, ISO; link: http://www.iso.org/iso/iso_catalogue/management_standards/understand_the_basics.htm.]

Quality Management and Total Quality Management:

Quality Management, from wikipedia (http://en.wikipedia.org/wiki/Quality_management):

Quality management can be considered to have three main components: quality control, quality assurance and quality improvement. Quality management is focused not only on product quality, but also the means to achieve it. Quality management therefore uses quality assurance and control of processes as well as products to achieve more consistent quality.

Quality management is a recent phenomenon. … The first proponent in the US for this approach was Eli Whitney who proposed (interchangeable) parts manufacture for muskets, hence producing the identical components and creating a musket assembly line. The next step forward was promoted by several people including Frederick Winslow Taylor a mechanical engineer who sought to improve industrial efficiency. He is sometimes called "the father of scientific management." He was one of the intellectual leaders of the Efficiency Movement and part of his approach laid a further foundation for quality management, including aspects like standardization and adopting improved practices. Henry Ford also was important in bringing process and quality management practices into operation in his assembly lines. In Germany, Karl Friedrich Benz, often called the inventor of the motor car, was pursuing similar assembly and production practices, although real mass production was properly initiated in Volkswagen after world war two. From this period onwards, North American companies focused predominantly upon production against lower cost with increased efficiency.

Walter A. Shewhart made a major step in the evolution towards quality management by creating a method for quality control for production, using statistical methods, first proposed in 1924. This became the

foundation for his ongoing work on statistical quality control. W. Edwards Deming later applied statistical process control methods in the United States during World War II, thereby successfully improving quality in the manufacture of munitions and other strategically important products.
There are a huge number of books available on quality. In recent times some themes have become more significant including quality culture, the importance of knowledge management, and the role of leadership in promoting and achieving high quality. Disciplines like systems thinking are bringing more holistic approaches to quality so that people, process and products are considered together rather than independent factors in quality management.

The influence of quality thinking has spread to non-traditional applications outside of walls of manufacturing, extending into service sectors and into areas such as sales, marketing and customer service.

Total Quality Management, from wikipedia (http://en.wikipedia.org/wiki/Total_quality_management):

Total Quality Management (or TQM) is a management concept coined by W. Edwards Deming. The basis of TQM is to reduce the errors produced during the manufacturing or service process, increase customer satisfaction, streamline supply chain management, aim for modernization of equipment and ensure workers have the highest level of training. One of the principal aims of TQM is to limit errors to 1 per 1 million units produced. The application of TQM can vary tremendously from business to business, even across the same industry.

There are many methods for quality improvement. These cover product improvement, process improvement and people based improvement. In the following list are methods of quality management and techniques that incorporate and drive quality improvement:

1. ISO 9004:2008 — guidelines for performance improvement.
2. ISO 15504-4: 2005 — information technology — process assessment — Part 4: Guidance on use for process improvement and process capability determination.
3. QFD — quality function deployment, also known as the house of quality approach.
4. Kaizen — 改善, Japanese for change for the better; the common English term is *continuous improvement*.
5. Zero Defect Program — created by NEC Corporation of Japan, based upon statistical process control and one of the inputs for the inventors of Six Sigma.
6. Six Sigma — 6σ, Six Sigma combines established methods such as statistical process control, design of experiments and FMEA in an overall framework.
7. PDCA — plan, do, check, act cycle for quality control purposes. (Six Sigma's DMAIC method (define, measure, analyze, improve, control) may be viewed as a particular implementation of this.)
8. Quality circle — a group (people oriented) approach to improvement.
9. Taguchi methods — statistical oriented methods including quality robustness, quality loss function, and target specifications.
10. The Toyota Production System — reworked in the west into lean manufacturing.
11. Kansei Engineering — an approach that focuses on capturing customer emotional feedback about products to drive improvement.
12. TQM — total quality management is a management strategy aimed at embedding awareness of quality in all organizational processes. First promoted in Japan with the Deming prize which was adopted and adapted in USA as the Malcolm Baldrige National Quality Award and in Europe as the European Foundation for Quality Management award (each with their own variations).
13. TRIZ — meaning "theory of inventive problem solving"
14. BPR — business process reengineering, a management approach aiming at 'clean slate' improvements (That is, ignoring existing practices).
15. OQM — Object Oriented Quality Management, a model for quality management. [2]

More links to current practitioners of and other sources for management science:

Academic resources, from wikipedia:

- International Journal of Productivity and Quality Management, ISSN 1746-6474, Inderscience
- International Journal of Quality & Reliability Management, ISSN: 0265-671X, Emerald Publishing Group

Statistical process control, from wikipeida (http://en.wikipedia.org/wiki/Statistical_process_control):
Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible with the least possible waste. While SPC has been applied most frequently to controlling manufacturing lines, it applies equally well to any process with a measurable output. Key tools in SPC are control charts, a focus on continuous improvement and designed experiments.

