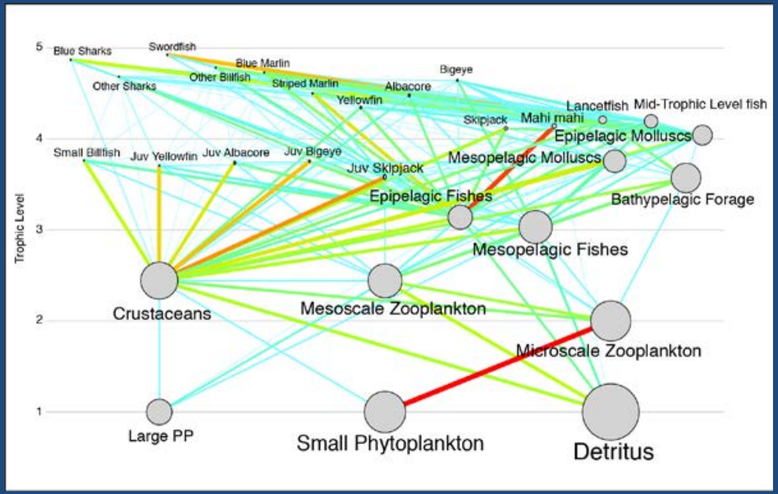
Future of the Central North Pacific Pelagic Marine Ecosystem



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Approach

1. HISTORICAL: Focus on the Hawaii Deep-set longline fishery. Use Observer and Logbook data – 1996 – 2012 to examine trends in catch rates of 23 species.

1. FUTURE PROJECTIONS: Use two ecosystem models: Ecopath/Ecosim and size-based to examine fishing and climate change impacts. Use NOAA's GFDL earth system model output for the 21st Century to drive climate impacts.

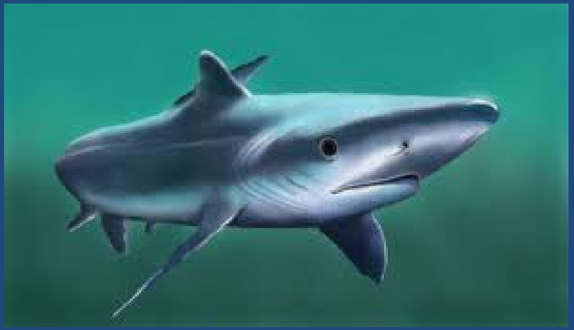
Over the period 1996-2012 many large apex species show substantial declines in annual CPUE

