Science, Service, Stewardship

Change in Southern Resident Killer Whale Population Growth Rates, Abundance & Viability

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NOAA FISHERIES SERVICE

New Analysis Developed for NMFS Biological Opinion on the Puget Sound Chinook Plan

Used Ward (2010) models to evaluate change in:

- pod growth rates,
- population abundance, and
- population viability

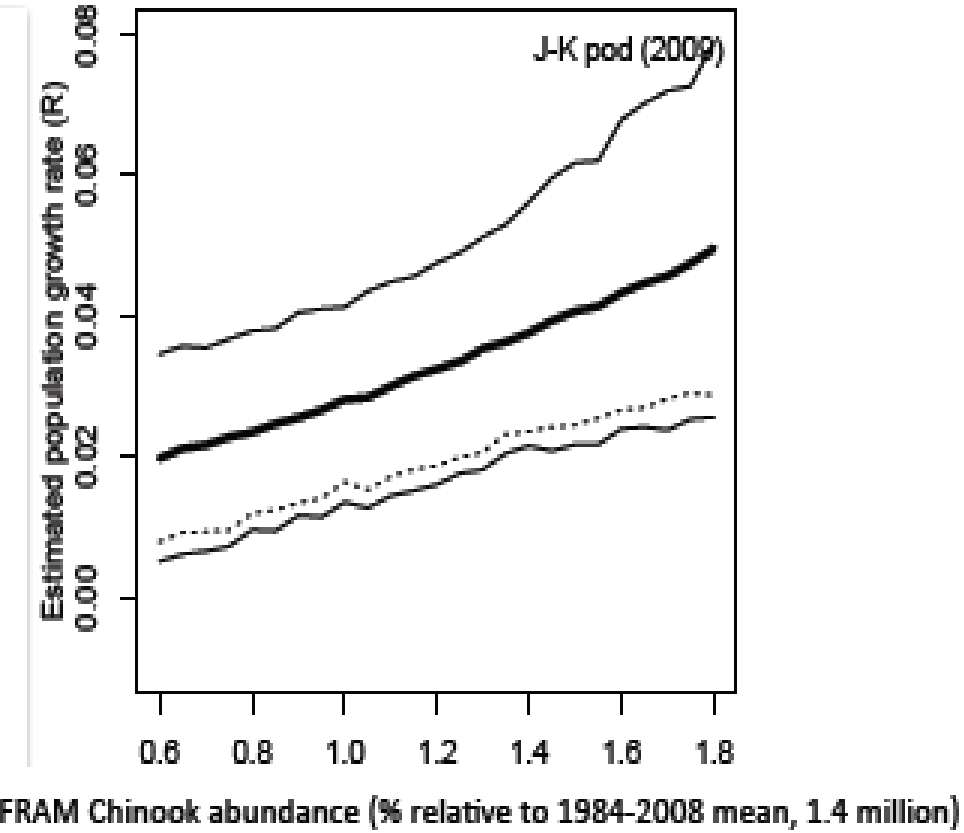
associated with 3-years of fishing.

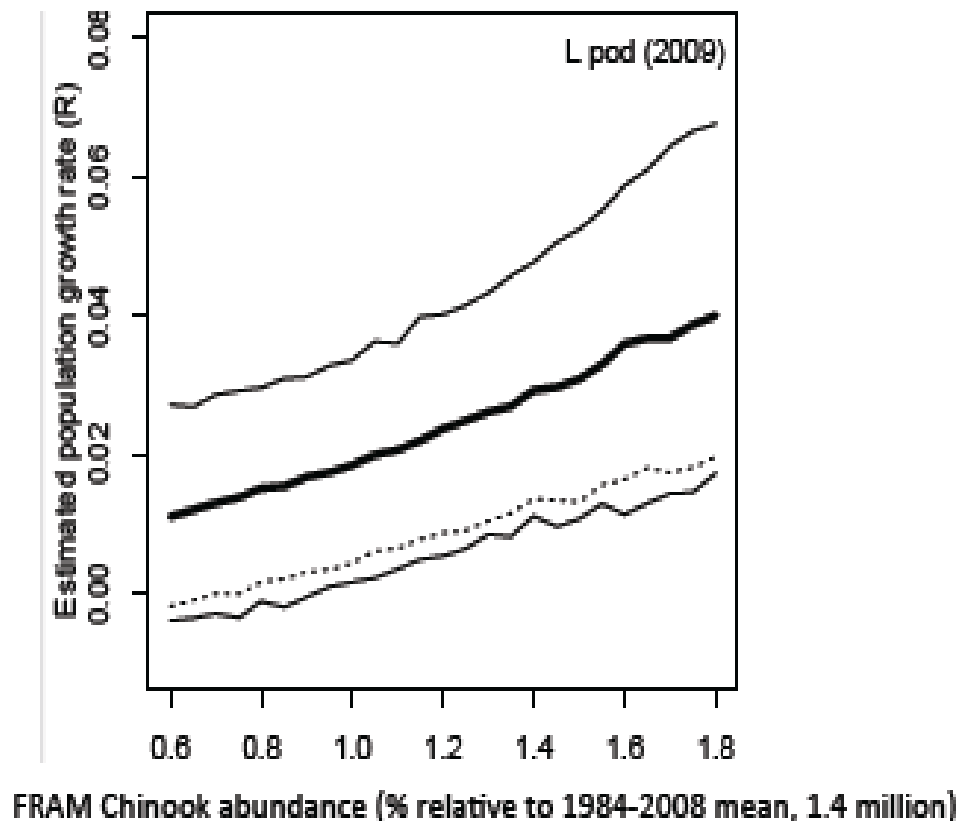
—Focused on July-Sept, when most fishing occurs.

