PASSAGE AND FLOW CONSIDERED ANEW –

WILD SALMON RESTORATION VIA HYDRO RELICENSING

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I. FISHERIES, DAMS AND INSTREAM ASPECTS OF WATER LAW

Historically, much of the focus of water law – both international water law and domestic water law – has been on the rules to determine rights to divert water out of stream. That is, international water law and domestic water law have addressed the questions of who has the right to divert water from a particular watercourse, how much water is each diverter entitled to take, and are certain out of stream uses (e.g. for essential drinking water and sanitation) entitled to a higher priority vis-à-vis other uses.

The articulation of rules and rights that govern how water is utilized instream, and that define the legal relationship between instream water demands and out of stream water demands, is a more recent development in the field of water law. Among the more critical instream water resources are fisheries. There can be multiple stakeholders interested in fisheries conservation, including indigenous communities whose cultural identity and diet is tied to particular fish species, non-indigenous fishers whose livelihood is based on the catch and sale of particular fish species, and environmental groups focused on the preservation of biologically diverse wild fish stocks.

Particular species of fish have particular habitat needs. For instance, some fish species have limited tolerance for salinity and salinity levels rise when upstream fresh water diversions and impoundments result in seawater intrusion. As another example, some fish species (such as cold water fisheries) cannot survive higher water temperatures and higher water temperatures

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are often associated with reduced downstream flow due to the diversion and impoundment of water upstream. As a third illustration, some fish species require the presence of gravel instream for spawning habitat yet such gravel is often trapped behind upstream impoundments. Lastly, there are some fish species that are particularly suited to spawning in the higher elevation reaches of a watershed but upstream passage to and downstream passage from such higher elevation reaches is often blocked by impoundments.

In the four examples noted above – salinity levels, water temperature, gravel transport and fish passage – upstream impoundments have significant potential impacts on the instream water demands of fisheries, impacts on both the quantity and quality of the instream habitat fisheries require. The term impoundments as used in this context refers to on-stream structures and reservoirs to store fresh water, more commonly known as dams.

This paper will review efforts in the United States of America (United States) to better address the relationship between the condition of fisheries and the operation of on-stream dams. More specifically, this paper will review the fishery-related aspects of the Federal Power Act (FPA). The FPA requires operators of most existing on-stream hydro-electric facilities in the United States to periodically apply to the Federal Energy Regulatory Commission (FERC) to relicense such facilities. As detailed below, the FERC hydro relicensing process in the United States has often provided an effective mechanism to modify the terms of dam operations to reduce the adverse impacts on fisheries, particularly impacts on Pacific Coast wild salmon.

The United States' experience with hydro relicensing and fisheries may hold lessons for other nations and international institutions involved in the approval, operation and licensing of on-stream hydro facilities. This experience suggests that a transparent and scientifically rigorous regulatory framework to periodically review and modify the way dams operate – regardless of whether this framework is called relicensing – can play a critical role in the restoration of wild fish stocks.

II. INSTREAM CONDITIONS NEEDED BY WILD PACIFIC COAST SALMON AND MISPLACED RELIANCE ON HATCHERY SALMON

To understand the relationship between FERC hydro relicensing and wild salmon stocks, there are two preliminary points that need to be explained at the outset. This first point is to identify the lifecycle and particular habitat needs of Pacific Coast wild salmon. The second point is to recount historic reliance on hatchery salmon as an anticipated replacement for wild salmon in the context of the initial approval and licensing of many Pacific Coast hydro facilities.

A. WILD PACIFIC COAST SALMON HABITAT NEEDS

All wild Pacific Coast salmon are anadromous, which means they spawn and spend the first period of their life in freshwater rivers, streams and creeks. The juvenile salmon then migrate downstream to the ocean where they spend several years in saltwater, ultimately returning upstream to their natal freshwater river, stream or creek to reproduce and die. Below are some of the conditions wild Pacific Coast salmon need to complete this lifecycle, and an overview of how on-stream dams can impact these conditions.