Bigeye tuna -2%/yr

Oceanic white-tip -7%/yr

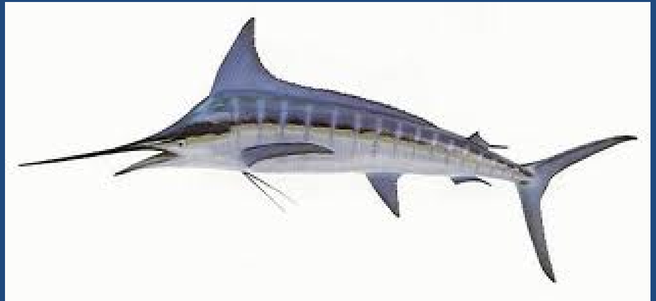
Shortbill spearfish -4%/yr

Blue shark -4%/yr



Blue marlin -5%/yr

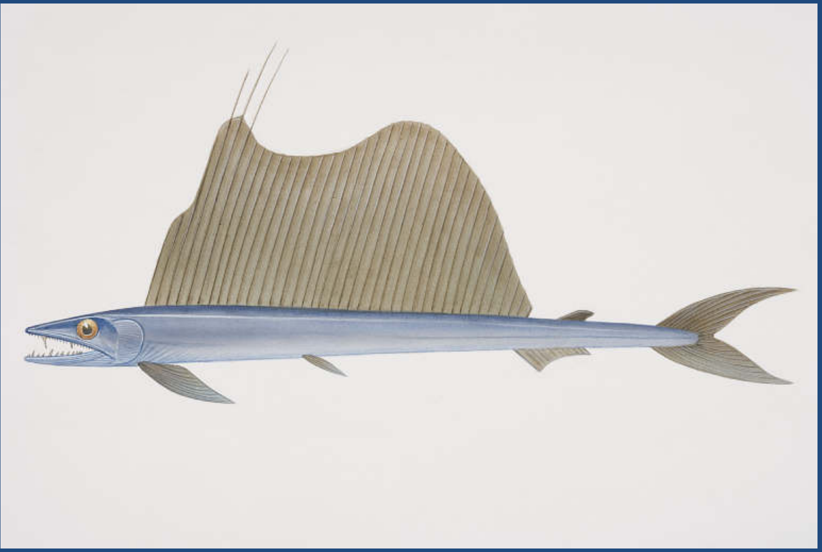
Striped marlin -5%/yr



While smaller, mid-trophic species, show substantial increases

Mahimahi (*Coryphaena hippurus*)
+7%/yr

Lancetfish (*Alepisaurus ferox*)+2%/yr

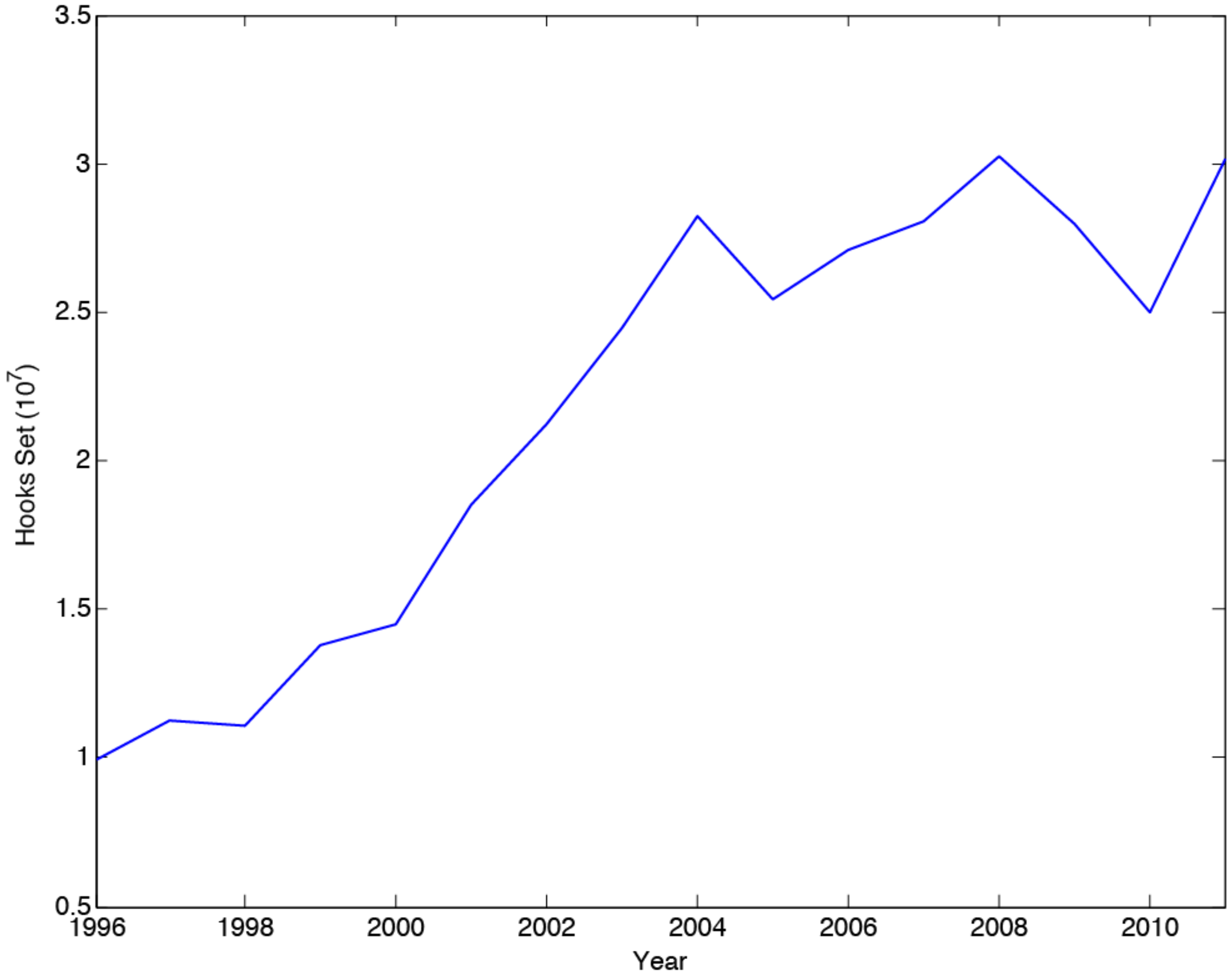


Escolar, walu, (*Lepidocybium flavobrunneum*)+12%/yr

Snake mackerel (*Gempylus serpens*)+15%/yr

Sickle pomfret (*Taractichthys steindachneri*) +6%/yr

