Northwest **Power** and **Conservation** Council

January 3, 2018

MEMORANDUM

TO: **Council Members**

FROM: **Laura Robinson, Program Liaison Coordinator**

SUBJECT: **Chinook salmon survival in the midst of increasing marine mammal predation**

BACKGROUND:

Presenters: Brandon Chasco, Oregon State University
Dr. Michelle Wargo Rub, NOAA Northwest Fisheries Science Center

Summary: At the January Council meeting, both Brandon Chasco and Dr. Michelle Wargo Rub will present on their latest research on marine mammal predation on Chinook salmon from the lower Columbia River and estuary to the whole Northeast Pacific Ocean.

Brandon Chasco is a SeaGrant Population Dynamics fellow at Oregon State University. He focuses on incorporating temporal and spatial processes into population dynamics models. In particular, he is interested in understanding the growth and movements for a range of protected species that include: martens, sea turtles, marine mammals, and salmonids.

Dr. Michelle Wargo Rub is a Fisheries Biologist for NOAA's Northwest Fisheries Science Center. Much of Dr. Wargo Rub's research is focused on salmon run timing and the effects marine mammal predation has on it. At the January Council meeting, Dr. Wargo Rub will present to the Council members the latest findings of her research, which is focused on

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the survival of spring/summer Chinook salmon through the estuary and lower Columbia River amid a rapidly changing predator population.

Relevance: Preserving program effectiveness by supporting expanded management of predators is a priority of the Council's 2014 Fish and Wildlife Program.

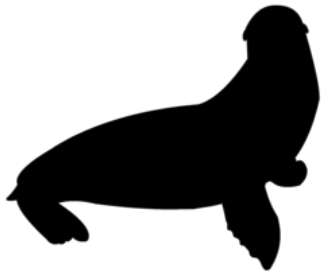
Background: Recently, Brandon Chasco published a paper with 16 co-authors on marine mammal predation research in which they used a spatio-temporal bioenergetics model of the Northeast Pacific Ocean to quantify how pinniped and killer whale predation has impacted Chinook salmon returns, and to compare the resulting estimates with salmon fisheries. Beginning in 2015, NOAA researchers began working with several universities and tribal agencies to assess the impacts that marine mammals may be having on protected Chinook salmon populations and endangered Southern Resident killer whales. Recent work by these NOAA researchers has shown that the reproductive success of Southern Resident killer whales is highly correlated with salmon abundance, and that localized salmon predation by rebounding pinniped populations could be limiting the recovery of not only the salmon but Southern Resident killer whales as well. Furthermore, the recent coastwide analysis by Chasco et al. demonstrates that long-term trends in Chinook salmon productivity may have been masked by increases in marine mammal predation. Thus, freshwater salmon mitigation efforts may have been more successful than previously realized.

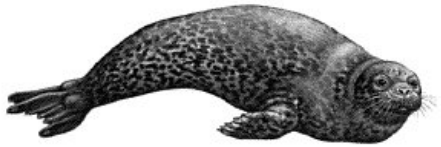
Additionally, NOAA researchers led by Dr. Wargo Rub have been studying the annual spring Chinook run since 2010 and have captured, marked and released several thousand fish, tracking their progress as they move up the river to spawn. NOAA contracts with commercial fishers to catch spring Chinook in the estuary around river mile 28, near Tongue Point east of Astoria. Researchers insert tags into the fish and release them back into the river. Sea lions also are tagged in the Astoria area so their movements in the river can be monitored. According to Dr. Wargo Rub, most stay in that area, but a small percentage travel all the way to Bonneville where up to half of the predation on spring Chinook occurs. Eight years of research has shown year-to-year variations on Chinook survival and run timing in the lower river and estuary. Of particular interest is a peak in Chinook mortality in 2014 and 2015. Many reasons could account for the variations such as the difference in flow years, but Dr. Wargo Rub feels confident that pinniped predation plays a large role.

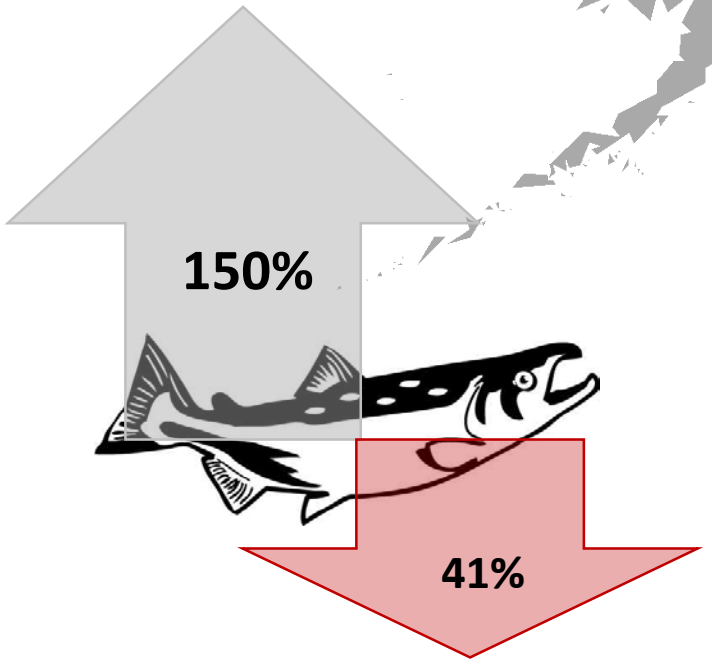
Competing tradeoffs between increasing marine mammal predation and fisheries harvest of Chinook salmon

Really have to thank my co-authors first

1. 16 co-authors
2. Three papers
3. Over 400 articles and reports cited
4. Lots of unpublished raw data
5. Many, many revisions
6. All of the code is on-line



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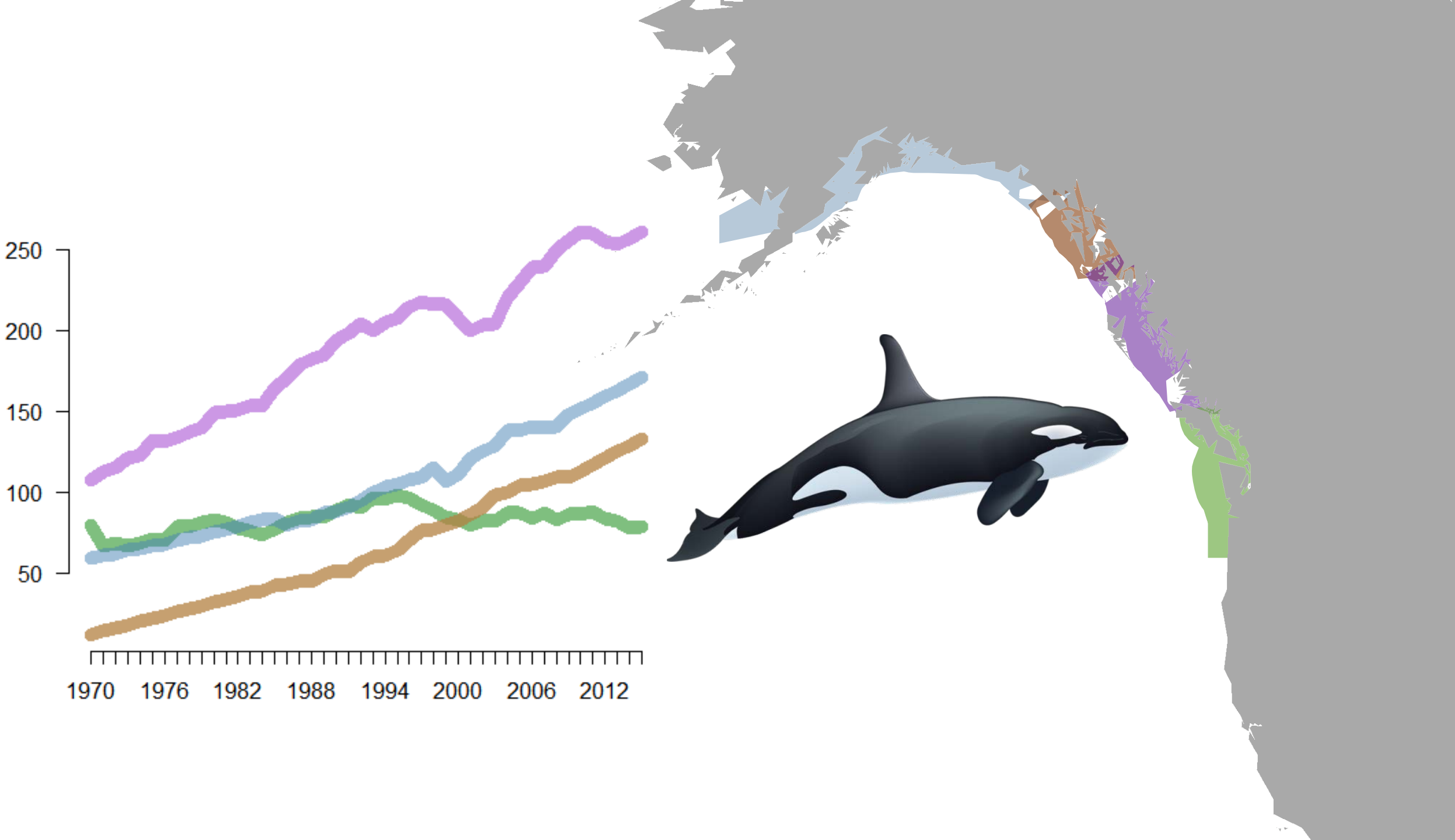
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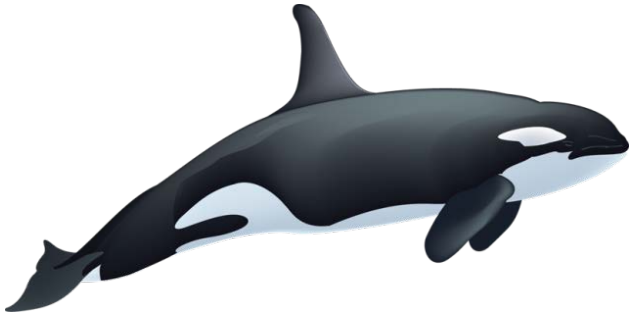
$\mathbf{Consumption = Growth + Metabolism + Waste}$

