Salmon Hatchery Feasibility Considerations

Outline notes for presentation to Yak Tat Kwaan board meeting of June 30, 2018
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Presenter background: Bart Watson has been involved with salmon hatchery investigation, development and operation since 1981. At that time he was hired by the newly-founded Armstrong-Keta, Inc. aquaculture corporation (AKI) to carry out an area-wide survey of salmon runs suitable for the hatchery broodstock. He also worked as part of the initial construction crew on installing the hatchery's 1200' water pipeline, erecting the hydropower facility, and building a flat-decked work barge for the operation. Elected to the board of directors in 1982, he became general manager of the corporation in 1987 and is still serving in that capacity. AKI's Port Armstrong Hatchery is located on southern Baranof Island and is now permitted for 105 million pink eggs, 60 million chum eggs and 5 million combined coho and chinook eggs.

His objective today is to offer the perspective of a hatchery operator who has personally gone through the hatchery permit application, start-up process and subsequent development and expansion of the program.

Following are many of the primary considerations for the establishment of a Yakutat salmon hatchery:

I. Site Selection

A. **Good Water.** Water is the life-blood of salmon, which require very high quality to water to thrive. Water quality data should be collected over a minimum of a one-year period, and preferably for multiple years, for any potential source of water for a salmon hatchery. Wherever historical records of water quality are available, they are an invaluable resource for determining the suitability of the site for salmon production.

1. Flows: Daily data is required, for many years if possible, to show the variations that can occur during different seasons and weather conditions. The average flows can be useful to determine which water sources warrant closer investigation, but other details are essential.

    a) Minimum flows: these are the most important numbers, which will indicate how many fish the water source will support at critical low-flow times of year. Calculating the minimum flows needed for the salmon in the hatchery at different life stages will allow you to determine how many salmon eggs of each species could be produced reliably at that site. For chums, the need for hatchery water is limited to the period from the egg takes (late July or early August) until their transfer to salt water net pens (anywhere from the beginning of January to early March, depending on temperatures). While in the hatchery, the chums require 15 - 20 gpm (gallons per minute) per million fry. A production facility of sixty million fry would require up to 1,200 gpm = 2.7 cfs (cubic feet per second). A lower production goal would require proportionally less water. It is essential to look over the water flow records for signs of droughts and critical low flow conditions, which can occur due to sub-freezing temperatures in the winter or during spells of sunny weather with no rain in the springtime.

b) Maximum flows: these are also important in order to determine the construction specifications near the river for buildings, fish ladders, weirs and any other facilities that could be damaged by extreme high river flows.

2. Temperatures: As with water flows, temperatures must be collected over at least one year, and preferably multiple years.
   a) Warm water: Promotes faster growth, but leads to lower dissolved oxygen for fish respiration and heightened risk of disease; temperatures above 16ºC (61ºF.) can cause problems for salmon.
   b) Cold water: Slows salmon growth, but supports higher dissolved oxygen and reduced disease risk.
   c) Subfreezing: Creates risk of freezing up water sources, or ice forming over the fish in net pens, and leads to very slow growth. Frazzle ice in subfreezing weather can also cause problems freezing up the pipelines and hatchery water systems if not properly designed.
   d) Egg development: The development from the newly fertilized eggs until the fry are ready for ponding into salt water net pens requires a cumulative amount of warmth, called temperature units (1 TU = 1ºC for 24 hours). The chums require 900 to 1,000 TU's from fertilization to emergence into salt water.

3. Quality: The water needs to be tested for silt, parasites, minerals, pH, silt, and chemical composition that could affect the eggs or fry.

B. Favorable Topography. A good site for a hatchery includes several positive characteristics and at the same time avoids several negative features.

1. Proximity to salt water: There is regular transfer of salmon between the fresh water and the salt water in the course of hatchery operations, so a good site needs to include both. The fry hatch in the freshwater incubators and then are transferred by flexible pipes from the incubator building to the saltwater net pens for rearing. Alternatively, the outgoing fry can be transferred to vessels for transport to a remote rearing and release site. The returning adults home in on the fresh water source that they imprinted on as fry: this is generally the closest freshwater source to the spot where they first enter saltwater after incubation. As adults, they will return up that stream, or else a fish ladder that has been installed next to the stream using the same water source.