Annual Hawaii Deep-set Longline Logbook Effort



Small and Large Size Groups

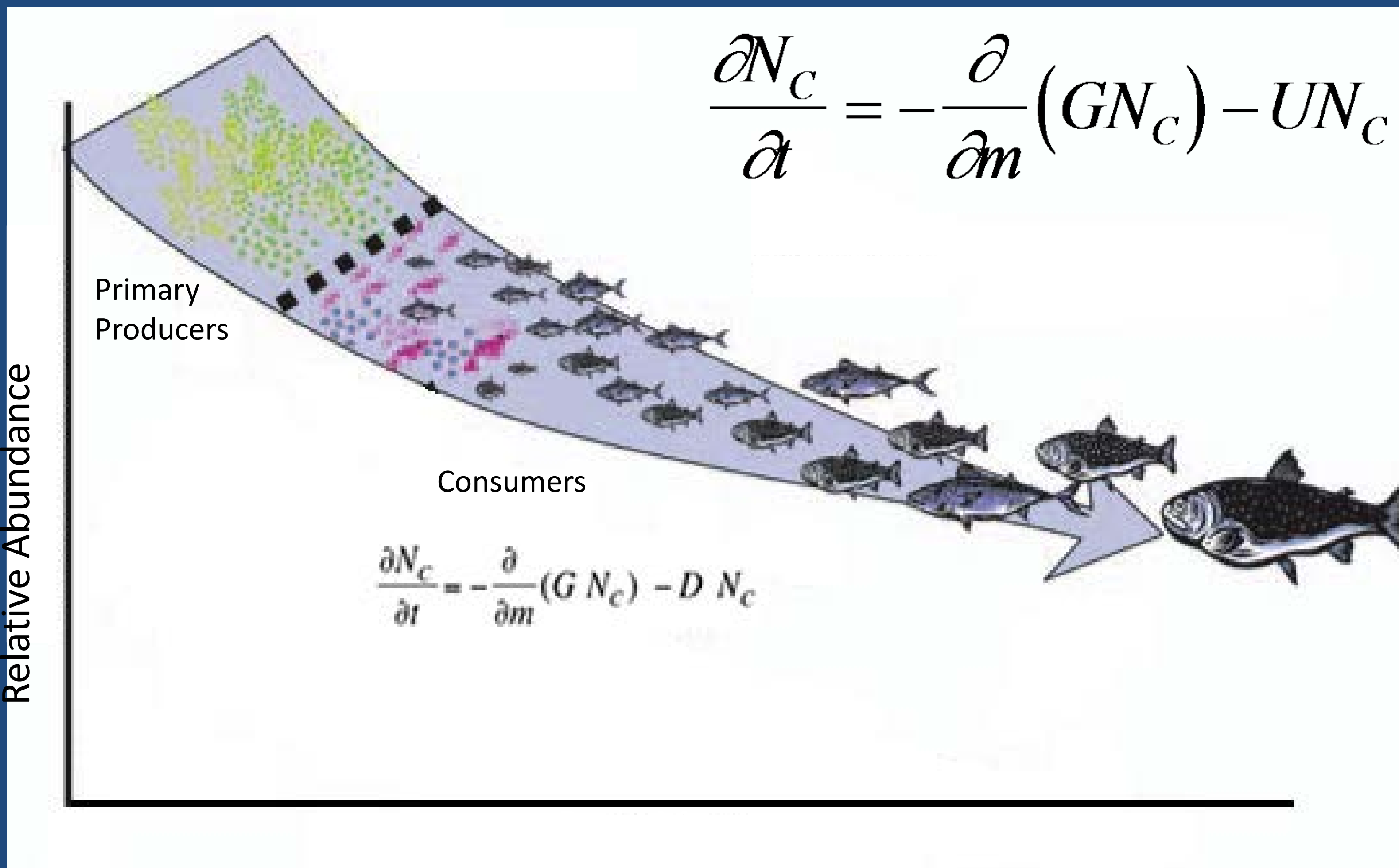
Small Fishes: 9 fishes with mean weight < 15 kg

Escolar
Mola
Skipjack Tuna
Mahi Mahi
Lancetfish
Great Barracuda
Pomfrets
Pelagic Stingray
Snake Mackerel

Large Fishes: 14 fishes with mean weight ≥ 15 kg

Blue Marlin
Blue Shark
Striped Marlin
Shortbill Spearfish
Shortfin Mako Shark
Swordfish
Yellowfin Tuna
Opah
Bigeye Thresher Shark
Unidentified Tuna
Bigeye Tuna
Oceanic White-tip Shark
Albacore Tuna
Wahoo

