

**APPENDIX E.**  
**WORK GROUP MEETING NOTES, NEAH BAY, WASHINGTON, JANUARY 18, 2018**

Makah National Fish Hatchery Vulnerability Assessment  
Makah Tribal Marina  
Neah Bay, Washington

**Meeting participants, U.S Fish and Wildlife Service (FWS) and Makah Tribe (MT)**

**representatives:** Angela McMurphy (MT), Benjamin Gilles (FWS), Bill Gale (FWS), Bill Mahone Sr. (MT), Deb Cooke (MT), Denise Hawkins (FWS), Don Campton (facilitator, FWS), Doug Peterson (FWS), Haley Kennard (MT), Jeremy Trimpey (FWS), Jim Bertolini (NWIFC)<sup>1</sup>, John J. Ides Sr. (MT), Joseph Hinton (MT), Katie Wrubel (MT), Kyle Hanson (FWS), Leah Neuneker (MT), Mike Chang (MT), Pat DeHaan (FWS), Patty Crandell (moderator, FWS), Ray Colby (MT), Rosina DePoe (MT), Seraphina Gagnon (MT), Sonia Mumford (FWS), Stephanie Martin (MT), Tiffany Petersen (MT).

**Purpose of meeting:** Identify and discuss adaptive strategies that could be implemented at Makah NFH and the Tsoo-Yess River watershed to reduce/mitigate the impacts of future climates projected for the 2040s.

**Format of notes:** The meeting notes below were recorded within an “Adaptive Capacity” template that was extracted from the draft report for Makah National Fish Hatchery (NFH).<sup>2</sup> Meeting notes are recorded below in *italics*.

**Outline of Notes:**

- i) Facilitator’s personal note
- ii) Adaptive Capacity: definition and concept
  - A. Adaptive measures already implemented or considered previously.
  - B. Potential adaptive measures: Chinook salmon impacts.
  - C. Potential adaptive measures: Coho salmon impacts.
  - D. Potential adaptive measures: Coho salmon and steelhead impacts.
  - E. How feasible is a chum salmon program at Makah NFH?
  - F. Potential adaptive measures: Hatchery infrastructure impacts.
  - G. Next steps.

**i) Facilitator’s personal note:**

*Overall, the meeting was very productive with a lively, open discussion. The meeting was characterized by a proactive viewpoint among participants for dealing with future environmental issues at Makah NFH. At the outset, representatives of the Makah Tribe noted that adaptation strategies for Makah NFH could not be addressed in isolation but needed to be addressed in the context of the Tsoo-Yess River watershed and resource needs of the Tribe as part of a holistic ecosystem approach. This opening statement provided a solid foundation for the discussion that followed.*

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<sup>1</sup> Northwest Indian Fisheries Commission (NWIFC).

<sup>2</sup> U.S. Fish and Wildlife Service (USFWS). 2017. Makah National Fish Hatchery: Climate Change Vulnerability Assessment, DRAFT Report (December 12, 2017).

**ii) Adaptive Capacity: definition and concept:**

*Adaptive capacity is the existing ability or capacity of a system or species to adjust or adapt to the impact of an environmental disturbance such as climate change.*

In the context of assessing the vulnerability of human communities (e.g., NFHs), *adaptive capacity* often refers to the potential to implement planned adaptation measures to cope with change, including consideration of future strategies or potential changes that would *increase* the adaptive capacity of a system or species.

**A. Adaptive measures already implemented or considered previously.**

- 1. Impact (Chinook):** High water temperatures in the late spring have increased disease risks to age 0+ Chinook salmon prior to release.

**Adaptive measures:**

- Early release of Chinook juveniles
- Purchased a peristaltic pump to enable continuous formalin drip into raceways to combat parasites.
- Repeated use of antibiotics to treat bacterial outbreaks.

