SEDAR 19: Black grouper, *Mycteroperca bonaci*, in Southeast United States

Photo: Jack Randall

South Atlantic Fishery Management Council

Scientific and Statistical Committee

20 April 2010

Florida Fish and Wildlife Conservation Commission

Fish and Wildlife Research Institute

St. Petersburg, FL

Outline

- Data review
- Assessment models
- Base run
- Stock status
- Projections

Data Review

- Management History
- Life History
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  - Discard mortality
  - Age / growth
  - Reproduction
  - Movement/migration
- Commercial Fisheries
  - Landings
  - Discards
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Data Review

- Commercial fisheries
  - Biological sampling
- Recreational fisheries
  - Landings
  - Discards
  - Effort
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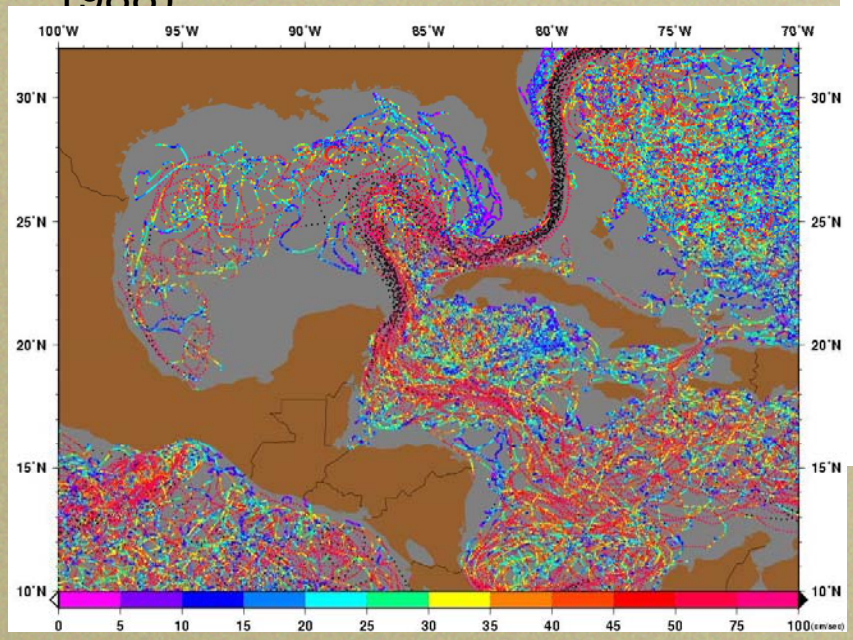
Management History Black grouper

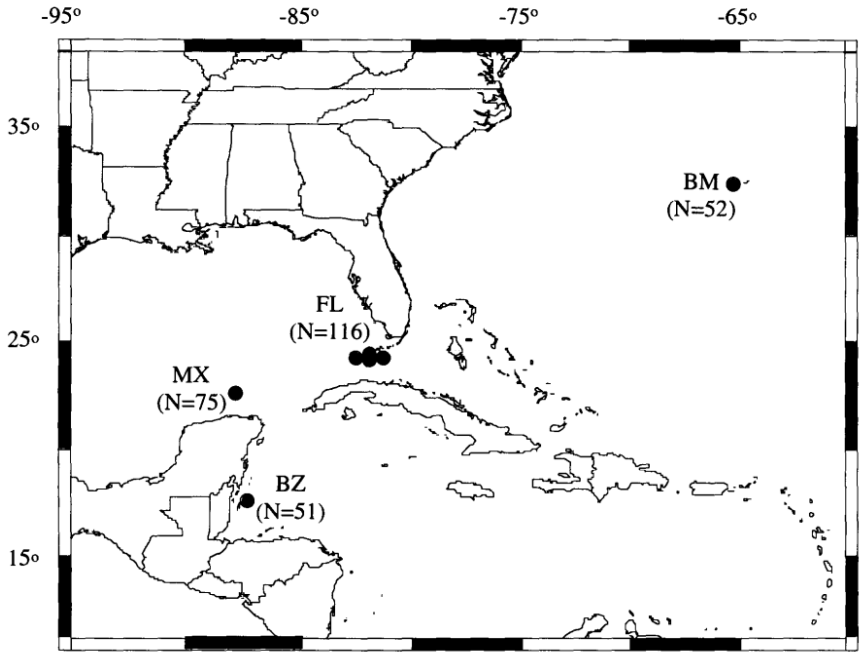
Year	Action	Agency
1983	Snapper-Grouper FMP	South Atlantic Fishery Management Council
1984	Reef Fish FMP	Gulf of Mexico Fishery Management Council
1985	18-inch minimum size	State of Florida
1990	20-inch minimum size	Gulf of Mexico Fishery Management Council State of Florida
1992	20-inch minimum size 5-fish aggregate grouper bag	South Atlantic Fishery Management Council
1999	24-inch minimum size Only 2 gag or black grouper in 5-grouper aggregate bag	South Atlantic Fishery Management Council State of Florida
1999	24 inch Commercial minimum size 22 inch Recreational minimum size	Gulf of Mexico Fishery Management Council
1999	MSY proxy 30% static SPR OY proxy 45% static SPR	South Atlantic Fishery Management Council

Stock definition

Population genetic substructure is absent from the Belize to Florida but Bermuda was distinct (6 microsatellite loci, 294 fish, Zatcoff 2001).

Larval duration is 35-50 days based on otolith settlement marks (Zatcoff 2001, Keener et a. 1988)





Life history working group concluded that the stock is the black grouper in SE US waters

Gyory,et al. 2008

Adapted from Zatcoff 2001 Figure 1

Natural Mortality

Catch curves (Chapman Robson 1960, Murphy 1997) were used to provide an upper limit to natural mortality. Data came from longline fishery

1992-1998

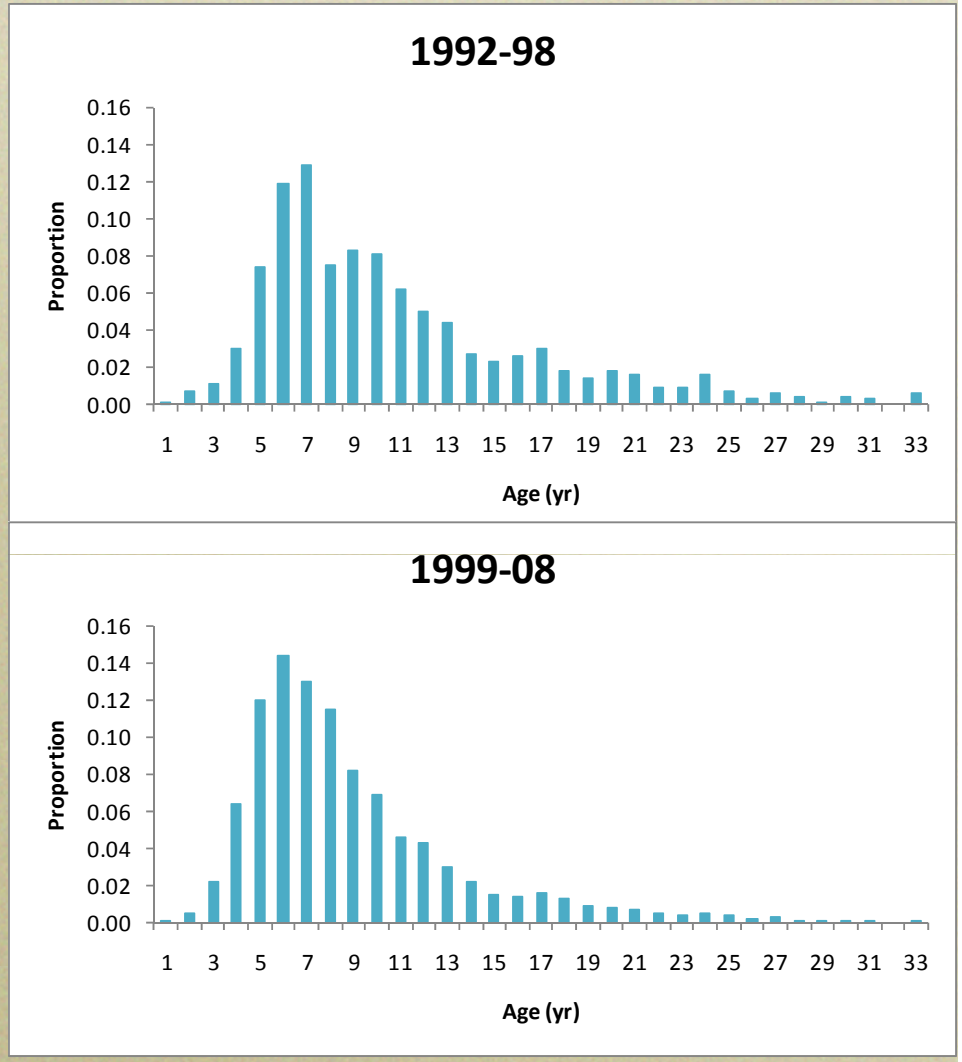
Z = 0.15, ().14 – 0.17) per year

n = 709 fish

1999-2008

Z = 0.18 (0.17 – 0.19) per year

n = 3132 fish



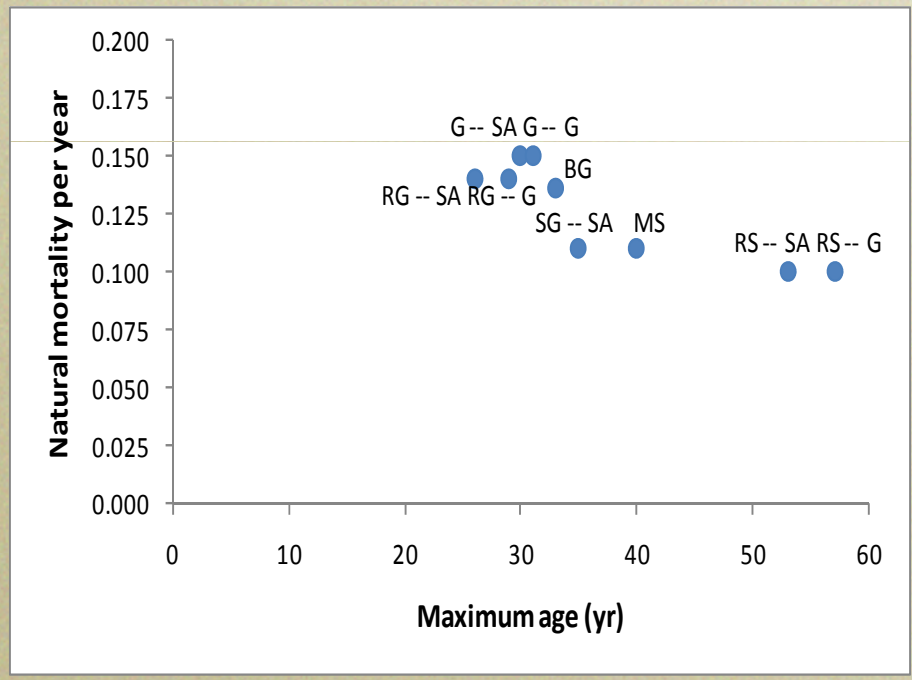
Previous studies used M = 0.2 per year; however, with tmax = 33 years, Hoenig's equation estimated M = 0.136 per year.

From AW BG Table 3.1.4.1

Natural Mortality

Comparison of natural mortality rates used in other reef fish SEDAR assessments

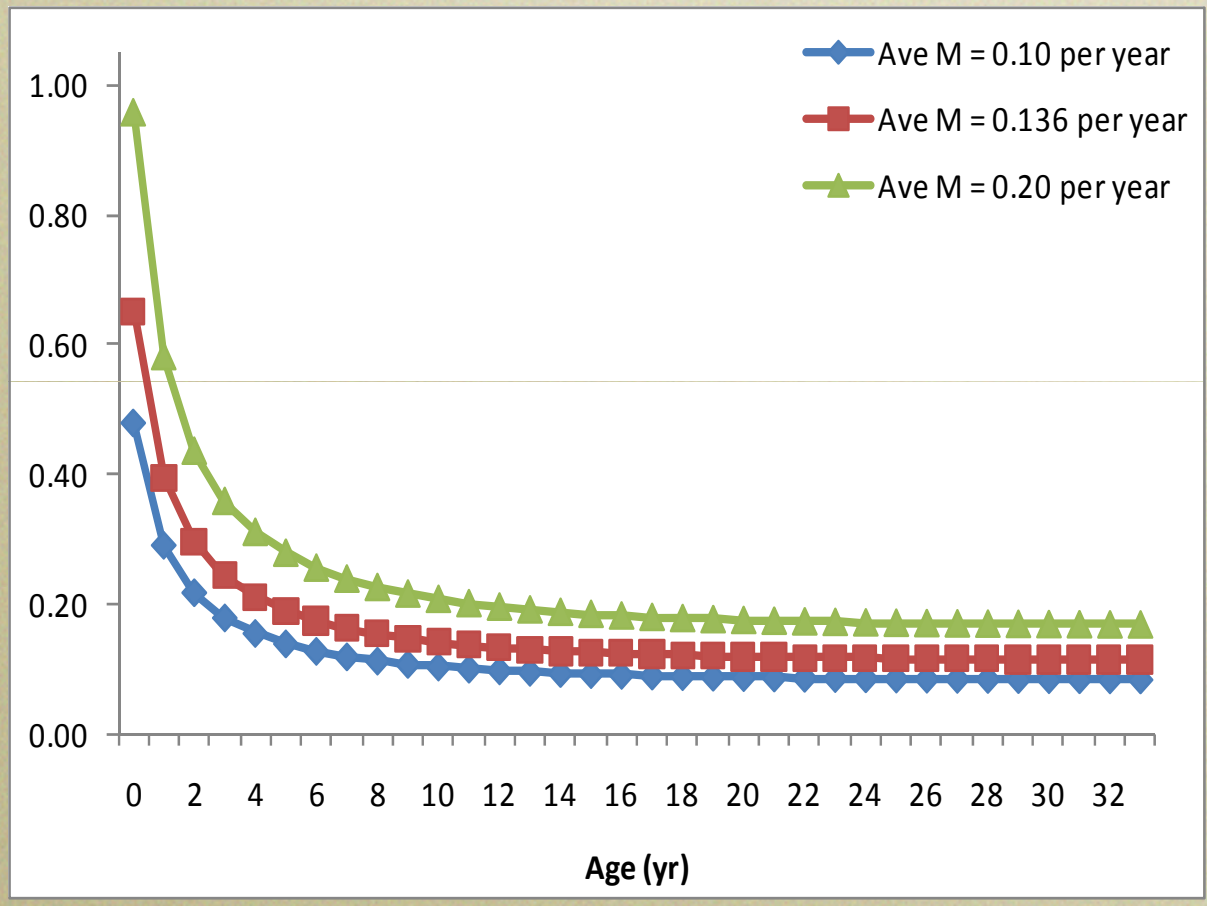
Species	SEDAR	Area	Tmax	M
Gag	10	SA	30	0.15
Gag	10	G	31	0.15
Red grouper	19	SA	26	0.14
Red grouper	12	G	29	0.14
Snowy grouper	04	SA	35	0.11
Black grouper	**19**	**SA & G**	**33**	**0.136**
Mutton snapper	15a	SA & G	40	0.11
Red snapper	15	SA	53	0.10
Red snapper	07	G	57	0.10



Natural Mortality

Age-specific natural mortality rates using Lorenzen (2005) equation and scaled such that the rates for ages 3-33 years averaged 0.136 per year (Hoenig's equation for t_{max} = 33 years).

Sensitivity runs used age-specific natural mortality rates averaging 0.10 per year (equivalent tmax = 45 years) and 0.20 per year (equivalent tmax = 22.3 years).



Discard Mortality

Discard mortality was estimated from the literature for species with similar life histories and from fishers comments.

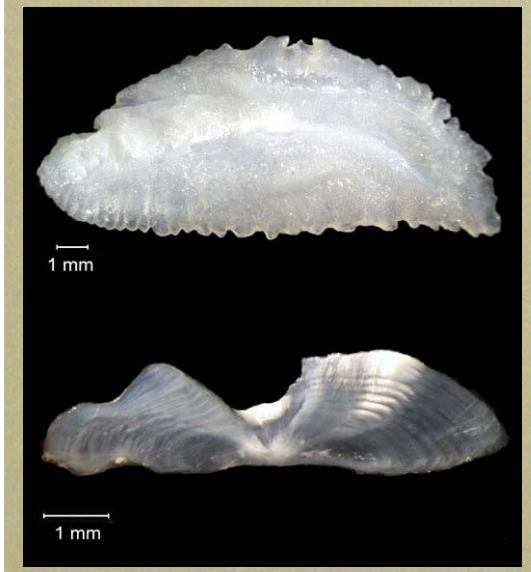
The DW recommended:

20% for hook-and-line fleets* (shallower depths) with sensitivity runs using 10% and 30%

30% for the longline fleet (deeper waters) with sensitivity runs using 25% and 35% .

*Because the commercial hook-and-line fleet operates in shallower waters than does the longline fleet, the DW commercial working group applied the 20% release mortality rate to the rate for commercial hook-and-line fleet (SEDAR19 DW Final report, Section 3.5, Decision 11). Operating in shallower waters was the same rationale that was used to adopt a dome-shaped selectivity curve for the commercial hook-and-line fleet.

Age/growth



SEDAR 19 - Black Grouper (*Mycteroperca bonaci*)
Age-Truncated Growth Curve [after Diaz et al., 2004]
(Fish below minimum size limits excluded)

Total Length$_{max}$ (mm)

Total Length$_{max}$ (inches)

Age (years)

CommLL, n=1,124
CommHL, n=175
Comm, n=148
RecHL, n=55
RecHB, n=67
Tournaments, n=17
Special Collections, n=620
Predicted Length at Age
Fishery Independent, n=20

Total Length$_{max}$=L_∞(1-e$^{-k(age-t_0)}$)
L_∞ = 1334.2, k = 0.1432, t_0 = -0.9028
n=2271, MSE=6003.0,
cv=9.89% for average lengths-at-age
non-linear fit by maximum likelihood

DW BG Fig. 2.15.5

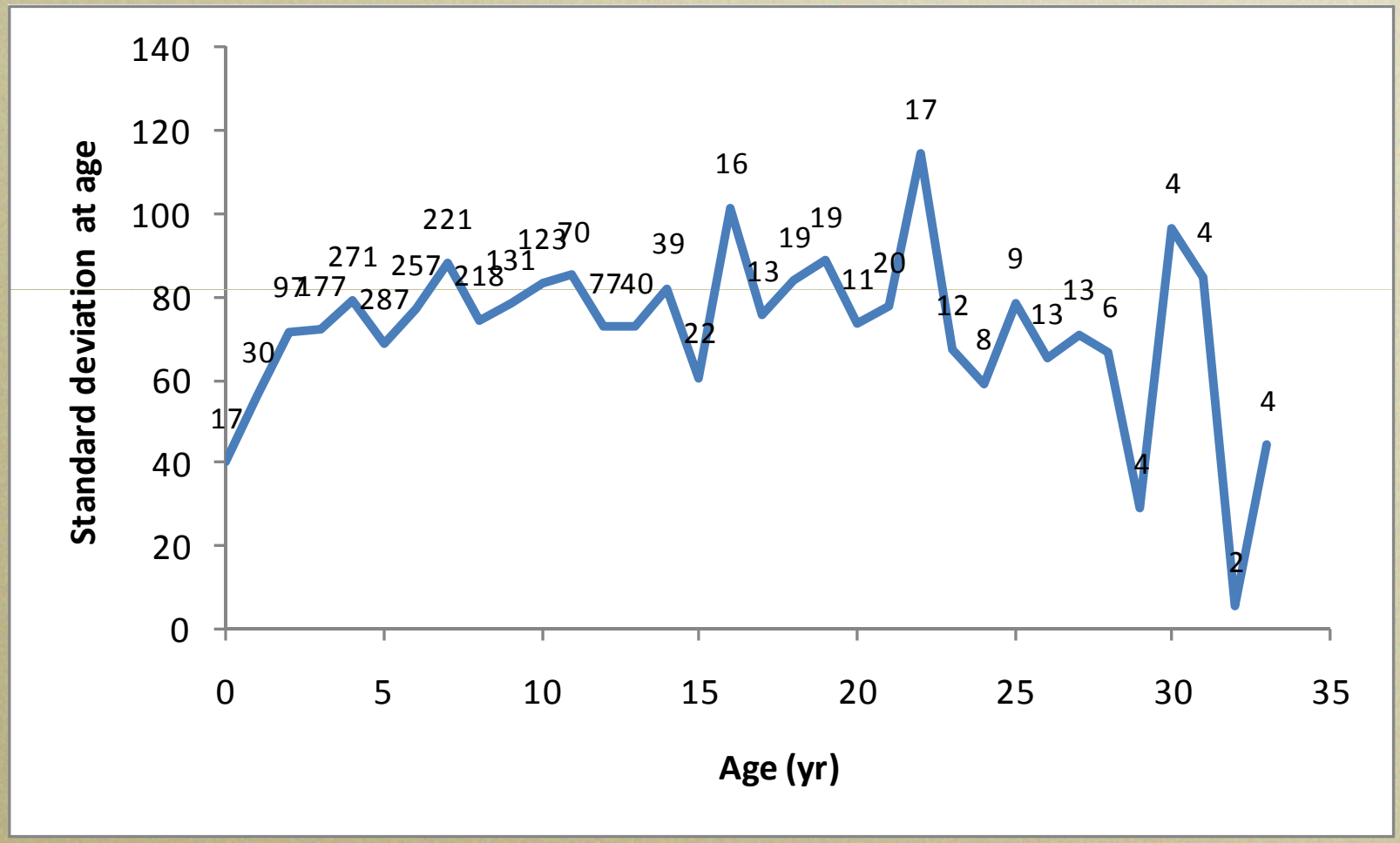
Age/growth

Von Bertalanffy growth curves by gear and period

gear_rev	period	N	Linf	Linf_se	k	k_se	t0	t0_se	rmse
HL	< 1992	37	1459	54.66	0.120	0.0097	-0.942	0.1497	79.63
HL	1992-94	28	1387	93.26	0.136	0.0172	-0.876	0.1117	55.28
HL	1995-98	34	1402	46.99	0.128	0.0103	-0.936	0.1435	76.34
HL	1999-01	47	975	40.30	0.278	0.0320	-0.639	0.1117	79.48
HL	2002-03	43	1390	87.97	0.132	0.0158	-0.979	0.1511	76.31
HL	2004	19	1017	59.13	0.259	0.0393	-0.619	0.0952	59.34
HL	2005	19	1386	95.61	0.134	0.0180	-0.874	0.1305	66.46
HL	2006	25	1278	146.56	0.151	0.0341	-0.847	0.1433	63.32
HL	2007	42	1190	61.84	0.182	0.0210	-0.753	0.1165	70.13
HL	2008	35	1172	51.02	0.204	0.0206	-0.702	0.0930	60.04
LL	1992-95	120	1291	14.23	0.161	0.0061	-0.801	0.0928	61.50
LL	1996-98	105	1315	17.18	0.148	0.0062	-0.804	0.1054	66.06
LL	1999-01	44	1364	34.69	0.149	0.0106	-0.820	0.1359	85.40
LL	2002	37	1397	68.15	0.137	0.0137	-0.846	0.1037	56.97
LL	2003	85	1396	24.21	0.139	0.0067	-0.822	0.1132	70.45
LL	2004	114	1380	25.37	0.131	0.0063	-0.867	0.1259	73.30
LL	2005	156	1417	33.95	0.119	0.0066	-0.946	0.1402	76.06
LL	2006	240	1478	39.73	0.113	0.0066	-0.935	0.1431	77.44
LL	2007	136	1424	35.98	0.124	0.0072	-0.951	0.1324	73.64
LL	2008	75	1288	46.07	0.153	0.0136	-0.823	0.1179	68.91

Age/growth

Standard deviations of length by age for all aged fish



Age/growth

Steps in stochastic aging process with von Bertalanffy growth curves:

a. Used ages 0 to 33 years.

b. Calculated the standard deviations in length by age from all aged fish.

c. Calculated the relative number at age starting with one age-0 fish with age-specific natural mortality rates.

d. Used the difference in cumulative probability distributions to obtain the probability of a fish of length, *l*, being, age , *a*.

e. Multiplied the numbers of fish at length by the age probabilities by gear and period.