U.S. Army Corp of Engineers



kcal day^{-1}

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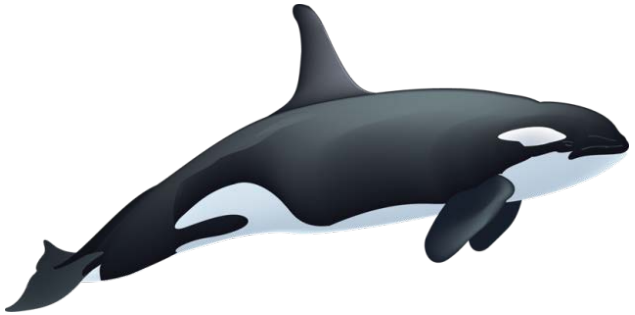

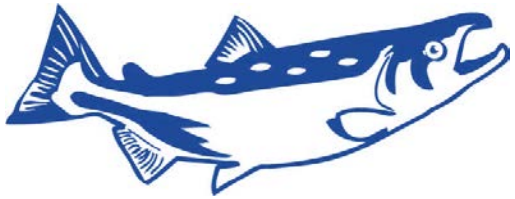

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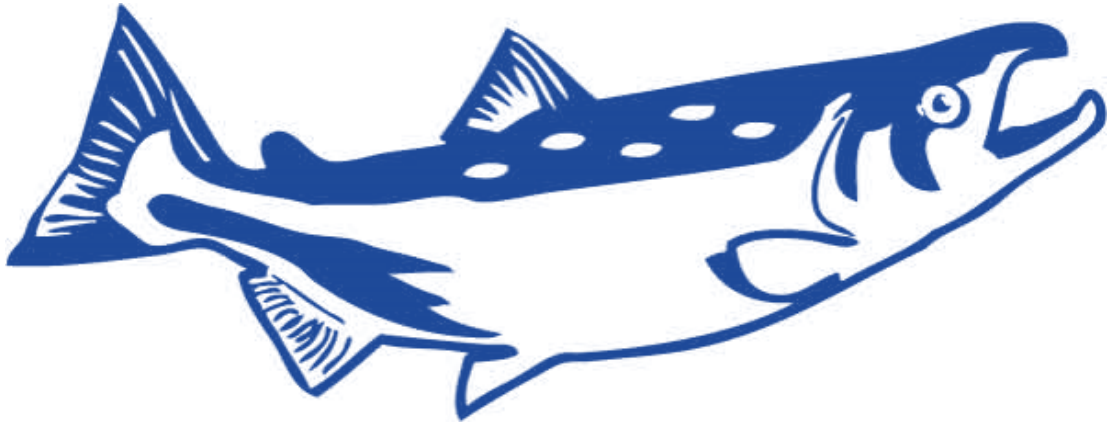
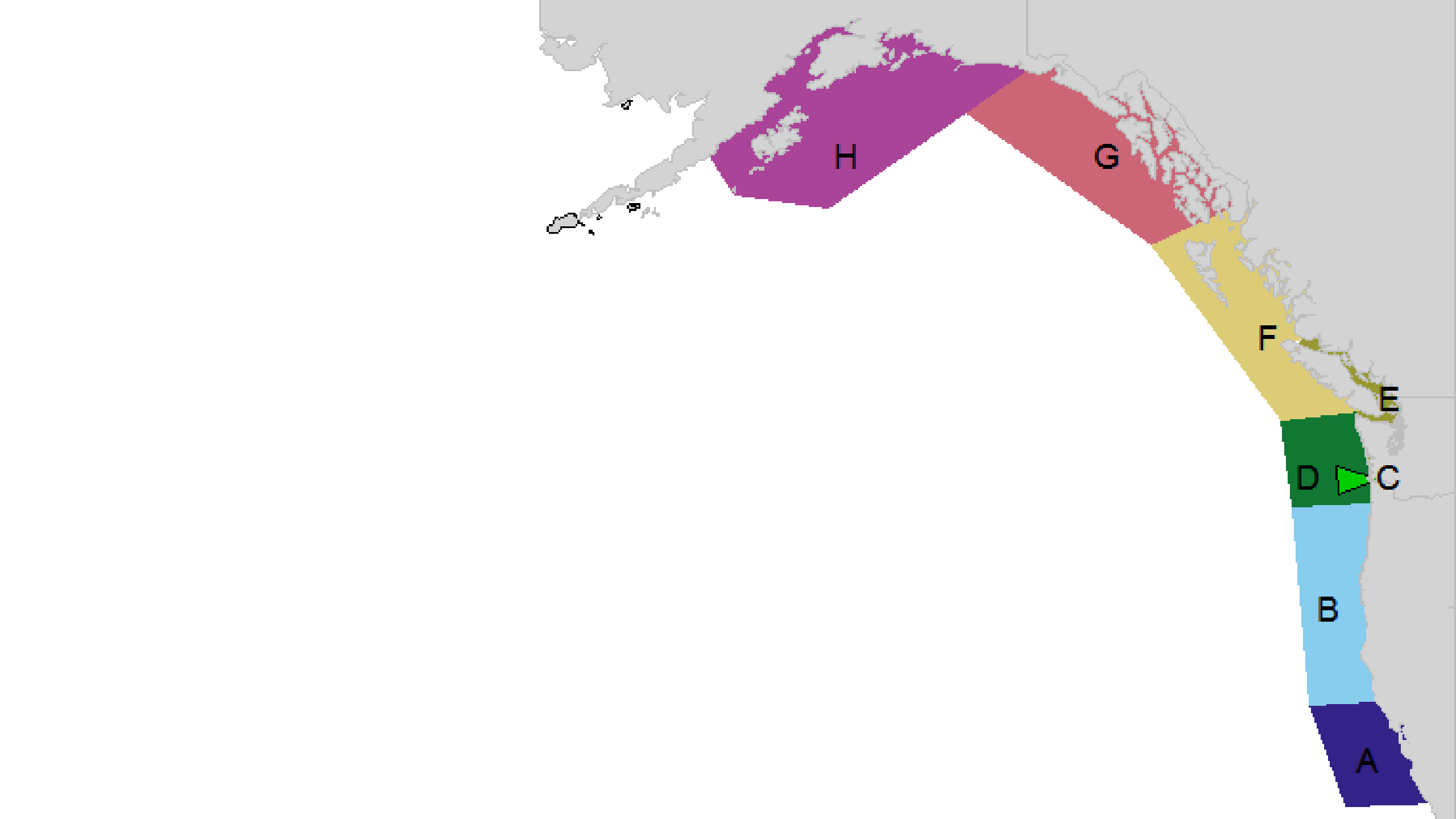


