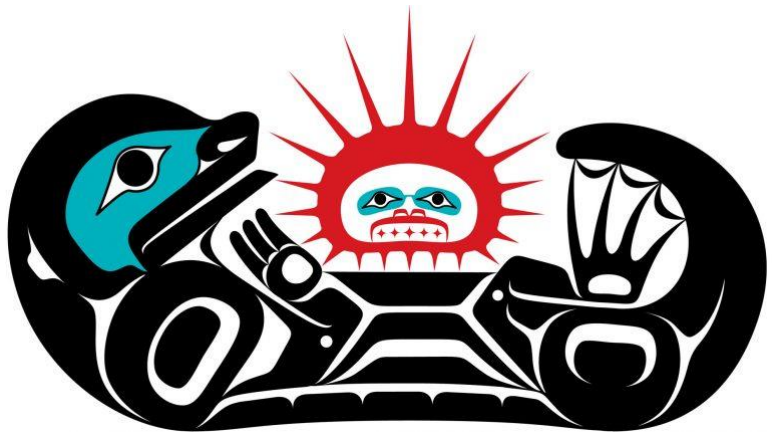
Sequential megafaunal collapse: “unsettled science”

EFB 370: Supplementary Lecture

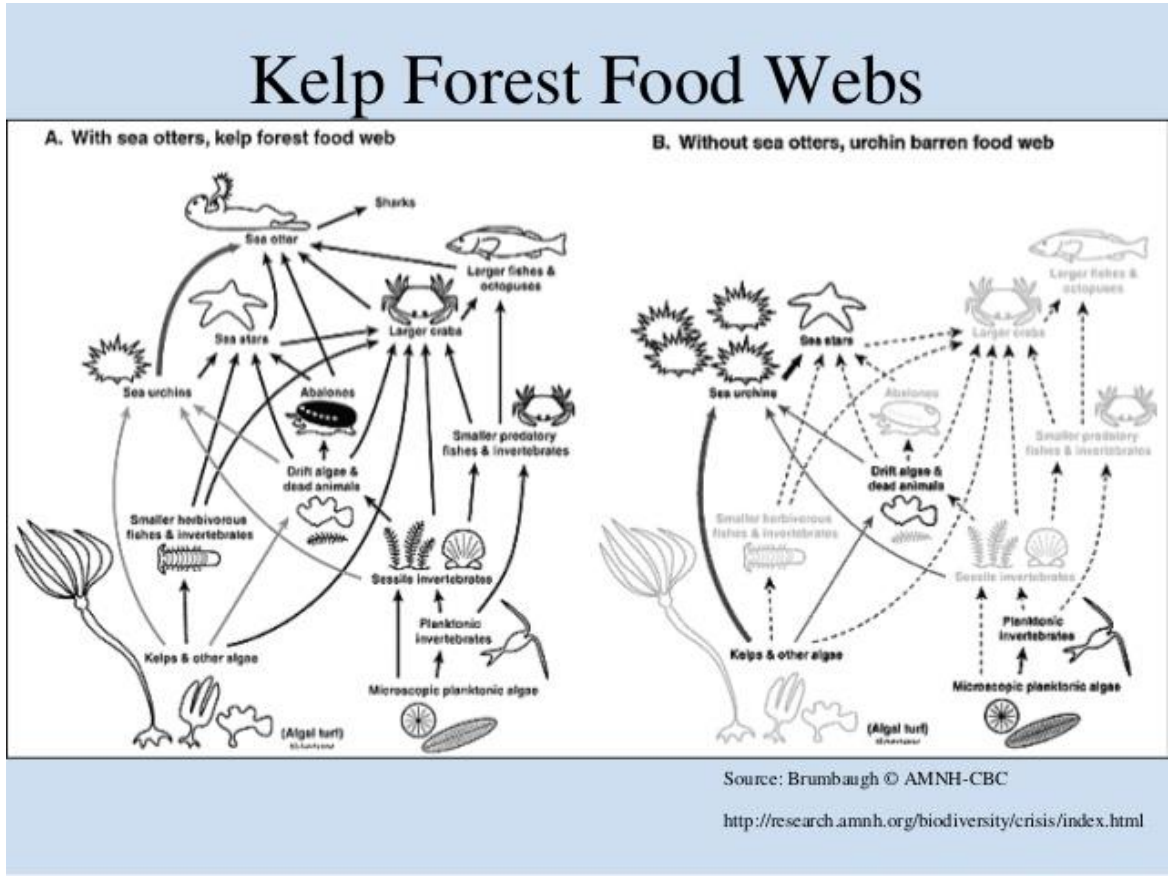
April 27, 2022



Kelp Worlds, Part I-A: Trophic Cascade

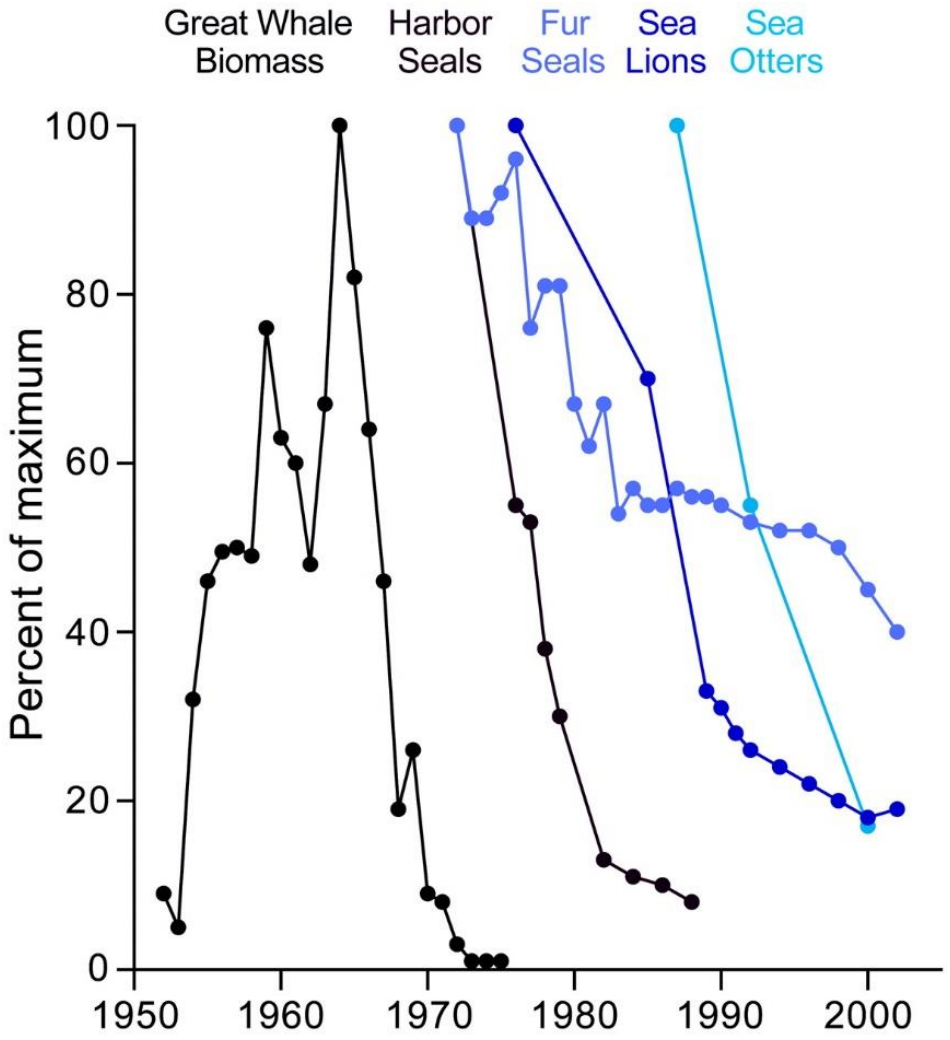
Jim Estes and the Aleutian sea otter

https://www.pbs.org/video/scientist-profile-jim-estes-bsdy4v/



Kelp Worlds, Part I-B:
Sequential megafaunal collapse

Observation:



We propose that decimation of the great whales by post-World War II industrial whaling caused the great whales' foremost natural predators, killer whales, to begin feeding more intensively on the smaller marine mammals, thus “fishing-down” this element of the marine food web.

Springer, Estes et al. 2003

Bioenergetic model:

6 killer whales can eat ALL the sea otters.

Williams et al. 2004

Controversy ….

And this is where his work went from being provocative to being… downright controversial…

… I won't go into all the details of the controversy because I think they say more about the scientific community than they do about actual science.

Adam Huggins

Controversy …

Sequential megafaunal collapse in the North Pacific **Ocean**: An ongoing legacy of industrial **whaling**?
AM Springer, JA Estes, GB Van Vliet... - Proceedings of the ..., 2003 - National Acad Sciences
... Increased predation by **killer whales** probably drove the **sea otter** collapse and may have been responsible for the earlier pinniped declines as well. We propose that decimation of the ...
☆ Save 99 Cite Cited by 636 Related articles All 32 versions »

[HTML] The **sequential megafaunal collapse** hypothesis: testing with existing data
DP DeMaster, AW Trites, P Clapham, S Mizroch... - Progress in ..., 2006 - Elsevier
... arguments, for predation by **killer whales** to have been an important factor in the declines of one or more of the three populations of pinnipeds and the **sea otter** population in the BSAI ...
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Killer whales, **whaling**, and **sequential megafaunal collapse** in the North Pacific: a comparative analysis of the dynamics of marine mammals in Alaska and British ...
AW Trites, VB Deecke, EJ Gregr... - Marine mammal ..., 2007 - Wiley Online Library