Reproduction

Black grouper are protogynous (females first) hermaphrodites.

Spawning season February-April

Spawning is more likely to be in southern Florida but larvae can be transported to other areas like the Carolinas.

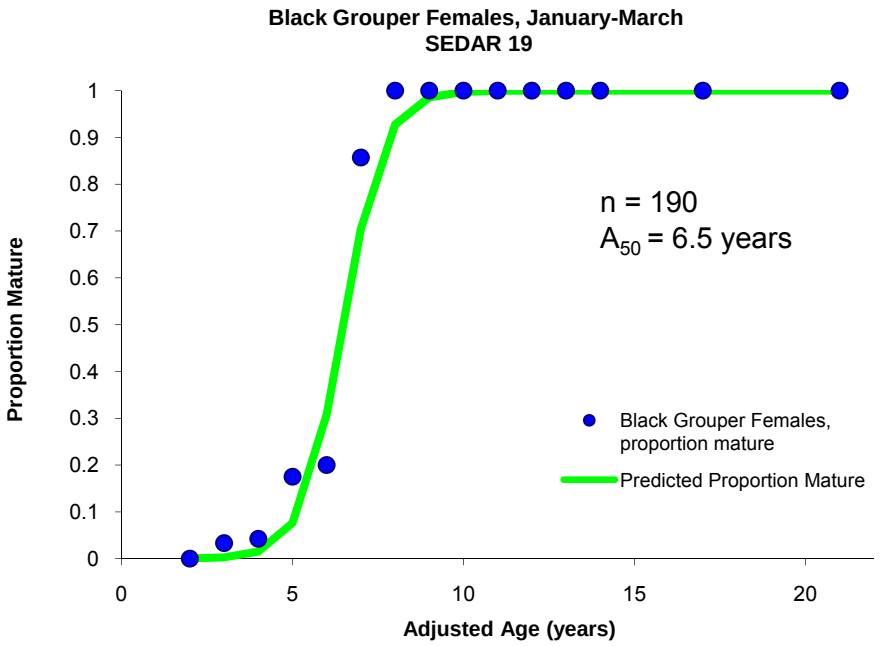
After a larval stage lasting about 31-57 days, postlarval fish (SL ≈ 15 mm) settle in seagrass beds in inshore waters such as estuaries or back reefs.

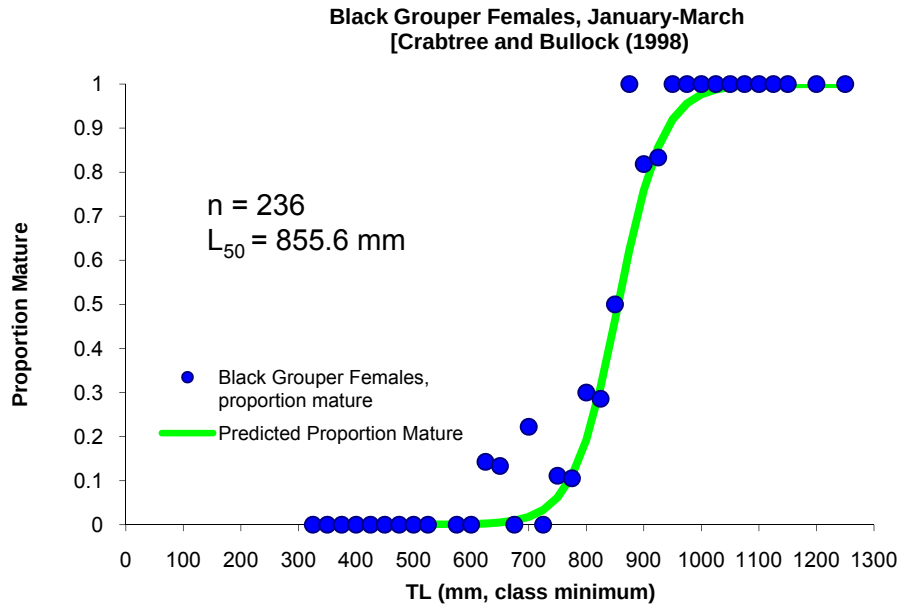
Reproduction

$$Mat = \frac{1}{1+e^{-1.68(a-6.48)}}$$

50% of black grouper females are mature at 6.5 years old and 856 mm TL based on fish collected in the Florida Keys during January-March and omitting stage 7 (resting) fish. The smallest mature female was 508 mm TL and the youngest was three years old. Spawning biomass includes males (Brooks et al. 2008).

$$Mat = \frac{1}{1+e^{-0.0258(TL-856)}}$$





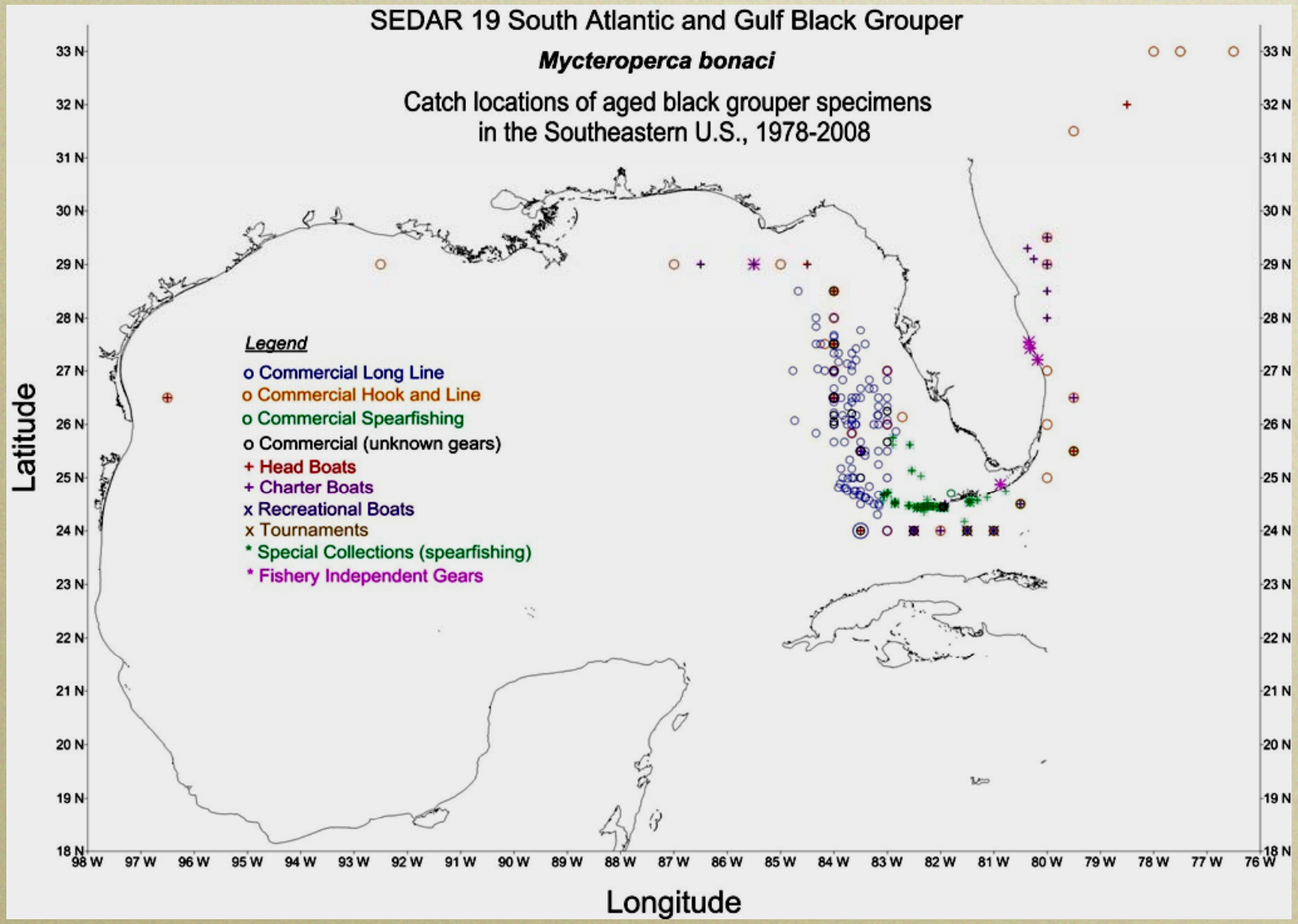
DW BG Fig. 2.15.6.

Movements and migrations

Little is known about black grouper movements other than juveniles settle in vegetated areas such as seagrass beds and adults are often found in association with rocky ledges and coral reefs (hard bottom areas). Generally, larger and older individuals are caught more often in deeper waters.

Photos: Lawrence University, Marine Biology Program and SCUBA Club, California State University at Dominguez Hills

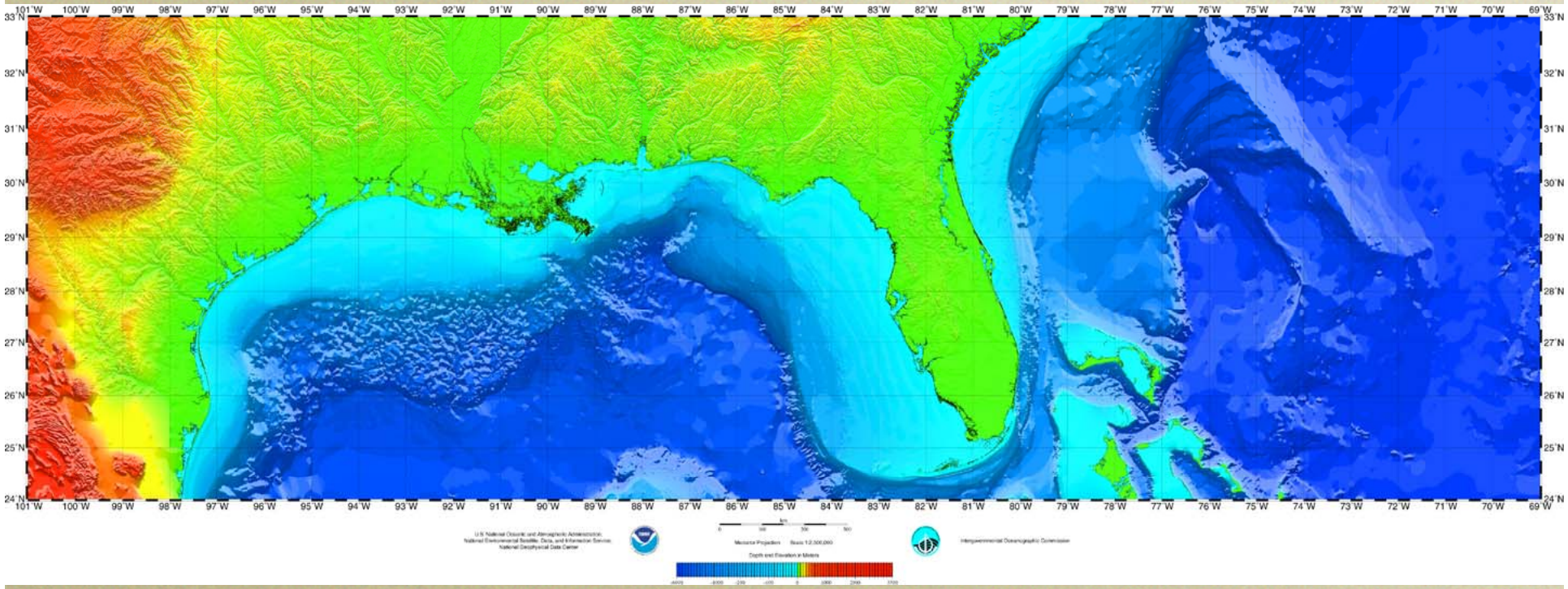
Distribution of landings



DW BG Fig.

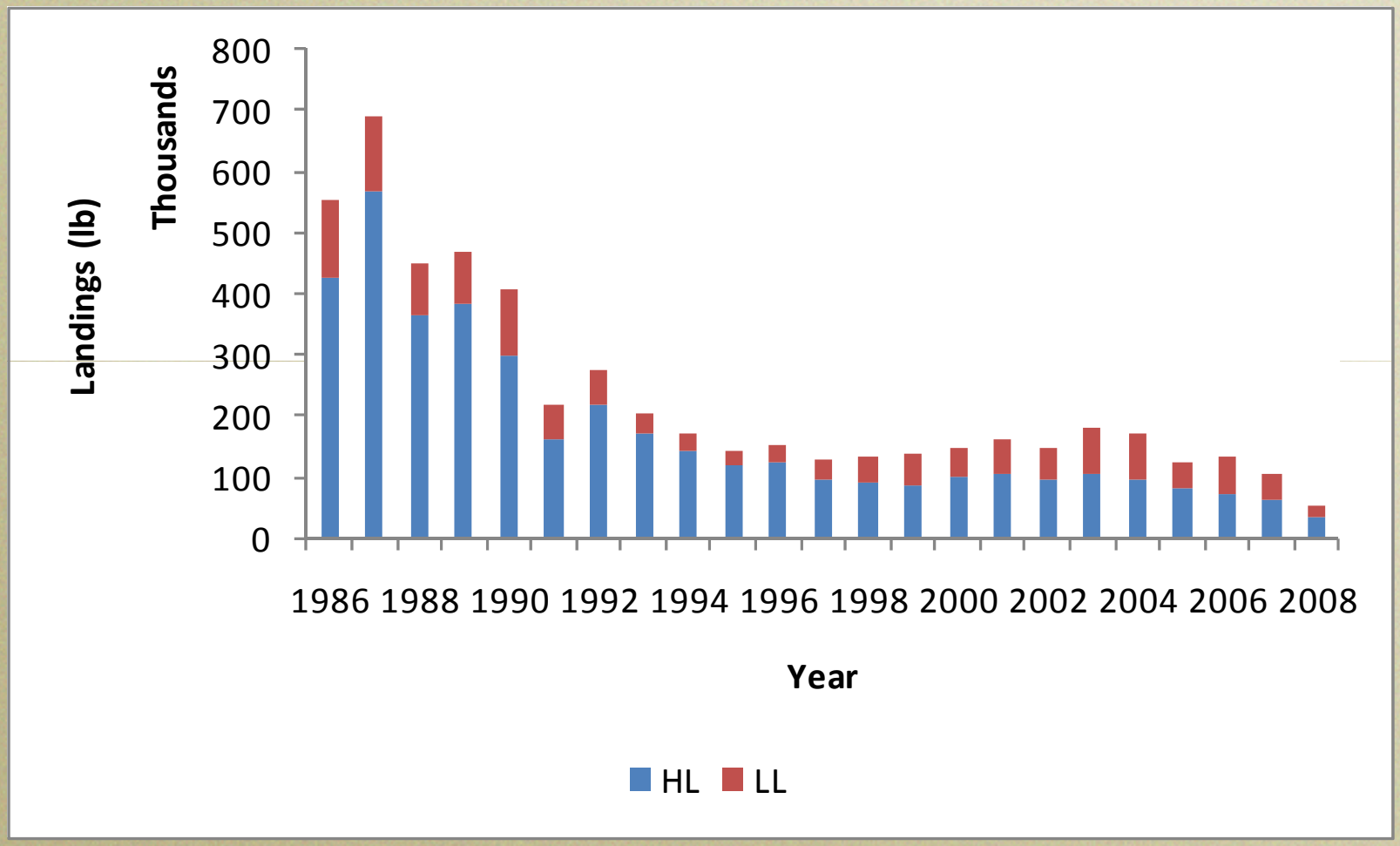
Distribution of landings

Gulf of Mexico Bathymetry



NOAA National Environmental Satellite, Data, and Information Service

Commercial fleets



Two fleets: hook-and-line including spears, traps, and other gears, and longline.

Commercial fleets

Landings (whole weight) and discards

18-inch minimum size (Florida state waters)

20-inch minimum size Gulf of Mexico
20-inch minimum size South Atlantic

24-in minimum both councils

	Pounds					
	Hook-and-line			Longline		
Year	Landings	Dead Discards	Combined	Landings	Dead Discards	Combined
1986	426,270		426,270	129,457		129,457
1987	567,539		567,539	125,101		125,101
1988	365,587		365,587	83,995		83,995
1989	384,267		384,267	82,395		82,395
1990	299,700		299,700	109,944		109,944
1991	163,451		163,451	53,681		53,681
1992	218,010		218,010	58,787		58,787
1993	165,666	6,517	172,183	35,670	86	35,756
1994	139,558	7,934	147,492	25,401	104	25,504
1995	115,303	6,587	121,889	24,975	93	25,068
1996	120,418	7,152	127,570	29,915	110	30,025
1997	89,464	7,566	97,030	34,644	120	34,764
1998	88,334	6,995	95,329	41,778	114	41,891
1999	79,719	11,586	91,304	51,646	340	51,986
2000	92,434	11,457	103,891	50,077	312	50,389
2001	100,951	9,915	110,866	55,020	293	55,313
2002	89,052	8,339	97,390	53,496	355	53,851
2003	97,394	10,555	107,949	77,142	330	77,472
2004	91,732	7,483	99,215	73,385	380	73,765
2005	73,266	11,452	84,718	45,734	219	45,953
2006	72,223	1,424	73,647	61,444	259	61,703
2007	54,849	12,385	67,234	43,457	260	43,717
2008	33,236	2,123	35,359	17,843	276	18,120

WW = 1.061 GW

DW BG Table 2.17.7.

After DW BG Table 3.13.1.

Commercial fleets

Biological sampling

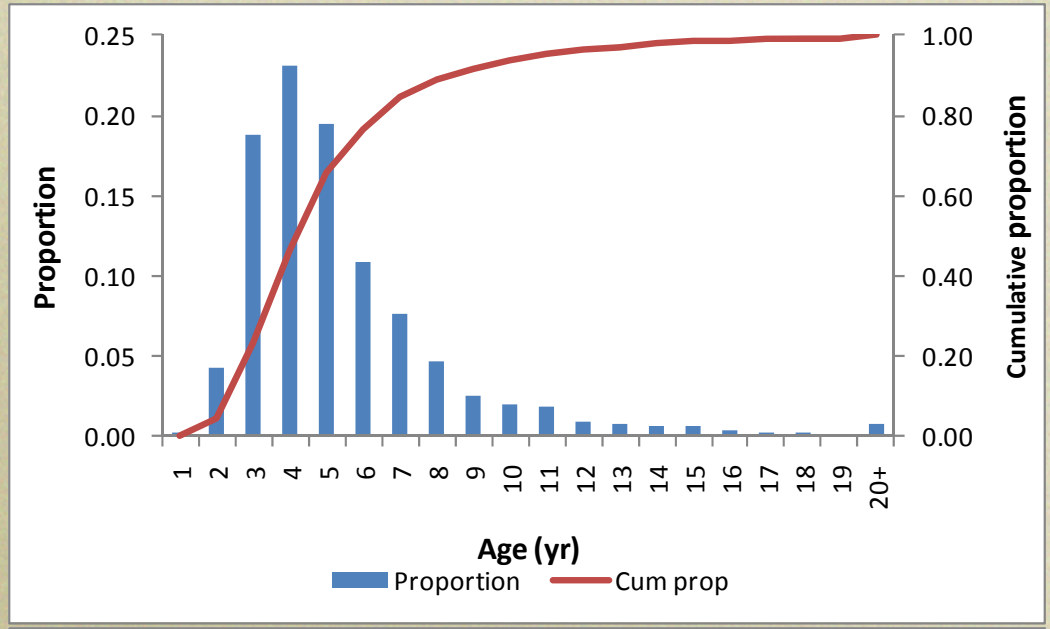
Year	Comm HL Lengths	Comm HL Ages	Comm LL Lengths	Comm LL Ages
1986	295			
1987	258			
1988	263			
1989	253			
1990	461			
1991	157	1		
1992	242	2	69	
1993	337	5	44	
1994	119	5	36	11
1995	132	8	65	109
1996	139	10	53	105
1997	178	2	125	
1998	172	5	324	
1999	166	10	471	3
2000	142	9	355	7
2001	277	16	274	34
2002	228	10	293	37
2003	166	13	450	85
2004	80	9	314	114
2005	162	17	350	156
2006	73	18	350	240
2007	94	31	179	136
2008	63	31	108	75
Totals	4457	202	3860	1112

DW BG Table 3.13.13.

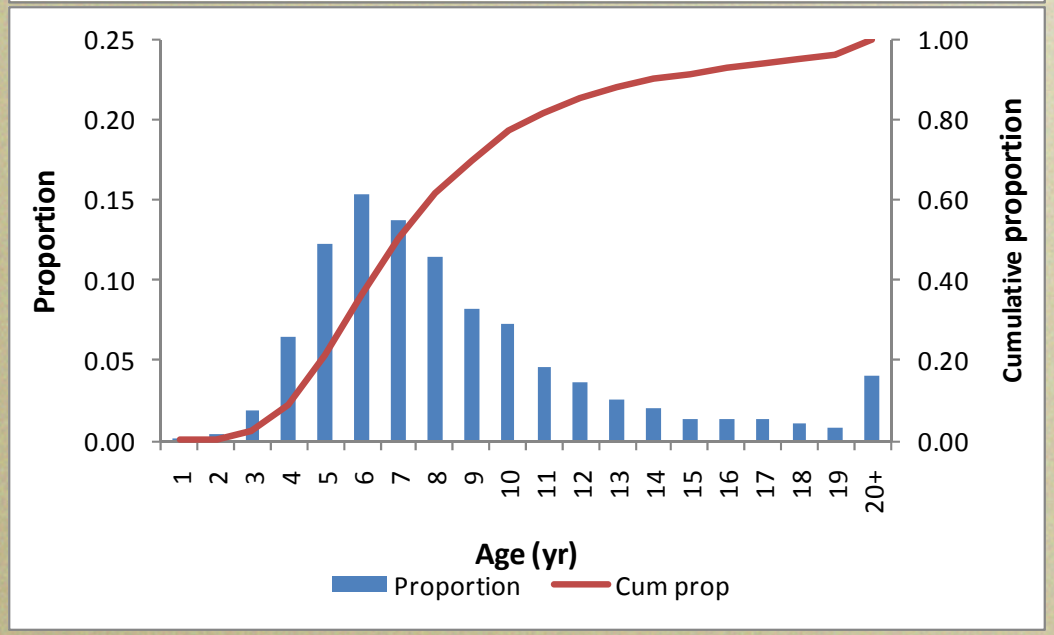
Commercial fleets

Differences in age composition of the commercial fleets using ages from 2000-2008 (24-inch minimum size limit).