$$N_{consumed} = \frac{kcal_{predator}}{kcal_{ch}}$$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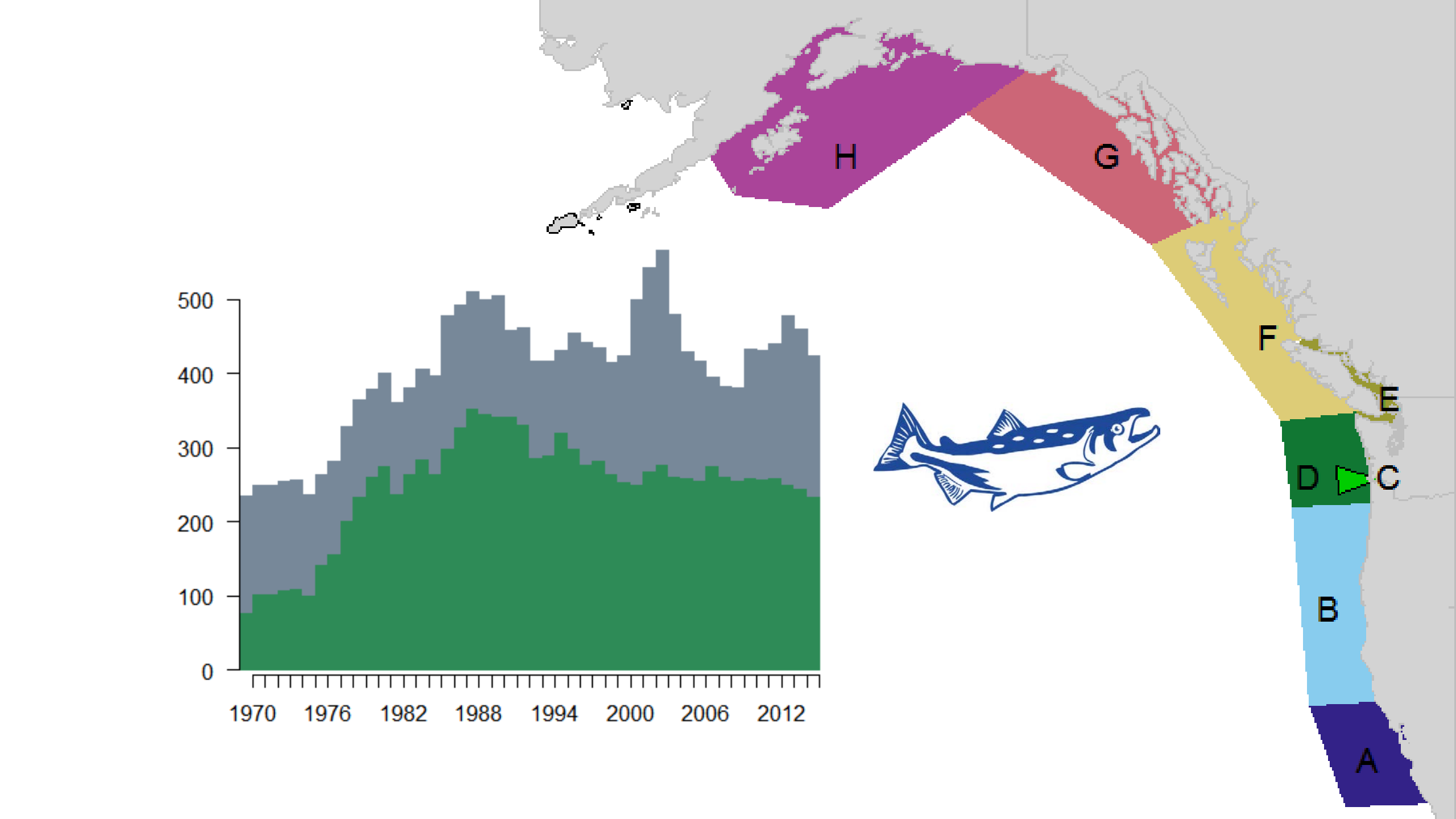
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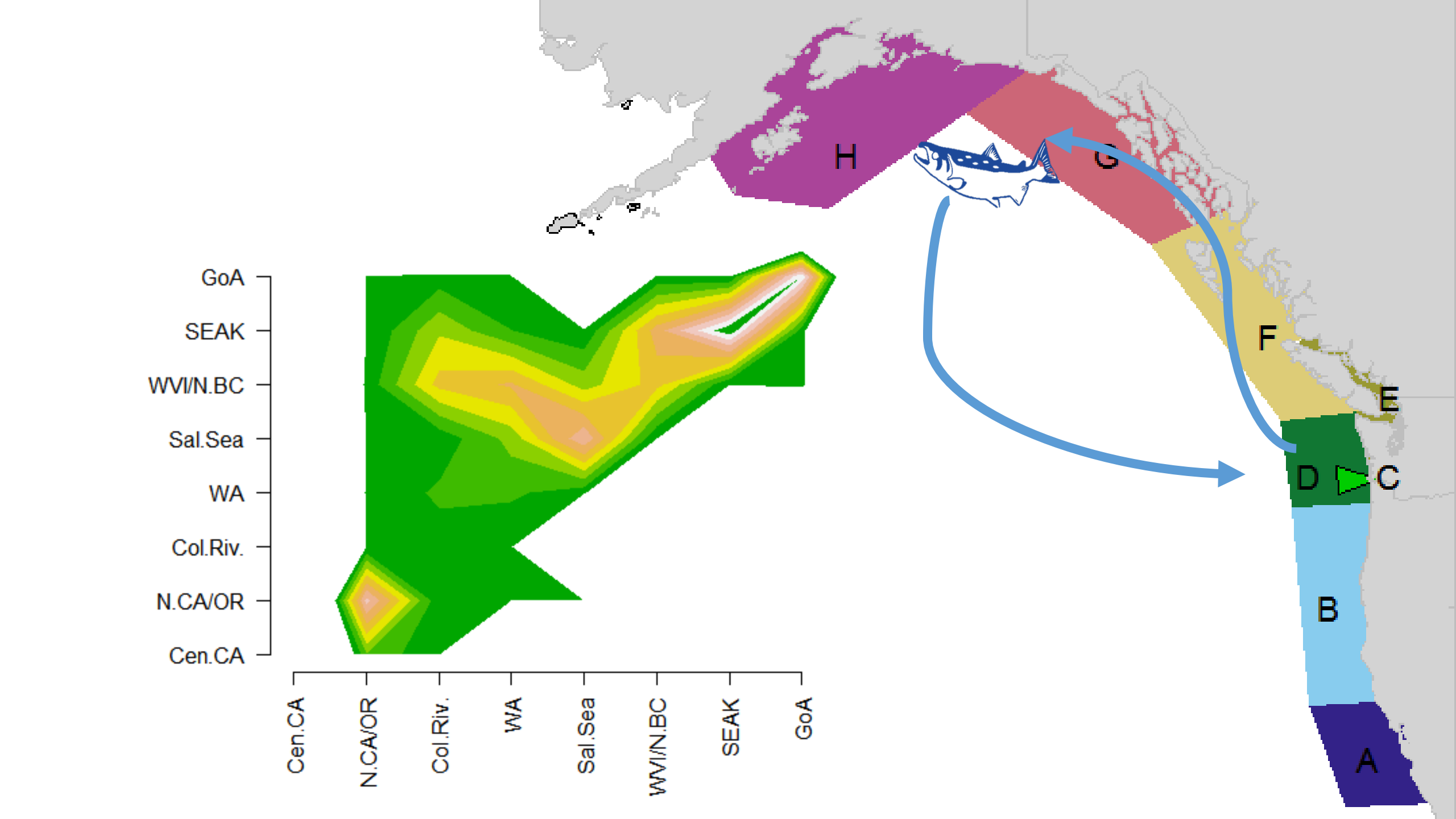
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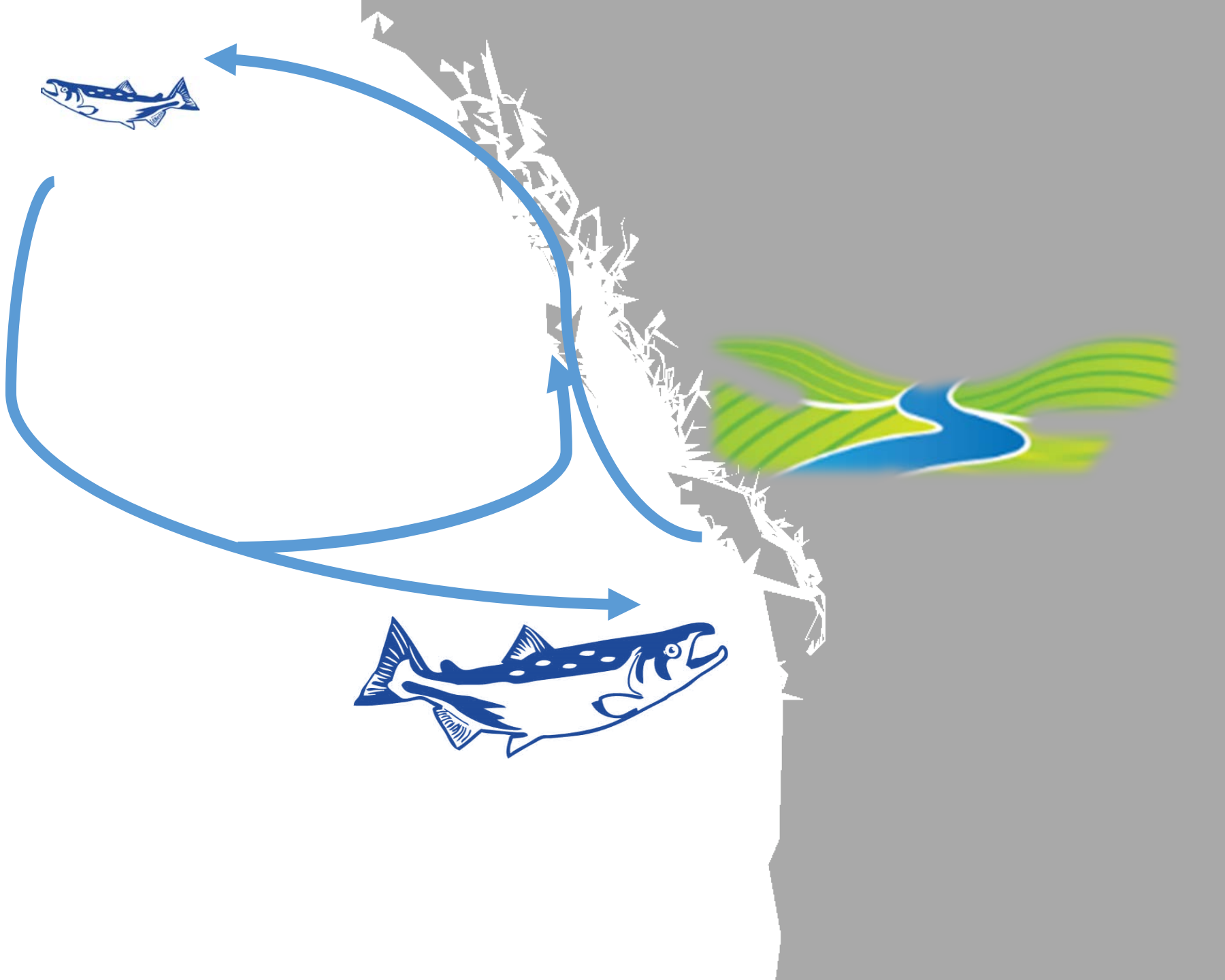
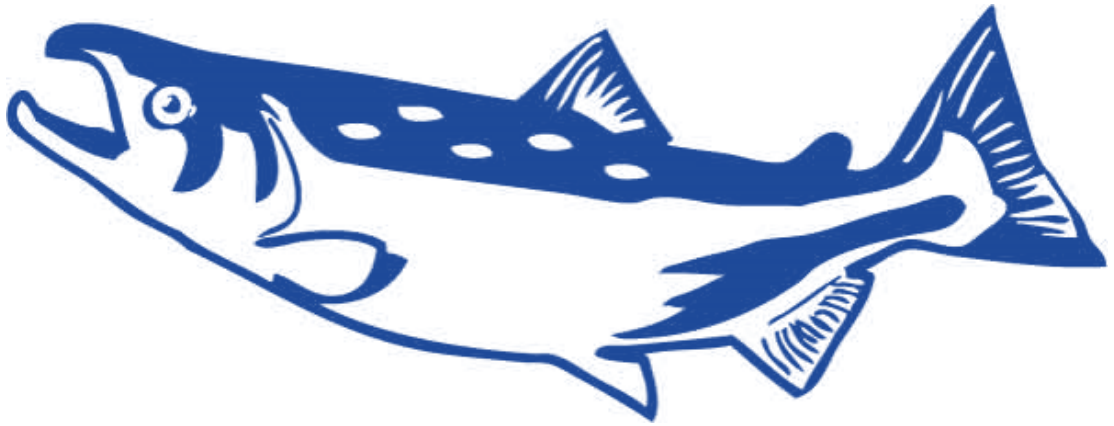
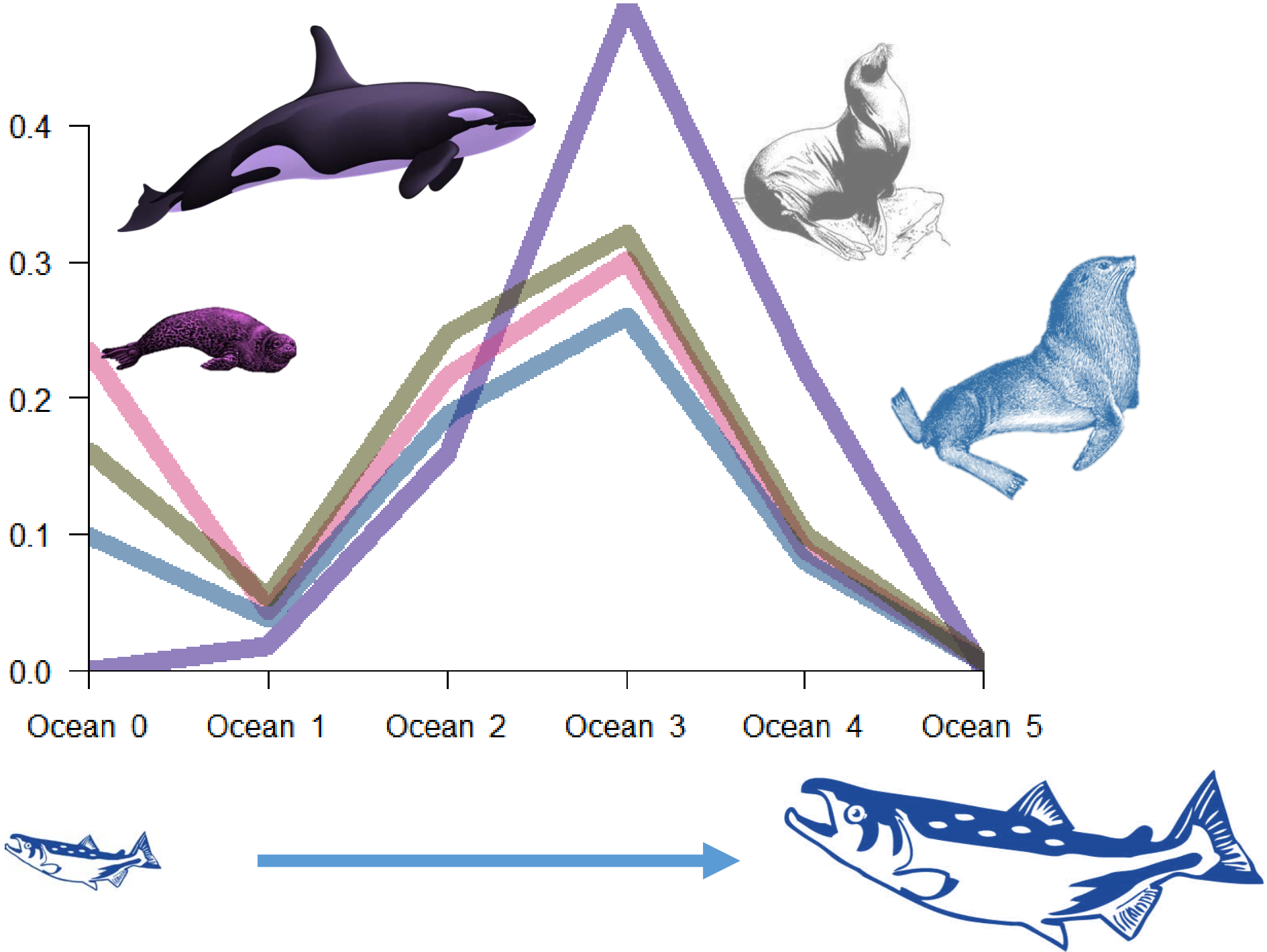


