United States Department of the Interior

NATIONAL PARK SERVICE
Water Resources Division
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Response to Technical Assistance Request

To: Randy Larson, Superintendent, Sitka National Historical Park, Sitka, Alaska

From: (Carl) Nicolas Medley, Aquatic Ecologist/Fisheries Biologist, WRD-NRPC-WASO-NPS, Fort Collins, Colorado

Re: Technical Assistance Request 1077: "Assist with the quantification of hatchery-spawned salmon straying into the Indian River."

Date: November 1st, 2012

Cc: Anna Dittmar, Scott Gende, Guy Adema, Bill Hansen, Paul Christensen, John Wullschleger

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Introduction

In March, 2011, Sitka National Historical Park (SITK) submitted a Project Management Information System (PMIS) funding request seeking funds to monitor straying of hatchery salmon from the nearby Sheldon Jackson Hatchery (SJH) to the Indian River (Attachment 1.). Subsequently, the park submitted a Technical Assistance Request (TAR, Attachment 2.) to the Fisheries Program of the Water Resources Division (WRD) of the Natural Resource Science and Stewardship Directorate (NRSS), Fort Collins, Colorado for help during fiscal year 2012. The TAR was created by Craig Smith, Chief of Resource for SITK and titled "Assist with the quantification of hatchery-spawned salmon straying into the Indian River." It was logged as TAR 1077 and assigned to Nic (Carl) Medley, Fisheries Biologist/ Aquatic Ecologist.

The TAR Problem Statement

The request for assistance reads; "Since the opening of a nearby hatchery that uses Indian River water for rearing and attraction, pink salmon escapement in the river has increased by nearly 4 orders of magnitude. Extremely high escapement rates make it seem likely that substantial straying is occurring and that hatchery strays may be overwhelming naturally spawning salmon. A recent permit for the operation of the hatchery indicates that measures to reduce straying will be implemented if straying is excessive, but there are no current measurements of straying. Hatchery salmon have thermally marked otoliths, so sampling of otoliths from fish returning to the river can provide information on the percentages of hatchery versus naturally-spawned fish. The park seeks assistance designing a sampling strategy to address these concerns".

What is SITK asking the NRSS to do?

"The Park has staff to conduct fieldwork but lacks expertise in designing sampling strategies for fish populations and extracting otoliths from salmon. The park needs assistance designing sampling strategies to address origins of anadromous fish returning to the river and assistance in developing a proposal to submit for future funding".

AGFO Site Visit and Issues Addressed in TAR Response

In response to SITK's request for technical assistance, Nic (Carl) Medley of the NRSS, traveled to SITK between August 28 and 31, 2012, to meet with park staff and representatives from Alaska Department of Fish and Game (ADFG) and the Sitka Sound Science Center (SSSC) and Sheldon Jackson Hatchery (SJH) and to conduct a field visit of SITK and the watershed of the Indian River. The purpose of the visit was to better understand the issues that the park is wanting to address in order to make recommendations on how the park should proceed.

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At the conclusion of the trip it was apparent that although straying of hatchery fish to the Indian River occurs, it is only one of a suite of interacting issues, all of which impact the natural resources of the park. Consequently, while the TAR specifically requested assistance in developing a study to characterize straying of hatchery fish, it is necessary to evaluate other factors that may influence straying rates so that appropriate recommendations can be made to comprehensively address the issue. The TAR will address the following topics:

1. Provide brief trip summary
2. Present the policy mandates of the three major stakeholders (NPS, ADFG, SSSC, SJH) regarding the management of salmon in the Indian River
3. Identify and evaluate the factors that might affect the health of native fish populations, including straying of salmon to the Indian River within SITK, and provide recommendations to address straying, and;
4. Provide general recommendations regarding management of natural resources within SITK and specific recommendations (Attachment 3; draft study proposal) to monitor straying of hatchery fish to the Indian River.

Trip Summary

Tuesday August 28, 2012: I was met late morning at the Sitka Airport by Craig Smith (Chief, Natural Resources, SITK). In the afternoon, we toured the park, focusing on the lower Indian River. Large numbers of pink salmon were observed staging at the mouth of the river. Many pink salmon had already moved upstream and were spawning within the park. A few chum salmon were observed spawning under the foot bridge. I fished Indian River in the evening in pouring rain. Pink salmon looked to be in great condition: large and strong fish. Several people informed me that in general, the pink salmon run was several weeks late this year, but the fish were larger than usual.

Wednesday August 29, 2012: Met with SITK and other NPS staff (Randy Larsen, Superintendent; Anna Dittmar, Chief of Resources; Craig Smith, Chief of Natural Resources, now retired; Scott Gende, Coastal Ecologist, NPS) in the early afternoon to discuss the upcoming meeting with SSSC and ADFG. Subsequently, we met with SSSC (Lisa Busch, Executive Direction; Lon Garrison, Aquaculture Director) and ADFG (Troy Tydingco). Primary focus of meeting was for SITK and myself to meet SSSC and ADFG staff in an effort to foster some mutual trust and cooperation so that the parties might cooperate in future research and monitoring and the development of an agreement that will balance the ecological needs of the river with the water needs of SJH. Much of the discussion was to educate the SSSC staff about the NPS laws and policies and why the protection of the river is of concern to SITK.

Thursday August 30, 2012: I toured the upper Indian River with Craig Smith. Large numbers (thousands) of pink salmon were observed all the way to the confluence of the two major forks of the river and beyond, and in all tributary streams. All available spawning habitat was being used. I fished the deep pool at the location of the USGS gage ("Near Sitka" gage), and the two pools immediately downstream to confirm the presence of Dolly Varden (DV). I caught ~10 DV, up to 16" on "beads" confirming the presence of a healthy resident DV population. No large anadramous DV were observed.

Friday, August 31, 2012: Spent the morning at SJH diversion structure on the Indian River. At that mornings flow, salmon could not negotiate the rock diversion structure. In the 2 hours that I was there, I did not observe a single salmon get over the rock diversion structure. The high flow channel on river left was dry. For the first hour, I also did not observe a single fish successfully negotiate the fish ladder, even though there was thousands of fish stacked below passageway and sufficient water going through structure. Upon inspection, I discovered a 4x1 plank about 3' long lodged diagonally in the passageway. Upon removal, fish immediately started ascending ladder at a rate of ~2-4/minute.

