NOAA FISHERIES

SEFSC

SEDAR 39

HMS Gulf of Mexico Smoothhound Complex

Stock Assessment

SEDAR 39

March 11, 2015

Outline

- Rationale
- Data inputs
- Model description
- Base model and results
- Uncertainty analysis (sensitivities)
- Projections
- Conclusions

Why assess a complex *vs.* individual species?

- Inability to differentiate among 3 species (*Mustelus canis*, *M. sinusmexicanus*, *M. norrisi*) due to difficulty of correct identification. This made it necessary to conduct the analyses on the complex of three species of GOM *Mustelus*

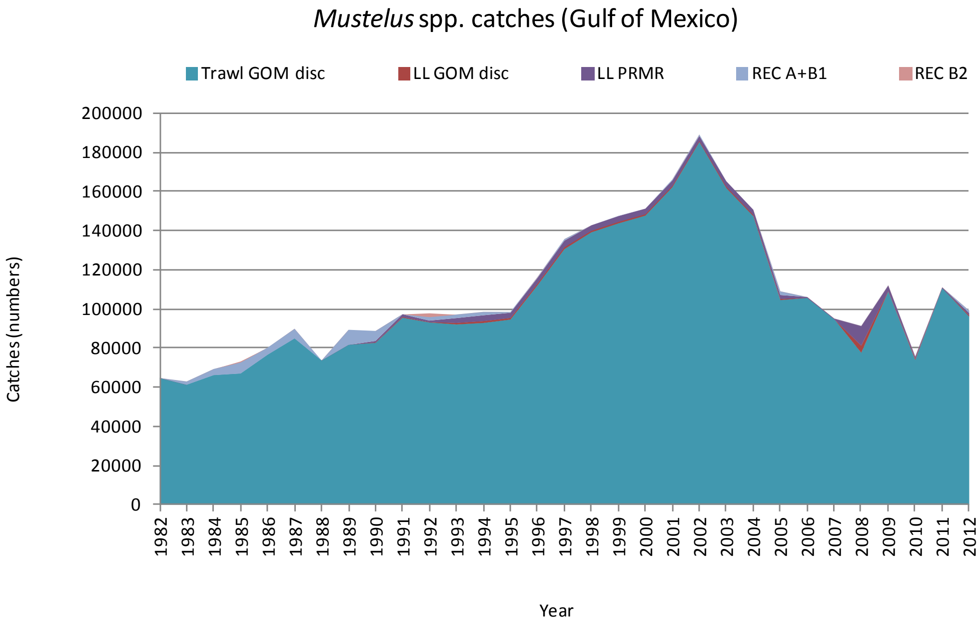
Why use surplus production models?

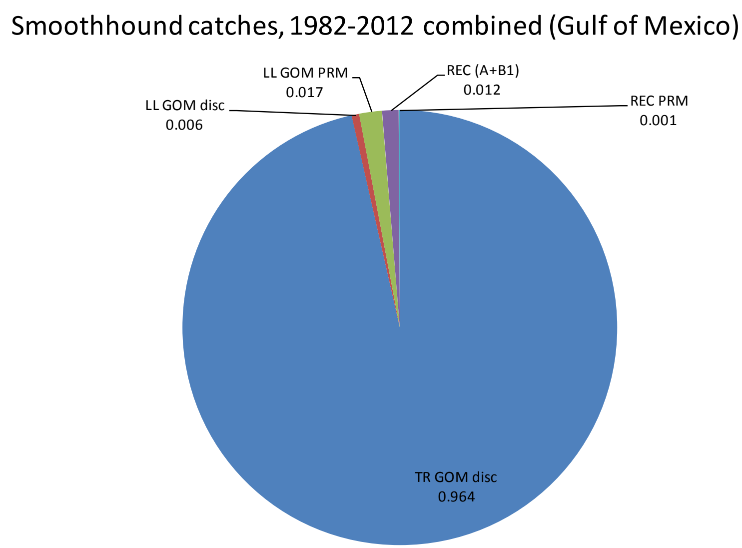
- Inability to differentiate among species precluded use of an age-structured model
- Use of a production model still allowed us to carry out quantitative projections
- Used a state-space Bayesian surplus production model, which in addition to considering observation error also considers process error

Data inputs

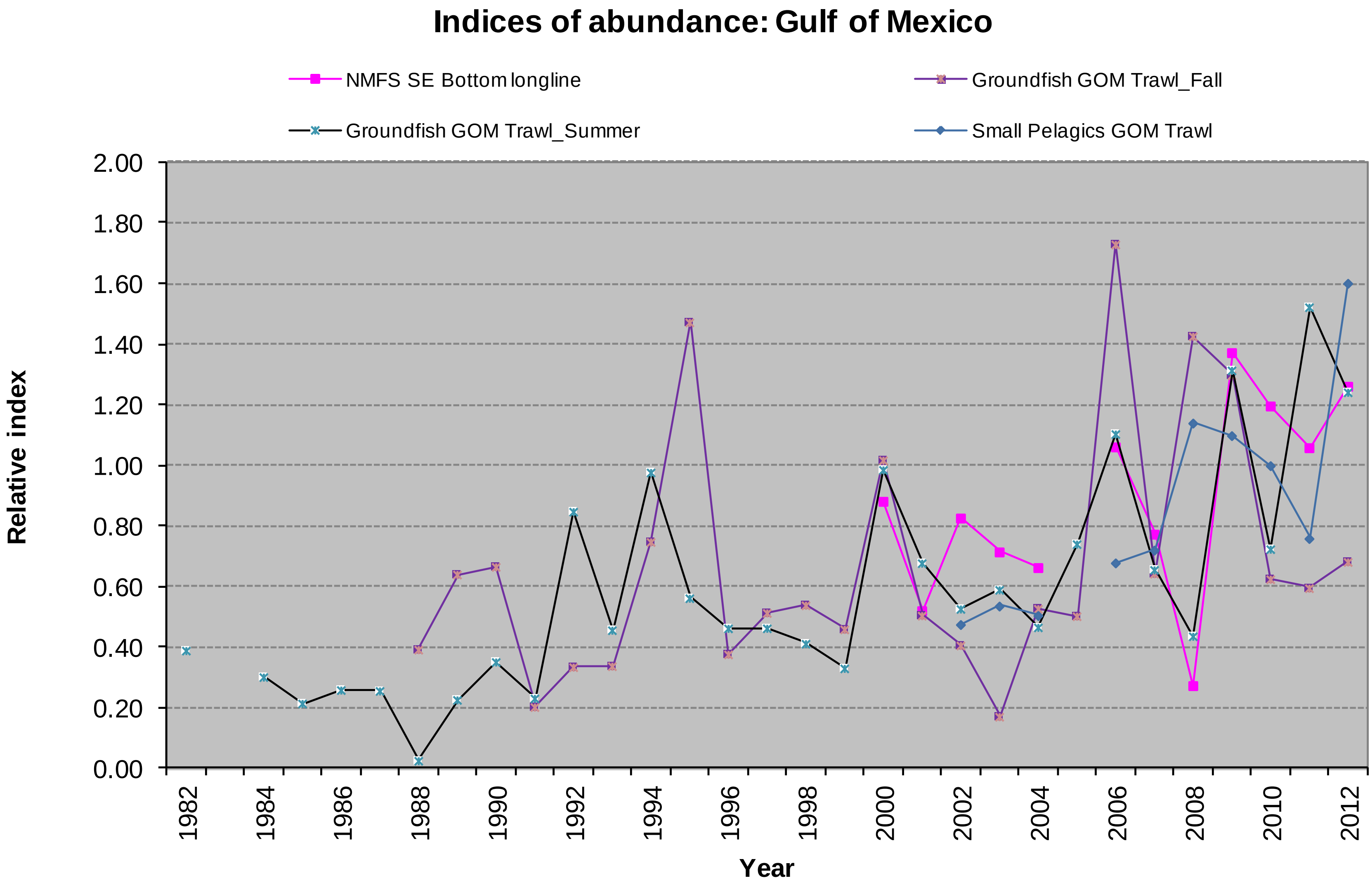
- Catch (one single series)
- Indices of abundance:
  1. NMFS SE Bottom Longline (NMFSSEBLL)
  2. Groundfish Trawl_Fall (GROUNDTRF)
  3. Groundfish Trawl_Summer (GROUNDTRS)
  4. Small Pelagics Trawl (SMALLPELTR)
- Priors for r, K, $P_{82}=N_{82}/K$ (initial depletion), observation error and process error variances, proportions of carrying capacity ($P_t=N_t/K$)

