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ATMOSPHERIC SCIENCE

Economic Assessment of the Biological Dynamics of Florida's Commercial Snapper-Grouper Fishery

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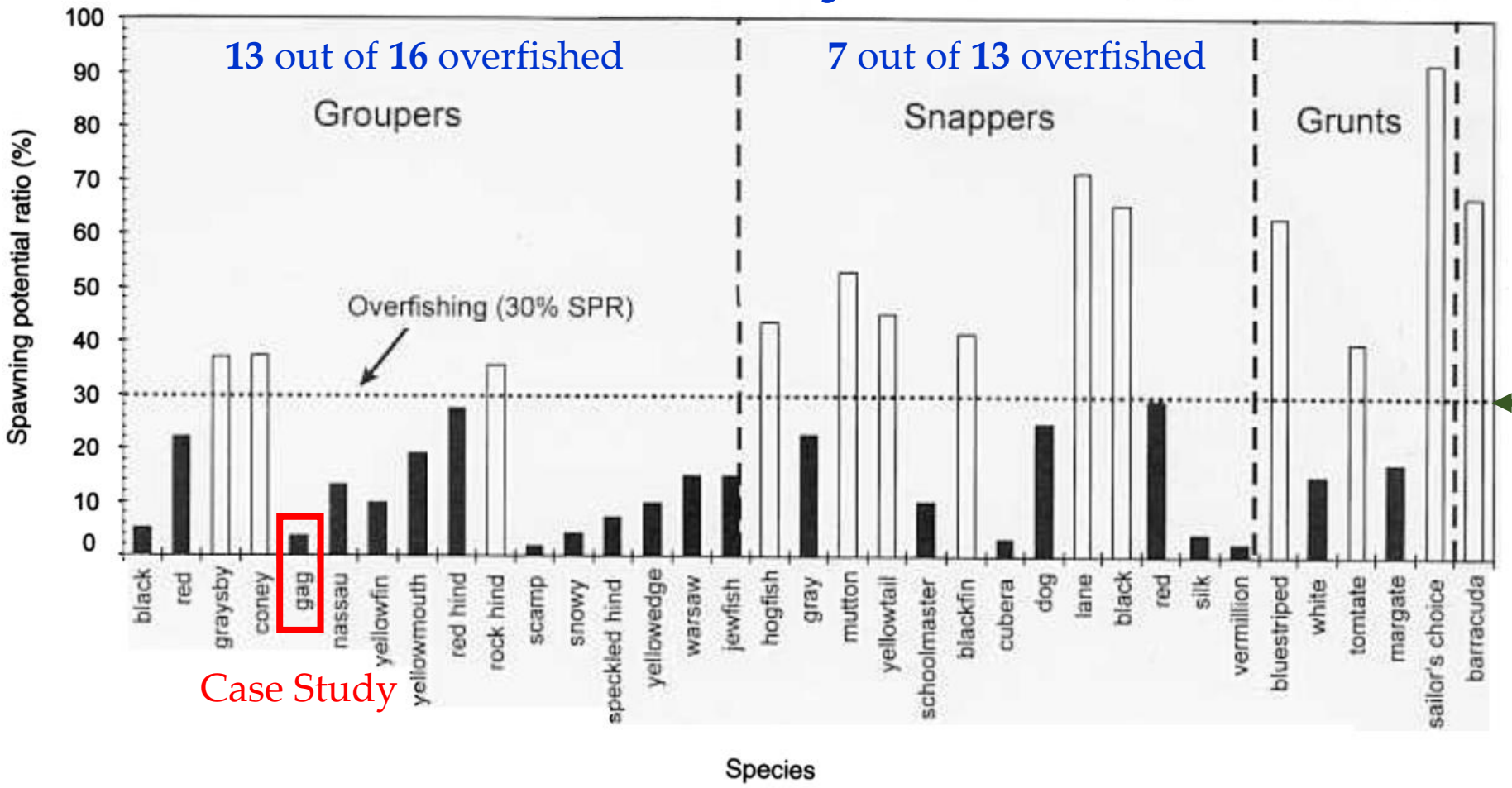
Goal

Determine long-term economic repercussions of transitioning from current to optimum catch biomass using an age-structured population production model to determine resource sustainability.

Florida Keys Reef Fish Sustainability Status in 1998



$$SPR_{30\%} = \frac{SSB}{SSB_0}$$

Spawning Potential Ratio (SPR) = Spawning Stock Biomass (SSB) to Unfished Biomass (SSB_0)

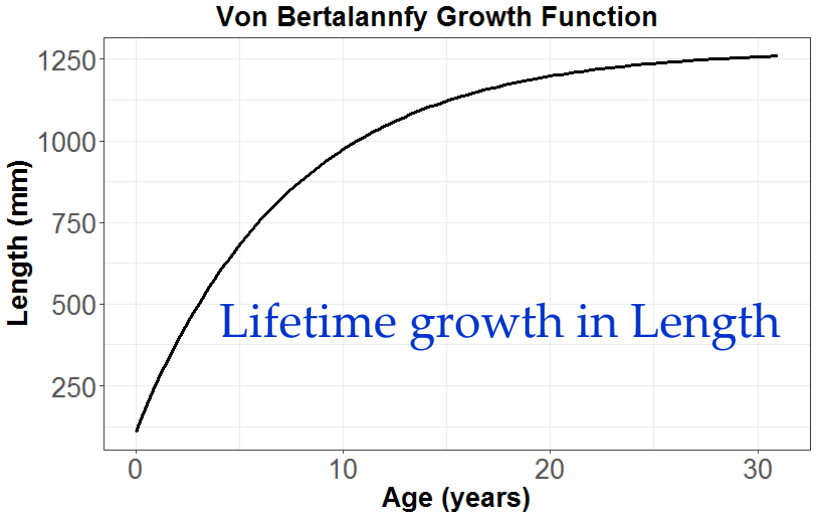
Ault, J.S., Bohnsack, J.A., Meester, G.A. 1998. A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys. Fishery Bulletin 96(3): 395-414.