Hook-and-line



Longline

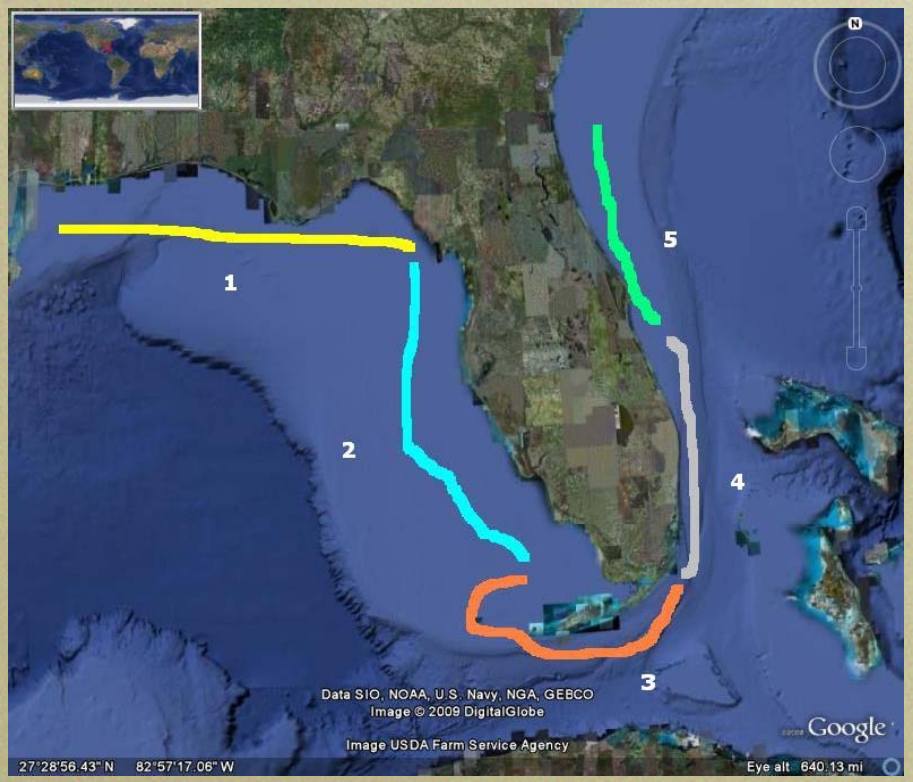


Recreational fleets

Two programs collect recreational fishing information

Headboat Survey

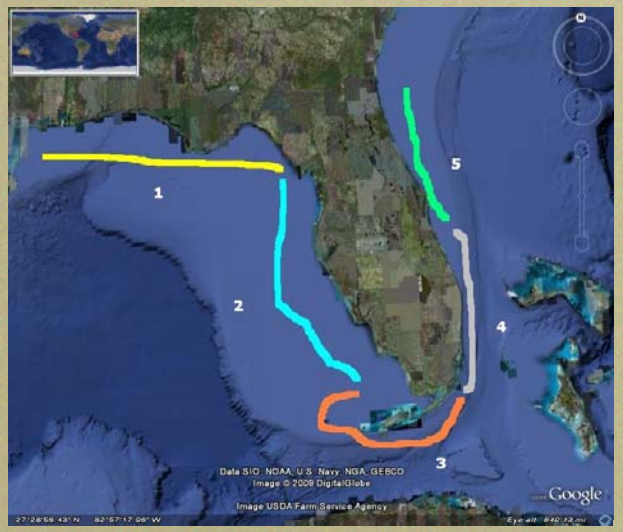
Marine Recreational Fisheries Statistics Survey



1 – Northwest
2 -- West coast
3 -- Florida Keys
4 -- Southeast
5 -- Northeast

Recreational fleets

Anglers catch black grouper primarily in the Florida Keys and in Southeast Florida



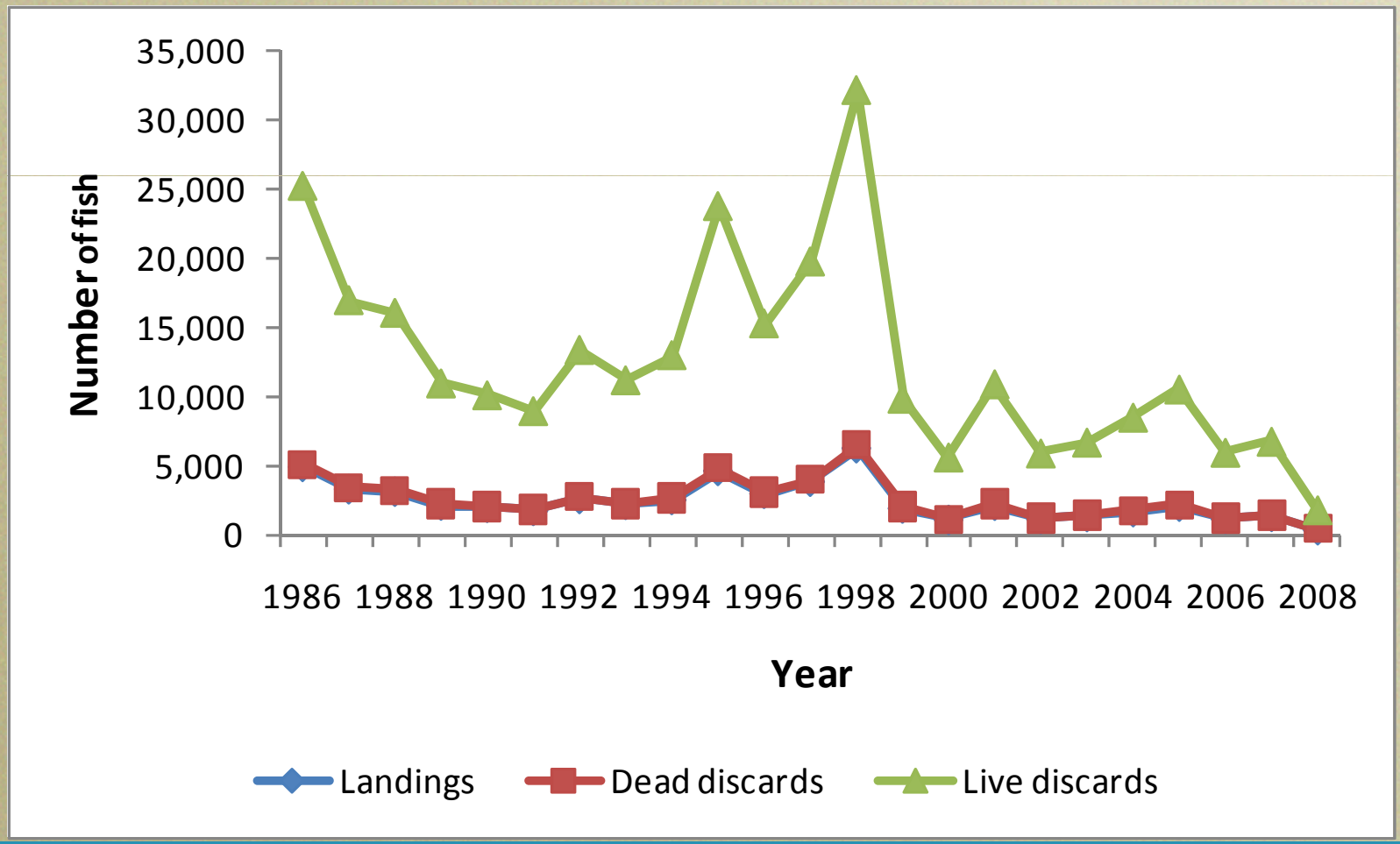
Landings

	Headboat			MRFSS		
Year	Number	Pounds	Ave Wgt	Number	Pounds	Ave Wgt
1986	4,803	19,976	4.16	62,293	447,266	7.18
1987	3,231	39,603	12.26	55,769	382,021	6.85
1988	3,056	24,288	7.95	29,269	188,198	6.43
1989	2,084	19,806	9.50	28,002	181,452	6.48
1990	1,921	17,764	9.25	21,959	74,441	3.39
1991	1,703	15,378	9.03	32,959	398,475	12.09
1992	2,546	20,965	8.23	34,094	281,616	8.26
1993	2,128	25,129	11.81	26,831	140,596	5.24
1994	2,474	24,053	9.72	21,996	166,073	7.55
1995	4,525	31,760	7.02	25,993	236,796	9.11
1996	2,911	36,613	12.58	37,155	316,559	8.52
1997	3,763	48,274	12.83	43,409	450,156	10.37
1998	6,122	84,984	13.88	30,635	389,372	12.71
1999	1,873	25,267	13.49	15,280	169,613	11.10
2000	1,065	15,118	14.20	8,763	112,952	12.89
2001	2,073	31,013	14.96	10,350	136,623	13.20
2002	1,120	15,271	13.64	11,663	139,377	11.95
2003	1,270	11,940	9.40	16,914	262,670	15.53
2004	1,613	18,414	11.42	15,585	139,018	8.92
2005	2,000	25,733	12.87	12,943	135,772	10.49
2006	1,130	17,862	15.81	7,732	92,165	11.92
2007	1,282	17,828	13.91	14,614	156,224	10.69
2008	339	3,930	11.59	14,671	162,408	11.07

DW BG Table

Recreational fleets

Headboat landings and discard**s.** The Data Workshop recommended using 20% for recreational **r**elease mortality. Live discards were estimated at 5.22 the number landed based on average MRFSS charterboat discards to landings ratio.



Recreational fleets

Lengths of discarded black grouper from observers the MRFSS Headboat at Sea program (n=76). Of the fish that were discarded, 75 were under-sized and one legal sized fish (673 mm TL) was discarded.

Ages of discarded black grouper

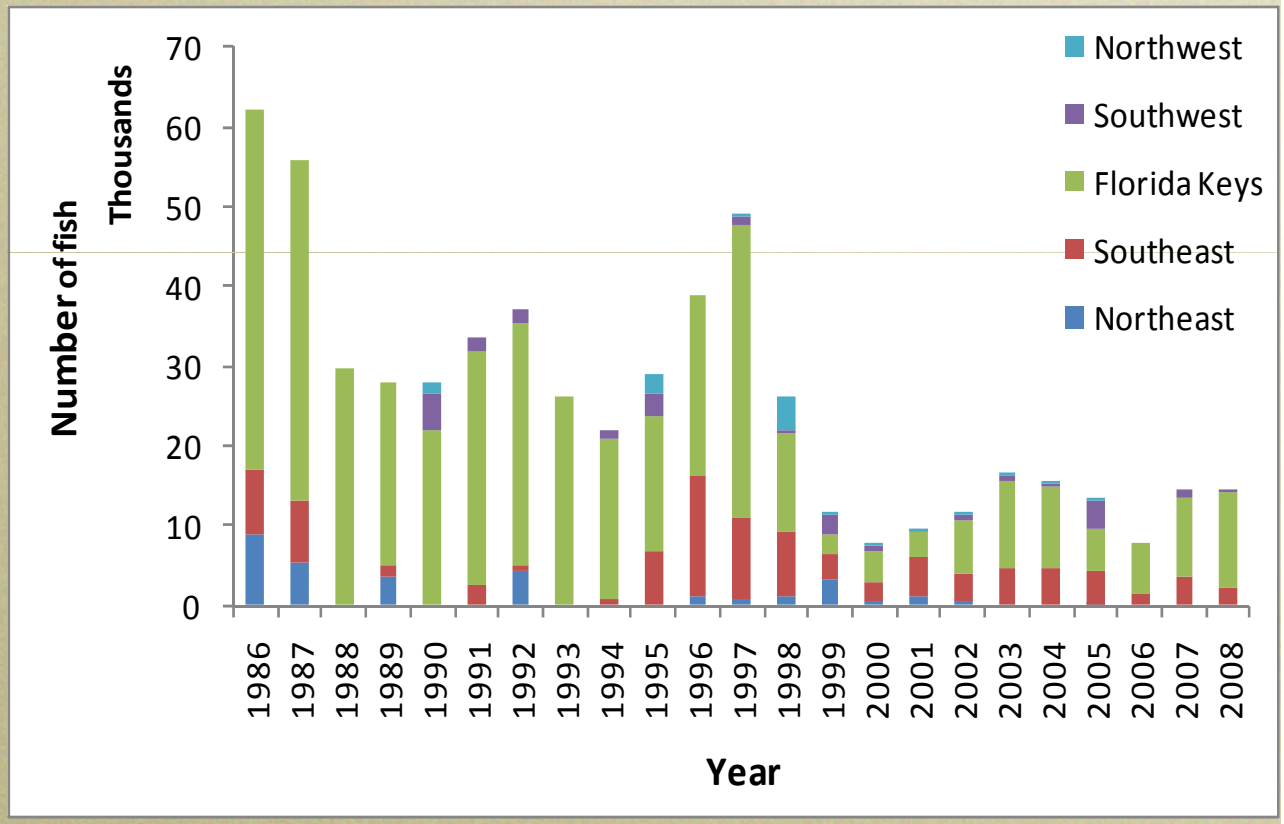
		Ages				
Year	n	0	1	2	3	4
2005	17	0	6	6	4	1
2006	17	1	9	6	1	0
2007	38	0	23	13	2	0
2008	3	1	1	1	0	0

	Year			
	2005	2006	2007	2008
n	17	17	38	3
20	0	0	0	1
21	0	0	0	0
22	0	0	0	0
23	0	1	0	0
24	0	1	0	0
25	0	1	2	0
26	0	0	0	0
27	1	0	0	0
28	0	0	0	0
29	0	0	1	0
30	0	2	2	0
31	1	0	1	0
32	0	0	3	0
33	2	0	5	0
34	1	1	1	0
35	0	1	2	0
36	2	1	2	0
37	0	1	2	0
38	0	1	2	0
39	0	0	2	0
40	0	1	1	0
41	0	2	2	0
42	2	1	0	1
43	0	1	0	0
44	0	0	2	1
45	1	0	2	0
46	0	1	1	0
47	0	0	2	0
48	1	0	1	0
49	1	0	0	0
50	0	0	0	0
51	0	0	0	0
52	2	0	1	0
53	0	0	0	0
54	1	0	1	0
55	1	0	0	0
56	0	0	0	0
57	0	0	0	0
58	1	0	0	0
59	0	0	0	0
60	0	1	0	0

Recreational fisheries

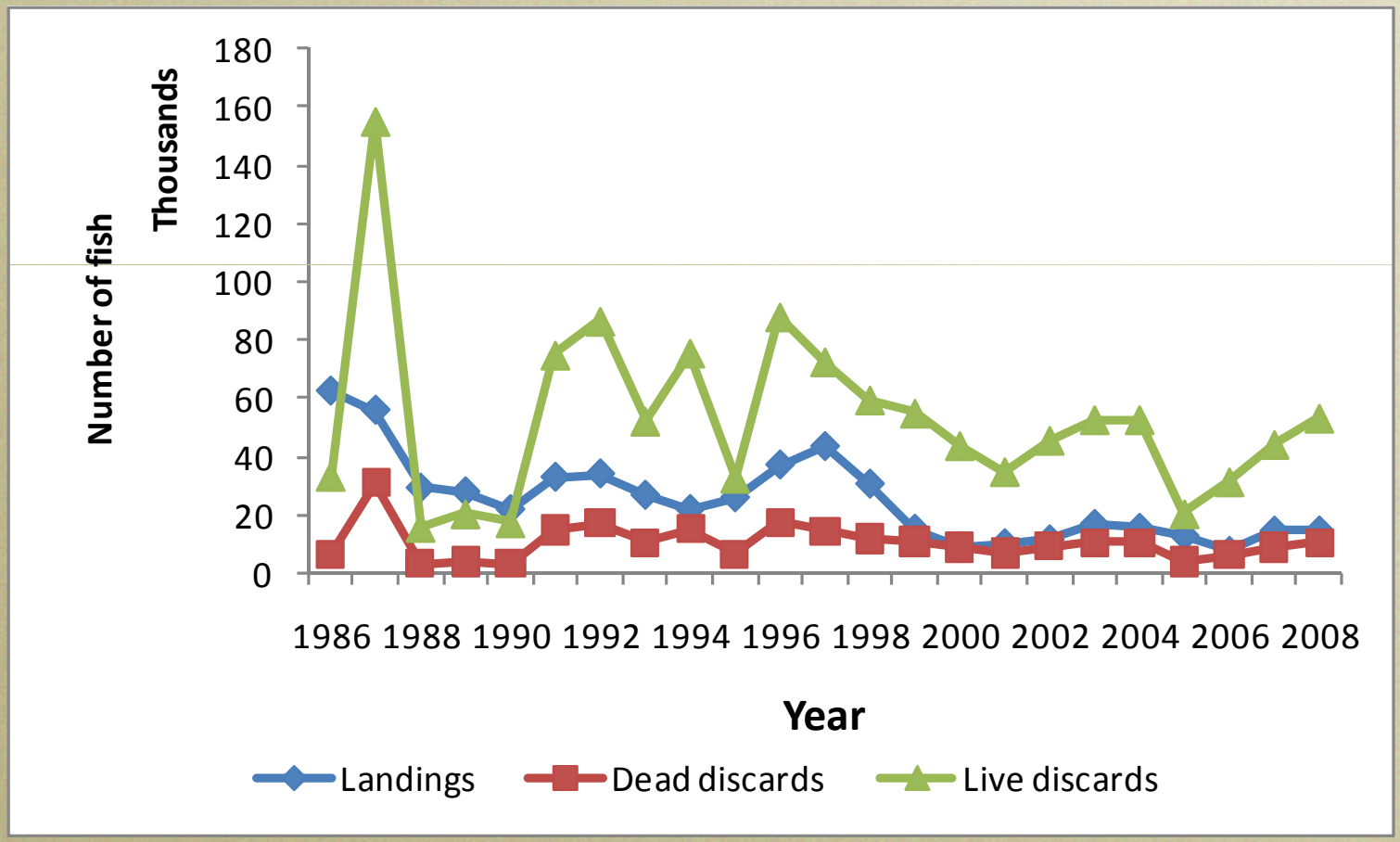
MRFSS landings include the fish that creel clerks examined and fish that anglers claimed to have caught, but NOT fish that were released alive. Fish that were released alive are estimated separately.

MRFSS landings



Recreational fleets

MRFSS landings and discards



Recreational fleets

Biological sampling

Number of length measurements and ages by fleet

	Lengths		Ages	
	Headboat	MRFSS	Headboat	MRFSS
Year	Number	Number	Number	Number
1986	55	14	0	0
1987	28	21	0	0
1988	18	4	0	0
1989	27	7	0	0
1990	25	1	5	0
1991	10	9	5	0
1992	11	21	2	0
1993	18	25	5	0
1994	21	24	6	3
1995	14	21	5	1
1996	24	40	2	0
1997	26	42	1	0
1998	30	96	0	0
1999	13	61	0	5
2000	7	64	0	0
2001	10	78	2	5
2002	9	56	0	10
2003	8	77	1	9
2004	6	46	2	8
2005	7	31	2	0
2006	10	17	1	6
2007	11	45	4	7
2008	2	26	0	4
Total	390	826	43	58

Indices of abundance

	Type	Description	Ages	Linked to fleet	Years
	FD	NMFS Logbook Comm hook-and-line	2+	Yes	1993-2008
	FD	NMFS Logbook Comm longline	5+	Yes	1993-2008
	FD	Headboat	1+	Yes	1986-2008
	FD	MRFSS	2+	No	1991-2008
X	FI	FWC Visual Survey	1+	No	1999-2004,2006-2007
	FI	FWC Visual Survey, Age-1	1	No	1999-2004,2006-2007
X	FI	NMFS-UM Reef Visual Census	1+	No	1994-2008
X	FI	NMFS-UM Reef Visual Census, Age-1	1	No	1994-2008

FD -- Fishery dependent

FI -- Fishery independent

X – Not used in base run

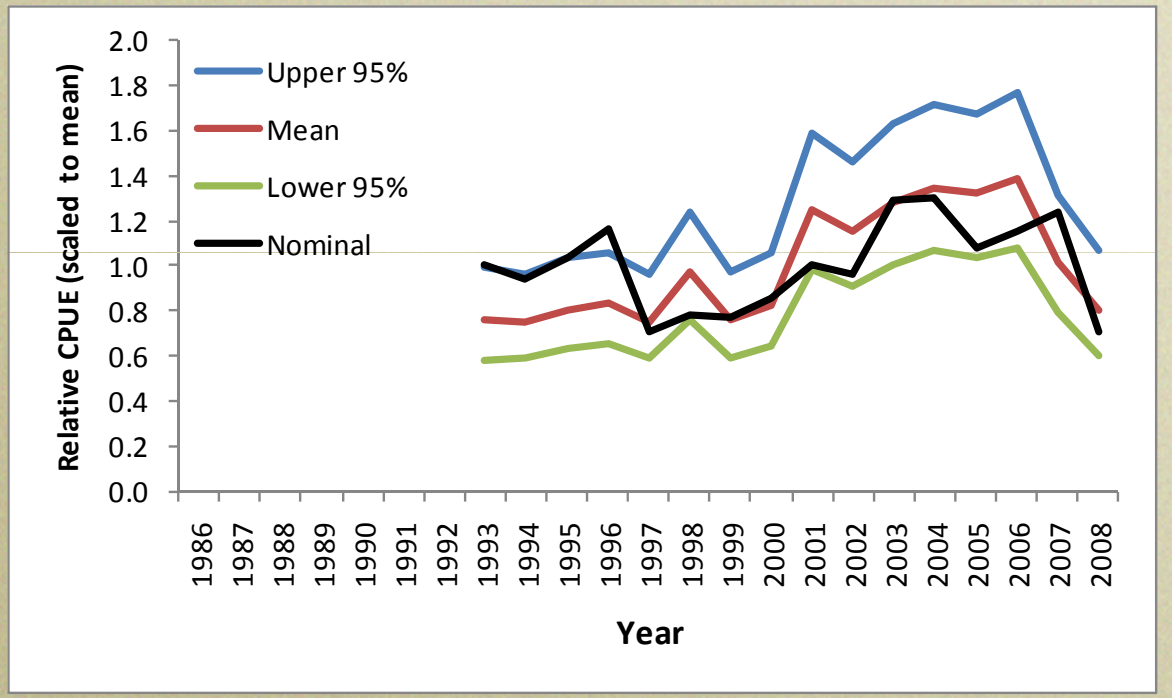
Table 2.2.1.

Indices of abundance

Data were subset using Stephens and McCall and standardized with a delta-lognormal approach. The response variable is the pounds per hook-hour.

This index was linked to the selectivity of the commercial hook-and-line fleet.

