Impacts of whale population recovery on pelagic ecosystems of the subarctic Pacific

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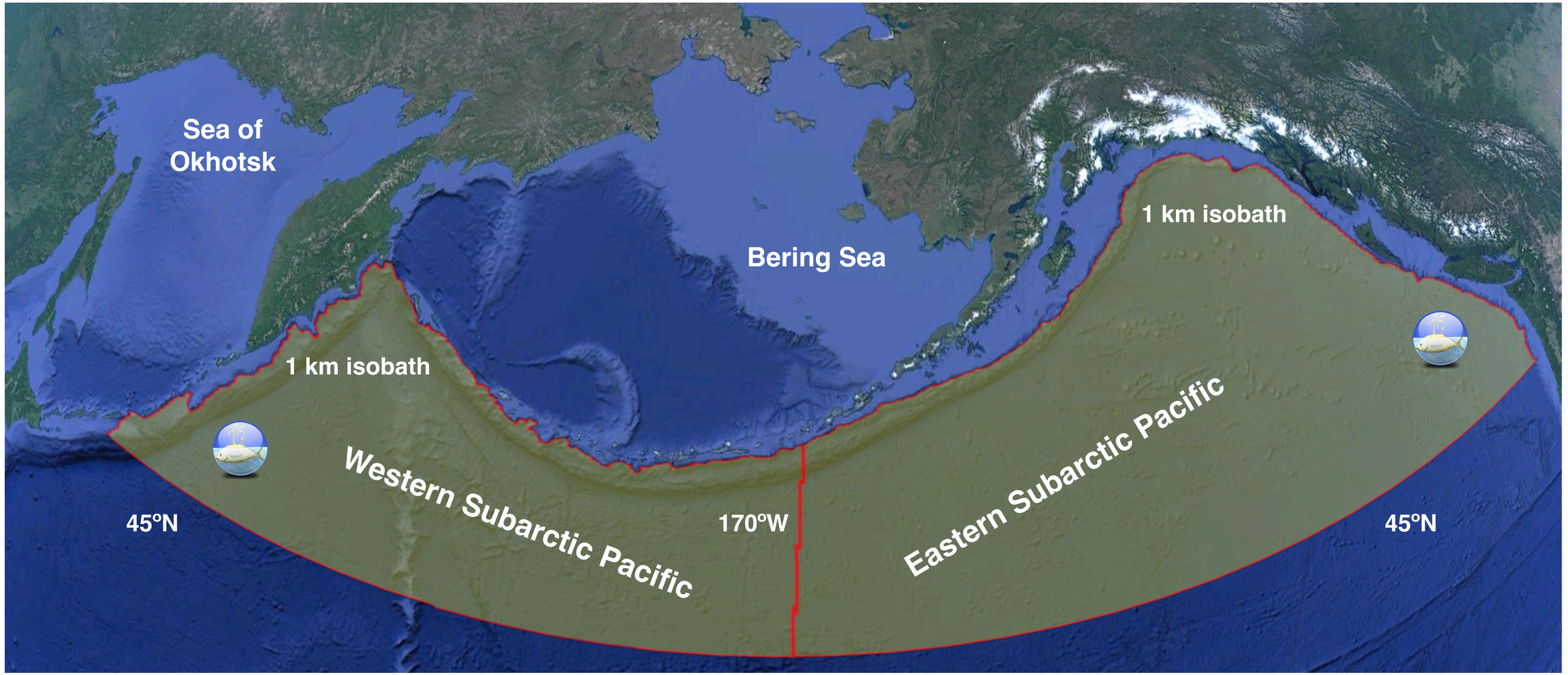
Introduction

- North Pacific whale populations depleted by heavy commercial whaling
- many of these populations are now recovering from historical depletion
- as large mammals, whales exhibit substantial prey consumption rates
- thus, consumption by recovering whales could impact prey biomasses

Research question

- how did, does, and will whale population recovery impact subarctic Pacific ecosystem structure and dynamics?