Current Management Strategies

Case Study: Gag Grouper (*Mycteroperca microlepis*)

- **Federal & State Management Entities**
  - Gulf of Mexico Fishery Management Council
  - South Atlantic Fishery Management Council
  - Florida Marine Fishery Commission
- **Potential Regulatory Strategies**
  - Annual Catch Limits (ACLs)
  - Seasonal Closures
  - Individual Fishing Quotas (IFQs)
  - Size Limits
  - Marine Protected Areas (MPAs)

Gag Grouper Population Status

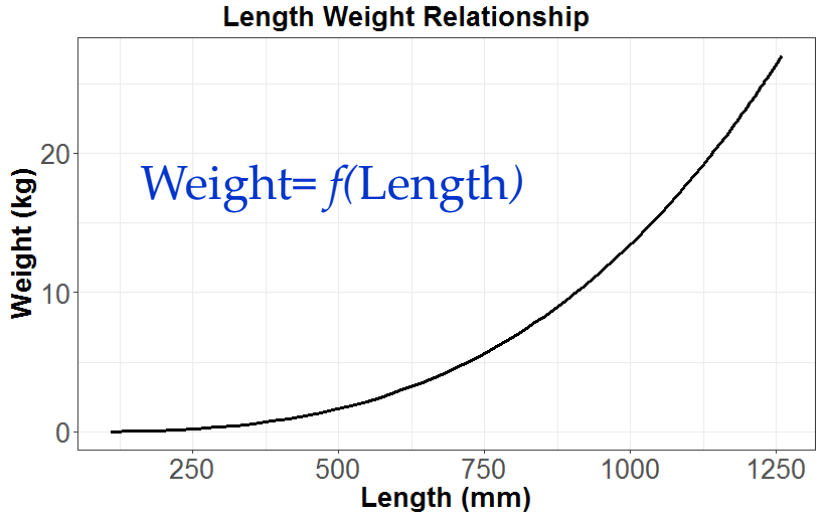


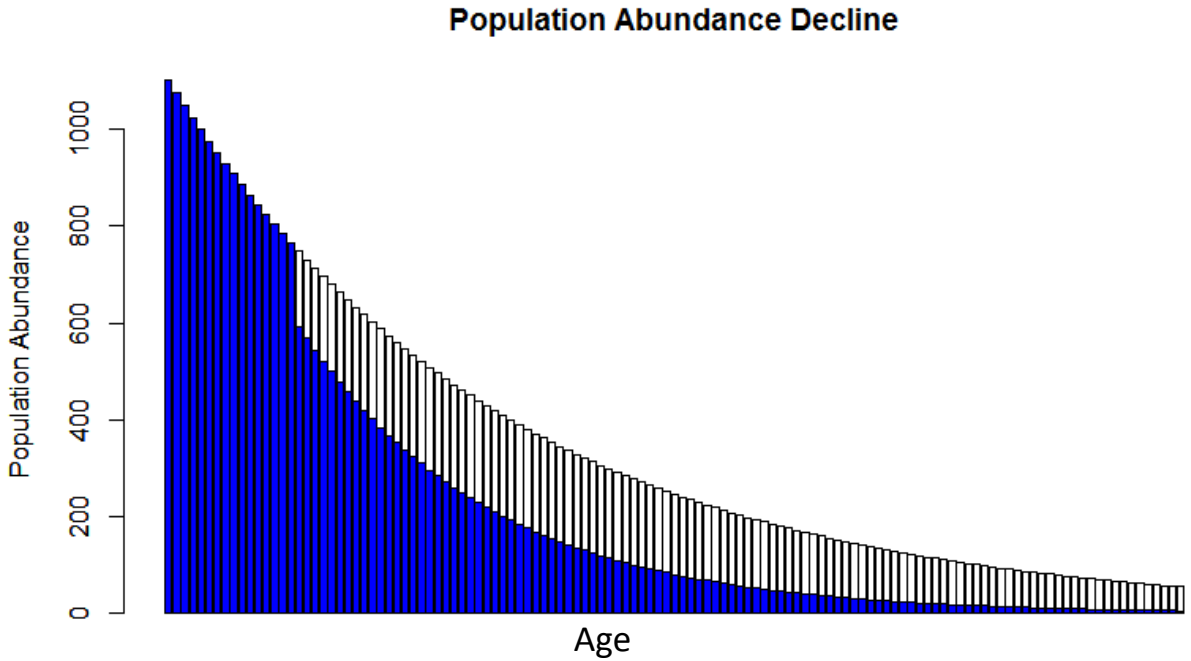
M = 0.0966

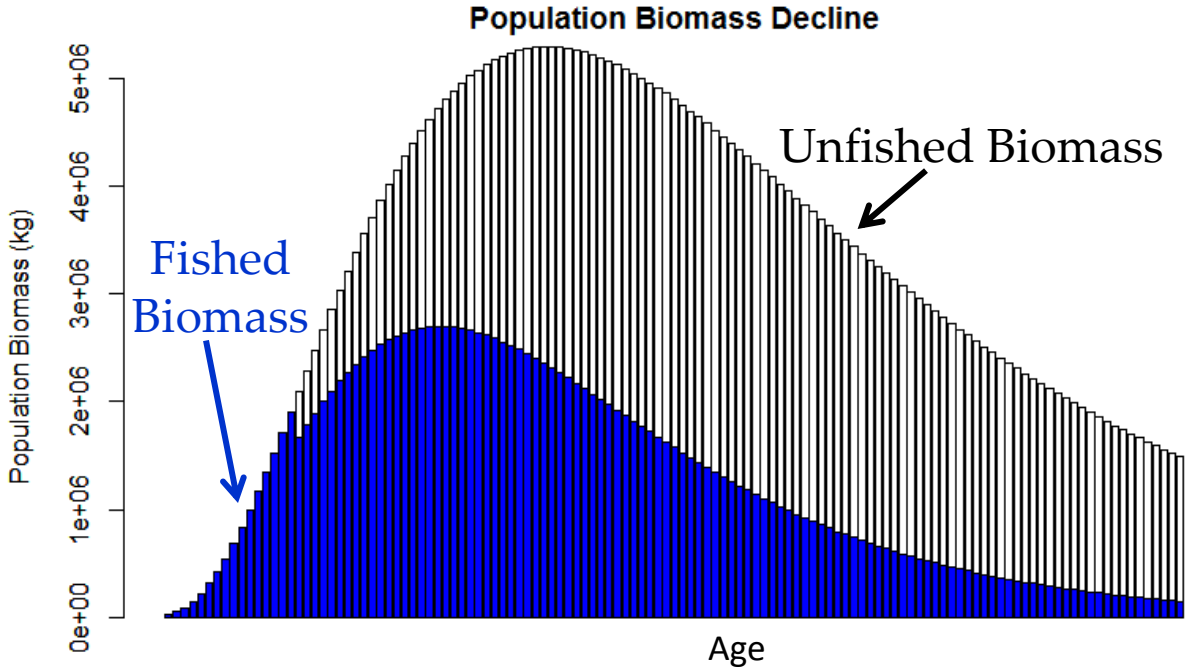
F = 0.3082

t_c = 4.16 yr

SPR = 13%







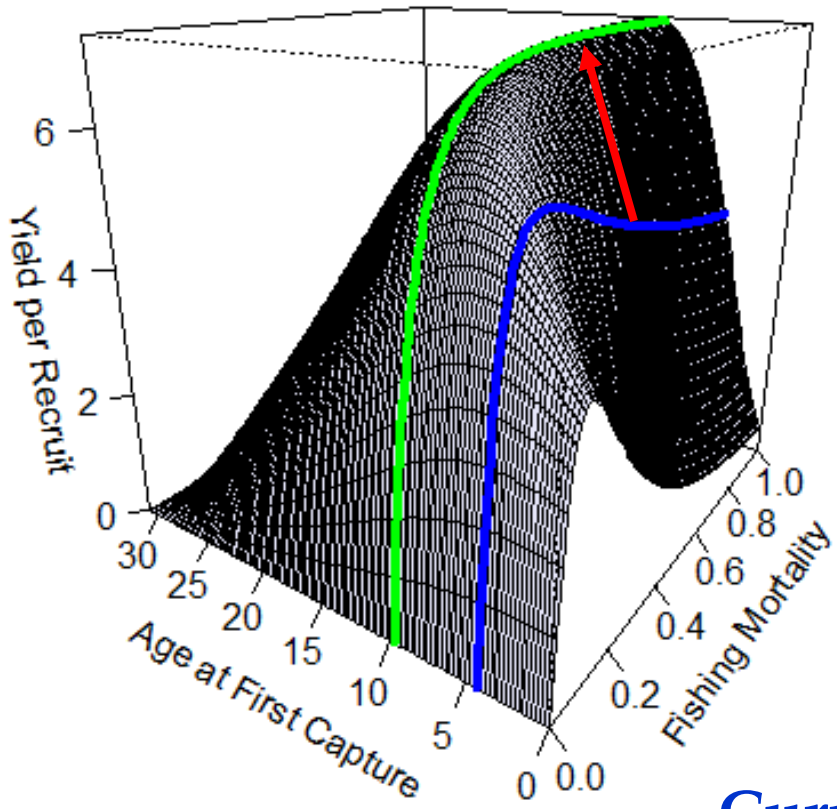