Catches of smoothhounds in the Gulf of Mexico, 1982-2012 (top) and as a proportion for all years combined (bottom)



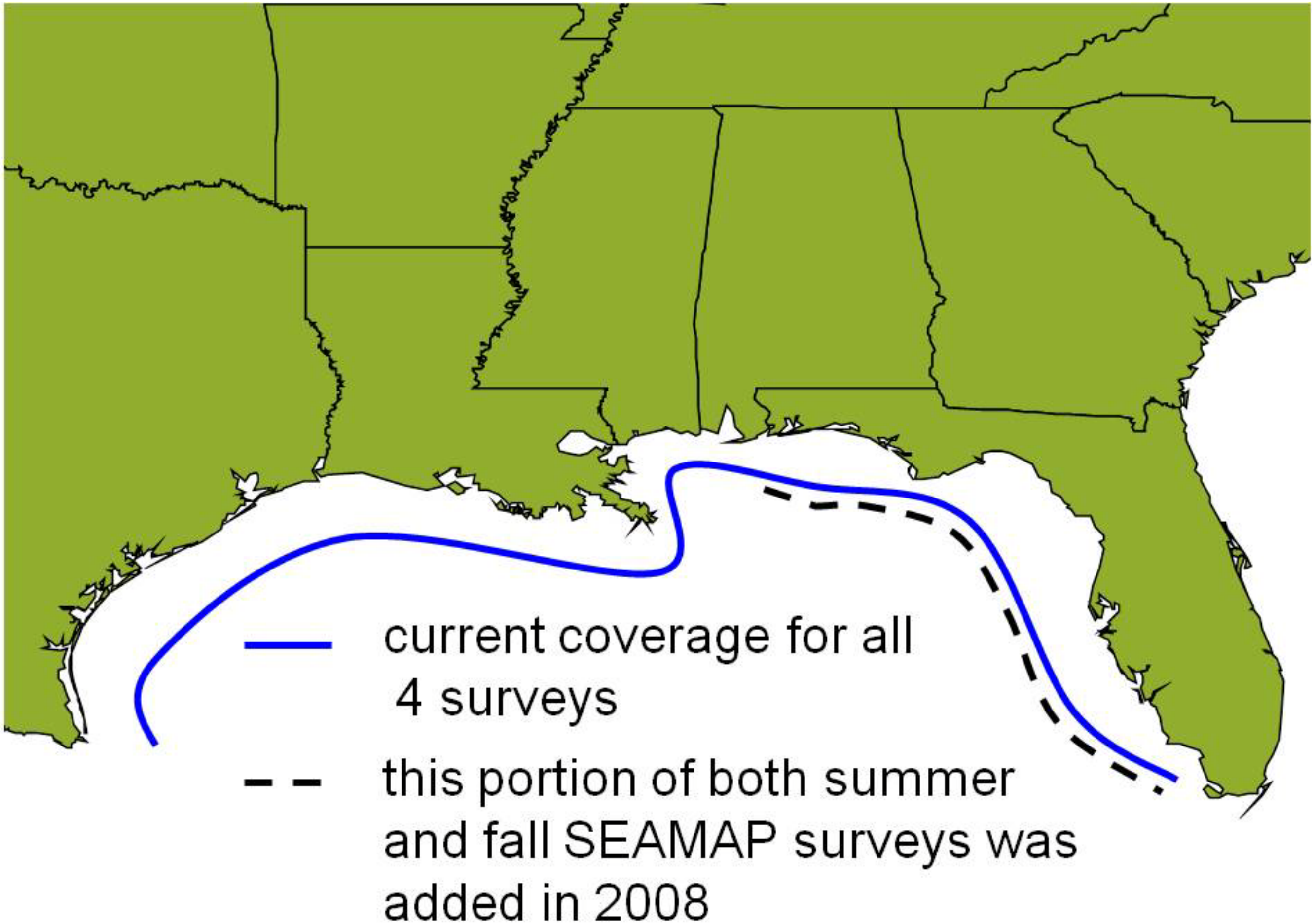


Indices of abundance



NOAA FISHERIES

Approximate linear coverage of specific abundance indices for *Mustelus* spp. in the Gulf of Mexico



r (*intrinsic rate of population growth*)

- *r* obtained from life tables
- Life History WG recommended using values for *Mustelus canis* + *Mustelus sinusmexicanus* and *M. norrisi* to bound the range of biologically plausible values
- Life tables were used to calculate r_{max} for these 2 groupings based on values listed in the DW report

Biological Inputs: *M. canis-M. sinusmexicanus*

- Von Bertalanffy growth curve:

  L_∞ = 113.8 cm FL, K = 0.130 yr^{-1}, t_0 = -3.87 yr
- Lifespan = 14 yr; a_{50} = 3.6 yr
- Length-weight relationship: $W = 2x10^{-6}L^{3.258}$
- Pup-production: pups = 10 (midpoint of 15 and 5)
- Parturition frequency: annual (1 yr)
- Natural Mortality = 0.30 (age-0) → 0.17 (a_{max})
- r = 0.28 yr^{-1}

