Threats

Lack of sufficient food

Too much disturbance

High contaminant levels
Distribution of salmon-eating populations
SRKW temporal and spatial distribution

Summer

Fall, winter, spring
Resident killer whale diet

Ford et al. 2015 and Hanson et al. in prep
Fraser River Chinook is majority of diet in Salish Sea in summer time

Upper, Middle, and Lower Fraser, and South Thompson are seasonally important
Whale eat a variety of Chinook stocks in the winter

- ~65% Puget Sound while in Puget Sound
- ~50% Columbia River while on coast
- Wide variety of other stocks
Trends in other marine mammals

- Killer whales
  - AK residents increasing
  - Northern residents 120 in 1975, ~280 currently
- CA sea lions ~6X increase since 1975
- Harbor seals 8-10X increase since 1970s
- Steller sea lions increase ~4X since 1975

Photo: ODFW
Chinook salmon predation and fisheries harvest of increasing marine mammal.

Competing tradeoffs between...
Mammal consumption of salmon

Adult Chinook salmon consumed or caught (millions)
Evidence for nutritional stress?

• Changes in body shape – Fearnbach et al. 2018 and unpublished
• High fetal loss rate – Wasser et al. 2017
Summary - whales

• SRKW population is not growing
• Other RKW populations (with overlapping diet) are growing
• Diet is heavily dependent on salmon, esp. Chinook
• The whales eat lots of different Chinook stocks, from CA – BC, including large hatchery stocks
• Correlation between whale survival/birth and salmon (but weakening)
• Some evidence of nutritional stress
• Prey availability = abundance + access
Overview of salmon status

• Historical abundance
• Long and short-term trends
• Focus on Chinook salmon
Historical Chinook salmon abundance

Source: Various, compiled by Jim Myers NWFSC
Many losses are due to extirpations

159/396 population extirpated
23/112 population extirpated

Source: Gustafson et al. 2007
Abundance trends over the past 40-70 years

Columbia River

Bonneville Dam Chinook salmon counts – 1938 - 2017
In some areas, things may be better now than they used to be

- “Unfortunately, most of the original salmon populations of these streams have been so seriously depleted by unscreened diversions, dams with improper ladders, and other bad conditions that it is very difficult to secure any first hand information regarding their time of appearance in these tributary streams”

- “Unfortunately the salmon runs of the Entiat River have been practically exterminated for many years because of dams built on the stream...” — Craig and Suomela 1941
Coast wide trend, BC to California

Historical estimate

Source: Robert Kope / CTC
Hatchery production

Historical (1908) estimate

Puget Sound

Current wild spawning abundance

Source: Robert Kope, PFMC, PSC
Run timing changes – Columbia River

Run Size (1,000s)

- LCR Spring
- LCR Fall/Late Fall
- UWR
- MCR/UCR Su/Fall
- SR Fall
- Interior Spring

Historical Estimate
Present Run Size
Run Timing Changes – other major rivers

![Bar chart](chart.png)

- Puget Sound Fall
- Puget Sound Spring
- Klamath River Fall
- Klamath River Spring
- Central Valley Fall
- Central Valley Spring

- Run Size (1,000s)
  - Historical Estimate
  - Present Day
Changes in hatchery diversity
Changes in salmon size and age

Ohlberger et al. 2017 Fish and Fisheries
Salmon recovery efforts

- Habitat
- Harvest changes
- Hatchery changes
- Dam removal and passage improvement
- Reintroductions
Extensive effort on habitat restoration

- 31,000 projects completed at over 51,000 locations throughout the Pacific Northwest. Over $1 billion spent on restoration to date.
Hatcheries

• Types of changes
  – Reduced releases
  – Control of straying
  – Hatchery Genetic Monitoring Plans
  – Local broodstock
  – Marking

• Hatchery reforms
  – Reduce use of non-local broodstock
  – Limit hatchery fish on spawning grounds
  – Marking/monitoring
  – Scaling releases to habitat capacity
Harvest

• Types of changes
  – Reduced exploitation rates
  – Risk assessments
  – Focus on hatchery fish
Hydro/large dams

• Types of changes
  – Improved fish passage
  – Predator control
  – Spill
  – Barging
  – Dam removal
    • Elwha
    • Condit
    • Rogue
    • Sandy
    • Hood River
Climate change

Temperature anomaly (degrees C)

Data source: NASA
External drivers

[Graph showing the PDO index (sum of May-Sept) with two distinct regimes (Warm and Cool) over the years from 1930 to 2010.]

[Graph showing the Oceanic Niño Index (ONI) from 1955 to 2015.]
Forecast SST anomalies
NOAA Climate prediction Center coupled forecast model 2

Feb-Mar-Jun 2018
Apr-May-Jun 2018
Jun-Jul-Aug 2018

Summary and conclusions

• Salmon have not been continuously declining – some very large returns have occurred in the last decade
• Big declines occurred early in the 20th Century – full recovery of wild salmon to historical levels is very challenging
  – Not just an ESA issue
  – Will require reintroduction of extirpated stocks
• Hatchery abundance is a major factor when thinking about whale food and salmon in the ecosystem
  – Hatchery Chinook are majority of return in Sacramento, Columbia, and Puget Sound
  – Some salmon recovery actions reduce hatchery abundance
• Restoring diversity is important – it’s not all about total numbers
  – Greater loss of spring run Chinook populations
  – Whales utilize a wide variety of stocks – no silver bullet
• Marine mammals consume a lot of salmon