Management Risk Analysis

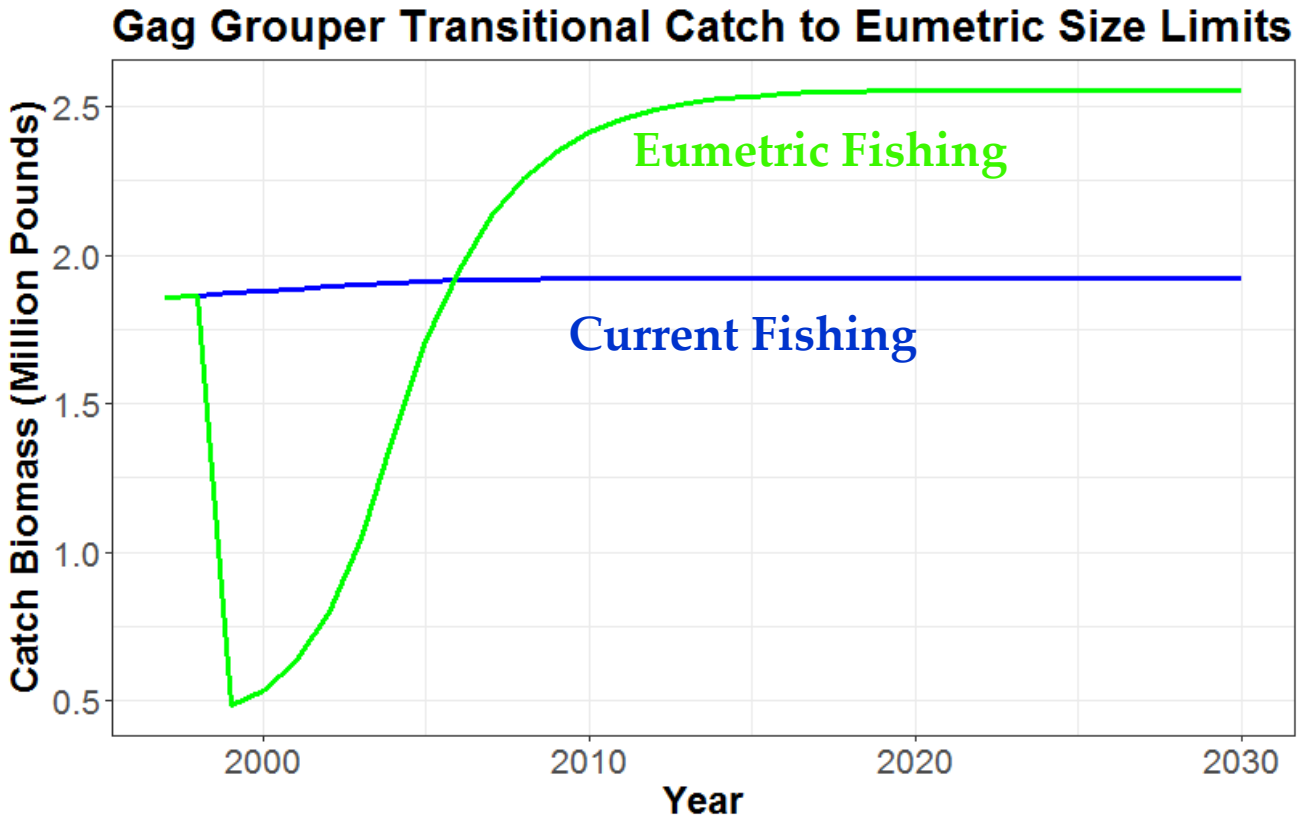
Question to be addressed in simulation study:

What if we had implemented **drastic** regulatory actions in 1999 to **optimize resource production** based on the recommendations of Ault *et al.* (1998)?

Ault, J.S., Bohnsack, J.A., Meester, G.A. 1998. A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys. Fishery Bulletin 96(3): 395-414.

“Eumetric” Fishing





	Current	Eumetric
t_c =	4.2 years	9.5 years
L_c =	24 inches	37 inches
SPR =	13%	38%

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fish. Invest. Ser. 2 Mar. Fish. G.B. Minist. Agric. Fish. Food No.19, 533 p.

Ex-Vessel Price Prediction Model

P = Ex-vessel price = $f(x)$

