Modeling the central North Pacific ecosystem response to predicted climate variations and fishery management scenarios

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Why look at this?

Polovina et al. 2009 paper - central North Pacific (HI Longline Fishery)

Observed CPUE (biomass) changes over 10 years

%Target Species ↓

%Incidental Species ↑

Can we look forward?

Climate

Have GFDL data to 2100

Ecosystem

Build EwE model for CNP

Fishing

F=1X | F=2X | F=0.5X

Do we expect trend to continue?

Increases in the relative abundance of mid-trophic level fishes concurrent with declines in apex predators in the subtropical North Pacific, 1996–2006

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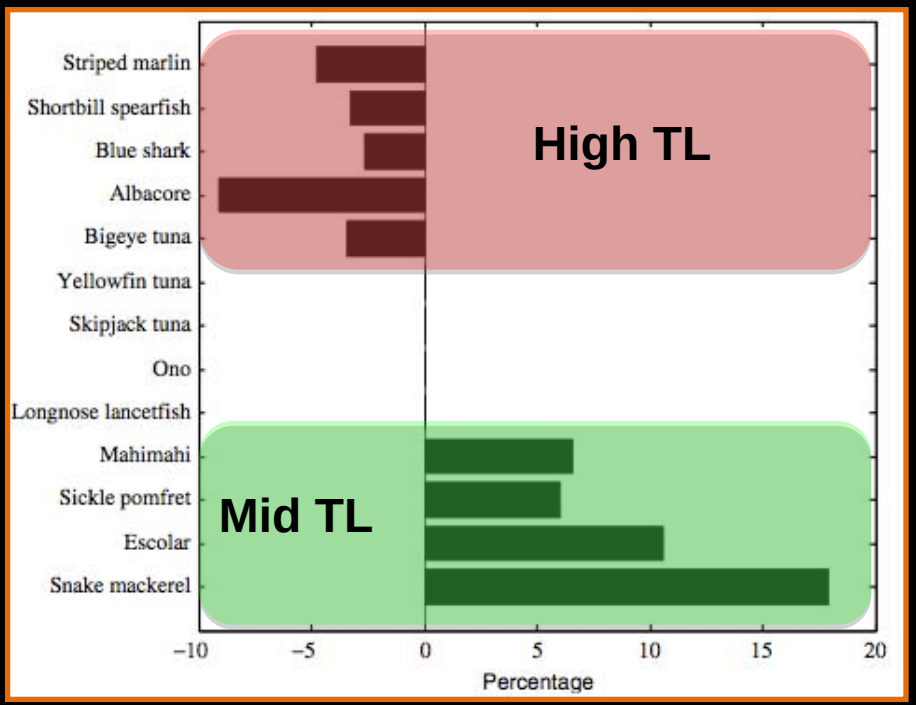


Model construction

Fishing (Top-down forcing): SPC + NOAA Longline

ETP EwE Model | *CNP Model* | *FishBase* | *Stock Assess.*

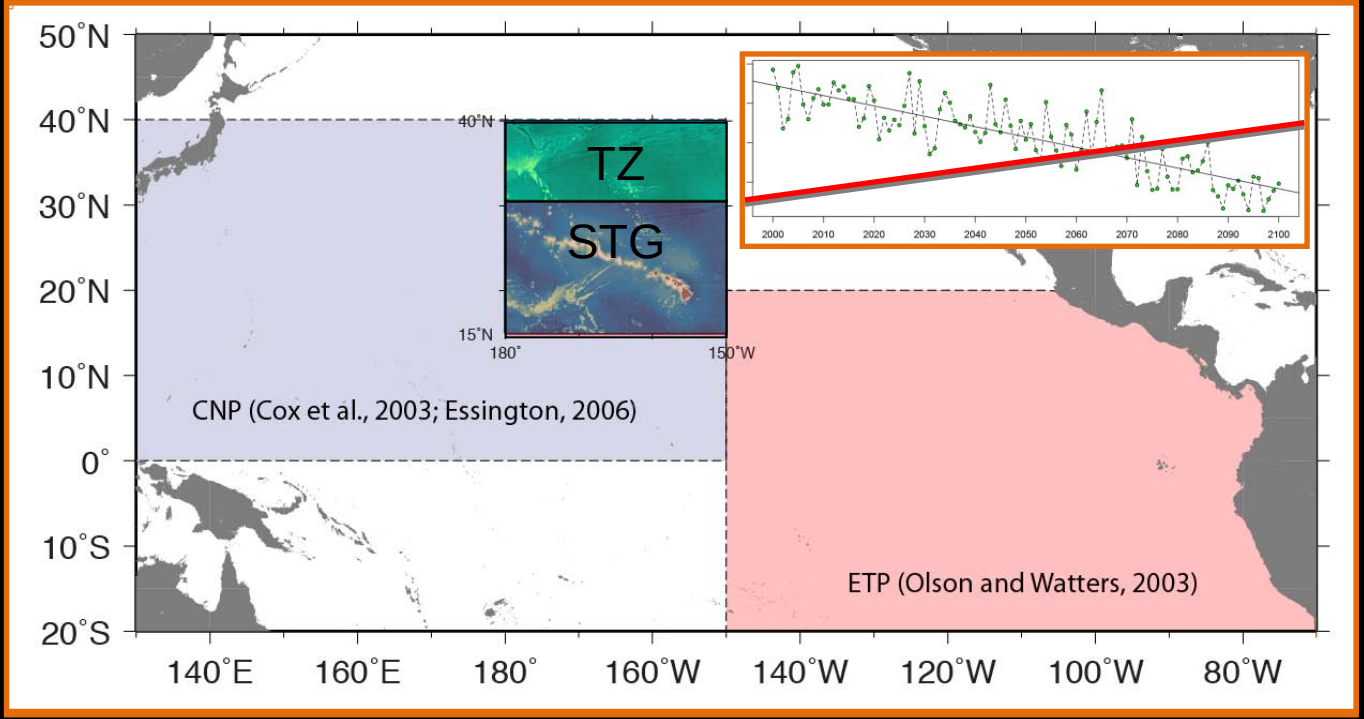
Phytoplankton (Bottom-up): GFDL ESM2.1 A2 NPZ projection

First: Ecosim run 1996-2006

Recreate trends observed?