- 2. Impact (Chinook, coho, steelhead):** High water temperatures promoting fast growth rates for Chinook, coho, and steelhead have resulted in raceway density indexes (D.I.) and flow indexes exceeding fish health guidelines of D.I. < 0.2 and F.I. < 1.0

**Adaptive measures:**

- Develop feeding strategies to reduce growth.
- Feeding is suspended when water temperature exceeds 18° C (coho, steelhead).
- Water volume of raceways was decreased to increase the number of water turnovers from 2/hour to 5/hour (coho, steelhead).

- 3. Impact (coho, steelhead):** High water temperatures during the late spring and summer increase disease risks to age 0+ coho salmon and steelhead.

**Adaptive measures:**

- Purchased a peristaltic pump to enable continuous formalin drip into raceways to combat parasites.
- Repeated use of antibiotics to treat bacterial outbreaks.
- Outplanting age 0+ coho fry into the upper Tsoo-Yess River watershed - prior to low-water, high temperature summer months - to (a) increase survival potential of coho juveniles and (b) increase available water for summer rearing of steelhead at the hatchery.

- 4. Impact (coho and steelhead):** Fast growth rates (due to high water temperature) of juvenile coho salmon and steelhead prior to release promote return of sexually-mature, two-year old males (aka “jacks”) among returning adults.

**Adaptive measures:**

- Develop feeding strategies to reduce growth.
- Feeding is suspended when water temperature exceeds 18° C (coho, steelhead).

5. **Additional adaptive measure considered previously:** Discontinue existing coho and steelhead programs at Makah NFH and consider (a) expansion of existing fall chinook program and/or initiation of chum salmon or native Tsoo-Yess River steelhead programs.

**B. Potential adaptive measures: Chinook salmon impacts.**

1. **Chinook salmon impact:** Projected water temperatures of the Tsoo-Yess River in the 2040s in September (mean temperature = 17.6° C) exceed the optimal spawning temperatures for Chinook salmon (9.0 – 12.3°C). As a result, adult Chinook salmon trapped and held for broodstock will likely experience increased physiological stress, potentially leading to increased pre-spawning mortality and decreased egg quality.

**Adaptive measures discussed and related comments:**

- *Warm water temperatures and low flows of the Tsoo-Yess River during the summer impede broodstock collection.*
  - *Chinook arrived in 2017 about 2 weeks “over-ripe”.*
  - *Balancing broodstock needs with harvest needs is difficult.*
  - *During holding of adult fish for broodstock, parasitic infections by Ich could potentially overwhelm the adults before they are spawned.*
  - *Difficult to change (or delay) return (and spawn) timing of adults (e.g., via selective breeding) without significantly reducing the number of fish collected for broodstock.*
  - *Chinook salmon require a large volume of attraction water to swim up the ladder into the adult holding pond. It is not feasible to chill the large volume of water required for attracting and capturing broodstock. Is there an alternative way to capture the adults that would allow chilling of less water (e.g., for only holding broodstock)?*
  - *Could fishers catch adult Chinook lower down in the river and then transport the adults to the hatchery for holding in chilled water prior to spawning?*
  - *Chilling the water needed for holding adults is not feasible with the current hatchery infrastructure (Ben Gilles, Hatchery Manager).*
  - *Water used for attracting Chinook salmon reduces water available for rearing coho salmon and steelhead. The programs are not independent.*
  - *Are there non-native stocks that are “better adapted” to warmer temperatures than the native Tsoo-Yess River stock (e.g., in California)? [Post-meeting comment by one reviewer: Introducing a non-native stock of Chinook salmon could pose fish health and genetic risks that might contradict fish management policies.]*
2. **Chinook salmon impact:** Higher water temperatures projected for the 2040s are likely to approach the upper physiological limits for fertilized eggs (12.4° C) during the egg incubation period.