= $f($ Gag grouper landings
Domestic grouper landings
Imported grouper biomass
Grouper imports price
Disposable income
Florida population size
Month
Regulatory changes$)$

$$P_{si} = \beta_{s0} + \beta_{s1}x_{si1} + \ \ldots + \beta_{sj}x_{sij} + \xi_{si}$$

Case Study: s = Gag grouper

s = species
i = monthly time steps
j = explanatory variables

Ex-Vessel Price Cross-Correlogram

Typical correlation when lag = 0

Lag (k_{sj}) = 0

$$p_{s1} - x_{s1j}$$
$$p_{s2} - x_{s2j}$$
$$\dots - \dots$$
$$p_{sn} - x_{snj}$$

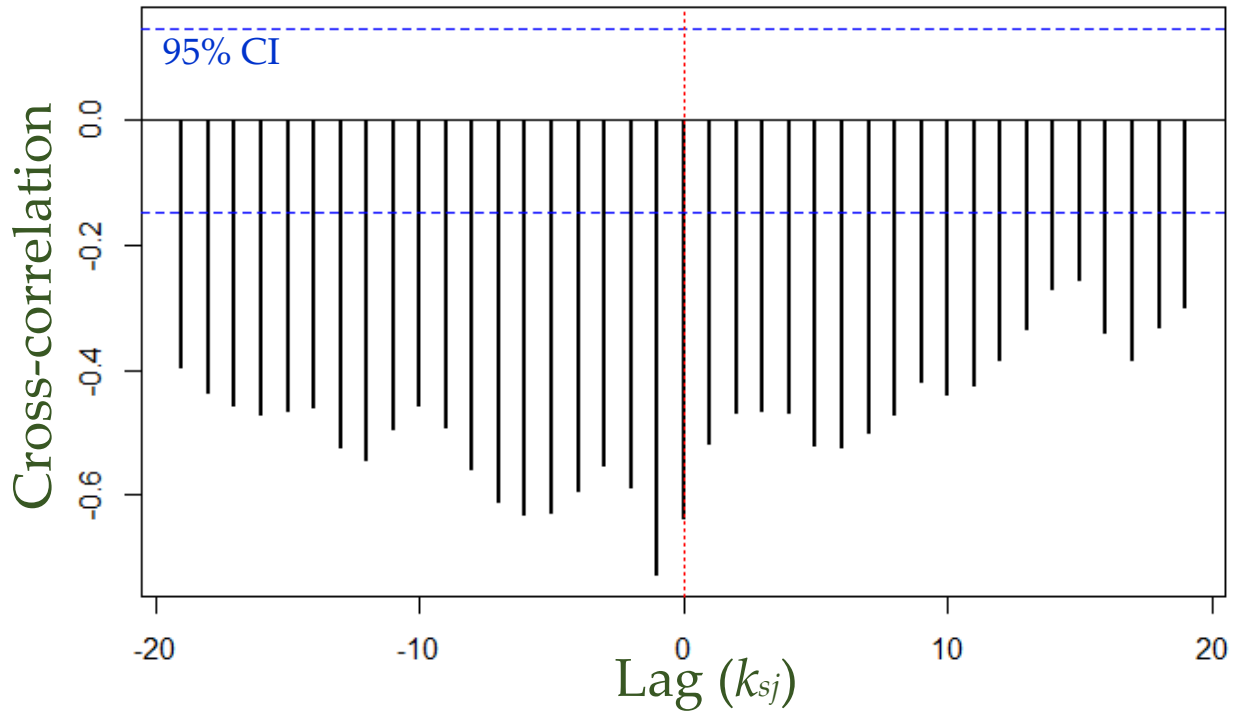
Lag (k_{sj}) = -1

$$p_{s1}$$
$$p_{s2} - x_{s1j}$$
$$p_{s3} - x_{s2j}$$
$$\dots - \dots$$
$$p_{sn} - x_{s(n-1)j}$$
$$x_{snj}$$