1. DOWNSTREAM AND UPSTREAM PASSAGE

To make the journey from their upstream freshwater spawning grounds to the ocean, wild Pacific Coast salmon need downstream passage from these grounds to the sea. Such downstream passage for salmon can be adversely impacted by dams in two ways. First, if no water is being released from a dam, salmon migrating downstream will find themselves trapped and confined to the reservoir located behind the dam. Second, if water is being released into high-speed turbines to generate hydro-electric power, salmon migrating downstream can be killed as they pass through the spinning turbines. Some dams include fish ladders which enable some outgoing salmon to go around the dam or avoid being pulled into the turbines. Sometimes ongoing salmon are collected upstream of the turbines, and then trucked below the dam where they are then released.

On their return journey from the ocean to their natal fresh water spawning grounds, wild Pacific Coast salmon need upstream passage. Such upstream passage can be blocked by dams, preventing salmon from reaching their natal spawning grounds to reproduce. Some dams include fish ladders which enable some returning salmon to navigate their way upstream around the impoundment. Sometimes returning salmon are collected below the dam, and then trucked above the dam where they are then released.

2. MAINTAINING COLDWATER TEMPERATURES

Salmon are coldwater fish with limited tolerance for higher water temperatures. Salmon prefer water temperatures below 55 degrees (Fahrenheit), suffer reduced growth and survival rates as water temperatures get close to 60 degrees (Fahrenheit) and are generally unable to survive in water warmer than 60 degrees (Fahrenheit).

Instream water temperatures tend to be hottest in the summer, which is also when water stored in reservoirs behind dams is used most intensely for agriculture and irrigation. The result is that there is often reduced releases of upstream water from dams at the time of year when increased air temperatures are pushing water temperatures up. The reduced volume of water flowing downstream causes downstream waters to warm, increasing salmon mortality rates.

Increased and timely reservoir releases of cold water can help maintain the downstream coldwater habitat conditions that salmon need, but such releases are often opposed by stakeholders who would like to divert reservoir water out of stream or would like the reservoir releases to occur only at times when hydro-electric power generation is needed. Releasing reservoir water downstream during periods when the turbines are not operating is sometimes referred to as “spilling” water.

3. GRAVEL AND WOODY DEBRIS FOR SPAWNING HABITAT

Salmon require shallow water with clean gravel beds to spawn and reproduce. Spawning can also be adversely affected if the velocity of the water where the eggs have been laid is too high, as this tends to wash the eggs out of the gravel and downstream. One of the ways the velocity of rivers, streams and creeks can be reduced is by the presence of large woody debris (e.g. fallen trees) which can create calmer eddies with reduced flow speeds.

The presence of upstream impoundments often traps gravel and woody debris behind the dam, so that the presence of these features/conditions is reduced downstream below the dam. The release of reservoir water for hydro power generation (which is designed to maximize the velocity of the water passing through the turbine) can result in high velocity flows below the dam which can wash out gravel and woody debris in these downstream reaches.

4. FRESHWATER FLOW TO REPEL SEAWATER INTRUSION

Although wild Pacific Coast salmon eventually make their way out to the ocean, at birth and during the early stages of their lifecycle their bodies are biologically adapted for fresh water. As such, increased salinity levels in water can adversely affect the survival rate and development of juvenile salmon suited to a freshwater environment.

When upstream dams impound and divert fresh water out of stream, this results in a reduction of freshwater flows below the dams. When freshwater flow is reduced, the seawater from the ocean begins to intrude further upstream causing salinity levels to rise.

Increased reservoir releases of fresh water can help to maintain salinity levels by repelling seawater intrusion, but (as noted above) such "spilling" of stored water is often opposed by stakeholders who would like to divert reservoir water out of stream or only at times when hydropower is being generated.

B. REPLACING WILD SALMON WITH HATCHERY SALMON

Many of the on-stream dams on salmon-bearing rivers on the Pacific Coast of the United States were built in the period from 1940-1970. In the time period in which these dams were built, there was a basic understanding of the lifecycle of wild Pacific Coast salmon, and more specifically there was a recognition that wild salmon stocks would be adversely impacted by the blockage of downstream and upstream passage resulting from the dams.

