**INTRODUCTION**

Preservation of natural resources within some natural range of variation is a core mandate of National Parks in Alaska and elsewhere. Both ANILCA and the NPS Management Policies of 2006 have language that requires parks to manage resources “...at levels they would occur absent human domination over the landscape” and in their ‘natural’ condition. While concern over ‘unnatural’ abundances of park resources often focus on rare or depleted resources (endangered wildlife, rare fish, soundscape, wilderness), it is equally important to manage overabundant resources, even if they are a natural component of park ecosystems.

Sitka National Historical Park currently faces a question regarding recent abundance of pink salmon in the Ḵaasda Héen or Indian River. The river is the predominant aquatic resource in the park and supports diverse biological and riparian communities typical of a small coastal river ecosystem. As such, is the duty of park managers to maintain “natural” levels of salmon abundance.

Evidence today suggests that populations of pink salmon returning to spawn in the Indian River have grown tremendously in the past forty years. In the 1980s, peak abundance estimates, conducted by the Alaska Department of Fish and Game (ADF&G) varied between several hundred and 20,000 fish. In the mid-1990s, however, peak spawner abundances regularly exceeded 100,000 and have regularly exceeded 400,000 pink salmon, three orders of magnitude higher than peak runs in the 1970s.

The question faced by park managers is to what extent the increase in abundance of pink salmon is unique to the Indian River (and therefore driven by some potentially “unnatural” cause). If the increase in abundance observed is reflected in other similar streams hosting pink salmon populations on Baranof Island and elsewhere in the region, then it can be argued that salmon populations are within their natural range of variation. If the Indian River’s populations of pink salmon are indeed regional outliers, the question then becomes what factors might contribute to this abundance, including natural geomorphic features such as length, area, and gradient, or the presence of a nearby pink salmon hatchery.

In an effort to address these questions, University of Washington PhD student Brian McGreal has been working with Professor Mark Scheuerell of the School of Aquatics and Fishery Sciences, along with Professor Tom Quinn and National Park Service Senior Science Advisor Scott Gende. The group visited Sitka in August of 2023 to interview interested parties and begin the process of gathering relevant information, perspectives, and data. Over the course of three days, the group met with representatives from Sitka National Historical Park, the Alaska Department of Fish and Game, the Sitka Tribe of Alaska, the Sitka Sound Science Center, and the Northern Southeast Regional Aquaculture Association, among others. In August of 2024, Brian McGreal traveled to Sitka and Ketchikan to follow up with some of these partners and update them on the progress of this research. The communications from each of these trips are detailed in this report.

**COMMUNICATIONS - 2023**

Between the 21st and 23rd of August 2023, the team from the University of Washington conducted informational interviews with parties from various state and federal agencies as well as private non-profits associated with salmon monitoring and aquaculture in Sitka. In addition to these interviews, Thomas Quinn presented a public talk on the changing shape of salmon conservation efforts over the course of his 45-year career. These communications are detailed below.

**Alaska Department of Fish and Game (ADF&G)**

21 August, 2023

ADF&G fishery biologists discussed many facets of the department’s monitoring of salmon abundance, prespawn mortality rates, and hatchery stray rates in northern Southeast Alaska. Salmon abundance is most often recorded via aerial surveys, given the vast and largely road-less area. While aerial surveys are not a precise method of assessing salmon abundance, they are the only practicable means by which many remote streams in the region can be surveyed. Prespawn mortality rates cannot be surveyed aerially, as direct sampling is required to determine what proportion of female fish in a given stream have died before or after laying their eggs. As such, there is less data on this topic readily available, although some such monitoring does occur.

Otoliths take on distinctive markings when embryos or young fish are exposed to rapid temperature fluctuations or other stressors. In this way hatcheries can distinctly mark fish prior to release. These mass-marking programs allow fisheries scientists to collect many forms of data, including the proportions of naturally- and hatchery-produced adult salmon on spawning grounds and in hatcheries. Otoliths are collected in different places and for different purposes, and are processed by ADF&G and other entities, so obtaining and organizing relevant data will be an important component of this project. For example, ADF&G and other biologists have noted that the proportion of strays from hatcheries in a given stream may vary with proximity to the hatchery and other site-specific factors, and the sampling date within the spawning season. Commonly, greater numbers of hatchery fish are purported to be observed earlier in the season, though this pattern cannot be assumed.