... **whaling** caused a **sequential megafaunal collapse** in the North Pacific **Ocean** by forcing **killer whales** ... models of **killer whale** predation on **sea** lions and **sea otters** have shown how just a ...
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[PDF] Mammal-eating **killer whales**, industrial **whaling**, and the **sequential megafaunal collapse** in the North Pacific **Ocean**: A reply to critics of Springer *et al*. 2003
AM Springer, JA Estes, GB Van Vliet... - Marine Mammal ..., 2008 - researchgate.net
... (transient) **killer whales**; that industrial **whaling** perturbed this ... of **killer whales**; and that this perturbation caused **killer whales** to ... of pinnipeds and **sea otters**, which **killer whales** turned to, ...
☆ Save 99 Cite Cited by 68 Related articles All 11 versions »

Mammal-eating **killer whales** and their prey—trend data for pinnipeds and **sea otters** in the North Pacific **Ocean** do not support the **sequential megafaunal collapse** ...
PR Wade, JM Ver Hoef... - Marine Mammal Science, 2009 - Wiley Online Library
... The lower panel shows the proportion of effort **killer whales** ... of a simultaneous decline of **whales**, pinnipeds, and **sea otters**); ... specialization and switching by **killer whales**. This creates ...
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Killer whales and marine mammal trends in the North Pacific—a re-examination of evidence for sequential megafauna collapse and the prey-switching hypothesis
PR Wade, VN Burkanov, ME Dahlheim... - Marine Mammal ..., 2007 - Wiley Online Library
... With the sole exception that the **sea otter** decline ... that a **sequential megafaunal collapse** from **whales** to **sea otters** occurred. The spatial and temporal patterns of pinniped and **sea otter** ...
☆ Save 99 Cite Cited by 83 Related articles All 20 versions

Trend data *do* support the sequential nature of pinniped and **sea otter** declines in the North Pacific **Ocean**, *but* does it really matter?
JA Estes, DF Doak, AM Springer... - Marine mammal ..., 2009 - Wiley Online Library
... The **Sequential Megafaunal Collapse** Hypothesis (SMCH) ... The **killer whales** subsequently broadened their diets to ... harbor seals, Steller **sea** lions, fur seals, and **sea otters**—driving them ...
☆ Save 99 Cite Cited by 9 Related articles All 12 versions