2. Level building ground: The incubation building requires about a 2,000 s.f. footprint to hold the 67 stacks of incubators needed to incubate 60 million chum eggs. A few hundred square feet more is convenient to include space for a ponding station and other associated tasks. The ceiling needs to be high enough to accommodate 5 incubators high (about 7') plus the overhead water distribution pipes, requiring a total 10' or greater ceiling height. The floor should be a poured slab with drainage trenches incorporated along the length of the building where the incubator stacks will sit. Additional storage buildings or outdoor storage space is necessary for net pen nets and other smaller fish culture equipment. Fish feed storage will ideally be in a shed mounted on a barge moored adjacent to the rearing pens in the salt water. No freshwater raceways are required for rearing chums, but adult raceways are useful for accumulating broodstock at the hatchery building when it's time to take eggs. Total land required for the hatchery could be less than a quarter of an acre.

3. Nearby elevation: Ideally, the water will be flowing from land above the hatchery site to the incubation building. Gravity flow is always preferable to depending on pumped water, due to the risk of electric power outages or pump mechanical failures that could kill the fish quickly, as well as the high cost of electricity running the pumps. There are a number of hatcheries in Alaska, though, that do depend on well or other pumped water. The key is to design multiple back-ups into the system in the form of an independent automatic electric generator system and redundant pumps. The construction costs of these facilities are much higher than most gravity flow systems. If the water flows from a high enough head above the hatchery facility, it may be possible to generate hydropower electricity from the same pipelines that then feed the incubation building, greatly reducing the operating costs of the hatchery. This hydropower arrangement is common in Alaskan hatcheries.

4. Steep slopes: Too much elevation and steep slopes near the hatchery site can present a risk of landslides or avalanches. Some Alaskan hatcheries have suffered damage from these events. The Tlingit & Haida Corp. Sandy Bay Hatchery on Baranof Island was damaged by not only several landslides, but one of the main residences was crushed by a large spruce tree falling across its roof.

5. Worker accessibility: It is very handy to have the hatchery site easily accessible by the workers, avoiding the cost of providing living quarters on site and making it easier to attract good help. Even so, it might be worth considering remote hatchery sites with superior water resources if no site can be found in town or on the road system with reliable water as well as all the other desirable features listed here. There may be bays north or south of Yakutat with suitable rivers, plenty of fresh water and lots of hydropower potential. A salmon run developed in one of those sites could create a valuable fishery for the local commercial driftnet fleet, if the fishing boats could get reasonable access to the adult fish when they return to the bay. Alaska has numerous remote site hatcheries, and that may or may not make sense for Yakutat, but it might be worth taking a look at.

C. Wild Salmon Runs. There are strong reasons to avoid setting up a salmon hatchery on rivers that support wild salmon runs, unless the hatchery run timing does not conflict with the wild run timing. Aside from the public opposition to any project that might threaten an existing salmon run, the mandate of the ADF&G fisheries managers is to protect the health of the wild fish runs, and they will usually reject any hatchery that might conflict with significant wild runs. The definition of “significant” here is somewhat vague, and you might get a permit to use a site that supports only a small number of wild fish if other factors make it a good hatchery site.

1. Nearby rearing habitat: A hatchery site should take into account where the salmon fry will be released and what local fish habitat is available. Chum fry generally stay near the shore for several weeks after they are released into the salt water to forage for food until they grow large enough to head out to the open ocean. A varied coastline of bays and islands can make good rearing habitat. Many hatcheries rear at least some of their fry to a large enough size inside the protection of the net pens to allow them to head straight out into the ocean at release, thereby avoiding nearshore predators, but this longer net pen rearing period costs more in labor and fish feed. It also runs a risk of keeping the fry crowded together during warmer water conditions when low oxygen and increased disease risk can become problems. The payoff is that the marine survivals from these larger fry are generally significantly higher.