Other Observations/Information

- I had a conversation with Kenneth Rear, owner of Sitka Alaska Outfitters, a local fly-fishing guide about what species of fish are in the Indian River. He stated that coastal cutthroat and rainbow trout were sometimes caught and are native but it was possible that some of the rainbows are derived from a population stocked in the Sawmill Creek watershed. He confirmed the presence of a small native spring run of steelhead and that the population used to be larger, but he had been told that the population had been severely depleted by historical gill netting. He also believed that there was a small anadramous Dolly Varden run. This was also supported by Lon Garrison (SSSC) who stated that DV were sometimes caught as by-catch of the SSSC cost recovery operation. It is unclear whether chum, coho and king salmon are native or derived from SJH operations.

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- On the night of August 28th (or perhaps shortly before? Need to obtain gage records), there was a significant spate event on the Indian River. It is likely that flow in the channel adjacent to the SJH diversion on river left allowed a large number of salmon to easily bypass the diversion. The response of fish to the occurrence of these transitory spates, and their subsequent access to spawning habitat above the diversion is likely to be an important factor influencing population dynamics in many years.

Policy Considerations

Sitka National Historical Park and NPS Mission and Policy

Sitka National Historical Park (SITK) is the oldest federally designated park in Alaska, designated as a Federal Reserve in 1890. It consists of two components; the Russian Bishops house, and the "Fort Site" unit located on a narrow strip of land between the estuary of the Indian River and the beach of Sitka Sound just south of the present town of Sitka, AK. The park was established to commemorate and protect the location of a decisive battle between colonist Russians and Tlingit Indians that occurred in 1804. This battle marked the last major Native resistance in Sitka to European domination of Alaska. In 1910 it was designated as a National Monument and upon passage of the Organic Act (16 USC 1, 1916) came under the management authority of the newly established National Park Service.

The National Park Service has the primary responsibility to manage the lands and natural resources, including the fisheries resources, within SITK, consistent with the statutory authority provided in the Organic Act. The National Park Service; "shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified … by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Accordingly, the fundamental purpose of the national park system begins with a mandate to conserve park resources and values. NPS managers must seek ways to avoid, or to minimize to the greatest extent practicable, adverse impacts on park resources and values. The impairment that is prohibited is an impact that in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. However, the impact threshold at which impairment occurs is not always readily apparent. Therefore, the NPS applies a standard that offers greater assurance that impairment will not occur. The Service does this by avoiding impacts that it determines to be "unacceptable." These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment. Park managers must not allow uses that would cause unacceptable impacts; they must evaluate existing or proposed uses and determine whether the associated impacts on park resources and values are acceptable.

NPS Management Policies (2006) establish the framework and provide direction for all management decisions to ensure that park resources are protected unimpaired. Adherence by NPS employees to policy is mandatory unless specifically waived or modified by the Secretary, the Assistant Secretary for Fish and Wildlife and Parks, or the Director. Chapter 4 of the management policies provides guidance on managing park natural resources. Natural resources will be managed to preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities. The Service will not attempt to solely preserve individual species (except threatened or endangered species) or individual natural processes; rather, it will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems.

To further this general management goal, the NPS policies articulate a suite of management principles for managing biological and water resources, which include:

Biological Resources Management: "The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems by;

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- preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur:
- minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them."

Genetic Resource Management: "The Service will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity."
Water Rights Management: "Water for the preservation and management of the national park system will be obtained and used in accordance with legal authorities. The Park Service will consider all available authorities on a case-by-case basis and will pursue those that are the most appropriate to protect water-related resources in parks. While preserving its legal remedies, the Service will work with state water administrators to protect park resources and participate in negotiations to seek the resolution of conflicts among multiple water claimants."

Watershed and Stream Processes Management: "The Service will manage watersheds as complete hydrologic systems and minimize human- caused disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. … The Service will protect watershed and stream features primarily by avoiding impacts on watershed and riparian vegetation and by allowing natural fluvial processes to proceed unimpeded. Where stream manipulation is unavoidable, managers will use techniques that are visually nonobtrusive and that protect natural processes to the greatest extent practicable."

Alaska Department of Fish and Game Policies regarding administration of the private, non-profit (PNP), salmon hatchery program in Alaska

Notwithstanding NPS authority to manage resources within land under its jurisdiction, the Alaska Department of Fish and Game has the primary authority to administer and manage fish and wildlife resources within the state, including the permitting of private, non-profit hatcheries (PNP's) such as SJH. Regional Information Report No. 5J12-05: "An evaluation of the Tutka Bay Lagoon salmon hatchery for consistency with statewide policies and prescribed management practices", (Division of Commercial Fisheries, Alaska Department of Fish and Game, http://www.adfg.alaska.gov/static/fishing/PDFs/hatcheries/RIR.5J.2012.05.pdf) provides a summary of statewide policies regarding genetics, fish health and fisheries management of PNP salmon hatcheries in Alaska. In Alaska, salmon hatcheries are used to supplement wild stocks to benefit the commercial and public fisheries. To further this goal, PNP hatcheries, are authorized to operate "for the purpose of contributing, by artificial means to the rehabilitation of the states depleted and depressed salmon fishery." However, "the program shall be operated without adversely affecting natural stocks of fish in the state and under a policy of management which allows reasonable segregation of returning hatchery reared salmon from naturally occurring stocks." (Alaska Legislature, 1974). Therefore, a key principle in the management of salmon in Alaska is the protection of wild salmon stocks and a suite of policies is used to meet this goal. The *Alaska Policy for the Management of Sustainable Salmon Stocks* (5AAC 39.222) mandates protection of wild salmon stocks in the management of salmon fisheries. Other important policies include the *Genetic Policy* (Davis et al. 1985), the *Alaska Fish Health and Disease Policy* (5AAC 41.080), the *Policy for the Management of Mixed-Stock Salmon Fisheries* (5AAC 39.200), the *Salmon Escapement Goal Policy* (5AAc 39.223) Policies of the ADFG state that in general, hatchery fisheries should be managed to limit straying to less than the 2% in nearby wild stocks (personal communication; Troy Tydingco, Division of Sports Fisheries, ADFG).

