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Effects of Ocean Acidification on Temperate Coastal Marine Ecosystems and Fisheries in the Northeast Pacific

Rowan Haigh[1], Debby Ianson[2,3], Carrie Holt[1], Holly Neate[1,3] & Andrew Edwards[1]

[1]Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, British Columbia, Canada.
[2]Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, British Columbia, Canada.
[3]School of Earth and Ocean Sciences, University of Victoria, Victoria, British Columbia, Canada.

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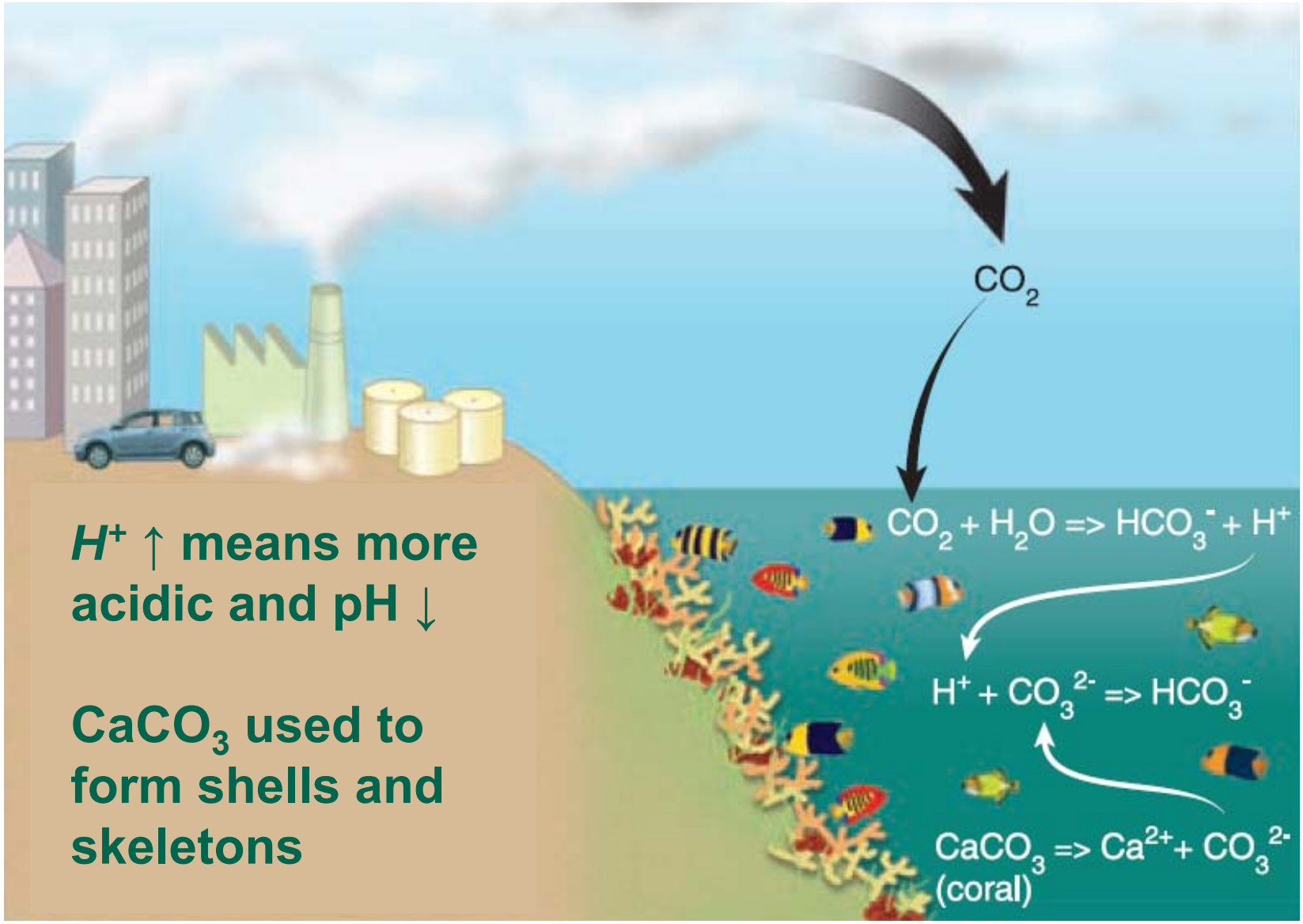
Canada