2. Hatchery/ Wild fish interactions: Because all Alaskan salmon hatcheries are non-profit by state law, there are no stockholders or owners looking for a profit. Instead, commercial and sport fishermen are the constituents of the hatcheries, and hatchery operators primary goal is to benefit the fishermen. For that reason, no hatchery operators want to produce hatchery fish at the expense of wild fish. Hatchery operators have alway worked closely with ADF&G, whose mandate according to the Alaska Constitution is to manage for the long-term sustainability of the wild runs, and not for the benefit of hatcheries at the expense of the wild runs. In order to make sure the hatcheries are not damaging the wild salmon in Alaska, there are ongoing multi-year studies of the impact of stray hatchery salmon spawning in wild rivers. Numerous fisheries scientists have studied hatchery production and published papers evaluating any effects that the large-scale production of salmon by hatcheries might have on wild salmon populations. Many years of studies by scientists from the US, Canada and Russia have turned up plentiful evidence that hatchery production has not caused significant harm to the wild runs overall. On the more local level, the siting of the hatchery and evaluations of the potential for interaction is a central part of the hatchery permitting process. As a hatchery begins production, ADF&G monitors the local wild runs to watch for any impact a hatchery run could have despite the precautions taken in the permit, and hatchery production may be limited or curtailed accordingly.

D. Harvest. A good harvest area for both the commercial fishing fleet and for the hatchery's own cost recovery harvest is important.

1. Cost recovery: As part of the hatchery permit application, the association will apply for a Special Harvest Area (SHA) where it can do its cost recovery fishing. This fishing is usually carried out by a hired seiner, in order to make sure all the returning fish are mopped up. Catching all the returning fish (as many as is practical) is a requirement of ADF&G. For Yakutat, where there is no local seine fleet, it may be more beneficial to us an alternative approach of the local commercial boats doing the cost recovery harvest and then paying a percentage to the association to cover its costs of operation. Even in this system, it may still be necessary to bring in a more efficient seine boat at the end to mop up the remaining fish. The SHA needs to be at the outlet of the fresh water source that the fry imprinted on when they were first introduced into salt water, since that's where the returning adult fish will be attracted to. The area must be large enough to allow however many boats need to operate there simultaneously, unless you establish a rotational system of fishing. The outer boundaries of the SHA should not extend into water where non-hatchery salmon are likely to be intercepted in any significant numbers.

2. Common property fishery: Unless the main fishery on the hatchery fish for the commercial fleet will be held in the SHA, it is important to figure out how the fleet will access the salmon run. Normally, salmon will spread out and mill around in adjacent waterways before they target their stream of origin. That usually provides plenty of opportunities for commercial fishermen, but the outer coast location of Yakutat and the small size of the driftnet boats may make that access more challenging. There are also many islands and protected saltwater passages close to town where fisheries could probably be held, as long as they don't conflict with wild salmon returns. This issue would have to be analyzed to catalog what areas and what dates the wild fish are moving through, and whether those times and places would conflict with a local common property fishery targeting hatchery returns. Note that the

hatchery permit can request that ADF&G manage the area to keep it closed to gear groups not currently permitted in this fisheries management district.

3. Processors: It is important to plan for sufficient processing capacity to handle all the returning hatchery salmon, both the cost recovery fish and those the commercial boats are catching. A large hatchery release take can generate a huge return of adults in a good year, which is very difficult to predict in advance. An egg take of 60 million chum eggs, for example, would typically be expected to create 1.2 million returning chums in an average year. About 100,000 of those would be used for broodstock for the next cycle of eggs, including a cushion for losses to predation and other losses in the terminal area. The other 1.1 million fish would average about 9 million pounds, spread over a four-week period of fishing. At current prices, that fishery would earn the community around $10 million, with a small cut of that going to cover the hatchery costs, which should typically be about half a million dollars for a hatchery of that size. The main costs of the hatchery are fish feed, labor and payments on the capital investment debt. If there is not enough processing capacity to handle that size of run locally, processors from other locations would willingly send in tenders to buy fish. The size of the hatchery egg takes could be adjusted to better fit the local capacity, but there is much variability in the size of hatchery returns, as there is with the wild fish. In some years, marine survivals may be much stronger than 2% of the fry released, potentially twice that number or even more, with corresponding greater numbers of adult chums showing up. It is always necessary to have a contingency plan in place for how to handle the big runs. Of course, in other years the returns will be much smaller, since salmon runs by their very nature are highly variable.