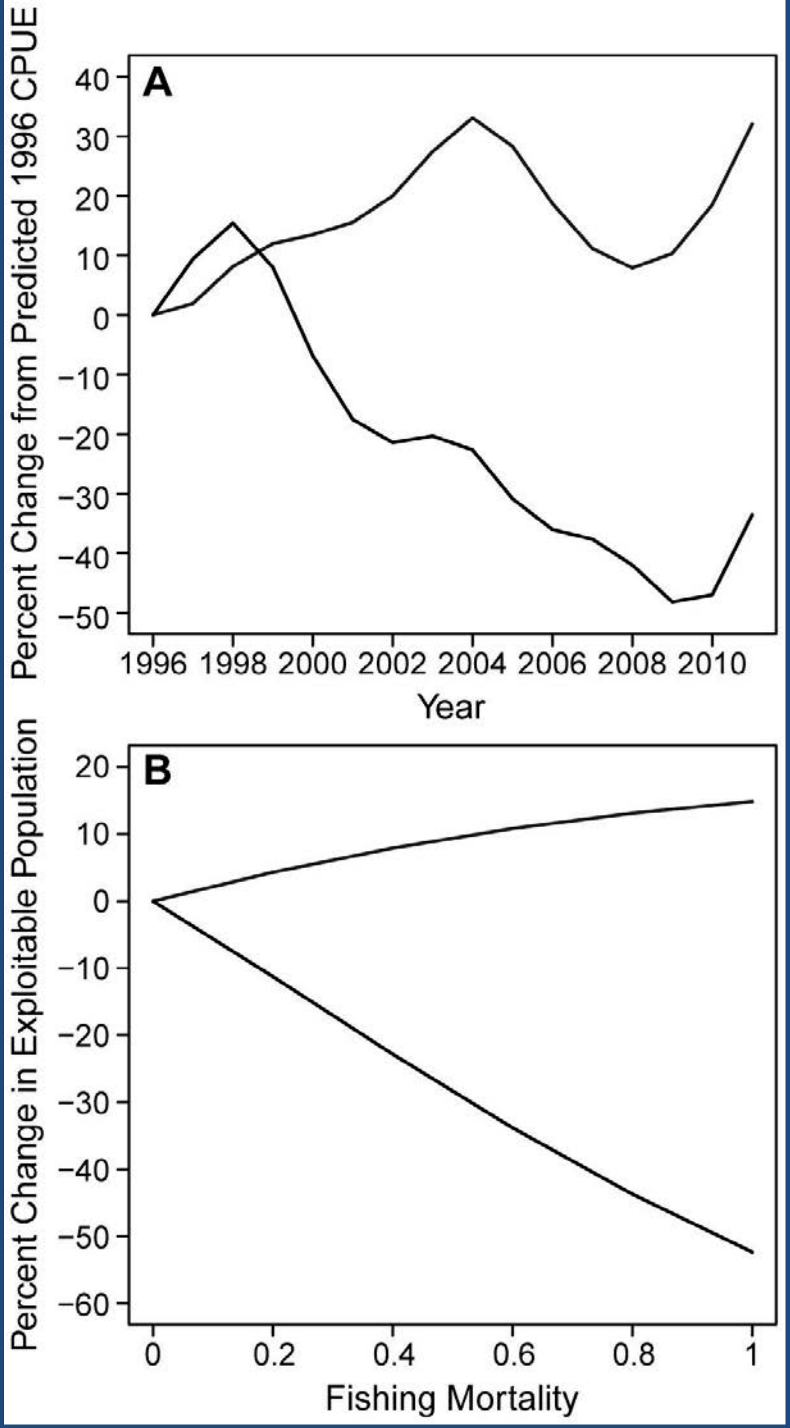
Size-based Food Web Model



From Blanchard *et al.* 2009, modified

(A) Percent change in generalized additive model (GAM) standardized CPUE for small fishes (<15 kg) (top line) and large fishes (>15kg) (bottom line).

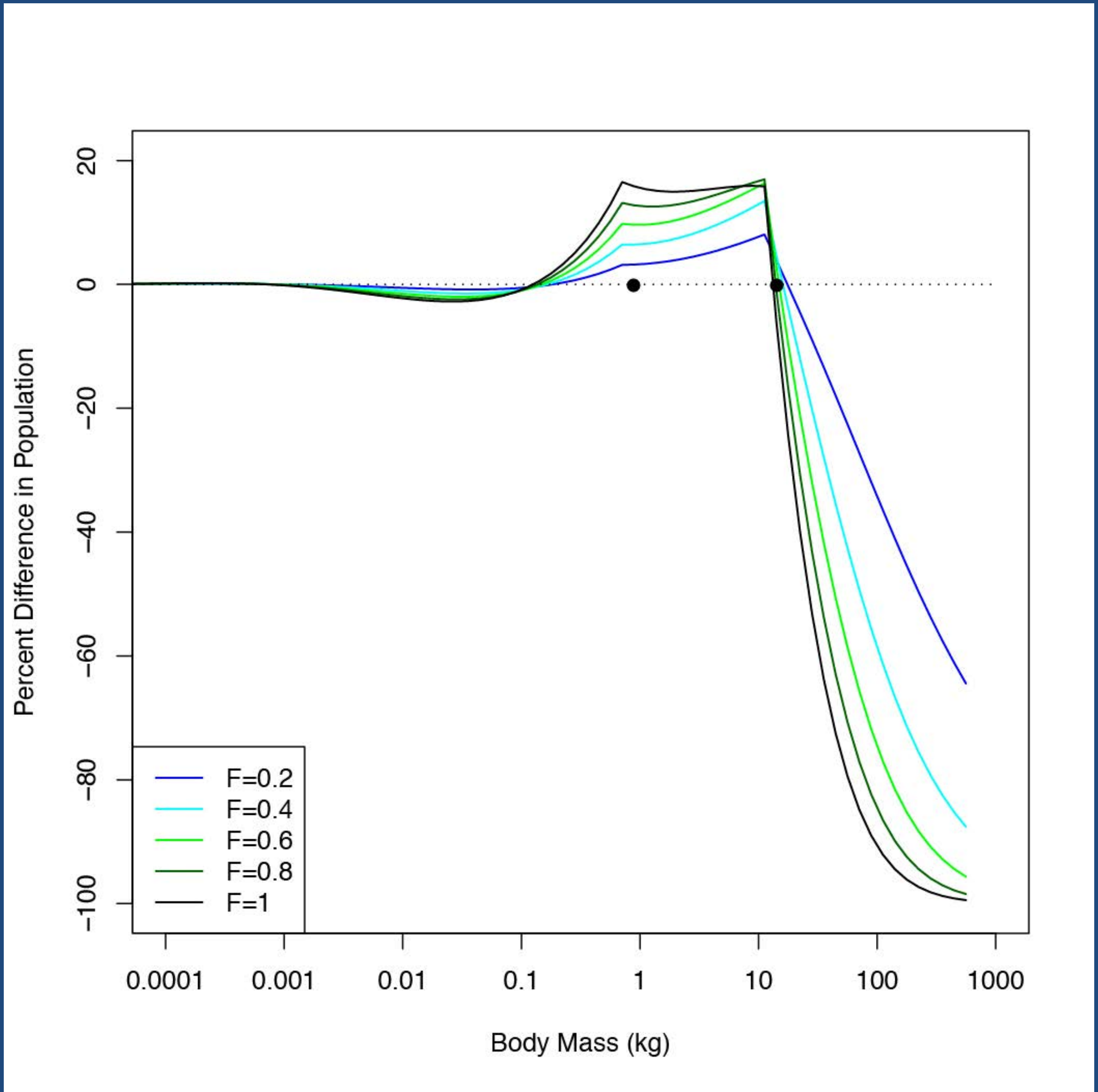
(**B**) change in size-based model estimated population size for small fishes (<15 kg) (top line), large fishes (>15 kg) (bottom line).