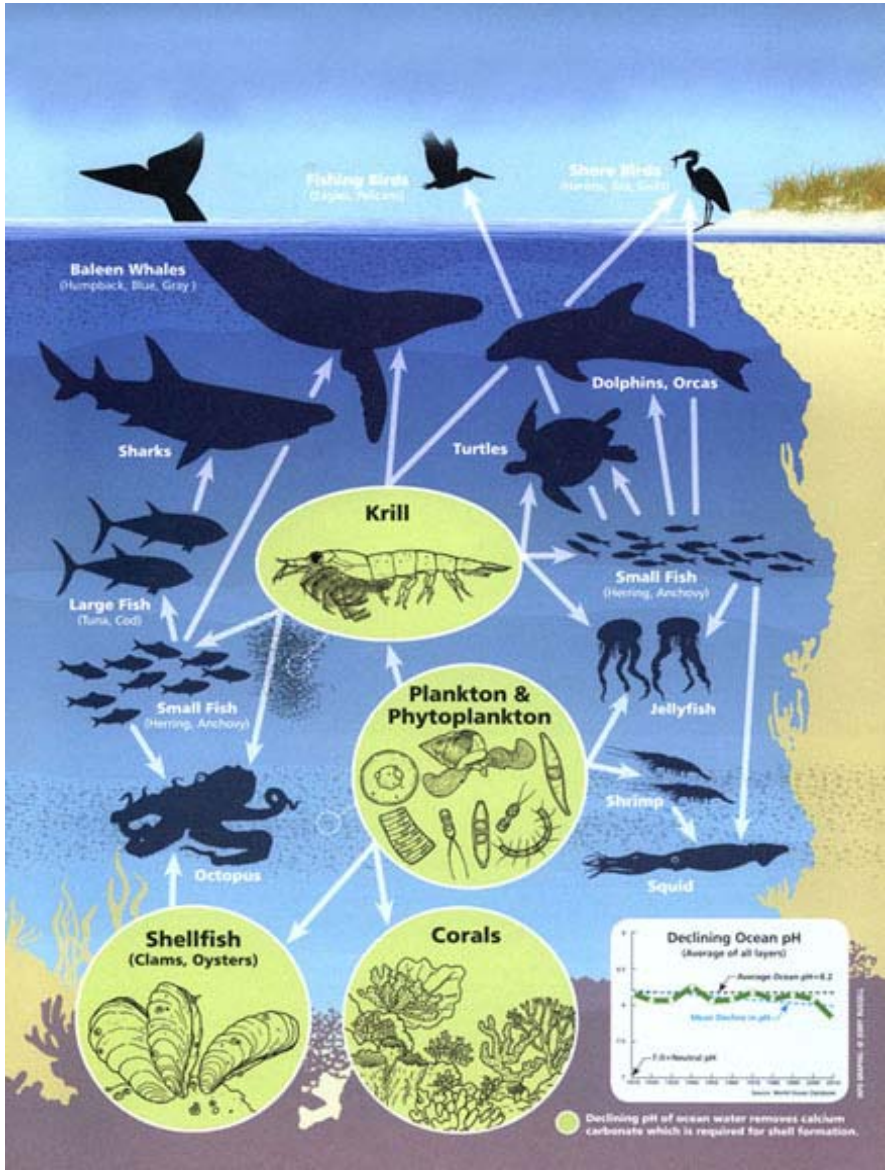
Outline

- Context:
  - Ecosystem impacts of ocean acidification (OA)
  - Oceanography and fisheries of Northeast Pacific (Canada)
- Objectives
- pH depth profiles offshore and inlets
- Direct and indirect effects on taxonomic groups
- Risks and knowledge gaps

photo: Okeover Inlet BC Oyster hatchery — Debby Ianson DFO



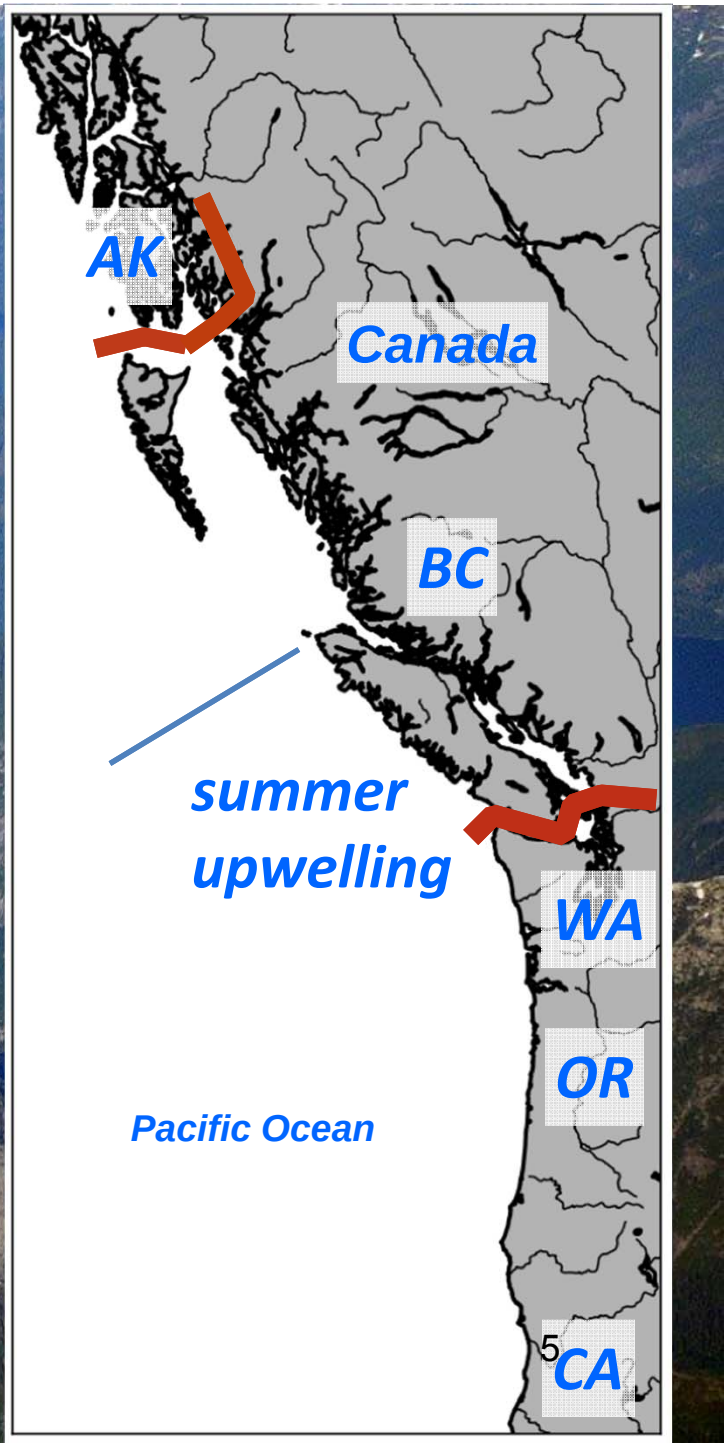
(Hoegh-Guldberg *et al.* 2007)