Lag (k_{sj}) = 1

$$x_{s1j}$$
$$p_{s1} - x_{s2j}$$
$$p_{s2} - x_{s3j}$$
$$\dots - \dots$$
$$p_{s(n-1)} - x_{snj}$$
$$p_{sn}$$

Ex-Vessel Price (p_s) ~ Landings (x_{sj})



Gag grouper landings *lead* ex-vessel price (k_{s1} = -1)

Correlation of Explanatory Variables

Remove correlation ($r_{x_{s(i-1)1}, x_{si2}} = -0.486$) between **landings**, $x_{s(i-1)1}$, and **price of imported groupers**, x_{si2} .

$$x_{si2} = b_{s0} + b_{s1} x_{s(i-1)1} + \phi_{si2}$$

x_{si2} = imported grouper price
$b_{s(j+1)}$ = regression coefficients
$x_{s(i-1)1}$ = lagged landings
ϕ_{si2} = residuals of price on lagged landings ← new explanatory variable

Final model with residuals, ϕ_{si2}, in place of correlated variable, x_{si2}

Estimate of b_{s0}	74.49% reduction in CV
Estimate of $b_{s(j=\text{landings})}$	29.48% reduction in CV

Final Inverse Demand Function

$p = f$(lagged gag grouper landings, import price residuals, IFQ)

$$p_{si} = b_{s0} + b_{s1}x_{s(i+k_{s1})1} + b_{s2}\phi_{si2} + b_{s3}x_{si3} + \varepsilon_{si}$$

s = species

i = month

$x_{s(i-1)1}$ = lagged landings (k_{s1} = -1)

$\phi_2 = x_{si2}$ = imported grouper price residuals

x_{si3} = IFQ

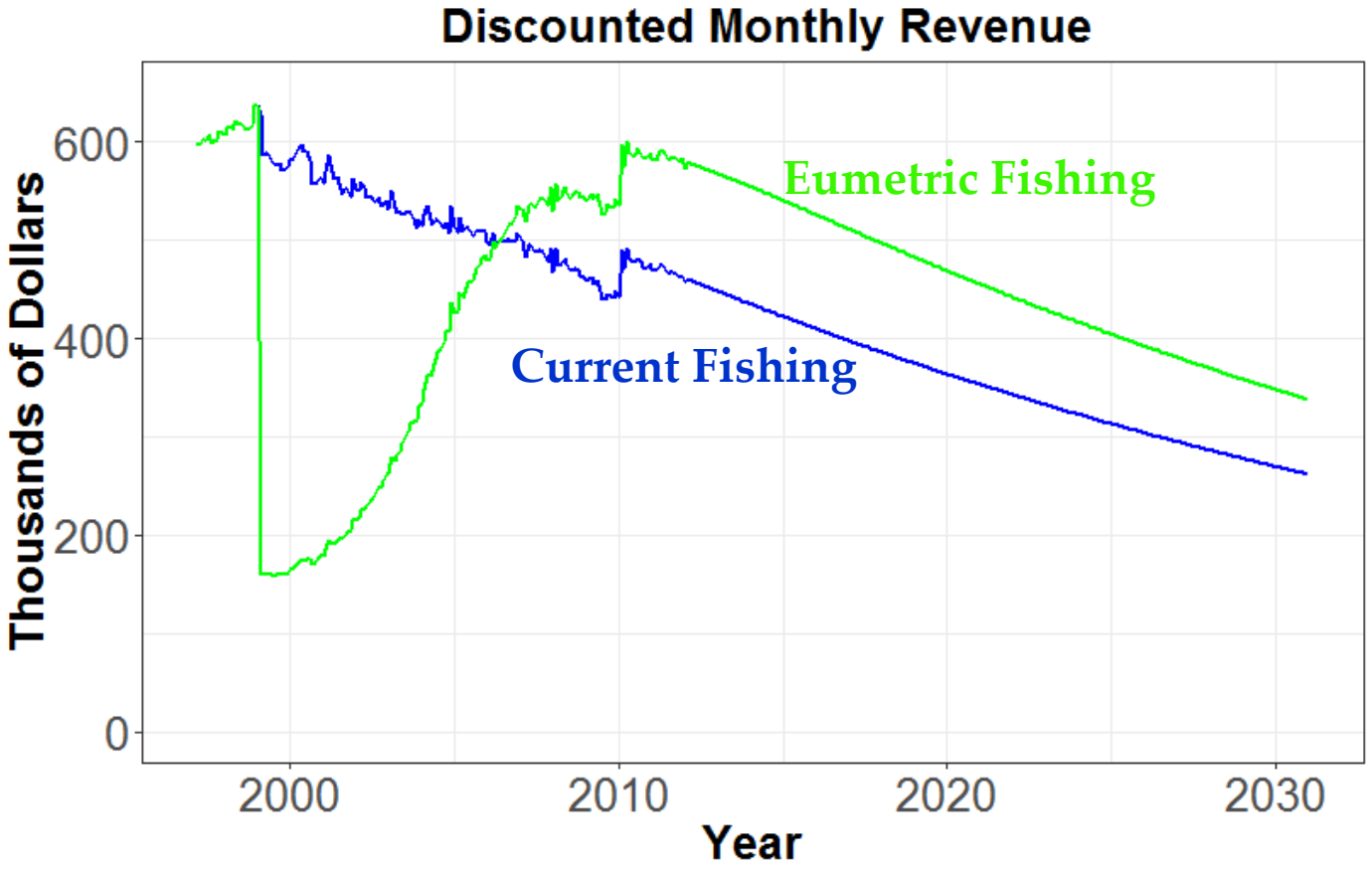
Parameter Estimates

b_{s0}	= 4.46	p<0.0001
b_{s1}	= -2.45E-06	p<0.0001
b_{s2}	= 0.0460	p<0.0001
b_{s3}	= 0.384	p<0.0001