**Sitka National Historical Park (SNHP)**

22 August, 2023

SNHP Superintendent Mary Miller and park staff discussed the National Park Service mandate to conserve the scenic, natural, and cultural resources within the park. Park management is specifically focused on maintaining healthy salmon habitat in the Indian River, due to its ecological importance and cultural significance as an historic fishing ground of the Sitka Tribe of Alaska. In particular, SNHP staff expressed interest in what effect, if any, straying hatchery fish released from the nearby Sheldon Jackson Hatchery are having on the proportion of wild fish in the river, as well as any impact on the reproductive fitness of both Pink and Chum salmon.

During the spawning season, the park collects data on salmon abundance, body size, prevalence of prespawn mortality, and salmon origin (wild or hatchery). Data is also available on habitat conditions in the Indian River, including (but not limited to) water temperature, turbidity, and levels of dissolved oxygen.

After meeting with Superintendent Miller and staff, park biologists led a hike up the length of the Indian River within SNHP boundaries (accounting for about a mile). Being a late August day with mild weather, stream flows were gentle and thousands of salmon, mostly pink and some chum, were present in the river’s lower reaches. Salmon carcasses provided ample evidence that this healthy abundance supported the subsistence of various wildlife (bears, eagles, ravens, seagulls).

**Northern Southeast Regional Aquaculture Association (NSRAA)**

22 August, 2023

Technicians provided an overview of NSRAA’s otolith laboratory, the only facility in Sitka where otoliths from salmon are processed. Observing otolith markings from salmon sampled at various sites allows NSRAA to assess the extent to which hatchery origin fish contribute to salmon abundance. NSRAA’s otolith laboratory is currently only involved in processing otoliths collected from NSRAA hatchery monitoring efforts. Otolith samples collected from other monitoring efforts are typically sent to be analyzed at ADFG’s otolith lab in Juneau, and coordinated with otolith marking conducted elsewhere.

**Sitka Sound Science Center**

22 August, 2023

Aquaculturists at the Sitka Sound Science Center led a tour of the Sheldon Jackson Hatchery (SJH), the center’s associated educational hatchery. Located on Crescent Bay, the SJH rears and releases on site 3 million pink salmon, 3 million chum salmon, and 250,000 coho salmon per year. As an educational hatchery, the SJH partners with local high schools and the University of Alaska to provide students with immersive training in aquaculture.

SJH technicians expose salmon embryos to a series of timed de-watering events to distinctly mark the otoliths of the fish. SJH aquaculturists described this method of dry marking as equally effective to traditional thermal marking and coming at a much lower cost because it does not require large amounts of water to be heated or cooled. After being marked, the SJH raises fry before releasing them into the bay. Upon the return of adult fish, the hatchery retains enough broodstock to guarantee the necessary number of eggs for next season. Any further returning spawners are harvested for cost recovery via contracts with local seafood companies.

SJH aquaculturists were particularly interested in this project as they share an academic and professional interest in the extent to which hatchery released fish are spawning in the Indian River. Additionally, aquaculturists are interested to determine what percentage of their cost recovery and broodstock may be wild born salmon.

**Thomas Quinn, University of Washington**

22 August, 2023

On the evening of 22 August, Tom Quinn of the University of Washington team gave a lecture detailing changes in salmon conservation over the course of his 45-year career. The talk provided a personal view of the changing research themes and social perspectives regarding salmon and trout that he has experienced over more than four decades of studying them. Topics such as logging, commercial and recreational fisheries, hydroelectric dams, hatcheries, invasive species, diseases, contaminants, aquaculture, marine mammals, and other threats, have changed in their real or perceived importance. The social setting and laws related to salmon and trout, and natural systems in general, have also changed greatly since the 1970s. Tom presented his perspective on some of these changes in order to spur conversations about present and future conservation efforts for salmon and trout, their ecosystems, and the people who care about them.

