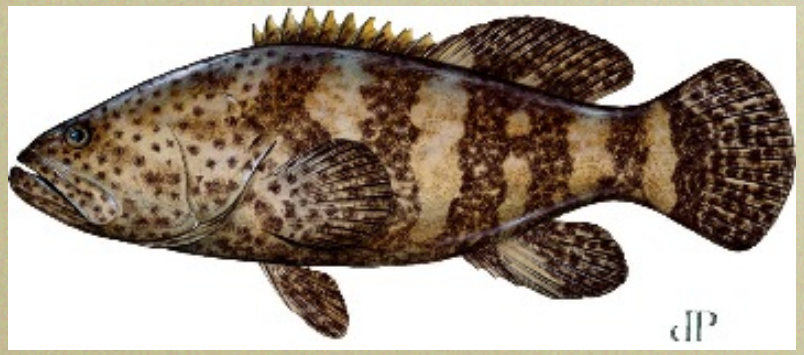
SEDAR 47: Assessment Data and Methods. Comparison of data used in previous Goliath Grouper Assessments



Joe O'Hop and Joseph Munyandorero

Fish and Wildlife Research Institute,
St. Petersburg, FL
May 17, 2016

Adult Goliath Grouper aggregating at the MG111 barge wreck off of Jupiter, FL in 65 feet of water. Photo by Mr. Walt Stearns, Underwater Journal (http://www.waltstearns.com/underwaterjournal.html)

The prohibition on retention of Goliaths

- The Councils were evaluating their management plans for reef fish, and amendments were being developed to adjust size limits and management goals.
- Over the course of the 1980s, a marked decline in the numbers and size of Goliaths in the catch was noted and brought to the Councils' attention.
- The State of Florida prohibited retention of Goliaths caught in Florida waters in February, 1990. The Councils took this action for federal waters in August and October of 1990
- A life history study (Bullock et al. 1992) was conducted to characterize age, growth, and maturity.

A data workshop, two assessments, and an update

- SEDAR 3 (March 2003)
  - Data workshop concluded that data were insufficient to conduct a quantitative stock assessment, but survey data were subsequently discovered leading to the Review Panel recommending that an assessment should be attempted.
- SEDAR 6 (2006)
  - Review workshop only to consider Goliath Grouper and Hogfish assessments.
  - First use of the “catch-free” model and relative benchmarks
- SEDAR 23 (2010)
  - Data, Assessment, and Review Workshops, catch-free model used
  - Review Panel rejected the assessment because it did not provide absolute benchmarks (TORs)
- FWC update (2015)
  - Updated indices for the catch-free model.
- SEDAR 47 (2016) – in progress