— Recomputed estimated % prey reduction in units of numbers of fish.

— Evaluated change from Puget Sound fishing, as well as from all U.S. and Canadian fishing in inland waters.

Review of Ward (2010) Results



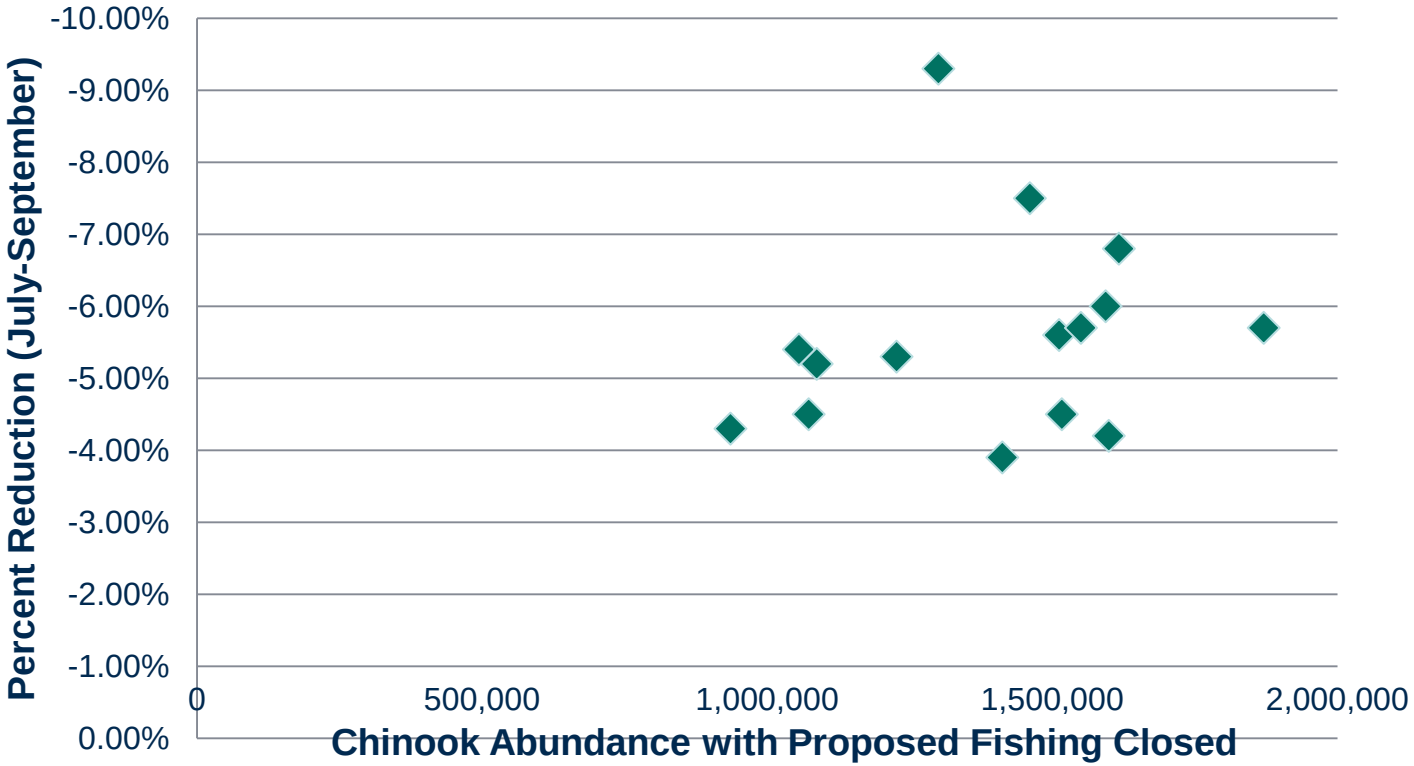


Prey Reductions from Puget Sound Fishing (in Units of Numbers of Fish)