Second: Ecosim runs 2000-2100

Observe similar trends?



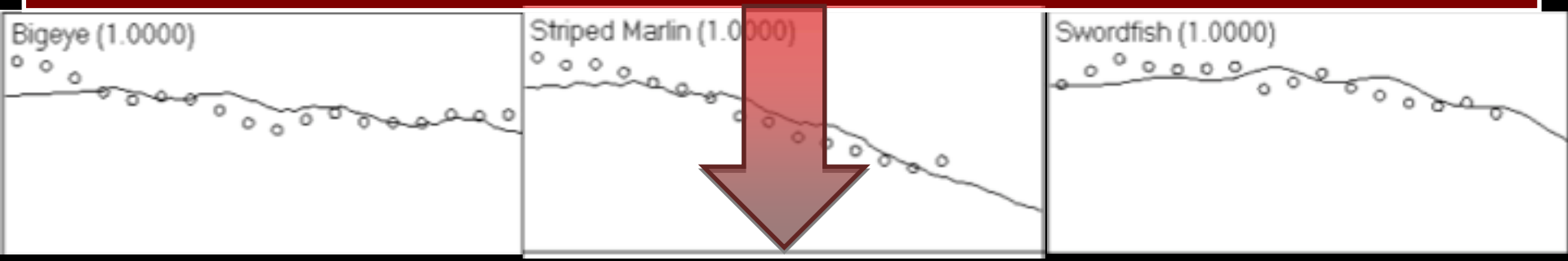
Initial model run results: 1996-2006

Force PP biomass (L/SM) with GFDL (high corr w/ SeaWiFS)

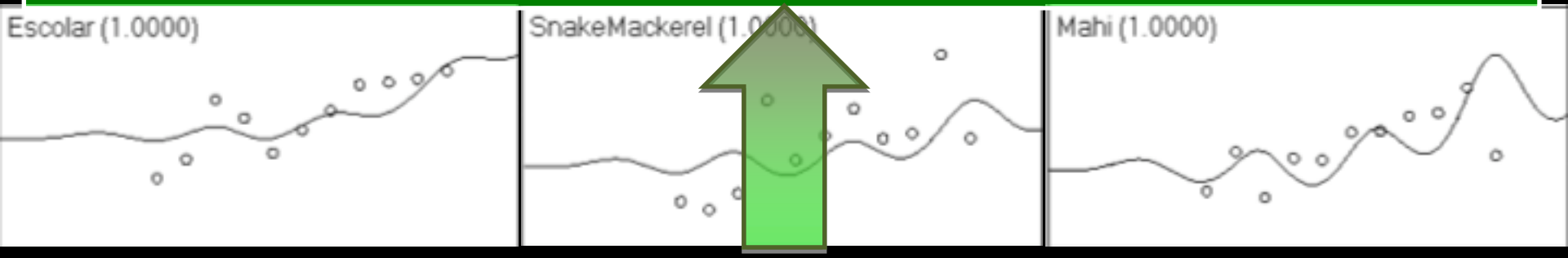
Fishing effort from NOAA/SPC Monthly effort

Ecosim 1990-2010, subset 1996-2006 Compare Biomass

Target species: Fit to stock assessment biomass (*B*) time series



Incidental species: Fit to fishery CPUE (*B* proxy) time series

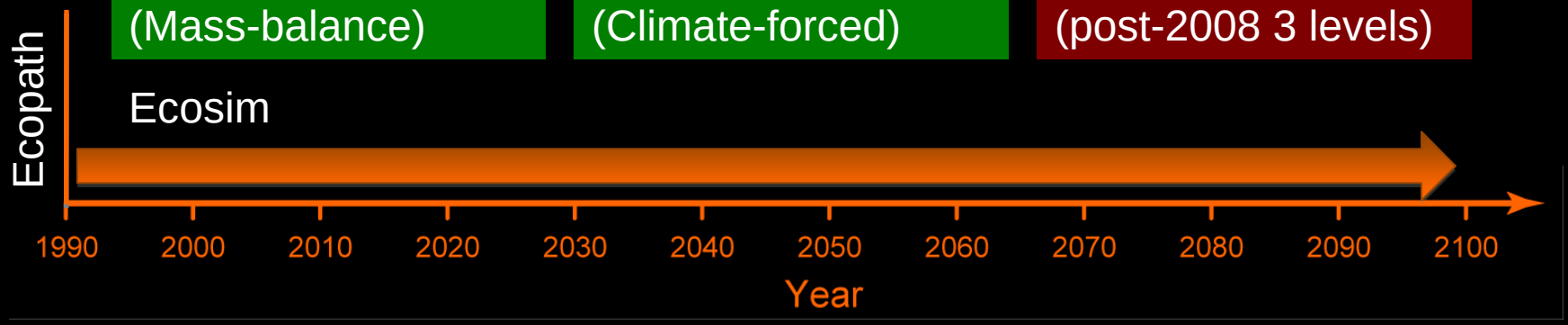


Ecosim runs to 2000-2100

Ecosim-derived PP (Mass-balance)

GFDL-derived PP (Climate-forced)