1,450  ≈ 

$$\mathrm{kcal}_{\mathrm{ch}} = 0.00002 \times (\mathrm{Fish\ Length})^{3.6047}$$

O'Neill et al. 2014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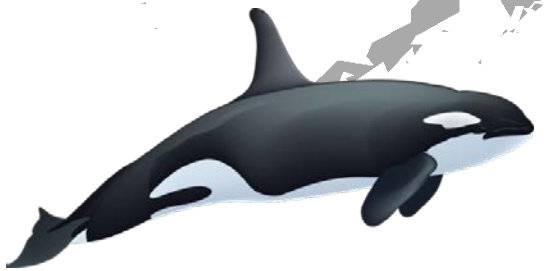
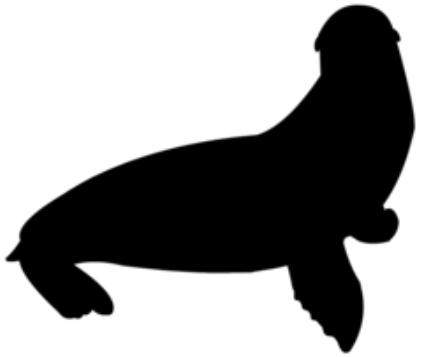
Review of model inputs

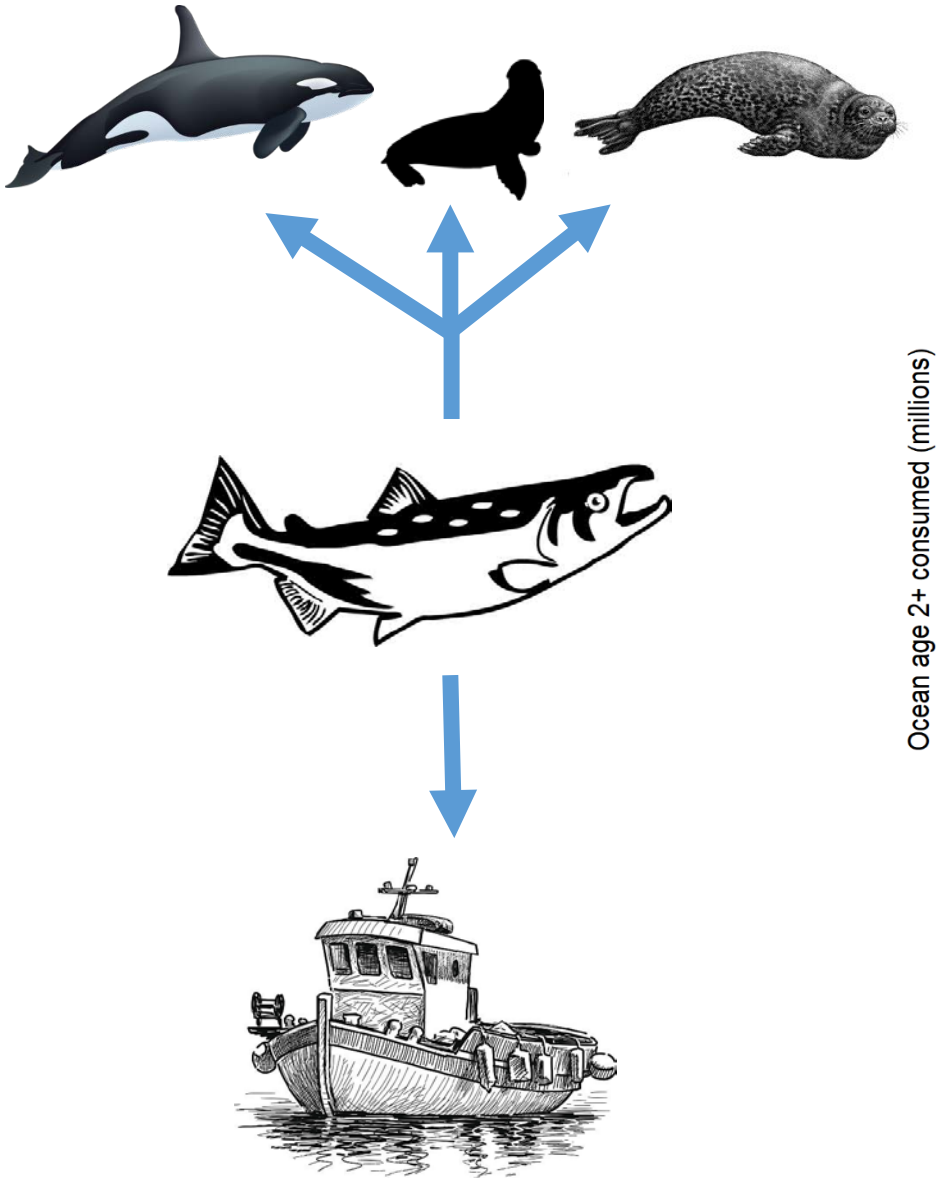
1. Number of predators (NOAA and state surveys)
2. Location of the predators (NOAA and state surveys, expert opinion)
3. Energy demands of the predators (Literature)
4. Chinook diet fraction of the predators (Literature)
5. Size selectivity of the predators (Literature)
6. Production of the Chinook salmon (Literature, federal and state estimates, RMIS)
7. Location of the Chinook salmon (Weitkamp (2010), literature, and expert opinion)
8. Energy content of salmon (O'Neill et al. 2009)
9. Growth of Chinook salmon (FRAM)
10. Fisheries catches (PSC and PMFC)