R-Squared = **0.6797**

Economic Evaluation

Implementation of IFQs increased gag grouper ex-vessel price by $ 0.38

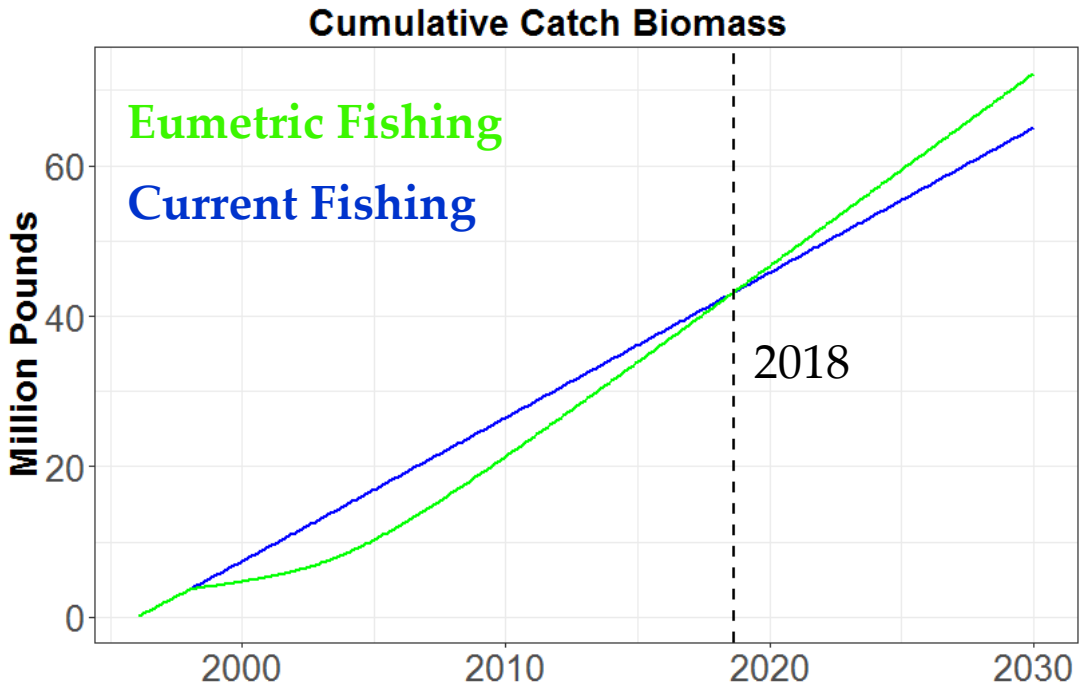


Price flexibility

$$\frac{dp_{si}}{dx_{s(i-1)1}} = b_{i1}\left(\frac{\bar{x}_{s1}}{\bar{p}_s}\right) = -0.0868$$