At the time these dams were constructed (in the 1940-1970 period), however, the approach was generally not to consider how the design or operation of dams could be modified to maintain wild salmon stocks. Rather, at that time, the focus was on developing "hatchery salmon" facilities below the dams that would replace the wild salmon stocks that would be lost or reduced as a result of the dams. In her 2005 article, *The Salmon Hatchery Myth: When Bad Policy Happens to Good Science*, Melanie Kleiss explains: "Salmon hatcheries create their stocks by killing returning adult females, harvesting their eggs, and fertilizing them with sperm from returning males. After incubation and hatching, the offspring are then raised in a captive environment until they are ready to migrate to the ocean."

Unfortunately for the salmon, and the indigenous communities and fishers reliant on the salmon, the salmon hatchery programs have generally not been successful, and there is a growing body of scientific data and literature on how hatchery salmon are in fact contributing to the further decline of wild salmon stocks.

There are two primary reasons hatchery salmon mitigation has fallen short. First, numerous scientific studies have confirmed that hatchery salmon have lower overall survival rates than wild Pacific Coast salmon, as well as significantly lower breeding success rates than wild Pacific Coast salmon. Second, when large numbers of juvenile hatchery salmon are released into rivers from their captive environment, they are particularly aggressive at this stage and tend to out compete wild juvenile salmon for food. The result of these two dynamics is that hatchery salmon tend to displace and further deplete wild salmon stocks but these hatchery salmon then later have trouble surviving and reproducing.

These tendencies and interactions were not well understood when most Pacific Coast dams were initially approved and constructed in the 1940-1970 period. Going forward, however, in the context of proceedings to relicensing hydro facilities, there is no longer a credible scientific basis to rely on hatchery salmon programs to effectively off-set the loss of wild salmon stocks. This recognition has led to an increasing focus on how the design and operation of existing hydro facilities can be modified to restore wild salmon stocks. It is in this context, of the previous experience with misplaced reliance on hatchery salmon mitigation, that the FERC relicensing process can assume a pivotal role.

III. FISHERY ASPECTS OF HYDRO RELICENSING IN THE UNITED STATES

A. FEDERAL POWER ACT (FPA) PROVISIONS

The requirements of the Federal Power Act (FPA) apply to all non-federal hydro facilities operated on navigable waters in the United States. Although hydro facilities operated by the United States Bureau of Reclamation (a federal agency) are outside the scope of the FPA, there are many other hydro facilities operated by non-federal entities that the FPA covers. For instance, in California there are on-stream hydro facilities operated by such non-federal entities as the California Department of Water Resources (a state agency), the San Francisco Public Utilities Commission and the East Bay Municipal Utility District (local/regional public agencies) and Pacific Gas & Electric (a private water utility).

Under the FPA, the Federal Energy Regulatory Commission (FERC) issues initial hydro facility licenses for periods of 30 to 50 years. Once an initial license is set to expire, the project operator must apply for a new license through the relicensing process. During relicensing, FERC evaluates the project and determines whether continuing to operate the project is in the public interest and, if so, under what conditions.

Between 1990 and 2010, FERC relicensed about 500 hydro projects in the United States. Of these 500 relicenses hydro facilities, FERC required fish passage improvements or other fish restoration improvements in more than 40% of the new licenses. FERC's authority and obligation to include these fish restoration conditions in the relicensing process derives from Sections 10(a), 10(j) and 18 of the FPA. These last of these two sections of the FPA (discussed below) set forth how FERC's relicensing authority interacts with the authority of the two other federal agencies with main authority for fishery management, the National Marine Fisheries Service (NMFS) and the United States Fish & Wildlife Service (FWS).

Section 10(a) of the FPA provides that a project must serve the public interest in the river basin, not just the licensee's interest in hydropower generation. More specifically, Section 10(a) requires that a license must ensure that the project adopted "will be best adapted to a comprehensive plan for improving or developing a waterway or waters for the use of benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, and for the *adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat)*." (italics added.)

Section 10(j) of the FPA requires that a FERC license "adequately and equitably protect, mitigate damages to, and enhance fish and wildlife (including related spawning grounds and habitat) affected by the development, operation and management of the project." NMFS, FWS or a state fish and wildlife department may recommend such conditions. If timely submitted, the FPA provides that FERC must generally include such conditions in the license.

