APPENDIX A

Analysis of the Adequacy, Efficiency, Economy and Reliability of the Power System

Executive Summary

The U.S. Ninth Circuit Court of Appeals' 1994 decision in NRIC v. Northwest Power Planning Council characterizes the fish and wildlife provisions of the Northwest Power Act as "[a]ttempting to balance environmental and energy considerations."[1] The Northwest Power Planning Council's Columbia River Basin Fish And Wildlife program must consist of measures to "protect, mitigate, and enhance fish and wildlife affected by the development, operation, and management of [hydropower] facilities while assuring the Pacific Northwest an adequate, efficient, economical, and reliable power supply."[2] "Assuring" the region of such a power supply implies a reasonable degree of certainty that the objectives of adequacy, efficiency, economy and reliability will be achieved.

The Council must also determine whether the Fish and Wildlife program (Program) is consistent with the purposes of the Northwest Power Act.[3] These purposes include encouraging conservation of electricity and timely repayment of the Bonneville Power Administration's (Bonneville) debt to the federal treasury.[4] An adequate, efficient, economical and reliable power supply that includes a healthy and financially viable Bonneville is essential to carrying out those purposes.

In terms of their effect on the power system, the newly adopted amendments to the Program have very little impact relative to the NOAA Fisheries' 2000 Biological Opinion (current operation). Relative to that operation, the Program decreases annual hydroelectric generation by less than five average megawatts, out of a total system average generation of about 16,000 average megawatts. The average regional cost is less than $10 million per year, compared to an estimated $6 billion per year regional electricity industry[5]. The implementation of the mainstem operation in the Program will effectively have no impacts to the adequacy, efficiency, economy or reliability of the power system. However, the 2000 Biological Opinion (BiOp) itself has a sizeable impact on power generation, which has arguably affected adequacy, efficiency, economy and reliability in a significant way.

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1 NRIC v. Northwest Power Planning Council slip opinion at p. 10879 (9th Cir. 1994)/

2 16 U.S.C. § 839b(h)(5).

3 16 U.S.C. § 839 b(h)(7)

4 16 U.S.C. § 839(1), (4).

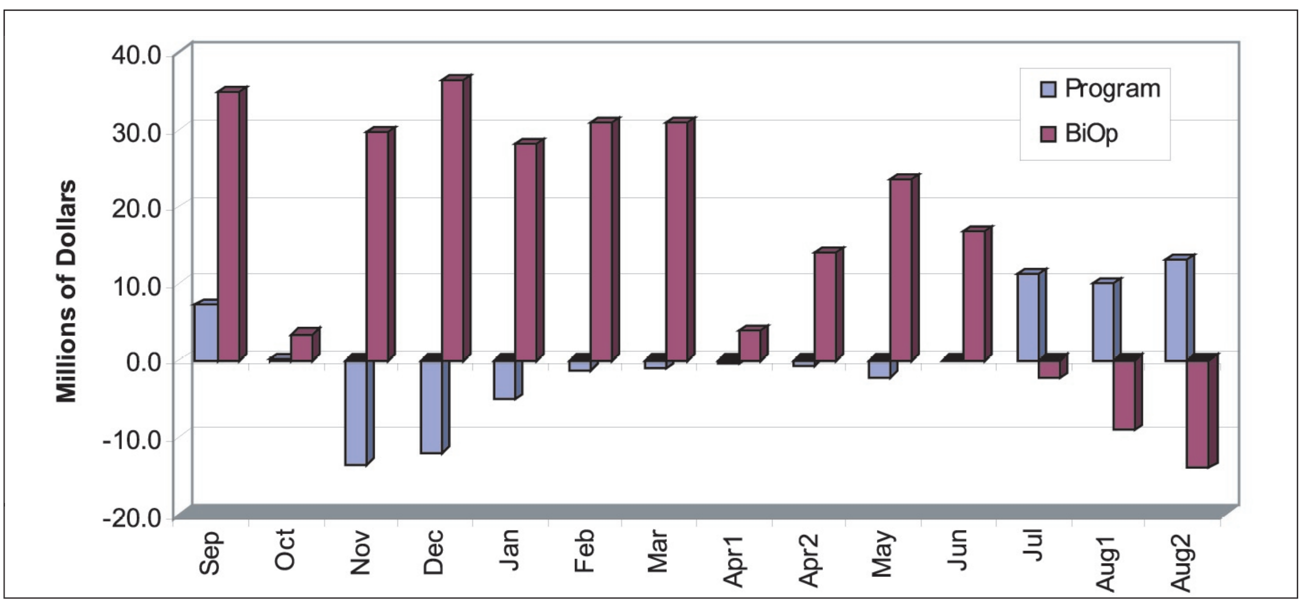
5 Bonneville's net revenue requirements are on the order of about half this amount or about $3 billion per year. Obviously, electricity prices affect these estimates.

Current Operations and the Council Amendments

Council analysis has found that the BiOp, relative to a "pre-1980"[6] operation, reduces net regional power system generation by approximately 1,050 average megawatts on average[7] and has an average annual power system cost of approximately $260 million when evaluated using wholesale electricity market prices based on average water conditions and an efficiently functioning market.[8] However, as the experience of 2000-01 demonstrated, the impacts can be much greater when conditions deviate significantly from those assumptions. Bonneville estimated that for 2001, the additional power purchases and foregone revenues attributable to the flow and bypass spill requirements of the BiOp were $1.5 billion.[9] Had bypass spill not largely been curtailed, the cost would have been considerably larger. The large increase in costs is attributable to the fact that market prices across the period were approximately a factor of 10 greater than those seen under "normal" market conditions. More on this topic can be found in Appendix 2 to this analysis.

Figure 1 shows the average monthly change in hydroelectric generation for the Program relative to the BiOp and also for the BiOp relative to a "pre-1980" operation. In other words, the lighter colored columns reflect generation changes from current operations. The darker columns reflect how current operations have affected generation compared to the "pre-1980" case. (Adding the two bars for each month yields the combined effect of the BiOp and the Program relative to the "pre-1980" operation). On average, implementing the Program will increase winter generation, thus potentially improving reliability since the northwest is a winter-peaking system. In the summer, the Program decreases river flows and subsequently also hydroelectric generation. This has the potential to affect summer reliability as our summer loads grow. And, because market prices are higher in the summer, it will have a larger cost impact. Historically, the northwest has not had to plan for summer peaks because of the extensive hydroelectric capacity of the system. With the exception of September, the generation impacts of the Program move in the opposite direction of the BiOp. In other words, the Program incrementally shifts the generation (and flows) back in the direction of a "pre-1980" operation.

Figure 1
Average Monthly Changes in Hydroelectric Generation



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6 The operation of the system has always taken into account multiple purposes such as flood control, recreation, navigation and irrigation, all of which impact the power producing capability of the system. However, beginning in the 1980s, restrictions on the operation of the system for the purpose of aiding the downstream migration of juvenile salmonids were implemented.

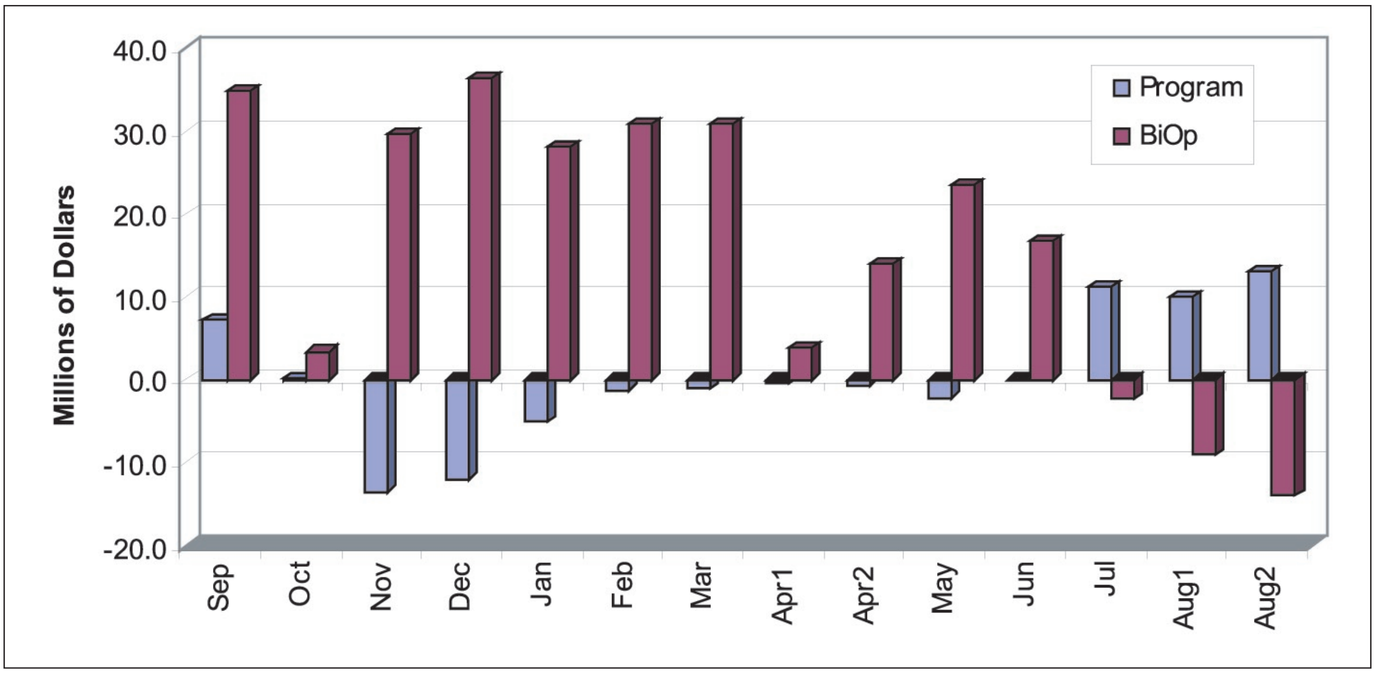
7 Average regional hydroelectric generation is about 16,000 average megawatts based on a fifty-year historical water record.