Have North Pacific **killer whales** switched prey species in response to depletion of the great **whale** populations?
SA Mizroch, DW Rice - Marine Ecology Progress Series, 2006 - int-res.com
... of seals, **sea** lions and **sea otters** in the northern North Pacific **Ocean** and Bering **Sea** because of increased predation by **killer whales** Orcinus **orca**. They asserted that mammal-eating ...
☆ Save 99 Cite Cited by 71 Related articles All 11 versions

Killer whales and **whaling**: the scavenging hypothesis
H Whitehead, R Reeves - Biology Letters, 2005 - royalsocietypublishing.org
... , living large **whales**, small cetaceans and **sea otters** more frequently. **Killer whales** have ... 2003 **Sequential megafaunal collapse** in the North Pacific **Ocean**: a legacy of industrial ...
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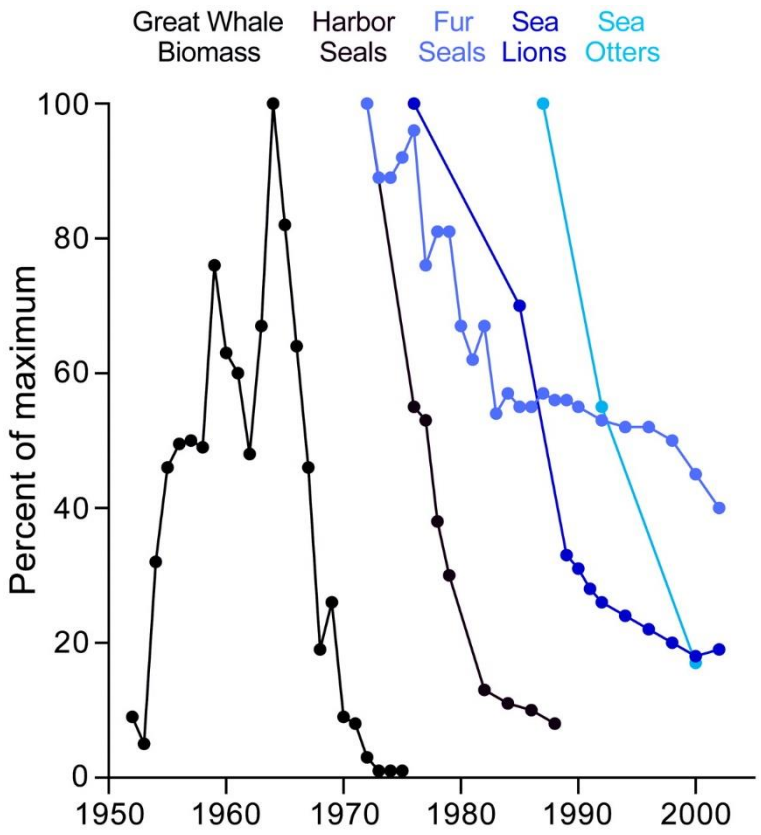
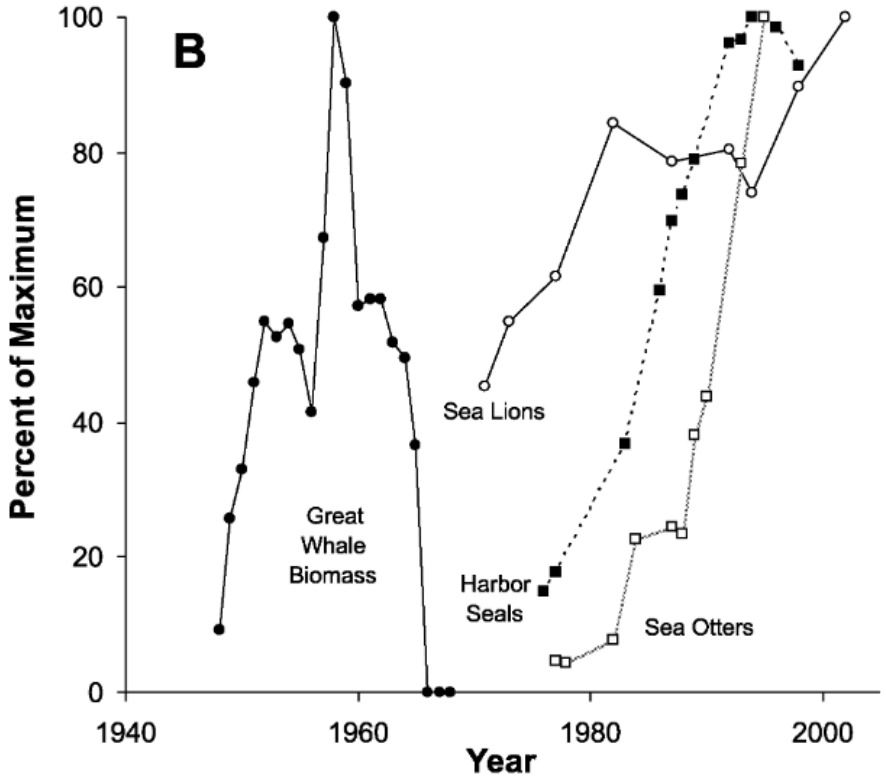
One counter-argument:

Exact opposite trends observed in British Columbia coast. (*Trites et al. 2006*)