Section 18 of the FPA, NMFS or FWS prescribe a facility for fish passage (such as a fish ladder or a trapping site to recollect fish for truck transport), operation and maintenance of the facility, and any other conditions necessary to ensure effective passage. A Section 18 prescription may apply to upstream or downstream passage. As with Section 10(j) of the FPA, FERC must generally incorporate a Section 18 fish passage prescription submitted by NMFS or FWS.

The implementation of Sections 10(a), 10(j) and 18 of the FPA is closely related to compliance with two other federal laws, the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA). In connection with FERC's relicensing decision, NEPA requires the preparation of an environmental impact statement that must consider alternatives and mitigation measures to reduce the adverse impacts of the project on fisheries. Under the ESA, if the continued operation of the hydro project will result in death or injury to fisheries listed an endangered, NMFW or FWS must prepare a biological opinion that includes conditions to ensure the project does not jeopardize the survival of the species. The alternatives and mitigation measures identified in the NEPA environmental impact statement, and the conditions set forth in the ESA biological opinion, often serve as the basis for the fishery restoration terms later included in FERC's relicensing decision.

B. RELICENSING IN ACTION: CASE STUDIES ON HYDRO AND WILD SALMON

1. OROVILLE HYDRO RELICENSING ON THE FEATHER RIVER IN CALIFORNIA

Oroville Dam was built in the 1960s by the California Department of Water Resource (DWR) on the Feather River north of Sacramento, California. The Feather River flows south/southwest until it empties into the Sacramento River, and the Sacramento River flows south to San Francisco Bay and eventually out to the Pacific Ocean. The initial 1957 Oroville permit was for 50 years (until 2007).

Construction of Oroville Dam on the Feather River, Circa 1963

At the time Oroville Dam was built, it was already known that there were extensive salmon spawning grounds upstream of where the dam would be located. Oroville Dam is 770 feet high, the tallest dam in the United States, with no fish ladders to provide for upstream or downstream passage of salmon. Lake Oroville has a water storage capacity of over 3.5 million acre-feet. For the reasons discussed above, at the time Oroville Dam was built DWR proposed to develop a hatchery salmon program below the dam to compensate for the dam's anticipated adverse impacts on wild salmon. Although hatchery salmon now account for the majority of salmon on the lower Feather River, the overall numbers of salmon on the lower Feather River have declined drastically since Oroville was built (and for the reasons noted above) there are studies indicating that the hatchery salmon may be contributing to the decline of wild salmon stocks on the lower Feather River.

During the Oroville relicensing proceedings, there was considerable focus on what could and should be done to restore wild salmon runs. In 2006, after several years of negotiations between FERC, DWR and fishery stakeholders, an agreement was reached over the terms and conditions to be included in the new license.

Given the height of Oroville Dam, the prospects of installing fish ladders to provide for upstream and downstream salmon passage was generally viewed as a cost-prohibitive and unfeasible modification. Instead of fish passage, the new relicensing terms instead focused on a three-pronged approach to improve habitat for wild salmon in the portions of the Feather River below Oroville Dam.

The first prong of the Oroville relicensing wild salmon restoration conditions concentrated on flow and water temperature improvements. Under the terms of the new license, sufficient water from Lake Oroville (the reservoir behind Oroville Dam) must be released to maintain water temperatures in the lower Feather River at below 56 degrees Fahrenheit from September 1-30, and below 55 degrees Fahrenheit from October 1-May 31. These periods cover the main spawning and migration seasons for salmon on the Feather River.

The second prong of the Oroville relicensing wild salmon restoration conditions concentrated on gravel supplementation. As discussed above, salmon spawn in gravel in clear shallow water. Oroville dam blocks 97% of the gravel from passing downstream to the lower Feather River which has reduced salmon spawning habitat. Under the terms of the new license, DWR will deliver and deposit 8,300 cubic yards of gravel in specified locations below the dam.