Sheldon Jackson Hatchery and the Sitka Sound Science Center

Historically, the Sheldon Jackson Hatchery was operated by the Sheldon Jackson College and used to train many of Alaska's fisheries scientists. Since 2007, the facility has been operated as a PNP, salmon hatchery by the Sitka Sound Science Center, a 501c3 nonprofit corporation that assumed management of the hatchery when the college closed. SSSC manages SJH under a PNP permit given by the ADFG, consistent with the four documents required in regulation (5AAC 40.110-990 and 5AAC 41.005-100 and statute (AS 16.05.092): hatchery permit with basic management plan (BMP), annual management plan, fish transport permit, and annual management report. The mission of the SSSC states; "The SSSC is dedicated to increasing understanding and awareness of terrestrial and aquatic ecosystems of the Gulf of Alaska through education and research. Our vision is to build on Sitka's legacy and potential as an educational and scientific community." In September 2010, the SSSC submitted a permit alteration request to ADFG to renew its PNP permit to operate SJH. In the "Statement of Applicant Goals and Objectives" SSSC states that "The organization desires to

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continue operations of the SJH into the foreseeable future, with an eye toward instruction of fisheries-related subjects, supporting research efforts, *and utilizing cost recovery of returning adult salmon to help fund hatchery operations.*" Specifically, SJH requested permission to increase pink salmon egg production from 1 million to 3 million in order to increase adult fish returns to the raceway of the adult holding facility. Increasing the number of returns would increase the number of salmon in the common commercial fishery and allow for considerably higher cost recovery revenue which would be used to fund operation of SJH and generating revenue for SSSC. SJH also proposed to increase coho salmon production from 150,000 to 250,000 eggs. Consequently, while SSSC primarily operates the hatchery as an educational tool in its larger mission, the production and harvest of pink, chum and coho salmon provides an essential revenue source for SCCC, and provides additional benefits by augmenting the public and commercial fishery. In 2012, ADFG granted SCCC a permit for its proposed salmon rearing activities. However, in response to concerns about straying salmon expressed by SITK and ADFG, the permit was granted on the condition that SJH monitor the extent to which SJH hatchery salmon may stray to the Indian River.

NPS Management Goal for Indian River

Sitka National Historical Park (SITK) is statutorily required to protect the Indian River and its associated natural resources, including salmonid populations. The Alaska Department of Fish and Game (ADFG) has the responsibility to protect natural salmon populations within Alaska and has acquired the right to seasonal instream flow reservations (priority date 1980) to protect river habitat. The mission statement of SSSC emphasizes education and science. The importance of the hatchery augmentation to SSSC is to allow them to conduct cost-recovery operations by selling salmon to offset the cost of activities that help them meet their primary mission goal. In meeting that goal, SJH should not want, or be allowed to take a quantity of water that would adversely affect the Indian River and natural salmon runs.

An appropriate management goal for SITK would be to foster natural resource management within SITK that is more consistent with the statutorily mandated mission of the NPS. It should do this by working with agency partners and other stakeholders to develop agreements that are consistent with federal and state laws and regulations and that are mutually beneficial to all parties. In meeting this goal, it is the intention of the NPS to work cooperatively with the SSSC and ADFG in a manner that allows SSSC to operate SJH to meet its mission goals, and simultaneously allows the NPS to protect park resources consistent with federal laws, regulations and policies.

In managing for this goal, the NPS acknowledges the important mission of the SSSC and its operation of the SJH. The NPS understands that there will always be some level of straying, and that there will always be need for a minimum SJH diversion requirement as long as the hatchery is in operation. It is interested in finding a way to do this that balances the natural resource needs of the park, with the water needs of SJH.

Evaluation of Fisheries Issues at Sitka National Historical Park

Indian River Fish Community

The Indian River is a short river, approximately 8 miles long, which originates in the mountains northeast of Sitka, Alaska, on Baranof Island in the Alexandra Archipelago of Southeast Alaska. It flows southwest and enters the ocean one mile southeast of downtown Sitka. Sitka National Historic Site is located on the west bank of the Indian River where the river meets the ocean. The Sheldon Jackson Hatchery (SJH) is located just west of the Park and the mouth of the Indian River.

Since salmon rearing activities began in 1975, significant changes have occurred in the size and composition of Indian River salmon stocks. Peak salmon escapement data collected by ADFG (Table 1.) suggests that historically (1962-1973), the Indian River possessed a small, native population of pink salmon and perhaps coho salmon. Other native salmonid species present were resident rainbow trout and anadromous steelhead, resident and anadromous Dolly Varden, and perhaps some coastal cutthroat trout. The available data suggest that the reported presence of other salmon species (chum, Chinook and sockeye) is a consequence of SJH operations. While their presence may not be natural, the small numbers reported, and the absence of opportunities to interbreed with natural populations suggests that their presence is not a serious threat to the river ecology and they will not be considered further.

Year	Pink	Coho	Chum	Chinook	Sockeye

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1962	500				
1963	600	30			
1964	300				
1965	500				
1966	300				
1967	150				
1969	500				
1971	300				
1972	200				
1973	500				
1977	17500				
1978	2000				
1979	5991	96			
1980	2893	110	125		
1981	16000	32	4		1
1982	12000	125			
1983	21000	55			
1984	6000	175			
1985	11000	86			
1986	10000	93	286		
1987	3000	53	1372		
1988	1651		556		
1989		603			
1990	1750	20	500		
1993	800				
1994	55000				
1995	14000				
1996	185000		500		
1997	260000				
1998	66000				
1999	160000		500		
2000	85000		2210	50	
2001	90000		1000		
2002	68000		152		
2003	270000				
2004	73000		2215		

Table 1. Peak salmon escapement for the Indian River from 1962 through 2004 compiled from the ADFG Division of Commercial Fisheries, Integrated Fisheries Database (Eckert 2006).