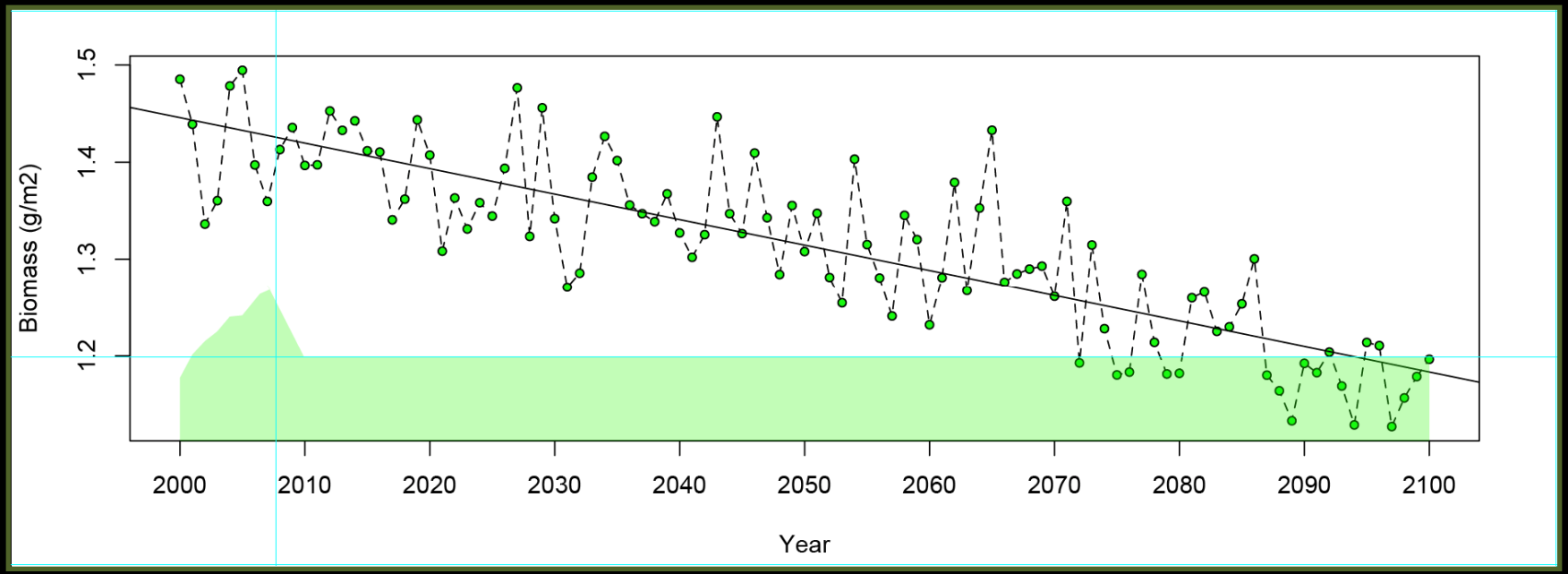
Fishing Effort (*F*) (post-2008 3 levels)