Much of the power of SPC lies in the ability to examine a process and the sources of variation in that process using tools that give weight to objective analysis over subjective opinions and that allow the strength of each source to be determined numerically. Variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer. With its emphasis on early detection and prevention of problems, SPC has a distinct advantage over other quality methods, such as inspection, that apply resources to detecting and correcting problems after they have occurred.

Management science applied to government; Erie County, New York, a case study:

http://wwww.erie.gov/exec/public/pdf/Six%20Sigma%20Website%20Overview.pdf

"Learning Faster Than Your Competitor May Be The Only Sustainable Competitive Advantage"
from Erie County Lean Six Sigma Overview

http://wwww.erie.gov/exec/?reform-government/lean-six-sigma-initiative/projects.html
List of Lean Six Sigma projects Erie County

Erie County Six Sigma featured by Minitab Incorporated

Erie County Lean Six Sigma featured by Quality Digest Daily online

[Return to Part 3.1] [Return to Part 3] [Return to Table of Contents]

Appendix 5: Adaptive Management

[Return to Part 3.2] [Return to Part 3] [Return to Table of Contents]

Excerpts from article in wikipedia: http://en.wikipedia.org/wiki/Adaptive_management

Adaptive management (AM), also known as **adaptive resource management** (ARM), is a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management. AM is often characterized as "learning by doing."

Adaptive management can be considered either passive or active. Passive adaptive management begins by using predictive modeling based on present knowledge to inform management decisions. As new knowledge is gained, the models are updated and management decisions adapted accordingly.

Active adaptive management, on the other hand, involves changing management strategies altogether in order to test completely new hypotheses. So while the goal of passive adaptive management is to improve existing management approaches, the goal of active adaptive management is to learn by experimentation in order to determine the best management strategy.

Key features of both passive and active adaptive management are:

- Iterative decision-making (evaluating results and adjusting actions on the basis of what has been learned)
- Feedback between monitoring and decisions (learning)
- Explicit characterization of system uncertainty through multi-model inference
- Bayesian inference
- Embracing risk and uncertainty as a way of building understanding

Adaptive management is particularly applicable for systems in which learning via experimentation is impractical. However, any one of five process failures can seriously compromise effective adaptive management decision making (Elzinga et al. 1998):

- The monitoring is never completed.
- The monitoring data are not analyzed.
- The analyzed results are not conclusive.
- The analyzed results are interesting but never reach decision makers.
- The decision makers do not use the results because of internal or external factors.

Because adaptive management is used to make decisions regarding the management of valuable natural resources, it directly affects (and is affected by) public policy and politics.

Applying adaptive management in a conservation project or program involves the integration of project/program design, management, and monitoring to systematically test assumptions in order to adapt and learn. This definition can be expanded by looking at its 3 components:

- **Testing Assumptions** is about systematically trying different actions to achieve a desired outcome. It is not, however, a random trial-and-error process. Rather, it involves using knowledge about the specific site to pick the best known strategy, laying out the assumptions behind how that strategy will work, and then collecting monitoring data to determine if the assumptions hold true.

- **Adaptation** involves changing assumptions and interventions to respond to new or different information obtained through monitoring and project experience.
- **Learning** is about explicitly documenting a team's planning and implementation processes and its successes and failures for internal learning as well as learning across the conservation community. This learning enables conservation practitioners to design and manage projects better and avoid some of the perils others have encountered.

[Return to Part 3.2] [Return to Part 3] [Return to Table of Contents]

Appendix Six: Procedural History of the CAO

[Return to Part 3.3] [Return to Part 3] [Return to Table of Contents]

Chronology of Events Whatcom County Critical Areas Ordinance

1991: First Citizens Advisory Committee formed

January 16, 1992 First draft of what the County Planning staff refers to as the Temporary CAO issued

January/February, 1992: First SEPA Appeal of DNS to Hearing Examiner by Skip Richards

Decision: Nothing in SEPA requires the County to perform an EIS on environmental regulations; the Council is the primary authority in that regard; inadequate notice to affected parties.