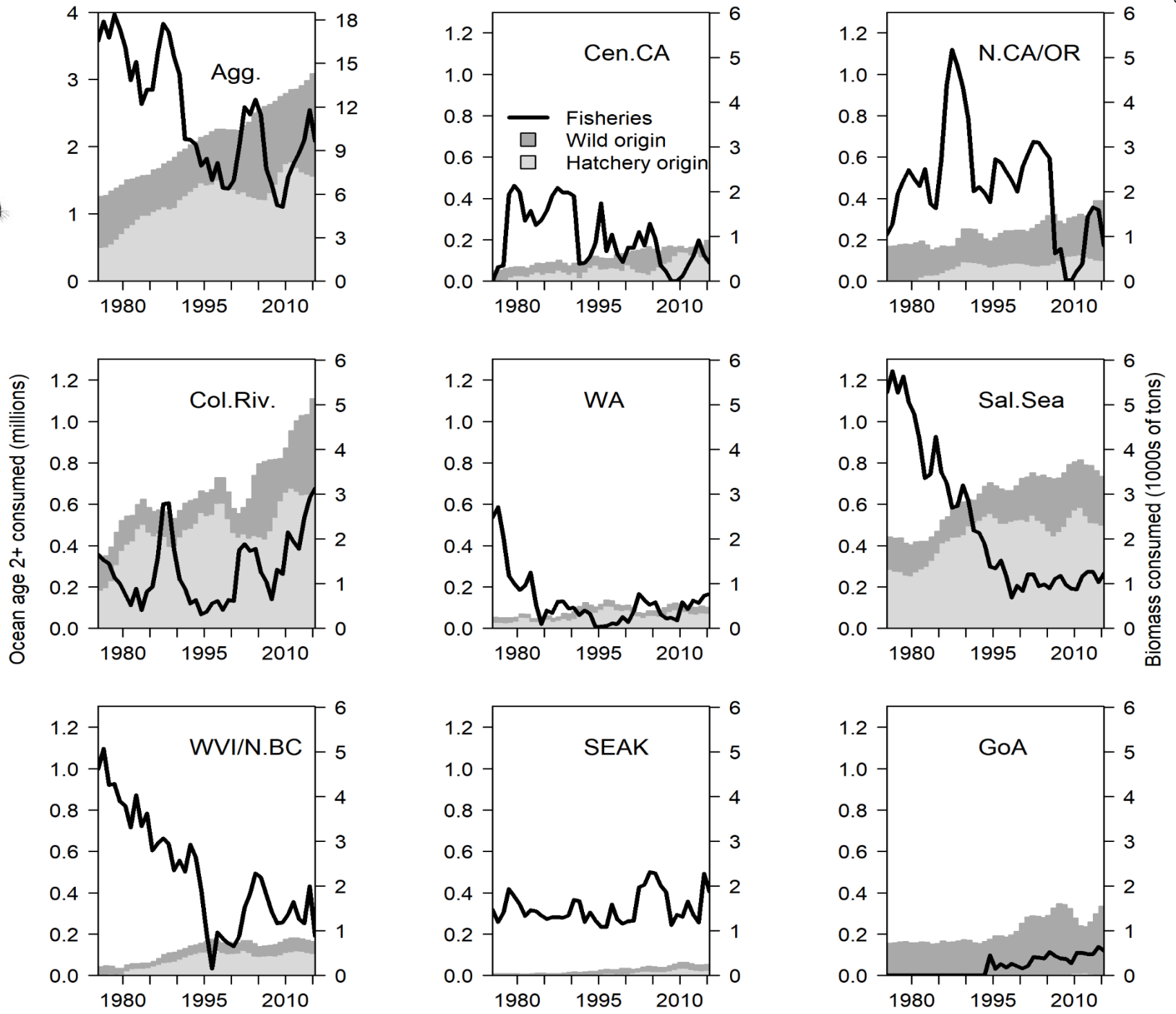
Focus on aggregate findings and the Columbia River