8 This estimate is based on an annual average wholesale electricity price of about $28/megawatt-hour and assumes a bypass spill operation revised in 2003.

9 It should also be noted that the cost of all other non-power hydro operations in 2001 were equally affected by the high electricity prices.

Figure 2 summarizes the average monthly cost impacts of the Program and the BiOp. Again, as in Figure 1, the Program costs are relative the BiOp and the BiOp costs are relative to a "pre-1980" operation. Positive values in Figure 2 reflect regional costs and negative values represent a reduction in costs (or benefits). Since the cost of a particular change in hydroelectric system operation is inversely proportional to the change in generation, the pattern in Figure 2 is similar but reversed from that in Figure 1. In other words, an operation that causes a decrease in generation represents a cost to the system. The pattern is not exactly the inverse because electricity prices vary from month to month. In shifting generation from the summer to the winter, the Program effectively reduces the system's revenues because it is moving generation from a period of higher prices to one of lower prices. What is interesting to note is that although the Program incrementally moves the operation in the direction of a "pre-1980" operation, it adds cost, albeit a small cost at about $6 million per year. For perspective, the average power-system cost of the BiOp is about $260 million per year.

Figure 2
Average Monthly Costs



Generally speaking, impacts to winter reliability stem from reservoir operations that are rigid and offer little or no flexibility in terms of drafting water below the rule curves during short emergency periods. Having more hydro energy available during the winter months clearly helps in this area but the ability to shape that energy into the peak demand hours is the key component to reliability. Currently, the Northwest is not facing a reliability concern. Under this condition, implementing the hydroelectric operations in the Program will not change the winter loss of load probability (LOLP) relative to the BiOp. Under a BiOp operation, if the system were closer to load/resource balance with an LOLP over 5 percent, implementing the Program measures could decrease (improve) the winter LOLP by one or two percent.[10]

[10] This estimate is based on the Council's 2000 study on adequacy in which a 3,000 megawatt increase in capacity dropped the LOLP by 12

Background

There is a very wide spectrum of views in the region regarding the meaning of an adequate, efficient, economical and reliable power supply. Some hold that it must be considered entirely in the context of the power system that existed in 1980 (pre-fish-and-wildlife constraints). In this view, an acceptable power supply is one whose characteristics only differ in a minor way from those of the 1980 system. For others, it may mean doing whatever is necessary to accommodate the needs of fish and wildlife, so long as some kind of power system can be maintained that is roughly as adequate, efficient, economical and reliable as those in other parts of the nation.

It would be difficult to argue that the power system impacts of the BiOp have made the power system inadequate, inefficient, uneconomical and unreliable in an absolute sense. For several years the system has been operated under similar fish and wildlife constraints without disastrous consequences for the system or the regional economy. However, the cost to the power system was nonetheless considerable. Consequently, the Council is very interested in the power system impacts of mainstem actions. The question of how the impacts of fish operations on the power system can be lessened while still fulfilling the objective of protecting, mitigating and enhancing the fish and wildlife of the Columbia Basin is in the forefront of the Council's thinking. In fact, the Council's amendments call for a reevaluation of specific mainstem actions (e.g. bypass spill at lower river projects).[11] The Council has already done some work to evaluate the cost of spill at specific projects.[12] This information, considered in light of the uncertainty regarding the effectiveness of flow and spill should help frame some of the mainstem components of a research agenda that would improve the cost-effectiveness of actions designed to protect fish and wildlife.[13]

In 2000-01, the system was unable to meet loads, satisfy the requirements of the BiOp and maintain moderate prices in what turned out to be a very poor water year. However, while the effects of fish operations on the power system contributed in some measure to the problem, they were by no means the cause. As is discussed in greater detail in Appendix 2 to this analysis, the problem was the consequence of a systemic failure to develop sufficient resources, exacerbated by characteristics of an immature and, particularly in the case of California, poorly designed power market. One of the mechanisms by which the power system coped with the crisis was to dramatically reduce bypass spill in order to be able to increase summer energy production and reduce purchased power costs and to store energy (water) for winter use. Some argue that reliability of the power system was protected at the expense of fish and wildlife.[14] Yet in spite of these actions, as was noted earlier, very large costs were still incurred by the power system in meeting the flow requirements of the BiOp in 2001.

In general, it is likely that the adequacy, reliability, efficiency and economy of the region's power supply can only be fully gauged in the context of a full revision of the Council's Power Plan, which is currently underway. Congress appears to have had this in mind. Congress anticipated that the Council would develop the fish and wildlife program immediately after passage of the Act.[15] In contrast, the Council was given up to two years to develop the power plan. Among its several purposes, the power plan is intended to lay out a resource strategy that will:

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11 Mainstem Amendments to the Columbia River Basin Program, April 10, 2003. http://www.nwcouncil.org/fw/program/mainstem/Default.htm

12 Cost and Energy Impacts of Fish and Wildlife Operations, http://www.nwcouncil.org/library/2002/costenergyimpacts/slide1.HTM

13 "Mainstem Passage Strategies in the Columbia River System: Transportation, Spill, and Flow Augmentation" by A. Giorgi, M. Miller, and J. Stevenson of BioAnalysts, Inc. (Giorgi et al. 2002).

14 In reality, changes in fish operations were only one aspect of the response to tight supplies and high prices. Other responses included very large long-term curtailments of electricity loads and substantial new "emergency" generation.

15 Remarks of Rep. Dingell, Cong. Rec. p. H10683, November 17, 1980.

> reduce or meet the Administrator's [of the Bonneville Power Administration] obligations with due consideration by the Council for (A) environmental quality, (B) compatibility with the existing regional power system, (C) protection, mitigation and enhancement of fish and wildlife and related spawning grounds and habitat, including sufficient quantities and qualities of flows for successful migration, survival, and propagation of anadromous fish, and (D) other criteria which may be set forth in the plan.[16]

In a sense, the Act establishes a reciprocal arrangement between the fish and wildlife program and the power plan. The fish and wildlife program must still assure the region that it will not cause the power system to be inadequate, inefficient, uneconomical and unreliable. In return, the requirements of the fish and wildlife program are factors to be taken into account in the development of the power plan. In other words, the mutual impacts of fish and power measures are intended to be examined together.[17] It may be that the potential impacts of a particular fish and wildlife measure look different in the context of a full revision of the power plan than they do during the fish and wildlife amendment process. That is, it is likely that we will be better able to assure an adequate, efficient, economical and reliable power supply that also adequately supports the protection, mitigation and enhancement of fish and wildlife in the context of a full revision of the Power Plan.

The experience of 2000-01 revealed serious problems with the planning, development and operation of the power system in the then-current market environment with respect to maintaining an adequate, efficient, economic and reliable power system. While there have been significant changes in the market since then, it is not clear that all the root causes have been adequately addressed. The revision of the power plan that is underway is analyzing these problems and possible solutions. Among the specific issues is the interaction of the fish operations and the power system during periods of power system stress and how to assure equitable treatment of fish in that context.

This does not mean that, in adopting the fish and wildlife measures, the Council need not make a determination that the fish and wildlife program does not jeopardize the ability of the region to have an "adequate, efficient, economical and reliable power supply." It must do so. But its determination must recognize that a fuller analysis of the issue will follow in the revision of the power plan.

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[16] 16 U.S.C. § 839b(e)(2).

[17] 16 U.S.C. § 839b(e)(3)(F).

Summary and Conclusions

The adequacy, efficiency, economy and reliability of the power system is best thought of in two time frames: the short-term (the next 2-3 years) during which period it would not be possible to complete large changes to the power system to respond to fish and wildlife program requirements; and the long-term during which there is time to respond, provided the market and/or regulatory incentives are there to promote actions. Based on our analysis, in the near term (the next 2-3 years), the region is expected to have an adequate, reliable and efficient power supply. This is largely the result of still-depressed demand for electricity and the number of new power plants that have recently entered service or are under construction here in the Northwest and elsewhere in the West. While the pace of development has dropped off recently, the lowered demand combined with the plants that have been or soon will be completed, provide sufficient adequacy and reliability in the near term.

The "economical" objective is somewhat more questionable. Bonneville and other utilities in the Northwest are facing financial problems as a consequence of both the costs of power purchased at elevated prices during the electricity crisis and reduced revenues as a result of the depression in prices in the *wholesale* electricity market over the past year. The Northwest economy is in recession and, while increased *retail* electricity prices are not the primary cause, they have been a contributing factor. Bonneville is facing the need to cut costs and either increase rates or risk higher probabilities of being unable to meet its treasury repayment. Bonneville's current financial situation is, for the most part, attributable to problems with the structure and operation of the power system. The incremental cost of fish and wildlife operations did not put Bonneville in this position but it also certainly doesn't help Bonneville in the short term.

