Are current hatchery strategies designed to engage with future ocean variation?

(this will be very Chinook salmon-centric)

Brian Beckman
NWFSC, NMFS, Seattle
The ocean has been variable and unpredictable but “stable” flipping between two states.

https://psl.noaa.gov/pdo/

I stole this slide from Burke’s talk.
Hatchery production strategies were developed during a period of predictably "good" ocean conditions.

https://psl.noaa.gov/pdo/
Trajectory of hatchery production strategies in the Puget Sound
Ecological implications of changing hatchery practices for Chinook salmon in the Salish Sea

Benjamin W. Nelson, Andrew O. Shelton, Joseph H. Anderson, Michael J. Ford, and Eric J. Ward

Chinook Salmon Hatchery Releases

(chillions)

Puget Sound

Strait of Georgia

1950 1970 1990 2010

30 km
Current natural fish migration timing is variable and extended (6 months)
Current hatchery fish timing is unimodal and short (6 weeks)

Nelson et al. 2019

Abundance of migrating Chinook salmon smolts at weirs/traps
Variation in hatchery release time and release size of Chinook salmon in Salish Sea has decreased and become unimodal

from CWT records

Nelson et al. 2019
Puget Sound strategy: release of a uniform group of smolts in the early summer

Forty million on: 5 June at 40 fpp

Based on:
A history of success
Size/time release studies
A common Col R strategy is a single release of yearlings in the spring. Based on a history of success and size/time release studies, one million fish were released on 5 April at 18 fpp.
Are current hatchery strategies always successful? Or, is there a consistent return of fish?
Spring Chinook salmon count at Bonneville, 2019 – 2021
Do we have a problem?

http://www.cbr.washington.edu/dart/query/adult_graph_text
Current hatchery strategies may result in poor returns but stability of ocean ecosystem has ensured success when ocean conditions return to a cool and productive regime?

2020??

=> Maintain current strategies based expectations of a stable ocean?

https://psl.noaa.gov/pdo/
Patterns of ocean variation are changing

CHENG ET AL.

(a) Global ocean heat content change in the upper 2000 m (IAP/CAS)

OHC anomaly (ZJ)


1 Zeta Joules (ZJ) = \(10^{21}\) Joules
Baseline 1981-2010

95% error bar

Annual mean

Monthly mean

Cheng et al. 2022
Heat waves are increasing in frequency and magnitude.

Total surface area of all heatwaves (km²)

2020-21 California Current Ecosystem Status Report
NOAA California Current IEA Team
Emerging risks from marine heat waves

Thomas L. Frölicher¹,² & Charlotte Laufkötter¹,²

**Fig. 2** The effect of a simple shift towards a warmer climate on the probability of land-based and marine heat waves. **a** shows the observed distribution of the linearly detrended and deseasonalized local daily surface air temperature anomalies over land using the CRU-NCEP-v8 data set²¹,²². **b** as for **a** but for local daily sea surface temperature anomalies using NOAA’s daily Optimum Interpolation sea surface temperature data set¹¹. Solid black lines show the distributions over the 1982–2016 period and solid gray lines indicate the same shape of the distributions, but the land is shifted by $\Delta T_{\text{land}} = 2^\circ$C and the ocean by $\Delta T_{\text{ocn}} = 1.33^\circ$C. Here we assume $\Delta T_{\text{land}}/\Delta T_{\text{ocn}} = 1.5²⁰$. A heat wave is defined as temperature exceeds the 95th percentile (red and blue shaded areas). The inset highlights the changes in land-based heat waves.
There is an increasing trend in marine heat
Variability is increasing
The variation is becoming more intense

The ocean is becoming more unpredictable
Marine conditions are exceeding historic norms
Might the PDO “flip” become unstable?
Do we want to continue with the current strategy (the big bet) or perhaps consider some alternatives?

One million on: 15 April at 18 fpp

Based on:
A history of success
Size/time release studies
Are hatchery goals 1) maximizing return every year or 2) minimizing variance in return between years?
Are there alternative production strategies that might produce different patterns of variance?

the big bet

something else

Year
Are there alternative production strategies that might produce different patterns of variance?

Annual mean is higher
Max annual catch is higher

Minimum annual catch is higher
Variance is lower

Abundance

Year

the big bet

something else
Bet small – win small but don’t bust

250k each on: ???? at ????
What data do we have on "small bets"

Willamette spring Chinook salmon, ODFW
4 hatcheries, varying release dates, several decades of CWTs

Mining RMIS
How does November compare to March? Fold-difference, Nov - March

(Nov – Mar)/Mar

Release Year

On average, March release SAR is higher, ~ 30% of the time November release SAR is higher

November is higher - 12

About the same - 6

March is higher - 21

1978 – 2018, Willamette, Marion Forks, South Santiam, McKenzie
Spring Chinook salmon CWTs
lumped and averaged
November returns are never “great”
This is not a solution – it’s an approach to consider.

Bet small – win small but don’t bust.
There are different ways to generate diversity, within a program or within a sub-basin between programs. => No reason any one program needs to generate all diversity.
There are opportunities to examine effects of current variation in release timing

Chinook programs with variable release timing (my knowledge):
- Cowlitz, Lewis, Kalama spring Chinook salmon
- Upper Columbia summer Chinook salmon
- Snake River fall Chinook salmon
- Klamath River spring Chinook salmon
There are other axes of diversity to explore

Size

Age (steelhead)

???
How do we make short-term management decisions, within varying and unpredictable marine conditions, while considering a long-term trend?
Do we need to be running a “continual experiment” to assess a variable and changing ocean?

Invest a portion of production into assessing diversity and marine survival?