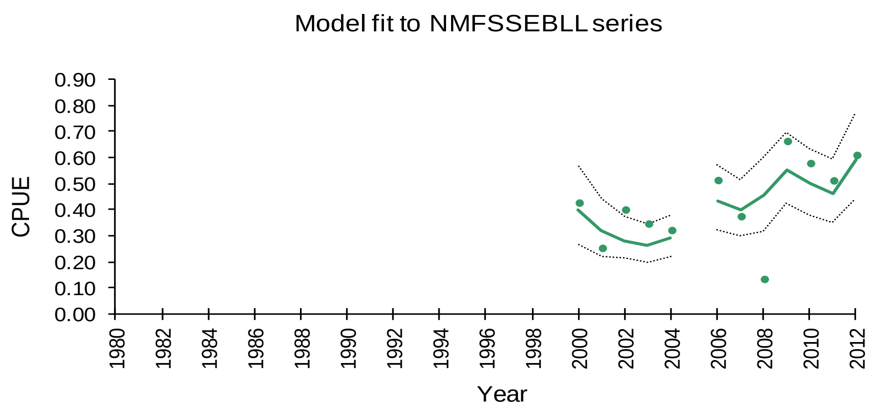
Biological Inputs: *M. norrisi*

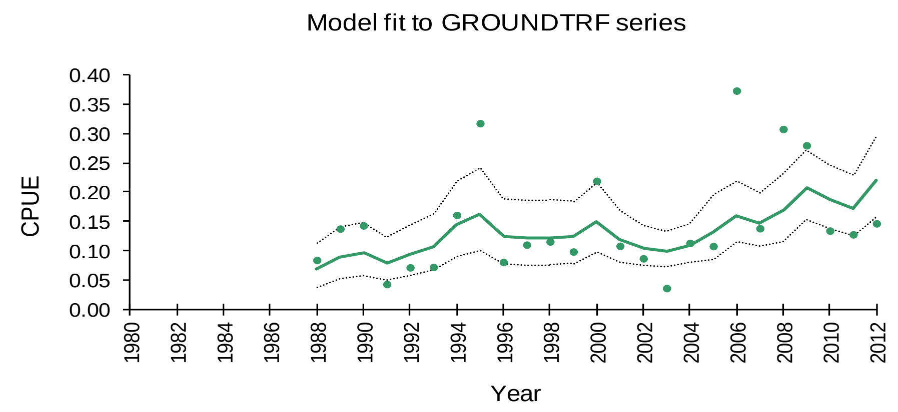
- Von Bertalanffy growth curve:
  L_∞ = 95.05 cm FL, K = 0.250 yr^{-1}, t_0 = -2.03 yr
- Lifespan = 9 yr; a_{50} = 3.6 yr
- Length-weight relationship: $W = 2x10^{-6}L^{3.2486}$
- Pup-production: pups = 11.3
- Parturition frequency: annual (1 yr)
- Natural Mortality = 0.47 (age-0) → 0.24 (a_{max})
- r = 0.18 yr^{-1}

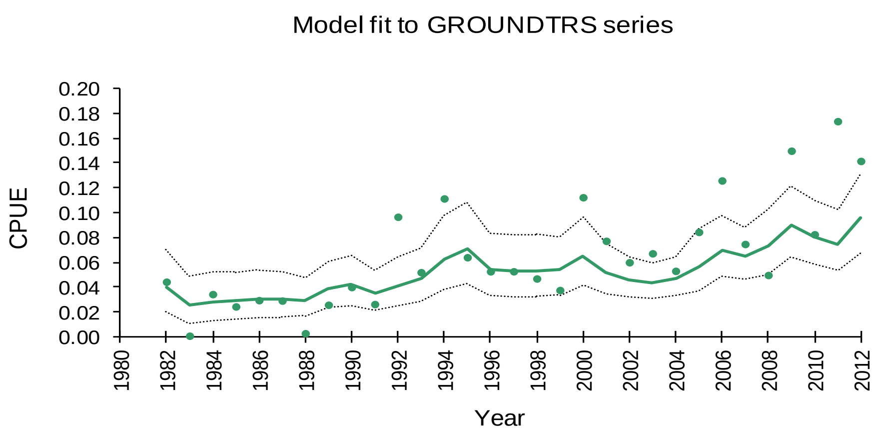
Model configuration

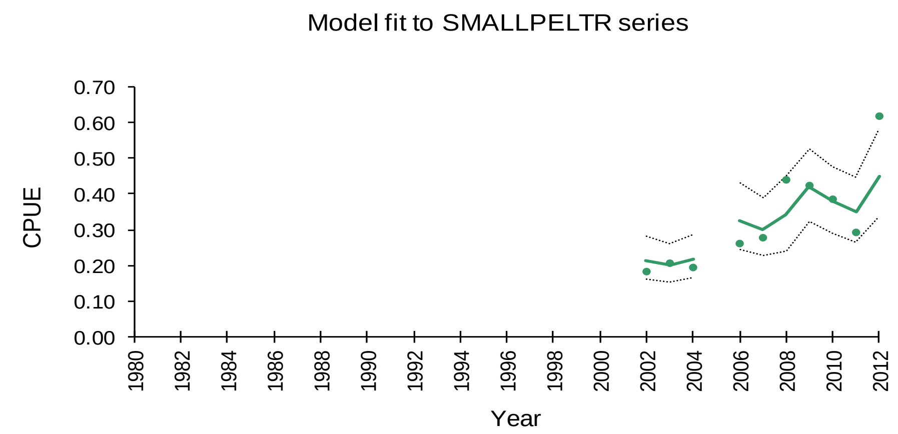
- Model started in 1982 and ended in 2012
- The first year in which both CPUE and catch data were available was 1982
- In the base run, each individual index of abundance value was weighted equally
- Model is fitted to the CPUEs and catch is treated as a known constant