Aleutian Islands



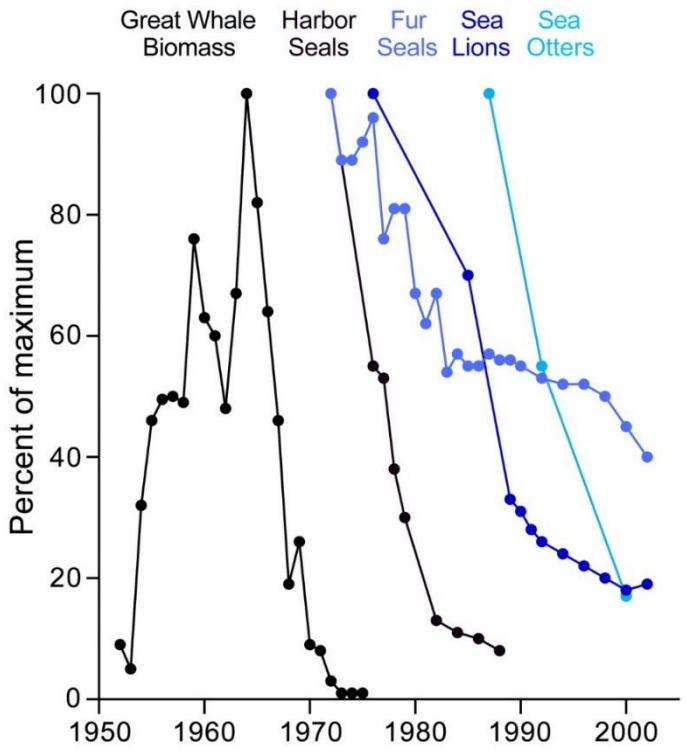
BC coast



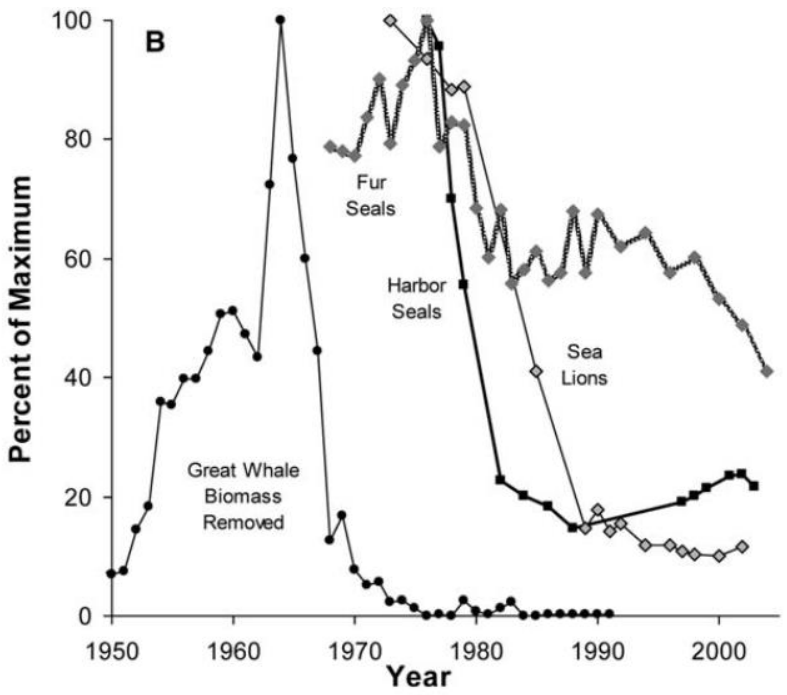
Another counter argument ....

Not *actually* sequential. If you estimate parameters (with confidence intervals), there is no statistical difference in most of the curves. Also, why Steller sea lions later than harbor seals or fur seals?