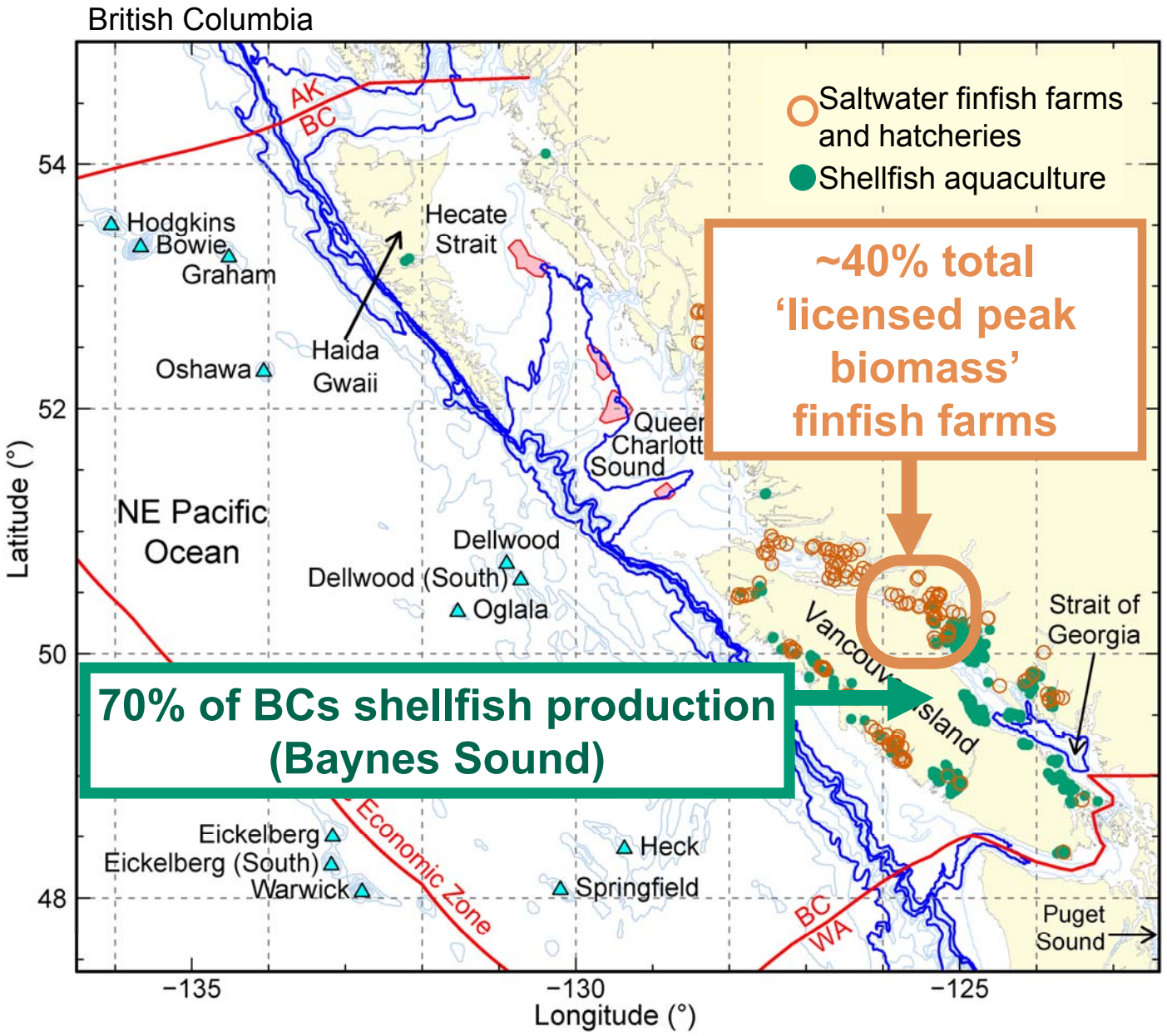


(Jerry Russell, in Belli 2012)

BC

- Capture fisheries on the outer coast, where upwelling controls extreme OA conditions
- Aquaculture in the inlets