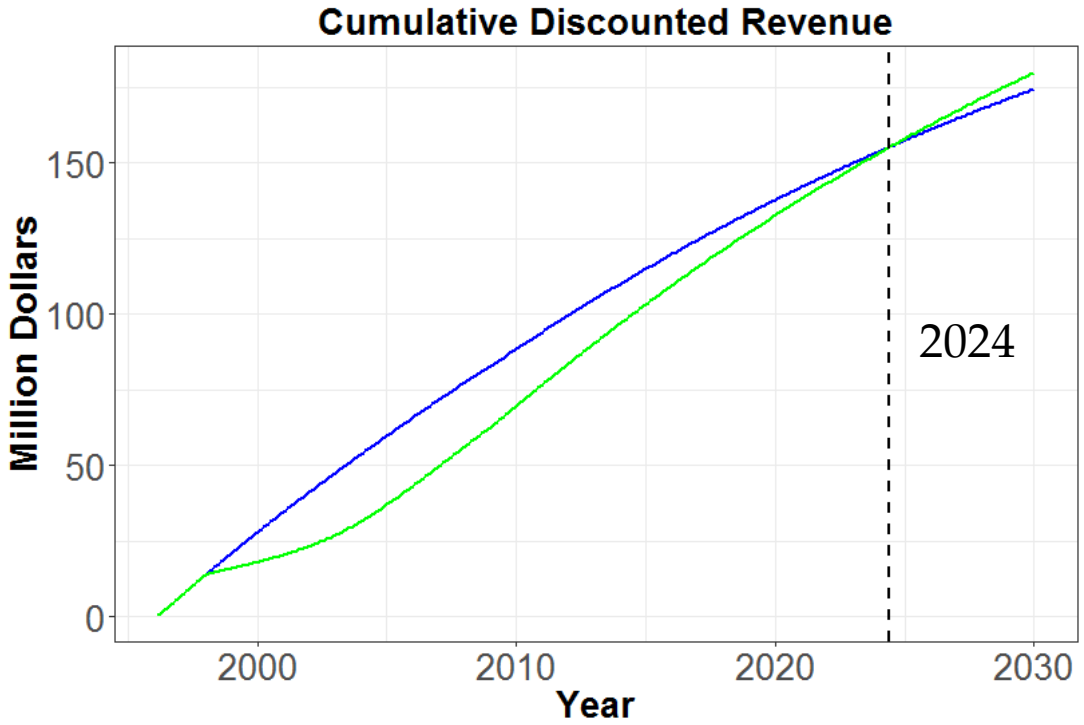
Delta method significance test

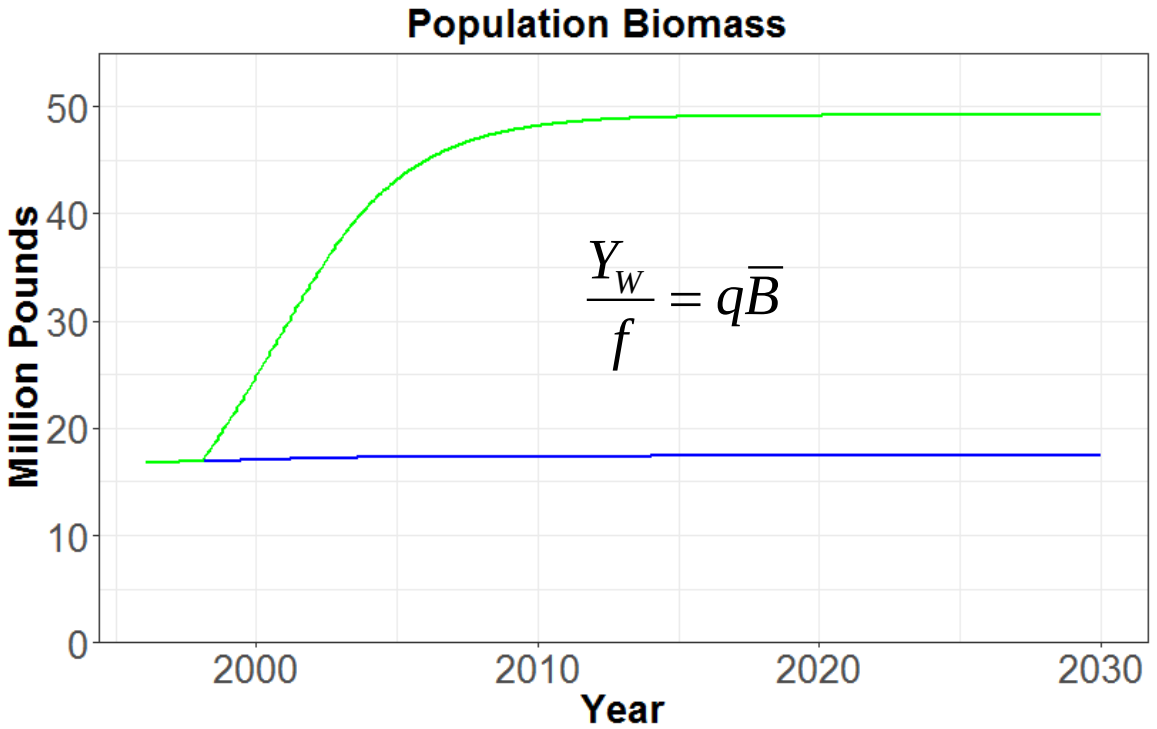
$p < 0.0001$



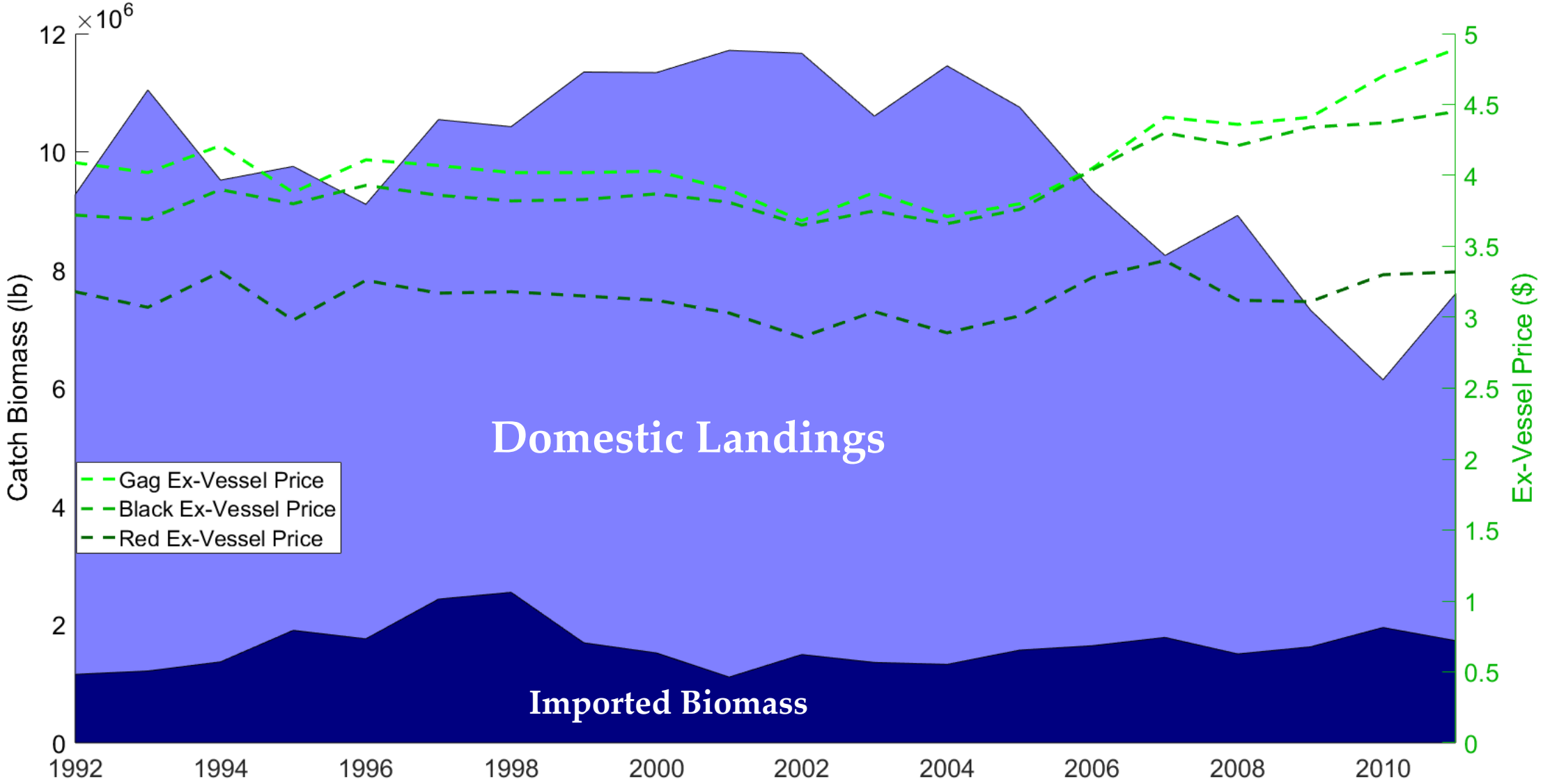
Gag Grouper Projections

- Allocation transfers—expected profits (~$2/lb)
- Current t_c 2013 discounted profit: $ 2,882,429
- Eumetric 2013 discounted profit: $ 3,767,390