Size-based Top-down Response

The percent change in ecosystem abundance by size between the unfished size structure and the fished size structure for F ranging from 0.2 to 1.0.

The black dots are located at 1 and 15 kg to indicate the size at entry to the fishery and the size of full recruitment.



Projected Climate Changes for N Pacific over the 21st Century

Basin-wide warming

Tropical easterlies weaken

Westerlies and polar easterlies weaken and shift poleward

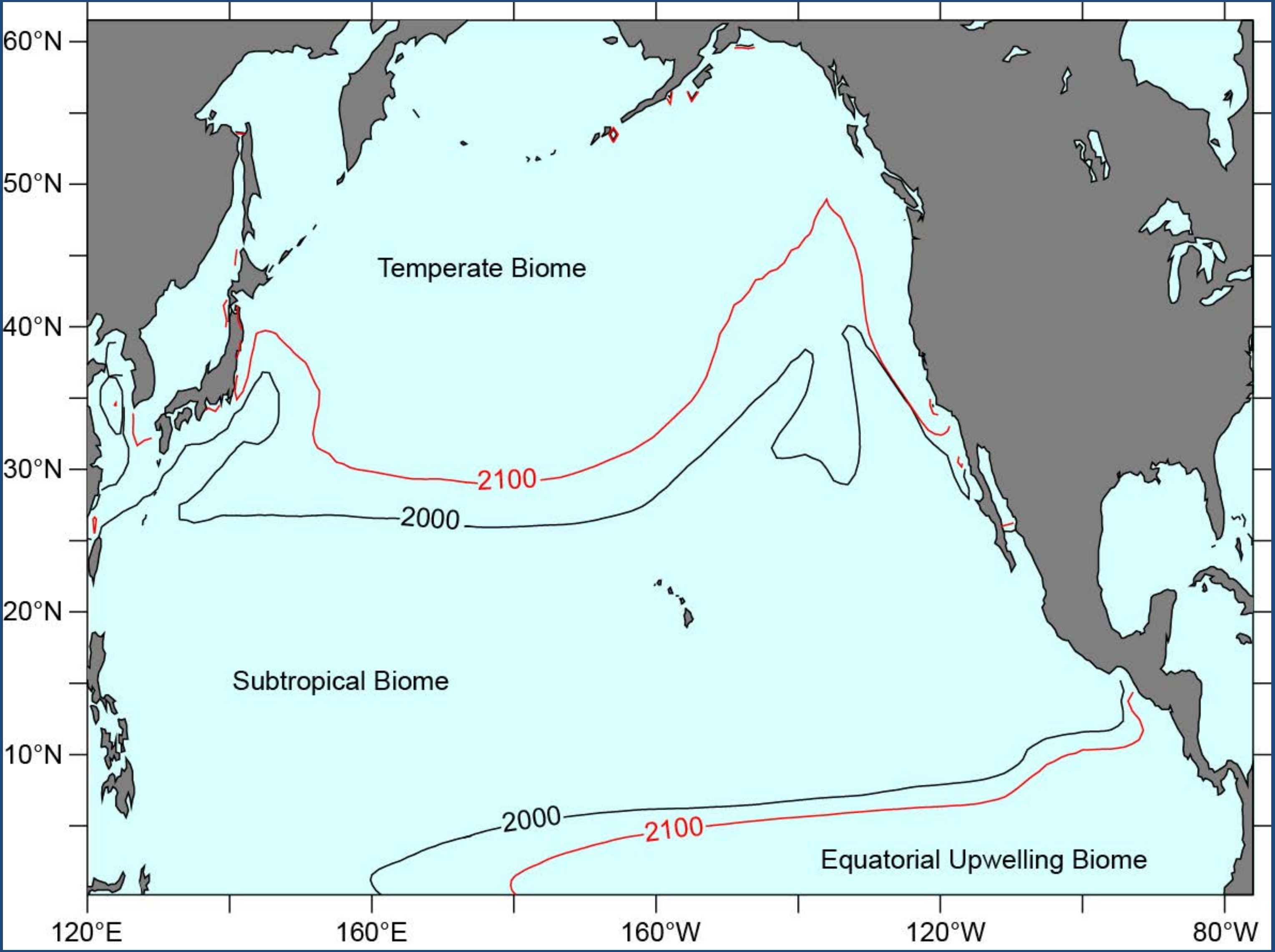
Reduced wind-stress curl

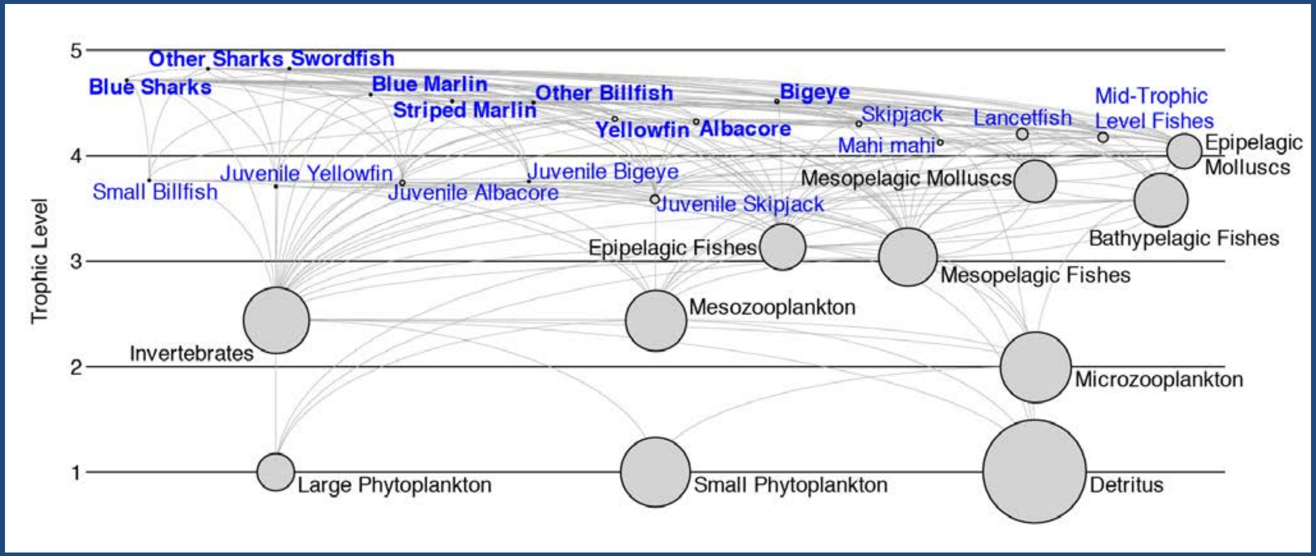
Weakened vertical velocities and increased stratification

Nutrient redistribution

Rykaczewski and Dunne 2010, Sarmiento *et al*. 2004, Vecchi *et al*. 2006, Yin 2005

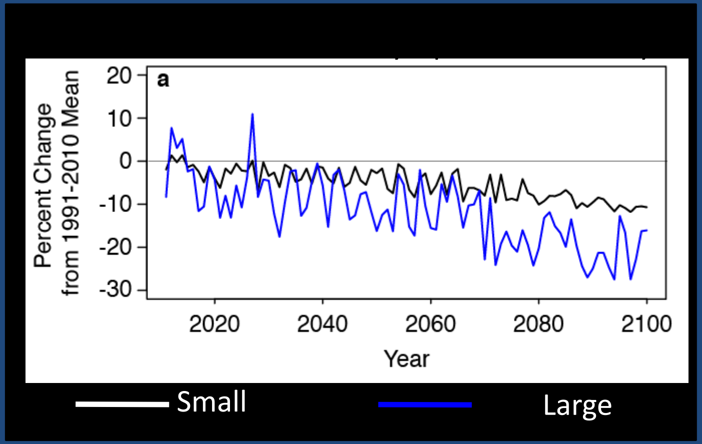
Biome Boundaries at beginning and end of the 21st Century