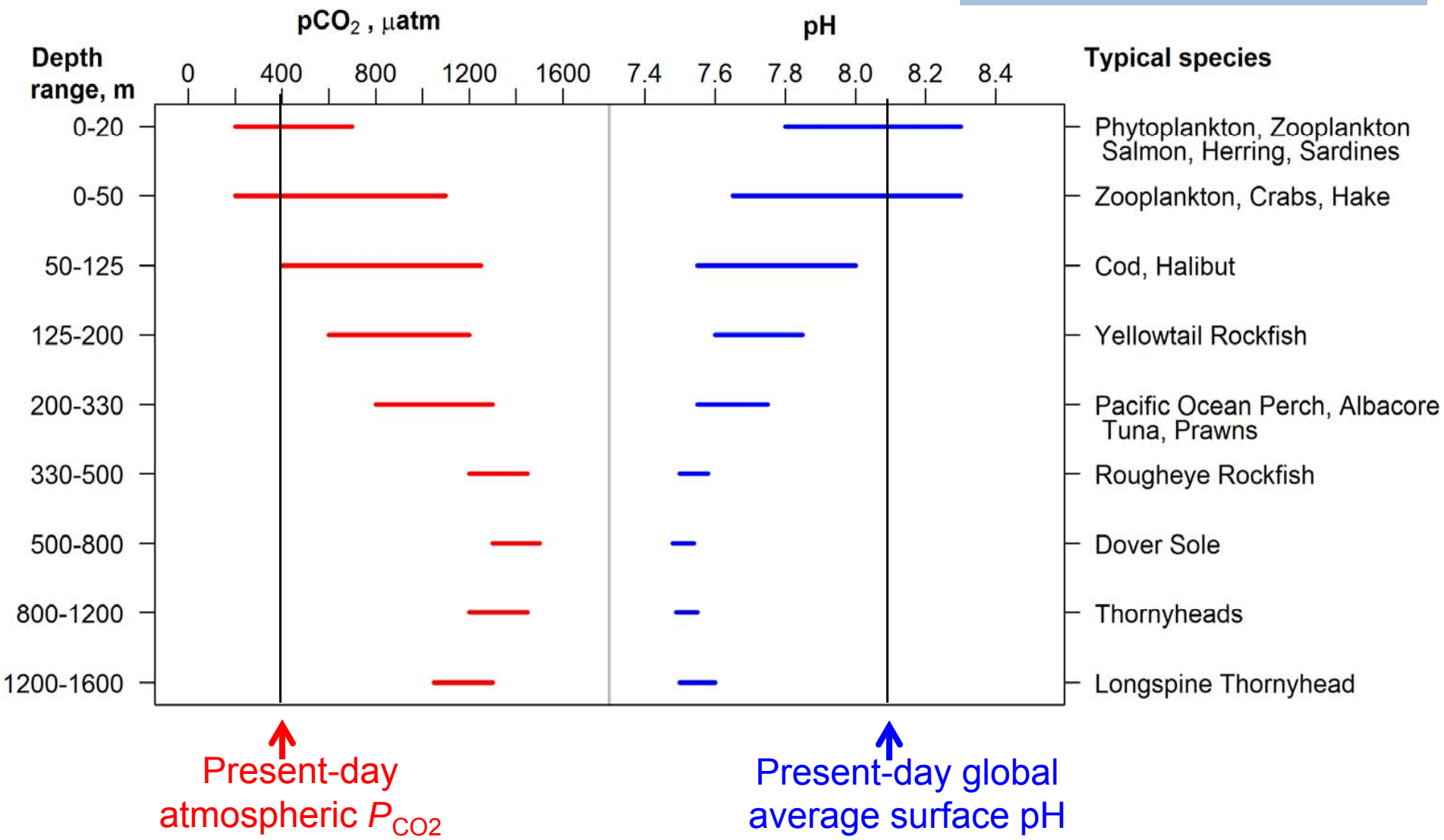
Haigh et al. (2015) PLOS ONE

Objectives

1. Characterize present-day pH and P_{CO2} by depth in local waters
2. Assess direct and indirect effects of OA on both wild and cultured species in the region based on a systematic literature review (to 2014), and comparing anticipated changes in P_{CO2} with current conditions
3. Identify predominant risks to the marine ecosystem, and critical gaps in knowledge

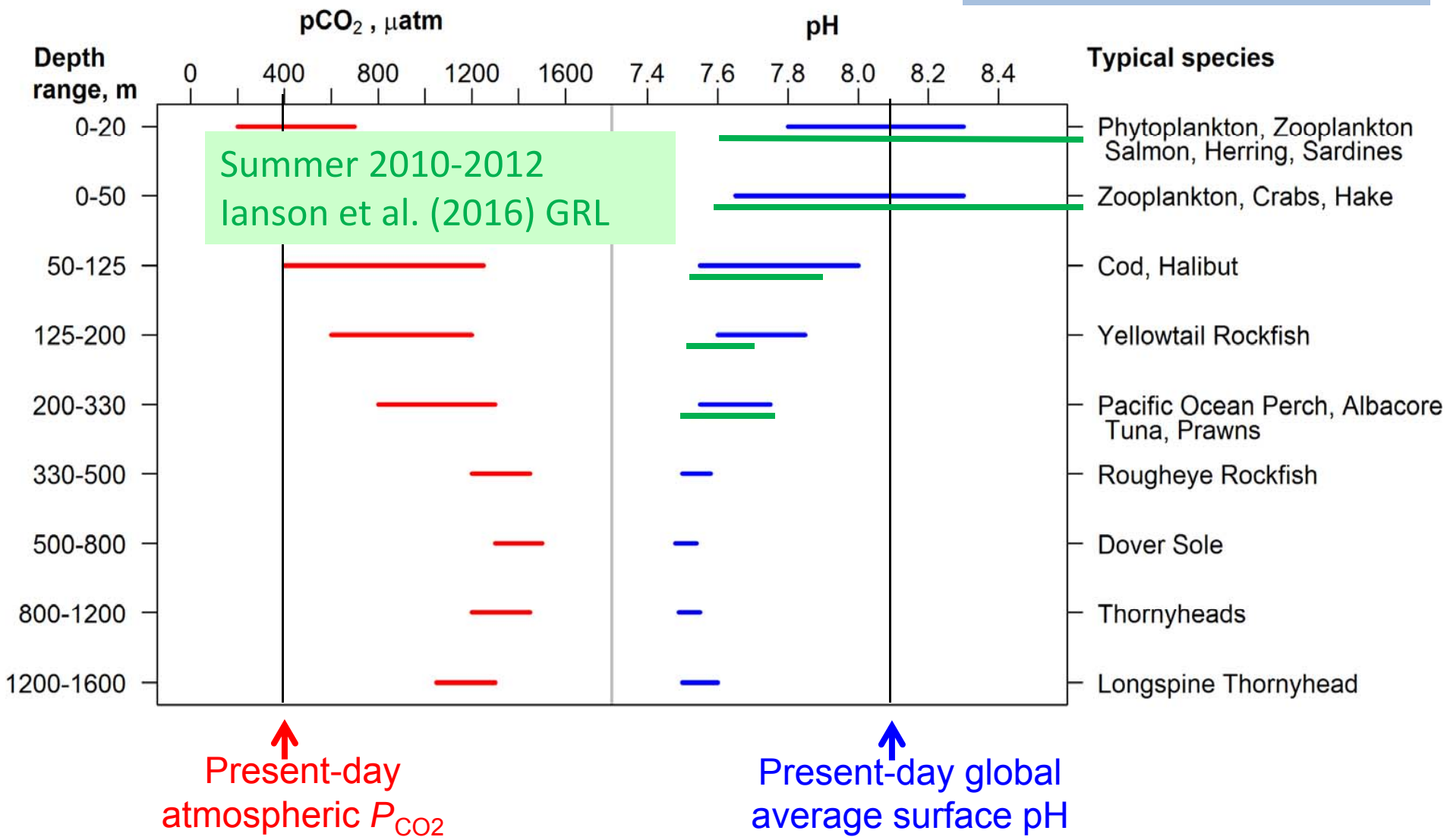
West coast of Vancouver Island (offshore)

Summer 2010
Ianson, unpublished data
after Fig. 2 Haigh et al. (2015)