Study area


Sea of
Okhotsk
Bering Sea
1 km isobath
1 km isobath
Western Subarctic Pacific
Eastern Subarctic Pacific
45°N
170°W
45°N

Surplus production models

- species-specific (fin, sei, and sperm whales)
- published recent abundance estimates (*N*) for North Pacific populations
- published carrying capacities (*K*): North Pacific (fin, sei), global (sperm)
- published population rates of increase (*r*): 0.04 (fin, sei), 0.0096 (sperm)
- exponent *z* = 11.2 (fin, sei) for more exponential curve (Kanaji et al. 2024)

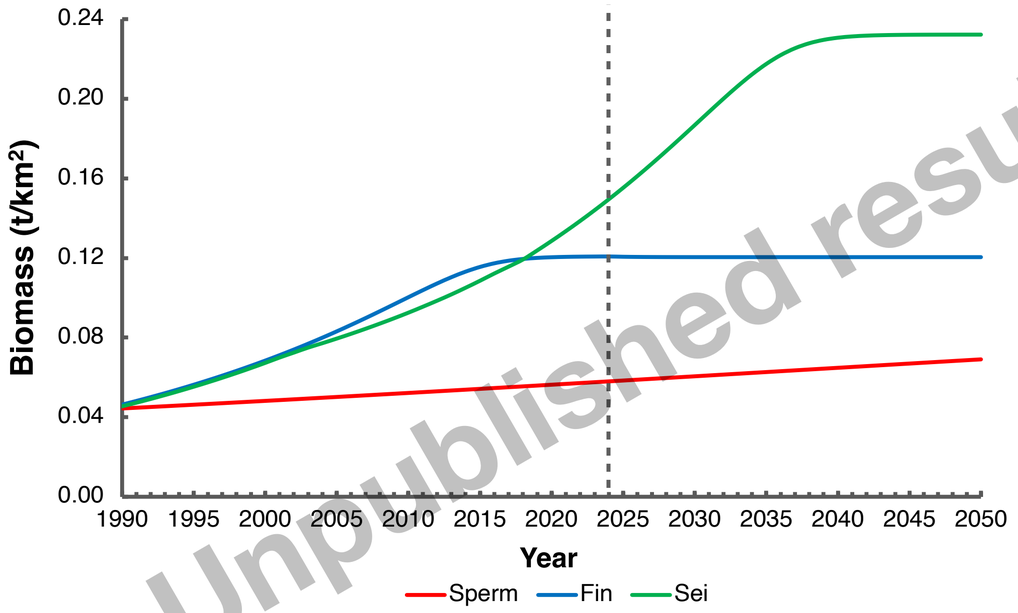
Whaling scenarios

specify future Japanese annual catches in surplus production models

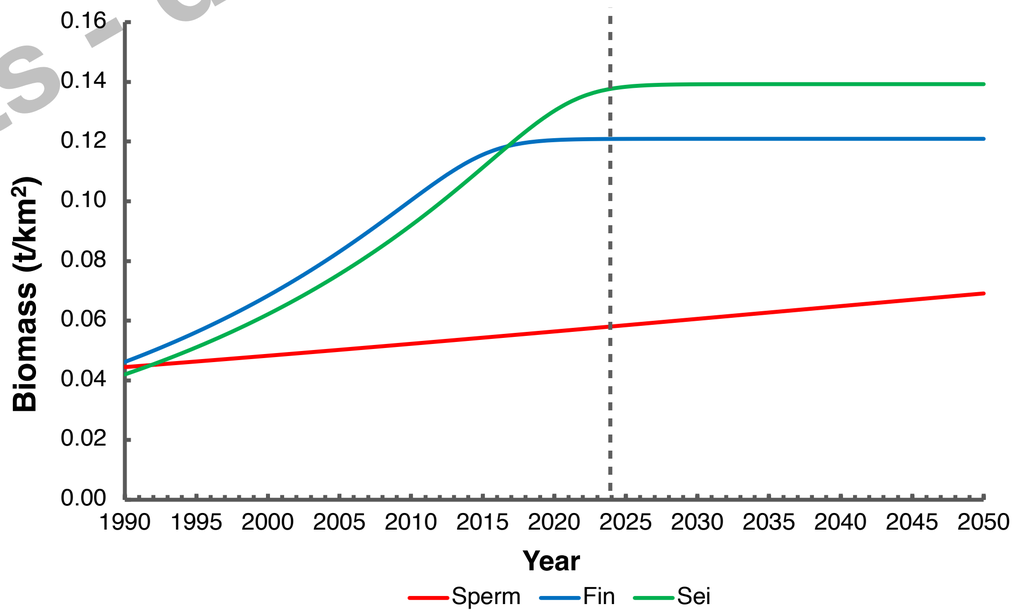
- fin whale: 0, 30, 60, 120 individuals caught annually (current quota: 59)
- sei whale (W Pacific): 0, 12, 25, 50 individuals / year (current quota: 25)

