Assessing Direct and Indirect Risk to Ecosystem Components in the Northeast Pacific

Cathryn Clarke Murray, Megan Mach, Rebecca Martone, Gerald Singh, Kai Chan and Miriam O

Canada

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Cumulative impacts

What is the impact on Humpback whales?

Activity

↓

Stressor

↓

Impact

RISK ASSESSMENT

Ecological Risk Assessment

Objectives:

- Risk to an iconic place?
- Risk to species or habitat?
- Risk of activity or development?

Ecological Risk Assessment Framework

Risk = Exposure x Consequence

Hobday et al 2011 Fisheries Res; O et al 2013 DFO Res Doc

Qualitative Risk Assessment

Exposure to Stressor

Spatial scale	Restricted - Widespread (1-3)
Temporal scale	Rare - Continuous (1-4)
Intensity	Low - High (1-3)

Consequence/Sensitivity

Negligible impact - Irreversible loss (1-6)

Miriam O et al 2013. DFO CSAS Res Doc

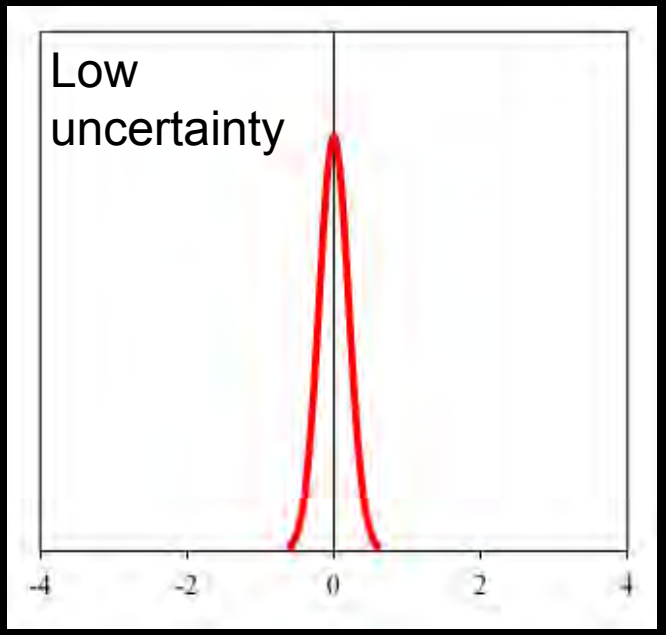
Incorporating Uncertainty

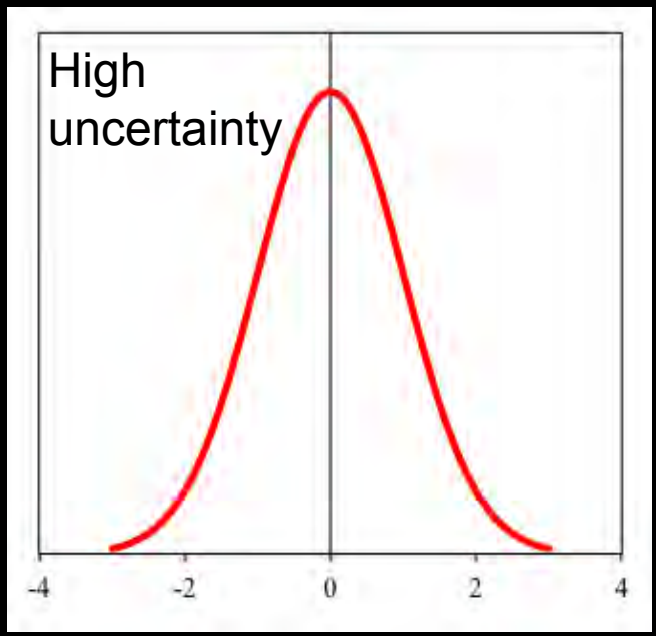
Uncertainty Scoring		
Score	**Literature**	**Definition**
1	Extensive	Extensive scientific information; peer-reviewed information; data specific to the location; supported by long-term datasets (10 years or more)
2	Substantial	Substantial scientific information; non-peer-reviewed information; data specific to the region; supported by recent data (within the last 10 years) or research
3	Moderate	Moderate level of information; data from comparable regions or older data (more than 10 years) from the area of interest
4	Limited	Limited information; expert opinion based on observational information or circumstantial evidence
5	Little to None	Little or no information; expert opinion based on general knowledge

