An Assessment of Juvenile Chinook Salmon Population Structure and Dynamics in the Nooksack Estuary and Bellingham Bay Shoreline, 2003-2015

Eric Beamer¹, Correigh Greene², Evelyn Brown³, Karen Wolf¹, Casey Rice², and Rich Henderson¹

¹Skagit River System Cooperative
²NOAA Fisheries Northwest Fisheries Science Center
³Lummi Nation Natural Resources

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And
Josh Chamberlin (NOAA)
Lance Campbell (WDFW)
Why this study?

• Puget Sound Chinook Salmon listed under ESA in 1999
• Watershed Specific Chinook Recovery Plans submitted to NOAA in 2005 and approved in 2007
• WRIA 1 Plan has actions related to filling data gaps
  – Near-term Action #7 includes: “investigate the role of estuarine and nearshore marine habitats in Nooksack early Chinook productivity and abundance”
Over 50 beach seine sites used
- 2003-2013 (LNR)
- 2014 & 2015
Population structure of juvenile Chinook salmon

- Temporal habitat use by natural (NOR) and hatchery (HOR) origin juvenile Chinook salmon
- Includes at what size and relative abundance fish occupy habitats
- Incorporates juvenile life history type (e.g., portfolio effect - important for population diversity and resilience)
Nooksack River Outmigrants

• NOR juvenile Chinook migrants are made up of individuals that can take advantage of habitat opportunities within the Nooksack River, Nooksack tidal delta, and Bellingham Bay nearshore (i.e., fry, parr, yearlings).

• 11 year average outmigration size = 190,000 fish / year

• The Nooksack River basin’s freshwater system is not at carrying capacity for parr migrants.
• The total juvenile Chinook population using the study area each year is dominated by releases of HOR fish from within or nearby the study area (over 5 million fish/year).
• Marking practices are good; effects of mistaking unmarked hatchery and natural juveniles is minimized.
NOR & HOR juveniles in Nooksack Tidal Delta & Bellingham Bay Nearshore

- Consistent use of Nooksack tidal delta habitat by NOR juveniles but densities are lower than in Bellingham Bay nearshore habitats.
- Consistent use of pocket estuary habitats by NOR juveniles within Bellingham Bay.
- The relatively few NOR juveniles are actively residing in rearing habitats (i.e., remaining for weeks to months) while the abundant HOR juveniles are migrating quickly (i.e., days to weeks) through the tidal delta system and largely avoiding pocket estuaries.
• Seasonal curve present
• Wild fish arrive earlier than hatchery fish
• B’ham Bay shoreline sites had more fish than Nooksack estuary sites in 2014 & 2015
Within B’ham Bay:

- Shoreline sites that are protected from wave energy and have freshwater inputs had more wild fish.
Potential for ecological interaction between NOR and HOR juveniles

• Hatchery/wild interaction would not be possible for the NOR Chinook life history types that extensively rear in the tidal delta or pocket estuary habitats early in the year.

• Hatchery/wild interaction is possible for the NOR Chinook parr life history type and all NOR Chinook life history types once they reach exposed nearshore habitats during summer.
Fish migration pathways within the Nooksack tidal delta

- Not all habitat has an equal opportunity to be utilized by rearing Chinook salmon.
  - best access upper Nooksack tidal delta
  - least access Lummi Bay
- The channel-spanning logjam has changed landscape connectivity. Changes occurred relatively rapidly (i.e., over a few years).
- Post logjam Nooksack River juvenile Chinook migrants have
  - better access to west side habitats
  - poorer access to east side habitats
- Restoration of connectivity within the hydrologically muted areas should improve access to existing (and future restored) habitat.
Nooksack River early run and fall populations produce juveniles capable of expressing the life history types that rear extensively within their natal estuary and pocket estuaries.

NOR juveniles in the Nooksack tidal delta were predominately Nooksack origin fish comprised of early run fish in the fry migration period followed by a combination of early and fall run fish in the parr outmigration period.

Bellingham Bay nearshore and pocket estuary habitats were mostly comprised of Nooksack origin NOR juvenile Chinook early in the season.

Out-of-system NOR juveniles Chinook in Bellingham Bay nearshore habitats were primarily from the Whidbey basin and were generally not present before summer months.
Are NOR juveniles experiencing density dependence in the Nooksack tidal delta?

- There is consistent use of Nooksack tidal delta habitat by NOR juveniles but density data does not exhibit a density dependence relationship.
- The Nooksack tidal delta is underseeded by NOR juvenile Chinook salmon.
NOR juvenile Chinook growth (growth is good for survival!)

• Functional conditions exist in the Nooksack tidal delta and B’ham Bay pocket estuaries (based on prey availability and modeled fish growth).

• Growth differences between habitats & years were due to temperature differences (not prey quality or abundance).

• No single habitat type systematically offered better juvenile Chinook growth benefits.

• These findings suggest that habitat diversity is important to provide optimal conditions across the fish rearing season in order to buffer impacts from particularly cold or warm time periods.
Original hypothesis:

• Growth of juvenile Chinook in Puget Sound offshore habitat in May-July is a “Critical Period” for determining survival to adult (There is a big jump growth in fish after transitioning from nearshore to offshore)

Updated results and hypothesis:

• Size-selective mortality did not occur prior to early August in sub-yearling Chinook outmigrants (7 hatchery and 2 wild populations across Puget Sound).

• Taken in context with previous research indicating a positive relationship between July weight and survival to adulthood, these results suggest that early marine growth is important regardless of the habitat in which it is achieved.
Does any of this matter? The fish just get eaten later anyway ... right?

Estuary/ocean entry = 42 mm

Estuary/ocean entry = 92 mm
The small fish do survive!

- There are regional differences in success of juvenile life history strategies.
- Chinook populations from North Puget Sound watersheds have higher proportions of successful fry outmigrants than South and Central Puget Sound Chinook populations.
Watershed strategies for moving ahead
(WRIA 1 might not be able to ‘fix’ the Salish Sea, but it can make improvements at home!)

• Use of Nooksack tidal delta habitats by NOR Chinook is concentrated in only one area. Restoration of connectivity to other areas would vastly increase the use and carrying capacity for Nooksack NOR juvenile Chinook salmon.

• It is also true the restored capacity of the Nooksack tidal delta will not be realized (much) at the current NOR juvenile outmigrant levels.

• Prioritization and sequencing of restoration of Nooksack tidal delta and Bellingham Bay nearshore habitats should be considered not only through our findings derived under low NOR outmigrant population levels, but also should be determined by considering the habitat extent, connectivity, and quality needed for the desired future Nooksack Chinook populations (including anticipated pressures due to climate change).
References


Salish Sea Marine Survival Project studies: http://marinesurvivalproject.com/research-activities/
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We are done!