However, within two years of the first salmon rearing operations (the life cycle time for pink salmon), estimated peak escapement of pink salmon in the Indian River increased from 150-600 fish to 17,500 individuals. Escapement continued to rise through the 1980's and 1990's, and the annual peak escapement now routinely numbers in the 100,000's, and has been as high as 270,000 fish. Significant numbers of coho and chum salmon were also reported beginning in 1979 where few or none had been observed previously.

Salmon populations fluctuate greatly, influenced by climatic cycles, local environmental conditions, and fishing pressure and regulations. Additionally, escapement is often difficult to accurately estimate. While these factors may confound the interpretation of cause and effect relationships between salmon abundance and the environment, the timing and increase in pink salmon escapement upon commencement of hatchery operations suggests that pink salmon returns to the Indian River, and perhaps also of chum and coho salmon, have been, and may continue to be influenced by augmentation and straying of fish originating from SJH.

Straying

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Straying occurs when adult salmon fail to return to the site where they hatched and were imprinted to the scent of their freshwater natal stream (or hatchery) as smolts, and return to spawn at a different location. While it usually refers to hatchery salmon straying to natural streams, salmon imprinted on olfactory cues in a natural stream can stray to a nearby hatchery if they share a primary water source. Water diverted from the Indian River is used to; 1) support basic hatchery operations throughout the year (< 2cfs), and; 2) to create an attractant flow (10-15 cfs) to encourage salmon to return to the hatchery raceway rather than the Indian River. Low returns of fish to the hatchery may be due to attraction of returning adult salmon to the natural outflow of the Indian River during attempted migration to their natal source (Paustian and Hardy 1995, Summit 2004). This would be expected because the water used at SJH originates from the Indian River. Returning hatchery salmon, imprinted as smolts on the chemical characteristics of Indian River water at SJH, cannot differentiate between water originating from the SJH raceway or the natural river. Since the flow of the river is often greater than that originating from SJH, and is not ponded behind a rock breakwater, the river is easier for salmon to locate. Such straying would explain both the large increase in pink salmon returns to the Indian River and the low adult returns to the SJH raceway. If straying of SJH salmon to the river is a significant contribution to the magnitude of salmon stocks on the Indian River, then proposed increases in pink salmon production are likely to further increase the population of pink salmon returning to the Park, further impairing park resources. The results of this "natural experiment" are likely to be very apparent in 2014 when the fry derived from the 2012 year class return.

Pink salmon returns to the Indian River increased significantly two years (the life cycle of a pink salmon) after the start of SJH operations suggesting that straying from the hatchery to the Indian River may have augmented the natural run during this year. For the next decade, escapement estimates (assumed to reflect total return) remained higher than prior to the opening of SJH but varied widely. Sometime during the 1980's a fish passage structure was constructed at the SJH water diversion on the Indian River allowing salmon to more reliably access spawning habitat in the upper Indian River (Troy Ticongo). In response, estimated salmon escapement increased another order of magnitude in some years, reaching as high as 270,000 fish in 2003.

Consequently, the number of salmon, and the proportion of wild vs hatchery derived fish returning to the Indian River is likely dependent upon a suite of interacting factors, including;

- Areal extent and quality of spawning habitat available in the Indian River above and below the SJH diversion dam.
- Access to spawning habitat above the SJH diversion structure which is dependent upon sufficient natural flows for salmon to pass through or around the water diversion structure and/or the successful operation of the fish passage structure
- The number of naturally spawning adults returning to the area
- The number of hatchery released fish returning to the area
- The differential survival of hatchery vs wild spawned fish, if any
- Ecological factors that affect ocean survival and recruitment of both hatchery and wild fish
- Number of salmon caught in the commercial fishery
- The ability of fish to locate the hatchery raceway water or the natural outlet of the Indian River

In years where hatchery released pink salmon numbers are high and water levels in the Indian River are low and salmon cannot efficiently access spawning habitat above the SJH diversion, it is likely that the magnitude of salmon returns two years later will be relatively low with a relatively high proportion of hatchery derived fish. Conversely in years where hatchery released salmon numbers are low and water levels in the river allow efficient passage of returning fish to spawning habitat above the diversion, it is likely that the magnitude of the subsequent salmon return will be high and the proportion of hatchery derived fish will be low. In general, the number of naturally spawned fish returning to the river, regardless of whether their parents are hatchery or wild spawned fish is likely to be directly related to spawning habitat availability, which is a function of river flows and the efficiency of fish passage over the SJH water diversion. Similarly, the number of hatchery spawned fish returning to the river will largely be dependent upon the number released. The number of both naturally and hatchery spawned fish will also be dependent upon ocean survival and the number of salmon caught in the commercial fishery.

In conclusion, the magnitude of the pink salmon return and the proportion of wild to hatchery derived fish is likely to vary considerably from year to year. Presently, there is no analysis of the available data that can estimate the contribution of natural reproduction and hatchery reproduction. Suffice to say, that while straying of hatchery derived salmon may represent a significant proportion of the total return in some years (>80%?), it may represent a relatively small proportion (<20%?) in others. However, given the recent magnitude of hatchery releases (1 million pink salmon) it is very unlikely that the straying rate would be less than the 2% recommended by ADFG.

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If straying is a significant problem, it is likely that the proposed increase in the number of hatchery derived fish from 1 million to 3 million pink salmon will greatly increase the magnitude and proportion of SJH fish straying to the Indian River and SJH's request to increase production in an attempt to increase cost recovery may greatly increase returns of SJH fish to the river. However, to reduce the potential impacts of hatchery fish on naturally reproducing salmon it is necessary to minimize/prevent cross breeding between wild and hatchery fish and straying of hatchery fish to the Indian River. This may be accomplished by reducing/eliminating SJH production, or increasing hatchery returns to the SJH raceway. Consequently, an increase in production and the control of straying to less than 2% are likely contradictory, though no information exists to document this.

Hatchery selection, differential survival and possible genetic effects in the wild pink salmon population

Straying of hatchery derived fish to naturally reproducing populations is considered to be problematic because of the potential for hatchery selected fish to alter the genetic structure of wild populations. Escapement estimates suggest that pink salmon were the only salmon species present in the Indian River prior to SJH operations and therefore the only wild population that could be potentially affected by SJH hatchery strays. The available information suggests that the contemporary presence of other salmon species is due to straying of chum and coho salmon from SJH or the recent establishment of wild populations from SJH origin, although it is possible that escapement estimates do not capture the presence of small, wild population of other salmon species that historically retuned to the river.