- Only Puget Sound fishing open
- Specific to July - September

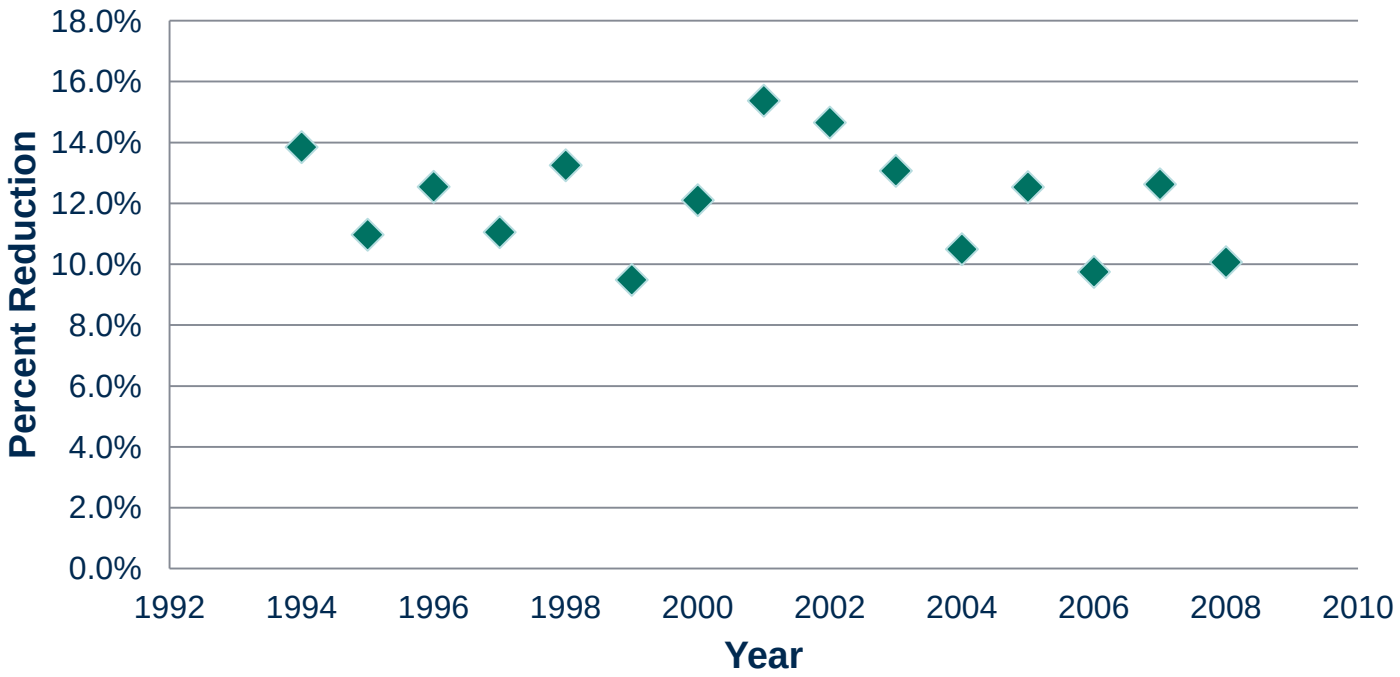
-3.8% = average reduction
-6.6% = maximum reduction

Prey Reductions from Puget Sound Fishing (Cont.)



No predictive relationship between reductions during Jul-Sept and the abundance of Chinook before fishing.