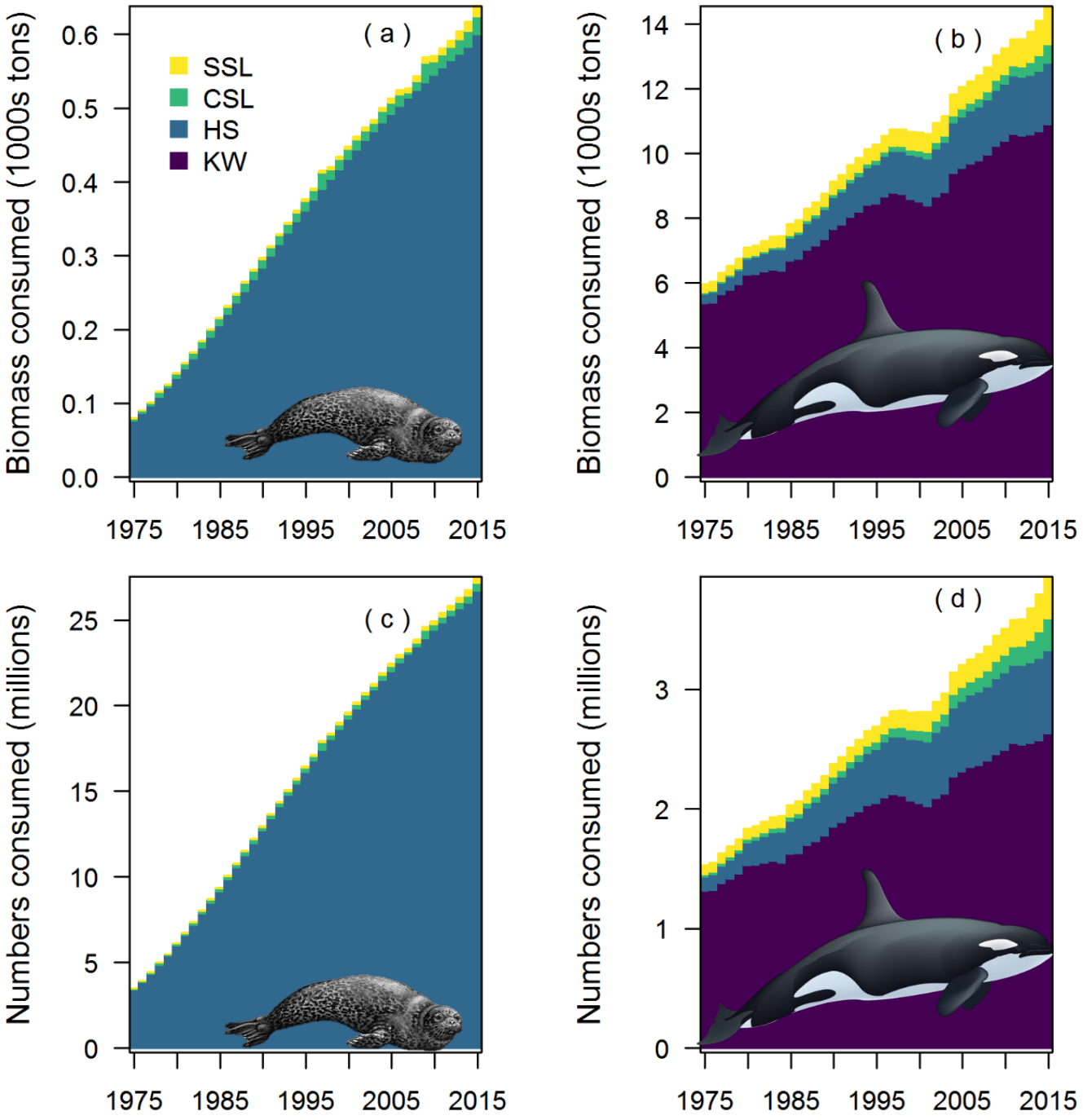


Aggregate removals

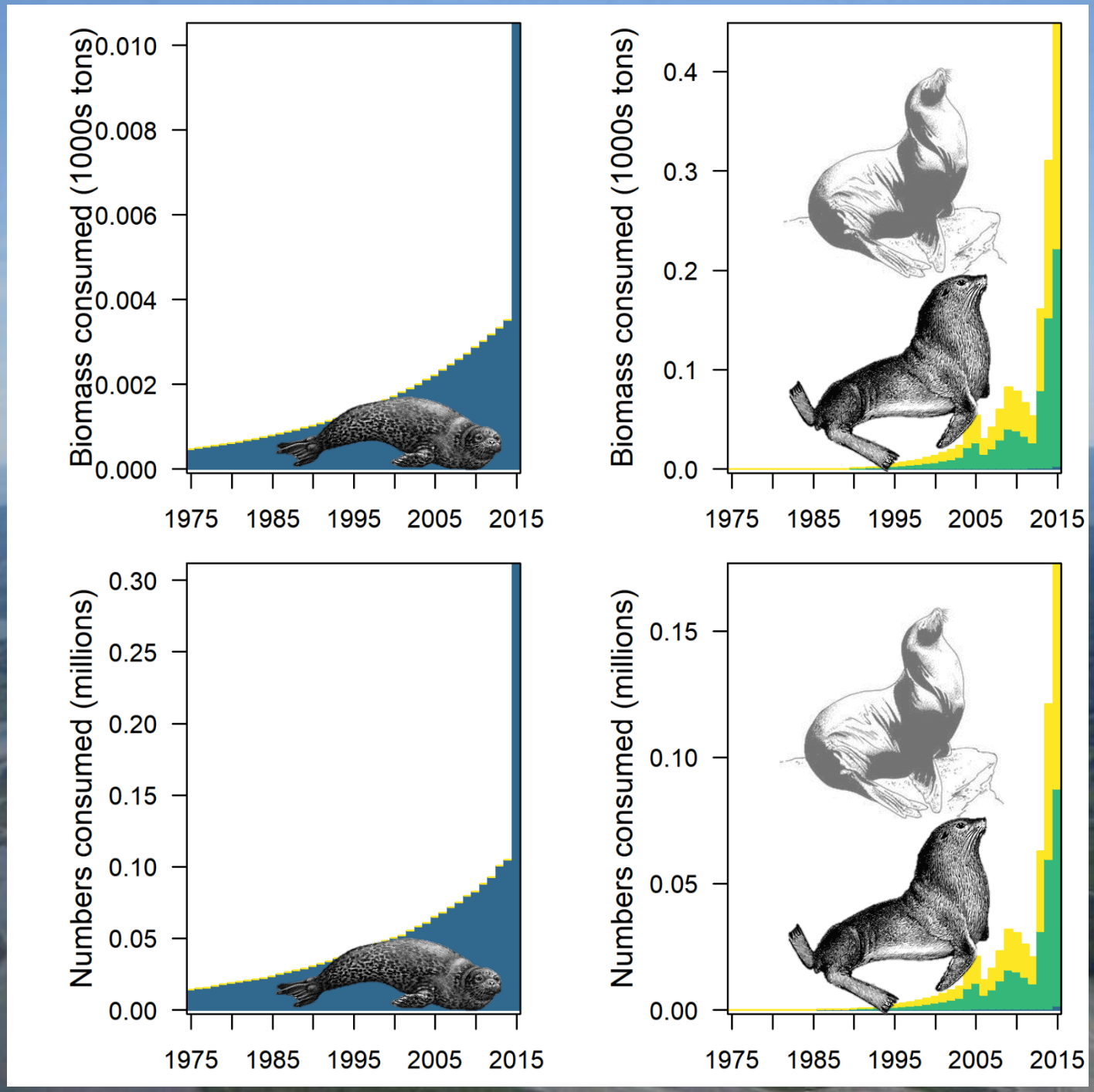


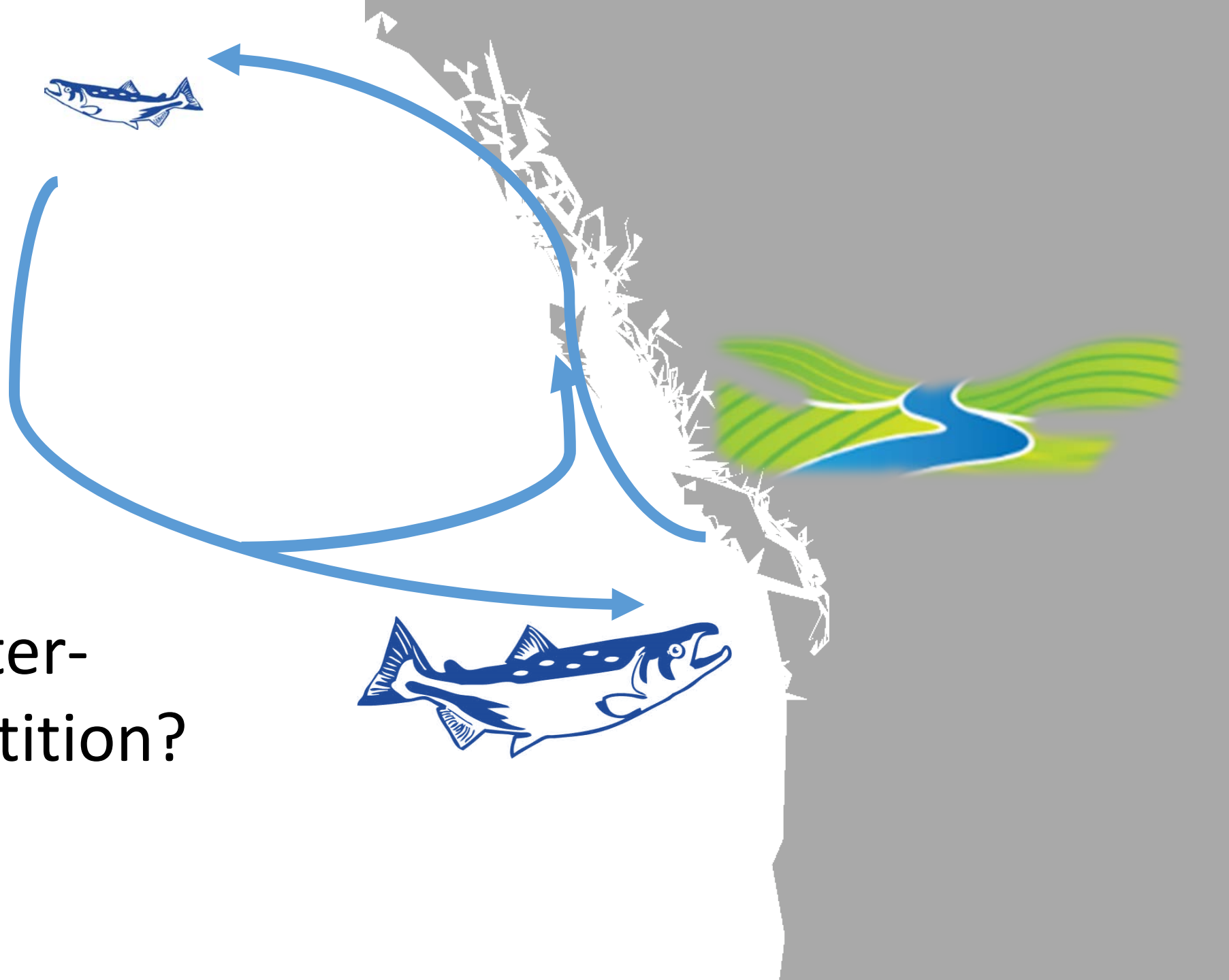


Aggregated predator consumption



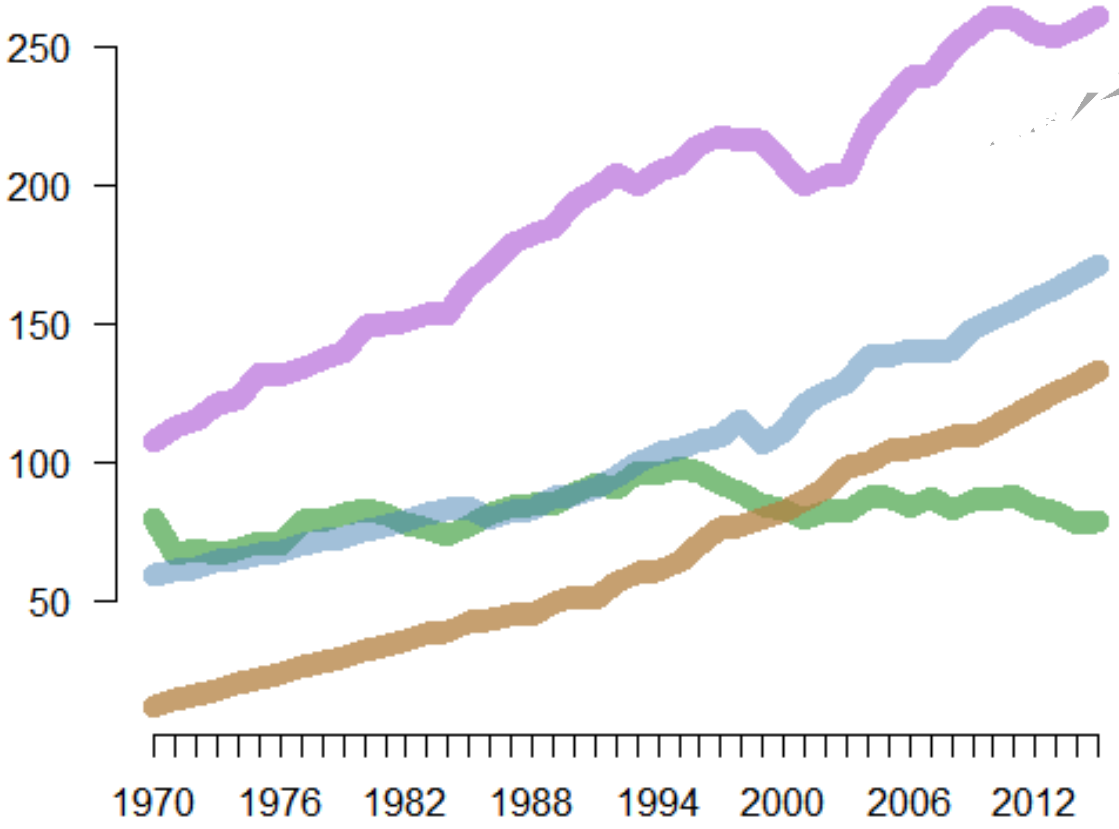
Regional predator consumption

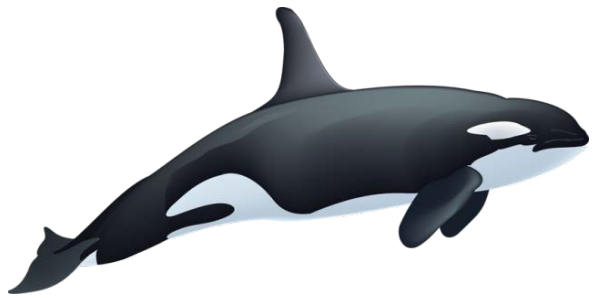




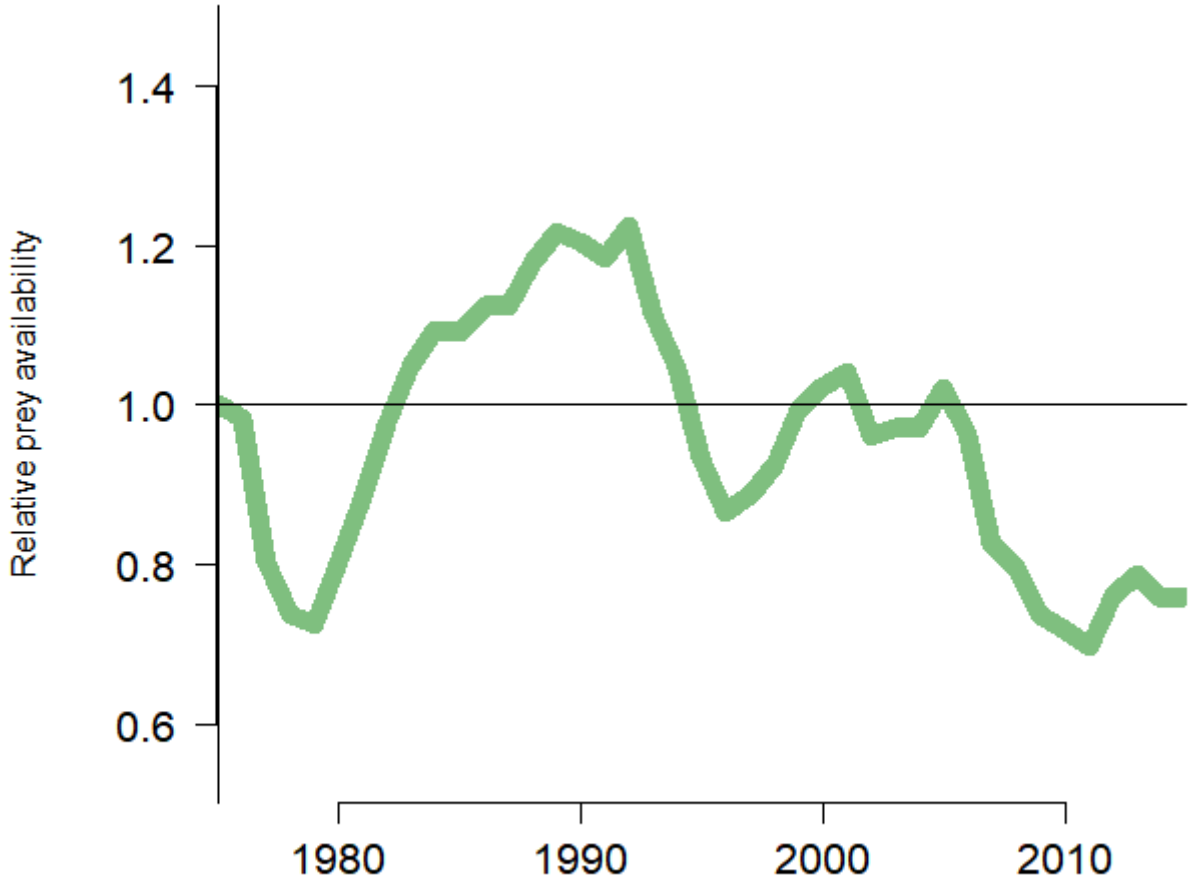
What about inter-specific competition?