Predicted fits to the four indices of abundance in the base run



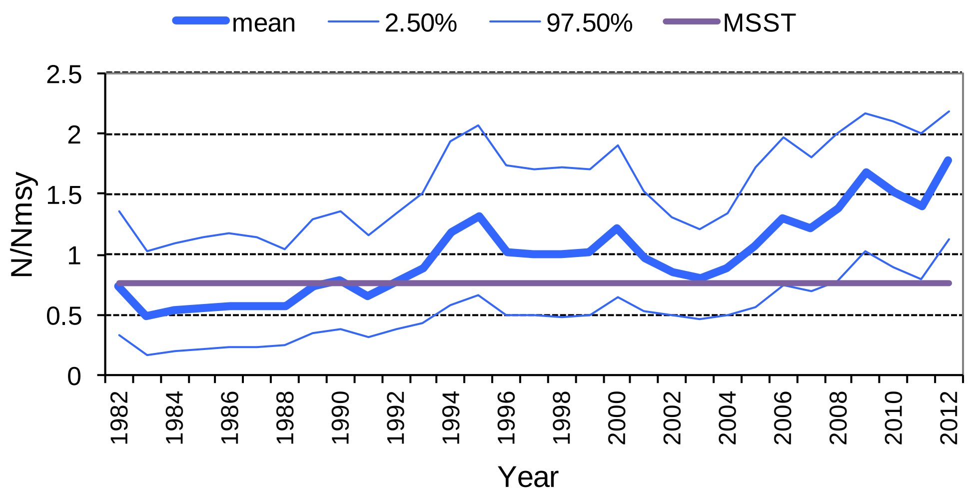


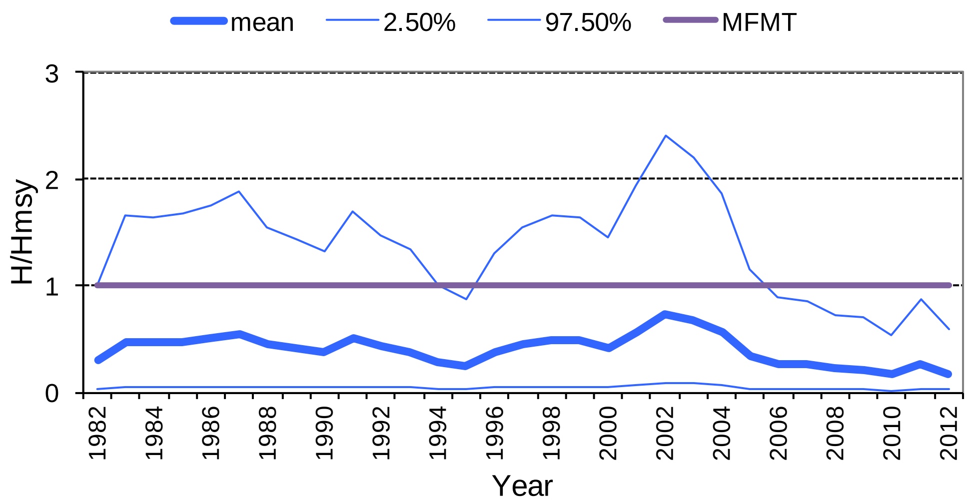




Solid circles are observed CPUEs, solid lines are mean predicted CPUEs, and dotted lines are 95% credible intervals.

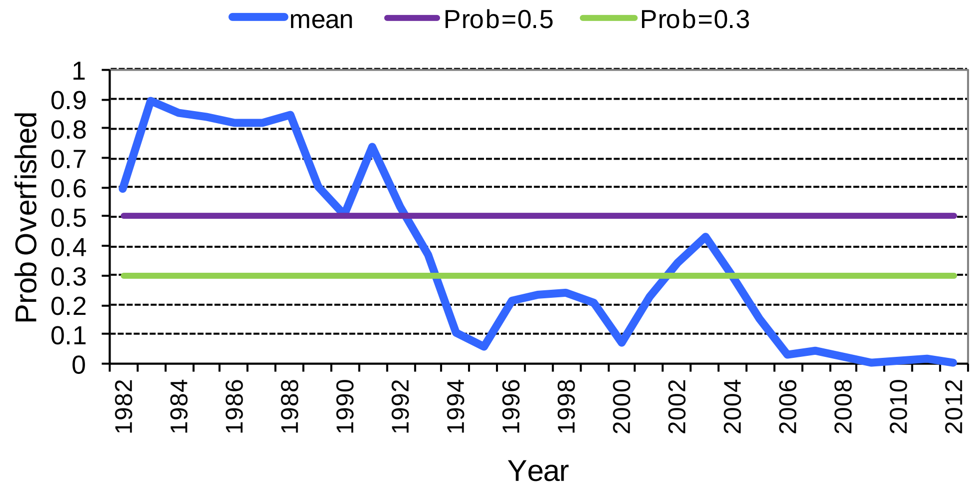
Predicted relative exploitable number (top) and relative exploitation rate (bottom) trajectories (with 95% credible intervals) for the base run