NMFS logbook hook-and-line



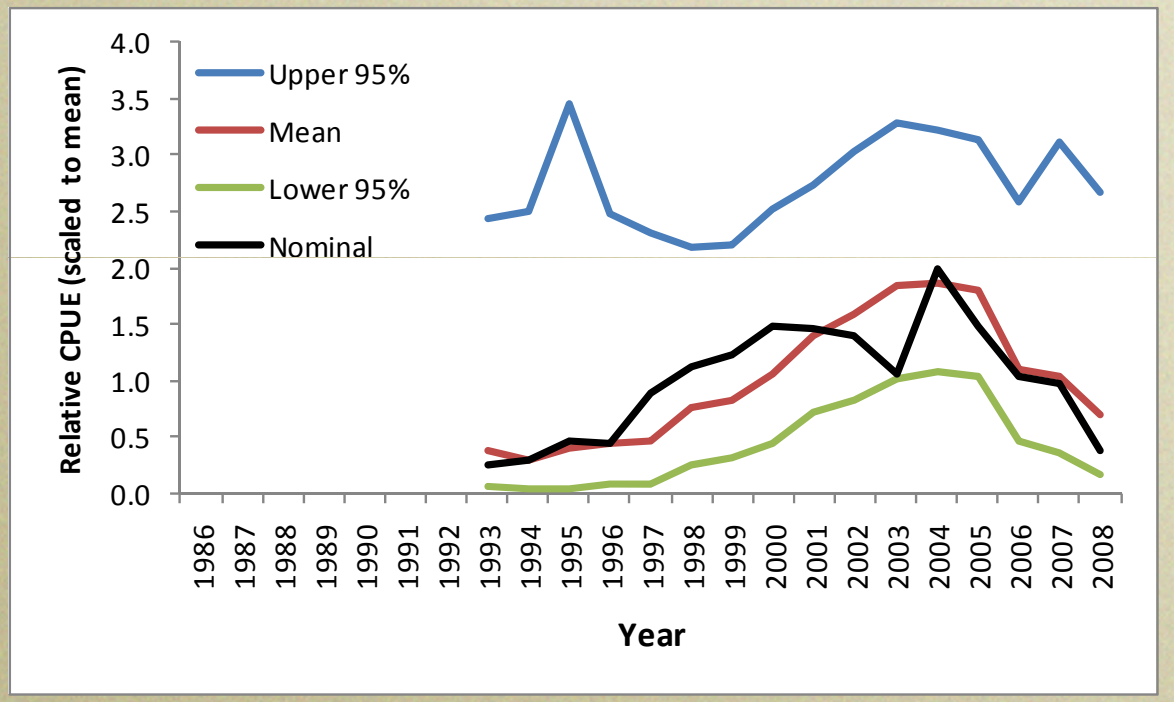
Redrawn from data in DW Table 5.15.

Indices of abundance

Data were subset using Stephens and McCall and standardized with a delta-lognormal approach. The response variable is the pounds per hook set.

This index was linked to the selectivity of the commercial longline fleet.

NMFS logbook longline



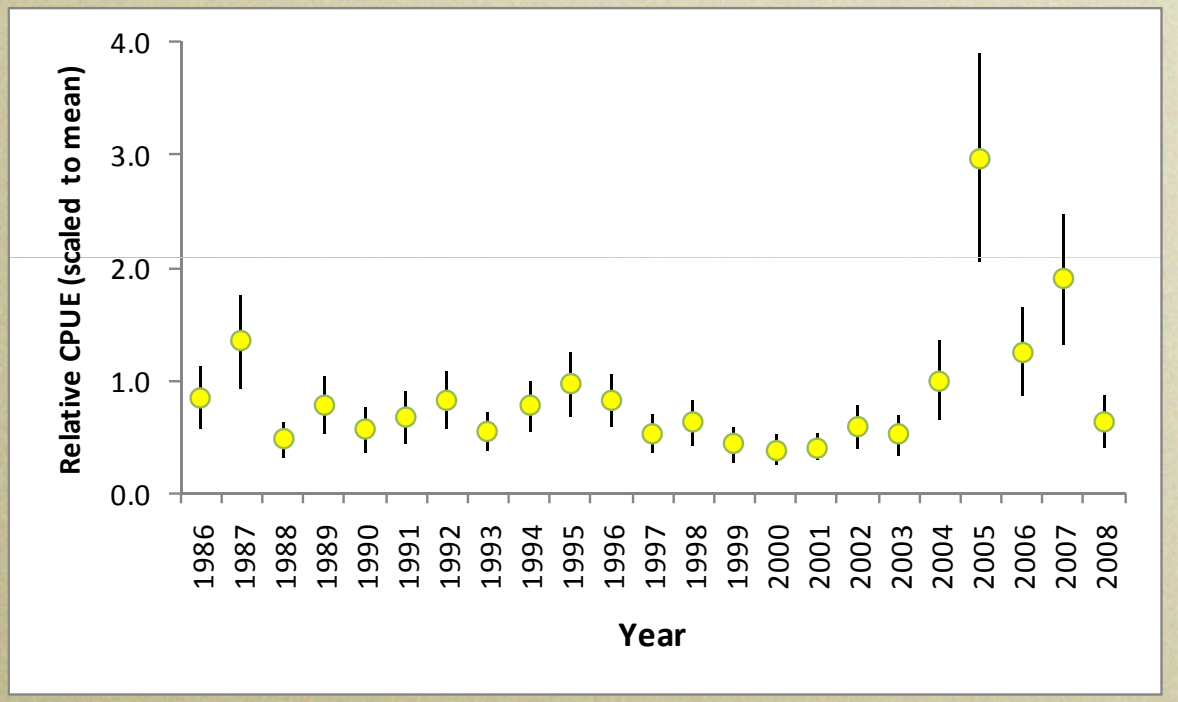
Redrawn from data in DW Table 5.16.

Indices of abundance

Data were subset using Stephens and McCall and standardized with a delta-lognormal approach. The response variable is the number per angler-hour.

This index was linked to the selectivity of the headboat fleet.

NMFS Headboat survey 1986-2008



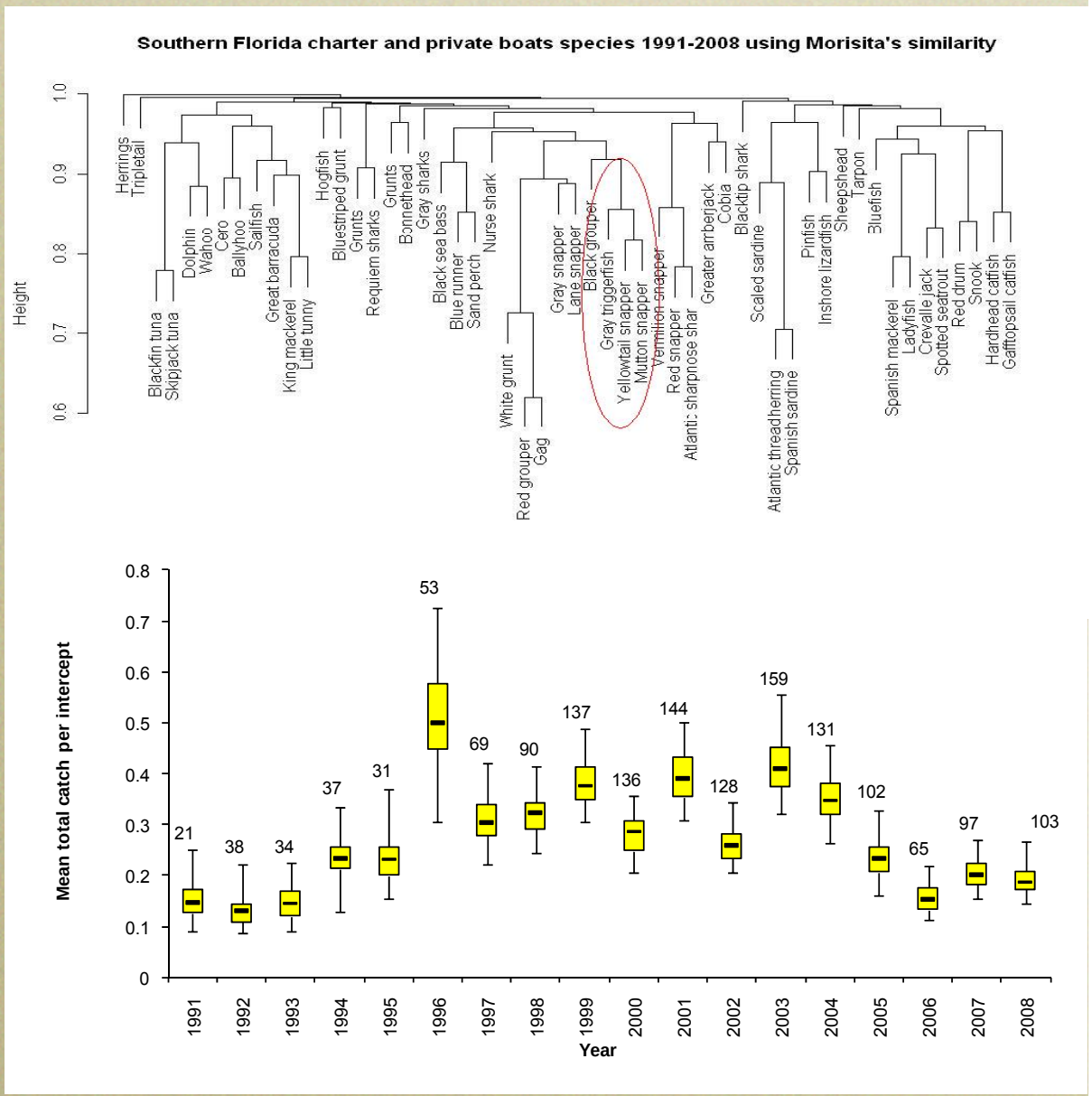
Redrawn from data in DW Table 5.12.

Indices of abundance

MRFSS 1991-2008

Intercepts from southern Florida, Tampa Bay to Cape Canaveral (Pinellas – Volusia counties), and charterboat and private /rental boat modes selected with cluster analysis. Any intercept with a black grouper, gray triggerfish, yellowtail or mutton snappers was included.

Because MRFSS collects information on the total catch including discards, this index was treated as a fishery-independent index and selectivity was fitted with a double logistic curve.



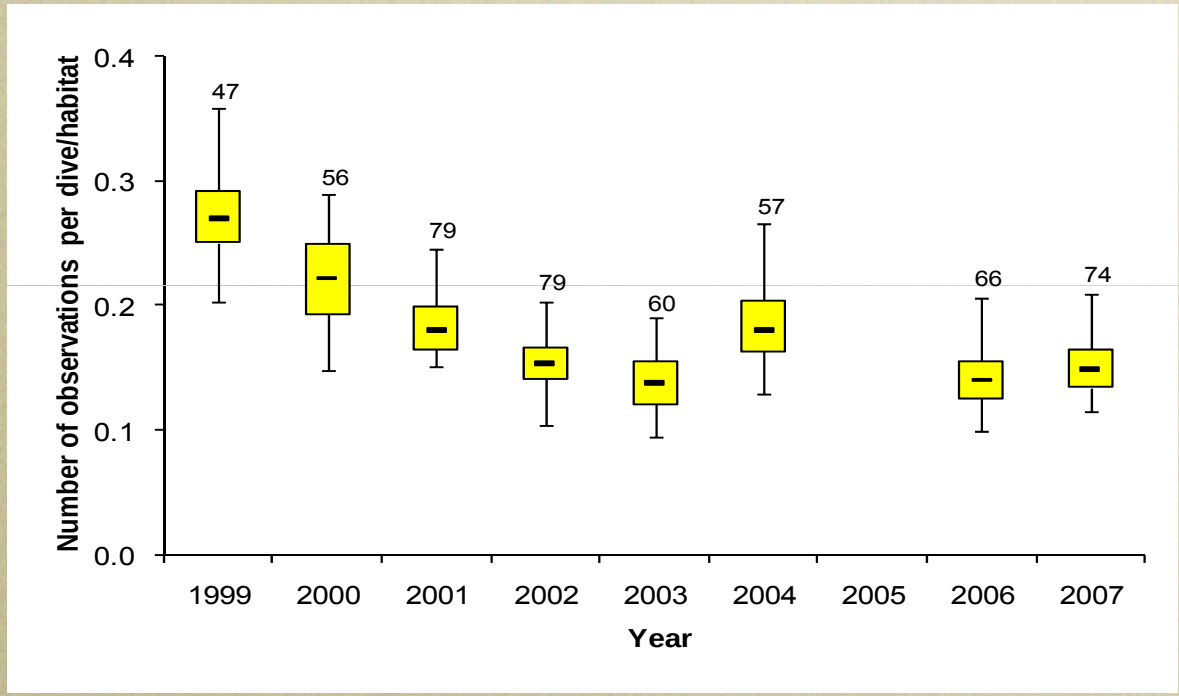
Indices of abundance

All visual survey trips from May through October were included in the analysis.

Standardized with GLIM using a binomial distribution with a logit link for the proportion positive and a gamma distribution with log link for the positive dive/habitats.

Selectivity was fitted with a double logistic curve.

FWC Visual Survey



Not used in base run

DW BG Fig. 5.3.

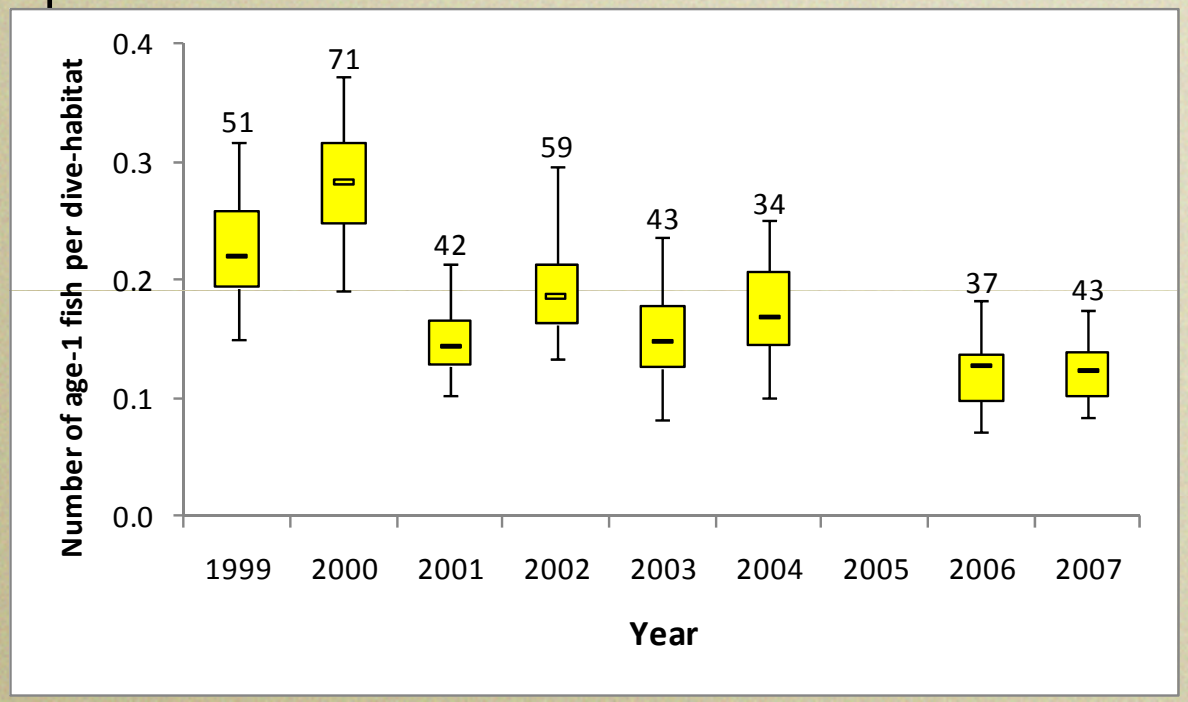
Indices of abundance

All visual survey trips from May through October were included in the analysis. Age-1 was determined from the overall von Bertalanffy growth curve.

Standardized with GLIM, using a binomial distribution with a logit link for the proportion positive and a gamma distribution with log link for the positive dive/habitats.

Applied to age-1.

FWC Visual Survey Age-1

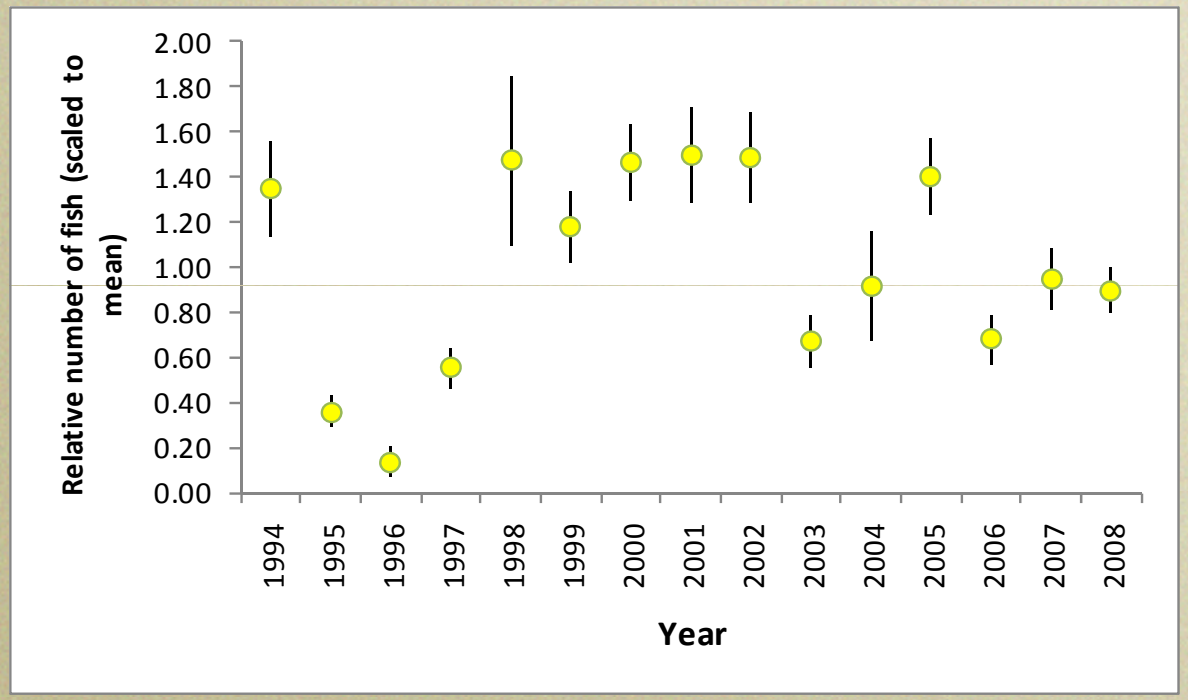


Indices of abundance

Two-stage, random sample design. Primary stage 200x200 m areas by habitat, fish are counted in two of these 7.5 m cylinders.

Selectivity was fitted with a double logistic curve.

NMFS-UM Reef visual census



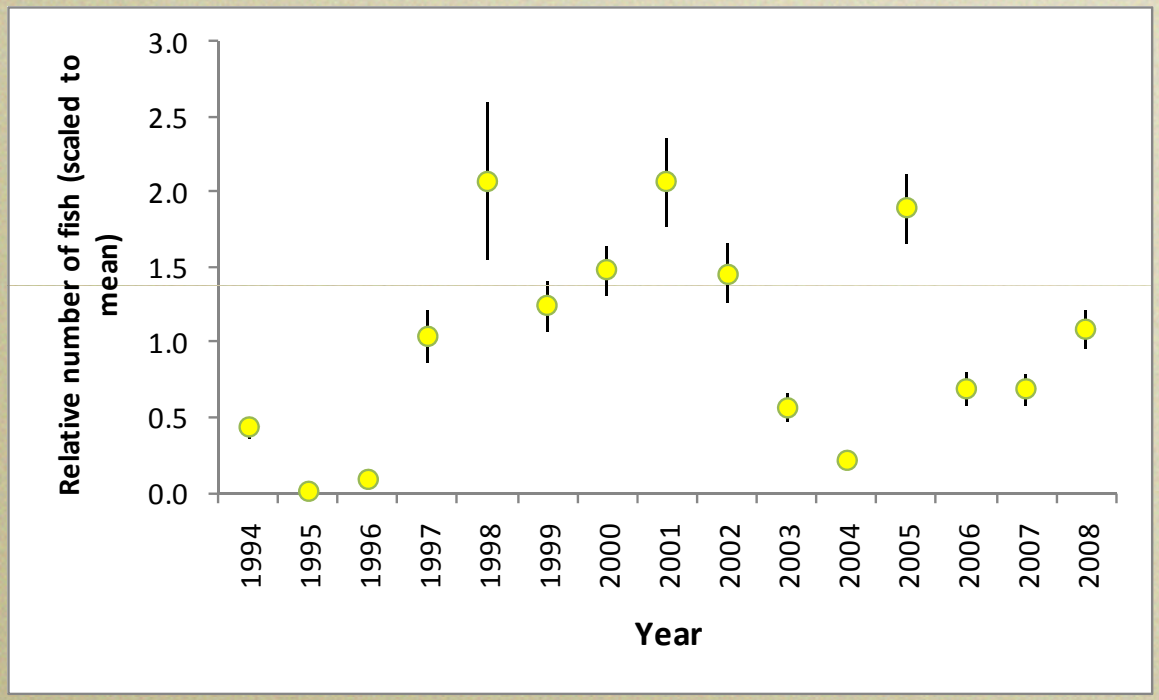
Not used in base run

Indices of abundance

Two-stage, random sample design. Lengths associated with age-1 were determined from the overall von Bertalanffy growth curve.

Applied to age-1.