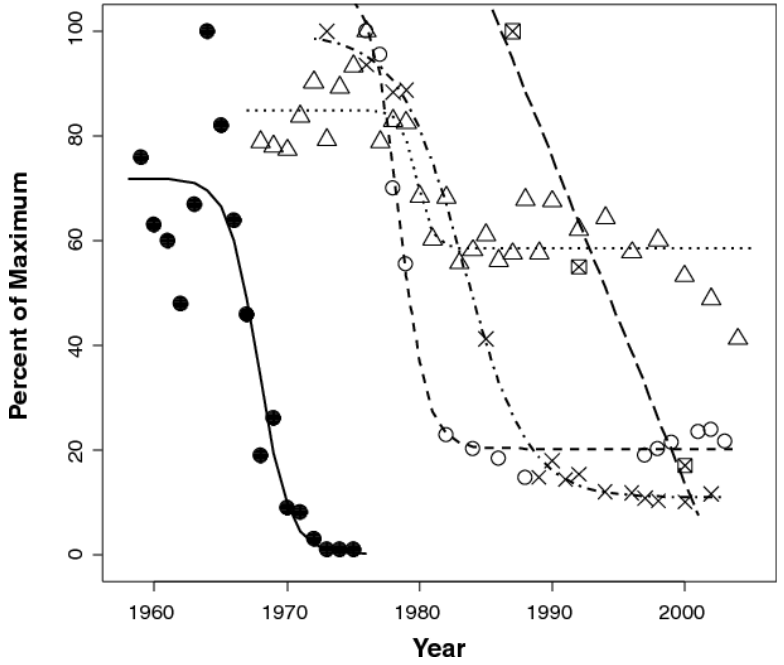
Springer data



Same data rescaled



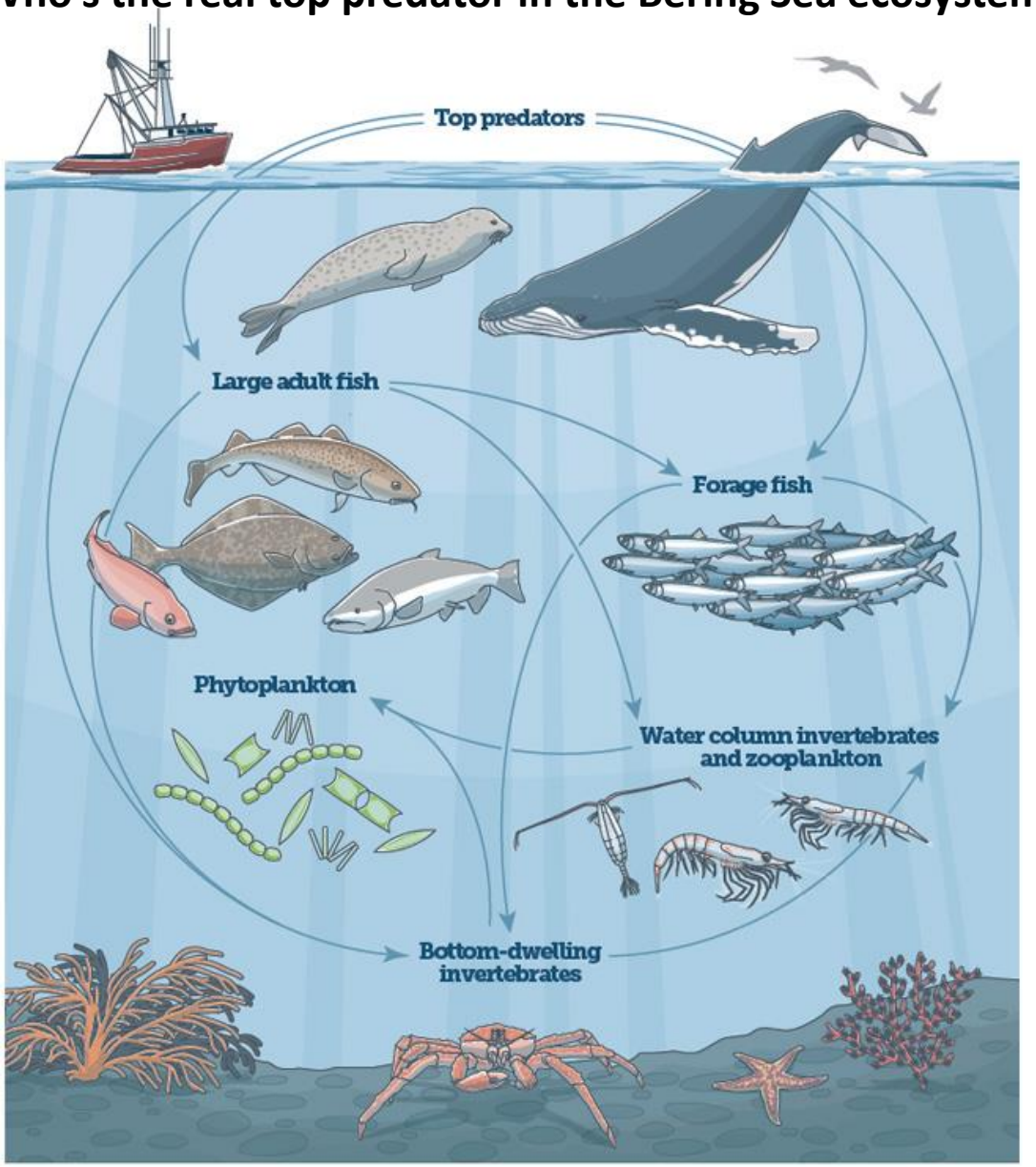
Fitted models



Why do people care?

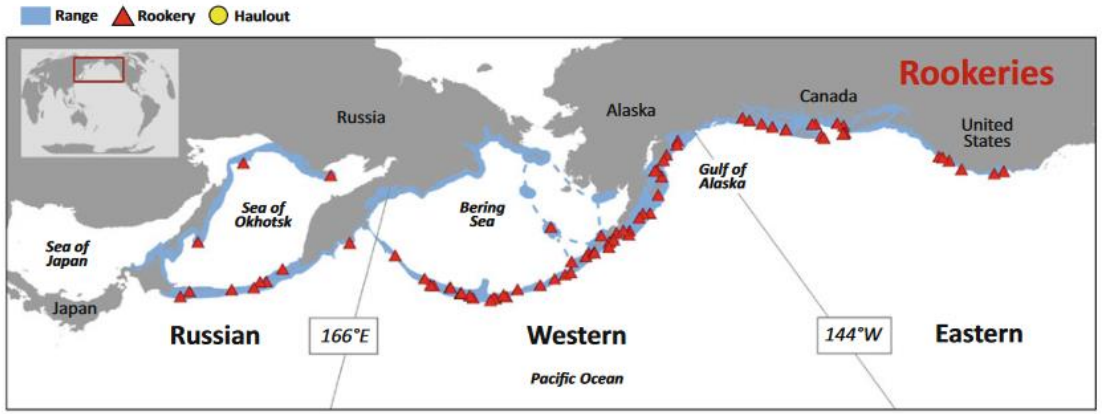
The Bering Sea Food Web

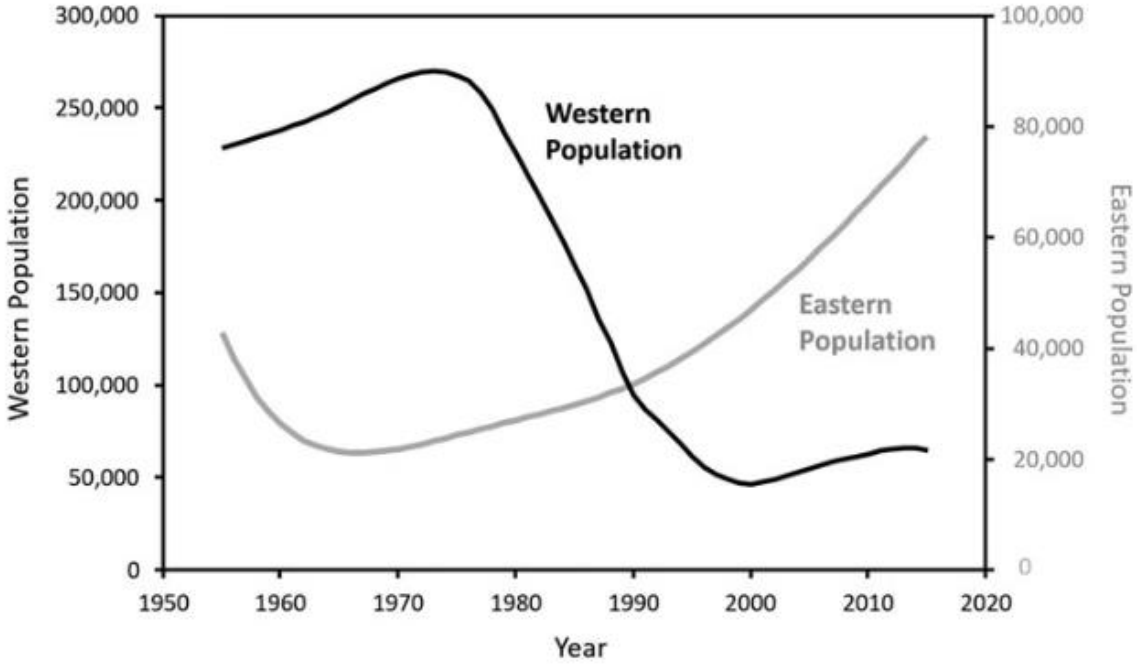
Who's the real top predator in the Bering Sea ecosystem?