**Adaptive measures discussed and related comments:**

- *Chill incubation water.*
- *What about brackish water incubation (cooler than FW?) of fertilized eggs? Is this feasible? Probably not (but maybe for chum salmon?). It would probably be more difficult and expensive to bring in salt water than chill the relatively small amount of water needed for egg incubation.*

3. **Chinook Salmon Impact:** Higher water temperatures projected for the 2040s in May are expected to (a) approach the upper physiological limits for proper smoltification of Chinook salmon and (b) approach or exceed the disease outbreak temperatures for several pathogens, thus increasing disease risks (especially for Costia and furunculosis) of age 0+ Chinook salmon prior to release.

**Adaptive Measures already implemented or considered previously:**

- Purchased a peristaltic pump to enable continuous formalin drip into raceways to combat parasites.
- Repeated use of antibiotics to treat bacterial outbreaks.
- Early release of Chinook juveniles before temperature stress and pathogens become a problem.

**New adaptive measures for Impact B3 were not explicitly discussed.**

4. **Chinook salmon Impact:** Faster growth rates of Chinook salmon juveniles will likely result in density index values in May that exceed the 0.2 guideline, further leading to increased disease risks of age 0+ fish prior to release.

**Adaptive measures already implemented or considered previously:**

- Develop feeding strategies to reduced growth

**New adaptive measures for Impact B4 were not explicitly discussed.**

**C. Potential adaptive measures: Coho salmon impacts.**

1. **Coho salmon Impact:** Mean water temperatures of the Tsoo-Yess River projected for the 2040s in September (17.6° C) and October (13.3° C) exceed the optimal spawning temperatures for coho salmon (5.7 – 11.7°C). As a result, adult coho salmon trapped and held for broodstock will likely experience increased physiological stress during holding and spawning, potentially leading to increased pre-spawning mortality.

**Adaptive measures already implemented or considered previously:**

- Discontinue existing coho (and steelhead) programs and consider additional fall chinook, chum, or native Tsoo-Yess steelhead production.

**New adaptive measures for Impact C1 were not explicitly discussed** (but see related comments for Chinook Impact #B1).

**D. Potential adaptive measures: Coho salmon and steelhead impacts.**

1. **Coho and Steelhead Impact:** Projected water temperatures during the late spring and summer months (June-September in the 2040s (monthly means = 17.6-20.5° C) exceed the optimal physiological temperatures for juvenile coho salmon and steelhead. Higher water temperatures during the late spring and summer are expected to increase disease risks (especially for furunculosis in coho salmon, and Ich and furunculosis in steelhead) compared to current and historic conditions. In addition, mean flows of the Tsoo-Yess River are projected to decrease by approximately 19% during the summer months (June-September) compared to historic baseline values.

**Adaptive Measures previously implemented/considered:**

- Purchased a peristaltic pump to enable continuous formalin drip into raceways to combat parasites.
- Repeated use of antibiotics to treat bacterial outbreaks.
- Decreased the volume of the raceways to increase the number of water turnovers from 2/hour to 5/hour.
- Outplanting age 0+ coho fry into the upper Tsoo-Yess River watershed during low-water, high temperature summer months to (a) increase their survival potential and (b) increase rearing capacity for steelhead.
- Discontinue coho and steelhead programs and consider additional fall chinook, chum salmon, or native Tsoo-Yess River steelhead production.