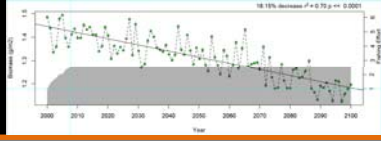
F = 1X 2008 levels

F = 2X 2008 levels

F = 0.5X 2008 levels



Results: F = 1X2008



2000 - 2020

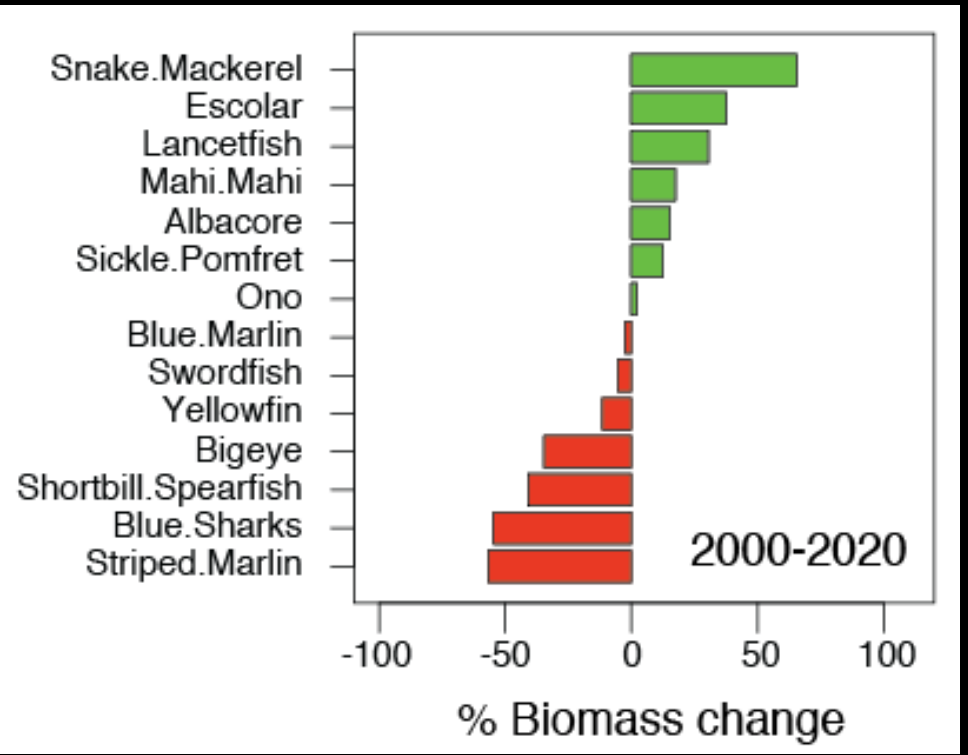
%Target Species ↓

%Incidental Species ↑

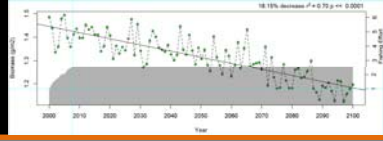
2080 - 2100

%Target Species ↓

%Incidental Species ↑

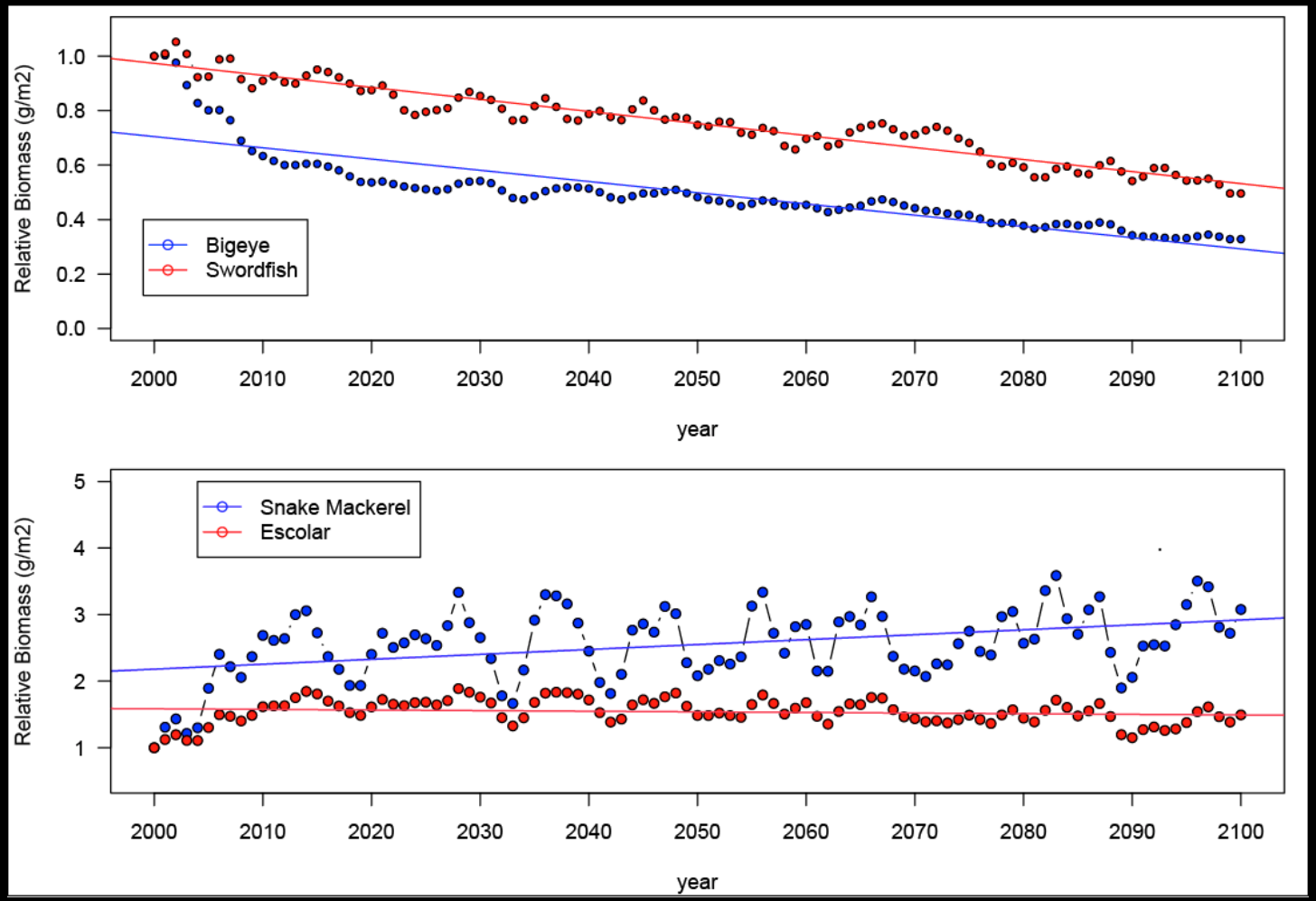


F = 2008

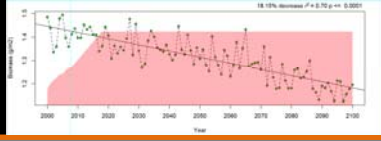


Example Targets
Bigeye tuna 60% biomass decrease
Swordfish 40% biomass decrease

Example Incidentals
Snake Mackerel 150% biomass increase
Escolar small biomass increase