- **Approximately $884,862 annual long-term gain**

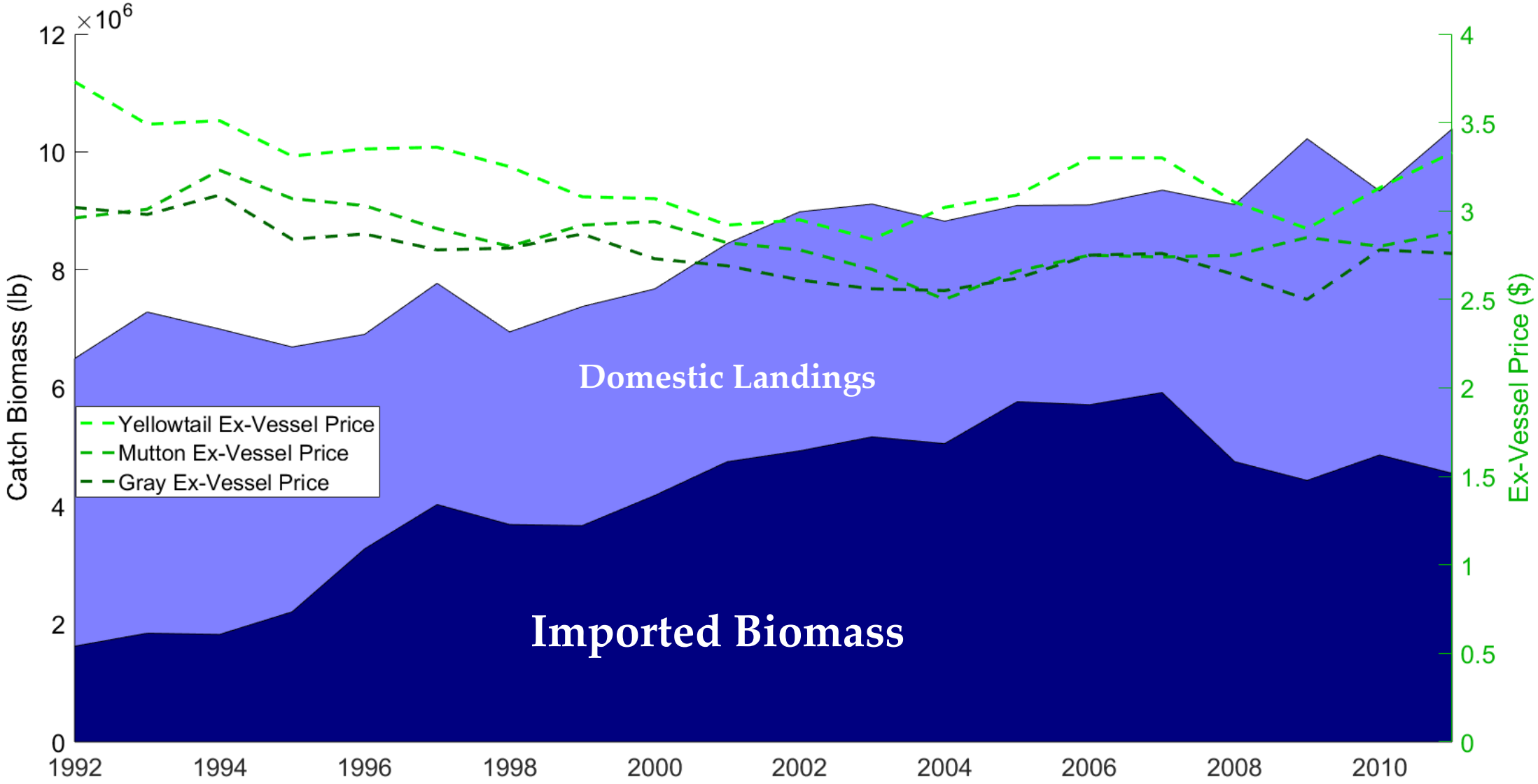




Grouper Production and Value



Snapper Production and Value



Future Focus

- Cost function associated with fishing effort
- Complementary snapper analysis
- Sensitivity to catch & release mortality

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