Incorporating uncertainty

Monte Carlo simulation

Uncertainty Score	Standard Deviation
1	0.2
2	0.4
3	0.6
4	0.8
5	1.0

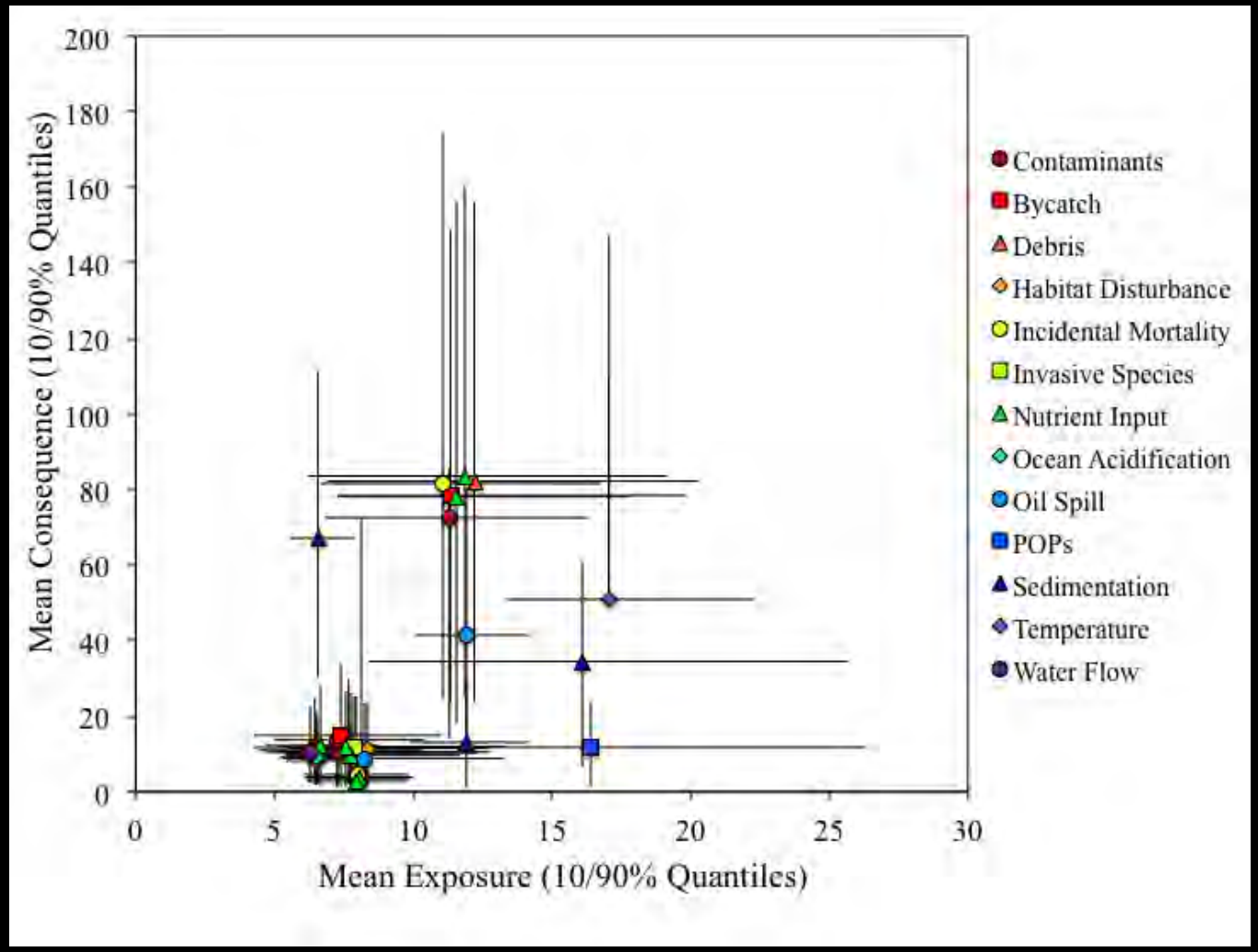




Estimating risk

- Pathways of effects models & evidence tables
- Ecological component-stressor risk =
  Spatial scale x Temporal scale x Intensity x Consequence