In the longer term, assuring the region an adequate, efficient, economic and reliable power supply will depend on the successful resolution of a number of issues: These include:

- The adequacy of financial or regulatory incentives for the development of new resources, both generation and demand-side;
- Mechanisms to increase the responsiveness of retail demand to increases in wholesale prices;
- The adequacy of mechanisms to ensure investment in cost-effective levels of new efficiency resources;
- Removing barriers to ensure adequate resource diversity to mitigate risk;
- Development of mechanisms to ensure equitable treatment of fish and power during extreme dry years.

These issues are being addressed in the Fifth Power Plan. With successful resolution of these issues, an adequate, efficient, economical and reliable power system can be assured with the fish operations embodied in the Council's Fish and Wildlife program. During the development of the power plan, the efficiency or cost-effectiveness of some fish operations (in particular bypass spill) will be examined. It is the Council's mandate to produce a power plan that reduces costs whenever possible, while not degrading protection for fish and wildlife.

Appendix 1

Definitions and Further Analysis of Adequate, Efficient, Economical and Reliable

Adequate and *reliable* have specific meanings in the power industry. Adequacy is a component of reliability. A Power system is ***reliable*** if it is:

–***Adequate*** - the electric system can supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.

–***Secure*** - the electric system can withstand sudden disturbances such as electric short circuits or unanticipated loss of system elements.[18]

Adequacy refers to having sufficient resources – generation, efficiency and transmission – to serve loads. Simplistically, in determining adequacy, resources are "derated" to take into account expected performance including scheduled and typical forced outages. Hydro resources are evaluated under worst case or "critical" hydro conditions. Similarly, loads are evaluated under extreme temperature conditions. Here in the Northwest, that typically means during a prolonged cold snap.

Security is achieved largely by having reserves that can be brought on line quickly in the event of a system disruption and through controls on the transmission system. These reserves can be in the form of generation or demand side curtailment that can take load off the system quickly. The National Electric Reliability Council (NERC) and the Western Electricity Coordinating Council (WECC) establish reserve requirements. The reserve requirement is frequently expressed in terms of a percentage of load or largest single contingency, e.g., the loss of Energy Northwest's Columbia Generating Station. The reserves required for security are an additional resource requirement necessary for a reliable power system.

Here in the Northwest, determination of power supply adequacy and reliability is complicated by the fact that the output of the hydroelectric system can vary widely from year to year. This is because the hydro system has limited storage capacity. Consequently, the output of the system can vary widely depending on the amount, timing and form (rain or snow) of precipitation in a given year. In addition, during cold snaps side flows into the system can be reduced, restricting the ability of the system to sustain a high level of output for an extended period.

For purposes of this analysis, adequacy and reliability need to be evaluated in two time frames: the short-term – the two to three years it takes to bring significant new resources into the system; and the long-term – three years and beyond. In the short term, the question is whether there exist sufficient resources to assure adequacy and reliability. In the long term, the question is whether the incentives, market or otherwise, or regulatory policies and mechanisms exist to ensure that sufficient resources, including demand side resources, will be added to the system.

Adequate and Reliable – Short-Term Analysis

In the short-term, we believe the Northwest has an adequate and reliable power system. The reasons are three: 1) The Fish and Wildlife program does not significantly affect the power output of the hydroelectric system beyond

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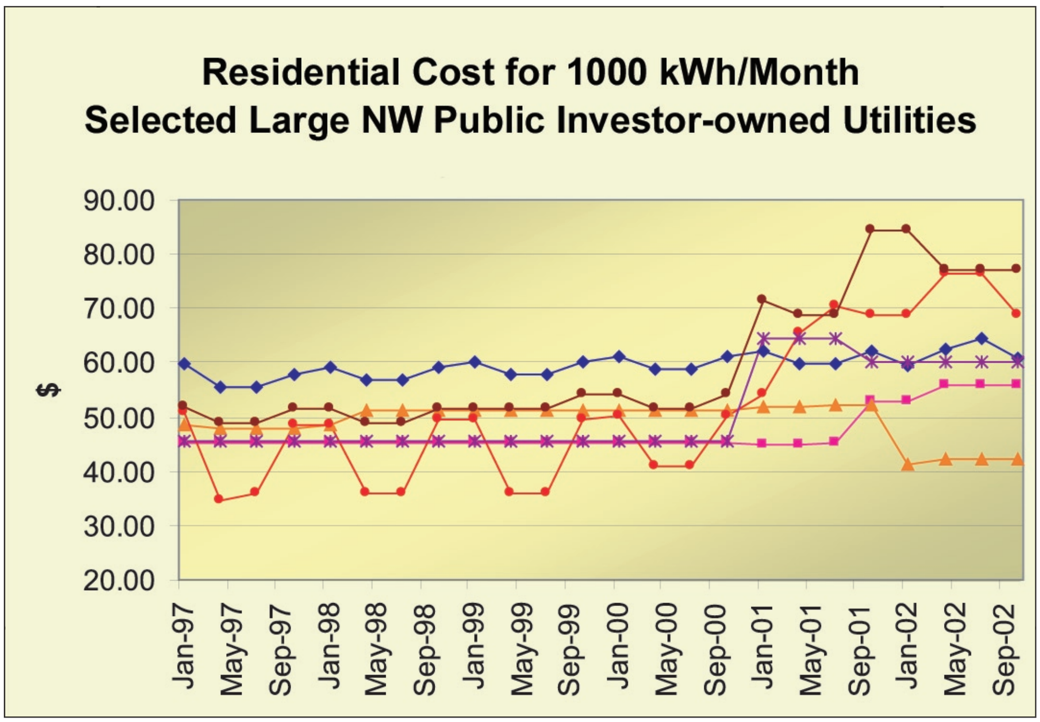
[18] "Glossary of Terms," North American Electric Reliability Council, Glossary of Terms Task Force, August 1996

the BiOp operations. 2) Slowly recovering demand means the stress on the system is less significant than when the Council did its 2000 reliability analysis; and 3) There has been substantial addition of new resources here in the Northwest and elsewhere in the West, even taking into account recent construction deferrals.

As noted earlier, the BiOp has had a substantial effect on the power production of the hydro system compared to a "pre-1980" operation. However the system has been operating successfully under these constraints for some time.

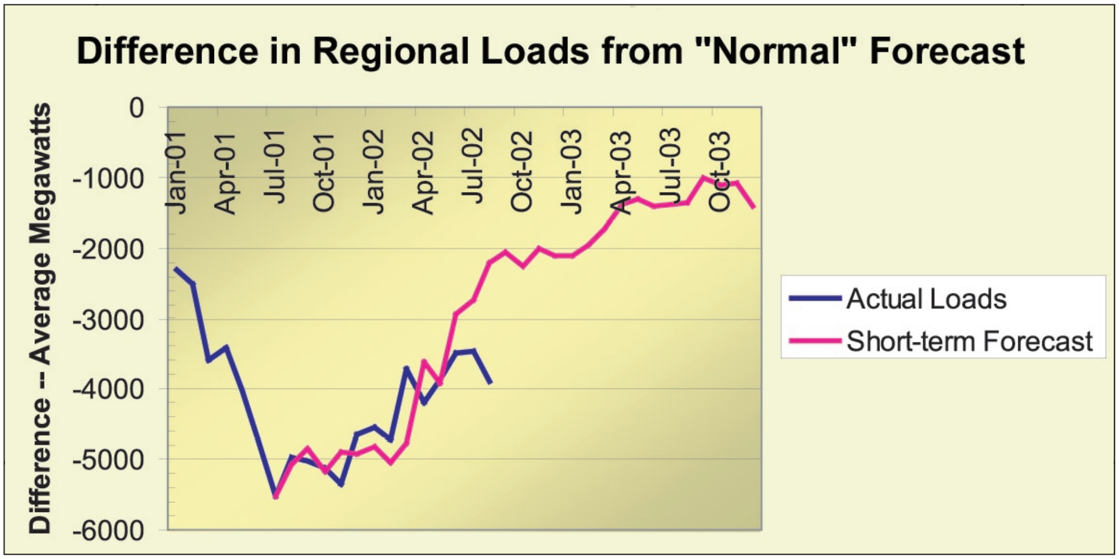
Regional loads are down substantially from "normal" levels. This is a function of depressed aluminum market (that, combined with higher power prices, precludes many aluminum plants from returning to operation), the effects of the economic slowdown, and "hangover" effects of the 2000-01 power crisis, (e.g., conservation stimulated by the increases in retail rates that have taken place over the last 6 to 12 months). For example, Figure A1 shows data compiled by the Washington Utilities and Transportation Commission comparing the cost for 1,000 kWh of electricity for 6 Washington utilities.