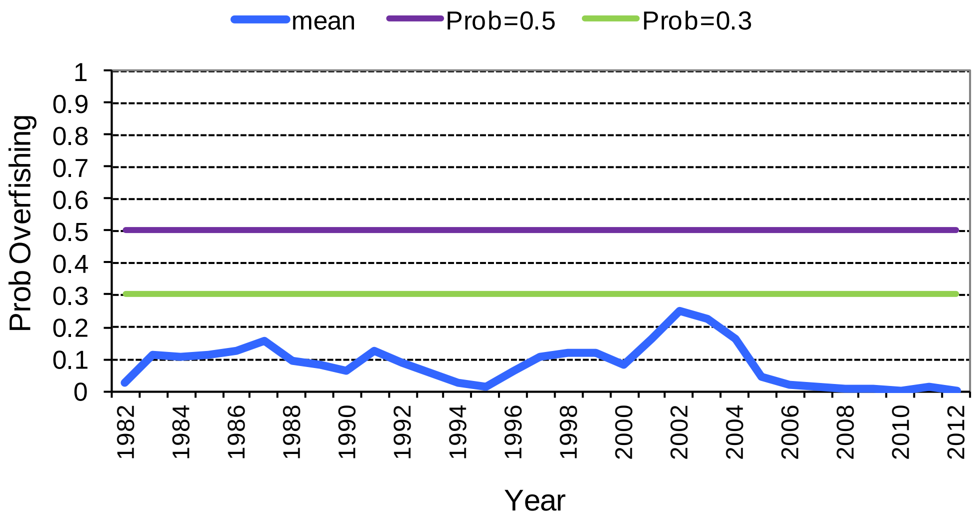




NOAA FISHERIES

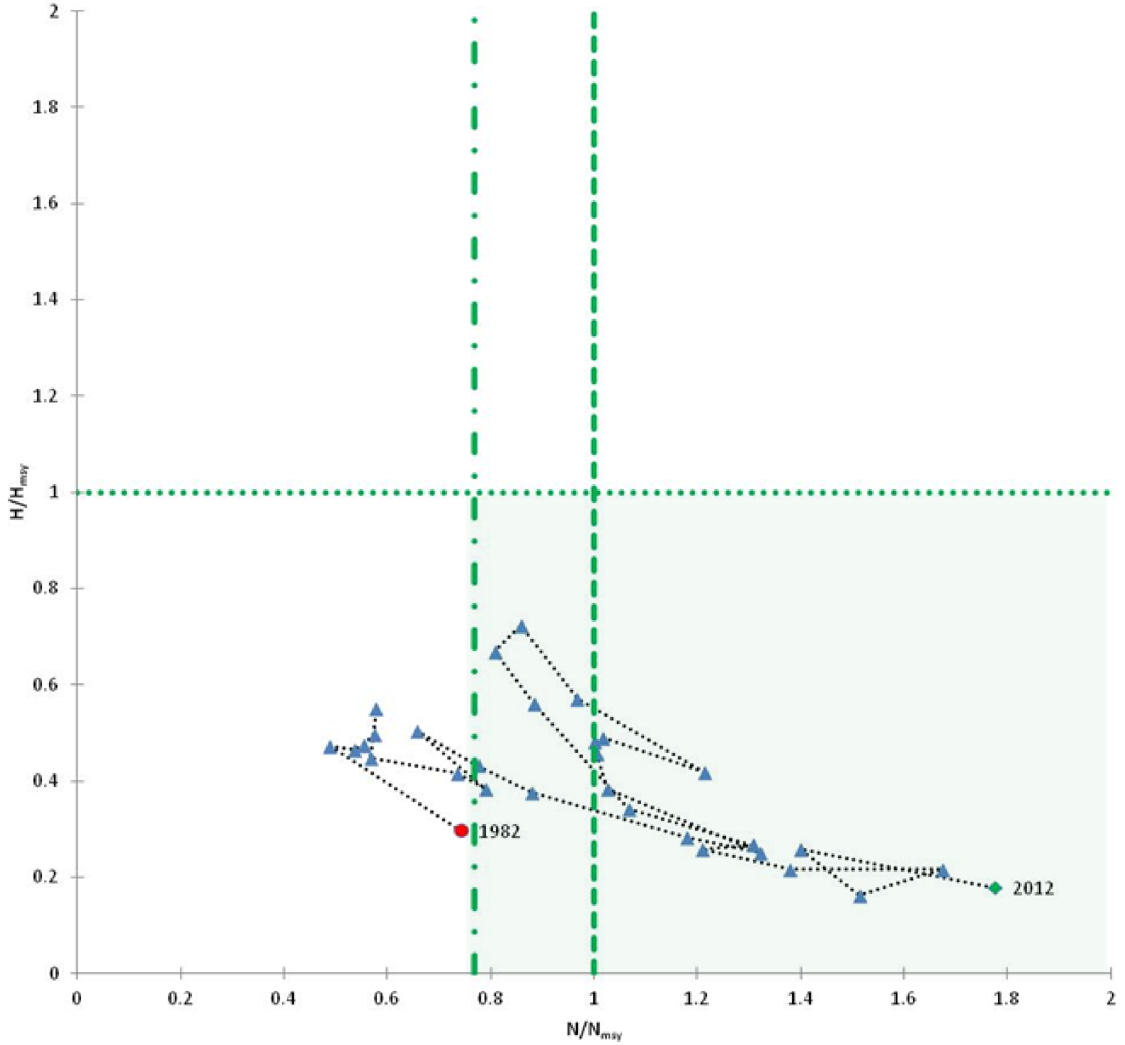
Probability of exploitable number being smaller than MSST (overfished condition; top) and probability of exploitation rate being larger than H_{MSY} (overfishing condition; bottom) for the base run





NOAA FISHERIES

Combined relative exploitable number and relative exploitation rate trajectory for the base run



Summary of results (mean and CV) for base model

Run	Base	
	Mean	CV
K	1.44E+07	0.88
r	0.212	0.40
MSY	6.89E+05	0.95
N_{2012}	1.27E+07	0.90
H_{2012}	0.018	0.96
N_{2013}ratio	0.787	0.24
N_{1982}	5.28E+06	0.98
H_{2012}/H_{MSY}	**0.179**	**0.89**
N_{2012}/N_{MSY}	**1.776**	**0.16**
N_{MSY}	7.19E+06	0.88
H_{MSY}	0.106	0.40
P_{1982}	0.589	0.20
MSST ((1-M)*N_{msy}	5.53E+06	
Convergence diagnostics		
Chain mixing	Good	
Autocorrelations	Low	
Gelman-Rubin	Good	
(MC error)/(posterior sd)	<5%	
Abundance index	**RMSE/(Index Mean)**	
NMFS SE Bottom LL	0.269	
NMFS SEAMAP Gr Tr (F)	0.487	
NMFS SEAMAP Gr Tr (S)	0.487	
NMFS Small Pel Tr	0.210	