Exposure and Consequence Risk Scores for sponges

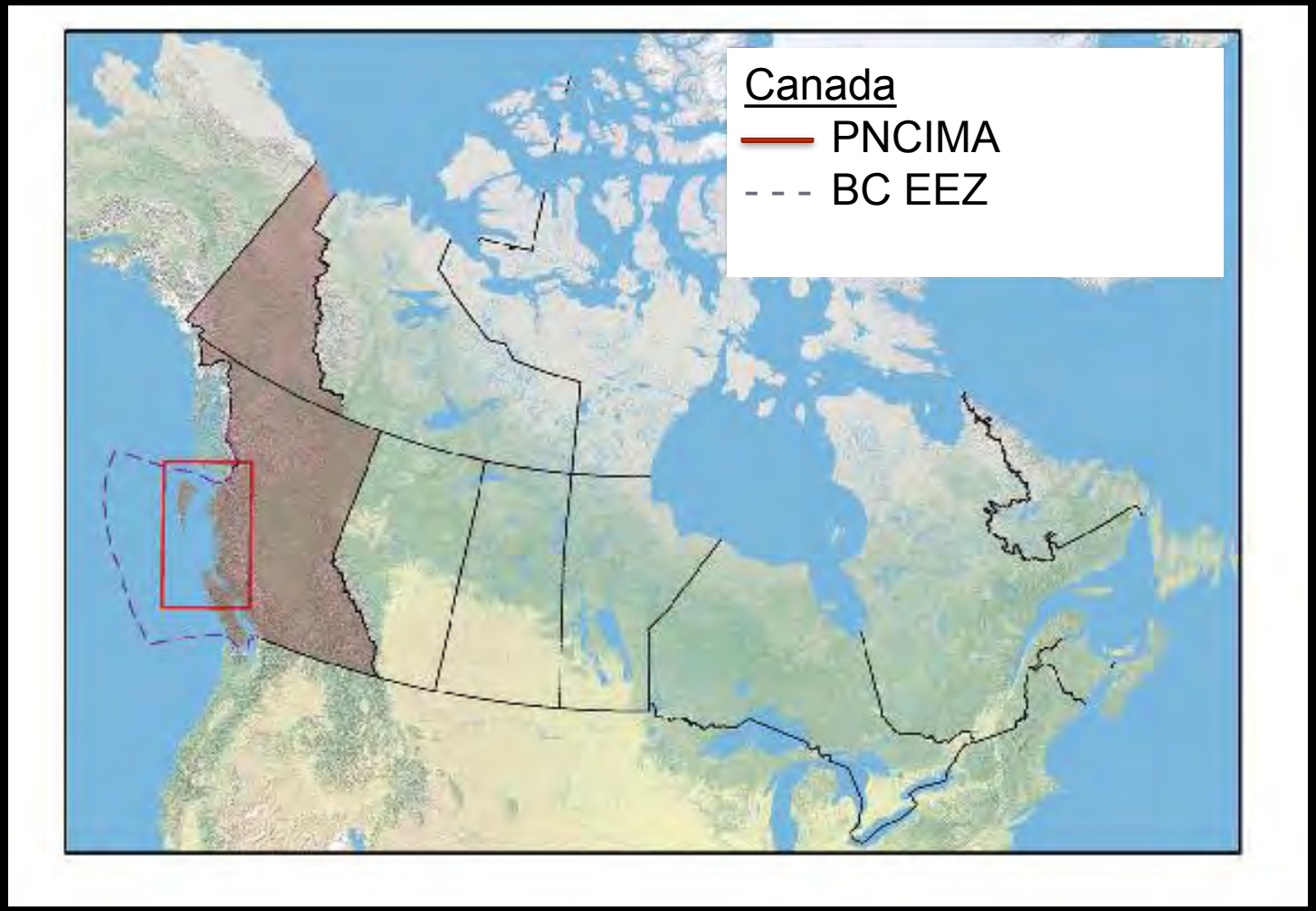


Estimating Cumulative Risk

- Cumulative risk is the sum of all risk scores across all stressors and activities for each ecological component
- Assumes additive relationships, rather than synergy or antagonism