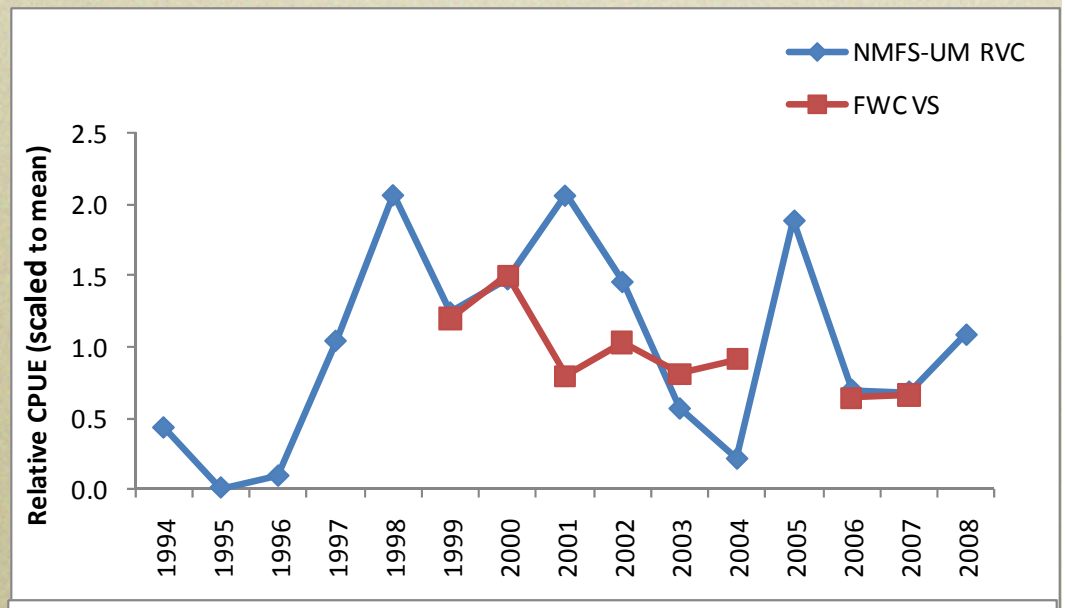
NMFS-UM Reef visual census, Age-1



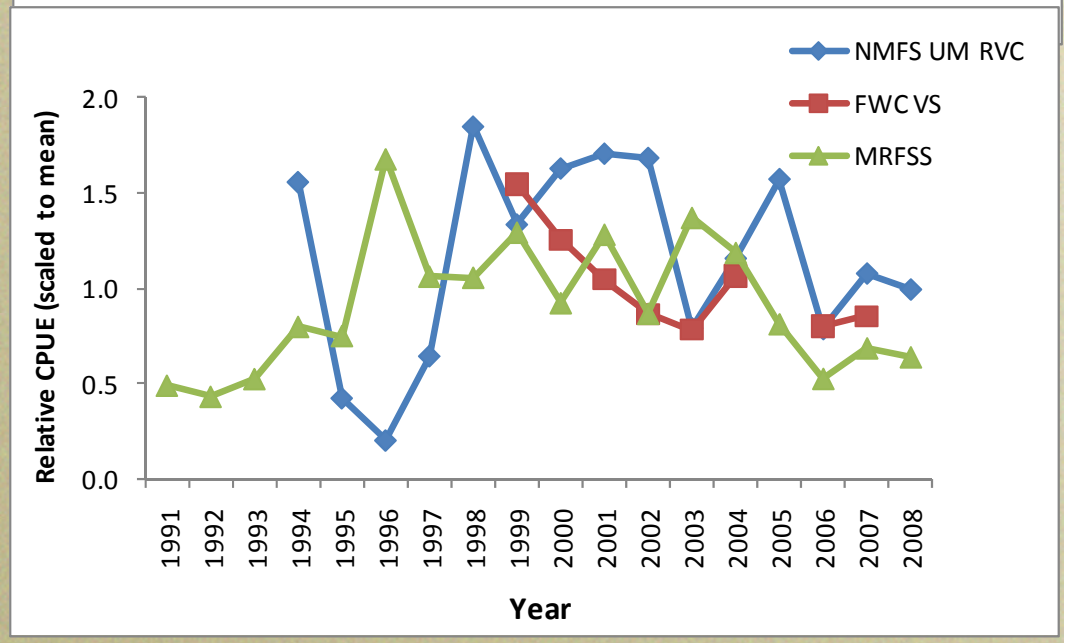
Not used in base run

Indices of abundance

Fishery independent – Age-1

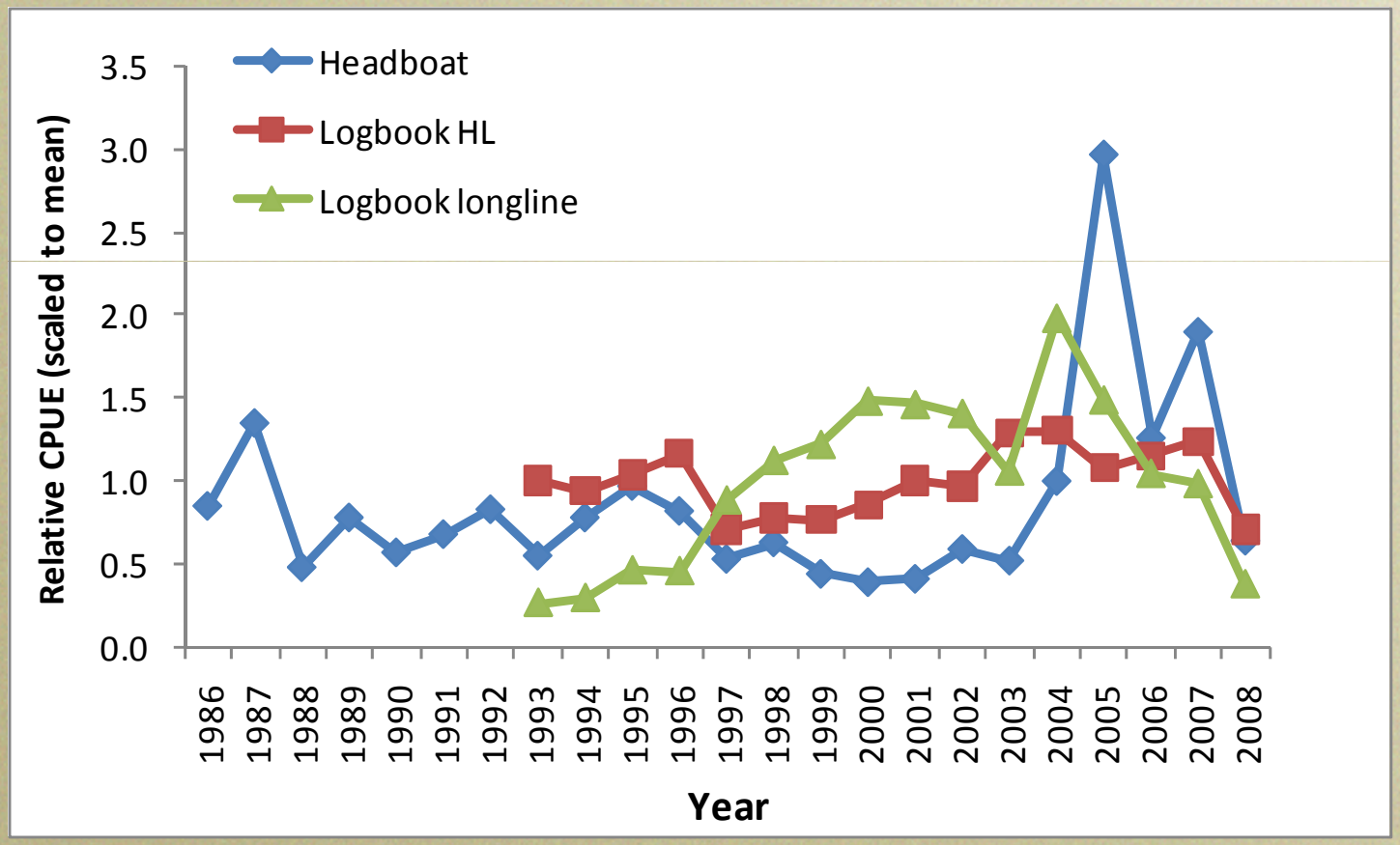


Fishery independent



Indices of abundance

Fishery dependent indices



Assessment models

- Catch curve
- Surplus production
- Statistical catch-at-age model

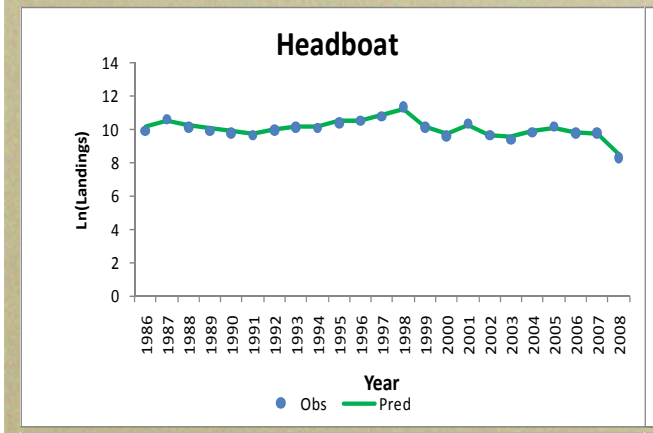
Statistical catch-at-age (ASAP2)

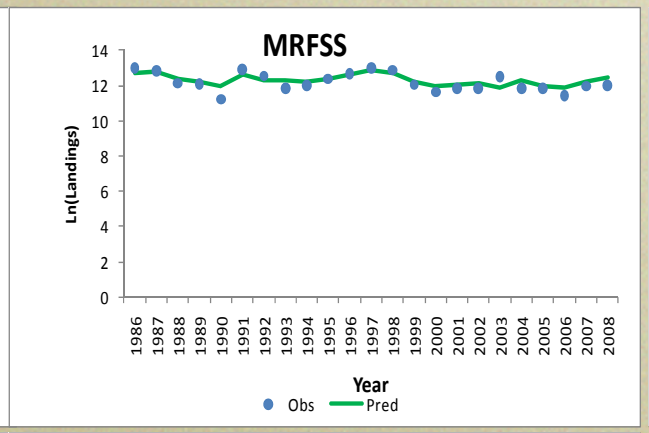
Fleets	HL, LL, HB, MRFSS.
Ages	1 to 20+ years.
Age composition	Length measurements assigned ages stochastically with gear and time specific von Bertalanffy growth curves.
Natural mortality curve	Age-specific M following Lorenzen averaging 0.136 per year for ages 3-33 years.
Tuning	Four fishery-dependent indices and one fishery-independent index in base run.
Steepness	0.60 to 0.95 in 0.05 increments with 0.75 in base run.
Catchability	Constant.

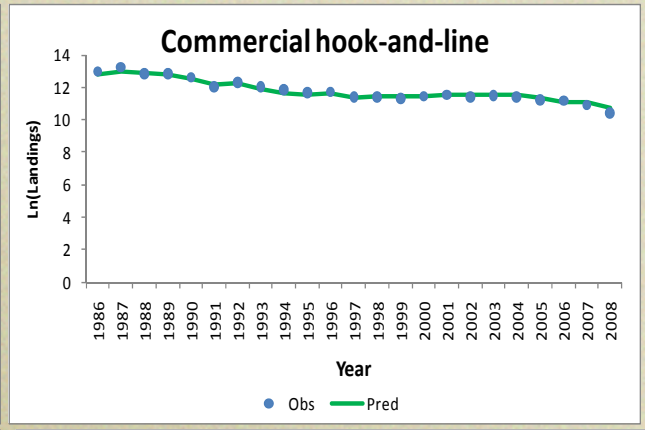
Statistical catch-at-age (ASAP2)

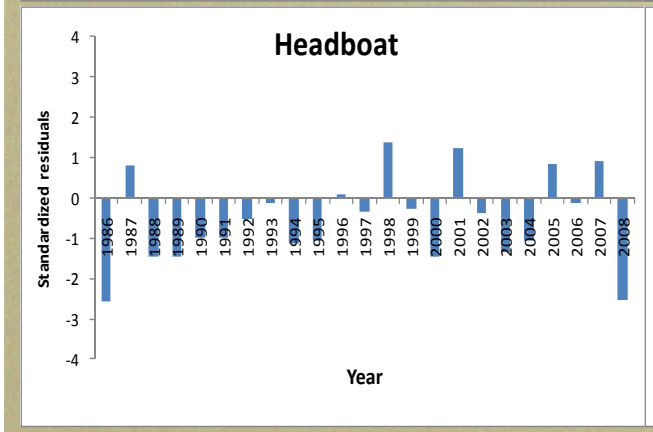
Model fit: Fleets

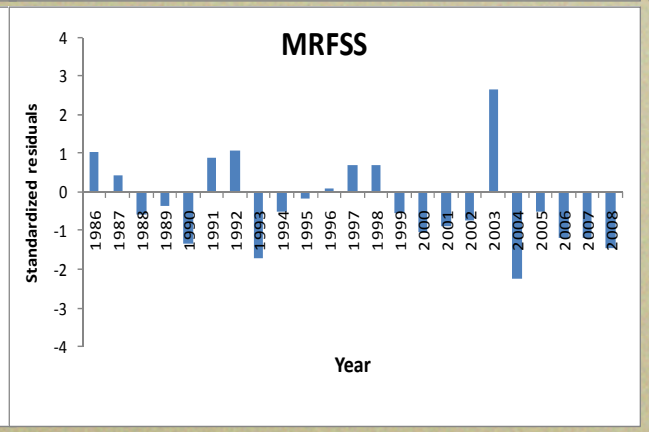
Fits and standardized residuals

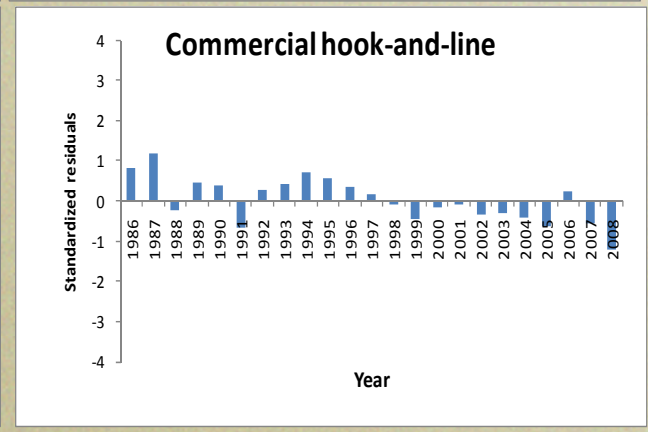






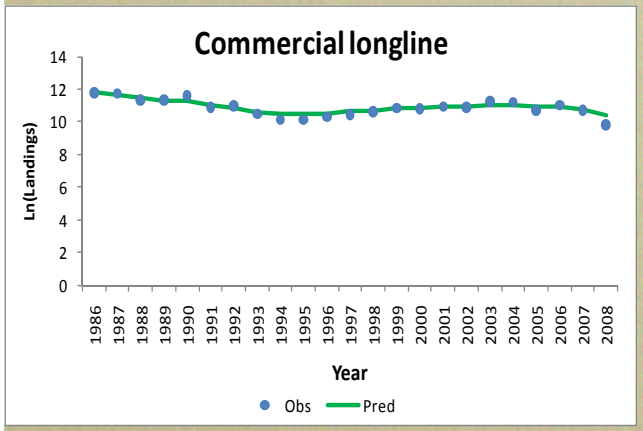


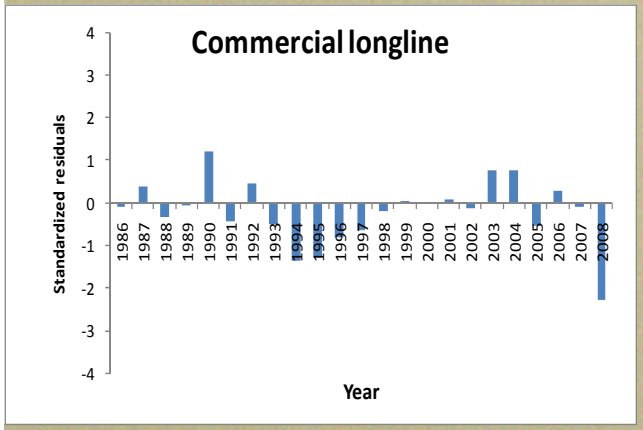




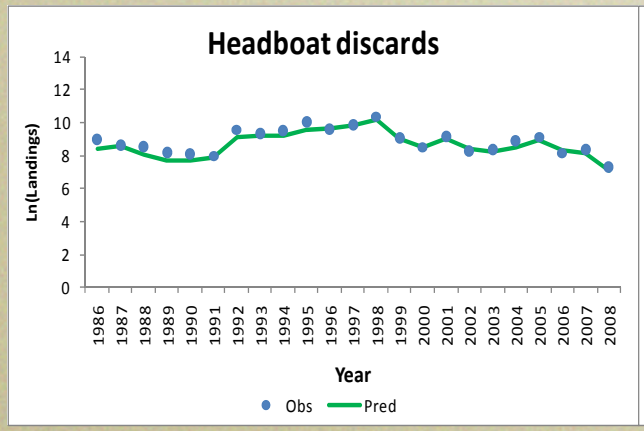
Statistical catch-at-age (ASAP2)

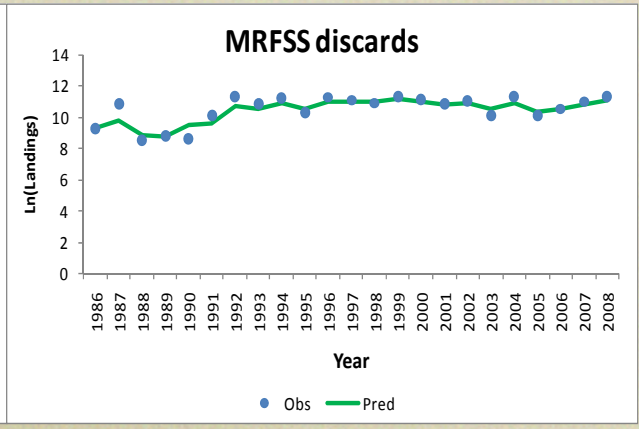
Model fit: Fleets

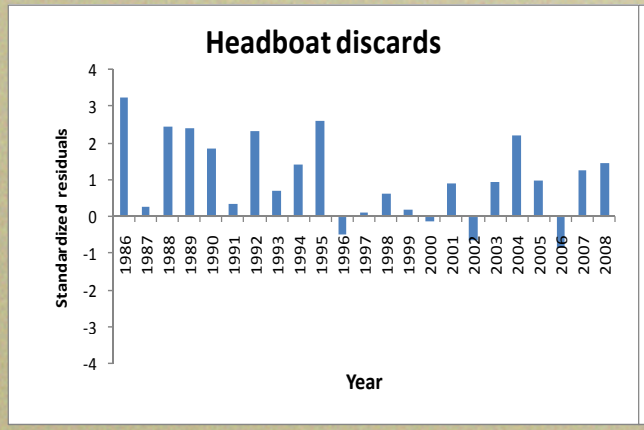


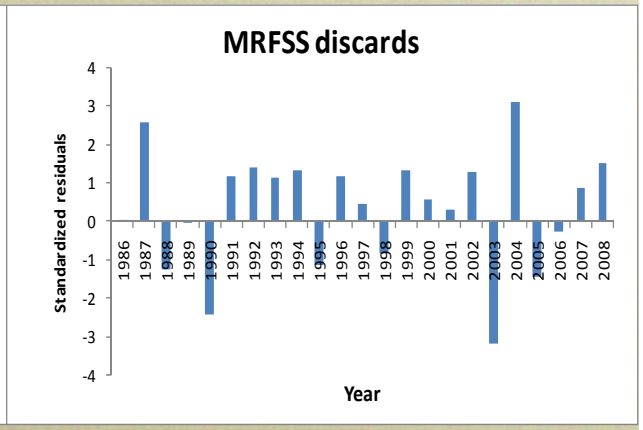


Model fit: Fleet discards



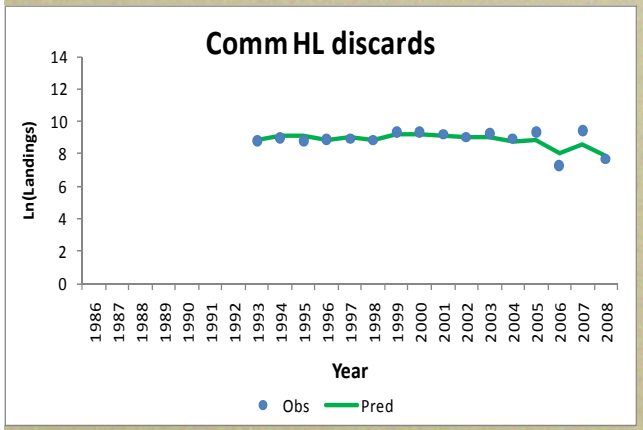


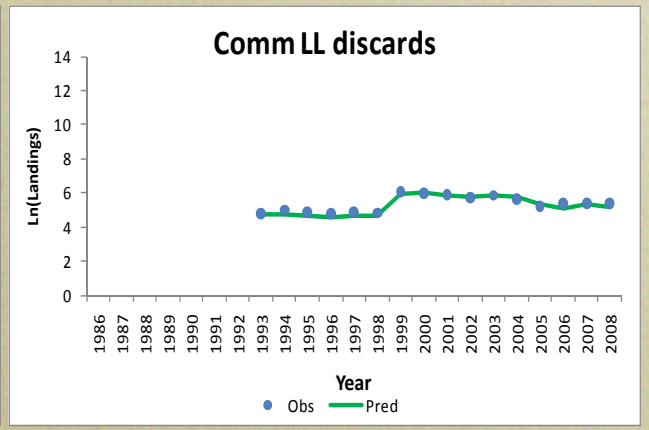


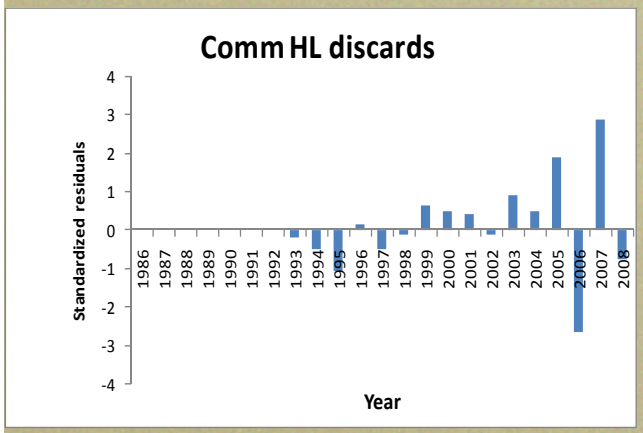


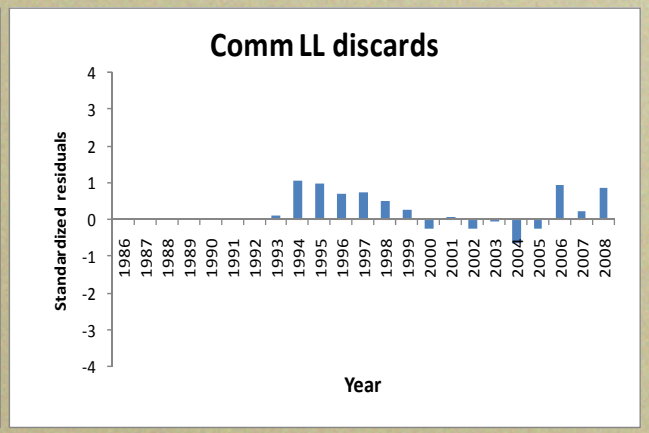
Statistical catch-at-age (ASAP2)

Model fit: Discards

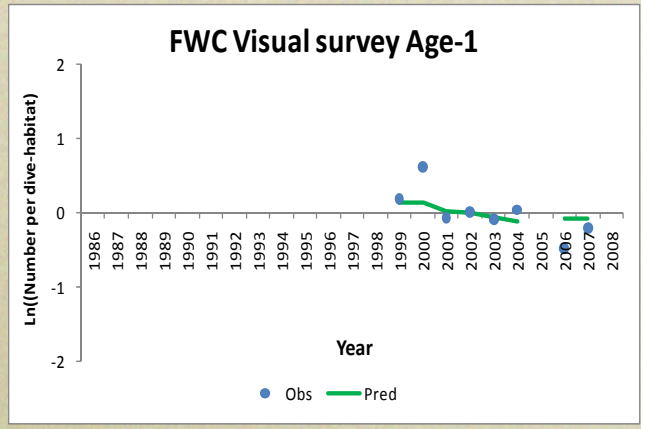


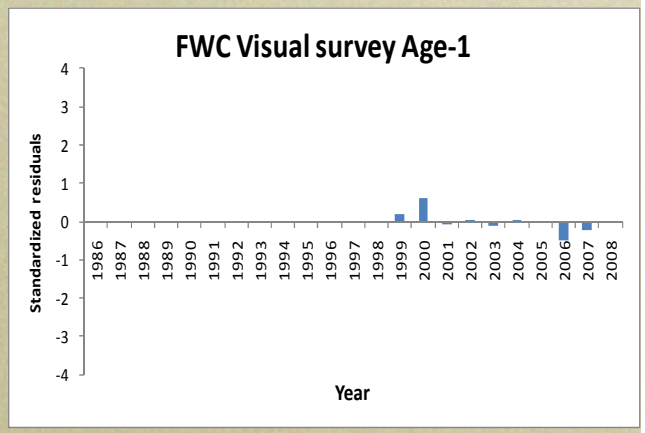






Model fit: FI index





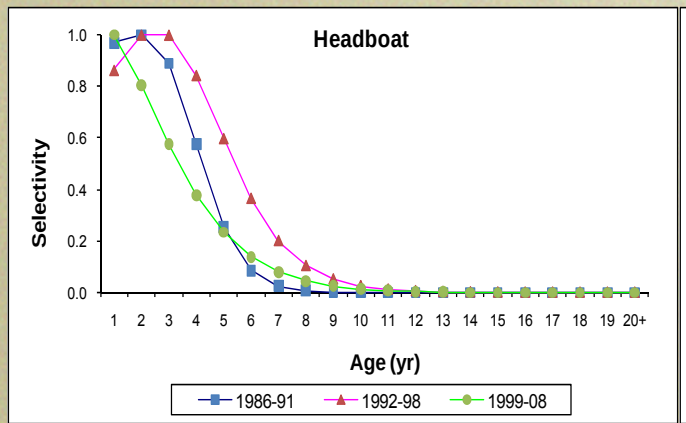
Statistical catch-at-age (ASAP2)