Why do I care?

Steller sea lion *(Eumetopias jubatus)*





Why might Dr. Drew care?

Bering Sea: largest fishery in the world

A key hypothesis for Steller Sea Lion decline: **Competition** with fisheries.

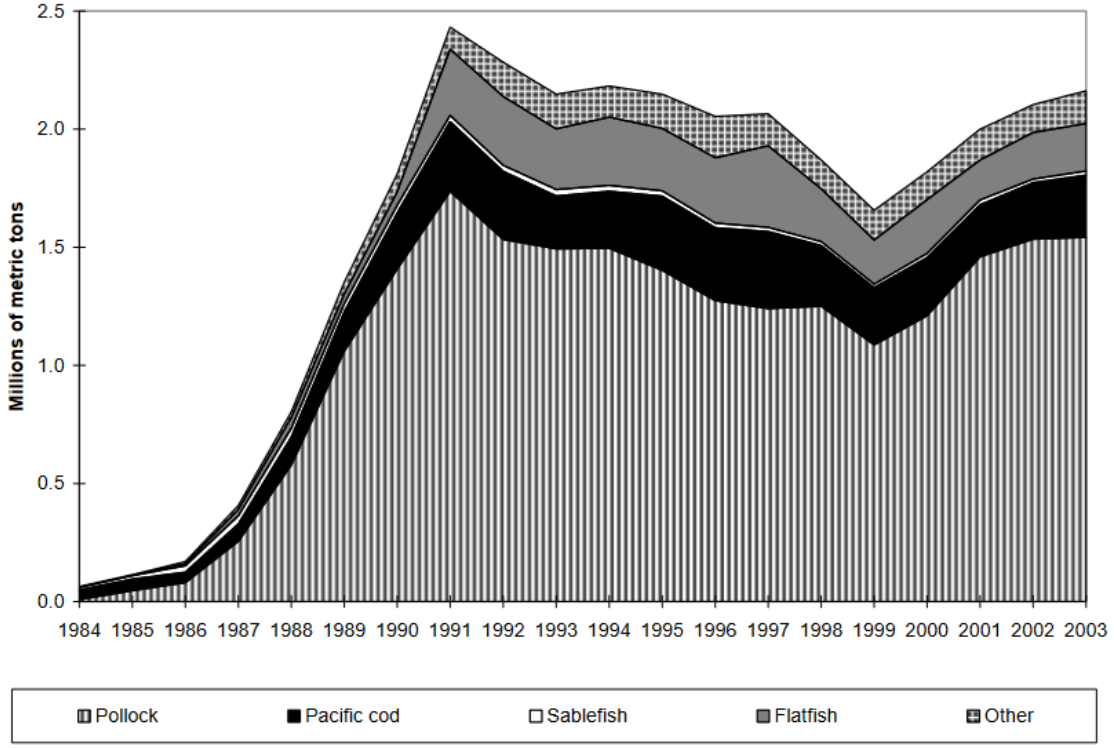
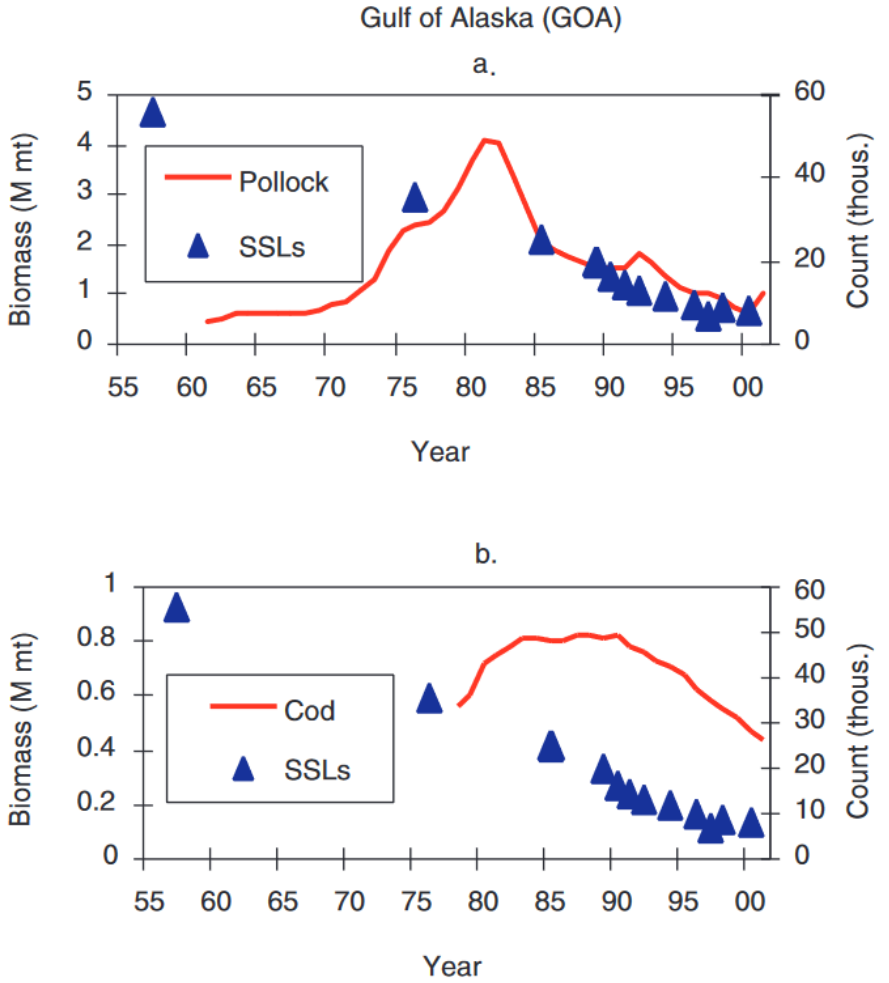