March, 1992: County Council sends out single-page legal-size generic notice to all property owners in the unincorporated areas of the County; notice describes CAO in bland terms and gives upcoming hearing schedule, including three "town meetings" held March 31, April 1, and April 2, 1992

March/April 1992: Informal meetings between County Planning Staff and interested parties including Skip Richards; some changes made to draft CAO, but unresolved concerns remained

May, 1992: Rural property rights organization founded by Skip Richards begins protest against CAO

March/June 1992: several revised drafts of CAO issued and Council work sessions and public hearings held

May/June, 1992: County Council holds series of public hearings on CAO

June 23, 1992: County Council adopts CAO by 7/0 vote.

August, 1992, Steve Brisbane files referendum proposing major amendments to CAO; decision to propose repealing the entire ordinance rejected by Brisbane and his supporters because it would put the County in violation of the GMA

December, 1992, group formed by Brisbane and managed by Skip Richards delivers over 11,500 signatures on petition for Referendum 92-3 (County Planning staff later mislabeled it Referendum 93-2, and that error crept into the official record in various places).

January 4, 1993: County Auditor certifies Referendum for placement on the November 1993 general election ballot; stopped counting valid signatures after required threshold of approximately 7,800 had been well exceeded. The Referendum would have taken effect immediately pending the vote, but …

January 7, 1993: Whatcom County Council votes 4-3 to sue to stop Referendum 92-3 from going on the ballot

January 12, 1993: Whatcom County Superior Court grants temporary injunction against Referendum 92-3

January 29, 1993: Superior Court rescinds injunction against Referendum

May 14, 1994: Whatcom County Superior Court grants summary judgment in favor of allowing the Referendum vote to proceed;

June 1, 1993: County Council votes 5-2 to appeal Superior Court ruling; appeal to be heard directly by State Supreme Court

October 24, 1993: After a lopsided debate on October 20 at Sehome High School, the Bellingham Herald endorsed Referendum 92-3, citing the important role of "[e]conomic, social, and constitutional issues …"

November 2, 1993: Referendum 92-3 wins with 53.5% of the vote; all County Council candidates who endorsed Referendum win their elections

January, 1994: local citizens group files appeal with Growth Management Hearings Board claiming Referendum version of CAO violates GMA

Later in 1994: State Supreme Court, in an 8-1 decision (***Whatcom County v Brisbane***), invalidates Referendum 92-3, declares all provisions of the GMA immune to local referendum, determining that only county legislative authorities have power to pass GMA ordinances such as the CAO

Later in 1994: Responding to the State Supreme Court's decision, Whatcom County Council decides to adopt Referendum 92-3, as is, as the CAO; planning staff attempts to require an MDNS under SEPA, inserting provisions that would restore much of what the Referendum removed

February, 1995 MDNS appealed to Hearing Examiner (HE); a citizen appeals to require an EIS, another (Skip Richards) to drop the mitigation requirements and leave the Referendum version intact; HE decides, consistent with previous ruling, that County Council can do as it sees fit, requires planning staff to drop mitigating conditions

Later in 1995 County Council passes ordinance making Referendum 92-3 the CAO.

1995/6: State Department of Ecology intervenes in appeal to GM Hearings Board action against County, pressures County to amend Referendum version of CAO

1996-1997: After months of protracted negotiations, County settles with DOE, adopts compromise amendments, resulting in CAO adopted November 1997. One of the bases cited for the amendments was the continuing deterioration of water quality and fish habitat.

2005: As part of the required GMA update process, County adopts a new CAO that features many of the provisions objected to back in 1992/93 era, plus other provisions arguably more restrictive than the 1992 version. One of the bases cited for the amendments was the continuing deterioration of water quality and fish habitat.

[Return to Part 3.3] [Return to Part 3] [Return to Table of Contents]

Appendix 7: Multivariable Analysis of Diminishing Returns
Supplemental Testimony submitted to County Council 050913
Regarding the draft proposed revised Critical Areas Ordinance (CAO)
Skip Richards, member, Citizens Advisory Committee on Critical Areas and Shorelines

[Return to Table of Contents]

Apparently council members had some difficulty in following the point I attempted to make last time regarding the relevance of a proper use of diminishing returns analysis in fulfilling the GMA requirement to use best available science in developing a CAO. In an attempt to clarify that point, I am providing this supplemental testimony. Figure 1, Page 3, illustrates the results of the studies selected by the consultant regarding buffer width effectiveness. In the upper graph, the horizontal axis measures land area consumed by buffer width, while the vertical axis represents the magnitude of the ecological functions protected as a function of the land area set aside for buffers. The graph illustrates an example of the general shape of the curves found by these studies, without regard to specific values. I have no reason to doubt their results (although I have not personally nor am I aware that anyone else, either on the Citizens Advisory Committee, county staff, or others, has undertaken to verify that the studies selected by the consultant are indeed representative of the entire range of peer reviewed scientific literature on the subject).