II. Broodstock

A. **Stock selection.** There are two main elements to broodstock selection: deciding what species to produce, and then finding a source of eggs to start the hatchery run of that species.

1. Species selection: There are five species of Pacific salmon found in Alaska: king, coho, sockeye, pink and chum.

   a) Kings (= Chinooks). These are the biggest and most valuable per pound, but they are the most expensive to produce and they come back in small numbers (around 1% overall marine survival), spread out over several years after release. They require an entire extra year of rearing in freshwater raceways before being released to the ocean at nearly two years old. The cost of the raceways, the huge amounts of fresh water required, and the costs of feed and labor really add up. For those reasons, they don't pay for themselves in a hatchery operation and won't cover the overhead costs of the hatchery.
   b) Cohos (= silvers). Like kings, cohos require an extra year of feeding along with the associated raceways and amounts of fresh water. They are worth less than the kings per pound, but they typically return at a 10% average marine survival (the returns are highly variable, as with all salmon). They can actually pay for themselves at a hatchery with the right water resources, but it's very difficult to pay for all the overhead costs of building and maintaining the hatchery with coho production because of the high costs that go into raising them.

c) Sockeyes (= reds). Sockeyes also require an extra year of rearing, and they have pretty good marine survivals, but they have a special challenge: they are susceptible to the highly contagious fish virus IHN that affects their livers. Hatcheries that raise sockeyes have to take extra stringent (and extra expensive) precautions to maintain strict sanitation and to keep many separate rearing areas isolated from each other, in case there is an IHN outbreak. If one fish contracts IHN, all the sockeyes in the same area must be destroyed; this is the reason for the sanitary isolation between different rearing cells. These are not easy fish to raise.
d) Pinks (= humpies). Pinks are the easiest salmon to produce: they are hardy, they don't take much feed because of their small size and short saltwater net pen rearing period of six or eight weeks in the spring, and they go directly into the net pens without the extra year of freshwater rearing and then head out to sea later that spring. They also return as adults one year later, at an average 2% marine survival in SE Alaska. That two-year cycle makes a quick return on the investment of rearing them. But they are the smallest salmon and the least valuable per pound. There are many pink hatcheries in Alaska, mostly in Prince William Sound and Kodiak, and they tend to do hundreds of millions of fry each year to achieve economies of scale. They are a good salmon to produce for seine fleets, but they are too much work to catch for most gillnetters.
e) Chums (= dogs or keta). Chums are not too hot and not too cold, but probably just right for Yakutat. Like pinks, they go to sea the first spring after the egg takes and don't need freshwater rearing. They do require longer rearing in the saltwater net pens than pinks because they usually hatch and then emerge from the incubators quite a bit earlier in the year. They eat more per fish because they are large, so the production costs are higher than with the same number of pinks. They achieve similar 2% marine survivals, but when they return as adults they are 2.5 times as large and worth 2.5 times more per pound, meaning that each fish is worth more than 6 times as much as each pink. That makes for a very favorable cost/benefit ratio. And they are an excellent gillnet fish, with most of the chums in SE Alaska going to the gillnet fisheries there.

2. Nearby broodstock: Ideally there will be a chum run that is relatively close to your chosen hatchery site. These nearby runs will tend to be better adapted genetically to the conditions on nearby sites. ADF&G prefers runs within a 50-mile radius, but that is just a guideline that can be modified in light of other considerations. Taking eggs from wild runs is labor-intensive, slow and expensive. The number of eggs you can take depends on how many surplus adult fish return in any given year beyond the number needed for the wild run's escapement. When starting up a hatchery, it is desirable to come up to full speed as rapidly as practical so that you can start developing your full returns. This will not only benefit the commercial and sport fishermen, but also start generating income from cost recovery harvest of the fish to cover the hatchery operating costs and begin paying back the capital and operating loans taken out to build and start up the facilities. It is also important to get enough eggs from the donor broodstock to maintain a broad gene pool with the hatchery chum run. Too narrow a gene pool can cause inbreeding problems and gradually declining marine survivals in the salmon runs.