Figure 2. Groundfish catch in the domestic commercial fisheries off Alaska by species, 1984-2003.



Alaska Senator Holds Budget Deal Hostage In Attempt To Undermine Endangered Species Act Protections For Steller Sea Lions (December 2000)

*Angrily pounding his desk on the Senate floor, Mr. Stevens denounced the administration's plan. "**The fishing limits**," he said, "**will put a considerable number of people out of work. Federal control of these magnificent fisheries is not going to be approved by this senator.**"*

Senator Stevens spent much of the day haggling with the Clinton administration over the fate of the Steller sea lion, which breeds in the Gulf of Alaska and the Bering Sea. (New York Times)

Stevens says: scientists unfairly target fishing industry!

Senator Ted Stevens
(1923-2010)

Federal Budget passed on creation of SSLRI

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[Docket No. 00–1220361; I.D. 022801A]

0648–ZB03

Steller Sea Lion Research Initiative (SSLRI)

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

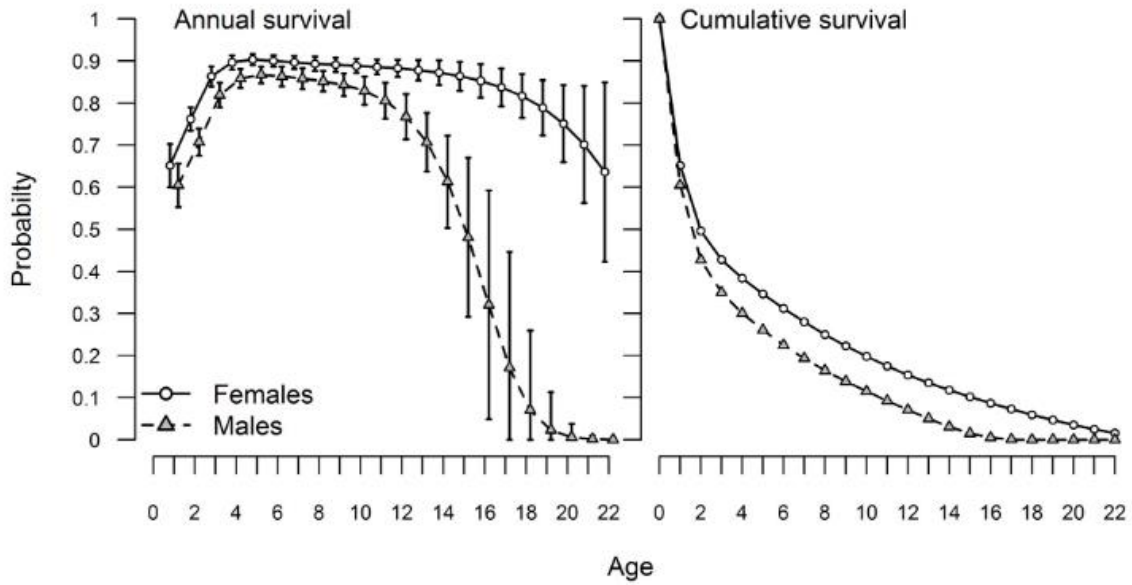
ACTION: Notice of availability of funds.

$20,000,000 is hereby appropriated to the Secretary of Commerce to remain available until expended to develop and implement a coordinated, comprehensive research and recovery program for the Steller sea lion, which shall be designated to study–(1) available prey species; (2) predator/prey relationships; (3) predation by other marine mammals; (4) interactions between fisheries and Steller sea lions, including localized depletion theory; (5) regime shift, climate change, and other impacts associated with changing environmental conditions in the North Pacific and Bering Sea; (6) disease; (7) juvenile and pup survival rates; (8) population counts; (9) nutritional stress; (10) foreign commercial harvest of sea lions outside the exclusive economic zone; (11) the residual impacts of former government-authorized Steller sea lion eradication bounty programs; and (12) the residual impacts of intentional lethal takes of Steller sea lions. Within available funds the Secretary shall implement on a pilot basis innovative non-lethal measures to protect Steller sea lions from marine mammal predators including killer whales.

Ultimately $190,000,000 to study SSL population ecology!
(with a subtle de-emphasis of fisheries impacts)

$190,000,000 (and lots of court cases) later ….

PLOS ONE | Steller Sea Lion Survival Rates in Russia



We know a lot …

- Life history
- Foraging behavior
- Ecology
- Interactions

But we don't know …

WHY!?