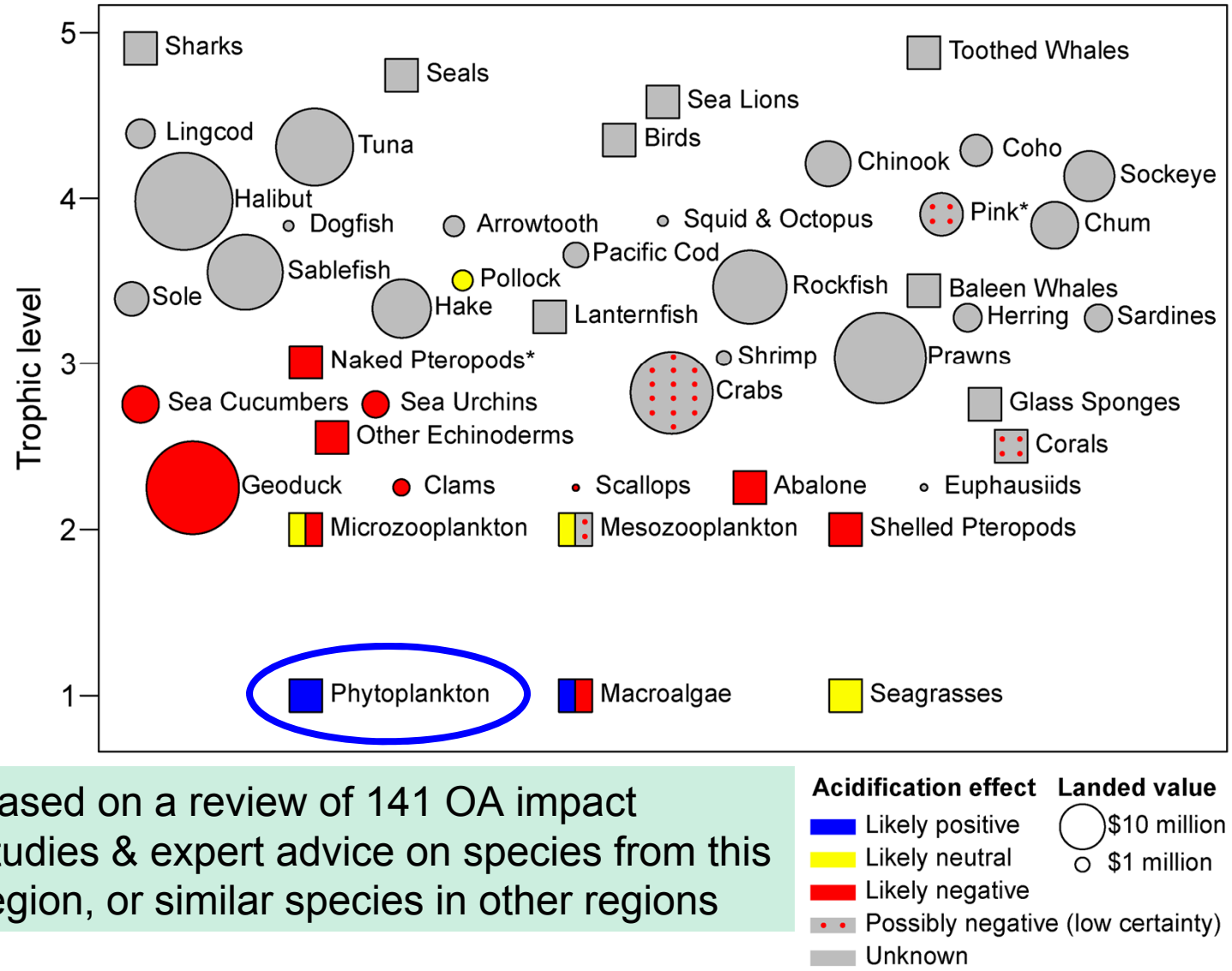


West coast of Vancouver Island (offshore) and Straight of Georgia (inshore)

Summer 2010
Ianson, unpublished data
after Fig. 2 Haigh et al. (2015)



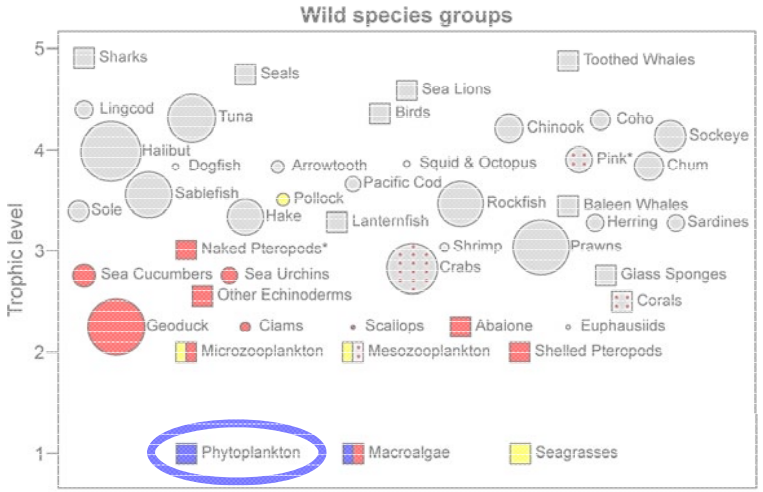
Wild species groups



Based on a review of 141 OA impact studies & expert advice on species from this region, or similar species in other regions

Haigh et al. (2015) PLOS ONE

Phytoplankton

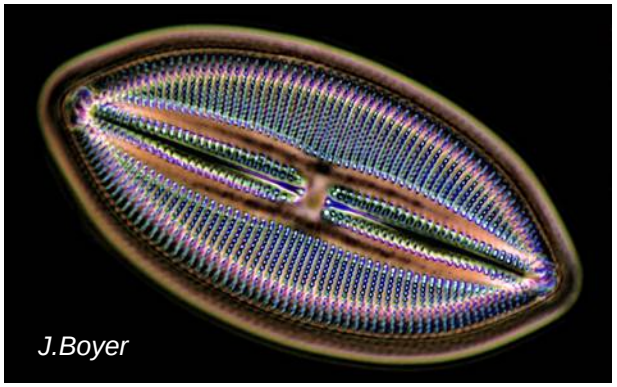


- BC coast dominated by diatoms and dinoflagellates
- Many diatoms are carbon limited

