Ecological interactions between forage fish, rorquals, and fisheries in Haida Gwaii

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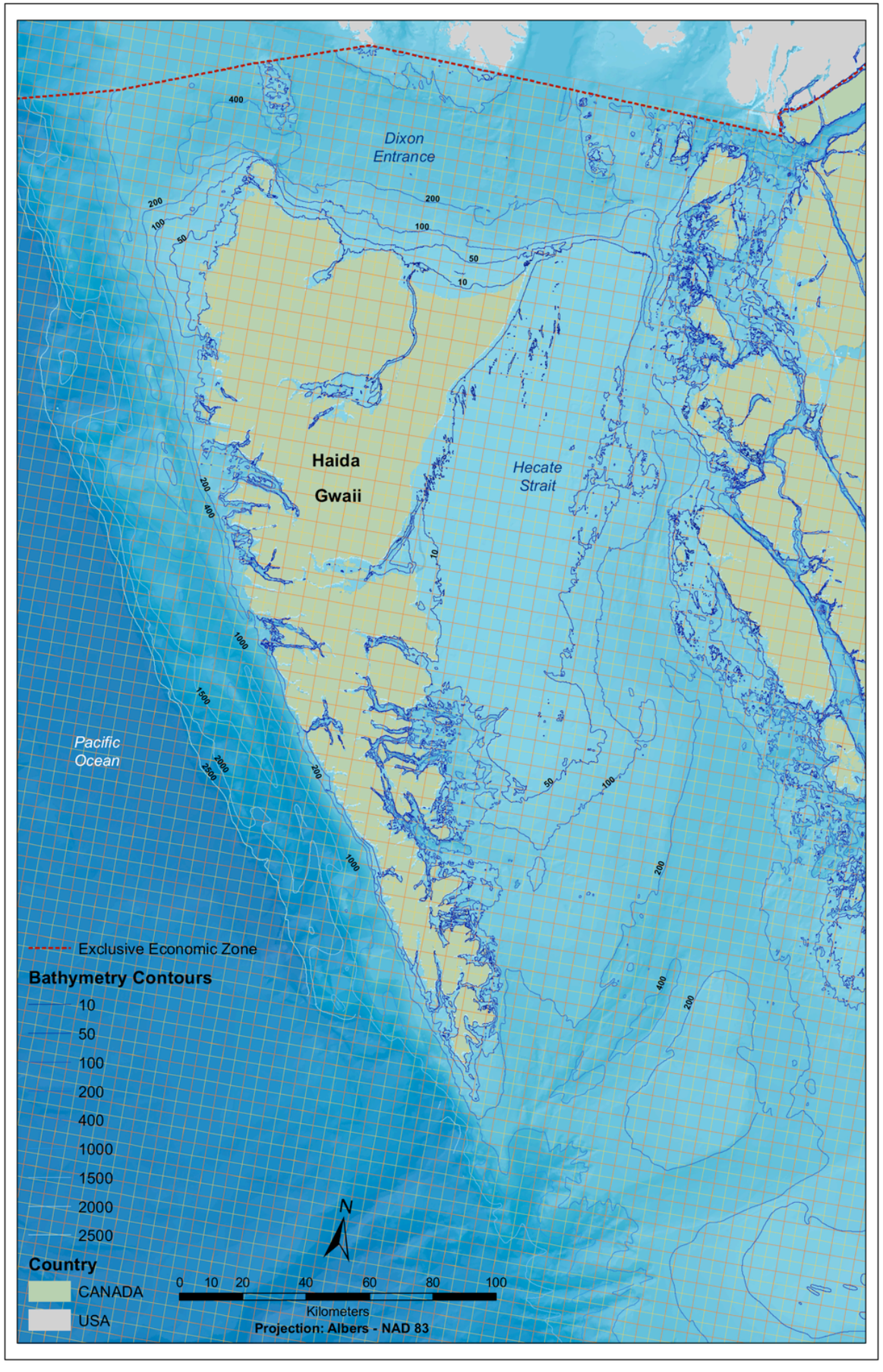
The problem

- rorquals: lunge-feeding baleen whales
- eat large quantities of krill and forage fish
- once very abundant in Northeast Pacific
- severely depleted by commercial whaling
- how would recovery affect ecosystems?

Study area: Haida Gwaii



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Forage fish in Haida Gwaii

play key role in pelagic food web

- Pacific herring (*Clupea pallasii)*
- Pacific sandlance (*Ammodytes hexapterus)*
- Pacific sardine (*Sardinops sagax)*

Rorqual feeding biology

consume large biomasses of prey due to:

- high metabolic rates
- high individual masses
- low trophic levels

* inference: top-down control possible

Rorquals in Haida Gwaii

species	status	abundance
blue	extremely depleted	<<25
fin	slowly recovering	<<500
sei	ecologically extinct	~2
humpback	recovering	<<1000

Research questions

What effects would the recovery of depleted rorqual populations have:

1) on forage fish populations?