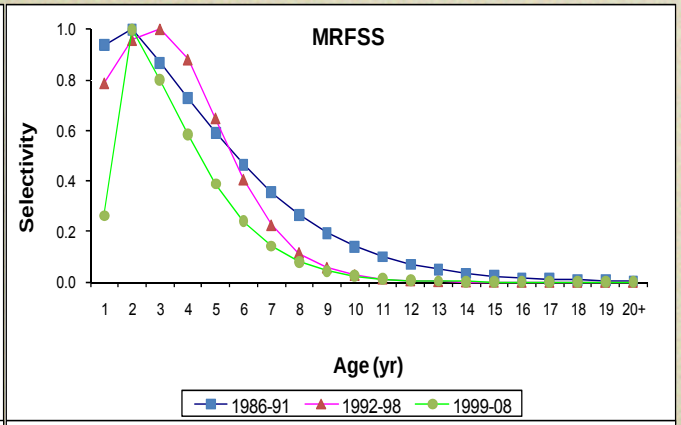
Model fits

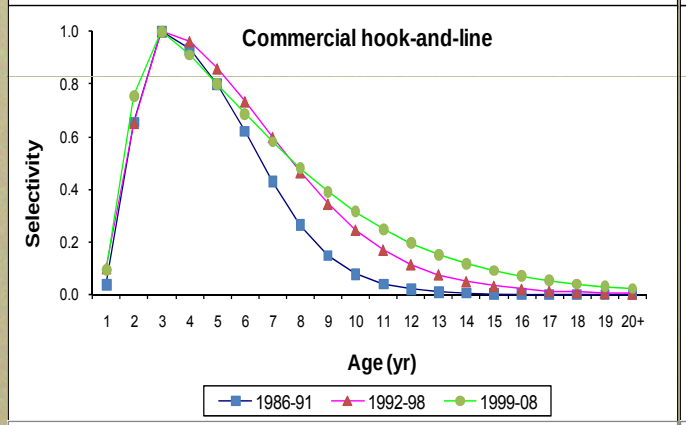
Type	Fleet or Index	SS	n	MSE	RMSE
Landings	Headboat	32.67	23	1.48	1.22
	MRFSS	29.39	23	1.34	1.16
	Commercial hook-and-line	6.96	23	0.32	0.56
	Commercial longline	13.82	23	0.63	0.79
Discards	Headboat	53.02	23	2.41	1.55
	MRFSS	52.61	23	2.39	1.55
	Commercial hook-and-line	22.93	16	1.53	1.24
	Commercial longline	5.66	16	0.38	0.61
Indices	Headboat	69.85	23	3.17	1.78
	MRFSS	48.49	18	2.85	1.69
	Commercial hook-and-line	23.67	16	1.58	1.26
	Commercial longline	8.89	16	0.59	0.77
	FWC Visual Survey age-1	18.52	8	2.65	1.63

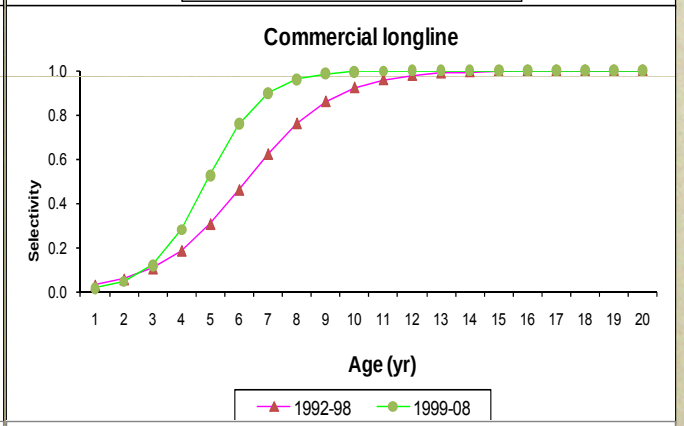
Statistical catch-at-age (ASAP2)

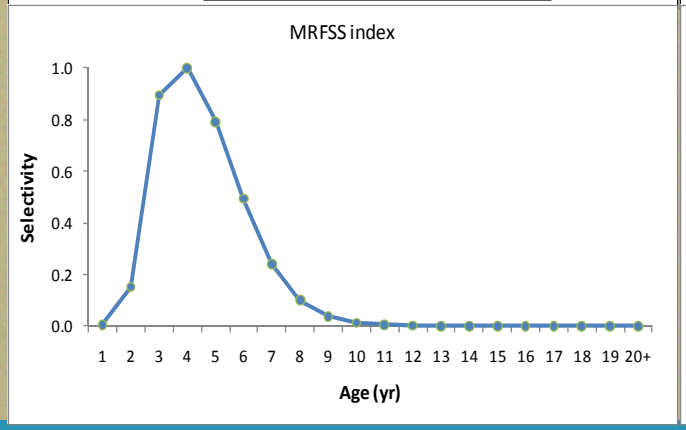
Selectivity

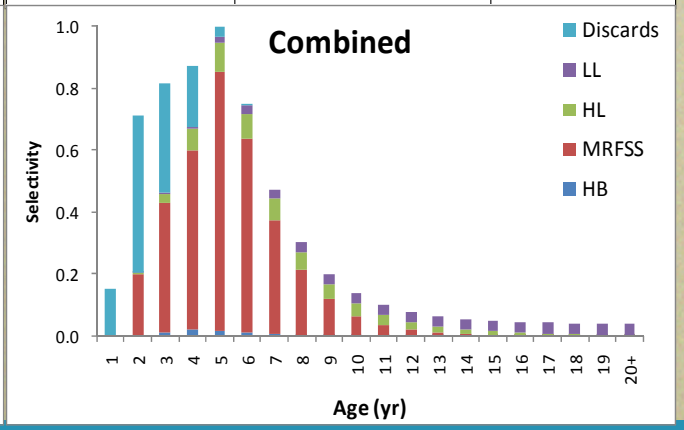






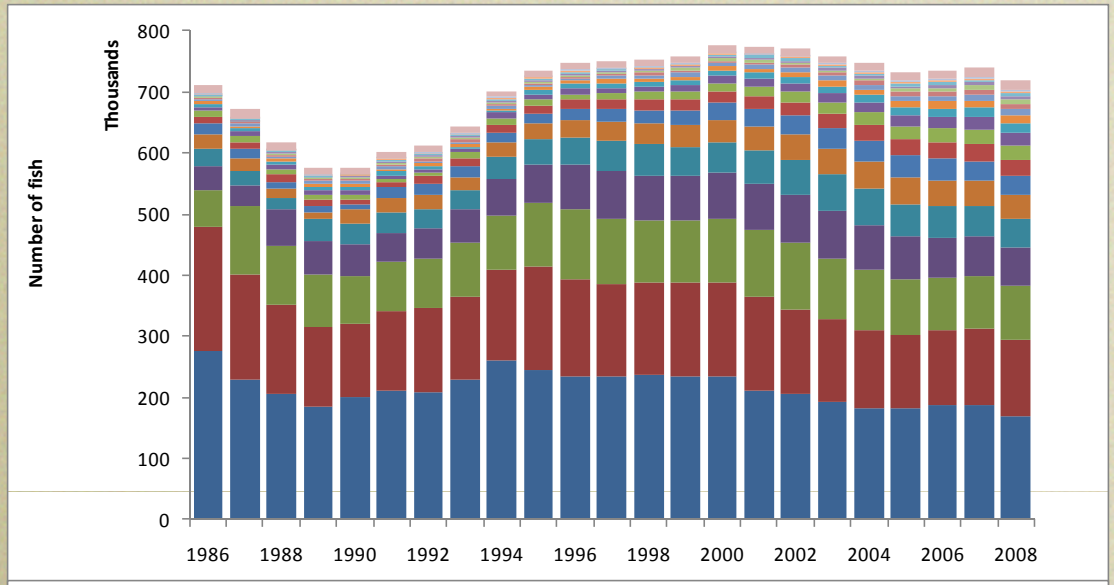




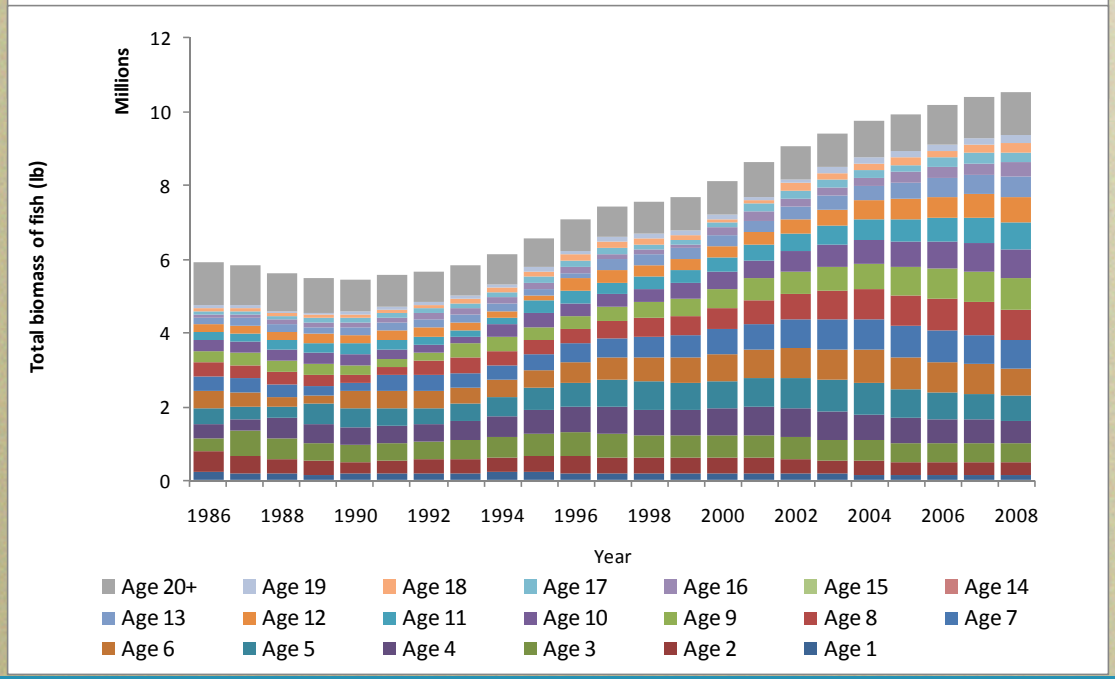


Statistical catch-at-age (ASAP2)

Numbers of fish at age

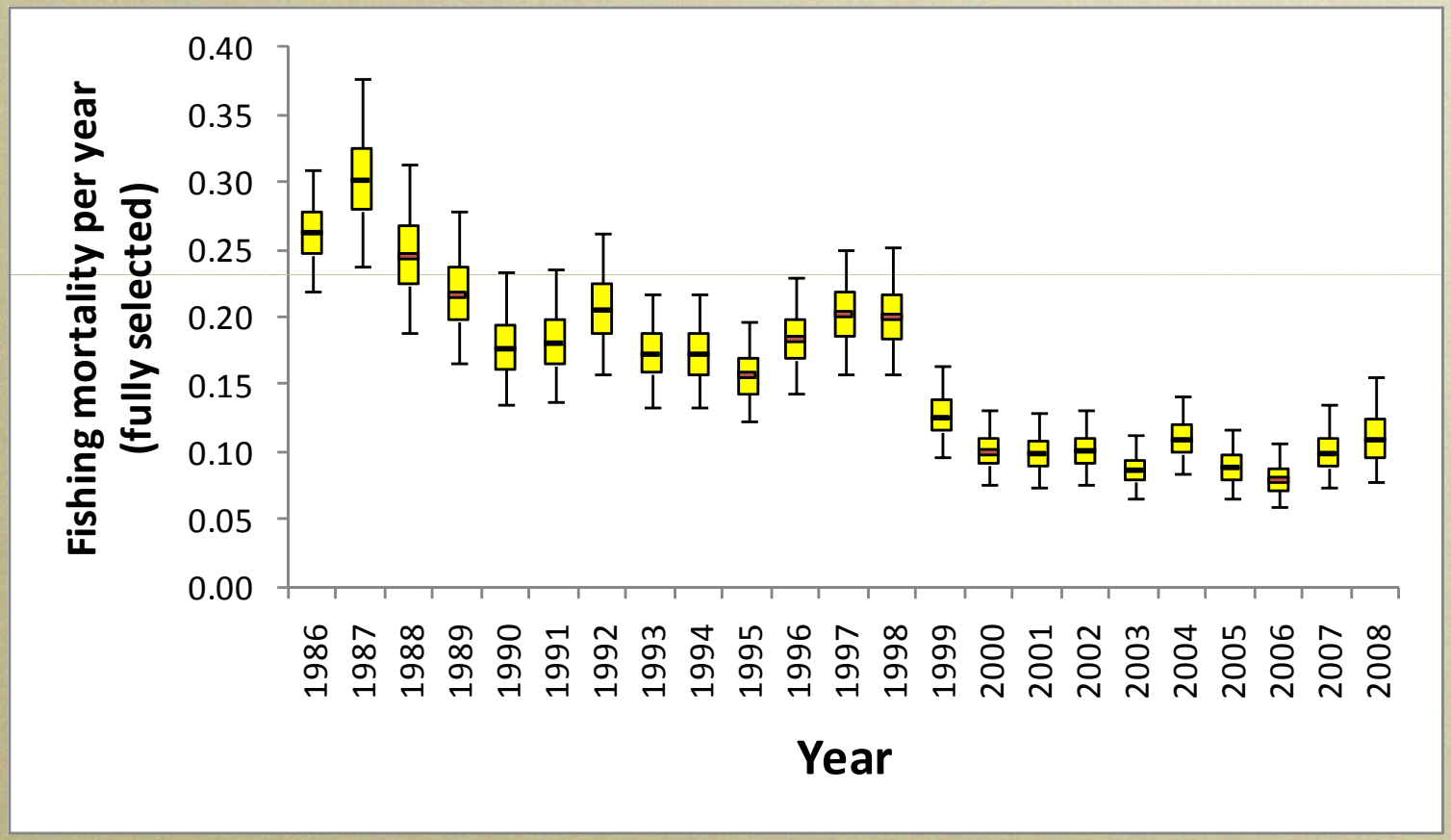


Biomass at age



SEDAR19 AW BG Addend Fig. 3.3.5.6. and

Statistical catch-at-age (ASAP2) Fishing mortality per year



Statistical catch-at-age (ASAP2)

Spawning biomass and recruitment

Base run:

Steepness = 0.838

$SSB_{F=0}$ = 22.4 million lb

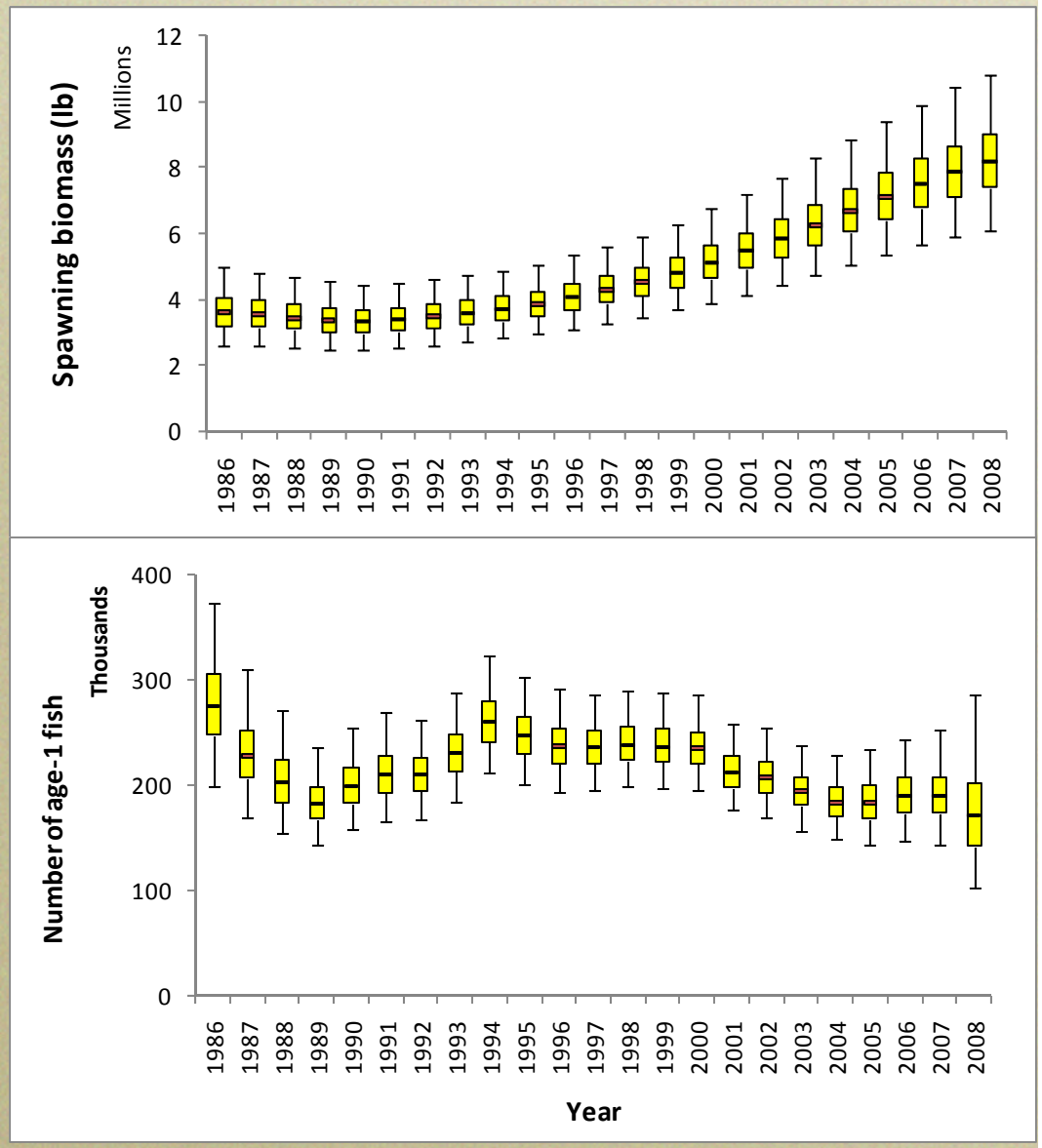
$F_{30\%}$ = 0.216 per year

$F_{45\%}$ = 0.143 per year

F_{2008} = 0.108 per year

$SSB_{F30\%}$ = 5.92 million lb

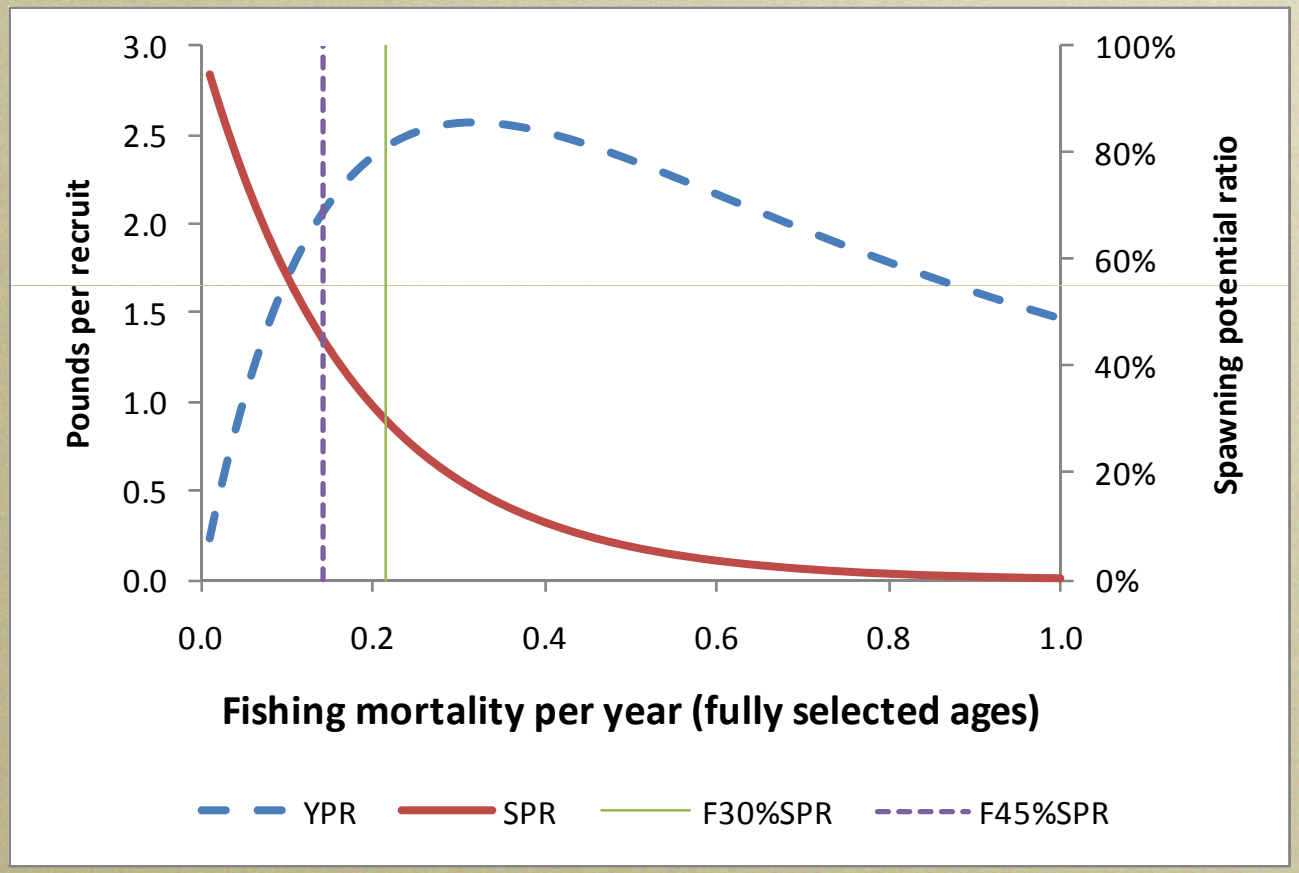
SSB_{2008} = 8.29 million lb



SEDAR19 AW BG Addend Fig. 3.3.5.9 and

Statistical catch-at-age (ASAP2)

Yield per recruit and static spawning potential ratio



Statistical catch-at-age (ASAP2)