**Trout Unlimited**

22 August, 2023

Trout Unlimited (TU) offered to assist this project through the provision of salmon habitat data for many streams in northern Southeast Alaska. Trout Unlimited is a major national organization that seeks to conserve and restore freshwater habitat for salmon and trout throughout the United States, and so is engaged in extensive habitat monitoring efforts, outreach, and related activities. Thomas Quinn is a Life Member of TU and will follow up on this contact.

**Sitka Tribe of Alaska (STA)**

23 August, 2023

Members of the University of Washington team had the opportunity to meet with Chairman Lawrence Widmark of the Sitka Tribe of Alaska. Chairman Widmark shared his perspective on the historical and cultural importance of the Indian River and surrounding area. The team briefed Chairman Widmark on the goals of the project and asked for his insights and concerns. Both he and Superintendent Miller highlighted the importance of the long-term working relationship the Tribe and the Park have enjoyed, and that they expected our research to mutually benefit both parties.

The University of Washington team was also put in touch with STA biologists who are involved in ensuring robust subsistence salmon harvests. Although their work mostly concerns Sockeye salmon largely absent from the Indian River, STA biologists are also interested in other issues affecting the Tribe’s customary and traditional area, such as hatchery stray rates. The STA’s deep understanding of northern Southeast Alaska ecosystems will provide valuable support for this project.

**NEXT STEPS - 2023**

The meetings described in this report did much to lend form and dimension to the research questions regarding salmon abundance in the Indian River. All parties involved seemed eager to see what information could be gleaned from an in-depth and careful analysis of salmon abundance and stray rates in the Indian River.

Next steps on the part of the University of Washington team will include continued contact with the agencies described above in order to receive and parse available data. As is often the case when multiple data streams are involved in some analysis, careful integration will be necessary to develop an accurate and useful dataset. From that point analysis of the data available will proceed.

Looking further, there is the potential to develop, in cooperation with Sitka National Historical Park, a fine-grained data set of salmon abundance and otolith marks over the entirety of the Indian River spawning run in 2024. Such a project would ideally serve to reinforce results derived from analysis of the integrated dataset described in the above paragraph, as well as provide the park with highly detailed information on this keystone species.

**COMMUNICATIONS - 2024**

Between the 19th and 22nd of August 2024, Brian McGreal traveled to Sitka and Ketchikan to meet with representatives from Sitka National Historical Park, Alaska Department of Fish and Game, and the Sitka Sound Science Center. These communications are detailed below.

**Alaska Department of Fish and Game (ADF&G) - Sitka**

19 August, 2024

ADF&G fishery biologists discussed in detail the procedures involved in surveying pink salmon in southeast Alaska using fixed wing aircraft. This information is very germane, as ADF&G’s pink salmon survey data is the primary data used to inform the regional analysis of pink salmon escapement in this research.

Each survey observation is concerned with one population of salmon returning to one of ADF&G’s Anadromous Waters Catalog index streams. Although index streams may be listed as ‘river’, ‘bay,’ ‘arm, ‘head’, ‘inlet’, et cetera, these are each to the best of ADF&G’s knowledge distinct populations. Biologists then proceeded to discuss the counting procedure and the veracity of these surveys. Biologists described the way in which surveyors are trained by past surveyors in order to ensure maximum consistency in estimates. While there is some variability between surveyors, this “corporate knowledge” essentially works to calibrate fish counts.

The counts ADF&G surveyors come up with routinely match up “fairly well” with both what fishers are seeing in-season, and with ADF&G crews conducting foot surveys of randomly selected index streams. These foot surveys are used to audit aerial survey counts, but also to establish the proportions of salmon species present in each stream. This is necessary, as runs of pink salmon and chum salmon have some overlap in SE Alaska and these fish species are indistinguishable from the air. Pinks constitute the overwhelming majority of fish in these streams by the time survey flights are being conducted in August (Chum arrive earlier in the season), but aerial survey numbers are nonetheless adjusted to reflect species proportions where applicable.