F = 2X2008



2000 - 2020

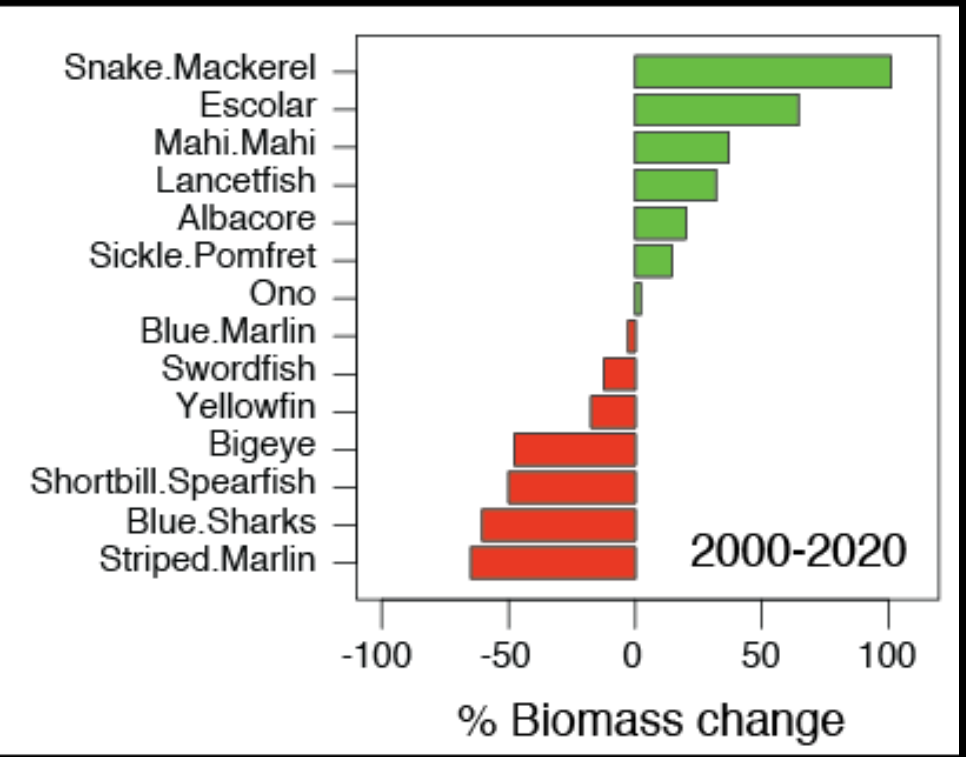
%Target Species ↓

%Incidental Species ↑

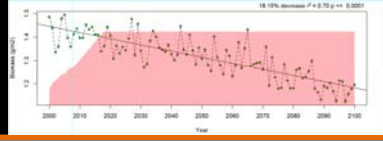
2080 - 2100

%Target Species ↓

%Incidental Species ↑

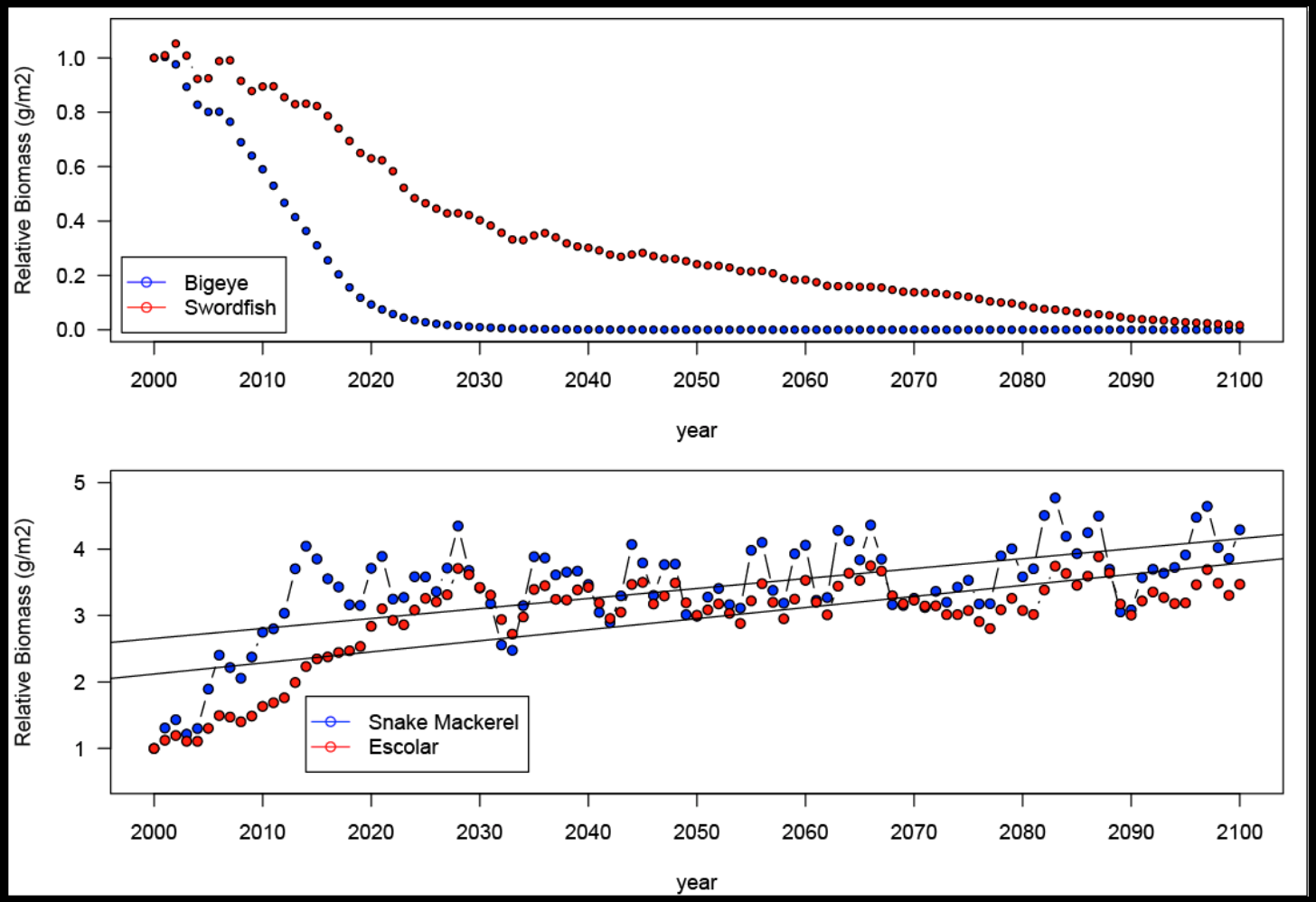


F = 2X2008

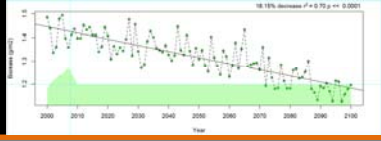


Example Targets
Bigeye tuna 100% biomass decrease
Swordfish 95% biomass decrease

Example Incidentals
Snake Mackerel 200% biomass increase
Escolar 200% biomass increase