Crain et al 2008 Ecol Letters; Darling & Cote 2008 Ecol Letters

Pilot study: NE Pacific



Ecosystem Components

17 species and habitats

Photos: Andrew S Wright, Doug Perrine, National Geographic

Activities & Stressors

30 human activities

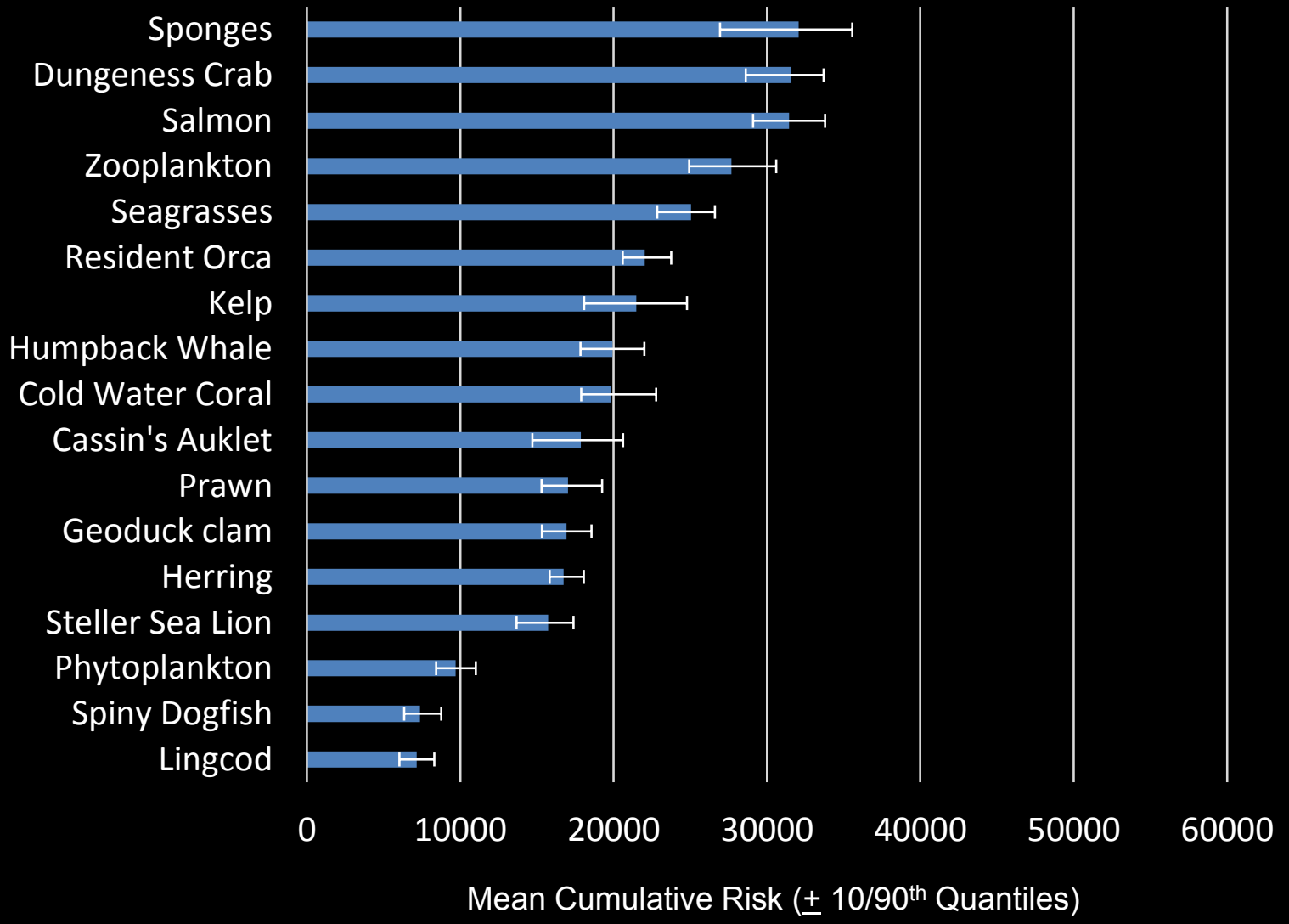
- Fisheries
- Human settlement
- Ports and marinas
- Shipping
- Aquaculture