Whale recovery trajectories

Western subarctic Pacific



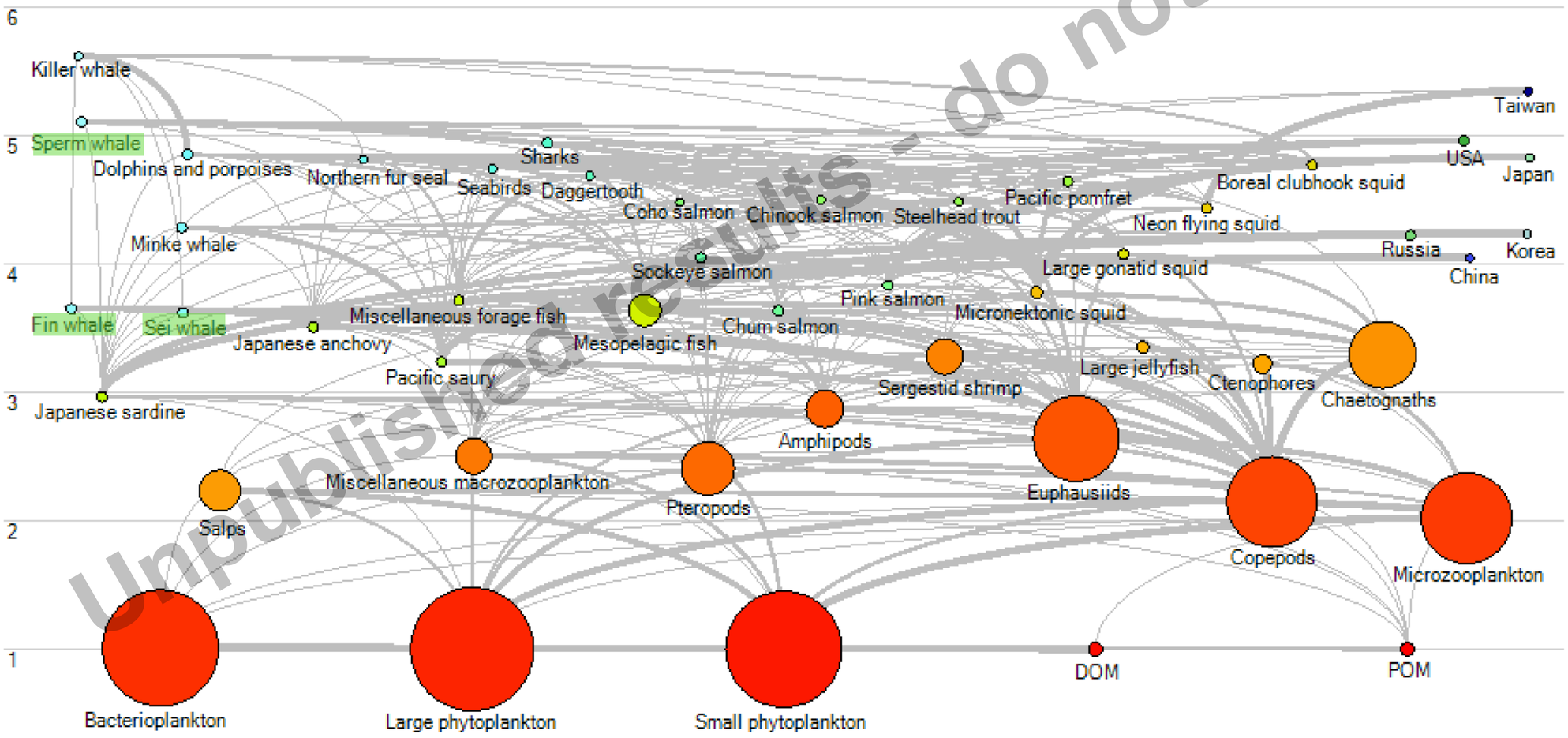
Eastern subarctic Pacific



Ecosystem models

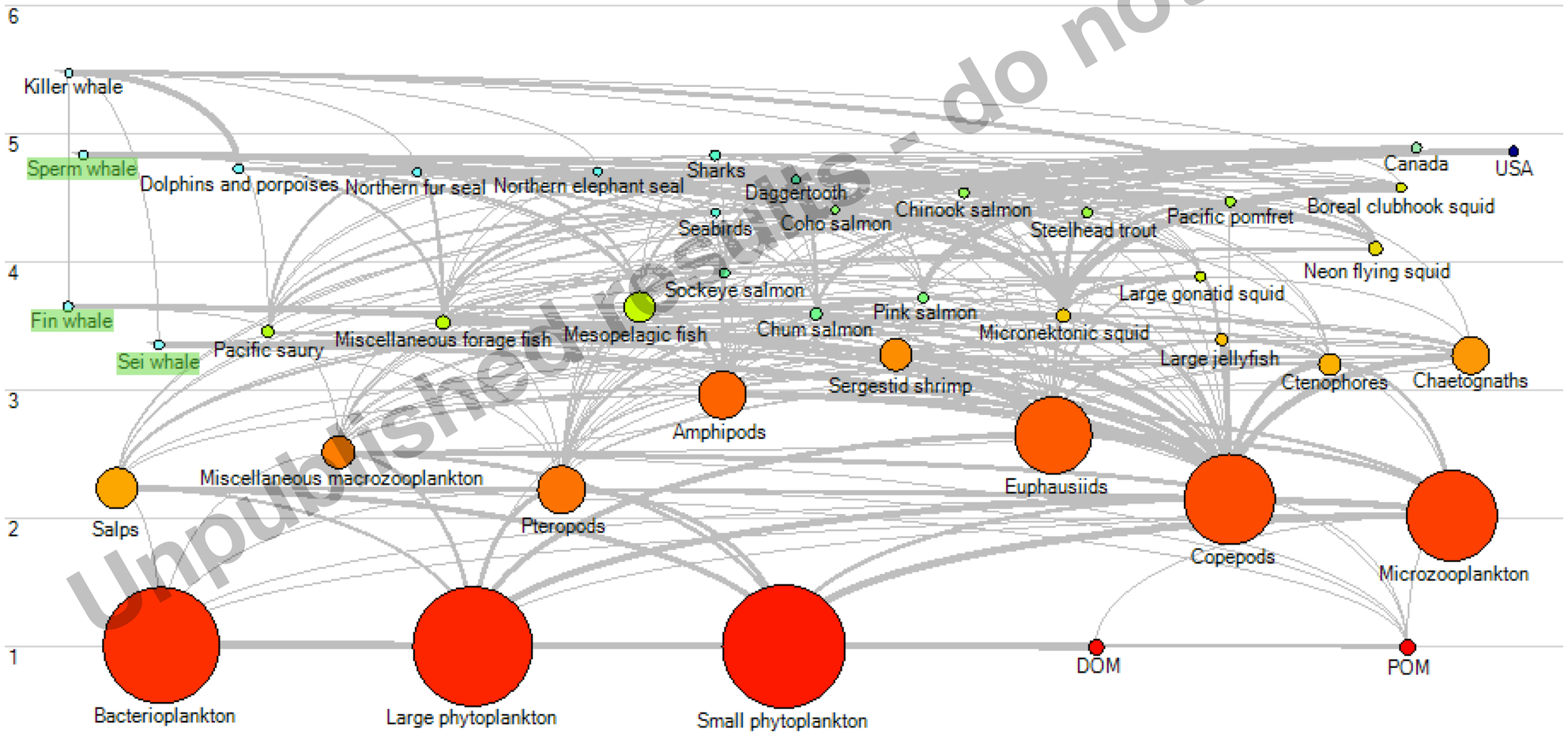
- Ecopath with Ecosim
- basic principle: mass balance (1st & 2nd laws of thermodynamics)
- Ecopath: static snapshots (early 1990s)
- Ecosim: dynamic simulations (1990-2050)