Figure A1



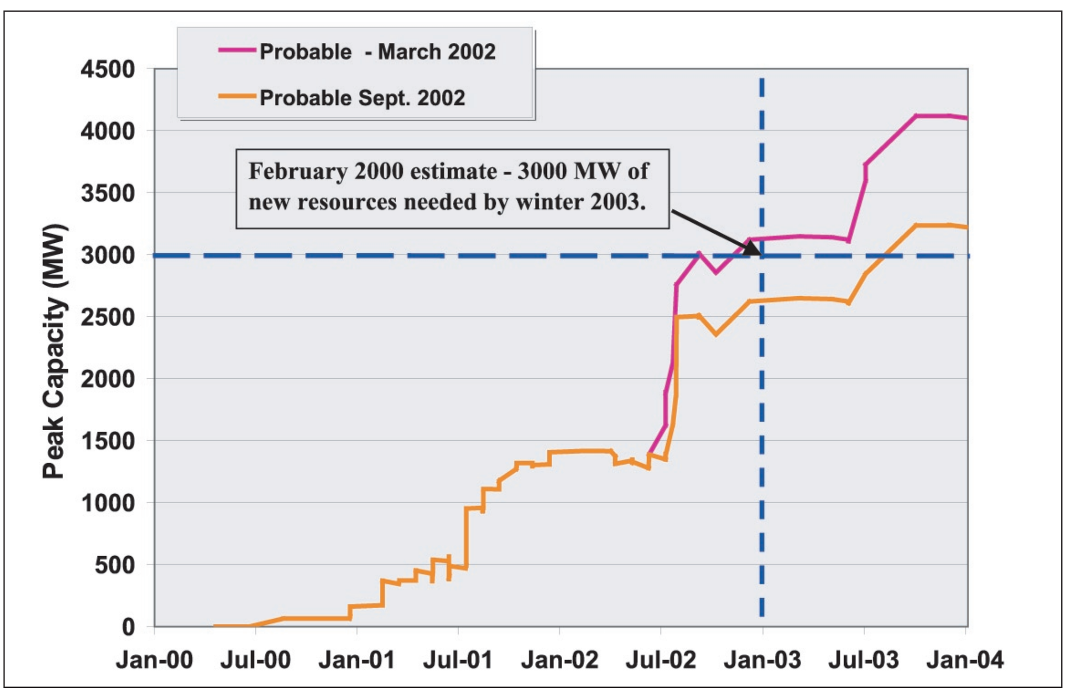
As this chart shows, many of these utilities have experienced substantial increases over the last several months. This is typical of other utilities both within Washington and elsewhere in the region. The increase in retail rates has stimulated conservation investments that are reflected in lower loads. A comparison of actual and forecast loads over the next year is shown in Figure A2

Figure A2



This figure plots the difference between the Council's long-term demand forecast (used in the 2000 Reliability Analysis) and actual regional loads. Also shown is the difference between the current short-term forecast and the long-term demand forecast from the Council's Fourth plan. Up until the electricity crisis of 2000-01, this forecast had been tracking actual loads quite well. The more recently developed short-term forecast reflects known load reductions, estimates of the effects of the recession, the effects of retail rate increases and estimates regarding the recovery of the aluminum industry loads. The short-term forecast anticipates that demand will remain at least 1,000 to 2,000 average megawatts below the Fourth Plan forecast for the next year. Actual loads appear to have been diverging from the short-term forecast in recent months. If that trend continues, suggesting a slower than anticipated economic recovery and slower recovery of aluminum industry loads, the difference from normal loads will be even greater.

Figure A3

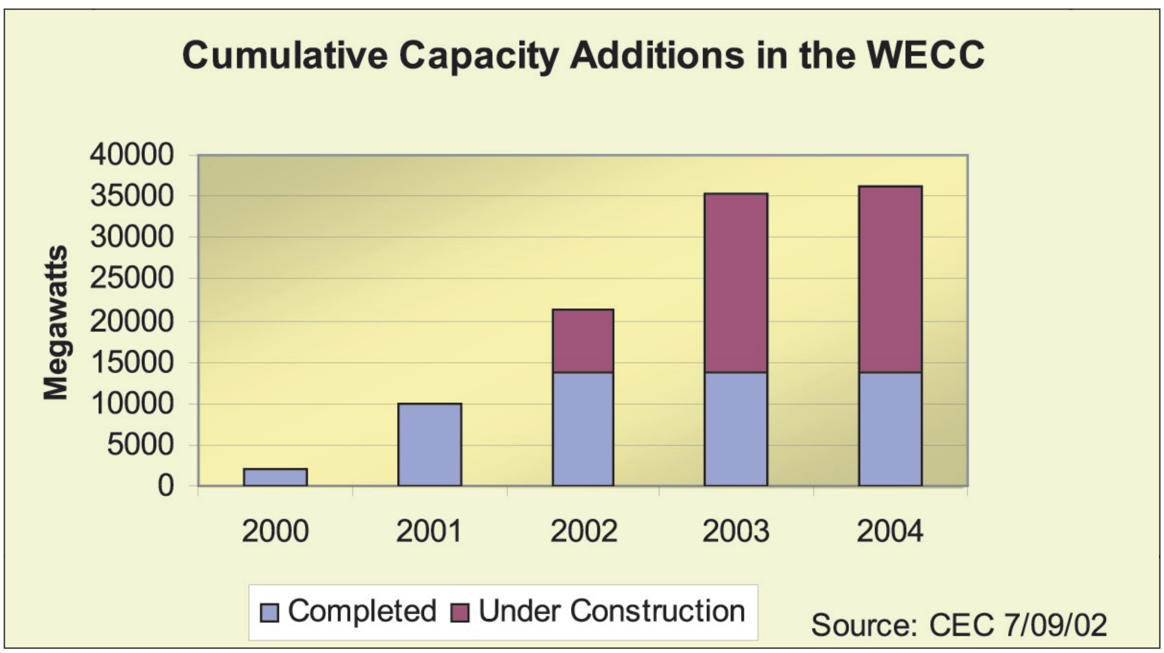


The high prices during the Western Electricity Crisis also stimulated the development of substantial new generation. Figure A3 shows the cumulative amount of new generation in the Northwest that has been recently completed or that is under construction judged to be likely to be completed. As the figure indicates, however, our view of what is likely to be completed is imperfect at best. Our estimates as of July of 2002 proved to be optimistic as the suspension of construction was announced at three major plants.

As this figure shows there has been a drop-off in the amount of new generation scheduled to be added to the system. Nonetheless, we believe there will be sufficient generation capacity in relation to the reduced loads to assure adequacy and reliability over the next couple of winters. In addition, those plants that have been deferred should have a relatively short construction period to complete, provided prices recover to the point that the developers can restart or load serving entities contract for a sufficient amount to justify restart.

There have also been significant resource additions in the rest of the WECC. Figures A4 and A5 show resource additions for the entire WECC since 2000. Figure A4 shows the cumulative amount of additions and Figure A5 shows the yearly breakdown by type. The values in these figures are in relation to a peak demand in the WECC of about 130,000 Megawatts. As is the case in the Northwest, there have been some deferments of the "Under Construction" capacity since this data was compiled. However, at least in the near term, the WECC expects a margin of resources over peak demand in excess of minimums even without further resource additions.[19]

Figure A4



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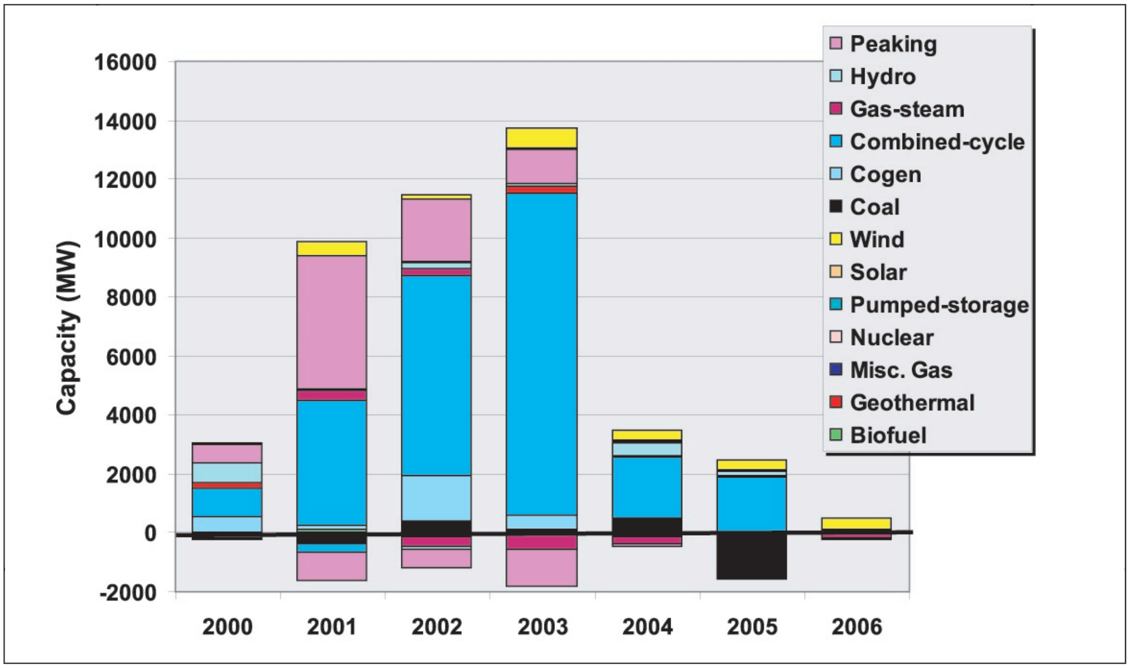
[19] WECC 10 year Coordinated Plan Summary 2002-2011, Western Electricity Coordinating Council, 2002, P 26.