Pink salmon have a two year life cycle and salmon returning to spawn in "odd" and "even" years can be considered separate populations with independent genetic histories. While the genetics of odd and even year populations of wild pink salmon in the Indian River may have been similar in the past because of their very similar evolutionary histories, each is now potentially impacted by the odd and even year stocking history of SJH.

For the first year of SJH operations in 1975, pink salmon eggs (1,747,935) were derived from the Indian River (91%) and the Katlian River (9%) (Table 2 in 2012 Annual Management Plan Sheldon Jackson Hatchery). The large increase in pink salmon escapement in 1977 suggests that naturally spawning pink salmon in the Indian River in 1977 were mostly comprised of strays of SJH origin. Because these salmon were hatched from eggs collected from wild pink salmon of Indian River origin, it is likely that the genetics of the wild spawned fish in 1977 was similar to that of the historic wild pink salmon population, but with a 9% contribution from Katlian River fish. In subsequent years, pink salmon eggs were taken from this SJH augmented stock as they returned to the SJH hatchery. Consequently, pink salmon in odd years are still largely derived from the original stocking event in 1975 and still possess a predominantly Indian River genotype with a minor contribution of Katlian River fish.

However, in 1976, almost all the pink salmon eggs (1,949,664) used in SJH pink salmon operations were derived from Starrigavin Creek (97%) with only a minor contribution from the Indian River (3%). Consequently, the even year, Indian River, wild spawning pink salmon population in 1978 was dominated by a pink salmon genotype originating from Starrigavin Creek fish. Since fish returning to the hatchery from this stock have used as the SJH egg source since that time, it is likely that the present, even year pink salmon genotype is largely that of Starrigavin Creek fish and is not representative of the historic wild Indian River pink salmon genotype.

The extent to which the Indian River pink salmon genotype may have been altered is thus dependent on two factors; 1) genotypic differences between the historic Indian River pink salmon populations and the source of pink salmon eggs used in the first odd (1975) and even (1976) years of SJH operations, and 2) the potential for artificial selection resulting in genotypic differences between salmon hatched and reared in SJH and those hatched in the natural Indian River environment.

Pink salmon are known to have a high incidence of straying perhaps contributing to their wide geographic distribution. Consequently, it is likely that there is considerable natural inter-breeding between pink salmon stocks originating from different river basins that are in close proximity. Katlian Creek and Starrigavin Creek are the two largest drainages immediately north of the Indian River and all three rivers empty into Sitka Sound within ~15 miles of each other. While the genotypes of each ancestral population may possess unique characteristics perhaps driven by different characteristics of each watershed and/or by neutral genetic drift, it is also likely that these closely spaced salmon populations are genotypically similar due to a high incidence of straying and the similarity in life histories driven by physical, chemical and biological evolutionary pressures that are similar in watersheds in close proximity.

Although undocumented, pink salmon egg hatching and rearing in SJH is also unlikely to create *severe* artificial selection pressures which results in significant changes when compared to wild pink salmon stocks, although the potential is always there. SJH diverts Indian River water for use in the hatchery without any treatment. Consequently, the temperature, and the degree days that SJH eggs experience, is similar to eggs overwintering naturally in the Indian River. The only difference is the rise in temperature that eggs experience in the hatchery as the water is cyclically warmed to

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create the unique thermal otolith mark in each stock of fish, and a small rise in the average temperature of hatchery water compared to Indian River water. While the temperature differences are small, pink salmon eggs hatch early enough that the pink salmon hatchlings are artificially fed for a few weeks before they are transported to pens close to the SJH raceway outfall where they imprint to SJH water and subsequently released. Consequently, they may be a little larger at time of release. It is not known how SJH hatching time compares to Indian River hatching time, or if there are differences in the timing of the outward movement to the ocean of the timing of smoltification (imprinting to the natal water source). Additionally, it is not known if there is a differential ocean survival of SJH vs Indian River fish due to the larger size of the former at release. While it is possible that there is some level of artificial selection during the hatchery phase, both SJH and Indian River wild spawned hatchlings experience the same selective pressures during their ocean phase. Consequently, any pink salmon returning from the ocean, whether of SJH or Indian River origin, are likely to experience mostly natural selection pressures and its survival represents a successful fish.

Pink salmon eggs for SJH operations are collected from fish returning to the SJH raceway. While these might be assumed to be first generation SJH fish, many are likely to be of wild origin. Just as fish may stray from the hatchery to the Indian River, it is likely that fish also "stray" from the Indian River to the SJH raceway. Therefore, while the proportion of fish derived from eggs originating from first generation SJH fish and wild spawned fish may change substantially from year to year (see Straying section above), the proportion of wild pink salmon (independent of whether their parents were of hatchery or Indian River origin) and SJH derived fish harvested at the SJH raceway is likely to be identical to the composition of fish in the Indian River. Consequently, unless there are severe selection pressures operating on eggs hatched in SJH, the health of the salmon population in the Indian River is largely independent of whether eggs come from SJH derived or wild spawned fish, or whether those eggs are collected from fish in the Indian River or the hatchery raceway. This circumstance also suggests that the eggs used for SJH operations are not taken from brood stock fish that experience years of uninterrupted hatchery selection, but are harvested from fish that always include a proportion, sometimes a high proportion, that are the offspring of wild spawned fish. Consequently, the probability that a particular fish is descended from a lineage with multiple generations of SJH fish is small, and decreases exponentially with each generation.