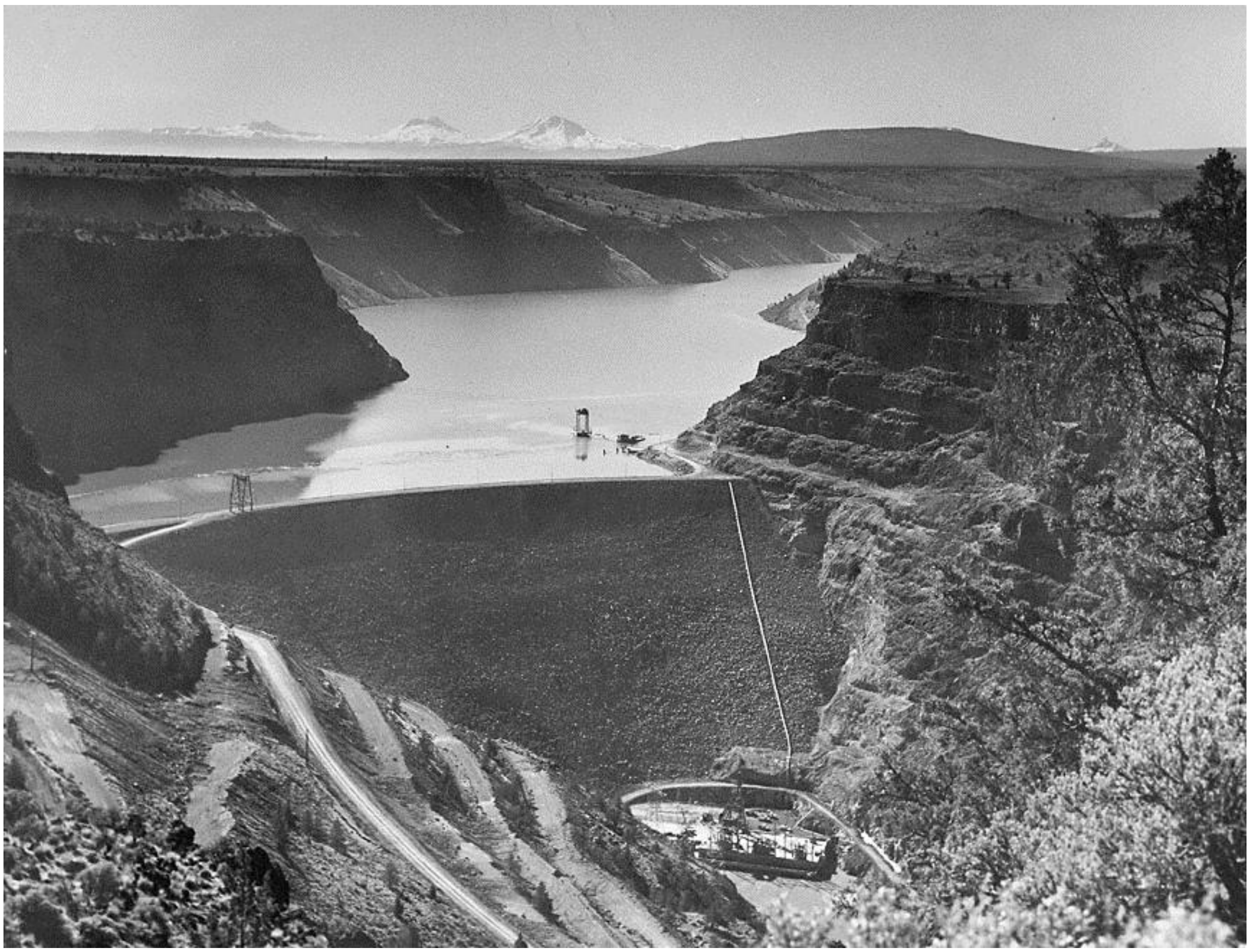
The third prong of the Oroville relicensing wild salmon restoration conditions concentrated on supplementation of large woody debris. Large woody debris (such as fallen trees) creates essential habitat elements for salmons like pool and eddies with reduced water velocity. Oroville Dam currently blocks the downstream movement of large woody debris in the lower Feather River. The new Oroville relicensing terms requires placement of several hundred pieces of large woody debris in locations on the lower Feather River that maximize benefits for salmon.