Figure A5



Most of the generation in these figures is located in California, Arizona and Nevada. These data suggest that for the next two or three years there will be sufficient generation in the rest of the WECC for the Northwest to draw on in the event of winter emergencies and a substantially reduced likelihood that summer loads in these areas would place unusual demands on Northwest resources.

A complete reliability analysis using the GENESYS model will be a part of the Fifth power plan. Preliminary analysis suggests it is unlikely there would be reliability problems over the next few years. Nonetheless, the plan will look in detail at the years through 2005-06 because if additional permanent generation resources were needed by this period, construction would have to begin now. This will be a stochastic analysis, running several hundred simulations in which water conditions, temperatures (which affect loads) and forced outages are sampled according to their probabilities. This simulation will also estimate the potential supply from outside the region and use imported power where necessary. The data from these simulations can be used to estimate the probability, magnitudes and duration of supply shortfalls.

Adequate and Reliable – Long Term Analysis

The experience of the past few years has put a somewhat different light on the meaning of an adequate, efficient, economical and reliable power supply. It is this experience that frames the fundamental questions being addressed in the Council's Fifth Power Plan. Are the institutional, regulatory and market structures of the power system such that we can be assured of an adequate, efficient, economical and reliable power system, with or without fish constraints, and if not, what changes are required? While fish operation requirements added to some degree to the magnitude of the supply shortfall during 2000-01, they did not cause it. It was the fundamental failure of the power system to provide adequate resources that was the root problem. Because of this failure, there is some justification in saying that the power system failed in its obligation to protect, mitigate and enhance the fish and wildlife resources of the Columbia Basin. And in fact, one of the tools used to help the power system through this period was to largely eliminate bypass spill at federal projects until resource/load balance had been restored, as permitted by the BiOp in emergency conditions. There is some disagreement about what damage this may have caused to listed and unlisted species. However, that the system failed to provide the operations called for in the 2000 Biological Opinion is very clear. However, the power system and the other users of the power system also bore major consequences in the form of curtailed load, high purchased power costs and high costs for emergency resources.

Efficient

The objective of planners and operators of the power system is to provide a system that is as efficient as possible given that the largest component, namely the hydroelectric dams, have equally important non-power uses. From the single objective of power operations, the power system is less efficient than it was at the time of the passage of the Act. This is the result of many factors, some of which are just related to characteristics of new resources available to meet growth and some related to the effects of fish recovery measures. It is still, however, a very efficient system relative to systems elsewhere. The Council does not believe that the framers of the Power Act meant the term "efficient" to establish an absolute standard. The system is currently operated efficiently given the constraints under which it must operate. The consequences of not doing so are economic — additional costs to supply a given amount of power. In the past, the expansion of the power system has also been efficient. Regulation and least-cost planning requirements encouraged the development of efficient resources. The question of whether or not the power system is structured to assure the most efficient operation and expansion going forward is one that is being addressed in the Fifth Power Plan.

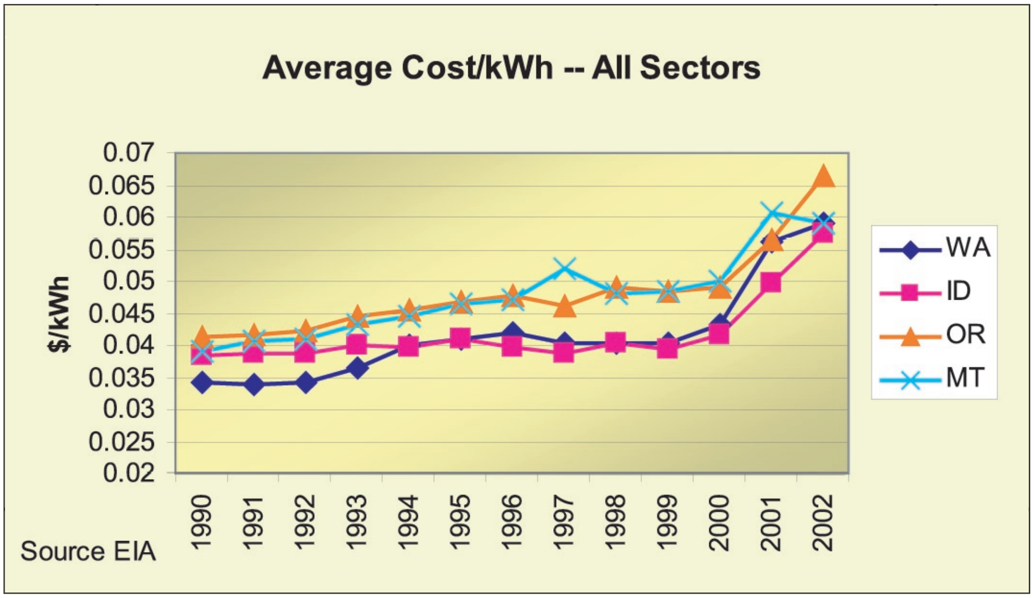
The Northwest Power Act clearly expected a balancing of fish and power objectives, i.e., operating the system with multiple objectives. Fish objectives should also be met as efficiently or cost-effectively as possible. Given the high cost of some fish measures and the relative lack of information regarding their effectiveness in meeting biological objectives, it is imperative that efforts be made to assess and improve the cost-effectiveness of these measures. The Council has addressed this issue in its amended Fish and Wildlife program.

Economical

Many of the concerns with respect to adequacy, reliability and efficiency boil down to the question of economics. We can certainly assure ourselves of an adequate and reliable power system if we are willing to spend the money. But will the system still be economical? We can degrade the efficiency of the system, but that will affect its economics.

There are perhaps three ways of thinking about the economical criterion. One is whether the per-kilowatt-hour costs of the system have been caused to increase significantly in comparison to other regions. On this basis, the power system is clearly less economical than it was. Over this same period, the Northwest states have gone from being the lowest electric rate states to being between the 11^{th} and 29^{th} lowest. Figure A6 shows average revenues from the sale of power for the Northwest states compared to the US average through the 1990s up to 2001 in nominal (not adjusted for inflation) dollars.

Figure A6



As this figure shows, there was some erosion of the Northwest's competitive advantage in electricity prices through 1990s, some of which is attributable to the effects of fish operations. However, the largest impact on the economics of the region's power supply came about over the last two years as a consequence of factors related to the structure, operation and immaturity of the wholesale electricity market as has been described elsewhere in this appendix.

Unfortunately, this kind of aggregate look at the question does not capture the potential impacts on particular elements of the economy. In particular, electricity-intensive industries, such as aluminum smelting, are proportionately harder hit by increases in electricity costs. Many aluminum plants in the region have increasingly become "swing" plants that are only economic to operate when aluminum prices are relatively high. Fish recovery costs have contributed to this, although in the current context, they are not the major contributor.

Finally, economical relates to the question of whether the fish and wildlife program is consistent with other purposes of the Act, in particular, timely repayment of Bonneville's debt to the United States treasury. Bonneville is currently in difficult financial circumstances arising primarily from the market circumstances of the last two years, although fish and wildlife costs are a contributor to Bonneville's overall cost structure.

The longer-term question of assuring an economical power supply in the future is being addressed in the Fifth Power Plan. The fundamental issues are the same as those related to the adequacy and reliability of the system: Are there adequate incentives for the development of new resources; can retail loads be made more responsive to wholesale prices; and is the developing a resource portfolio that adequately hedges risks which still achieving low cost.

Appendix 2

The Energy Crisis of 2000-01

If we are to avoid or at least lessen the likelihood and severity of such events in the future, it is probably useful to briefly review the experience of the last few years and the lessons we might derive from that experience.

The period leading up to summer 2000-01

The period of the late 1990's was a period of significant change and uncertainty in the power industry. Years earlier, national policy had set in motion a move to a competitive wholesale power market in which most development of new generation is undertaken by independent power producers (IPP).[20] The vast majority of power plants currently under construction or in the permitting and planning process are IPP projects. Unlike traditional vertically integrated utilities, IPPs do not have a native load customer base from whom to recover the fixed costs of new power plants. To build, they require adequate market prices and/or sufficient long-term sales contracts to justify financing.

The primary source of uncertainty affecting the industry was the movement toward retail competition in various states and nationally. This raised the concern that a utility's customers today might not be their customers in the future. The potential for investments in new resources becoming stranded investments weighed on heavily on the industry's thinking. This situation coincided with a period of very low market prices in the West brought about by several successive years of average or above average hydro conditions combined with what was initially excess capacity on the system, primarily in California. The availability of low cost market power made it uneconomical for developers to build power plants as merchant plants selling into the spot market. It also further discouraged utilities with load serving responsibility from placing long-term contracts for power supply with IPPs. The prudence of such contracts could be and in some cases were called into question in the face of the then-current low market prices.

The net effect was little development of resources. Figure B1 shows Northwest generating resource development through the 1990s.