F = 0.5X2008



Clim2000-2020 2080-2100

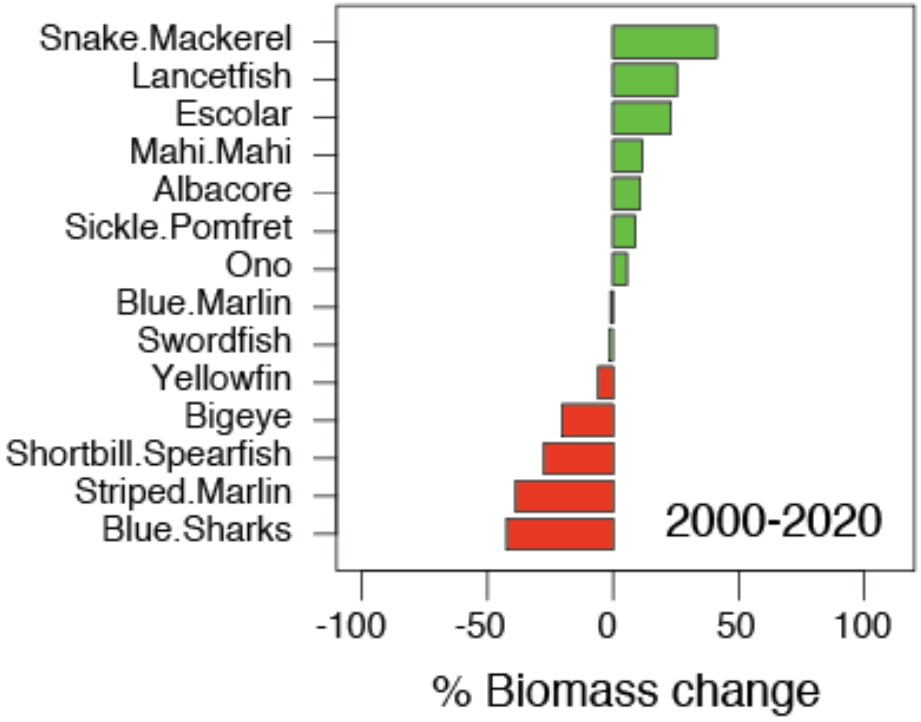
2080 - 2100

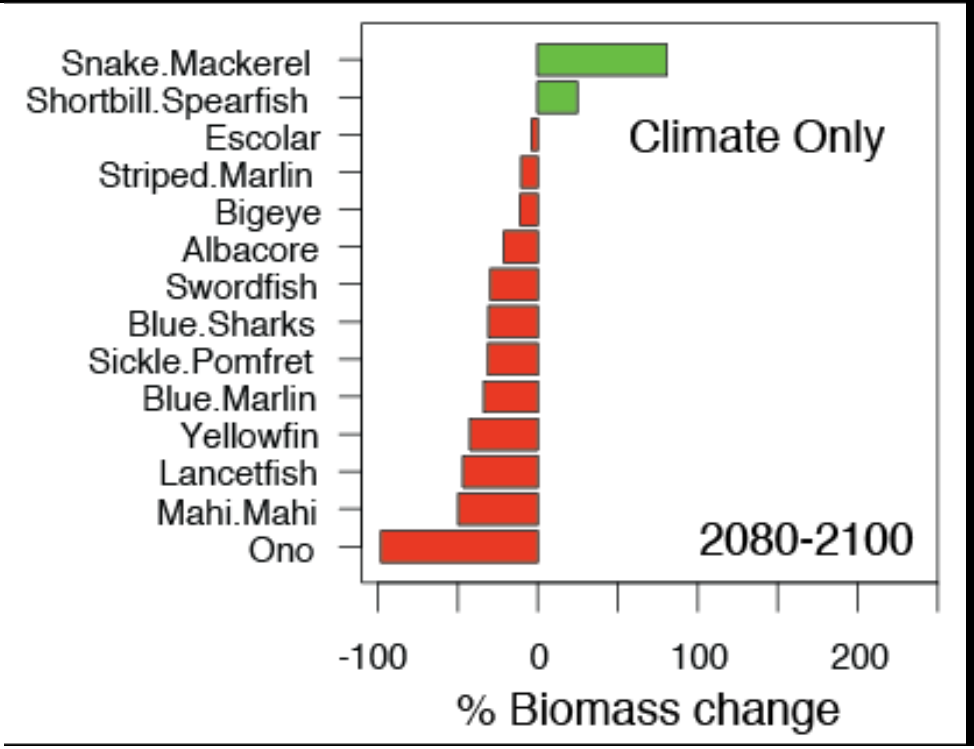
%Target Species ↓

%Incidental Species ↑

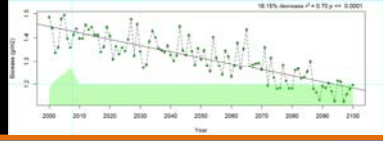
%Target Species ↓

%Incidental Species ↑



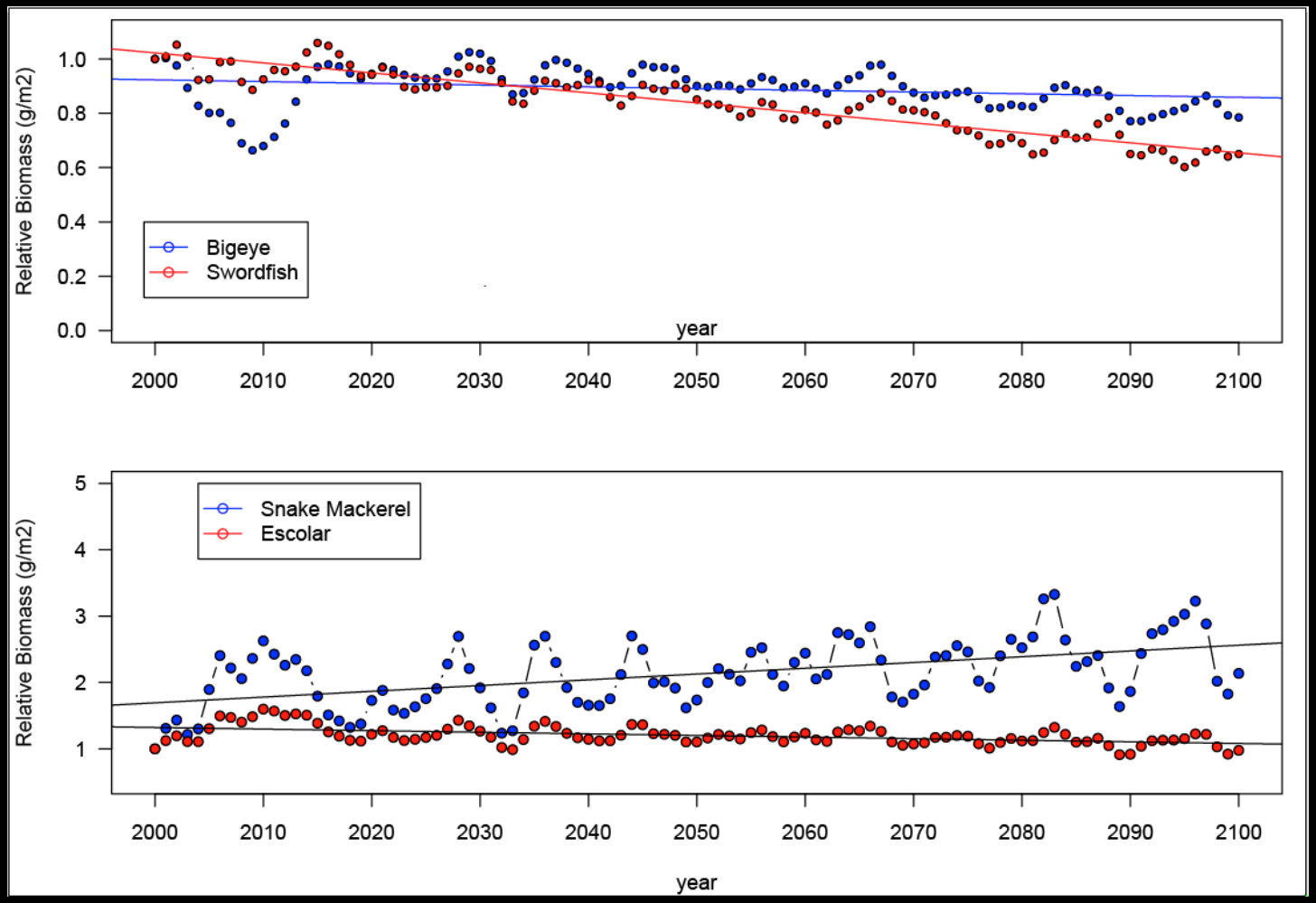