Western subarctic Pacific



Based on Aydin et al. (2003) - summer 1990s

Eastern subarctic Pacific



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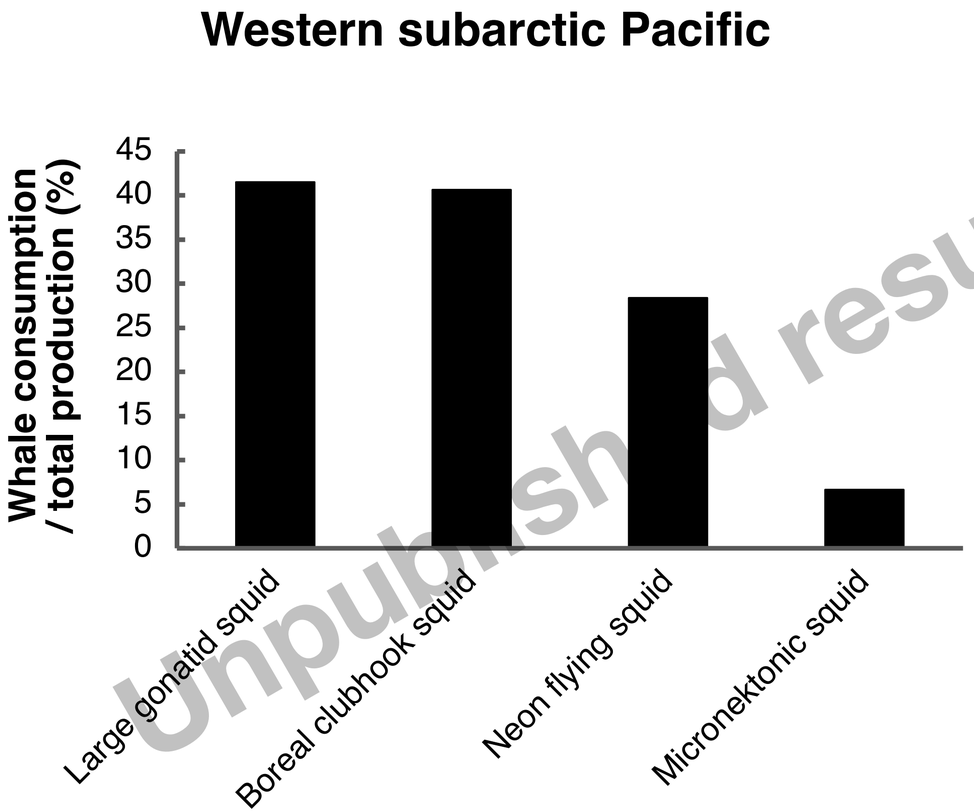
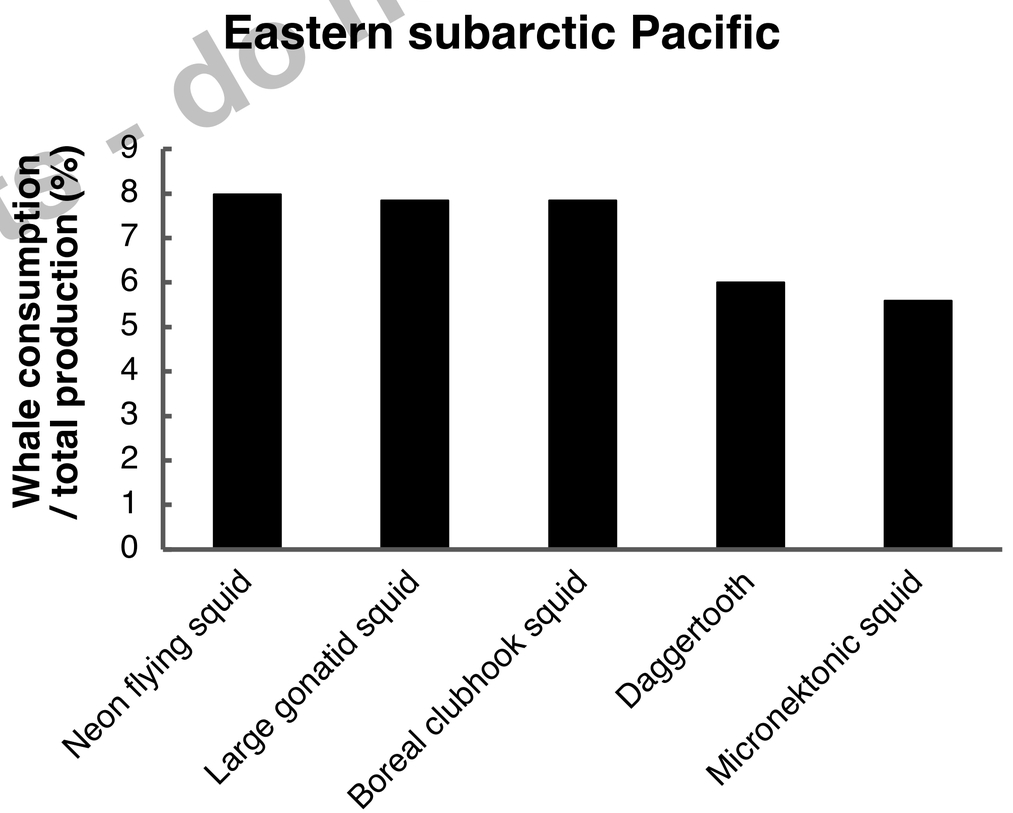
Prey consumption