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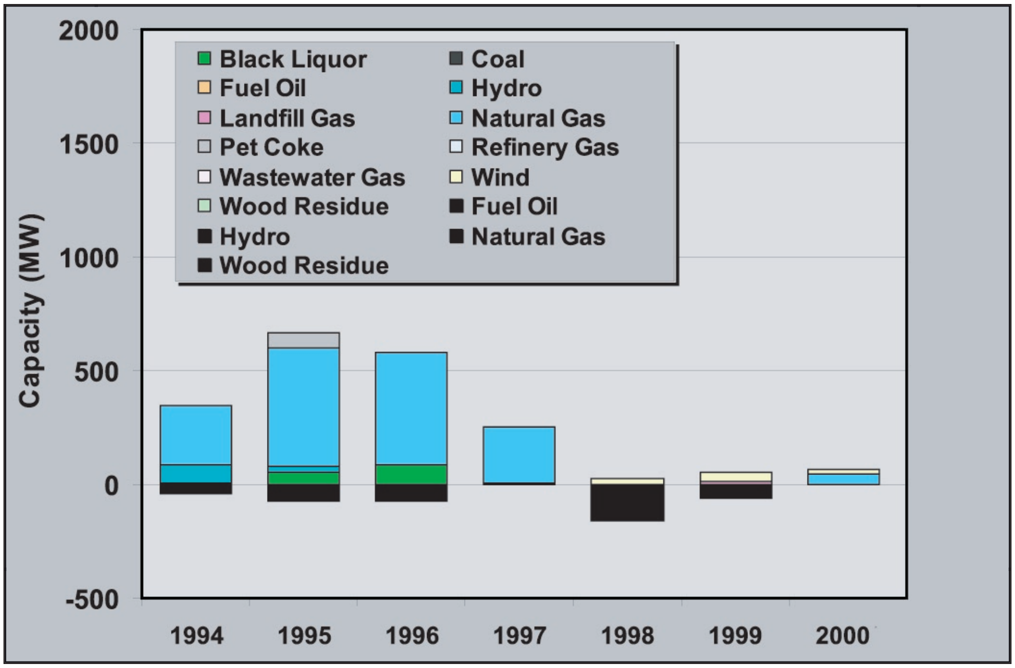
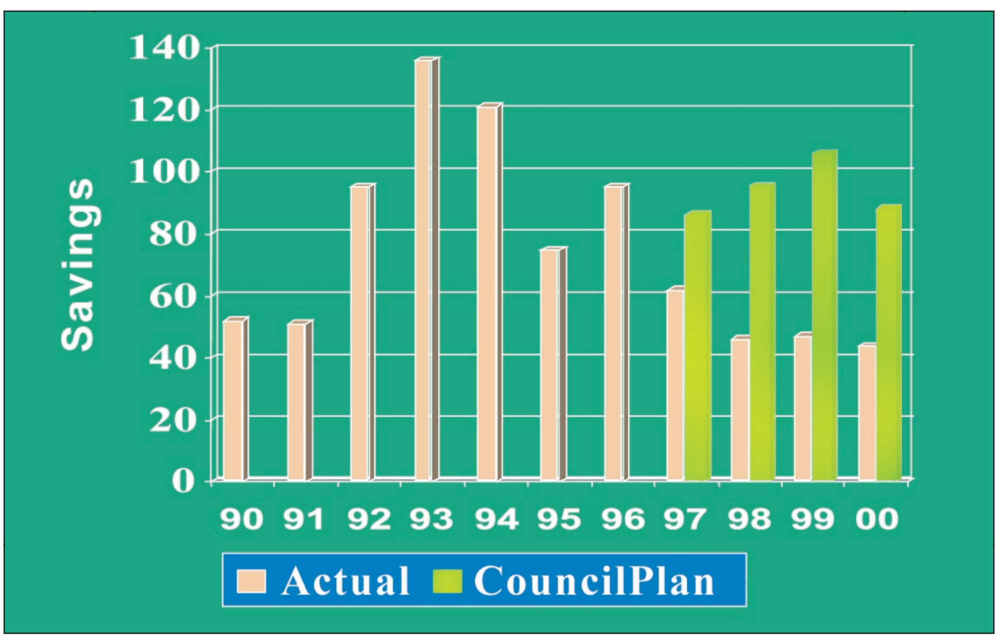
[20] Relevant policies were established as early as 1978 in the Public Utilities Regulatory Policy Act (PURPA) and more recently in the National Energy Policy Act of 1992.

Figure B1
Northwest Generating Resource Development



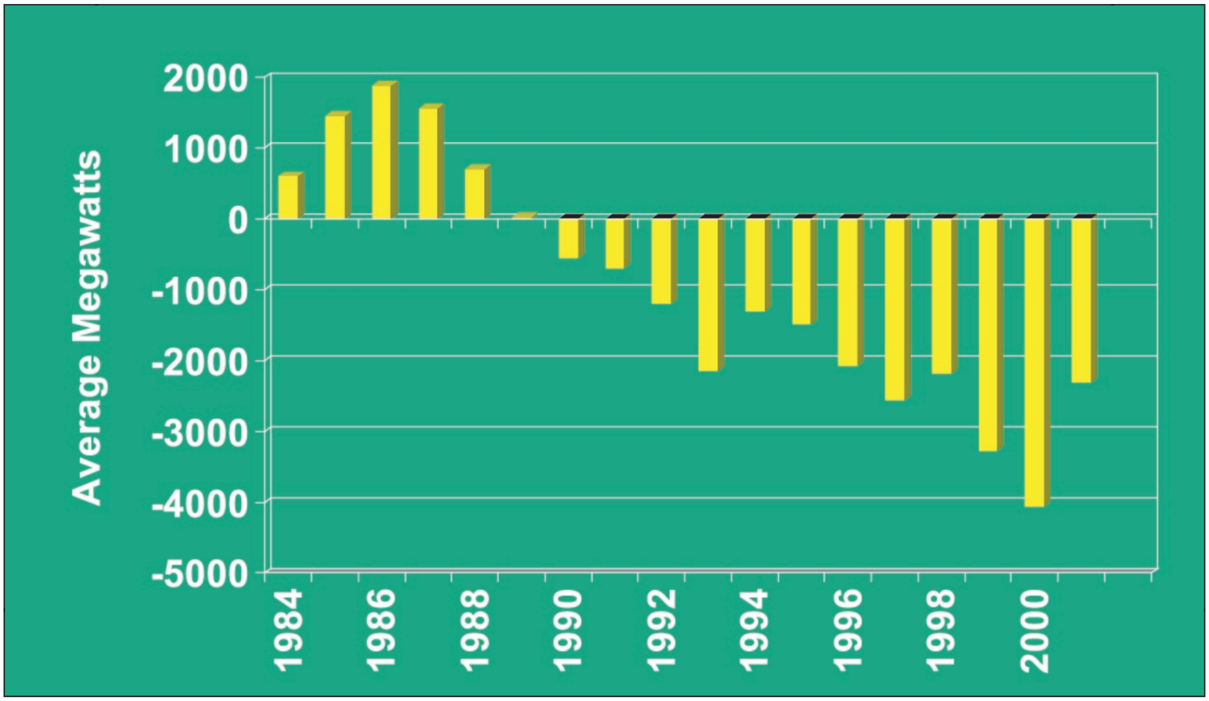
The same behavior is evident in the development of efficiency resources as shown on Figure B2. Conservation development dropped off dramatically from the early 1990s to levels that were less than half the recommended cost-effective level in the Council's Fourth Power Plan.

Figure B2
Annual Utility Conservation Development



The 1990s were also a period of sustained rapid economic growth and prosperity. The net effect of the low level of energy development combined with robust regional growth was plainly evident in the annual estimates of load-resource balance compiled by the Pacific Northwest Utilities Conference Committee (PNUCC).[21] This report compiles from regional utilities the statements of loads (annual energy and January Peak), including export commitments; and resources, including conservation and contracted imports. The analysis assumes critical water hydro. While each year's report includes a forecast going forward 10 years, we have compiled the data for each forecast going back to 1984 using only the data for the first year in each forecast. This is shown on Figure B3.

Figure B3
Annual Pacific Northwest Load-Resource Balance



These data show that the region has not been in critical water load-resource balance for more than a decade. At some level, this is good. The Northwest has strong electrical interconnections with California and the Southwest. The load diversity between these regions (the Northwest peaking in the winter, California and the Southwest peaking in the summer) means that there is usually excess power for the Northwest to purchase in the winter when our supplies are tightest as well as a market for excess power in the summer. Taking appropriate advantage of this regional diversity is an important requirement for an efficient and economical power system. However, for several years, regional utilities leaned too heavily on the market to fill out their resource needs.

In addition, most years' water supply exceeds the amount observed in the driest (critical) year. Averaged over the 50-year historical record, the hydroelectric system produces nearly 4,000 average megawatts more energy than it does in the driest year. In the highest runoff year, the system produces nearly 8,000 average megawatts more. The combination of having out-of-region supplies and greater than critical water runoff has masked the inadequacy in the power system over the last decade.