F = 0.5X2008



Example Targets
Bigeye tuna 20% biomass decrease
Swordfish 35% biomass decrease

Example Incidentals
Snake Mackerel 100% biomass increase
Escolar tiny biomass increase



Fishing scenario comparison

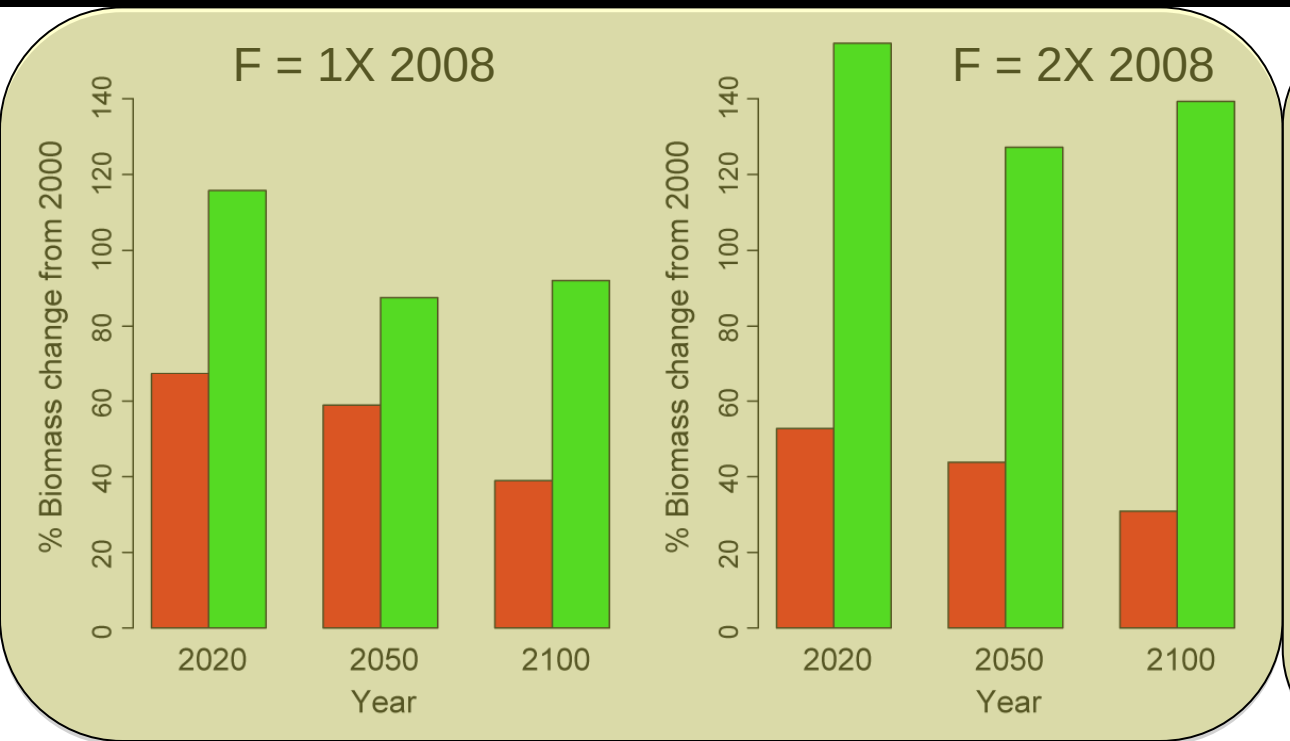
Grouped biomass snapshots at 2020, 2050, 2100