Survey flights are conducted throughout the duration of the pink salmon run. Early in the season, flights are mostly focused on river mouths and intertidal zones, as fish congregate in these areas preparing for their push upstream. Later in the season, flights will cover the length of the stream if the stream is wide enough for fish to be seen despite the forest canopy. There is no hard rule for the number of passes surveyors make, flying a particular stream or intertidal zone as many or as few times is necessary to come to an estimate they are satisfied with. Water clarity can be a problem with these fixed wing aircraft surveys after periods of heavy rain, and so flights may not occur when these conditions are present.

With regards to this research project, ADF&G biologists suggested conducting an analysis of pink salmon escapement restricted only to streams that open into the ocean (rather than a channel). If also focused on northern SE Alaska, this restricted analysis would be largely (but not entirely) concerned with coastal streams on Baranof Island and Chicagof Island. ADF&G biologists suggested the differentiation between even and odd year runs is much higher among streams emptying out on the channel side of Baranof Island, and that an analysis restricted to coastal streams like Indian River may reduce statistical noise due to the deviant behavior observed elsewhere. In addition to this, ADF&G biologists advised that, prior to 1989, the dam that diverts water from the upper Indian River to Sheldon Jackson Hatchery was in fact a complete barrier to fish passage. This would be a necessary component to include in any time series analysis of Indian River data that extends prior to the year in question.

**Sitka National Historical Park (SNHP)**

19 August, 2024

The biologist for Sitka National Historical Park discussed the current state of research at SNHP. The current park biologist had recently come on board and so was still coming up to speed on the various projects undertaken by her predecessors. The names of the National Parks Service’s data manager and a contractor with deep understanding of the Indian River system came up in conversation, each of whom may be worth pursuing future communications with.

The park biologist also describes the state of stream gages along the Indian River. A USGS gage above the diversion is present, although she was uncertain as to whether it is above or below the diversion dam beyond Sawmill Creek Road (USGS location data would indicate it is upstream of the diversion). She also mentioned a stream gage within the park installed by the previous biologist. This gage may contain data not only on temperature and flow regimes but also particulate matter in the stream, but her best guess was that this gage was installed in 2021, and so would not be useful for running time series analysis. It could however provide a potentially useful picture of the difference in flows above and below the diversion point. There was also mention of a potential gage existing upstream related to hydropower generation, although this would need to be further substantiated.

Conversation then turned to the nature of the Indian River system as pink salmon spawning habitat and stream modeling in the abstract. The shifting river bed over the years was suggested as a potentially critical factor in explaining pink salmon escapement throughout recent decades. The park biologist advised that, currently, the stream bed within the park boundaries is largely rocky and most likely unsuitable for pink salmon nests.

This meeting was useful also in bringing the new park biologist up to speed on this research project. There is every intention of future collaboration on both sides.

**Sitka Sound Science Center (SSSC)**

21 August, 2024

A large group of aquaculturists and researchers from the Sitka Sound Science Center and by extension the Sheldon Jackson Hatchery (SJH), sat to discuss the Indian River system, as well as the state of pink salmon hatcheries and releases in SE Alaska. The conversation began by touching on the idea of the Indian River shifting and changing physically throughout the years, taking different courses above the diversion dam due to the influence of weather on Barnaof Island. It was suggested that this changing course of the riverbed may somehow be connected to the low variability in pink salmon escapement seen from year to year in both odd and even runs. The team suggested that research projects using remote sensed LIDAR data have previously been able to determine the former paths of streams with courses known to be highly variable. It may be possible to leverage these research techniques to determine whether other pink salmon streams exhibiting low year-to-year variability in escapement also exhibit highly changeable courses.

Next the team discussed pink salmon hatchery releases in SE Alaska. Hatchery driven pink salmon production primarily occurs north in the Prince William Sound, but there exists some notable hatchery production along the Alaska panhandle as well. The Port Armstrong Hatchery at the southern tip of Baranof Island is by far the largest producer of pink salmon in the region, releasing 40 million fish a year along the island’s inner coast. Beyond Port Armstrong, the SJH releases 3 million pink salmon per year, and the Northern Southeast Regional Aquaculture Association (NSRAA) release 300,000 pink salmon per year, which given the high numbers of these fish in the region can be viewed as a negligible amount.