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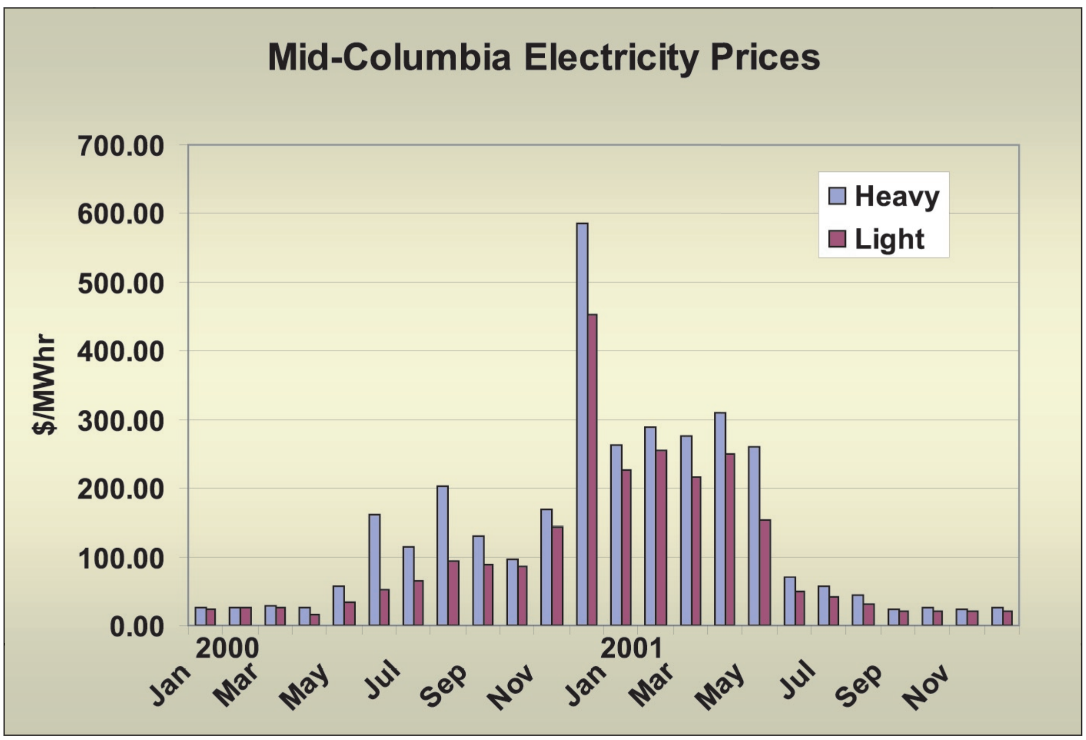
[21] Pacific Northwest Regional Forecast, Pacific Northwest Utilities Conference Committee, Portland, OR.

However, there is a limit. The increasing deficits observed in Figure B3 and in Bonneville's "White Book"[22] prompted the Council to undertake an analysis of the region's power supply adequacy. This report, released in early 2000, focused on the ability to meet regional loads in the winter, which is usually the most difficult period for the Northwest. Stochastic analysis techniques were used to estimate the probability of being unable to fully meet loads during one or more periods across the winter season.[23] Hydro conditions, temperatures (and, therefore, loads) and forced outages on generating facilities were sampled according to their statistical probability of occurrence. Several hundred winter seasons were simulated. The analysis found that by the winter of 2002-03, the region faced a 24 percent probability of some level of shortfall (loss of load probability – LOLP) despite heavy use of imports and hydro system flexibility[24]. Ordinarily a 5 percent probability would be considered acceptable. It was estimated that the equivalent of 3000 MW of new generating capacity would be required to achieve the desired 5 percent LOLP.

Summer – Fall 2000

The limit to which we could push our reliance on good water and a healthy market was reached in the summer of 2000. A history of market prices at the Mid-Columbia trading hub from January 1, 2000 up to this writing is shown in Figure B4. In a sense, this chart provides a history of the Western Electricity Crisis.

Figure B4
Source: Energy Market Reports



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22 Pacific Northwest Loads and Resources Study, http://www.bpa.gov/power/pgp/whitebook/whitebook.shtml, Bonneville Power Administration

23 Northwest Power Supply: Adequacy/Reliability Study Phase I Report, Northwest Power Planning Council, March 2000.

24 Hydro system flexibility implies drafting reservoirs deeper than would ordinarily be the case in order to meet extreme loads and then attempting to replace the water to meet April flood control levels through imports and greater use of thermal resources.

The year 2000 began with "normal" prices and, in the spring, good runoff. However, in late June and throughout the summer and fall, the West experienced much higher than normal power prices, punctuated by some extreme price spikes. During the same period, California was frequently on the verge curtailing loads and did so several times. There were a number of factors that lead to this situation. There were physical and economic factors including:

- Declining generation margins resulting from lack of investment in new resources:
- Higher than normal weather-driven demands throughout the West;
- An unusual pattern of hydropower generation – an early run-off followed by reduced hydro generation in late May that substantially reduced the availability of Northwest electricity exports to the California market;
- A high level of planned and forced outages of thermal generating units; and
- High natural gas and oil prices that were further inflamed by the high demand for gas-fired generation.

There were also factors related to market immaturity and transitional uncertainties including:

- The lack of a demand-side response to increases in wholesale prices;
- Inadequate utilization of risk mitigation strategies; and
- Factors related to the design and operation of the California market including some level of market manipulation by some market participants.[25]

High power prices and power supply concerns persisted through the fall. The fall was extremely dry and the forecast of a moderately cold weather event in mid-December of 2000 prompted real concern of potential supply problems in the Northwest. In California, large amounts of generation that would normally be available to the Northwest were offline. The reasons were several:

- Older plants that had been run hard through the summer and fall were legitimately shut down for necessary maintenance;
- So-called QF plants that had contracts for sale of power to California utilities were not run because of the fear that they would not be paid as a result of the increasing financial problems of the California investor-owned utilities;
- Some older plants had used up their emissions allowances and could no longer run;[26] and
- There was some level of withholding plants from production to manipulate prices.

The Northwest responded in many ways:

- The region's governors made appeals for conservation and curtailment of unnecessary use;
- Utilities faced with rapidly declining reservoirs began seeking additional sources of supply – sometimes expensive contracts, sometimes relatively expensive emergency generation, typically diesel generators or small turbines; environmental controls were relaxed to allow older, more polluting regional gas turbines to run for extended periods; and
- Efforts were made to contract for load reduction, particularly in the aluminum industry.

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25 Study of Western Power market Prices: Summer 2000, Summary of Final Report Northwest Power Planning Council October 2000.

26 This issue was addressed fairly quickly and most of these plants were returned to service.

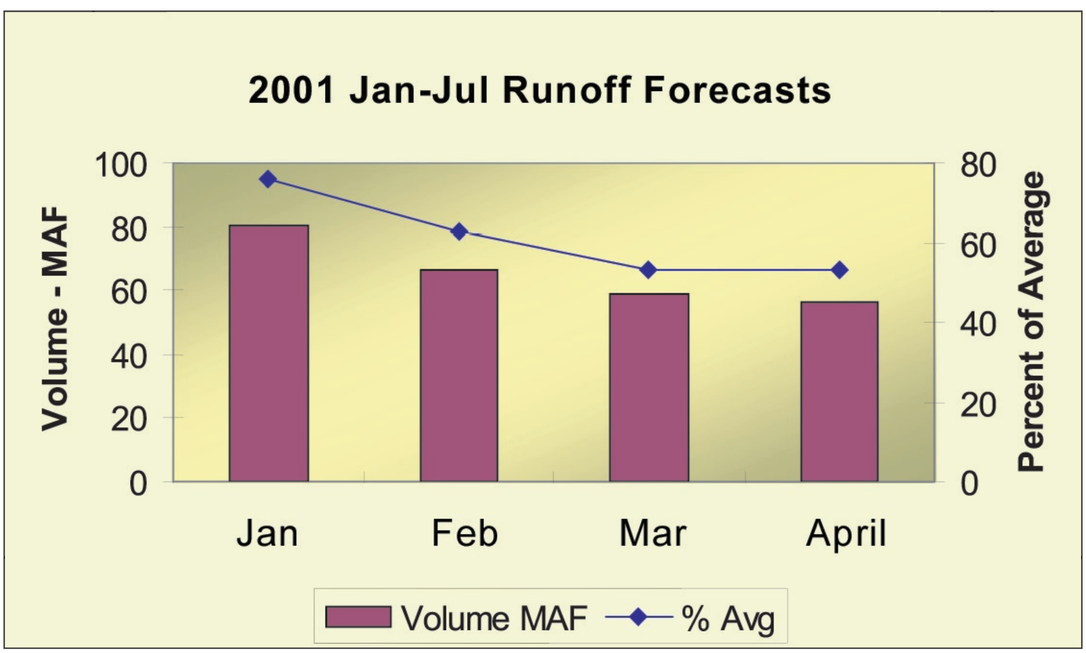
December also marked the first order by the Federal Energy Regulatory Commission to address problems with the California market. The remedies instituted, like eliminating the requirement that utilities purchase their requirements in the day-ahead market and establishing penalties for under scheduling of load, were steps in the right direction. However, they were too little too late.