Distribution of Goliaths

From Aquamaps

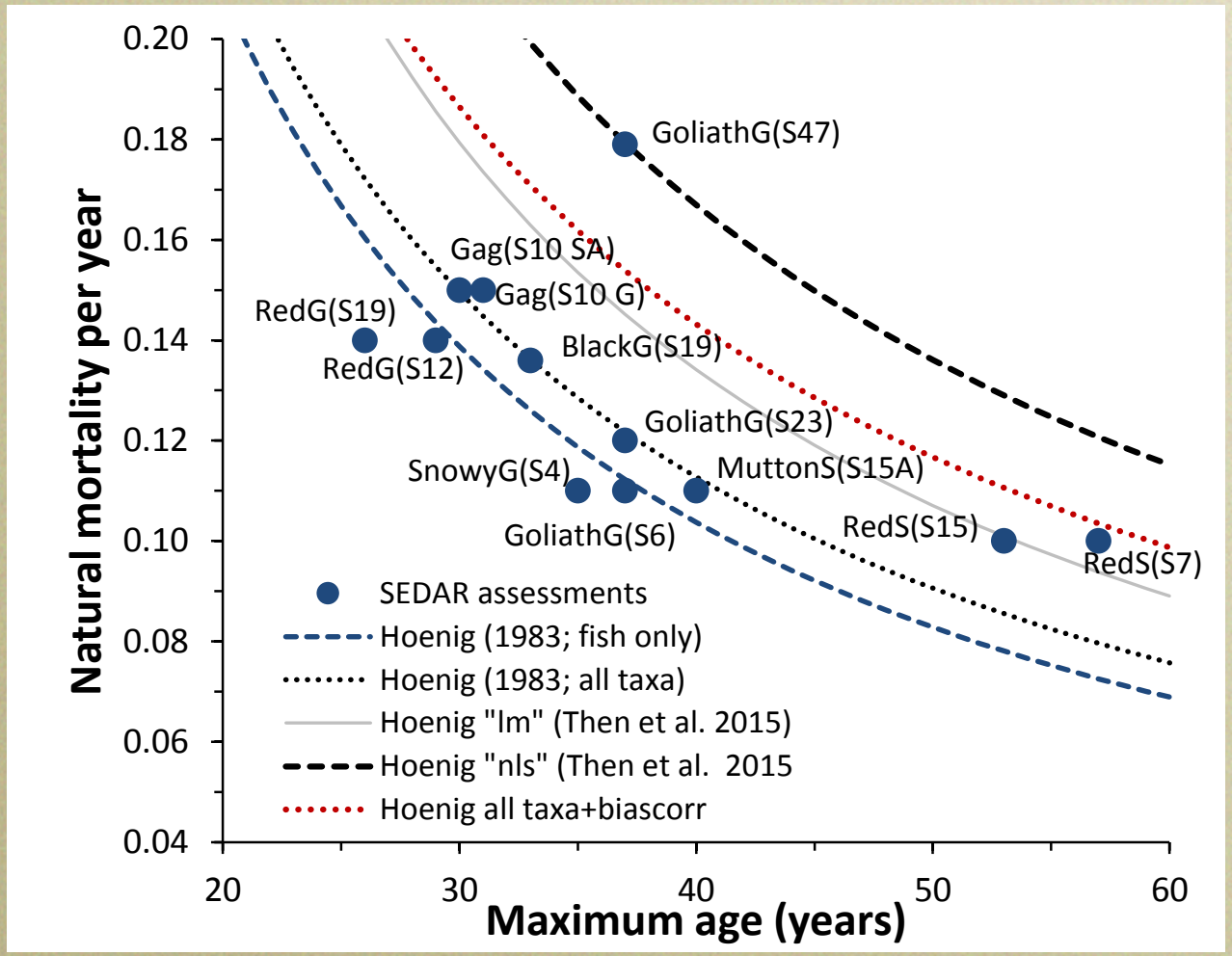
Genetics of Goliaths

- There is documentation of genetic differences between Goliaths in Belize and Florida, and Brazil and Florida.
- Goliaths in Gulf of Mexico and the South Atlantic waters belong to a single stock.
- Tringali et al. (in manuscript) recently looked at the genetics of Goliaths in Florida and developed an analysis of kinship for this group. The conclusions from this analysis were that Goliaths in the South Atlantic from the Florida Keys northward were very closely related. Kinship among Goliaths on Florida's Gulf Coast was less structured. Additional work is planned.

Data Inputs for the models

- Basic Life history parameters
  - Growth model (von Bertalannfy used, others possible)
  - Length-weight conversion equation
  - Natural mortality
- Indices of abundance
- Selectivities for indices of abundance
- Specification of time intervals to track changes in fishing mortality
- Specification of a prior for the effect of the moratorium on harvest (catch-free)
- Estimates of catch, landings, and releases (SRA)

Natural Mortality Estimates - examples



There are several variations for the "Hoenig" estimator for natural mortality. The data for the "Hoenig" estimates were from catch curves, so these are really total mortality estimates (Z) which approximate M when populations are lightly fished. Treat them as "upper bounds" on M rather than absolute values.

Maximum Age of Goliaths – 37 years (but…)