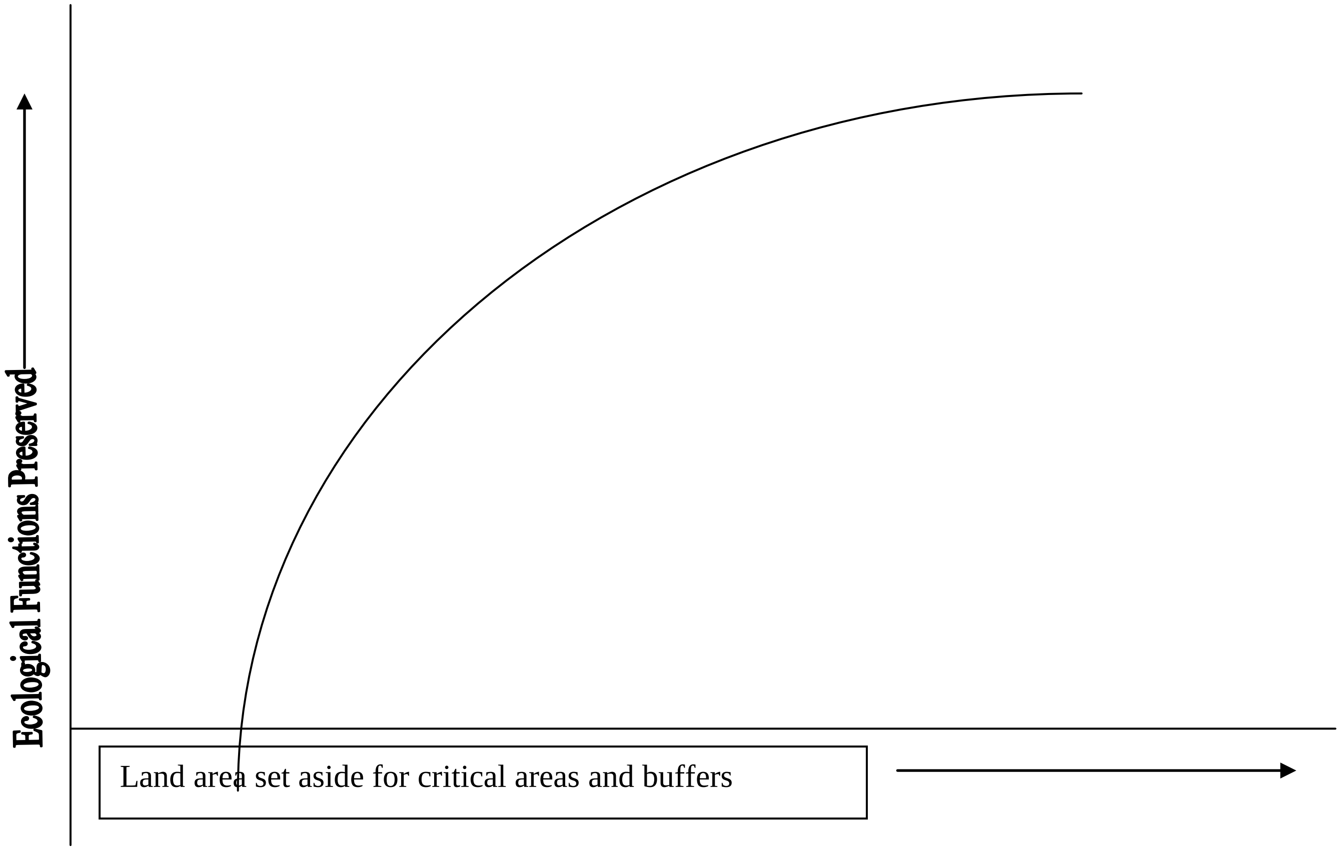
The lower graph in Figure 1 illustrates the missing portion in any valid diminishing returns analysis, namely, the costs incurred on the economic side as a function of the land taken out of productive use by critical areas and their buffers. In the lower graph, the land area set aside for buffers lies along the horizontal axis, as with the upper graph, while the productive capacity of the land, captioned as "yield," lies along the vertical axis. Again, the curve is idealized; the actual shape and values will vary widely depending upon type of use and site-specific factors. The impact can by anywhere from minimal, to devastating, rendering the parcel in question incapable of productive use.