This period also began to reveal another problem related to the competitive wholesale power market – the inability and/or unwillingness of regional load serving entities (LSEs) to provide information regarding the sources and amounts of purchase power. Similarly, merchant generators located within the region could not or would not provide information regarding the disposition of power from their plants. This information is important to the ability to assess the adequacy of resources available to the region. However, even though the data were only to be used in the aggregate without individual entities identified, most LSEs and merchants were unwilling to provide this information. Some of this reluctance may have come from concerns about their own competitive position becoming known or that they would be charged much more if it became known that they were short. In other instances it may have been that the source of power behind contracts with power marketers was not known until after the fact. Whatever the reason, this information gap seriously handicapped the ability to assess power supply adequacy.

Winter-Spring 2001

High prices persisted through the winter and early spring of 2001 with heavy load hour prices averaging over $200 per megawatt-hour. There were times during which prices were much higher than that. January also marks the first snow pack measurements and estimates of runoff – essentially an estimate of the amount of water that will be entering the hydro system over the spring and early summer. The runoff forecasts for the first several months of 2001 are summarized in Figure B5. The anticipation of poor runoff conditions was reflected in high forward prices. By the first of February, publicly quoted forward prices for the second and third quarters of the year were in the $350 – $400 per mw-hr range.

Figure B5



At this time, the Council, Bonneville and others were attempting to look forward and assess power supply adequacy across the summer and into the following winter. These assessments were made difficult by several factors:

- The high degree of uncertainty surrounding runoff early in the season;
- Uncertainty with respect to how successful efforts to reduce loads would be;
- Uncertainty with respect to how much emergency generation might ultimately be brought on line; and
- Uncertainty with regard to the availability of power from California and the Desert Southwest in the fall and winter as well as uncertainty with regard to NORTHWEST obligations to supply power to California in the summer.

A further and generally unrecognized uncertainty was the economic slowdown that was just beginning.

Across the winter and spring of 2001, the Council did several assessments of power supply adequacy. By the time the Council did its first assessment in early February, the runoff forecast had fallen to 67 million acre-feet (maf), about 63 percent of normal. This analysis focused on the winter season. Under extreme weather conditions, this analysis indicated a significant potential for shortages. This analysis also looked toward the summer and noted the large amount of energy loss associated with bypass spill.

A second analysis was done in March. It incorporated updated estimates of load reduction and emergency generation as well as a deteriorating runoff forecast. This analysis looked at summer conditions for two water years that bracketed the then current runoff forecast. It then assessed the winter situation. Because the region would be coming off a dry year, it was assumed that fall-winter 2001-02 runoffs would be limited to those of the driest two thirds of water years in the historic record, treating each with equal probability. The findings of this analysis were that it was not possible to avoid summer curtailments and return reservoirs to BiOp levels by the end of August without significant reductions in spring and summer spill. Failure to return the reservoirs to BiOp levels would result in very high probabilities of winter power supply problems. Even with reductions in spill, the winter season loss of load probability was 20 percent. Council fish and wildlife staff estimated the effects on downstream migrants and found them to be relatively small. The staff conclusions at that point were:

- Decisions on bypass spill had to be made soon but could be revisited
    1. If spring spill is maintained, energy is lost, more stringent and expensive steps may be required later
    2. Spill can be restored if conditions improve or other resources become available
- Winter 2001-02 outlook called for continued and increased attention to load reduction, conservation and generation.

Spring-Summer 2001

In May, the Council reassessed the power supply situation. This analysis incorporated increased estimates of new generation expected to be available during the period of analysis. It also incorporated a reduced load forecast and increased conservation. In addition, it attempted to refine its look at summer conditions by analyzing a range of 7 "synthetic" run off volumes and patterns that were intended to better represent the range of uncertainty in runoff. The analysis assumed that no imports were available in the summer while firm export obligations were met. Intertie loadings at the time tended to support this assumption, showing the Northwest as a net exporter during this period, albeit at levels well below levels typical of a normal water year. This analysis found that without reductions in spill, there was still the potential for power supply problems early in the summer for several of the water years analyzed, although the magnitudes of the problems were significantly reduced from the March analysis.

The analysis again looked at the winter 2001-02 situation, limiting the analysis to the driest 2/3 of the historic water years. While the winter reliability situation looked better than in the earlier analysis, the loss of load probability was still uncomfortably high (17 percent). The analysis went on to assess the value of increased storage in Canadian reservoirs. It found that storing 1,500 megawatt-months of energy in Canadian reservoirs could reduce the winter loss of load probability to 12 percent. This was still high but significantly better than 17 percent. The analysis went on to look at the ability to store that amount of energy. It was found that if spill were maintained, we could be confident of storing 1,500 megawatt-months of energy only if a January-July Runoff volume greater than 59 million acre-feet (maf) were achieved. If there were virtually no spill at federal projects, the storage could be achieved with a 56-maf runoff. Since a runoff of 56 maf appeared considerably more likely, eliminating spill appeared the prudent choice (2001 runoff turned out to be 58 maf). This information was influential in the decision by the federal agencies to largely eliminate spill at the Federal projects.[27]

Later in May and late June the Federal Energy Regulatory Commission issued price mitigation orders, first for California and later for the entire WECC. The WECC order established a price cap slightly under $100/megawatt-hour for sales in the West. As Figure B4 shows, prices had already begun heading down. This may be because the market had already internalized the price caps. Or, it may be that the market was finding that it could not sustain the very high prices in the face of reduced loads and increased generation. It is likely that both had an effect. However, the fact that prices barely paused as they moved below the price cap suggests that the fundamental change in the supply-demand situation played a major role in reducing prices.

Fall 2001 and Winter 2001-02

Wholesale power prices continued downward through the fall and early winter. In one sense, this marked the end of the Western Electricity Crisis, although the effects of the crisis on retail rates and perhaps on future fish runs will extend for some time. In September and October of 2001, the Council reassessed the adequacy and reliability of the power system for the winter of 2001-02. By this time it had become clear that in addition to utility and government-initiated conservation and curtailment efforts, the slowdown in the economy was having an effect on loads. The analysis found a winter season loss of load probability well under 5 percent. The major factor behind this was a much lower estimate of winter loads. In total, the estimated loads for the period October 2001 through March 2002 were approximately 11,000 megawatt-months less than the May estimates for the same period. In addition, approximately 3,700 megawatt-months of energy had been stored in Canadian reservoirs (as opposed to the 1,500 analyzed in May) and constraints on the use of that water had been reinterpreted in such a way as to make the water much more useful for addressing periods of high demand. In moving the LOLP from about 12 percent in the May analysis to under 1 percent in the October analysis, the greater than expected drop in demand contributed about 7 percent of the drop, the additional water stored in Canadian reservoirs and the greater flexibility in the use of that water contributed another 3 percent and a better forecast of expected winter water conditions contributed 1 percent. The winter remained moderate, precipitation and resulting runoff were close to normal, wholesale prices were again below the full cost of new generation (and much conservation) and everyone was asking what happened to the Western Electricity Crisis.

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[27] Approximately 1,000 MW-Months of energy was spilled at federal projects compared to the several thousand that would ordinarily be

What issues are raised by the experience of 2000-01?

The experience of 2000-01 was the consequence of actions and inactions in the preceding years that resulted in a power system that was not adequate to maintain a reliable and economical power supply in the event a very dry year. Fish operations had reduced the power capability of the system but those effects were certainly internalized into the thinking and planning of the industry by 2000-01. The primary causes of the supply and price problems of 2000-01 had much more to do with the changes going on in the industry, the industry structure, particularly in California, the relative immaturity of competitive wholesale markets, and so on.

The experience of 2000-01 raises two basic sets of issues. First, what changes in power planning, policy, regulation and implementation need to take place to avoid a similar situation in the future? Second, if such situations do arise again in the future, how might they be better managed? The first raises such issues as:

- Are Western electricity markets progressing toward a well structured and consistent design that will reduce the uncertainty in investment in electricity infrastructure?
- Are there adequate "incentives" for the development of new resource, both generation and efficiency. If load-serving entities have learned to limit their exposure to the market by making more long-term resource investments even when they are facing very low short-term market prices, the answer may be yes. If not, other mechanisms will have to be explored.
- Are there acceptable and effective ways to better link retail consumption decisions with wholesale prices to achieve quicker and more predictable load reductions in the face rising wholesale prices? To do so would both mitigate prices increases and reduce the likelihood of involuntary curtailments.
- Is the region carrying adequate physical hedges against volatility in electricity prices and the underlying fuel prices? How well do different resource strategies limit risk and at what cost? What barriers exist to implementing such strategies? How might those barriers be overcome?

The experience of 2000-01 also suggests that to better manage such situations should they occur in the future, will require better information regarding loads, resources, imports and export obligations, conservation and curtailment efforts and so on. It will also require better coordination among the responsible parties. The information requirements and flows need to be worked out in advance and everyone needs to provide such information with confidence that their own competitive position will not be compromised.

It is also clear that attention needs to be paid to assuring the fish and wildlife needs and reliability needs are balanced appropriately is crisis situations. Staff believes that over this period, there was a balancing that took place. Yes, spill was dramatically reduced but so were power system loads while expenditures for power and new generation were greatly increased. Still, there needs to be a way to ensure that one value is not being sacrificed unnecessarily for the sake of the other – that there is equitable treatment of the two goals. We don't expect a 0 percent loss of load probability. It would be too expensive to achieve such reliability under all possible circumstances. Similarly, we should not expect a 0 percent "loss of fish operations" probability.