**Adaptive measures discussed and related comments:**

- *High water temperatures are today, not just in the future (21° C in 2015). We are already reaching temperatures that are approaching those projected for the 2040s. If 2015 looked like the expected “average” for the 2040’s, then the future will be worse in some years than 2015.*
- *Makah Tribe withdraws water from the Tsoo-Yess River upstream of the hatchery for domestic use on the reservation. This withdrawal represents another demand besides the hatchery for water during the summer.*
- *The Tribe already has water restrictions for domestic use, April-October.*
- *Summer water availability has always been an issue for the Tribe.*
- *What about Educket Creek as a back-up water supply for the hatchery? Not a good source. Educket Creek was a “tiny trickle” in summer of 2015. It is already a back-up domestic water source for the Tribe, but the water quality is not as high as other sources, and the Tribe tries not to use it.*
- *Well water: Geology of area may not be adequate for sustaining recharge rates of wells.*
- *The Makah Tribe has discussed saltwater desalination. Is this feasible?*
- *Can we capture and store freshwater in the watershed before it runs off into the ocean?*
- *One adaptive strategy: outplant age 0+ coho in the upper watershed in the spring to free up water for (a) rearing steelhead during the summer and (b) attracting/trapping adult Chinook salmon for broodstock in the late summer and early fall. A feasibility study is planned for spring 2018. An upcoming Hatchery Evaluation Team (HET) meeting will discuss this adaptive measure.*
- *What is the feasibility of satellite facilities for incubation, hatching, and rearing?*
- *Can fish be maintained farther up in the Tsoo-Yess River for rearing where water temperatures are cooler?*
- *Can we transfer and rear age 0+ coho in acclimation ponds in the upper watershed? Is the upper watershed acceptable for acclimation ponds? The alternative strategy of outplanting coho juveniles into tributaries would allow the fish to find suitable pools for rearing in the watershed prior to smolting and outmigration.*
- *Offsite acclimation facilities could attract predators, potentially defeating the purpose of moving fish off station.*
- *Outplanting age 0+ coho into the upper watershed could be a “proof of concept” for a potential satellite acclimation facility. But wouldn’t we want adult fish to return to the hatchery, not the acclimation ponds? A weir might solve this problem?*

- *Need to know where adult coho are spawning in the upper watershed to identify appropriate release locations. Perhaps we can apply radio tags on adults passed upstream so that we can identify where we should (or should not) outplant hatchery-origin age 0+ coho.*
- *If we outplant coho fry in the upper watershed on top of natural-origin juveniles produced by adults that were allowed to pass upstream, would we be negatively impacting the survival or growth of those natural-origin juveniles? This needs to be evaluated.*
- *Could take genetic samples from adults before they are passed upstream to assess their genetic contribution to natural-origin smolts. We could do the same thing for the parents that are spawned in the hatchery to compare “adult-to-smolt” and “adult-to-adult” contributions of the two methodologies (hatchery-origin adults passed upstream to spawn naturally vs. fry outplants from adults spawned in the hatchery). We could use smolt traps to assess total smolt production from adults that had been passed upstream to spawn 1.5 years earlier. We can also use DNA markers to determine if smolts are natural-origin or outplanted hatchery-origin fish. Plans are in place to initiate both of these efforts. Indeed, genetic samples from adult coho spawned (a) at the hatchery and (b) passed upstream during the 2017 season were collected for those purposes.*
- *We may need to do additional habitat assessments for rearing coho salmon in upper watershed. What is the current habitat capacity for juvenile coho salmon in the upper watershed? [Post-meeting comment: This is a question/theme that has been raised at other meetings for other hatcheries.]*
- *We need to also consider the needs of the native stocks in the watershed. Our assessments assume we know everything and money is not an issue.*
- *Potential winter flooding of an acclimation facility in the upper watershed might be an issue.*

**At this point in the meeting, the discussion transitioned to habitat issues and questions in the upper Tsoo-River watershed.**

- *Have habitat restoration measures been assessed as an “adaptive” measure? Used LiDAR to assess habitat conditions, wetlands, and connectivity. [Facilitator’s comment: Parties/individuals conducting the LiDAR surveys were not identified.]*
  - *In the upper watershed, there are only a few large conifers present to help cool water.*
  - *Most of the riparian areas on Tribal lands have not been harvested for timber, but the Tribal Council has little control over privately held lands that would prevent future harvest of mature timber.*
- *Conservation easements would be desirable to prevent changes in land management, but then the rights of people to build houses, harvest timber, etc. could be impeded.*
- *Need to make people knowledgeable about the impacts of their land-use actions (A need to inform landowners and stakeholders).*
- *Makah Tribe has higher water quality standards than the State.*
- *Two worlds: On-reservation vs. off-reservation with respect to land management.*
- *It’s not just the private landowners that are an issue; it’s the regulations under which they manage their private lands. For example, bureaucratic obstacles exist for formal declaration of a “drought year” by state resource agencies. These obstacles impede water conservation measures at the local watershed level when they are needed.*