Beverton-Holt spawner-recruit

Steepness = 0.838

SSBo = 22.4 million lb

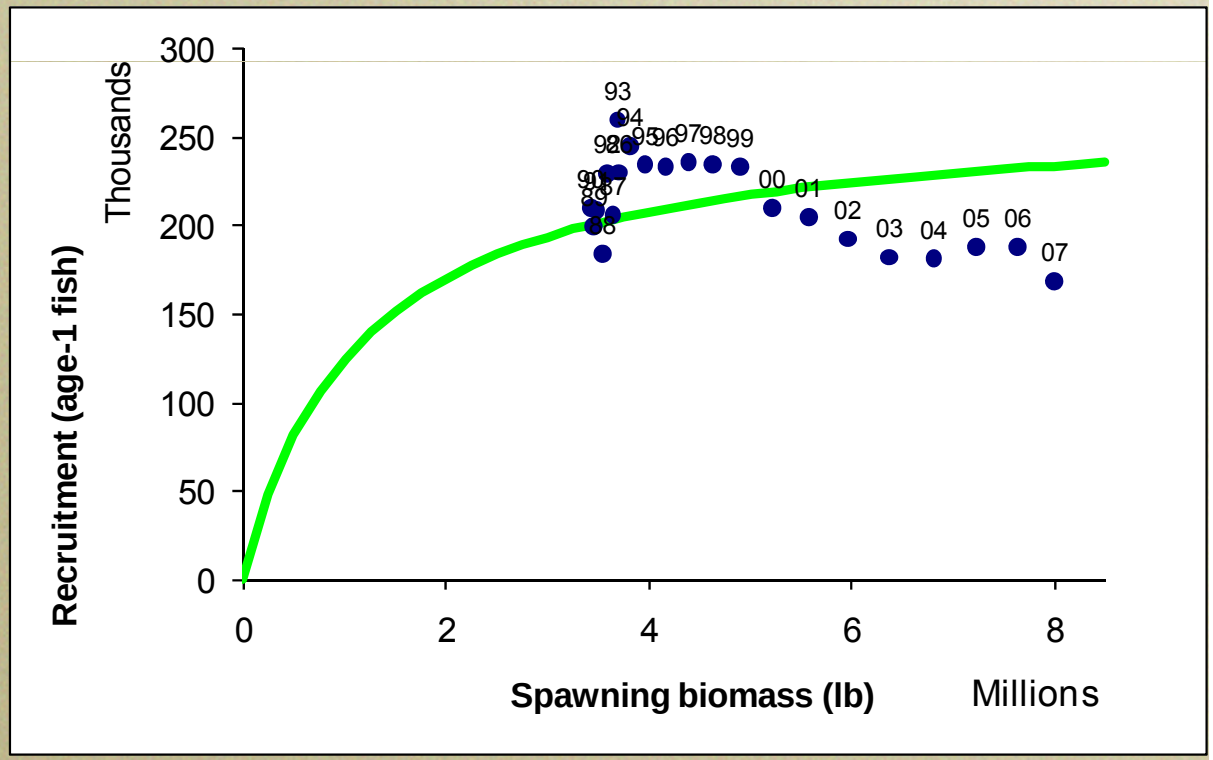
Ro = 254,000

SSBo/Ro = 88.1 lb

α = 267,000

β = 1.13 million lb

$$R_t = \frac{\alpha SSB_{t-1}}{\beta + SSB_{t-1}}$$

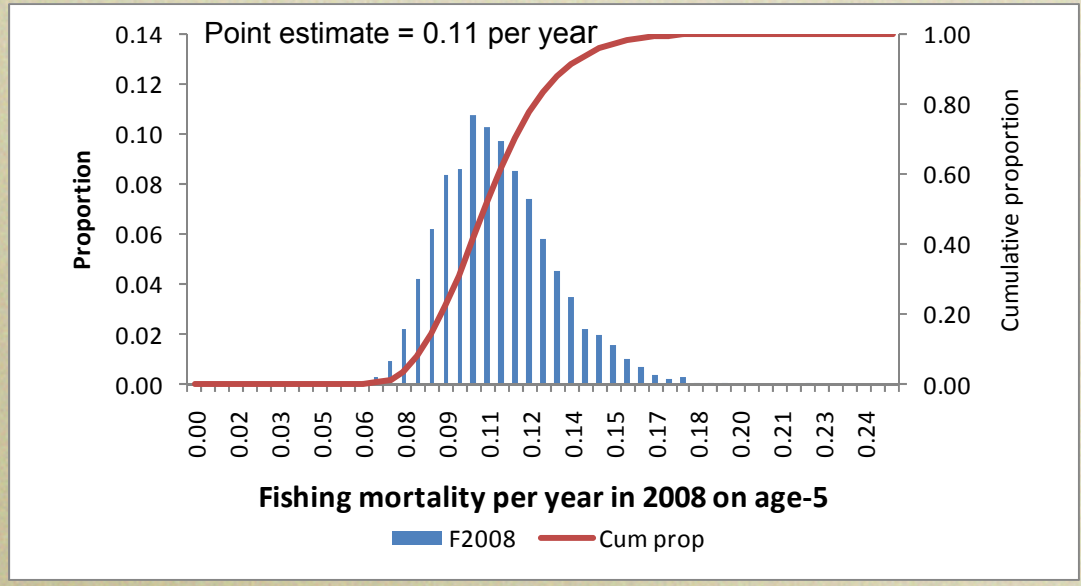


Statistical catch-at-age (ASAP2)

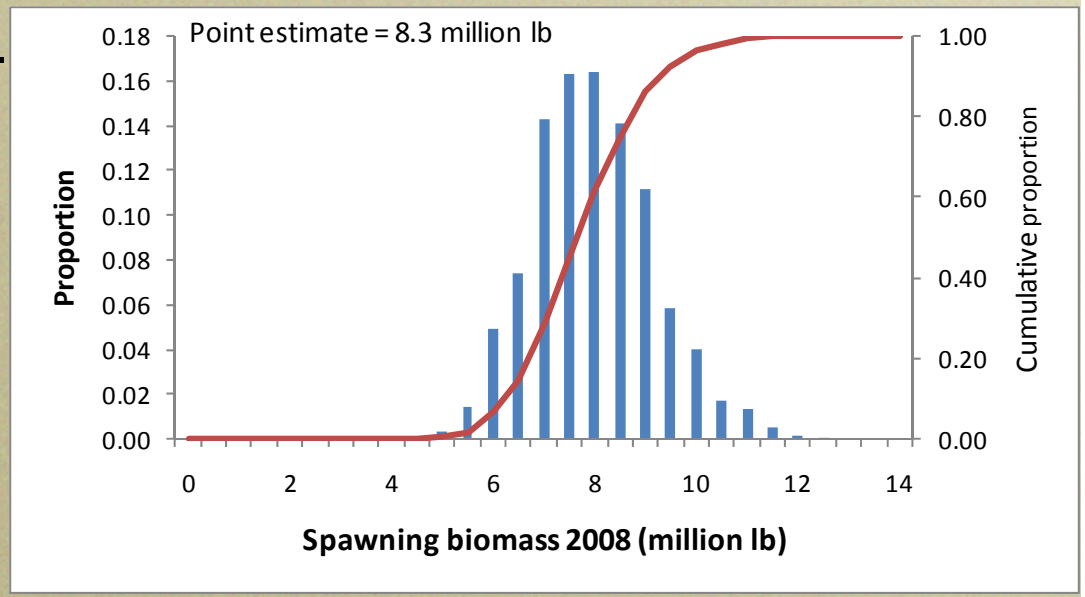
Uncertainty

Distributions of the fishing mortality rate in 2008 on fully selected ages (a) and the spawning biomass in 2008 (b) from the 2.5 million MCMC simulations.

a.



b.



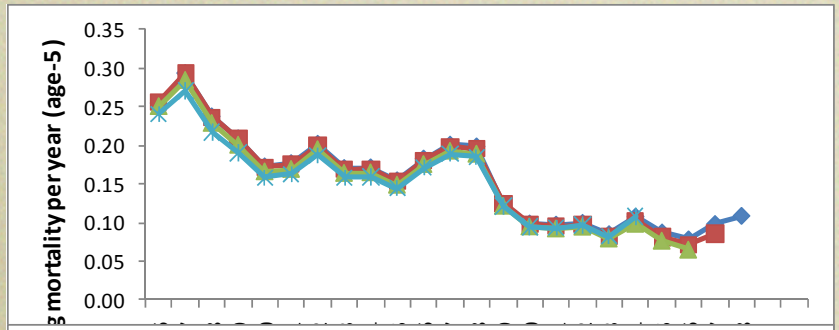
Statistical catch-at-age (ASAP2)

Uncertainty

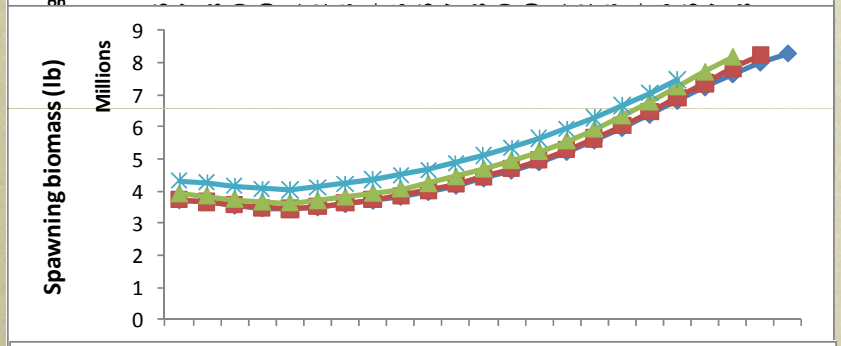
Retrospective analysis.

There was minimal retrospective pattern with additional years of data.

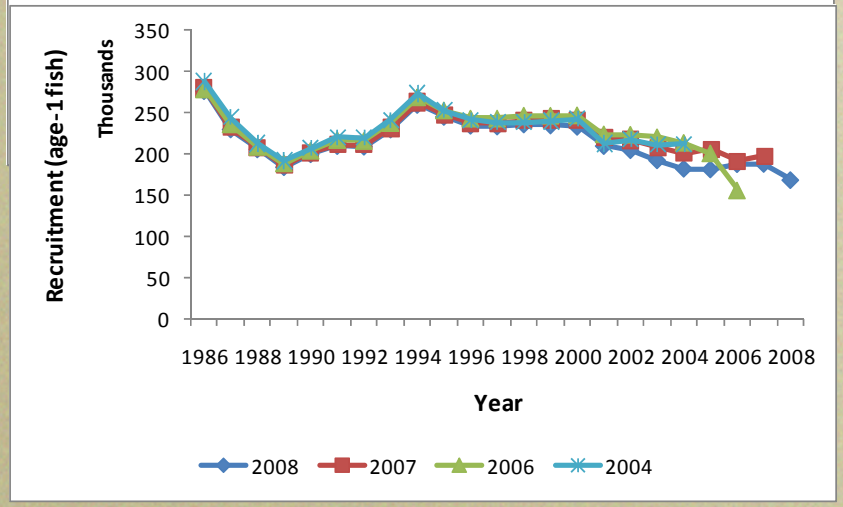
a.



b.



c.



SEDAR19 AW BG Addend Fig.

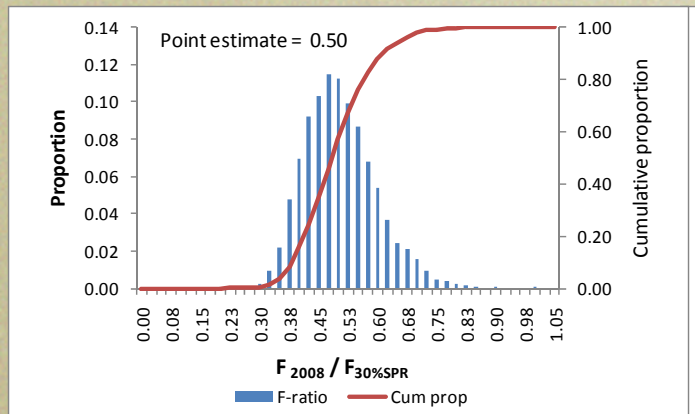
Stock status criteria

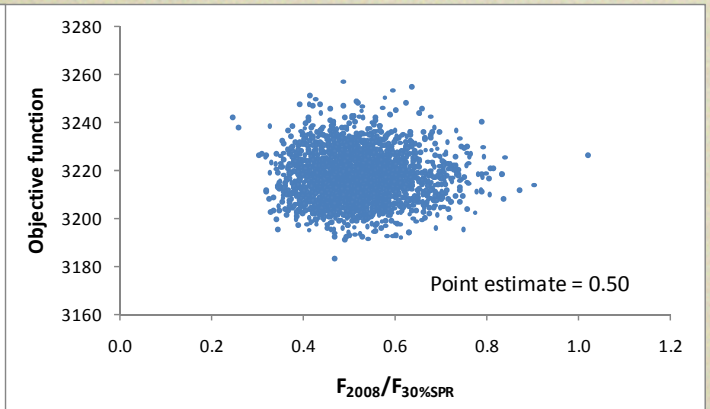
Base runs results

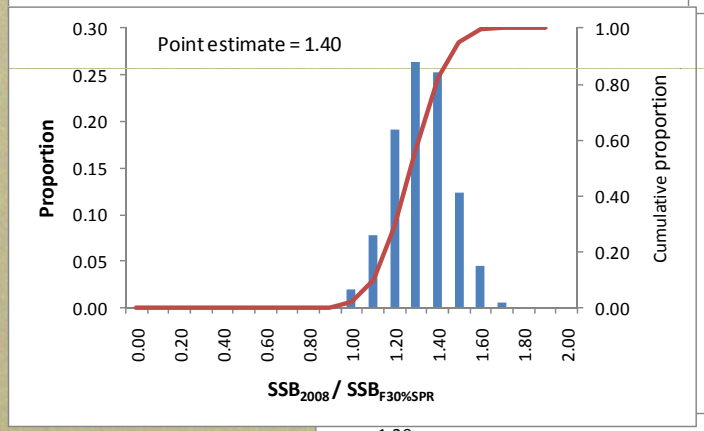
Parameter	Value	Units
Maximum sustainable yield (Yield $F_{30\%SPR}$)	519,864	Lb
Spawning biomass at MSY	5,924,460	Lb
Overfishing limit ($F_{30\%SPR}$)	0.216	Per year
Minimum spawning stock threshold	5,118,733	Lb
Fishing mortality at optimum yield ($F_{45\%}$)	0.143	Per year
Optimum yield ($F_{45\%}$)	468,640	Lb
F_{2008}	0.108	Per year
$F_{2008}/F_{30\%SPR}$	0.50	--
Spawning biomass (SSB_{2008})	8,291,540	Lb
$SSB_{2008}/SSB_{F30\%SPR}$	1.40	--

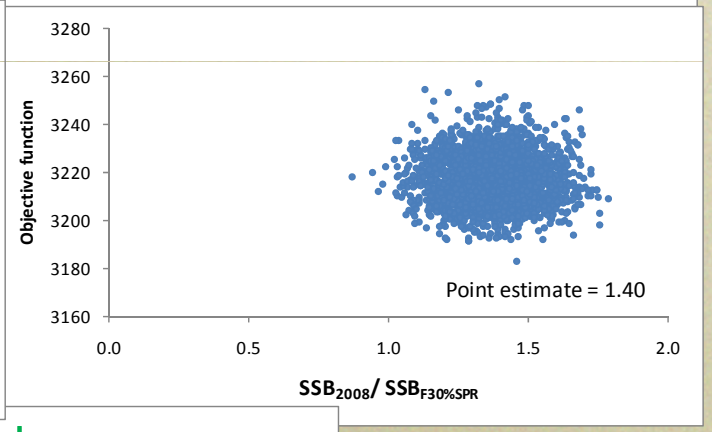
Status of stock

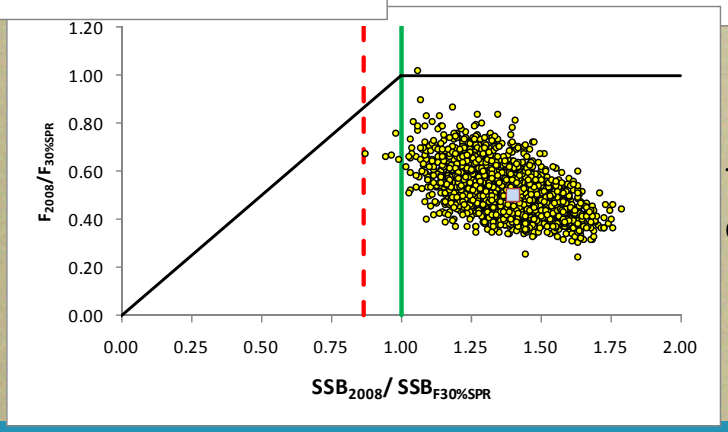
MCMC 2.5 million simulations, 1000 thinning rate.





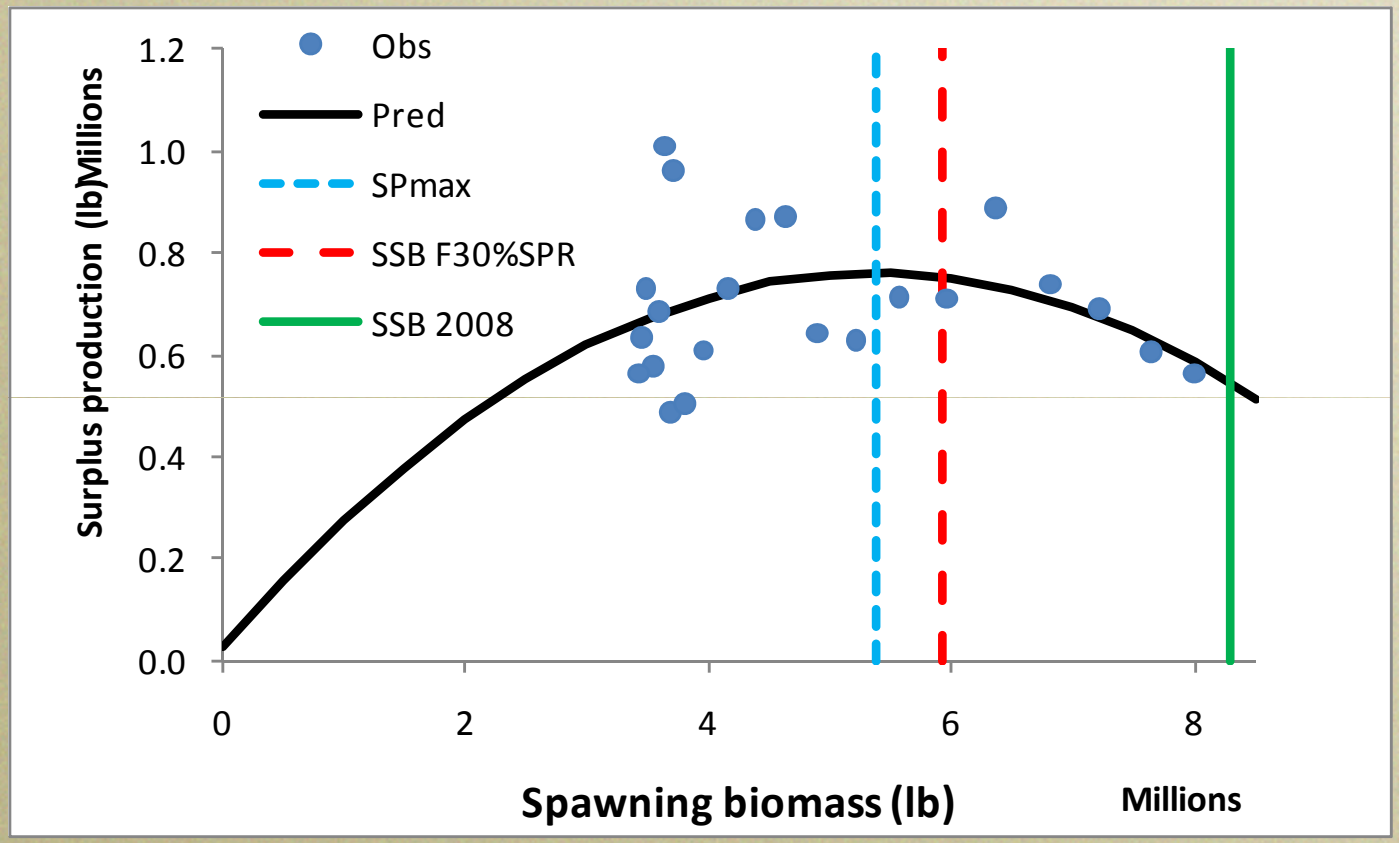






The light point indicates the point estimates from the new base run.

Comparison of surplus production and the F30%SPR reference point



SPmax = 761,400 lb at SSB = 5.38 million lb which is equivalent to F = 0.23 per year.

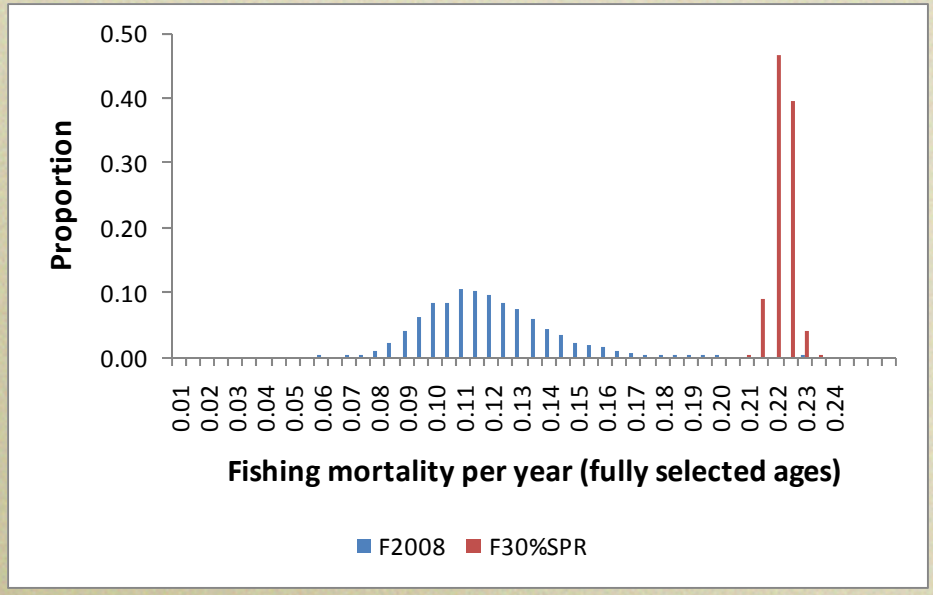
SSB F30%SPR = 5.92 million lb.

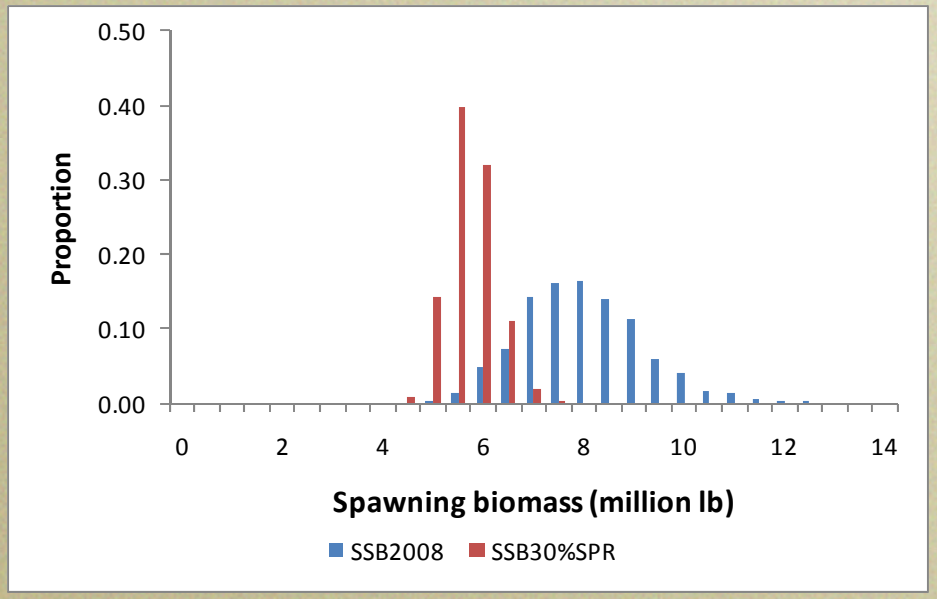
Hilborn and Stokes 2010. Fisheries 35:113-

Status of stock

An alternate way of looking at an F-ratio of 0.50 (a) or a spawning biomass ratio of 1.40 (b).