Evaluation of uncertainty

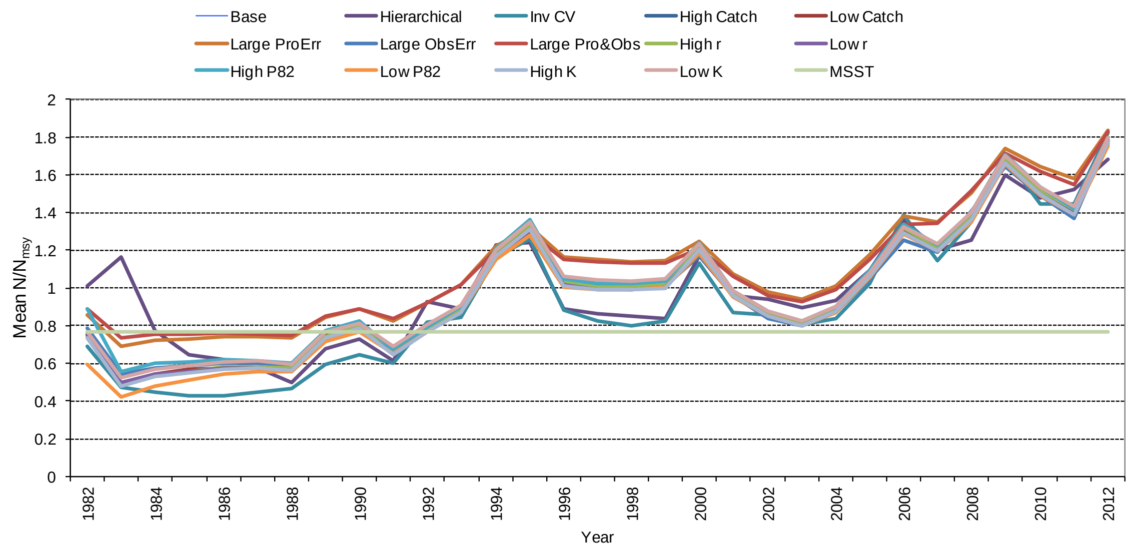
Different data inputs

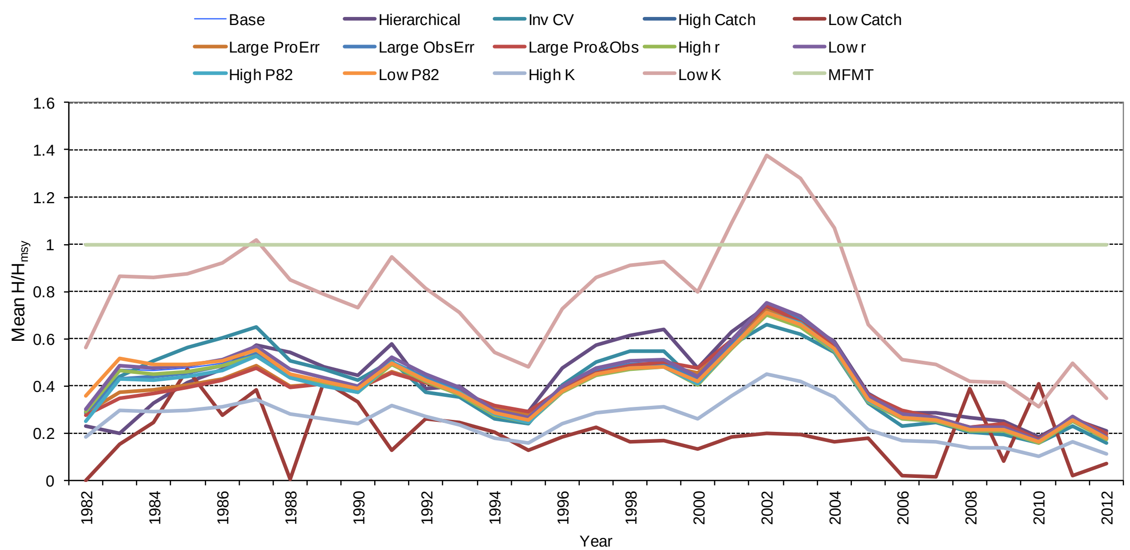
- *Sensitivity run 1 (Hierarchical index)*
- *Sensitivity run 2 (Inverse CV weighting)*
- *Sensitivity runs 3 and 4 (Low and high catch)*

Same data inputs

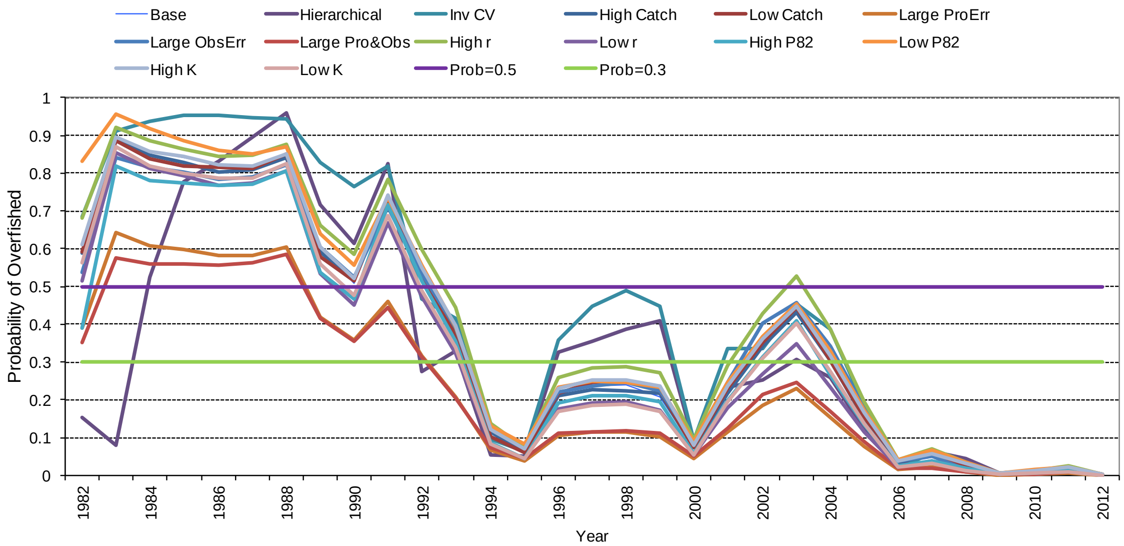
- *Sensitivity runs 5 and 6 (Low and high productivity)*
- *Sensitivity runs 7, 8, and 9 (Large process error variance, large observation error variance, and both simultaneously)*
- *Sensitivity runs 10 and 11 (High and low initial depletion)*
- *Sensitivity runs 12 and 13 (High and low carrying capacity)*

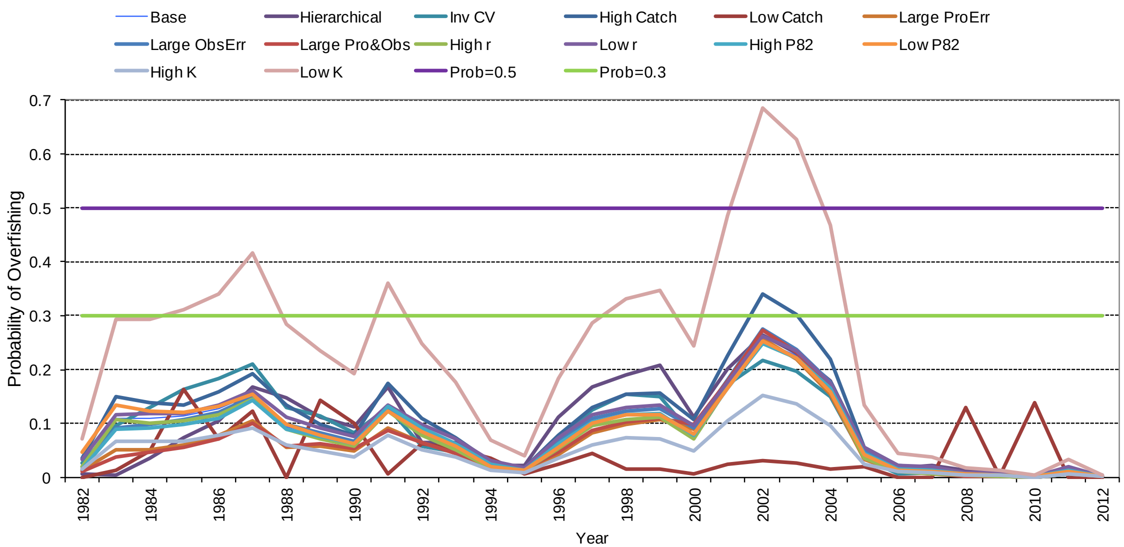
Predicted relative exploitable number (top) and relative exploitation rate (bottom) trajectories for each of the 13 sensitivity runs