If fully implemented, collectively these measures hold the prospect of contributing significantly to the restoration of wild salmon stocks that spawn in the lower Feather River. The value of these fish restoration improvements, over the course of the new license, has been estimated at around $450 million (U.S.). While this figure may initially appear to be a significant amount of money, it represents a small percentage of the value of the hydro-electricity and water that will be delivered during this same license period.

2. PELTON HYDRO RELICENSING ON THE DESCHUTES RIVER IN OREGON

The Pelton Round Butte Project (Pelton Dam) is located on the Deschutes River in north-central Oregon. The Deschutes River, with a robust historic sockeye salmon fishery, flows in a northerly direction to its confluence with the Columbia River. The Columbia Rivers then flows east where it empties into the Pacific Ocean. Pelton Dam was completed in 1965 pursuant to a 50-year license, and is owned and operated jointly by Portland General Electric Company (PGE) and the Warm Spring Confederated Tribes. Pelton Dam (whose official name is the Round Butte Development) stands 440 feet tall and creates a reservoir (Lake Billy Chinook) with a gross storage capacity of 535,000 acre-feet of water. It is therefore considerably smaller (in terms of both height and reservoir storage capacity) than Oroville Dam.

Like Oroville Dam, a hatchery salmon program was instituted at the same time Pelton Dam was built, to help offset some of the wild salmon stock losses anticipated to result once the dam was completed. Unlike Oroville Dam, however, Pelton Dam was designed with an adjacent fish ladder to assist wild salmon with upstream and downstream passage around the dam. Unfortunately, due to the slack water and circular currents in Lake Billy Chinook behind the dam, outbound juvenile salmon were usually unable to find the adjacent fish ladder that would provide them with downstream passage to the Pacific Ocean. When Pelton Dam came up for relicensing, a main focus of study and contention was on how to modify the design and/or operation of the facility to improve downstream migration of wild salmon.



Construction of Pelton Dam (Round Butte Development) on the Deschutes River, Circa 1965

The solution that emerged became known as the “Selective Water Withdrawal” (SWW) facility. The SWW is a 273-foot tall underwater tower in Lake Billy Chinook capped by an intake module that collects fish migrating downstream and separately sends water to the turbines to generate hydro-electricity. At the intake structure, fish are collected into two screens and sorted. Non-anadromous fish (such as bull trout) are returned to Lake Billy Chinook. Juvenile salmon move into a floating fish transfer facility, and are then loaded into a truck for transport and released below the dam to continue their migration to the Pacific Ocean.

The SWW was completed in 2009 and in its first five years of operation significant increase in salmon returns have occurred. The SWW cost $108 million to build. As with the costs associated with the salmon restoration efforts related to the Oroville Dam relicensing, this $108 million figure represents a small percentage of the value of the hydro-electricity and water that will be delivered during the license period.

The SWW component of the Pelton Dam relicensing represents an innovative effort to improve downstream passage for wild salmon, but the experimental nature of the proposed solution will require careful monitoring. More specifically, there remains questions about how the collection and truck transport of the juvenile salmon under the SWW approach may affect their long-term survival and reproduction rates. It should be remembered that there were also initially high hopes for the effectiveness of hatchery salmon programs, and in the early years these hatcheries produced increased numbers of salmon heading downstream. The shortcomings of hatchery salmon operations were not fully understood until smaller salmon returned that often failed to reproduce.

Notwithstanding these concerns, the SWW can still be seen as an attempt to address the downstream passage failures of the original design and operation of Pelton Dam. Because the SWW includes a rigorous monitoring program, there should be opportunities to revisit and modify wild salmon restoration strategies related to Pelton Dam if the SWW proves less successful than anticipated.

C. LOW IMPACT HYDROPOWER INSTITUTE (LIHI) CERTICATION FOR RELICENSING OF EXISTING HYDRO FACILITIES

The Low Impact Hydropower Institute (LIHI) is a United States-based independent nonprofit organization dedicated to reducing the harmful impacts of hydro projects by creating a credible and transparent standard to evaluate the environmental performance of hydro-electric facilities. Through the establishment of the Low Impact Hydropower Certification Program (LIHI Certification Program), LIHI certifies hydro facilities that seek to minimize the harmful impacts of their operations as compared with other hydro facilities based on objective criteria. The LIHI Certification Program covers both new proposed hydro facilities and the relicensing of existing hydro facilities.