In summary, we may conclude that:

1. Pink salmon returning to the Indian River are partially, or almost wholly derived from fish from other drainages. Consequently, the genotype of the historic Indian River pink salmon population has changed since the onset of SJH operations, especially in the even-year population largely derived from Starrigavin Creek pink salmon.
2. The proportion of hatchery fish straying to the Indian River is likely to be highly variable from year to year.
3. In every year, eggs and milt are harvested from both SJH derived fish and from fish derived from wild spawned Indian River fish. Although unconfirmed, current hatchery operations, and the current mixed source of SJH pink salmon eggs and milt are unlikely to cause significant artificial hatchery selection pressures resulting in deleterious genetic consequences.
4. Other than allowing natural evolutionary processes to occur, there is little that can be done to restore the historic genotype of the Indian River pink salmon population.
5. In many years, the naturally spawned pink salmon population in the Indian River is likely affected by low flows and the inefficient operation of the SJH water diversion structure and fish ladder

While the current pink salmon genotype has changed, it can perhaps be rehabilitated, if thought necessary, by allowing natural evolutionary processes to operate on the Indian River pink salmon population. This would require reducing the proportional impact of SJH derived fish on Indian River pink salmon. This can be done in two ways;

- Reducing the hatchery output from SJH
- Implementing management practices to increase hatchery salmon returns to the SJH raceway by imprinting outgoing salmon fry to artificially amended SJH hatchery water that has a different olfactory signal than unamended, natural Indian River water (see Attachment 4.).

Cost Recovery Operations and Raceway Flows

The cost-recovery operation is important to because the sale of salmon provides a significant funding source for SSSC to implement its core mission; education and science. Historically, SJH has relied on salmon returning to the raceway as a source of eggs and milt, and for salmon harvest for cost recovery operations. This requires the hatchery to divert a large amount of Indian River water to provide an attractant flow, at a time when river flows can be very low. However, the flows in the river are easier for the salmon to locate than the flows from the hatchery raceway and SJH is often looking for

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more raceway flows to attract a greater proportion of fish to the raceway in an effort to increase revenues from cost recovery. Currently, the SSSC is proposing a diversion rate of 15 cfs to support this practice; a flow that is often unavailable without significantly reducing natural river flows.

In order to increase cost recovery, SSSC now contracts with a local fishing boat to conduct a purse-seine operation in Sitka Sound a short distance from the outlet of the Indian River. Thus, SJH uses its PNP hatchery to produce more fish to generate greater income for SSSC through a "commercial" seine netting operation, hence the request to increase production from 1 million to 3 million pink salmon, which are currently fetching a high market price (~ $0.66 / lb). While the seine net cost recovery operation is largely independent of raceway flows, collection of eggs and milt to meet production targets still requires a raceway attractant flow. Therefore, the right to divert large amounts of Indian River water is considered to be a fundamental component of SJH operations, even if it may cause a severe negative impact to flows in the Indian River. However, there are other ways to acquire fish, eggs and milt. The capture of fish during seine net cost recovery can also be used as the source of reproductive material, obviating the need for ***any*** raceway flows. Fish can be netted, killed, put on ice and transported to the hatchery in a very short time, where eggs can be harvested. Alternatively, if fish need to ripen, they can be captured and placed in nets that can then be towed the short distance to the hatchery.

It is understandable that SSSC should want to leverage its existing resources to contribute to the common property fishery, provide opportunities for education, science and public outreach, and to provide a sustainable funding source. However, in meeting these mission goals SSSC should be required to balance production goals, funding needs, and raceway flows, and implement management practices that limit straying rates to the ADFG policy of 2%, and prevents adverse effects to the Indian River. Of particular concern to the park is the anticipated three-fold increase in salmon returns in 2014 in response to the increase in SJH production goals.

Water Rights on the Indian River

There are five known water rights on the Indian River. Basic information on the water rights is shown below (Table 2.):

Type of water right	*Number*	*Year of priority date*	*Owner*	*Status*	*Duty*	*Notes*
Federal reserved	—	1890	National Park Service	Not adjudicated	Not quantified	
ADL (state)	43671	1914	SSSC	Certified	30 ft^3/s	Under review.
ADL (state)	43672	1914	City and Borough of Sitka (CBS)	Certified	3.87 ft^3/s	For emergency use only.
ADL (state)	101686	1980	CBS	Received	5.41 ft^3/s	For emergency use only.
LAS (state)	12236	1989	Alaska Department of Fish and Game (ADFG)	Certified	35-101 ft^3/s	See Neal and others, 2004, p. 20, for diversion schedule.

Date Range	**Alaska Department of Fish and Game Flow Reservations (cfs)**
October 1 - October 31	101
November 1 - November	40
December 1 - April 15	35
April 16 - April 30	40
May 1 - June 30	51

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July 1 - July 15	43
July 16 - July 31	51
August 1 - September 30	61

Table 3. Alaska Department of Fish and Game flow reservations on Indian River from the mouth upstream to river mile 2.5 (cfs, cubic feet per second)

SITK has the presumed senior right on the Indian River sufficient to meet its statutory responsibilities to protect the purposes for which the park was established, even though the right has not been quantified, permitted or adjudicated. Additionally, SITK would never choose to file for such a right in lieu of a cooperative agreement between Indian River water rights holders that would meet the Park's needs. Sheldon Jackson Hatchery had a historic 50 cfs water right, originally permitted to allow hydroelectric power at the Sheldon Jackson College. The original right has a priority date of 1914. This right was never perfected, and subsequently reduced to 30 cfs. A portion of this right is presently used to operate the Sheldon Jackson Hatchery. The minimum quantity needed to meet this need has never been quantified, but is the focus of discussions between the Alaska Department of Natural Resources (ADNR), NPS and SSSC. The Borough and City of Sitka (CBS) has two permits to take water from the Indian River at times when its water needs cannot be met by water originating from Blue Lake on Sawmill Creek south of Sitka, the cities primary water source. While CBS has a permitted right to use Indian River water, it is difficult to do so, because of the treatment requirements. To ensure that CBS has sufficient high quality water, the Blue Lake Dam will be elevated 50 ft in the near future. It is unlikely that CBS will ever need to divert and use their Indian River water right. The ADFG owns a permit to protect instream flows below the SJH diversion structure with a priority date of 1980. However, the junior water right means that other senior water right holders (SJH and CBS) may divert their water right before the ADFG instream flow requirement is met. However, the ADFG right does place a restriction on future development in the watershed.