Figure two, Page 4, illustrates the comprehensive application of diminishing returns, where the benefits and costs of varying levels of critical area protection are overlaid. Without the data provided in the lower graph of Figure 1, there is no way to determine the decision-relevant intersection point of the two curves illustrated in Figure 2.

The magnitude of the cumulative economic, social, and ecological impact of taking land out of production is unknown, because the analysis has not been done. It is certain to be nontrivial. In the case of ag land, doesn't it make sense to ensure that the policies of preserving ag land are not undermined by a CAO that takes too much ag land out of production, either through buffers, or through the application of its deletion of the exemption of existing ag activities, per the PC proposal to delete the Section 16.16.230 D Exemption? In the case of development, the application of the comprehensive diminishing returns analysis might help reduce the odds that applications for some projects in areas selected for infill would be abandoned because of the prohibitive costs associated with the application of the CAO.

All this is not meant to question the particular choice(s) of buffer widths set forth in the wetlands or habitat sections of the proposed CAO; indeed, it would be difficult to do so since there are so many options provided that depend upon site-specific circumstances, which is as it should be. It is unfortunate that a more comprehensive analysis was not undertaken, not only so as to reduce the county's exposure to GMA-based legal challenges as the ordinance is applied in cases where the impact to the applicant puts them in a situation where they have little left to lose by rolling the dice of litigation, but also to a better job of fulfilling the purpose of the CAO, to "maintain harmonious relationships between human activity and the natural environment".

Figure 1:


Ecological Functions Preserved
Land area set aside for critical areas and buffers