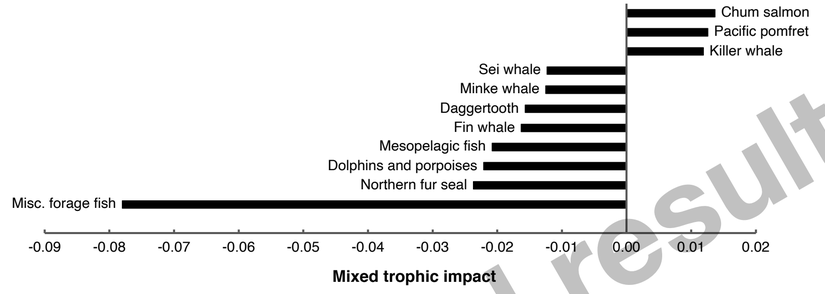




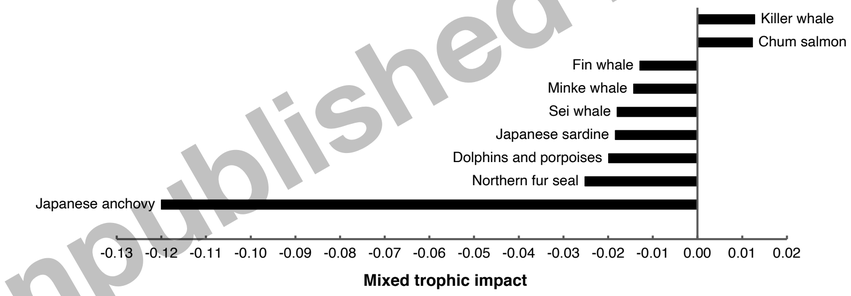
Mixed trophic impacts

Western subarctic Pacific

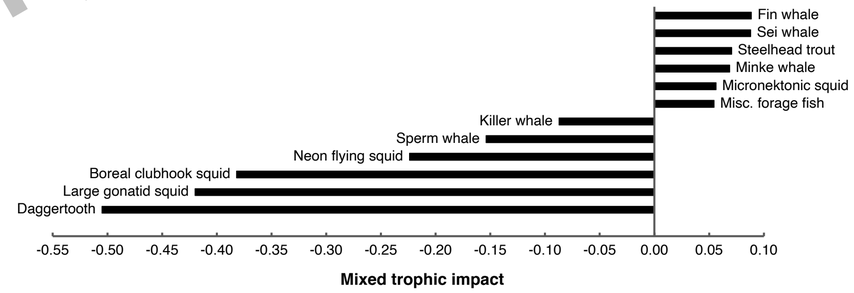
Fin



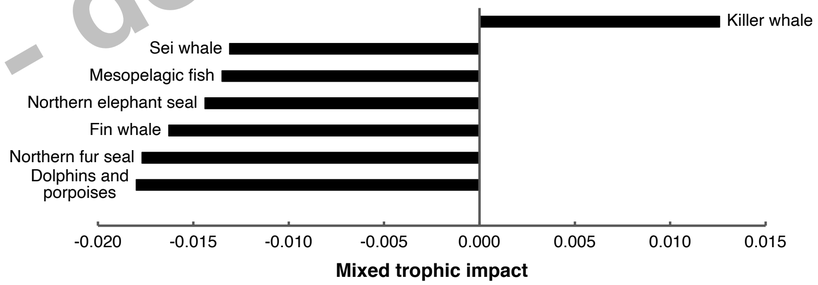
Sei

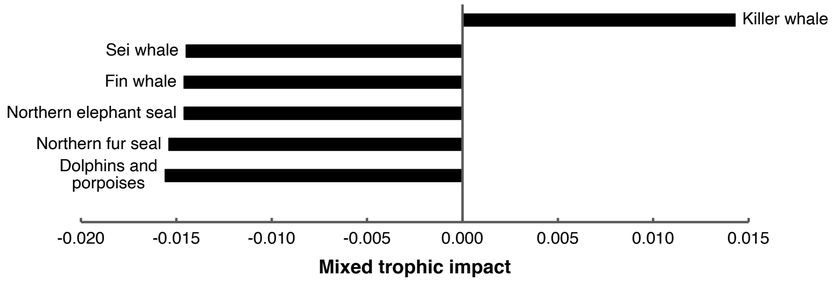


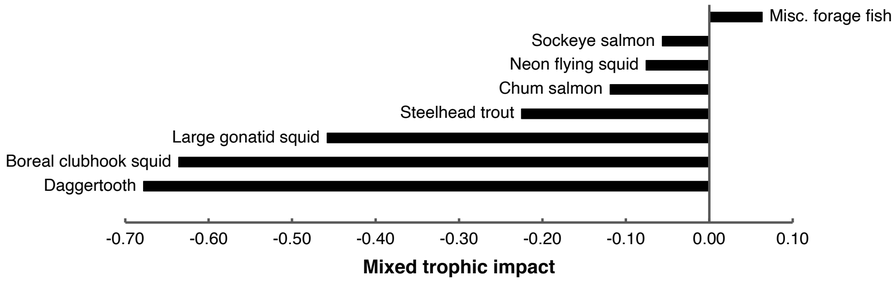
Sperm



Eastern subarctic Pacific

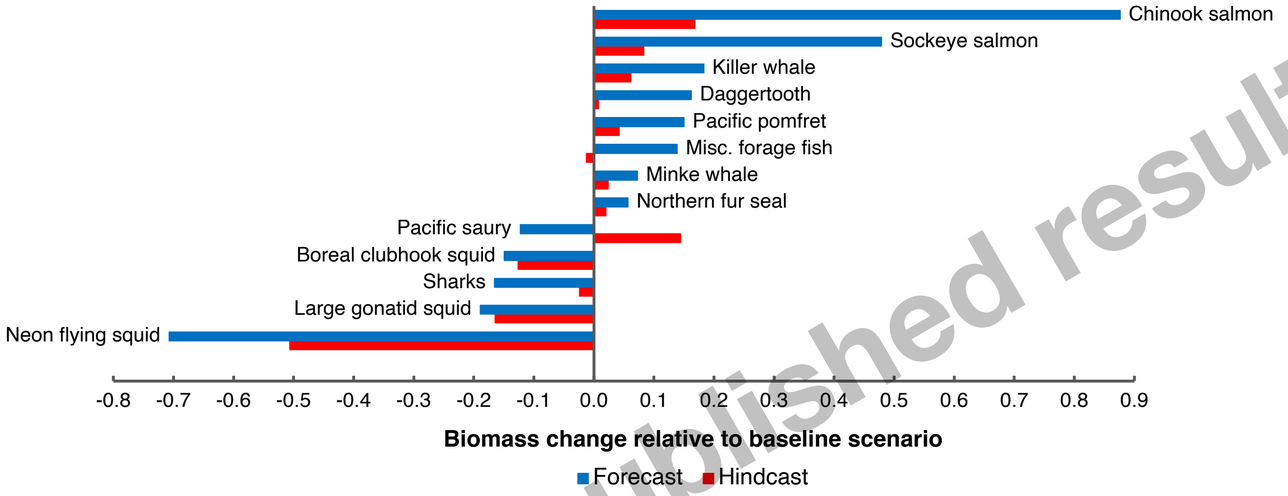