- OA will ↑ production because of ↑ P_{CO2}
- Mesocosm experiments of species assemblages suggest this increase will not be large (at most 10-30% ↑ primary production)
- Increase in harmful algal blooms

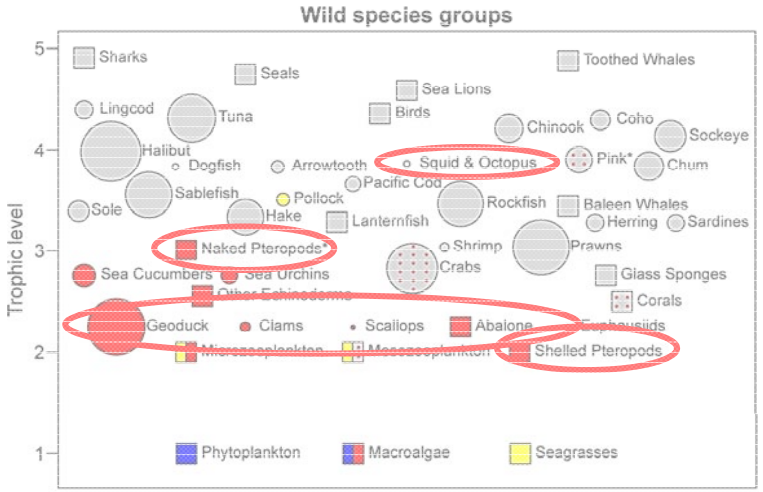
  Heterosigma akashiwo

  Pseudo-nitzschia



(Bellerby et al. 2008; Egge et al. 2009; Hein and Sand-Jenson 1997; Riebesell et al. 2007)

Molluscs

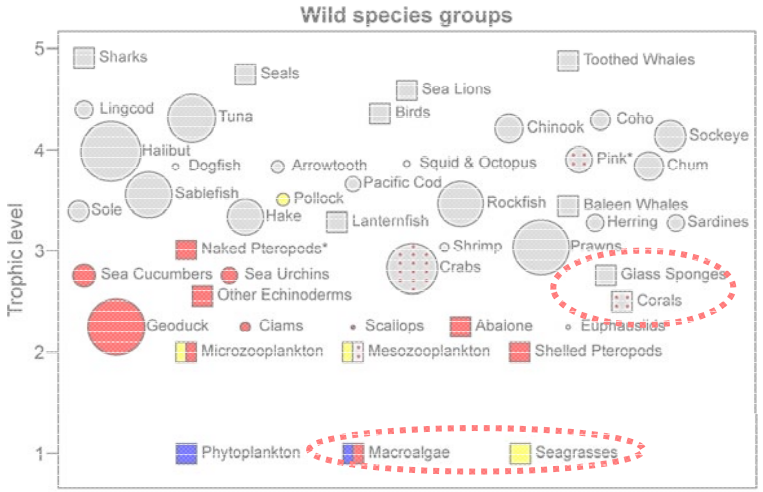


- Shelled molluscs are directly vulnerable to OA from ↓calcification, especially in larval stages

- Shelled pteropods (pelagic snails) especially vulnerable
- Also, reduced oxygen consumption and feeding rates of larval Pacific oyster (Ginger et al. 2013)

- Anticipated ↓survival rates, change in community structure

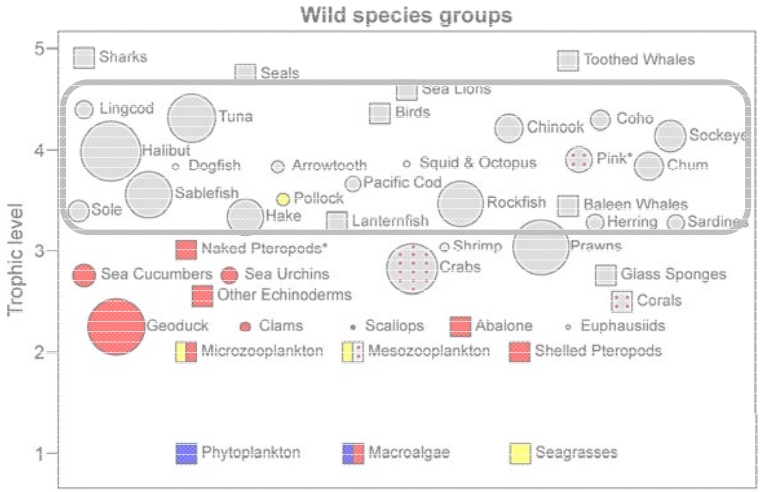
Benthic habitat



- ↑ growth of non-calcifying macroalgae (e.g., kelp) due to ↑ P_{CO2}
- ↓ growth and dissolution of protective shells in calcifying macroalgae (e.g., coralline red algae), shift in community assemblages
- Effects on cold-water corals and glass sponges have not been studied, though coral skeletons are partly calcified and may be sensitive