SJH water use has been measured and reported (NPS 2011). This data is the basis of an NPS recommendation to ADNR identifying the minimum required diversions for SJH operations. This recommendation does not include a raceway attractant flow because of NPS concerns regarding protection of river flows. SJH has proposed its own minimum flow requirement for basic operations (< 6cfs) and proposed a raceway flow of 15 cfs during salmon spawning season, which represents the entire flow of the Indian River in some years.

Month	*SSSC proposed diversions, ft^3/s*	*NPS **Maximum** recommended diversions, ft^3/s*
Jan	6.4	6.4
Feb	6.4	6.4
Mar	6.7	6.4
Apr	6.8	6.4
May	6.8	6.6
Jun	10.4	5.4
Jul	15.5	7.1
Aug	15.8	8.9
Sep	16.2	9.2
Oct	16.2	7.7
Nov	16.3	6.4
Dec	6.4	6.4

Table 4. SSSC proposed, and NPS recommended maximum diversion rates for SJH operations

It appears that the goals and policies of the ADFG in seeking a permit for an instream flow reservation and the mission and policies of the NPS are aligned; the protection of the stream discharge and its ecology, including salmon runs and other native fish. However, the NPS, as the presumptive senior water right holder on the river, may have to take the lead in encouraging SJH to reach an agreement that will protect the river because the ADFG reservation is junior to the SJH diversion right. It also appears that if the SSSC and its management of SJH are consistent with its mission statement emphasizing science and education and the protection of Sitka Sound, then SSSC should also have a desire to protect the natural function of the Indian River and its salmon runs.

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However, SSSC are likely to find themselves in a difficult position. On one hand, if the incidence of SJH salmon straying is higher than the 2% required by ADFG policies, then the NPS and ADFG should encourage SJH to find ways to reduce straying, perhaps by lowering their hatchery production. This would lead to lower cost recovery as fewer SJH salmon return to the area. Alternatively, if the SJH straying rate is low and most of the fish are of wild origin, then it would indicate that proper hydrologic function of the Indian River is necessary to protect the run suggesting that SJH should reduce SJH diversions, including cessation of the raceway flow during dry years to ensure the protection of the river. Either way, SJH should be encouraged to find ways to limit straying by reducing their production targets, getting more SJH salmon to return to the raceway, and to divert only the minimum water necessary for basic operations during periods of low flow; goals that are somewhat contradictory, as Indian River water diverted into the raceway is the current mechanism that SJH uses to attract salmon to the hatchery.

Attractant flows at the outlet of the SJH raceway are used to attract salmon from which eggs and milt are harvested. While this is convenient for the hatchery, the operation diverts a large proportion of the available flows in the Indian River during periods of naturally low flows. Alternatively SJH can take its eggs and milt for rearing operations from fish captured by the large purse seining operation that harvests the fish for cost recovery. In this circumstance, SJH would not need the raceway flow and the water could stay in the river. It is not desirable that river flows suffer at the expense of a little additional work by getting the salmon and eggs from the purse seine cost recovery operation.

If, as has been suggested, a large proportion of pink salmon returning to the Indian River are naturally spawned in the river, diverting Indian River water for raceway operations at the expense of flows in the river is inconsistent with protection of the natural fishery. As per their respective policies, both the NPS and ADFG should be working towards protecting flows in the river, enhancing fish passage over the diversion, and limiting the possible impact of straying SJH salmon. While the genetic issues may be minimal, augmentation of the natural pink salmon run may still have some negative impacts, perhaps on other native fish species, such as anadramous dolly varden. When production at SJH is increased from 1,000,000 pink salmon to 3,000,000 there is likely to be a 300% increase in returns of SJH derived fish to the river exacerbating any potential impacts and creating a severe nuisance for SITK.

Shortage Sharing Agreement

It is desirable that SITK negotiate a shortage sharing agreement with the SSSC that identifies a schedule of diversions during times of critical low flow that balance ecological and geomorphic needs of river with the reasonable operation of SJH (see Attachment 5). Since the park has the senior water right, even if has not been quantified, permitted or adjudicated, while it may , at this time, not want to assert this priority reservation, it can use the intent of the ADFG instream reservation to encourage SSSC to negotiate an agreement consistent with NPS and ADFG goals. Such an agreement would ensure that SJH would almost always be provided with a minimum flow by which it can continue to operate. During low flow periods, SJH would be limited to taking only what is need for basic operations (< 2 cfs) until flows in the river have reached at least 50% of the ADFG instream reservation. At this threshold, then SJH could take more water for holding adult salmon harvested from cost recovery operations so that they can harvest eggs. When SJH is restricted to 1-2 cfs SSSC should be encouraged to find way to recycle the available water to support SJH operations. For example, the outflow from the hatchery may be used to keep ripening adult fish for a few weeks. An agreement may propose limits on when SJH may take "raceway water", perhaps only when the ADFG instream reservation (61 cfs during August and September) has been met. This approach allows SJH operations to continue at almost all times, even during critically low flows, for the benefit of its students and allows some augmentation of the commercial fishery. It is consistent with the mission of the SSSC and the current SSSC cost recovery operation. It protects the river consistent with the goals of the ADFG reservation and the mission of the NPS. It does mean that SJH will have to get its eggs and milt from the cost recovery operation, not the raceway, but operation of the raceway should not be allowed at the expense of protecting the naturally spawning salmon run and providing flows that allows fish to pass over the diversion.

Water Diversion Structure

SJH diverts water from the Indian River approximately 0.5 km above the park boundary. Consequently, operation of the diversion has a major impact on park resources, especially at low flows. The correct operation and maintenance of the diversion structure is essential for any shortage sharing agreement to work. This requires that the elevations for each component of the diversion structure be set and diversions controlled to allow water to be passed or diverted in the appropriate amount and priority. Currently, fish cannot negotiate the rock diversion structure at low flows and must use

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the fish ladder. Consequently the SJH diversion needs to be engineered to ensure that at low flows, there is always sufficient flow in the fish ladder to allow fish to reach upstream spawning areas. Additionally, the SJH diversion should be operated so that only the SJH permitted water right is diverted from the river; that return flows should not be diverted and that the structure must be able to be operate to the required tolerances.