Prey Reductions from all U.S. and Canadian fishing (in Units of Numbers of Fish)



- All U.S. and Canadian fishing open
- Specific to July - September

-12.1% = average reduction
-15.4% = maximum reduction

Methods: Change in Growth Rate

Evaluated population growth with and without fishing:

- Used Ward's (2010) 50% maximum likelihood relationships:
  - J/K growth = 0.0250*(% FRAM Chinook abundance, relative to the 1994-2008 mean) – 0.0050;
  - L growth = 0.0242*(% FRAM Chinook abundance, relative to the 1994-2008 mean) – 0.0035.
- Used a range of Chinook abundance levels based on past Chinook abundance levels and knowledge of current and proposed management plans and agreements (15 years of retrospective analysis, 1994-2008).
- Two scenarios for fishing in Puget Sound- worst case and average case
- Four scenarios for all U.S. and Canadian fishing.

Results: Change in Growth Rate from Puget Sound Fishing

- Represented annual growth rate as lambda, or 1 + R.

Pod Group	Without fishing	With fishing	
		Worst case: 6.6% reduction	Average case: 3.8% reduction
L pod	1.013 - 1.029	1.012 - 1.027	1.012 - 1.028
J/K pod	1.012 - 1.029	1.011 - 1.026	1.011 - 1.027

- Likely to slightly reduce the annual growth rate of these pod groupings.

Methods: Four Paired Scenarios to Estimate Change in Growth Rate from all U.S. and Canadian Fishing

Paired Scenarios	With U.S. and Canadian Fishing	Without U.S. and Canadian Fishing
1	Max (-15.4%)	Max increase (15.4%) from the maximum Puget Sound fishing level (-6.6%)
2	Max (-15.4%)	Max increase (15.4%) from the average Puget Sound fishing level (-3.8%)
3	Average (-12.1%)	Average increase (12.1%) from the max Puget Sound fishing level (-6.6%)
4	Average (-12.1%)	Average increase (12.1%) from the average Puget Sound fishing level (-3.8%)

Results: Change in Growth Rate from all U.S. and Canadian Fishing

Scenario	Without fishing	With fishing
Pair 1 – Max		
J/K pod	1.013 - 1.031	1.011 - 1.026
L pod	1.014 - 1.032	1.012 - 1.027
Pair 2 – Max		
J/K pod	1.014 - 1.032	1.011 - 1.027
L pod	1.015 - 1.033	1.012 - 1.028
Pair 3 - Average		
J/K pod	1.013 - 1.030	1.011 - 1.026
L pod	1.014 - 1.031	1.012 - 1.027
Pair 4 – Average		
J/K pod	1.013 - 1.031	1.011 - 1.027
L pod	1.014 - 1.032	1.012 - 1.028

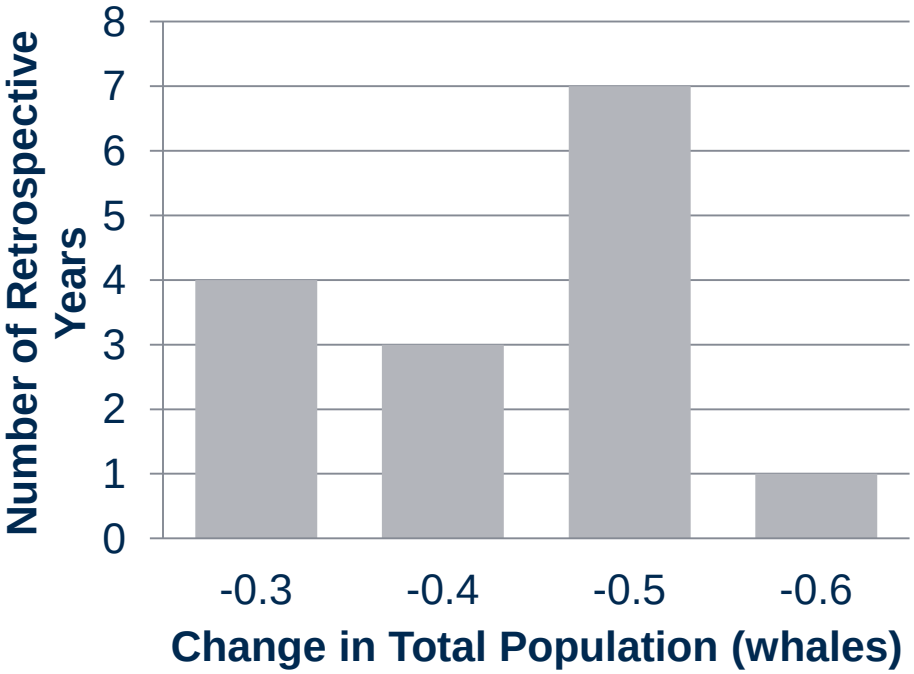
Slight reduction in the annual growth rates across scenarios.