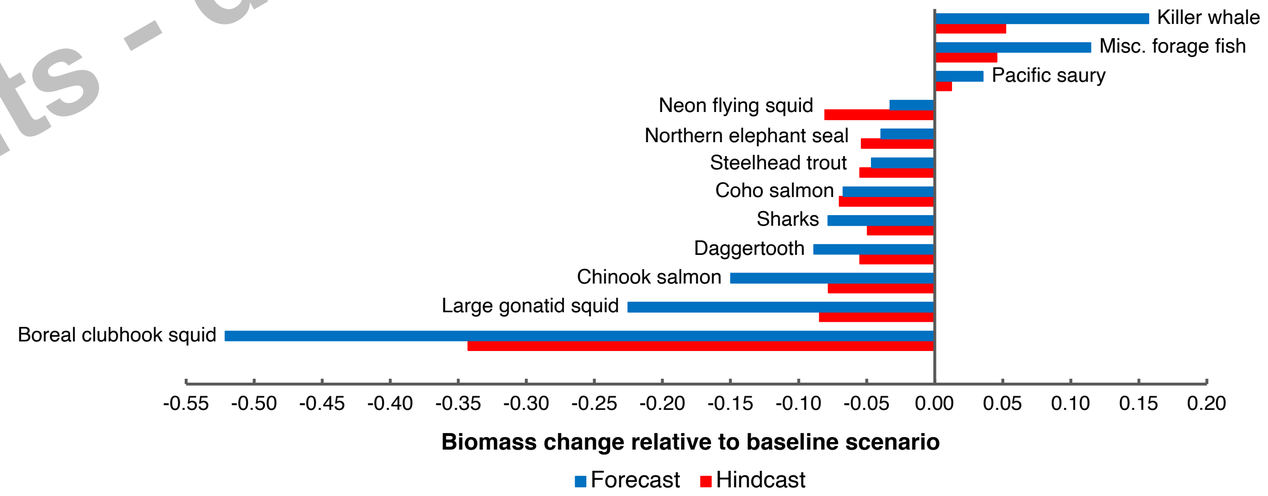


Recovery impacts - all whales

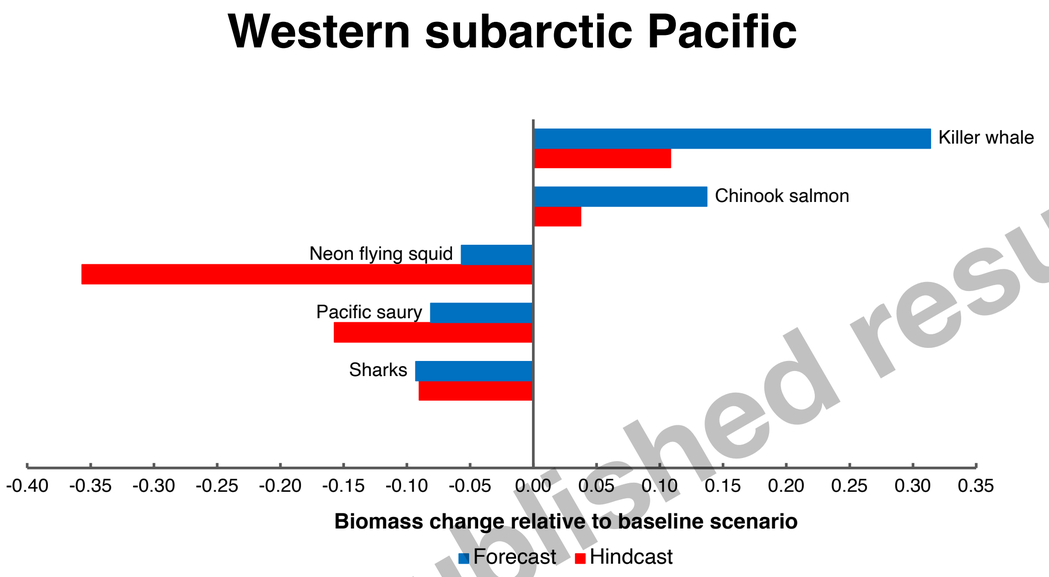
Western subarctic Pacific

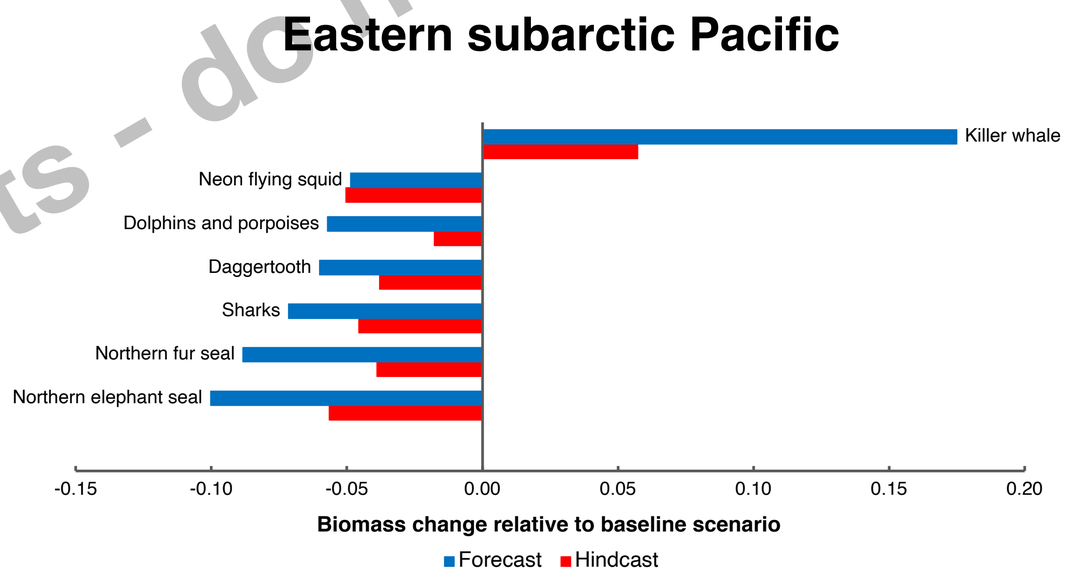


Eastern subarctic Pacific



Recovery impacts - baleen whales





Conclusions

- fin whales largely recovered, sei still recovering in western subarctic
- sperm whales consume notable proportions of annual prey production
- whales exert direct and indirect trophic impacts on many consumers
- whale recovery has had and will have notable impacts on food webs
- these impacts were and will be stronger in the western subarctic Pacific
- sperm whales are likely a keystone species in the subarctic Pacific

Acknowledgements


Thank you!
Mahalo