Recommendations

Fish Straying

- Work cooperatively with SSSC and ADFG to conduct annual monitoring of pink, chum and coho salmon straying rates in the Indian River and the SJH raceway, consistent with ADFG PNP operating permit (Attachment 3)
- Investigate the use of chemical attractants (morpholine, phenyl acetyl ethanol, amino acids, salts, humic compounds?) added to hatchery water to increase SJH fish returns to hatchery raceway, if operational. It is anticipated that the study would provide information to better manage the fishery and inform the development of a mutually beneficial hatchery management strategy that may increase adult salmon returns to SJH allowing for higher cost recovery revenues, without the need to increase hatchery production. (Attachment 4)

Cost Recovery Operations

- Modify SJH operations so that eggs and milt come from salmon caught during cost recovery operations rather than at hatchery raceway, eliminating need for raceway attractant flows
- Recommend that SJH salmon production goals are not solely driven by SSSC revenue concerns but are balanced with protection of the natural resources of the Indian River, consistent with NPS and ADFG policies.
- Monitor and release by-catch of SJH cost recovery purse seining operations to reduce impacts to other native fish species returning to the Indian River

Water Rights – See LS4 (AKRO-L) NPS File.

Water Management

- Work with ADNR and SSSC to adopt NPS recommended diversions. *Note: These should be considered the **maximum** allowable diversions, subject to a water sharing agreement for low river flows.*
- It is recommended that stakeholders work together to reduce diversions during low-flow periods, which harm salmon in the Indian River. Negotiate shortage sharing agreement that protects minimum instream flows while still allowing SJH to divert minimum operation flow (Attachment 5)
- It is recommended that SSSC measure its diversions. In lieu of measuring its diversions, SSSC could establish and operate another gaging station just upstream from the main dam on the Indian River. If a gaging station is operated just upstream of the main dam, the upper gage could be discontinued, provided a suitable site exists. It is also recommended that SSSC report quarterly data collected to interested parties.
- It is recommended that SSSC participate in the funding and/or operation of the lower gage along with the NPS, ADFG, and CBS.

River Habitat

- Conduct PHABSIM to characterize flow habitat relationships and identify and refine minimum flow needs of river in SITK. Until such an analysis occurs, use ADFG instream flow reservations to protect river and as the basis of a shortage sharing agreement

Diversion/Fish Ladder

- The diversion structure should be surveyed and a plan developed to reconfigure/reconstruct the structure so that it may be managed to be able to reduce impacts to the river and to implement a shortage sharing agreement. The diversion control structures need to be modified and properly administered to pass only SSSC's approved diversion rates, thereby reducing effects on instream flows and salmonids (see below).
- Currently, there appears to be considerable leakage of water around and under the fish passage way. While this is not an issue at higher flows, at critically low flow, this water is needed in the fish passage way to allow fish to move upstream past the diversion. The source of this leakage needs to identified and corrected.

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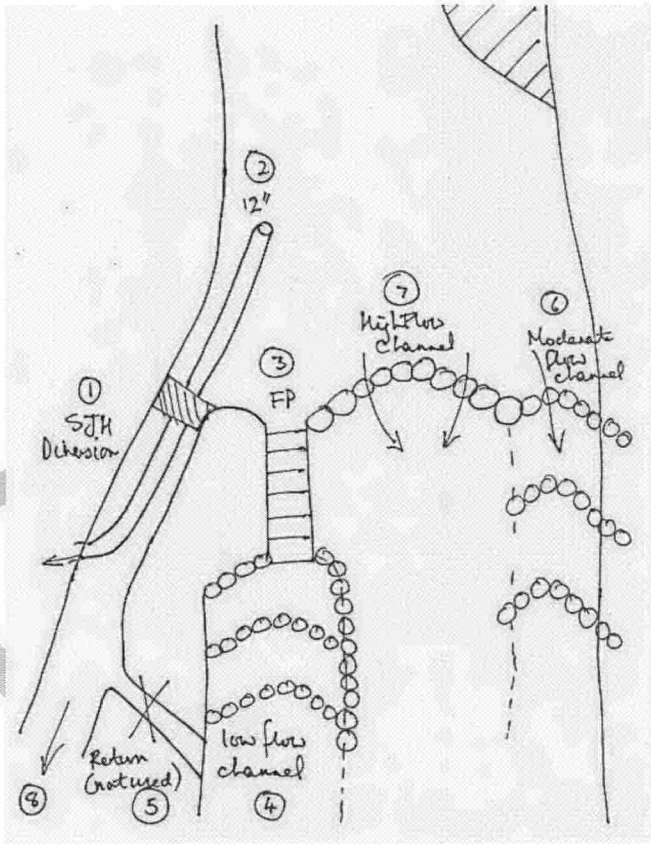
- Develop a maintenance/inspection plan for the SJH diversion. Diversion control structures and the fish passage structure needs to be adjusted and inspected daily, to ensure that there are no obstructions.
- NPS, ADFG and SSSC should work cooperatively to seek funds to reconfigure the SJH diversion.

The major elements of a functioning diversion infrastructure that would allow the implementation of a shortage sharing agreement at all flows are:



1. SJH diversion. Would only divert if SJH was operating raceway to attract salmon to hatchery. Otherwise dry. Would be controlled by a headgate
2. 12" pipe upstream of SJH diversion that delivers water for basic operational needs (1-2 cfs). Needs control gate to regulate flows consistent with shortage sharing agreement
3. Fish Passageway. Needs to be the low point (highest priority) in the system, and always functional, so that even at the lowest flows, fish may pass the diversion.
4. A low flow channel downstream of the fish ladder would direct fish into fish passageway at the lowest flows
5. The return flows to the river do not appear necessary. It is recommended that SSSC only divert the water necessary to support hatchery operations. The return-flow ditch at the Chapel Dam may be used, when maintenance is necessary. All hatchery water would be supplied by 12" pipe.
6. The elevation of the channel on river left would be set so that it would allow salmon to pass diversion at intermediate flows (this channel could be constructed in the middle of the river, but presently it is on river left, and will probably remain there unless river is realigned and the diversion is completely rebuilt)
7. High flow channel, together with (6) would pass all water at high flows
8. Canal would deliver water to SJH raceway when sufficient flows exist, consistent with shortage sharing agreement.

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