Methods: Change in Abundance

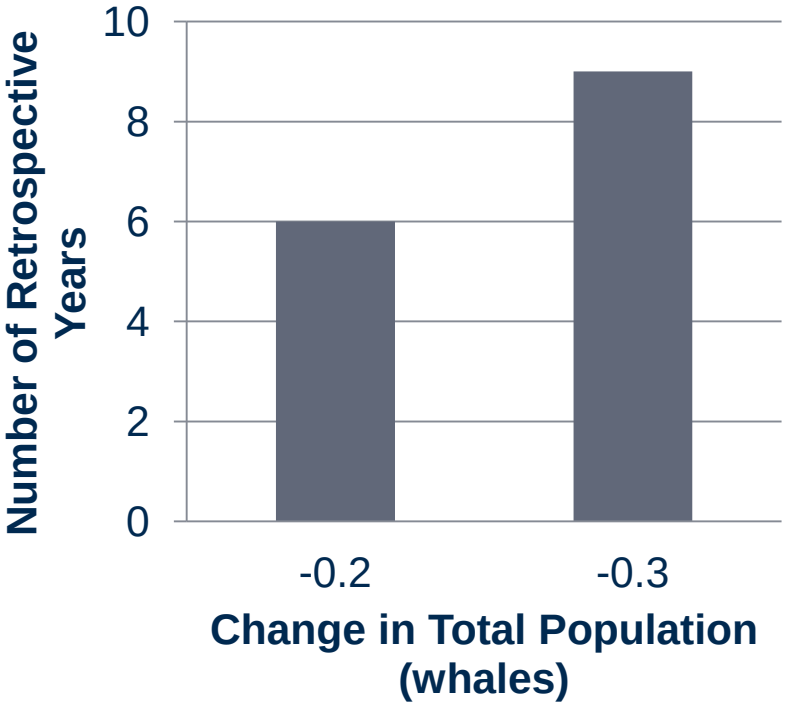
- NMFS used the growth rate predictions to project killer whale population abundance with and without fishing:
  - $N_{t+3} = N_t * (1+R)^3$
- Evaluated the same scenarios previously identified.

Results: Change in Abundance from Puget Sound Fishing

Worst case scenario:



Average case scenario:



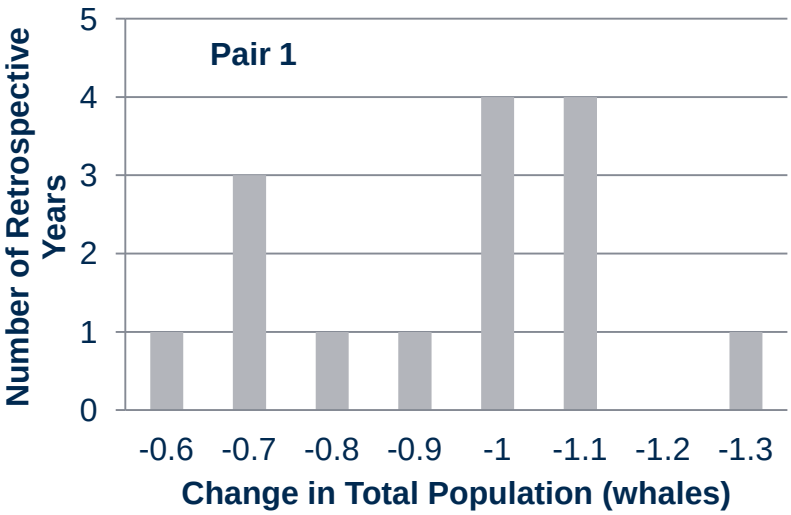
Reductions represent the result of whales not being born in future years, rather than the result of whales dying.