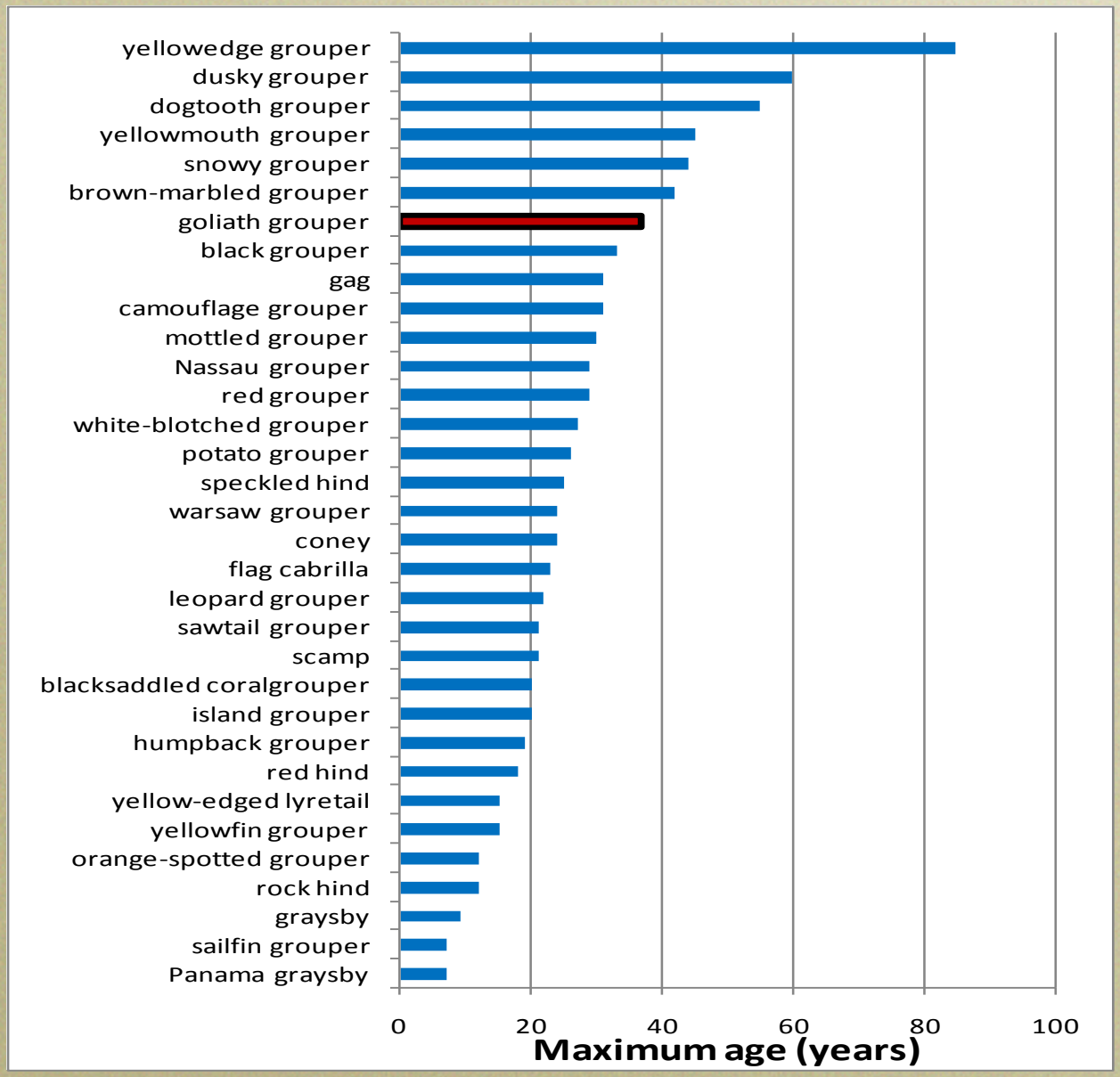


Fig. 2.6.2

Growth Curves (von Bertalannfy, non-linear fits)

Study	L_∞ (mm)	k (year^{-1})	t_0	n
Bullock et al. 1992	2006	0.126	-0.49	382
SEDAR 23 (and 47)	2220	0.094	-0.68	1405