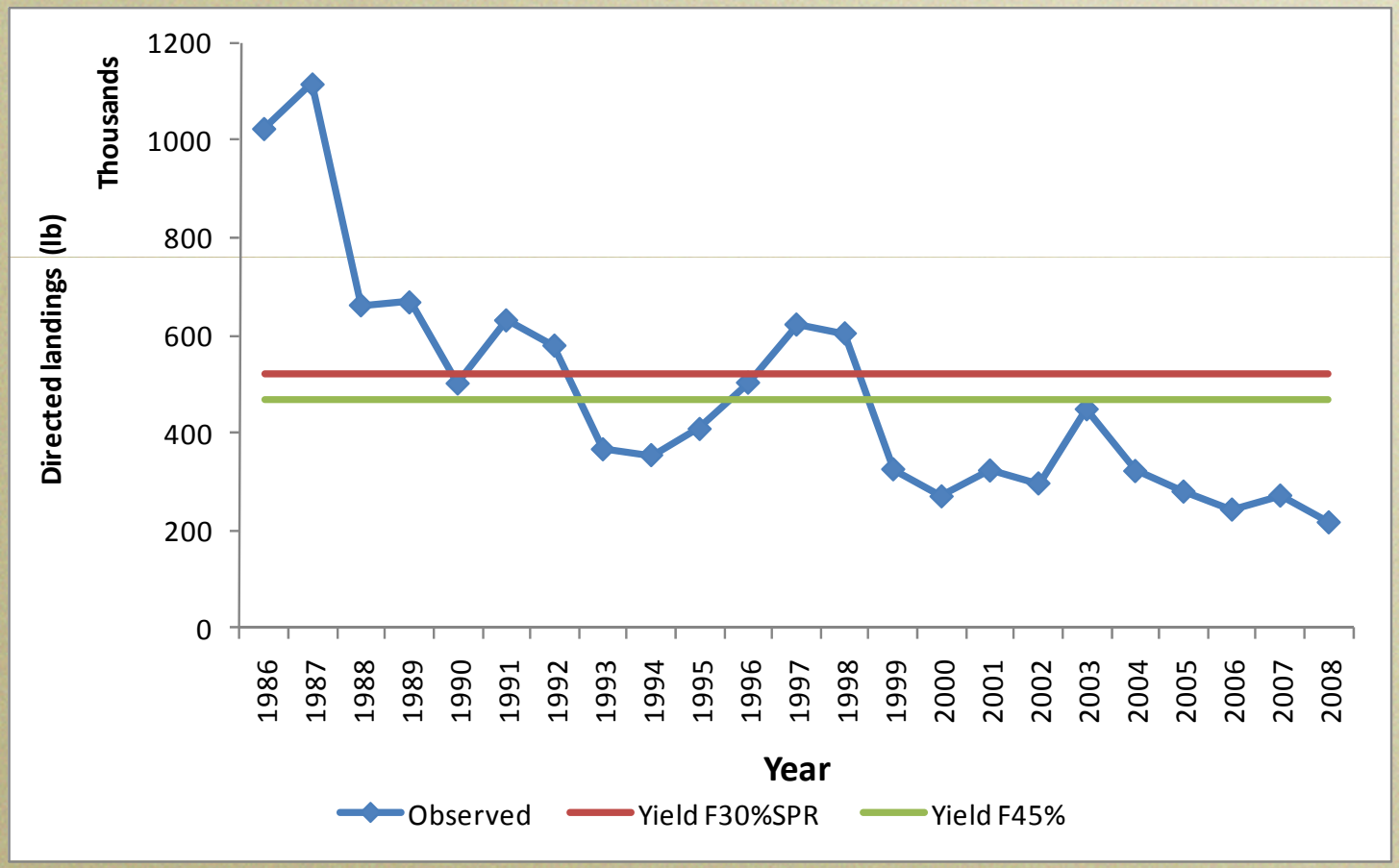
There was no appreciable overlap between the overfishing limit and the estimates while there was a some overlap (15%) of the spawning biomass in 2008 estimates and the spawning biomass at F30%SPR (overfished limit).





Status of stock

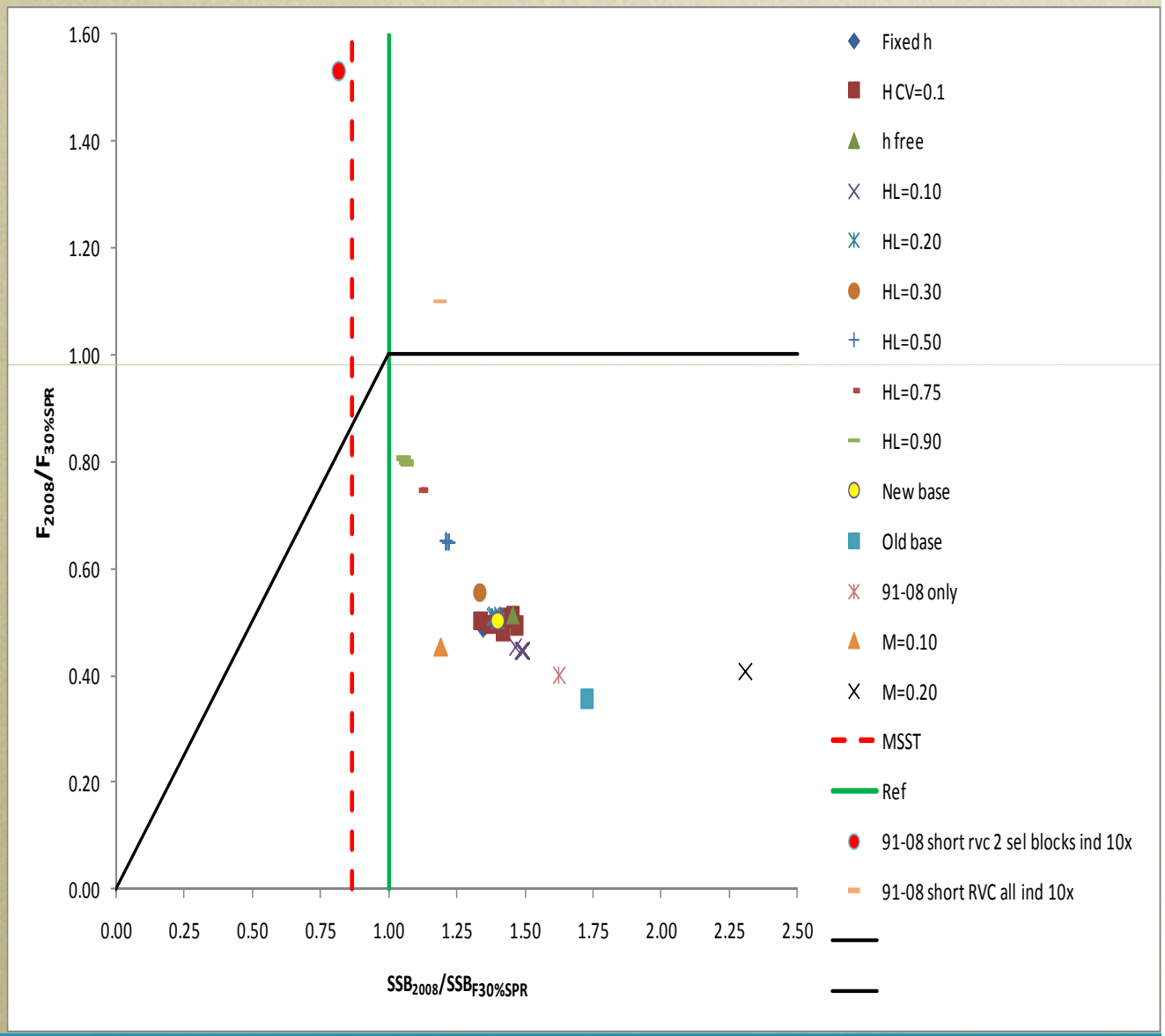
Comparison of MSY (yield at $F_{30\%SPR}$), OY (yield at $F_{45\%SPR}$), and historical landings



Sensitivity runs

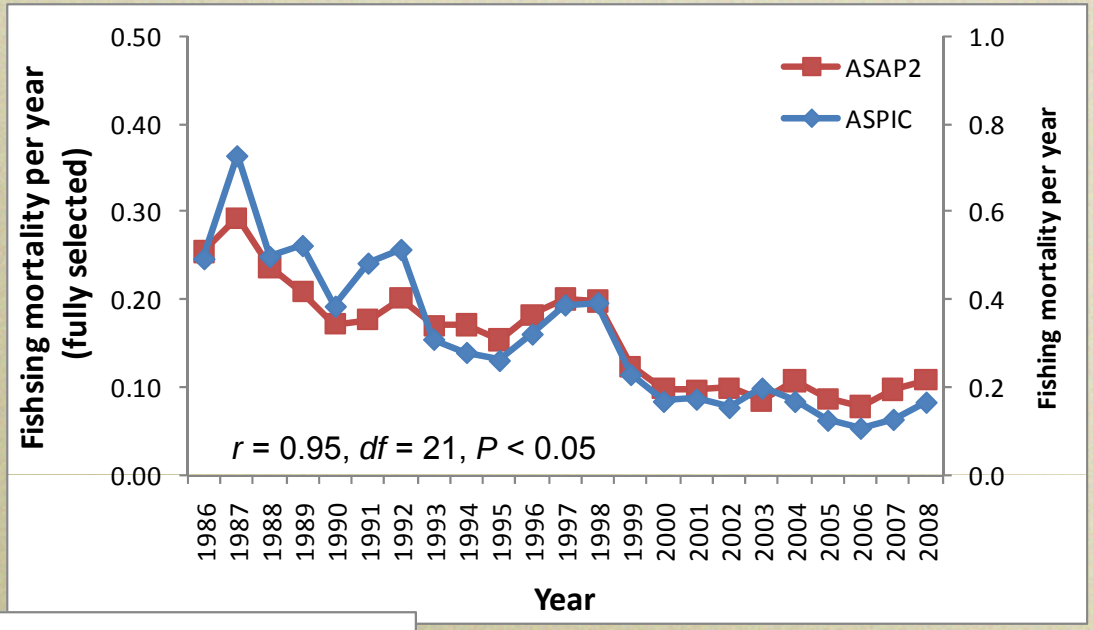
The release mortality points are labeled by the hook-and-line release mortality but there are six longline release rates at each of these points. Similarly, with the five steepness values.

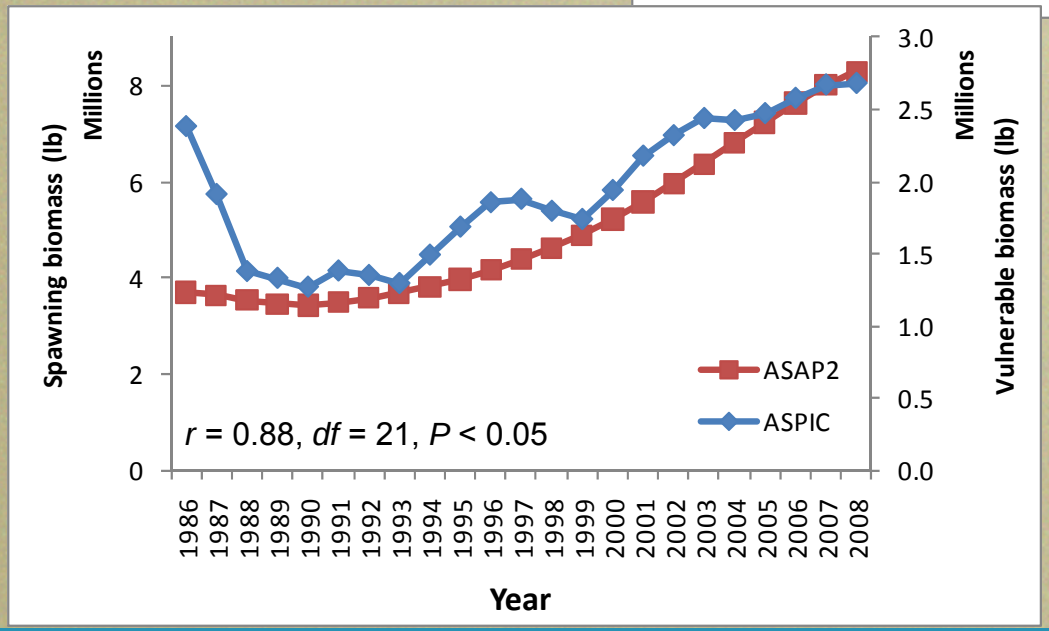
Varying natural mortality had only a minimal effect on the F-ratio but the higher M value had the highest SSB ratio.



Comparison of ASAP2 and ASPIC results

Fishing mortality rates

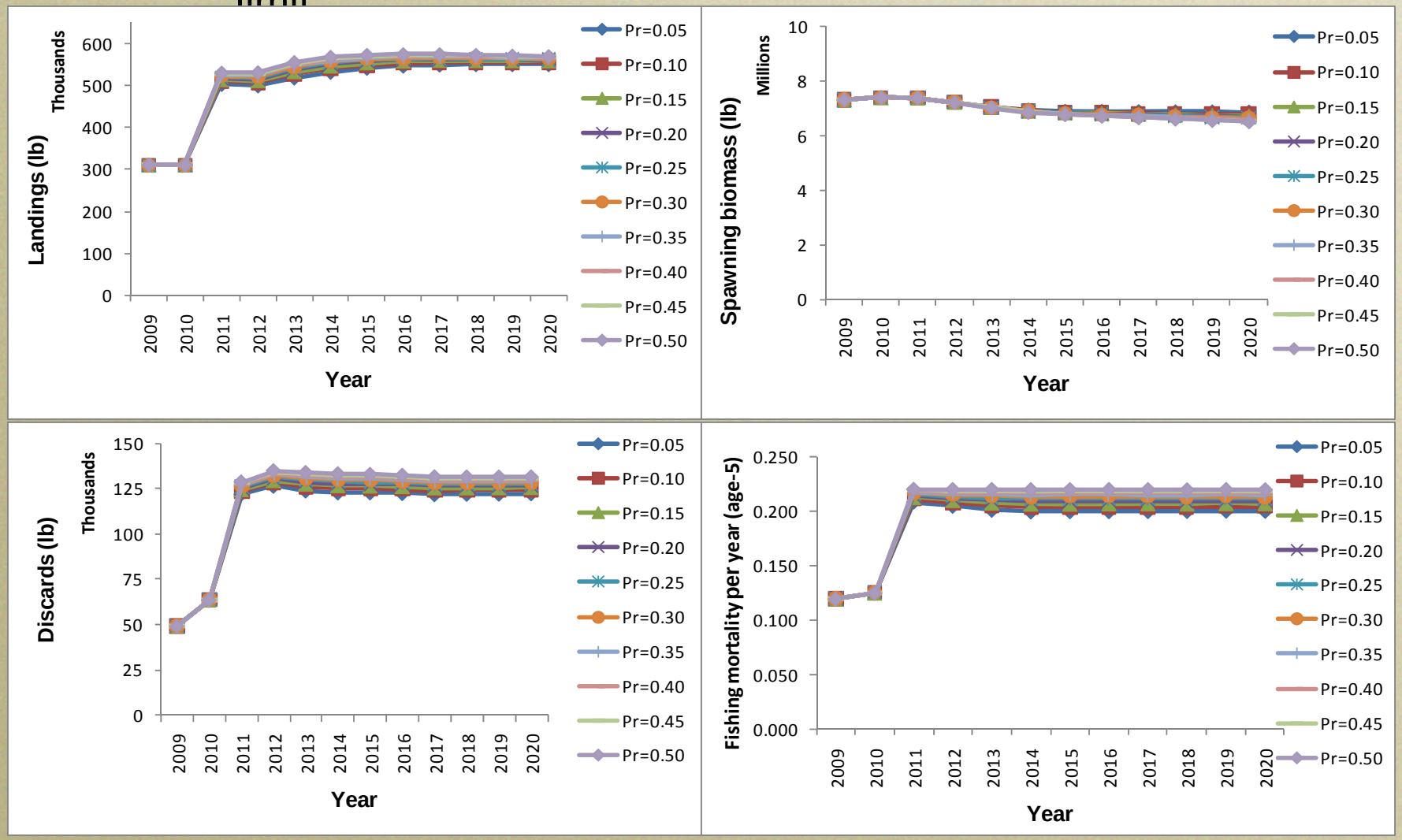




Biomass

Projections

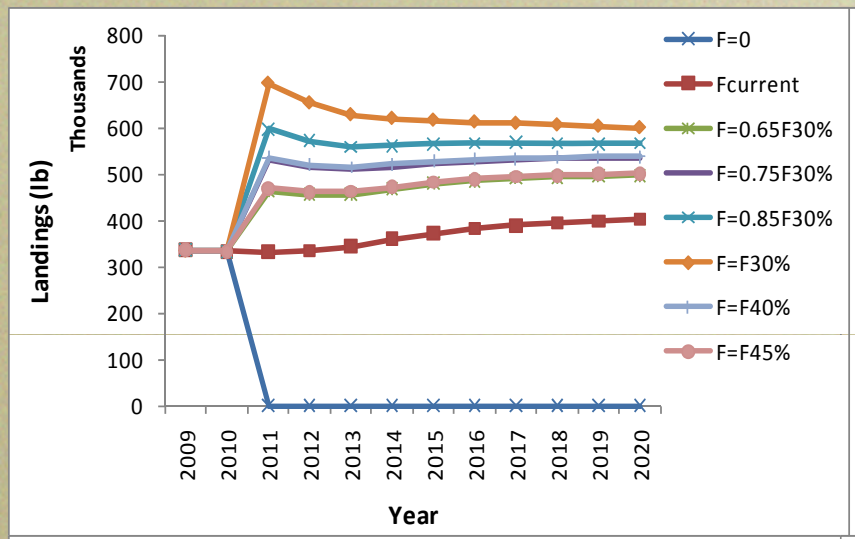
Projections using P* approach to not exceed the overfishing limit

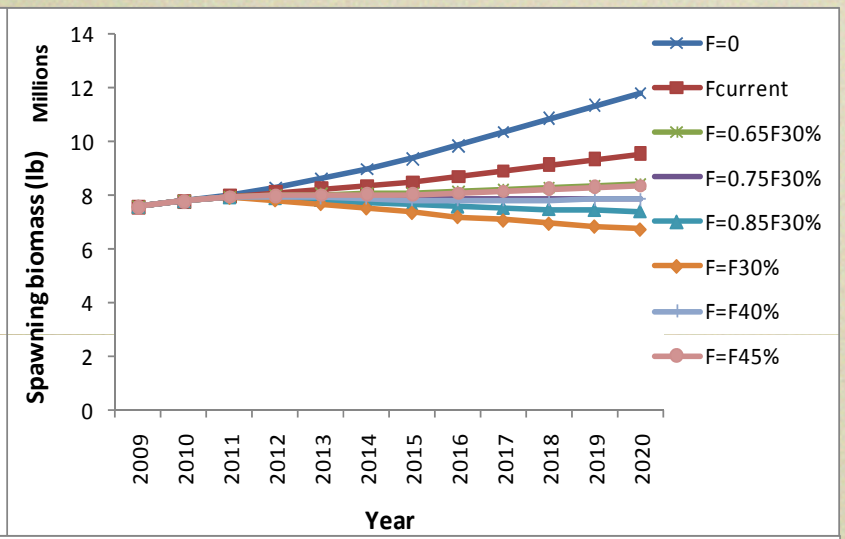


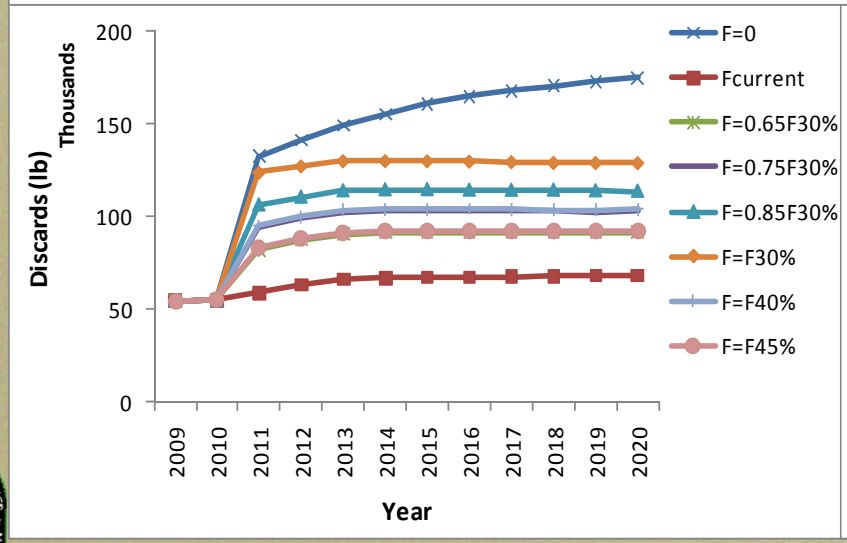
P* incorporates two sources of uncertainty: F limit and bias-correction.

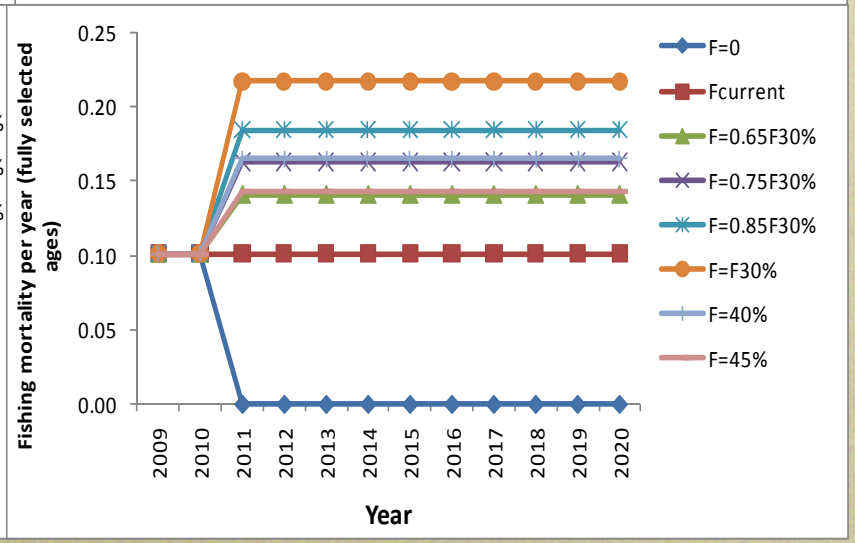
Projections

Annual median estimates from stochastic projections over a range of fishing mortality rates.









Any questions?

Photo: Floridalighttacklecharters.com/images