75 stressors

- Sedimentation
- Contaminants
- Shading
- Noise
- Bycatch

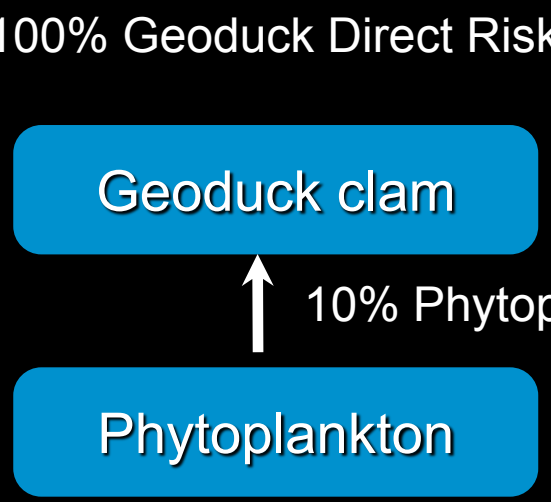
Qualitative risk scores

Cumulative Risk



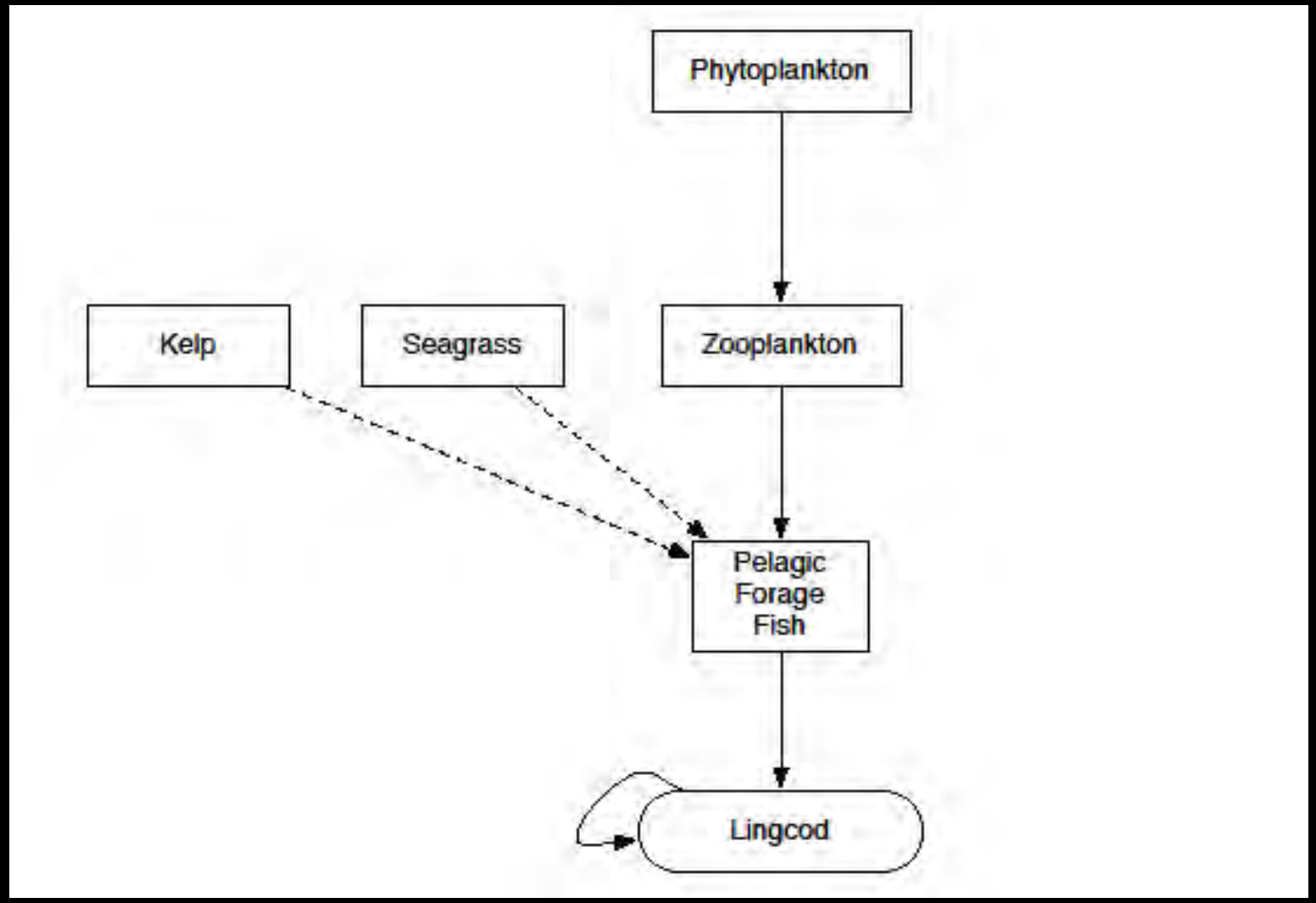
Direct v Indirect risk

- Food web links to add indirect risk
- Based on energy transfer principles – 10% rule
- Distinguish between obligate and generalist interactions