- *Urban, industrial, and land-use impacts in Puget Sound are not confined to Puget Sound, but they affect the entire region.*
- *Can we identify measures that will give us the “biggest bang for the buck” in terms of water conservation (quantity and quality)?*
- *What are things that we can do NOW? Next year? Five years from now? We tend to be too “reactive”, but we need to be more “proactive”. Changes need to be effective prior to the 2040s.*
- *Need to be proactive to make changes in response to the cost of collecting new information; otherwise, the investment in new information is wasted.*
- *We need to take actions now ... the future is now.*
- *Reliance on chemicals and antibiotics is not what is best for the fish or the watershed. “The right decisions” are not necessarily going to be the popular or easy ones.*
- *“Our children are our greatest resource”.*
- *Makah Tribe cultural issues are intertwined with Makah NFH issues.*
- *Ocean conditions? A major source of future uncertainty. FWS has focused on areas that we have control. Same was true for migration corridor in Columbia River. Also, for example, hazardous algal blooms are a possible future problem at Quilcene NFH, but that is an issue over which we have little control.*

**At this point in the meeting, the discussion transitioned to the steelhead program with some discussion of the differences between the steelhead and coho programs:**

- *How important are steelhead to the Tribe?” Answer: Over 1,000 hatchery-origin steelhead have already been caught this fall and winter in Tribal fisheries. Fishers are getting a good price for steelhead.*
- *Do we know where those steelhead were caught? Did those fish originate from Makah NFH or were they intercepted before they returned to another location/hatchery? Fishermen (anglers) could be reporting some steelhead caught in other watersheds as “Tsoo-Yess River” but we assume most fish “caught in the Tsoo-Yess River” were caught there, as reported.*
- *The Tsoo-Yess River is primarily a Tribal fishing area for steelhead. Not true for other rivers in the region.*
- *Steelhead begin returning at the end of November. Adult trapping and holding are not issues for steelhead.*
- *Coho and steelhead have different pathogen problems in summer. Coho problem: primarily bacteria that requires antibiotic treatments. Steelhead problem: primarily parasites that require formalin treatment.*
- *Overuse of antibiotics is a bigger issue, but environmental concerns of thousands of gallons of formalin discharged into the Tsoo-Yess River during the summer is also a big issue.*
- *Hatchery staff are hoping to reduce use of formalin by increasing water turnover rates in raceways holding steelhead juveniles. We will have more water during the summer of 2018 for steelhead at Makah NFH because of the current plan to outplant age 0+ coho in the spring. If coho fry are outplanted in the spring every year, then more water would be available for steelhead during the summer.*
- *One option: Could switch to the native stock of steelhead. Adults return in the spring (exact timing needs to be determined) which is later than adults of the current hatchery stock (they return primarily in winter). Hatched steelhead fry of the native stock could be moved outside to raceways in October after fall freshets and more water is available.*

- *[Post-meeting comment added by a FWS Team member]: There could be one advantage with the warmer water temperatures of the Tsoo-Yess River; it could allow the opportunity to get native steelhead juveniles to smolt size by the following spring for release as 1-year old fish. This is not possible for “native stock steelhead” at many other hatcheries. It would need to be tested and evaluated at Makah NFH.*
- *We do not allow the current introduced hatchery stock of steelhead to go upstream, but could integrate hatchery and natural production (treat as one population) if the native steelhead in Tsoo-Yess River are used as a future broodstock source.*
- *Last year was the first year that Sonia Mumford (FWS Fish Health) had to treat steelhead at Makah NFH for furunculosis (2 out of 4 raceways).*
- *Previous treatments of coho with two antibiotics have resulted in resistance to those antibiotics by pathogens when coho are now treated. In the future, we may not have an effective antibiotic for treating bacterial infections.*
- *Weir issue: We need to make a decision regarding the steelhead program at Makah NFH. If we don't have a weir in future, there would be potential impacts of the current, introduced steelhead hatchery stock on native steelhead in the Tsoo-Yess River.*
- *[Post-meeting comment]: Another potential advantage of switching to the native steelhead stock is that the need for a highly efficient weir to preclude upstream migration of adults in winter would no longer be necessary.*