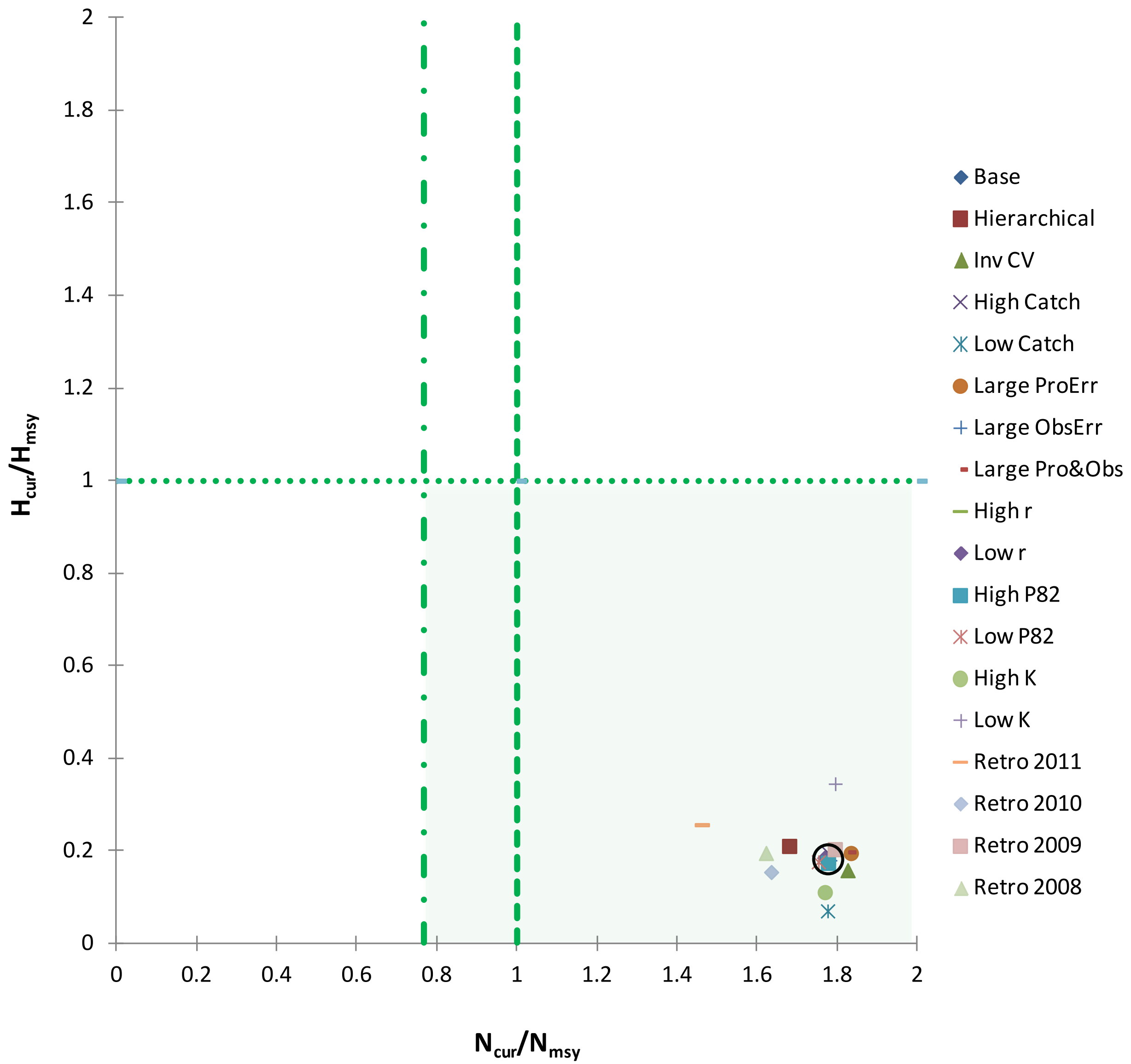
Probability of exploitable number being smaller than MSST (overfished condition; top) and probability of exploitation rate being larger than H_{MSY} (overfishing condition; bottom) for each of the 13 sensitivity runs





NOAA FISHERIES

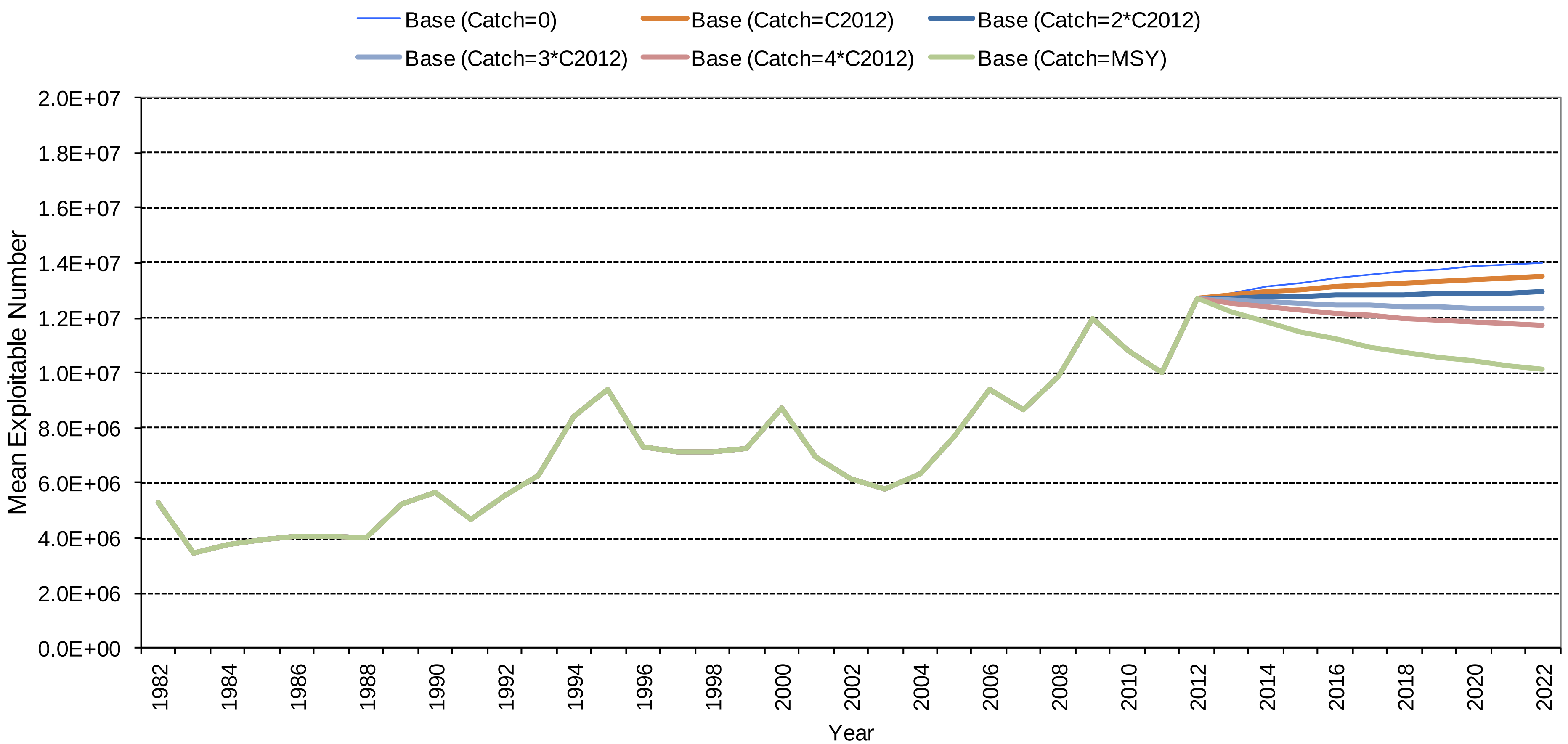
Phase plot of Gulf of Mexico *Mustelus* spp. complex stock status for all runs