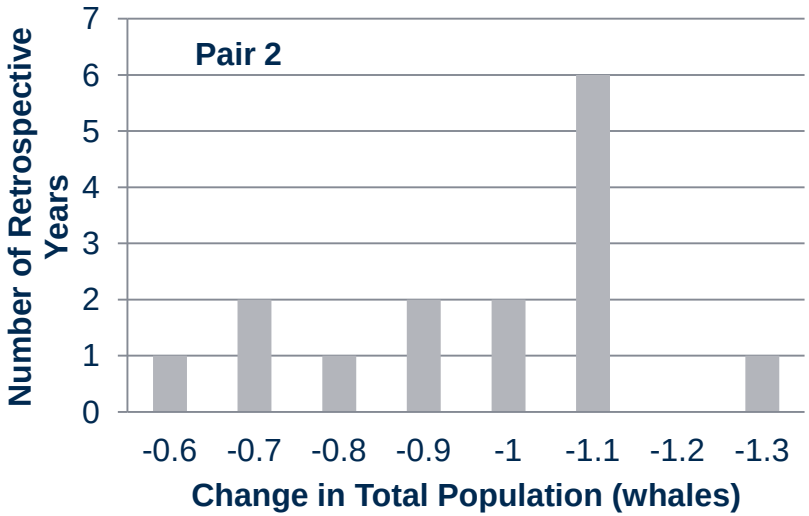
Results: Change in Abundance from all U.S. and Canadian Fishing

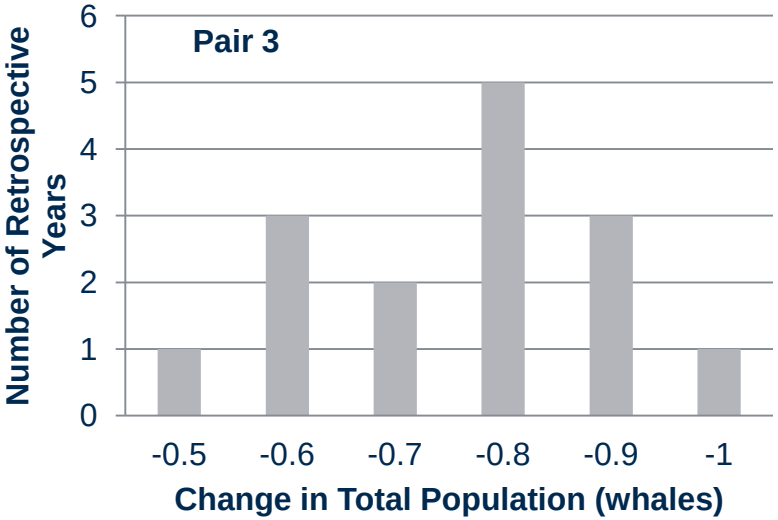
Paired Scenarios	Predicted Range in Reduced Abundance
1	-0.6 to -1.3 whales
2	-0.6 to -1.3 whales
3	-0.5 to -1.0 whales
4	-0.5 to -1.1 whales

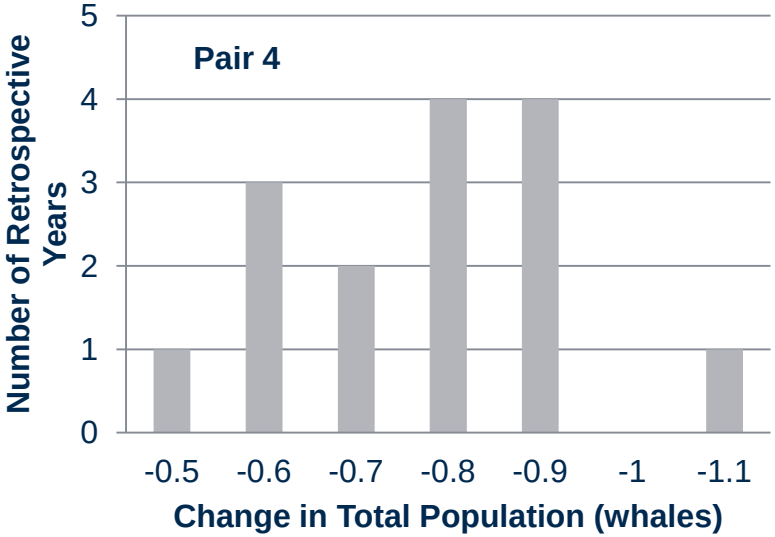
Similar results under each paired scenario evaluated.

Results: Change in Abundance from all U.S. and Canadian Fishing (Cont.)