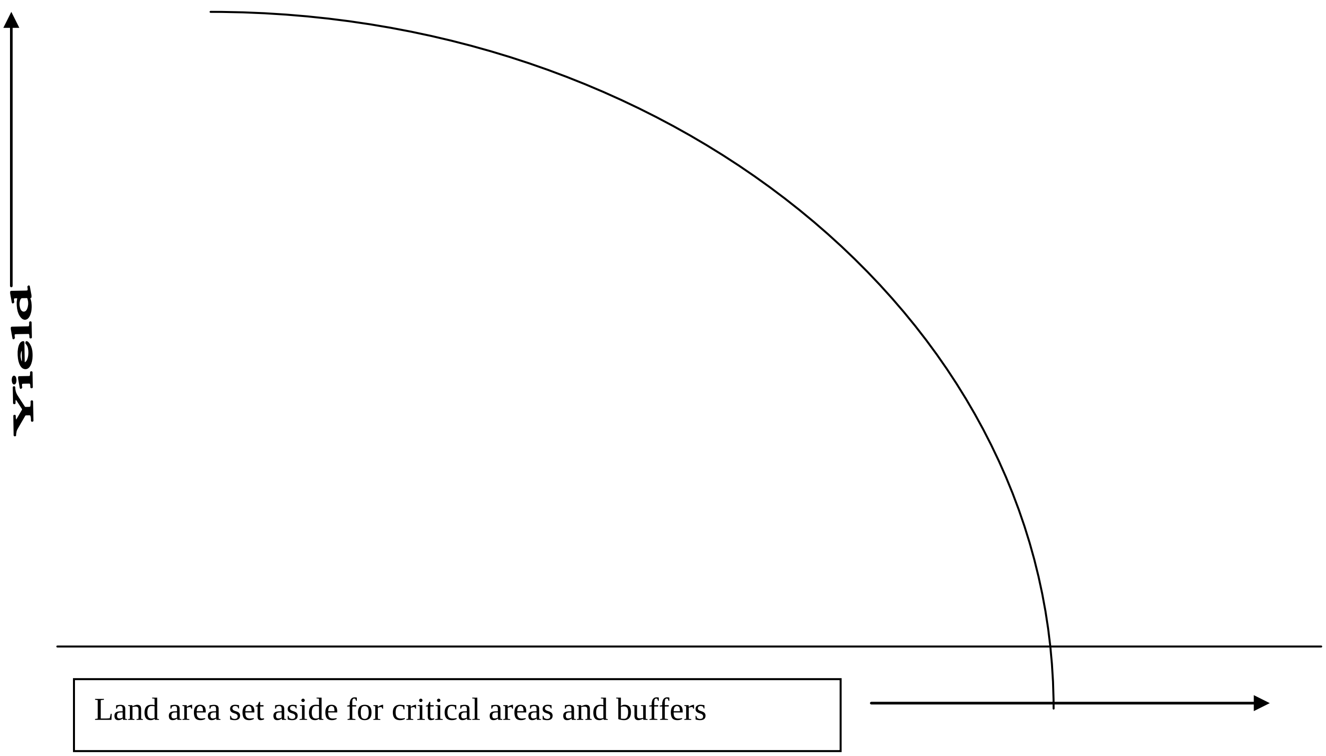
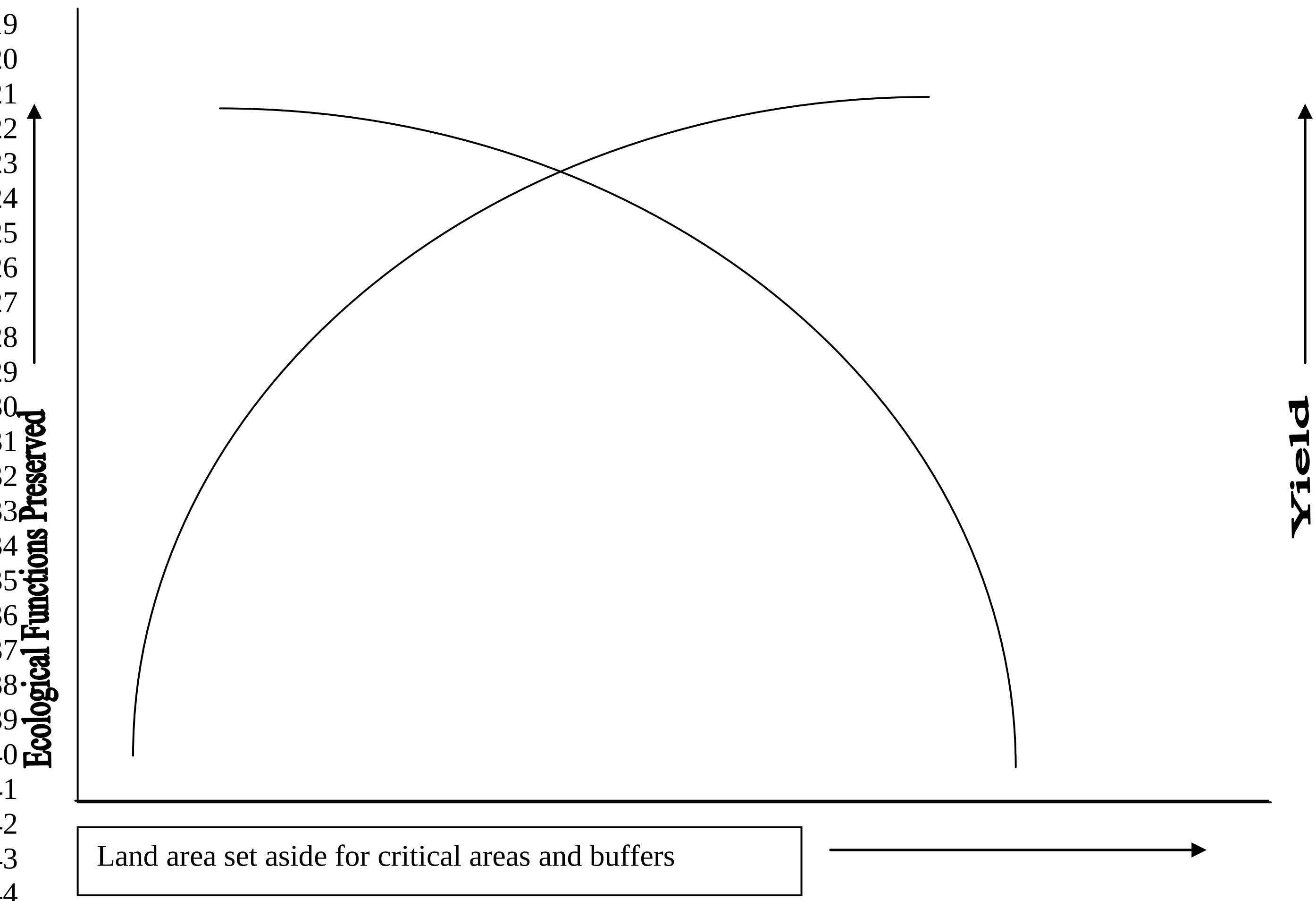

Yield
Land area set aside for critical areas and buffers

Figure 2:



[Return to Table of Contents]