Finally, the team discussed the straying of SJH pink salmon into Indian River and the concurrent straying of wild born Indian River pink salmon to the SJH. Each season, the hatchery samples cost recovery fish in an effort to determine what proportion of those pink salmon returning to the hatchery were indeed reared there. Any effort to model pink salmon population dynamics in the Indian River would be incomplete without taking both of these stray rates into account.

**Alaska Department of Fish and Game (ADF&G) - Ketchikan**

22 August, 2024

This meeting was scheduled to discuss not only the Indian River project and the state of pink salmon populations in SE Alaska, but also to brainstorm the potential to leverage detailed stream morphology data to determine characteristics of salmon habitat.

ADF&G biologists began the meeting by describing the huge boom in pink salmon populations observed in the outer portions of northern SE Alaska (including Baranof and Chicagof Island). In addition, huge runs have been observed recently in southern SE Alaska stocks as well. According to this group, the only places where pink salmon runs are in “rough shape” in SE Alaska are in the inner portions of the northern panhandle in even numbered years (odd year runs tend to be larger than even year runs in the region, although unlike elsewhere both are plentiful).

The conversation then turned to the nature of hatcheries and their impact on populations of natural-origin salmon. The ADF&G team referenced research that seemed to show a significant reduction in reproductive fitness among natural-origin pink salmon in Prince William Sound, due to straying from hatchery raised fish. The group then spoke on the resiliency of salmon fitness despite the presence of hatcheries, highlighting the historical presence of many, many sockeye salmon hatcheries in SE Alaska in the early 20th century, and opining that if the presence of these hatchery fish didn’t damage SE Alaska sockeye salmon on a genetic level “I don’t know what will”.

Next potential ideas for leveraging stream morphology data were discussed. ADF&G biologists expressed interest in identifying habitat for summer runs of coho salmon in the region. Summer runs of coho salmon occur in July and August, are not well studied, and in the experience of the ADF&G team, are strongly correlated with partial stream barriers beyond which fall-run coho cannot pass. These barriers are typically falls cut into bedrock, meaning they are unlikely to change from year to year. These summer-run coho are typically smaller (and presumably more nimble) than their fall-run counterparts, and so are able to access high stream reaches where they can nest with less competition. The team is interested in the potential for a model that may be able to identify these partial barriers and stream reaches where summer-run coho are likely to be found. To this end, they plan to provide a spatial dataset including a) streams with known partial barriers and summer-run coho, b) streams known to host summer-run coho but where a partial barrier has not been identified, and c) streams known not to host summer-run coho. A model could attempt to identify and predict barriers, and/or attempt to identify and predict quality summer-run coho habitat, with the presence of a downstream barrier likely a requisite.

Also of interest, although not directly related to any project currently being considered, ADF&G biologists mentioned Prince of Wales Island’s full road network, and the culverts that go hand in hand with these roads. The extent to which these culverts impact access to pacific salmon spawning habitat is not understood and could be an area for future research.

**NEXT STEPS - 2024**

The meetings described in this report provided clarity and dimensionality regarding the assessment of the pink salmon population observed at Indian River. All parties seemed interested to hear about the course of research work thus far, and eager to facilitate further modeling efforts where possible and to receive the final results of this study. In addition, the ADF&G team at Ketchikan are excited to embark on a project studying partial barriers to coho migration in southern SE Alaska.

Next steps on the part of the University of Washington team will include modeling the Indian River system in greater detail than has previously been undertaken. This will ideally involve the inclusion of environmental covariates as well as rates of straying to and from the park. This model, along with the regional analysis of pink salmon escapement already performed, will do much to determine whether the high numbers of returning pink salmon seen at Indian River in recent decades are in fact a result of releases from the Sheldon Jackson Hatchery.

The partial barrier project is also set to move forward with the receipt of a dataset describing known partial barriers and known summer-run coho habitat in SE Alaska. When the spatial boundaries of this dataset are known, Terrainworks (the company estimating and sharing data on physical stream characteristics based on USGS digital elevation models) can model those areas of interest if they haven’t already. When these data sets are in hand, the process of building a spatial model to predict the potential for summer-run coho habitat will begin in earnest.