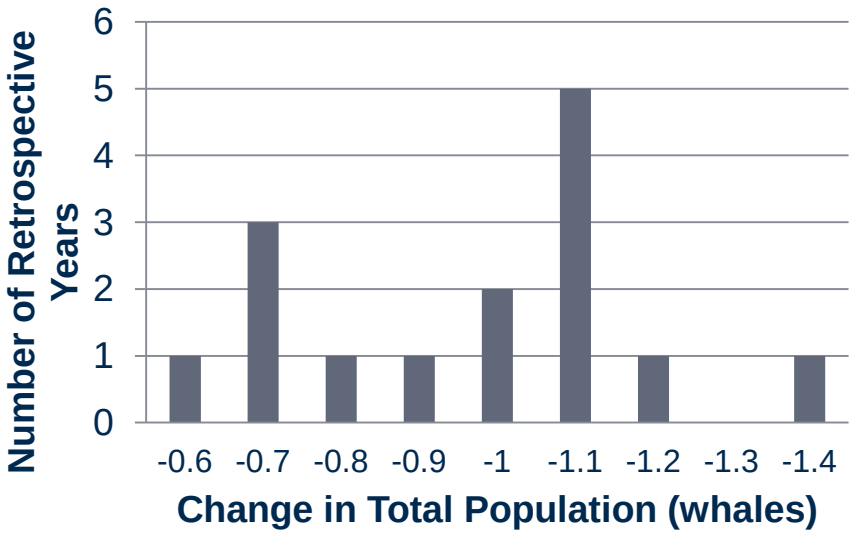


Change in Population Viability

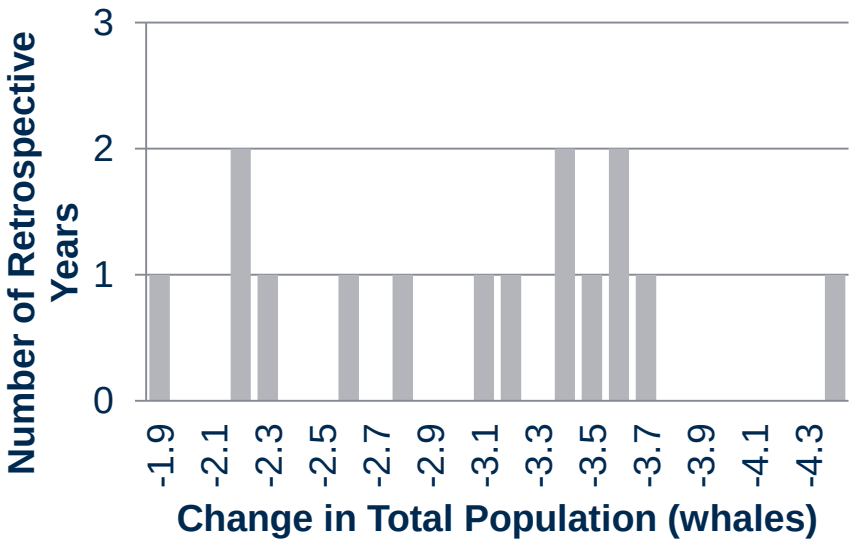
- Tools to quantify the change in extinction risk were not available yet.
- An incrementally small increase in risk is expected to occur (i.e. expect that as population growth decreases, extinction risk increases).
- The following factors informed NMFS conclusions about the anticipated incrementally small increase in extinction risk:
  - (1) Duration was short; 3-years of fishing were evaluated.
  - (2) Anticipated magnitude was small (based on the small reduction in abundance).
  - (3) Focused analysis on maximum or average reduction, and reductions could be less.
- NMFS concluded that meaningful change to viability was not likely.

Reduction in Abundance after a Longer Duration of Fishing

Puget Sound fishing – average reduction



All U.S. and Canadian fishing – average reduction



For example, a ten year projection.

New Approaches for Consideration

Develop a model to estimate change in population size using a Monte Carlo approach.

<u>Pros of this approach:</u>

- Can include distribution-based parameters to better represent variability (i.e. whale population size, likelihood level in Ward relationships, and harvest and Chinook abundance levels).
- Parameter sensitivity can be explicitly evaluated.
- Using distributions avoids the problem of identifying discrete harvest scenarios.
  - i.e. Can include a model decision-rule to re-select a new harvest level and Chinook abundance for each year of a given projection.

New Approaches for Consideration (Cont.)

- Adapt the new PVA to allow for quantitative assessment of effects on viability.
- Other thoughts?