Direct Risk to Geoduck + 10% Risk to Phyto

Lingcod



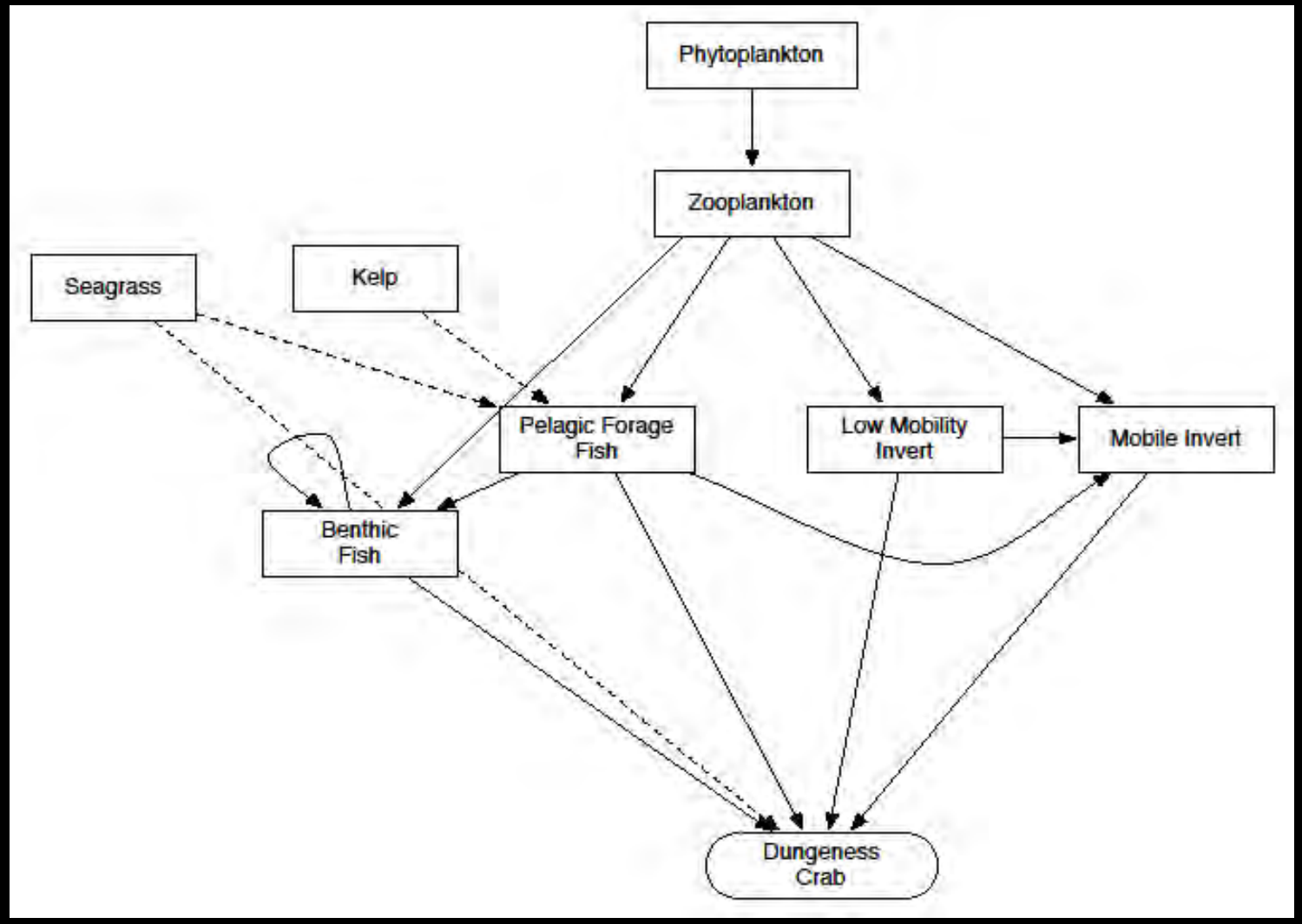
------ Habitat

——— Food web

10% Trophic/habitat

100% Obligate link

Dungeness Crab



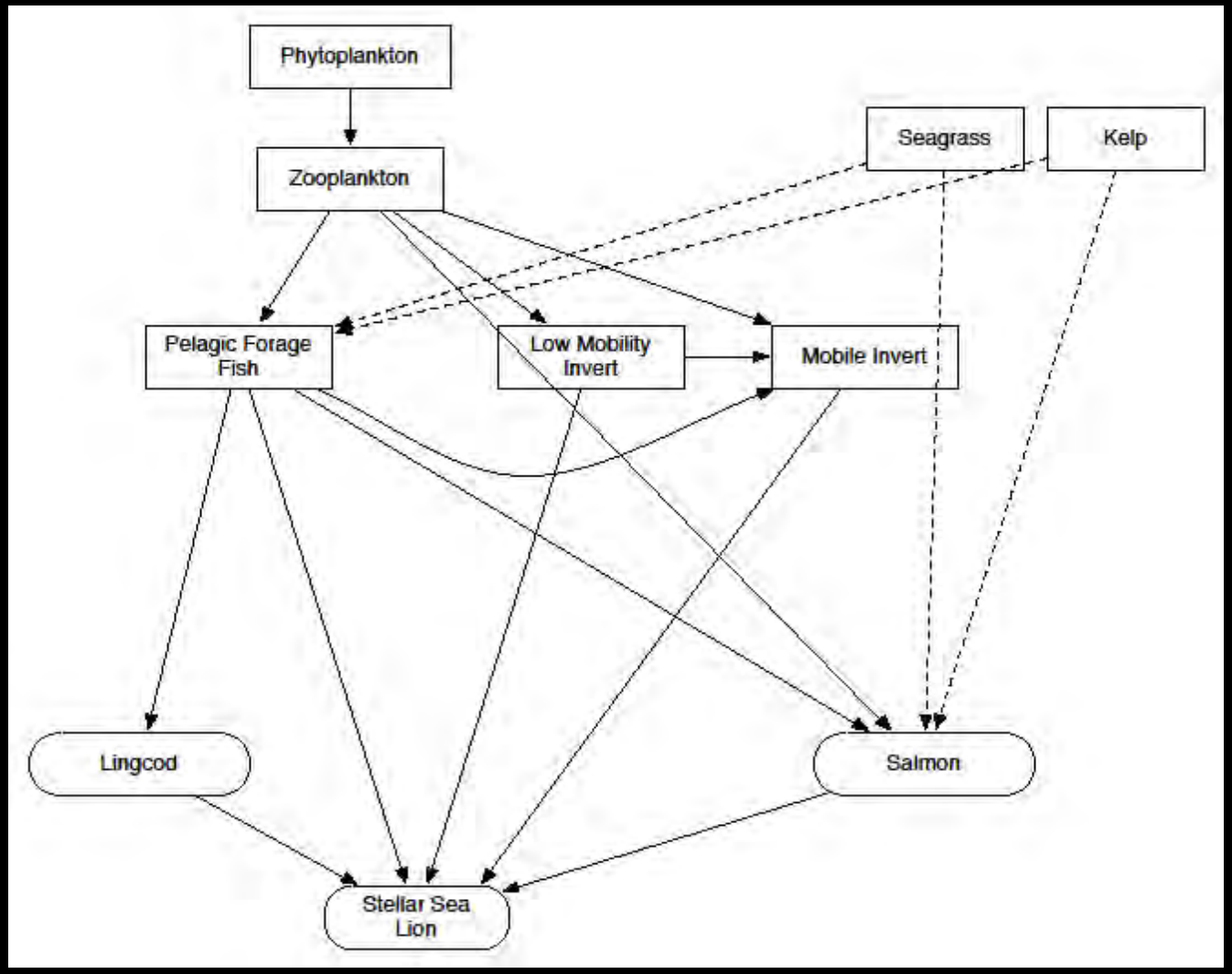
------ Habitat

—— Food web

10% Trophic/habitat