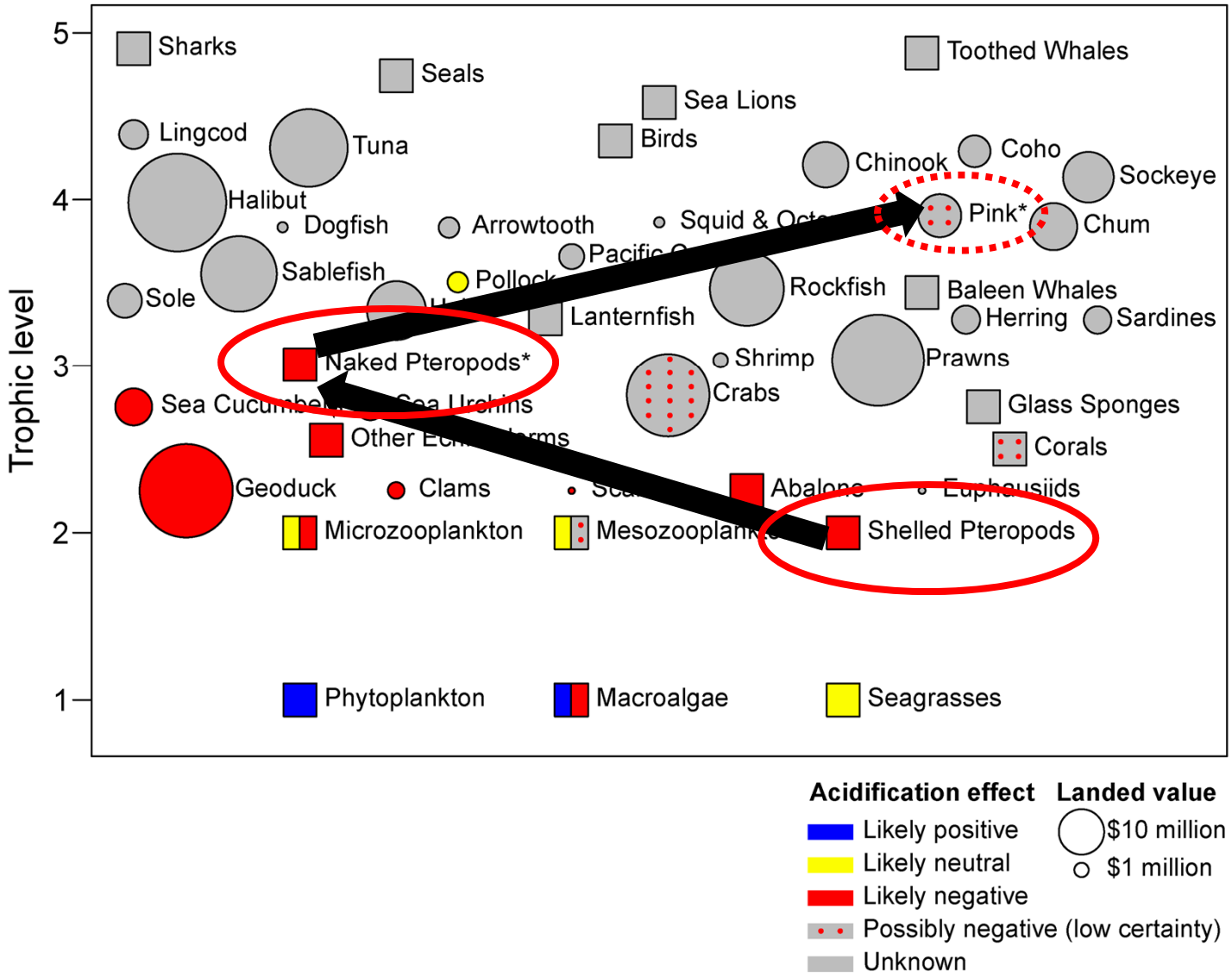
Fish

- Fish may be tolerant due to ability to control internal ion concentrations, though possibly vulnerable in larval stages



- Behavioural impacts of OA well documented in tropical species resulting in reduced survival, and similar effects may occur for temperate species (stickleback, pink salmon)
- Changes in habitat and prey

Fish:indirect effects



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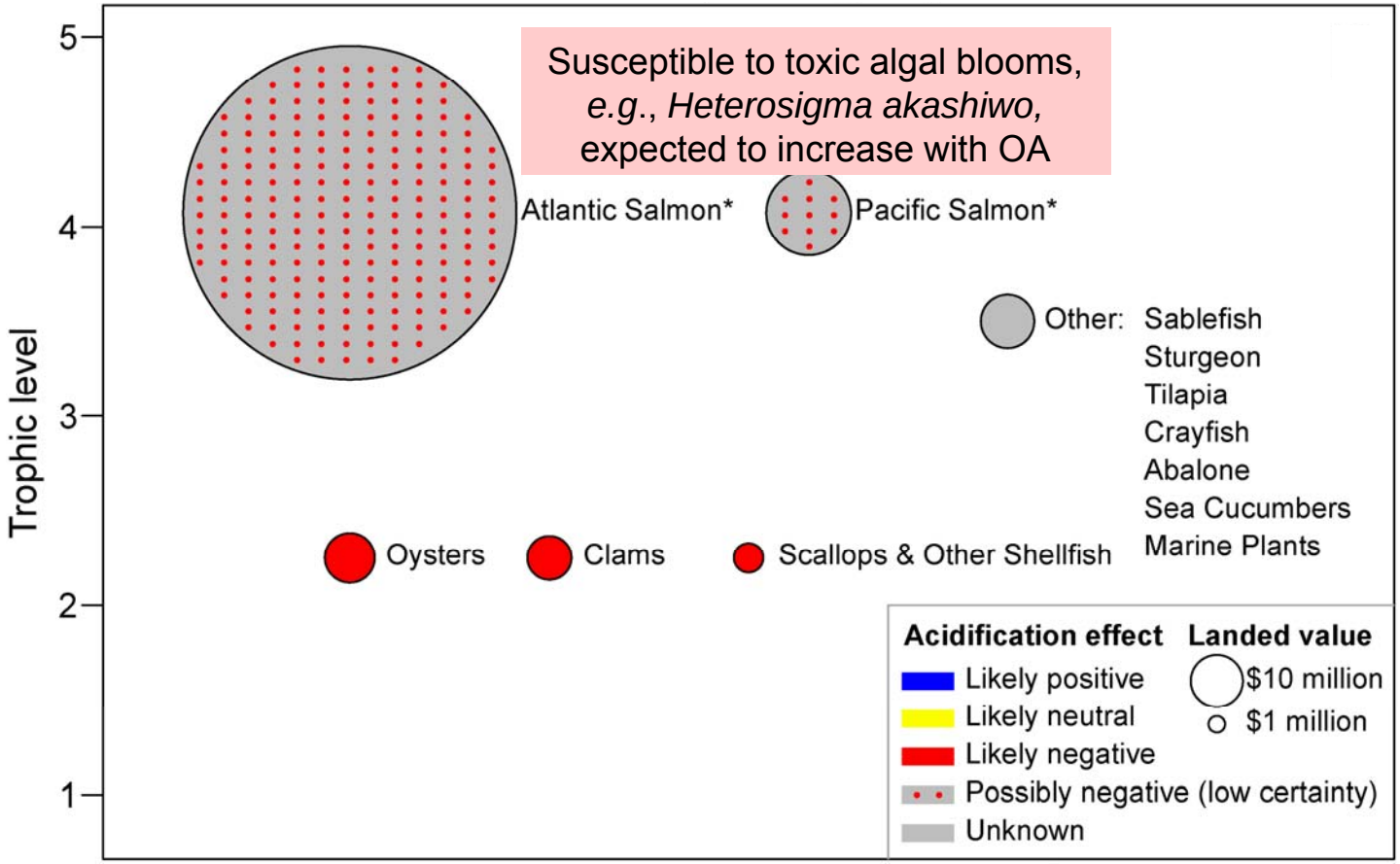
Cultured species groups