To be certified as low impact, a hydro facility must satisfy criteria in the following eight areas: (1) river flows; (2) water quality; (3) fish passage and protection; (4) watershed protection; (5) threatened and endangered species protection; (6) cultural resource protection; (7) recreation; and (8) compliance with facilities recommended for removal. A hydro facility that satisfies these criteria will be certified as a Low Impact Hydropower facility, and can use this certification when marketing hydro-electric power to consumers and purchasers.

In 2007, the relicensing of Pelton Dam received LIHI Low Impact Certification. The California Department of Water Resources did not apply for LIHI Low Impact Certification in the case of the Oroville Dam relicensing, and to date there have not been any applications for LIHI Low Impact Certification submitted for any dams in California. The primary reason that there are no LIHI certified projects in California is that the State of California (unlike many other states) does not utilize the LIHI Certification Program as the environmental standard to determine a hydro facility’s eligibility in its state Renewable Portfolio Standard.

A comprehensive review of all the LIHI Certification Program criteria is beyond the scope of this paper, but below is additional information on the two criterion that often relate most directly to wild salmon stocks – river flows and fish passage/protection.

1. LIHI RIVER FLOWS CRITERION

The LIHI River Flows criteria is designed to ensure that the river has healthy flows for fish, wildlife and water quality, including seasonal flow fluctuations where appropriate. For instream flows, a LIHI certified facility must comply with recent resource agency recommendations for flows. If there is not qualifying resource agency flow recommendations, an applicant can meet one of two alternative standards: (1) meet the flow levels using the Aquatic Base Flow methodology or the "good" habitat flow level under the Montana-Tennant methodology; or (2) present a letter from a resource agency prepared for the application confirming the flows at the hydro facility are adequately protective of fish, wildlife, and water quality.

2. LIHI FISH PASSAGE AND PROTECTION CRITERION

The Fish Passage and Protection criterion are designed to ensure that the facility provides effective fish passage for anadromous fish (such as salmon), and protects fish from entrainment in turbines and water diversion structures. For anadromous fish, a certified facility must be in compliance with both recent mandatory prescriptions regarding fish passage and recent resource agency recommendations regarding fish protection. If anadromous fish historically passed through the facility area but are no longer present, the facility will pass this criterion if the applicant can show that the fish are not extirpated or extinct in the area due in part to the facility and that the facility has made a legally binding commitment to provide any future fish passage recommended by a resource agency.

When no recent fish passage prescription exists for anadromous fish, and the fish are still present in the area, the facility must demonstrate either there was a recent decision that fish passage is not necessary for a valid environmental reason, that existing fish passage survival rates at the facility are greater than 95% over 80% of the run, or provide a letter prepared for the application by the FWS or the NMFS confirming the existing passage is appropriately effective.

IV. CONCLUSION – REVISITING FAULTY FISHERY ASSUMPTIONS

In the United States, many Pacific Coast dams were initially designed and approved on the assumption that hatchery salmon programs would replace the lost wild salmon stocks caused by the dams. The hydro relicensing process set forth in the Federal Power Act provides an important opportunity to re-examine the ways dams operate now that this initial assumption has proven faulty. This hydro relicensing process allows such questions as fish passage and downstream flows to be considered anew with improved science and fresh eyes.

Looking beyond the United States, the broader legal and policy take-away is that the operation and design of hydro facilities can be modified over time to greatly reduce adverse impacts on fisheries. Such modifications are unlikely to occur, however, unless there is an effective mechanism in place (such as hydro relicensing that reflects the criteria found in the LIHI Certification Program) to force operators of existing dams to periodically and systemically identify and incorporate feasible fish restoration measures. Without such a mechanism, the faulty fishery assumptions and chronic operational flaws of existing hydro facilities may continue in perpetuity.

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