2) on the ecosystem at large?

3) on local fisheries?

Reconstructing abundance

- Schaefer model (logistic growth - catch)
- N_0 back-calculated from N and catches
- catch data from whaling station records
- in all calculations, $N_0 = K$ and $r_{max} = 0.04$

Ecosystem modeling

Ecopath with Ecosim 6:

- Ecopath: static snapshot of food web (mass balance)
- Ecosim: dynamic simulation of food web interactions

Ecopath International R&D Consortium

Modeling rorquals

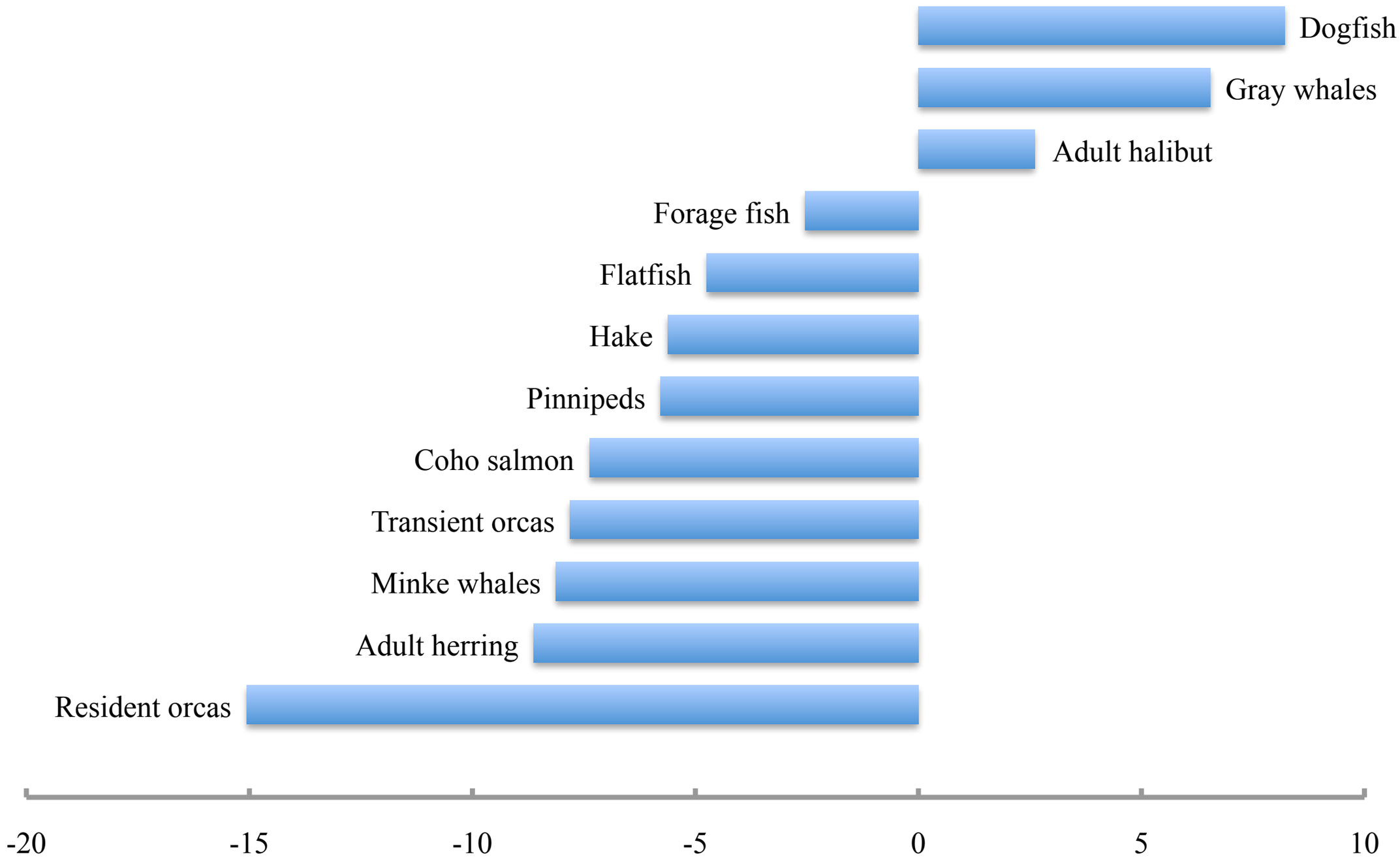
modifications to Northern BC model (2006)

- functional group for each rorqual species
- abundances from DFO surveys, photo-ID
- diets from stomach contents + sightings
- other parameters from published models