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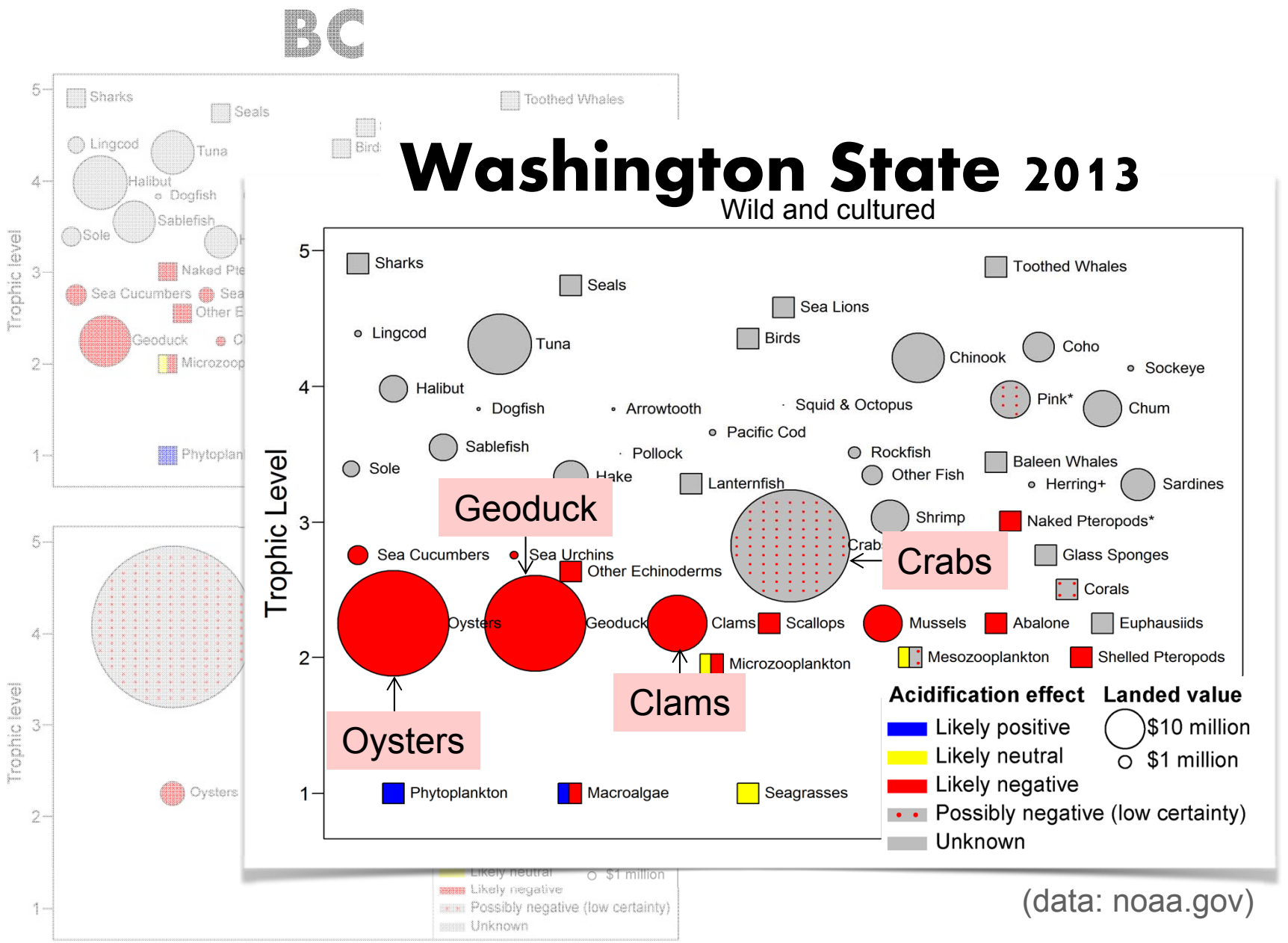

(data: noaa.gov)

Risks

- Shellfish aquaculture highly susceptible to OA through reduced shell growth and indirectly through possible increased toxicity of harmful algal blooms with OA
- Impacts of more frequent harmful algal blooms on salmon aquaculture
- Habitat changes may have negative impacts, especially for juvenile fish
- Food web changes are anticipated, but remain unknown

Critical knowledge gaps

- Impacts on several taxonomic groups unknown, e.g.,
  - lucrative geoduck clams
  - temperate marine fishes
  - upper trophic level species

- Impacts of behavioural changes on population dynamics and ecosystem structure and function
- Cumulative impact of multiple stressors (e.g., temperature, oxygen, pollution, UV)
- Likelihood of acclimatization & adaptation

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