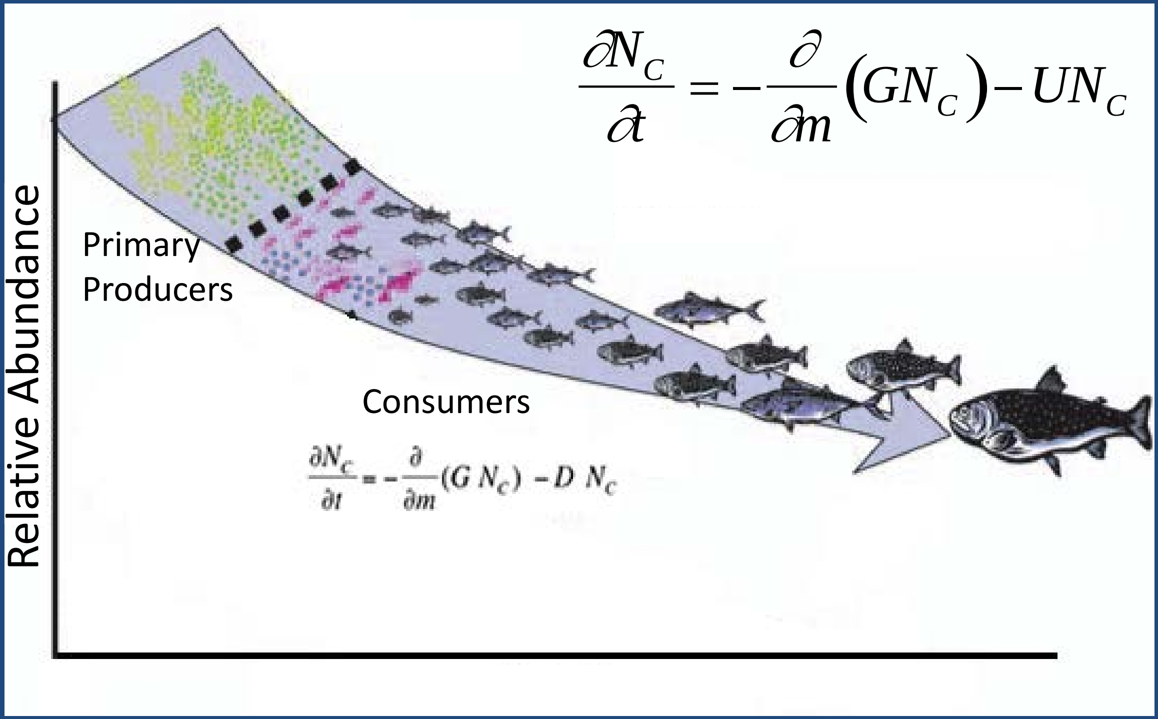




Species-Based:
Ecopath with Ecosim

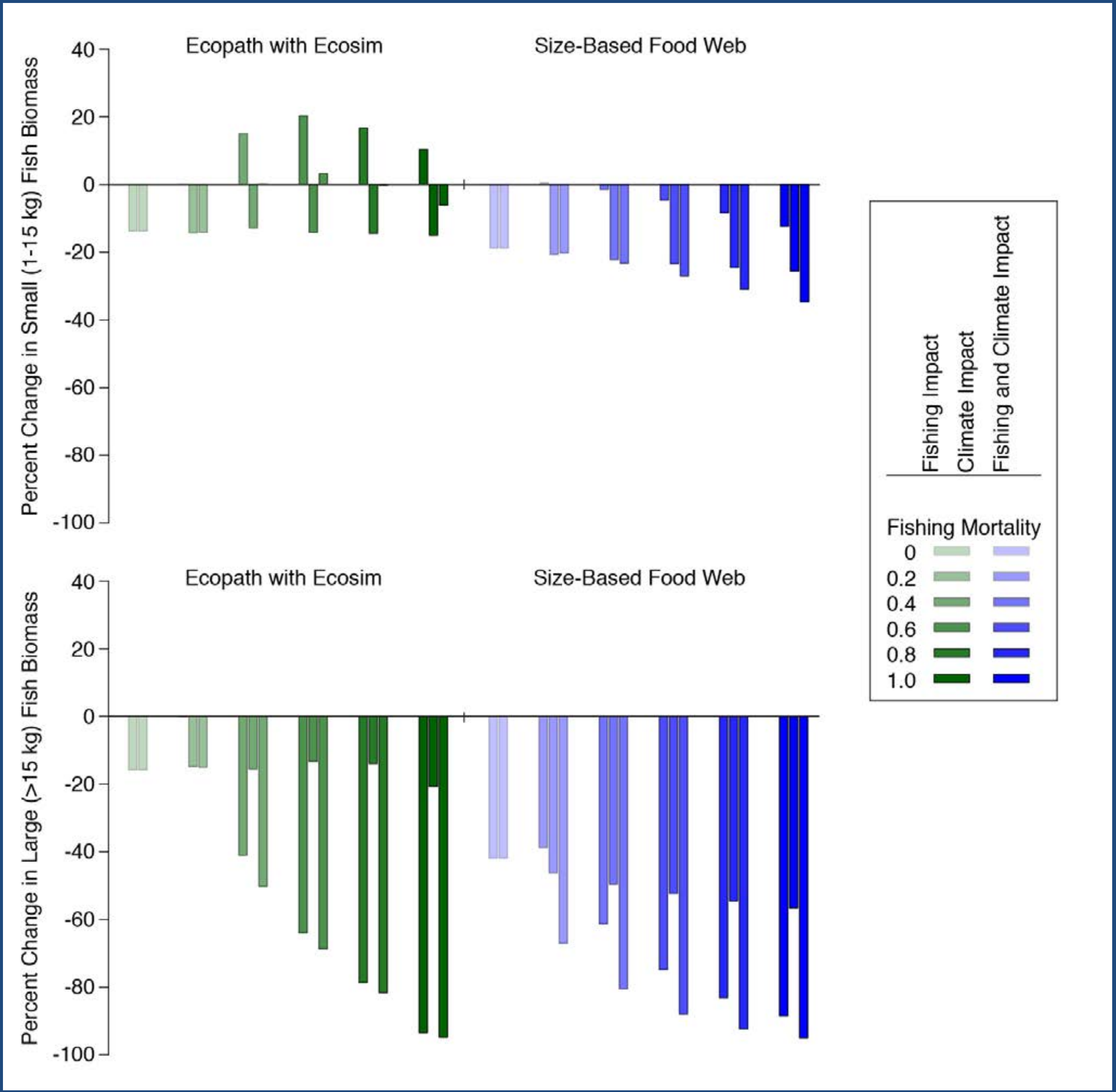
Size-based:
Size-based Food Web Model



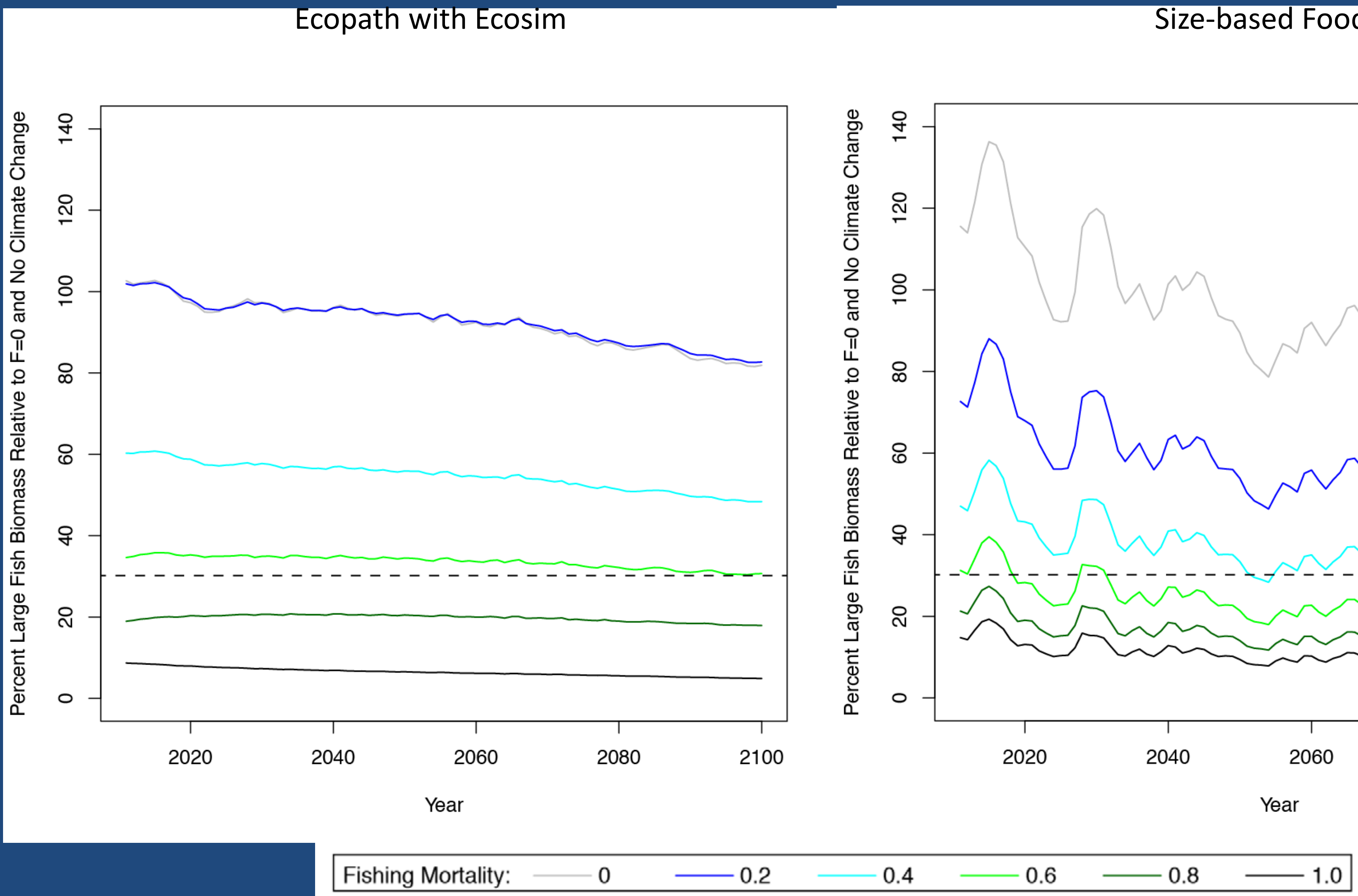


From Blanchard *et al.* 2009, modified

Impact of fishing and climate on large and small fishes biomass



Percent of large fish (>15 kg) biomass relative to large biomass in 2000 without fishing



Summary

The top-down response in this ecosystem means fishing and potentially bottom-up climate impacts will more negatively impact the larger rather than smaller fishes thus shifting the ecosystem size structure toward smaller sizes .

However, two ecosystem models suggest bottom-up impacts could range from moderate (-20%) to sever (-60%) depending on whether the ecosystem responds to a decline in the density of small size phytoplankton or the slope of the phytoplankton size structure.