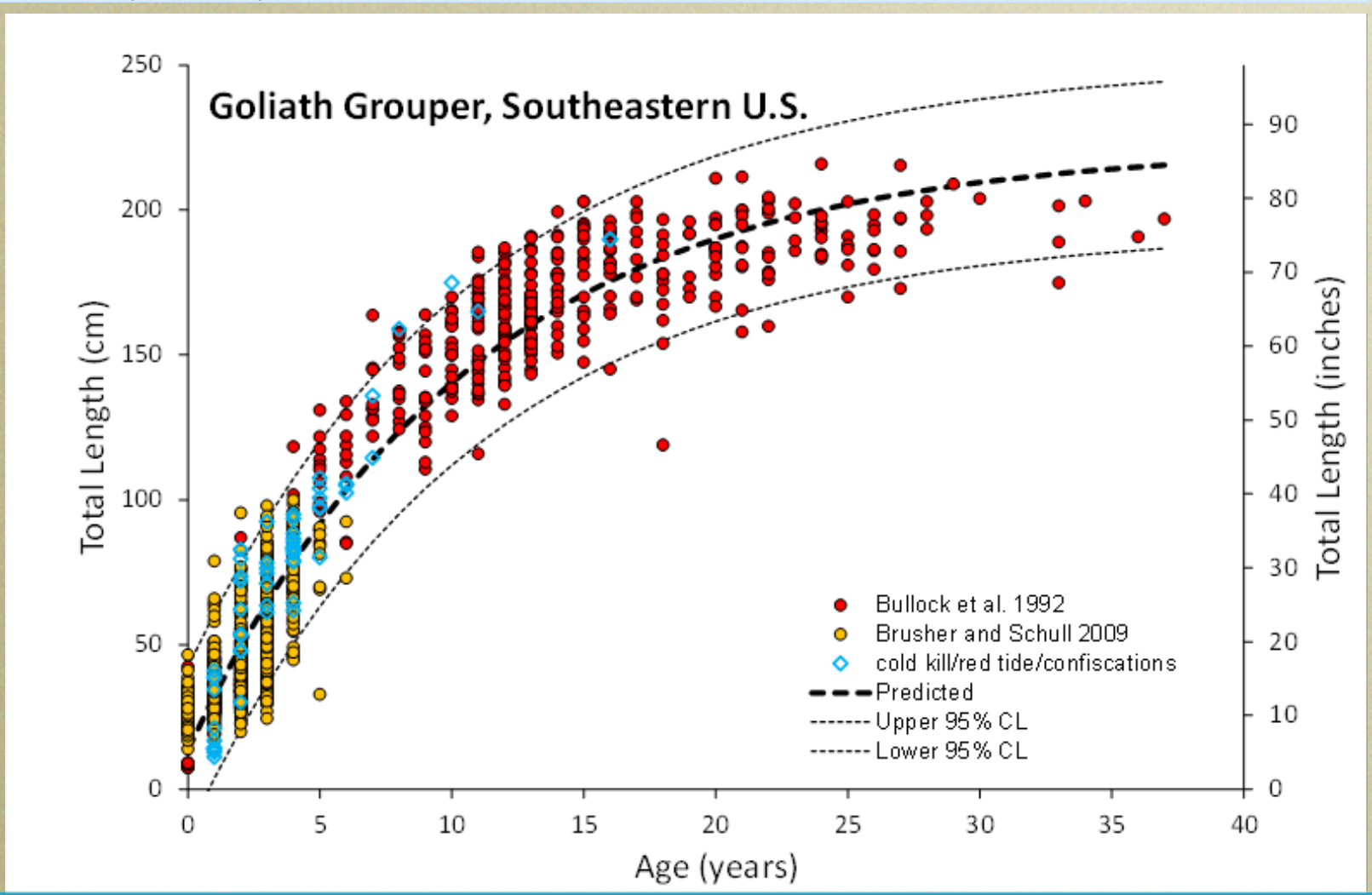
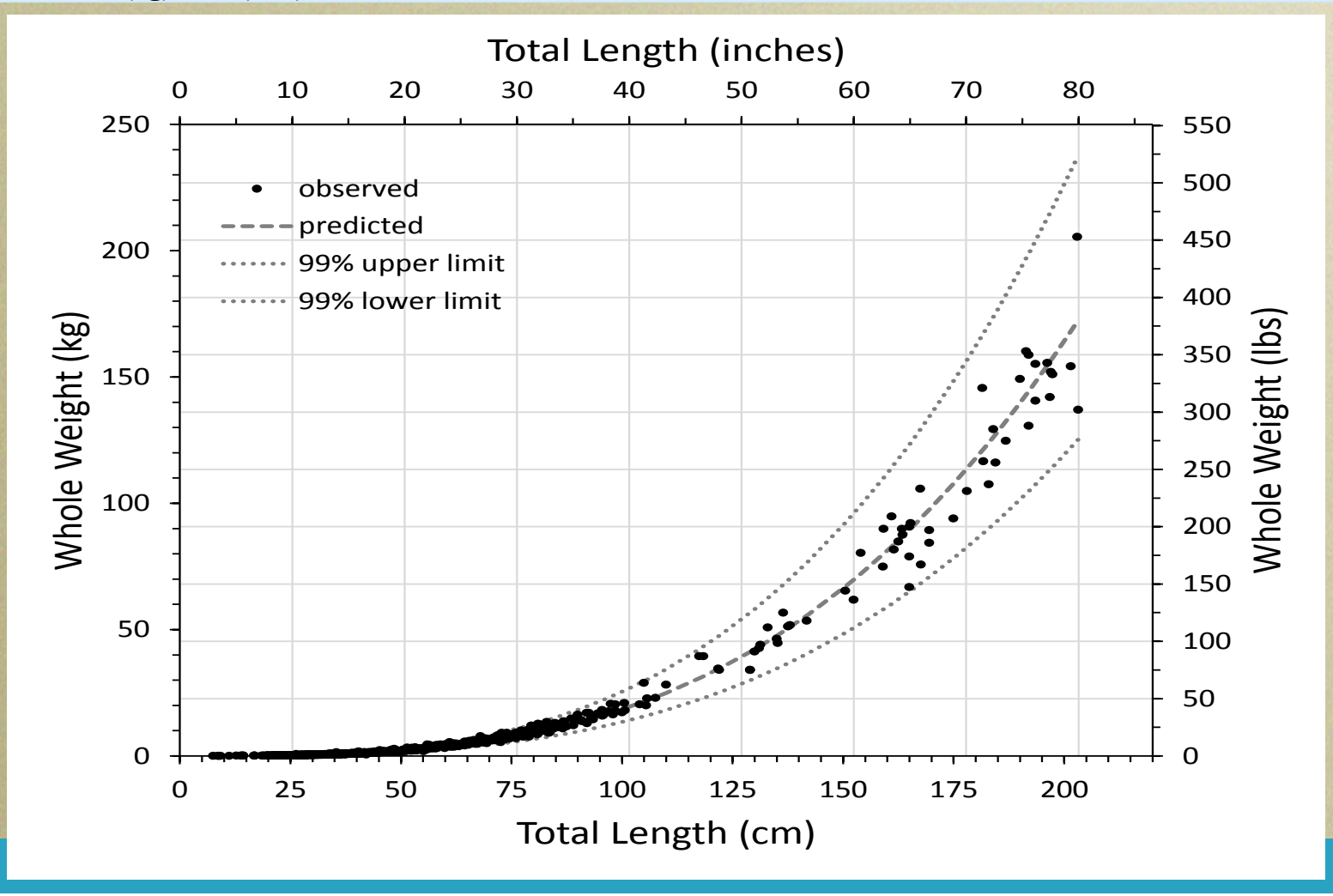