2. **Coho and Steelhead Impact:** Faster growth rates of juvenile coho salmon and steelhead in the 2040's will result in larger mean lengths and weights in most months of the rearing cycle, leading to flow index values that approach or exceed the upper guideline value of 1.0 for (a) age 1+ coho in February-April and (b) age 0+ steelhead in August and September.

**Adaptive Measures already implemented or considered previously:**

- Decreased the volume of the raceways to increase the number of water turnovers from 2/hour to 5/hour.
- Develop feeding strategies to reduced growth
- Feeding is suspended when water temperature exceeds 18° C (coho, steelhead).
- Discontinue coho and steelhead programs and consider additional fall chinook, chum, or native Tsoo-Yess steelhead production.

**New adaptive measures for Impact D2 were not explicitly discussed.**

3. **Coho and Steelhead Impact:** Faster growth rates of juvenile coho salmon and steelhead will result in predicted density index values that exceed the upper guideline value of 0.2 in July-September for age 0+ fish and January-April for age 1+ fish prior to release. Higher density indexes during the summer months are expected to further increase disease risks under current culture protocols.

**Adaptive Measures already implemented or considered previously:**

- Develop feeding strategies to reduced growth
- Discontinue coho and steelhead programs and consider additional fall chinook, chum, or native Tsoo-Yess steelhead production.

**New adaptive measures for Impact D3 were not explicitly discussed.**

4. **Coho and Steelhead Impact:** Faster growth rates of juvenile coho salmon and steelhead, including larger mean size of smolts at release, will most likely increase the frequency of sexually-mature, two-year old males (aka “jacks”) among returning adults.

**Adaptive Measures implemented/considered:**

- Feeding is suspended when water temperature exceeds 18° C
- Develop feeding strategies to reduced growth
- Discontinue coho and steelhead programs and consider additional fall chinook, chum, or native Tsoo-Yess steelhead production.

**New adaptive measures for Impact D4 were not explicitly discussed.**

**E. How feasible is a Chum salmon program at Makah NFH?**

- *Who would do the studies to assess potential economic benefits of a chum salmon program?*
- *Chum salmon value appears to be increasing in recent years.*
- *Price drives the economic return to commercial fishers. What is the cost-benefit ratio for chum salmon vs. other species (e.g., coho)? Chum: low cost to produce. Is the return for chum relative to cost as good as for coho?*
- *We could do a pilot release of chum salmon fry now to evaluate adult returns in 3-4 years. Makah NFH had the space this year to incubate and rear chum salmon.*
- *Comment by Stephanie Martin: The technical staff for the Makah Tribe should make a presentation/proposal to the Tribal Council after good, concrete information on feasibility of a chum salmon program is obtained.*
  - *Include assessments of future impacts to Tribal fisheries and economics.*
  - *Describe options to Tribal Council after “all ducks are in a row”.*
  - *Important also to inform the Tribal Community so that they understand options, potential impacts, etc.*
  - *The people need to be adaptable also.*
  - *Reply: FWS would be happy to assist the biologists and technical staff of the Tribe to help inform the Tribal Community.*
- *Need to also look at ways to take the stress off the freshwater environment.*
- *Makah NFH currently has capability to rear chum salmon with minimal impact on existing programs: we would need to reduce the number of coho and steelhead eggs collected, but a chum program would have little impact to the existing Chinook program.*
- *One immediate strategy: We could “backfill” with chum eggs (obtained from Quinault NFH) when there were Chinook broodstock shortages.*
- *Could do pilot releases of chum salmon fry (with fish from Quinault NFH) as a “proof of concept” as long as it did not impact coho and steelhead.*
- *Big issue: We would need to have a market buyer for chum adults established beforehand in order for chum salmon to be viable for the Tribe.*
- *One big advantage: Chum salmon would have a minimal freshwater impact. Fry could also be released directly into brackish water. Chum eggs start hatching in December.*
- *Is there a potential chum caviar market in U.S. or overseas that the Makah Tribe could tap into? Currently, chum eggs for caviar from fish caught in Washington State are sold to buyers from Asia (e.g., Japan).*