3. Other hatchery broodstock: A very attractive option is to procure chum eggs from another hatchery that is fully operational. A large hatchery will often have many millions of eggs available in excess of their own egg take needs. They will sometimes charge a price for the eggs equivalent to the amount they would have earned selling the broodstock fish to the

processor instead of setting them aside for the egg takes, but that is generally far less than the cost of remote egg takes. It is worth pursuing this option when possible, in this case possibly with the DIPAC chum broodstock at the Macaulay Hatchery in Juneau. This has been an extremely successful chum run over the past decade. An ideal approach might be to take what surplus eggs are available each year from the East River chum run that is relatively close to Yakutat, and then acquire the rest of the hatchery egg take goal from DIPAC until the Yakutat hatchery returns provide all the eggs needed each year from that point forward.

4. Production size: The question remains what size run you want to target with your facility and your permit. One place to start is by creating a pro forma that projects all your costs and all the income from the hatchery operation many years into the future, showing how the income will meet or exceed the costs during the life of the operation. The pro forma should start with the creation of the hatchery organization and move forward through the construction, first egg takes, full production and the final payoff of all the loans, and it should also project all the income from the fish with reasonable assumptions about marine survivals, size of fish, price per pound and several other factors. These projections are only theoretical estimates, of course, but they represent averages based on experiences at many other hatcheries and are very useful in identifying costs and determining how much production will be required to make the hatchery a financial success. All Alaskan salmon hatcheries are non-profit by state law, but they still need to pay their own way if they are going to survive. A carefully created pro forma provides a good basis for planning how to make the operation successful.

5. Community benefits: Since the hatchery will be non-profit, the main reason for its existence will be to help the local economy. The major benefit should be in supporting the local driftnet fleet, or some form of that fishery that might become important in Yakutat. Additional processing jobs and income is another major benefit to the community. The employment created by the hatchery operation itself, including the construction workers, suppliers and hatchery operators, can also be significant. These considerations can have a lot of bearing on how large a hatchery operation you want to plan for, as long as it is sized large enough to cover its own costs and stay solvent over the long term. It can be a good policy to start on the smaller side, based on the minimum size that will be able to cover all the costs of the hatchery indefinitely out into the future, but plan the construction to allow for easy expansion. As the community becomes involved in the harvest and processing of the fish as well as the production end of the business at the hatchery, it may well decide that more of a good thing is worth pursuing and end up wishing to expand the hatchery, as long as no significant negative impacts are encountered that would be reasons to keep the size more limited.

III. Hatchery permit.

A. **Timeline.** This is a long and painstaking process, requiring one to two years.

1. Analysis: The first step is to notify ADF&G and request them to perform a Management Feasibility Analysis. This step will take a look at the overall concept and note what issues may have to be addressed.

2. Permit application form: Next is to accumulate the detailed information required in the hatchery permit application, which requires data on water quality, hatchery site characteristics, the proposed harvest site, the broodstock to be used, and production goals.

3. ADF&G assistance: ADF&G PNP Hatchery Division personnel are very helpful. They will become actively involved in helping the applicant through the permitting process, providing advice and clarifying their legal obligations and constraints regarding approving a hatchery permit. They can provide copies of other hatchery permit applications as examples of the kind of information needed.

4. Public hearings: After the permit application is complete, ADF&G is required by statute to hold public hearings on the proposed hatchery, followed by public comment periods. This process can take many weeks.

B. **Previous work.** Yakutat has a history of investigations into establishing a local hatchery. Quite a bit of the information required in the permit application has been carried out by the Yakutat Regional Aquaculture Association, under a contract with Kathy Hansen, Executive Director of the Southeast Alaska Fishermen's Alliance. Several other experts have also been consulted in previous years.