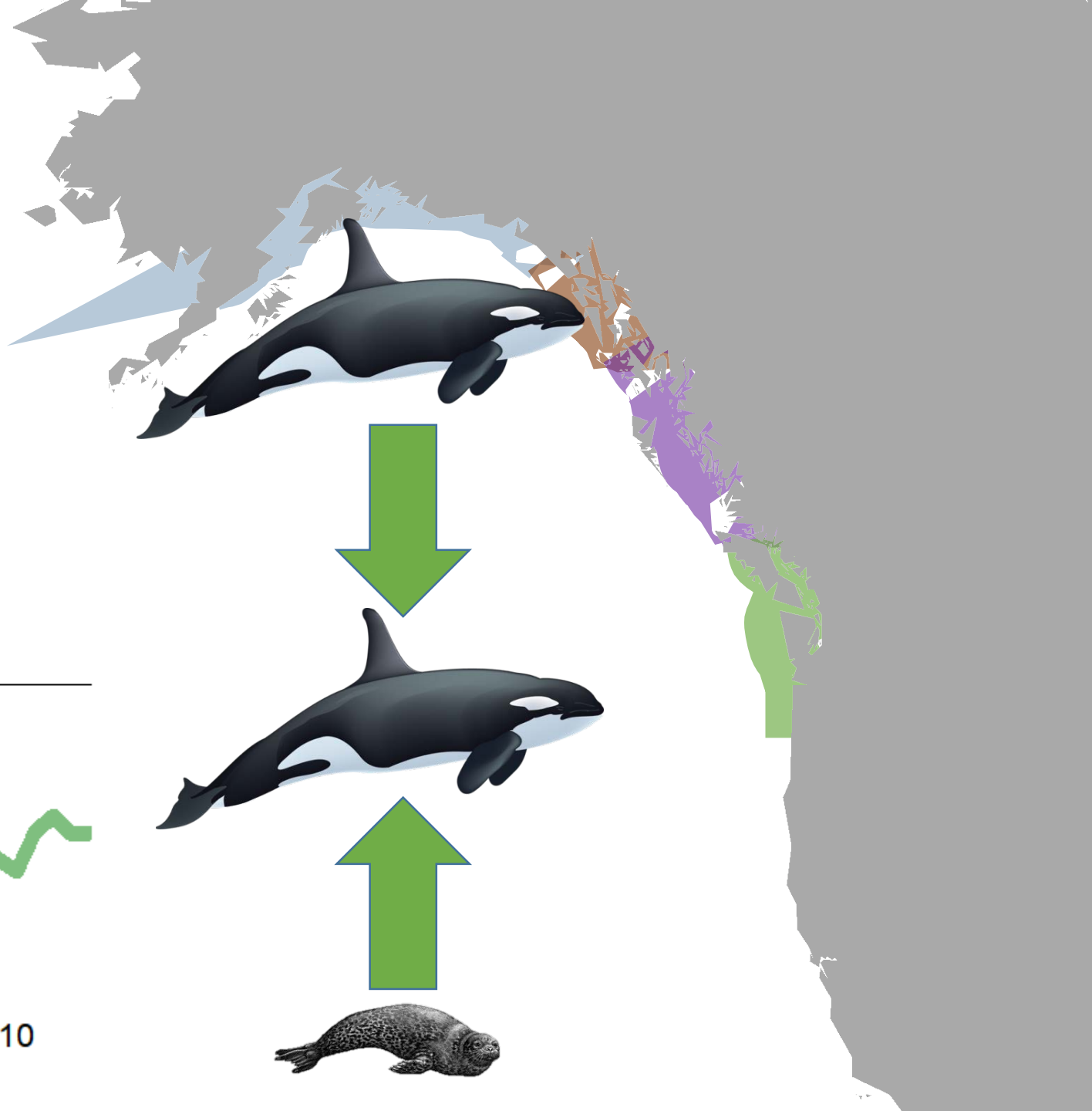
Southern Resident declines?