- *Could development of new markets/buyers in U.S. be coordinated with NWIFC?*
- *Fish or egg transfers from Quinault NFH to Makah NFH would need to be advised and informed by Fish Health.*
- *Is there overlap between chum and coho adult returns? “Yes...but it would be manageable” (Ben Gilles, Hatchery Manager). Coho salmon start returning in October; Chum salmon start returning in November. Coho salmon at Makah NFH are “Quinault NFH” stock origin.*
- *What would we do with adult coho when they return if we have a chum program? We could maintain a coho program at Makah NFH if we outplant age 0+ coho in the upper watershed at about the same time Chinook are released from the hatchery.*
- *To maintain “genetic effective population sizes” at viable, self-sustaining levels, sometimes need more adults than are necessary for egg collection and on-site rearing.*

**F. Potential adaptive measures: Hatchery infrastructure impacts.**

1. **Hatchery Impact:** Greater precipitation projected in the fall and winter for the Tsoo-Yess River basin in the 2040s is expected to increase flood risks to Makah NFH. The magnitude of 100-year floods is expected to increase by approximately 25% by the 2040s. Potential flooding of hatchery could be an issue.

**New adaptive measures for Impact F1 were not explicitly discussed.**

2. **Hatchery Impact:** Sea-level rise (SLR) is not expected to be an issue. Increasing storm intensities in the 2040s, coupled with sea-level rise, are expected to increase the likelihood of localized flooding and saltwater intrusion into the hatchery during storm surges. Saltwater intrusion into the hatchery would also pose a disease risk to fish on station from *Vibrio* sp., a saltwater pathogen of salmonid fishes.

**Adaptive measures discussed and related comments:**

- *The analyses performed by the FWS focused on climate-related projections for the 2040s (2040-2049), and SLR is not expected to outpace land uplift due to plate tectonics. However, after 2050, SLR is projected to outpace land uplift and is expected to be an issue in Neah Bay, the lower Tsoo-Yess River, and Makah NFH.*
- *Is investing \$6.5 million into a recirculating water system a good investment if SLR and saltwater intrusion are going to be issues in the future?*
- *Planning for only 10 years is not sufficient. Perhaps planning for 25 years (2040s) is not sufficient either?*

3. **Hatchery Impact:** Reduced water availability from the Tsoo-Yess River projected for the summer months in the 2040s would require increased use of reuse water pumped back through the serpentine channel (current adaptive protocol) to meet the fish culture needs of coho salmon and steelhead. Increased use of reuse water would reduce water quality, increase effective density indexes, and further increase disease risks to coho salmon and steelhead.

**Adaptive measures discussed and related comments:**

- *Can we disinfect source water (ozone?).*

- *Install RAS (recirculating water aquaculture system) to provide high quality water recirculation. Would be difficult to disinfect incoming water, but could disinfect recirculating water. (Ben Gilles)*

**G. Next steps.**

- *Need to inform the Tribal Community BEFORE recommendations are implemented so that the Community can be part of the decision process regarding future options.*
- *Makah Tribe Fisheries staff will discuss the CC assessment, options, planning process, etc. As soon as the Makah Fisheries staff have all the information in a finalized form, they can proceed.*
- *May need to revisit the goals for Makah NFH. Is the goal to solely produce salmon/steelhead to sustain harvest, or do those goals include restoration of natural populations in the Tsoo-Yess River?*