1. Expert contributors: Some of the experienced professionals involved in investigating the potential for a hatchery in Yakutat are Don Beard, engineer, who has been involved in planning and constructing several hatcheries in Alaska; ADF&G Hatchery Section Chief Sam Rabung, and PNP Coordinator Lorraine Vercessi; ADF&G SE Regional Resource Development Specialist Flip Pryor; and local Yakutat Area Biologist Nicole Zeiser. All of these individuals may be valuable resources for answering questions and providing impartial opinions about establishing a hatchery in Yakutat. Other hydrologists have done surveys in the past.

2. Current status: On the basis of so much work having already been accomplished, the hatchery permit application may be very close to being ready for submittal. The main bottleneck at this point appears to be the site selection for building the hatchery. Yak Tat Kwaan may be able to play a critical role in helping the hatchery becoming a reality for Yakutat if the corporation board of directors decides it favors a hatchery and is able to identify an appropriate site on its lands.

3. Outstanding issues: A fundamental issue to determine is whether any of the locations that have been identified as leading candidates for a hatchery on Yak Tat Kwaan land have a sufficient and reliable water source to support a hatchery large enough to pay for itself and become self-sustaining over the long run. Most other issues with the various sites under consideration appear to be relatively minor and solvable without too much difficulty.

4. Financial relationship: A hatchery operated by the YRAA on Yak Tat Kwaan land would require a long-term contract with the corporation in order to borrow funding from the State of Alaska Fisheries Enhancement Revolving Loan Fund and make the capital investments necessary to build the facilities. There are many ways to structure such a legal agreement, but all would most likely involve a long-term lease. The main financial options would be 1)

an annual triple-net lease fee with a built-in inflationary mechanism, which provides relatively predictable income streams; 2) a fee that was based a percentage of the cost recovery harvest revenues, which allows the hatchery to pay more in years when its fish returns are strong and pay less when runs are weak; and 3) a free or nominal amount in order to maximize the benefits to the Yakutat fishing fleet and the economic activity in the community by supporting the non-profit YRAA.

IV. Important Considerations

A. **Not a quick process.** The hatchery permitting process generally takes one and a half to two years, though YRAA has already completed much of the preliminary work. A similar amount of time may be required for construction of the facilities, and then broodstock needs to be collected from wild streams or other hatcheries. Chums return in significant harvestable numbers as four year olds and five year olds. Altogether, seven to eight years are required from starting work on the permit until reaping the first harvest. If the eggs to start production are taken only from wild streams, the first generation of returns will be limited in numbers and an additional four years may be required to come up to full permitted production.

B. **Not inexpensive.** The price tag for the facilities will depend on many factors, including how difficult it is to develop the required water source, the number of eggs to be incubated and fry to be reared, access to the site, and so on. The main hatchery facilities required are the water pipelines, the incubation building and plumbing, the incubator boxes, the rearing net pens and nets, feed storage facilities, and associated equipment such as docks and/or boats for accessing the net pens. The cost of building and acquiring these facilities from scratch is likely to be in the $1 million to $2 million range. But the state revolving loan fund is an excellent resource for funding a new hatchery.

C. **Not easy.** Not only the construction of the hatchery, but also its operation takes a lot of work. The facilities and especially the water quality and flow have to be efficient and reliable, which can be major challenges. A real commitment of time and money is required.

D. **Expertise required.** It is extremely important to rely on seasoned experts in the design, construction and operation of the hatchery. Salmon are delicate and a wide range of problems can kill them quickly if any corners are cut or the staff is not dedicated and attentive. All the components of the hatchery have to be done right, or it will fail. The hatchery can't be built or run by people who don't have both the education and the prior experience to know what they're doing. Fish culture is a technical skill that requires extensive study.

E. **Local employment.** Motivated residents of Yakutat can develop rewarding careers in salmon aquaculture. The work is exacting, but the jobs can be both interesting and rewarding. While the initial managers and fish culturists should have extensive previous experience, new employees will have a great opportunity to start at the bottom and learn on the job, becoming experts themselves over some years. There are also many good aquaculture eduction programs, some of which are online and designed for distant learning, offered in Alaska through the university system. Employment at the hatchery can be a significant addition to the primary economic benefit to the local commercial fishing fleet. Increased activity at local processing plants is

another source of employment for residents. Many other local businesses may in turn benefit from the money brought to town by this economic engine.

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