100% Obligate link

Steller sea lion



------ Habitat

—— Food web

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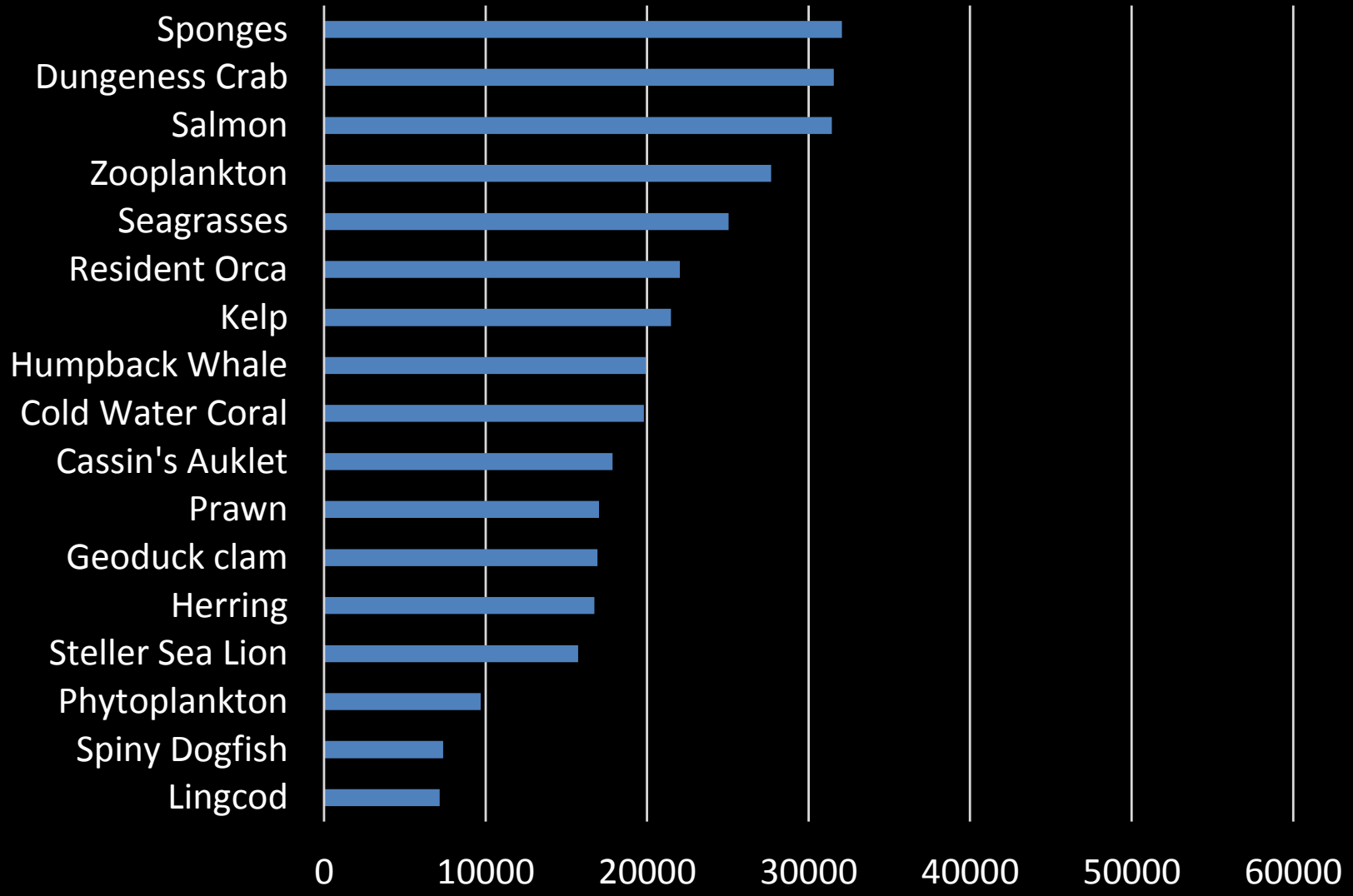
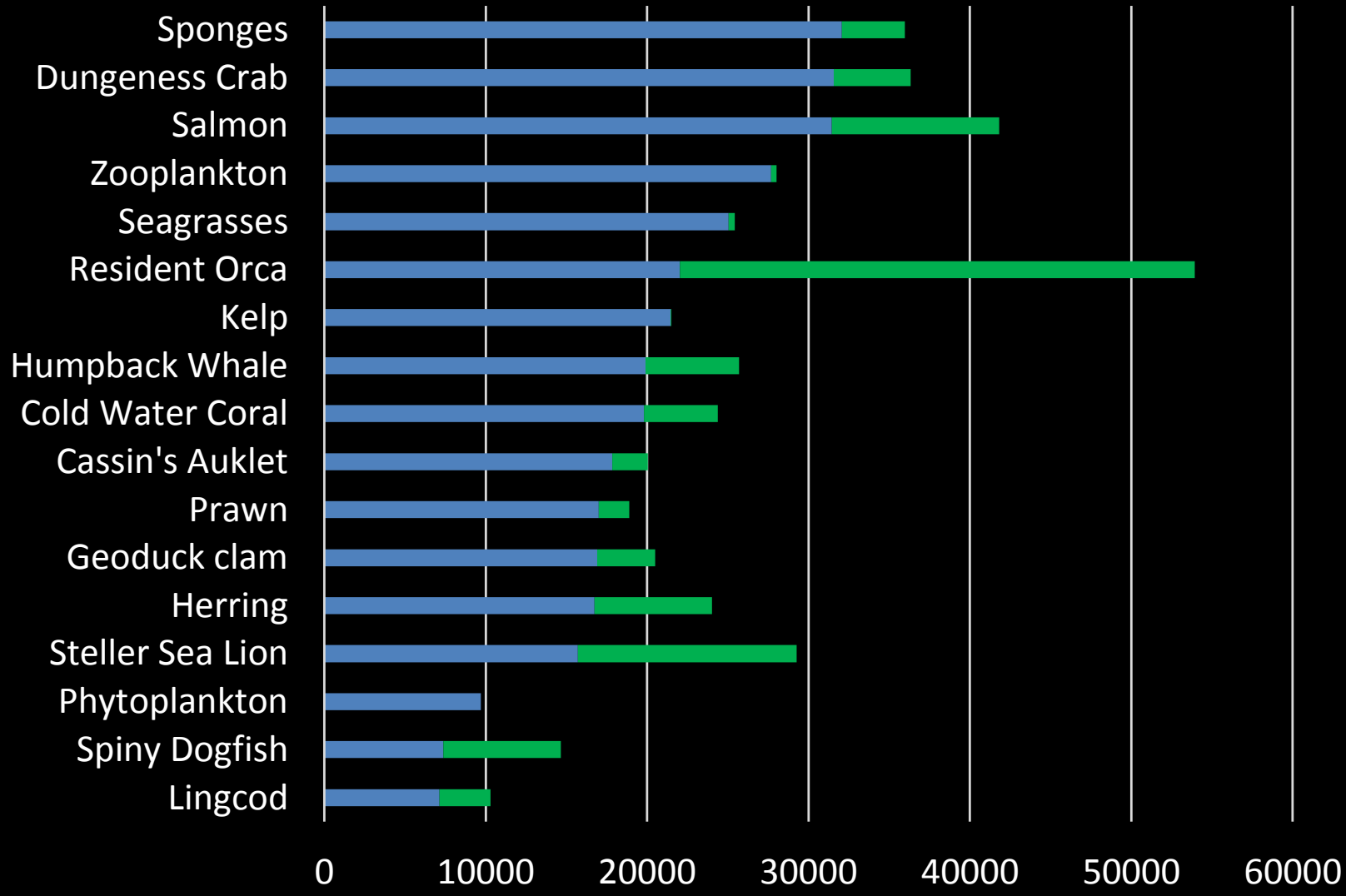
Cumulative risk



Cumulative risk



Cumulative Risk & Policy

- Incorporate indirect effects into cumulative effects assessments
- Tool for ecosystem-based management
- Applications to sustainable development & EIAs

- Future research - define thresholds of risk

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