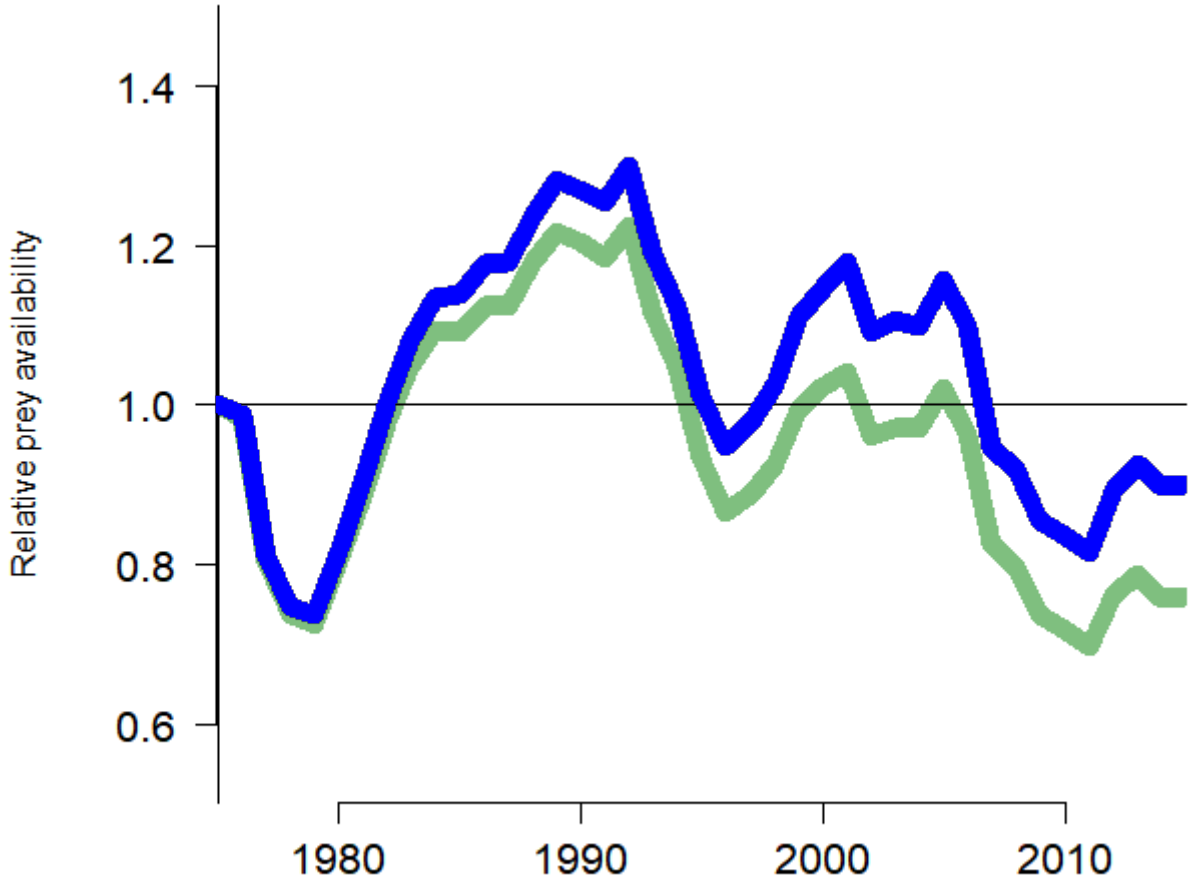


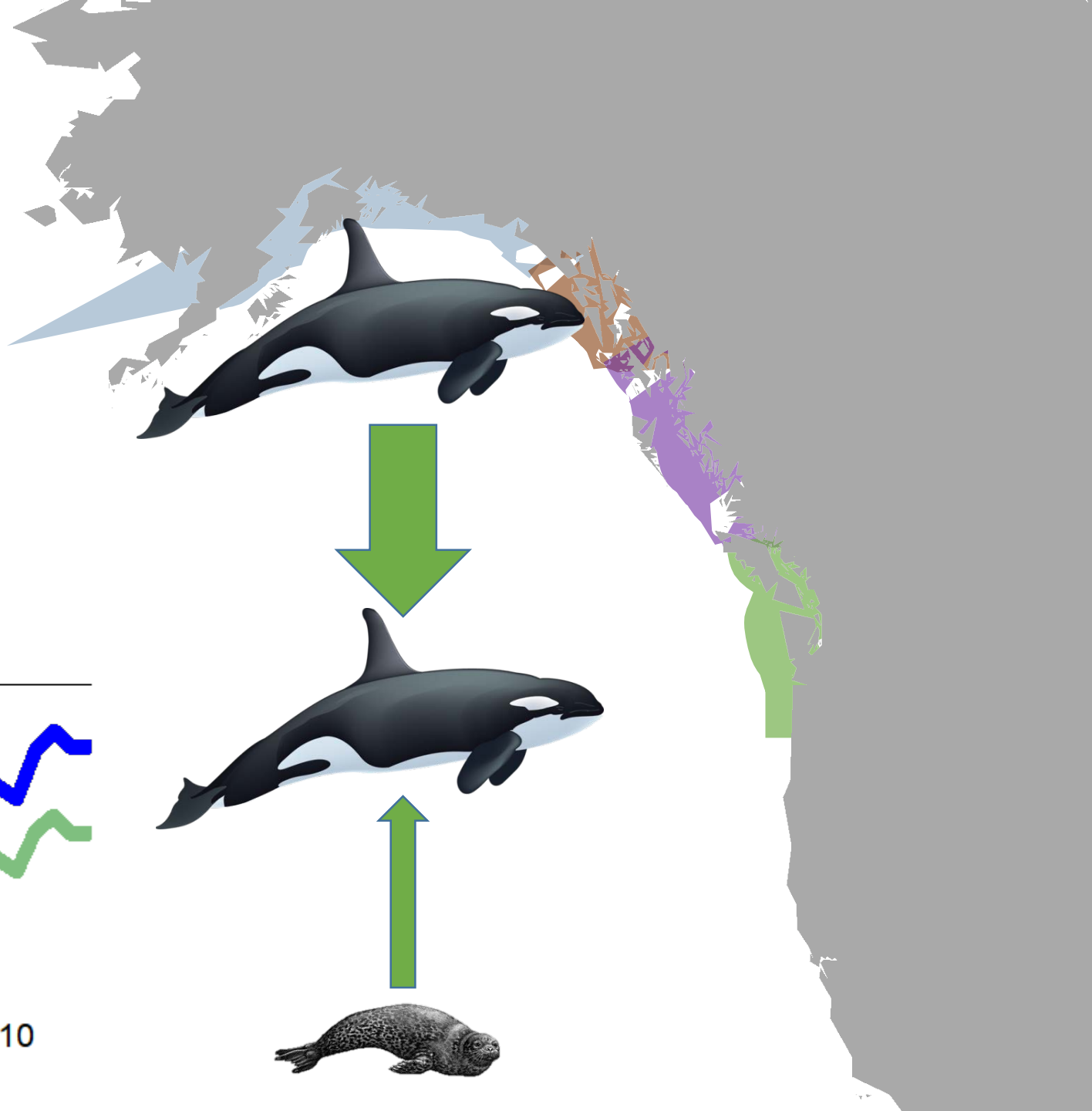
Southern Resident declines?



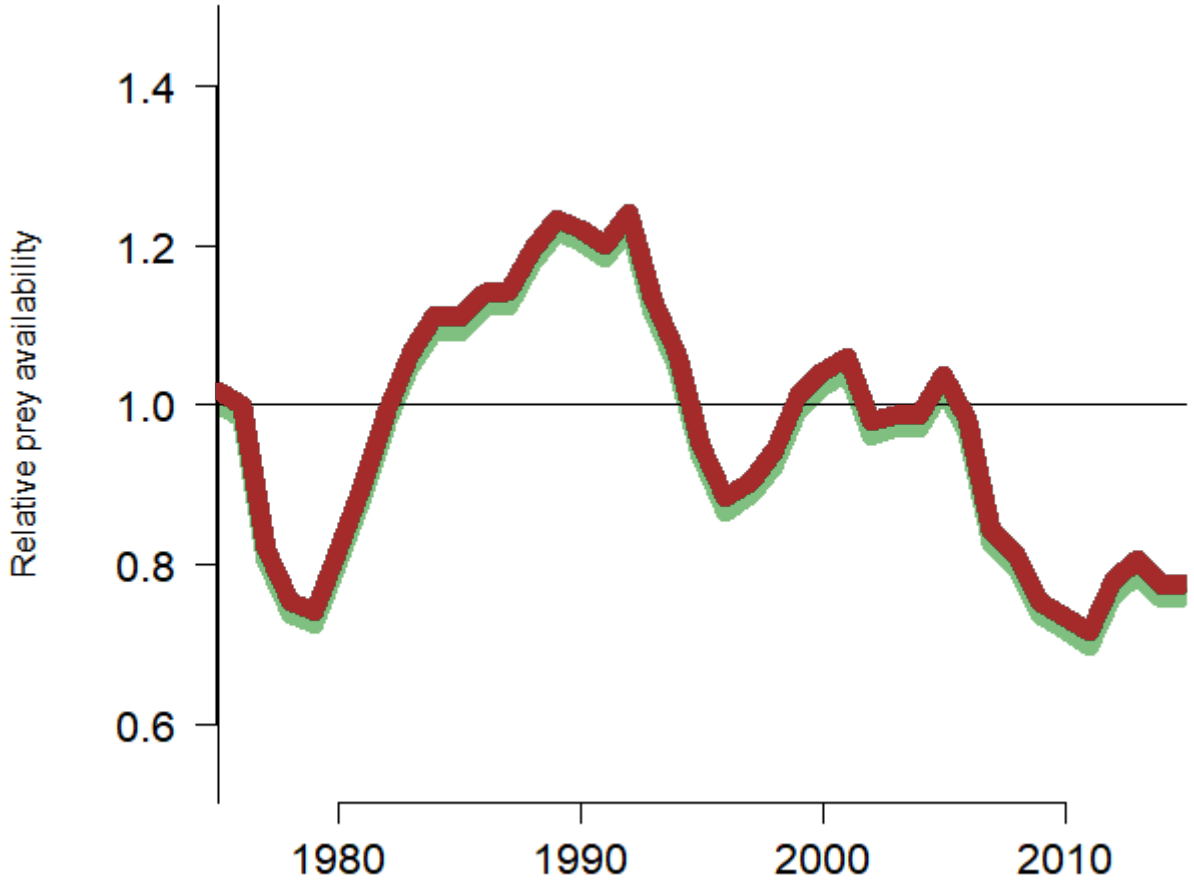


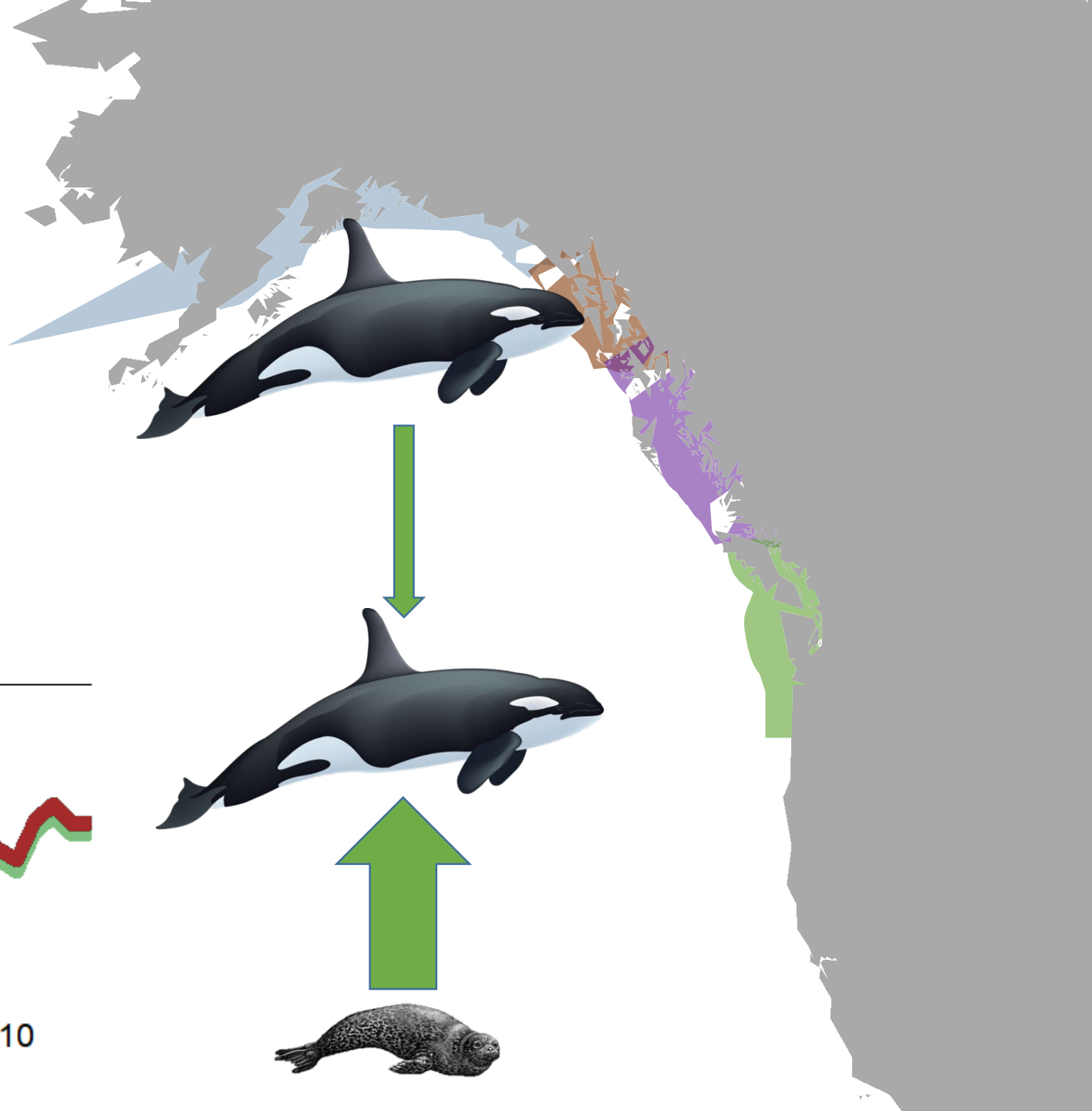
Southern Resident declines?





Southern Resident declines?





Conclusions

- Marine mammal consumption of salmon is likely increasing.
- Comparative estimates (e.g., Columbia River).
- Mortality –additive or compensatory?
- Abundances. Diet data. Size selectivity data.
- Feedback loop / fitting to catch and escapement data.
- Ocean survival.