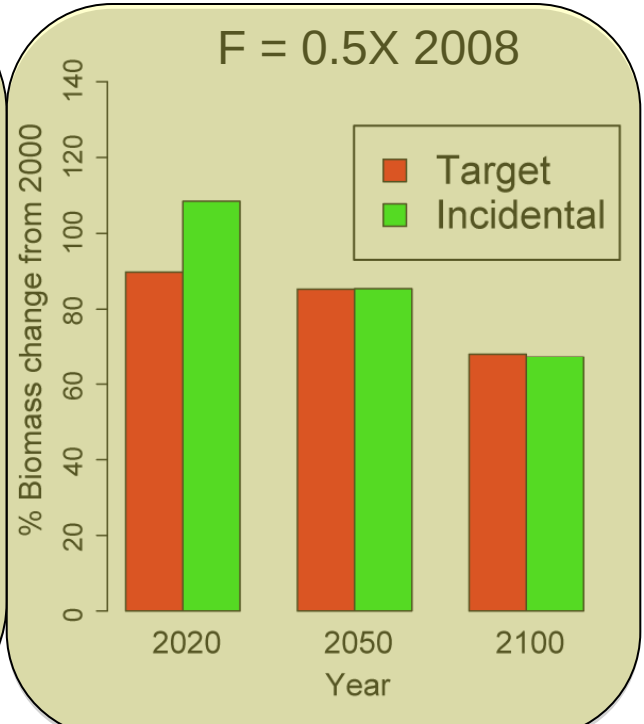
Target Species
(e.g. Tunas, Billfish)

Incidental Species (mid-TL)
(e.g. Snake Mackerel, Escolar, Mahi)

Fishing 1X,2X: Larger split target/incidental species

Fishing 0.5X: Comp. decrease in species over time





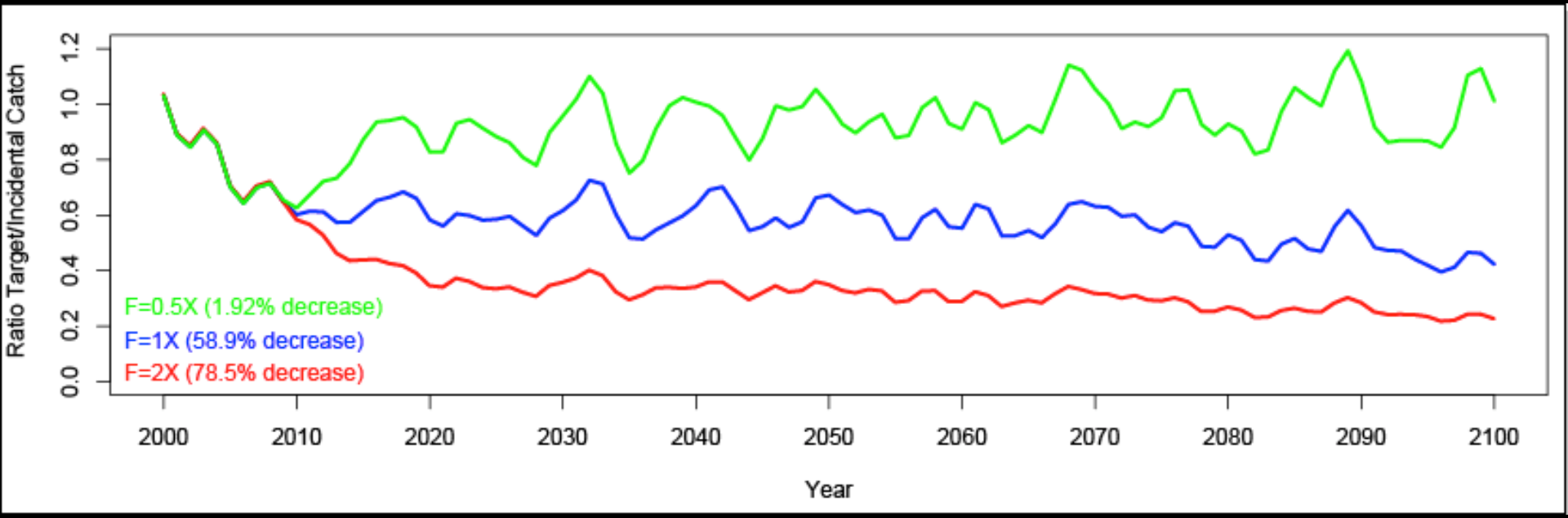
Fishing scenario comparison

T/I Ratio = $\frac{\text{Target Species}}{\text{Incidental Species}}$

Fishing 1X,2X: More effort affects T/I ratio

Overall view: almost all species decline in any scenario

Fishing 0.5X: Species decrease yet no ratio change



Summary and Future Work

GFDL climate scenario: ~18% drop in phytoplankton in HLFG. Bottom-up forcing = projected species decrease

Climate effects compounded by top-down fishing pressure. This results in lower projected target species B and T/I ratio

Based on projected results would recommend decrease in fishing effort in HLFG to preserve T/I ratio and decrease biomass reduction of target species

Continue to refine model where necessary, and understand sensitivities/uncertainties ("Peterman complex")

Future: Incorporate fishery yield and projected cost/loss based on model results (trade-offs)

What's for dinner?

2000 - 2020

2080 - 2100