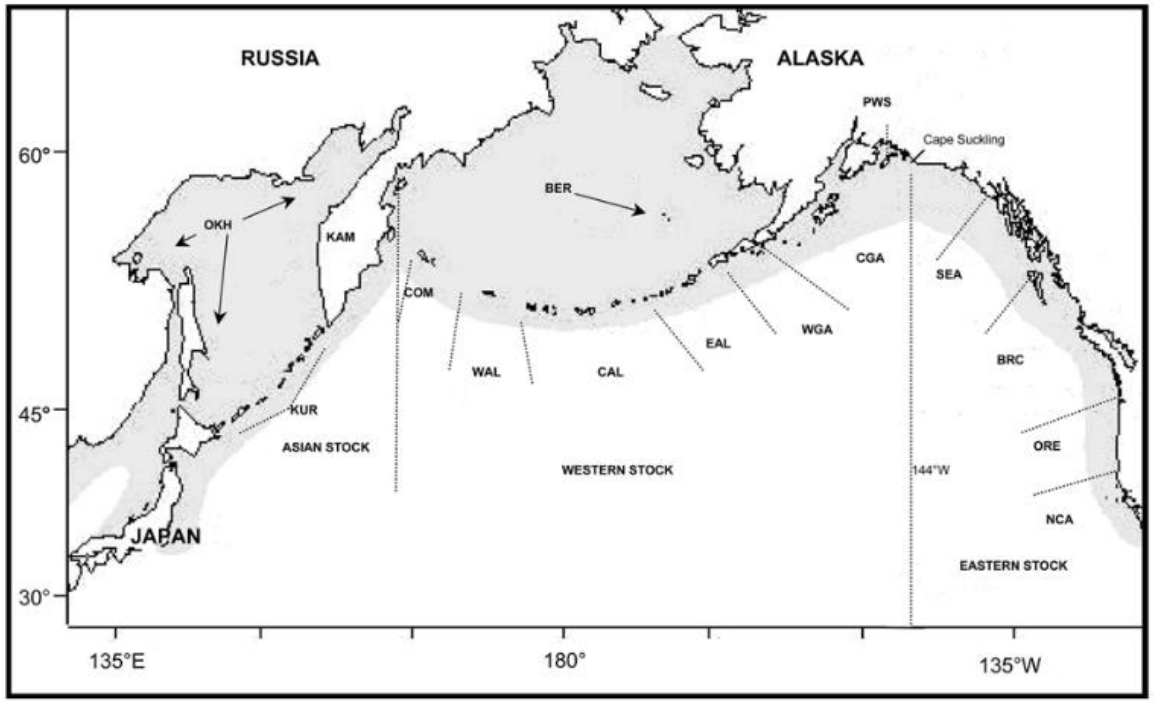
NEWSFOCUS

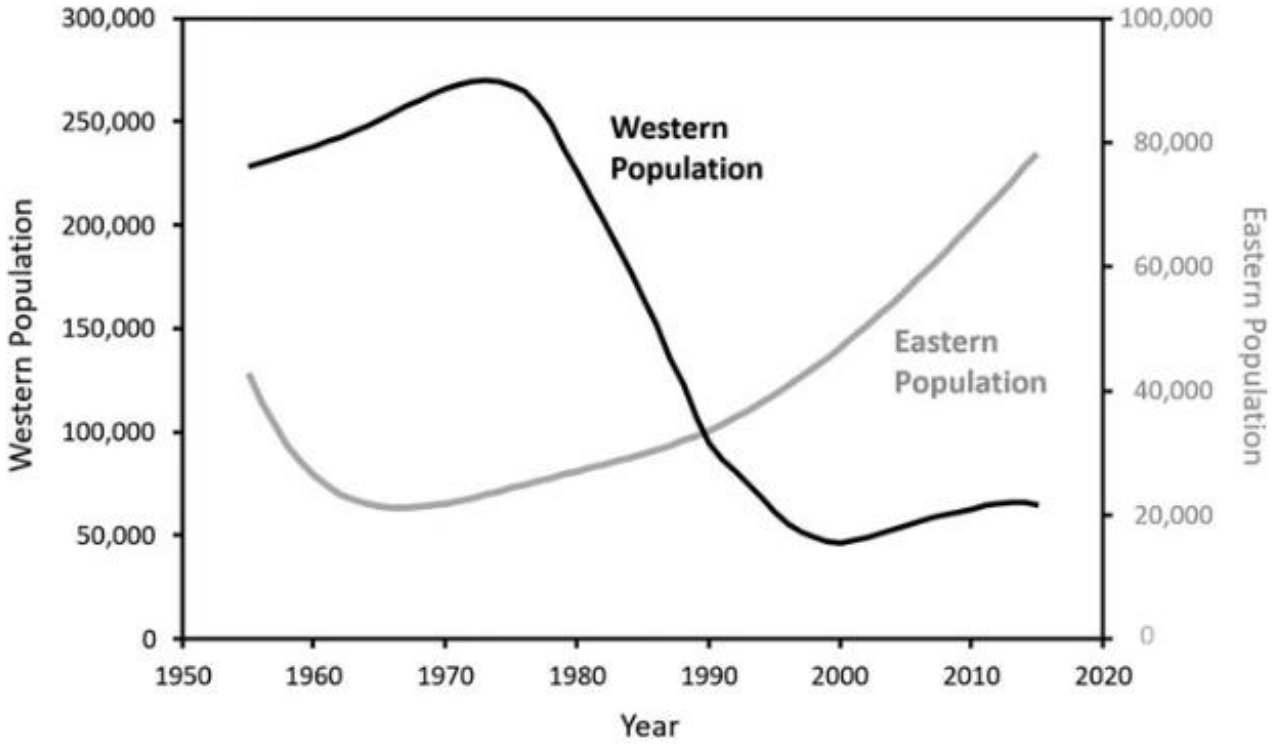
CONSERVATION BIOLOGY

Puzzling Over a Steller Whodunit

What plunged the North Pacific's Steller sea lions into a catastrophic decline, and why are numbers still low? After $190 million worth of research, scientists aren't sure

Was the “Asian Stock” a refuge for the Western Population?





Anyways – some takeaways…

In ecology, simple stories are Sexy (and *Science*-worthy) but nearly always incomplete. Complexity is the NORM.

- SSL & sea otter declines / recoveries are almost certainly controlled by a mixture of bottom-up and top-down and sideways forces

But … there (can be) benefit in the back and forth that emerges from controversy and debate

(thesis / antithesis / synthesis).

Ecology (as a science and in practice) never occurs in a vacuum!

- *Politics | Money | Society | Values | History| Individual egos*

It is important to be aware of the **context**, the **assumptions**, and even the **consequences**.