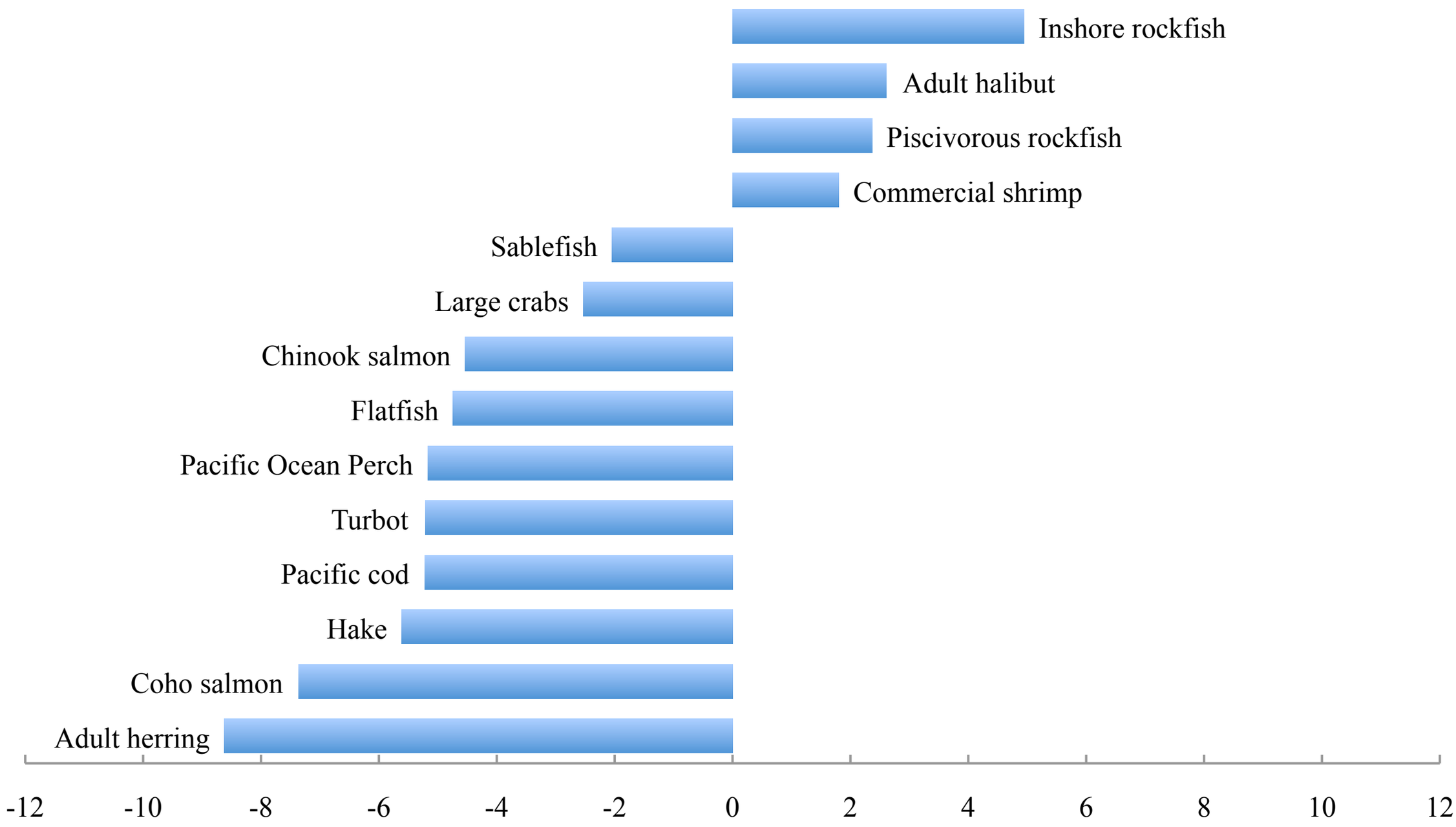
Reconstructed abundance

species	historical (~1910)	current (~2010)	historical / current
blue	~575	<<25	>23
fin	~2590	<<500	>5
sei	~585	~2	~292
humpback	1225	<<1000	>1.2

Effects on ecosystem



Effects on fisheries



Effects by whale species

magnitude of effects depended on % of fish in diet rather than on magnitude of recovery

- humpback whales: strongest effects
- fin whales: effect ~1/2 as strong as above
- blue & sei whales: weaker by factor of 10

Rorquals in the ecosystem

humpback and fin whale recovery may:

- increase predation pressure on forage fish
- intensify competition for forage fish as prey
- reduce prey availability for top predators
- cause trophic cascades in piscivorous fish

such effects unlikely for blue and sei whales

Rorquals and fisheries

humpback and fin whale recovery may:

- reduce yields of forage fish
- affect yields of piscivorous fish (+ or -)

conservation and management actions:

- plans for taxonomic shifts in catches
- ecosystem-based management strategy

Research directions

1) composition of local humpback & fin diet

2) consumption of all prey groups by each

3) EBM strategies for forage fish & fisheries

4) whale feeding grounds vs. fishing grounds

5) interactions with bottom-up forcing

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Questions?