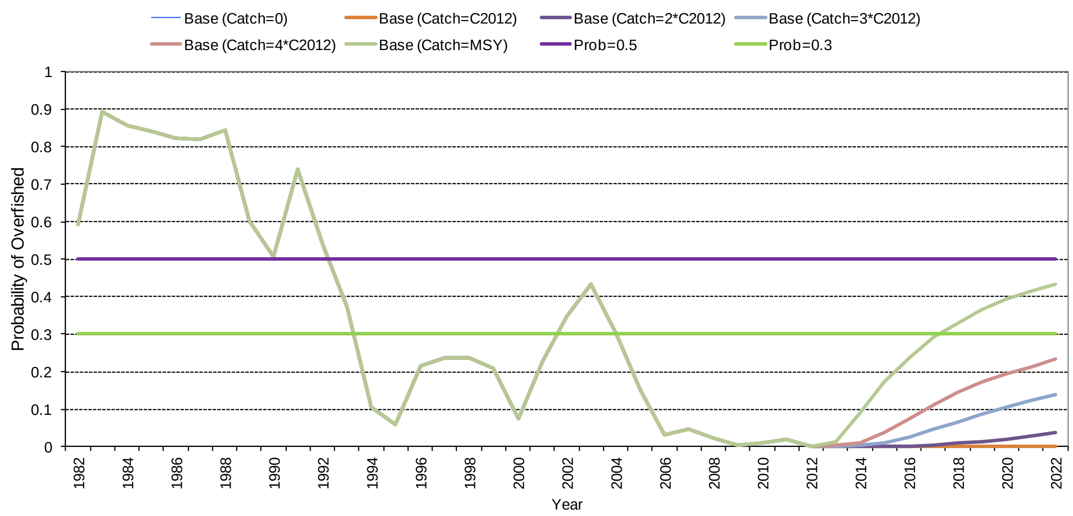
Generation time / Projections

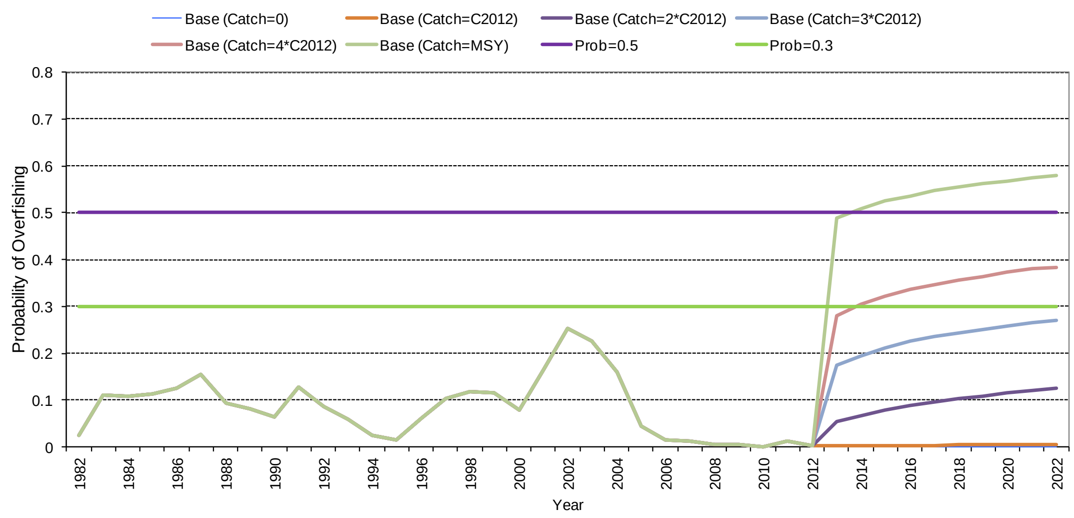
- Generation time was calculated using a life table approach
- This generation time (6.5 years) is defined as the mean age of parents of offspring
- The model was projected forward 10 years (ca. 1.5 generation times) using a fixed TAC strategy with six different levels of catches: no catch (0), the catch in 2012 (C_{2012}), 2* C_{2012}, 3* C_{2012}, 4* C_{2012}, and MSY

Mean projected exploitable number under six alternative constant catch level harvesting strategies for the base run



Probability of exploitable number being smaller than MSST (overfished condition; top) and probability of exploitation rate being larger than H_{MSY} (overfishing condition; bottom) under six alternative constant catch level harvesting strategies for the base run





NOAA FISHERIES

Projections for each of 6 runs representing plausible states of nature

- *Hierarchical index*
- *Inverse CV weighting*
- *Low catch*
- *High catch*
- *Low r*
- *High r*

Level of 2012 catches that allow for less than a 30% probability of the stock being overfished and overfishing occurring in 2022 with the projected base run and six alternative scenarios (1-6) corresponding to plausible states of nature

Scenario	Pr(Overfished)<0.3	Pr(Overfishing<0.3)
Base	$Catch_{2012}$ x 4	$Catch_{2012}$ x 3
Hierarchical	$Catch_{2012}$ x 4	$Catch_{2012}$ x 2
Inverse CV weights	$Catch_{2012}$ x 4	$Catch_{2012}$ x 3
Low catch	$Catch_{2012}$ x 0	$Catch_{2012}$ x 0
High catch	$Catch_{2012}$ x 4	$Catch_{2012}$ x 4
Low productivity	$Catch_{2012}$ x 4	$Catch_{2012}$ x 3
High productivity	$Catch_{2012}$ x 4	$Catch_{2012}$ x 3

Discussion and Conclusions

- This assessment can be considered data poor, or at least data limited, because of the inability to differentiate among species
- The fishery is essentially a bycatch fishery, with shrimp trawl discards accounting for over 95% of the catches during 1982-2012
- The stock assessment model fit captured this increasing trend in the four indices
- All model formulations coincided in predicting a negligible probability of the stock being overfished or overfishing occurring in 2012
- It appears that doubling the 2012 catches would still provide a sufficient buffer from the overfishing limit, such that the probability of overfishing occurring in any given year during 2013-2022 would be less than 30%