Fig. 2.6.3

Length-weight

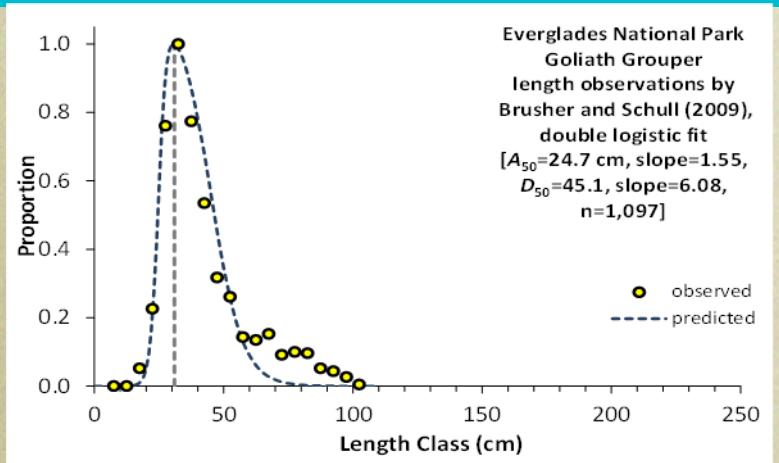
Bullock et al. 1992 data						
dep_var	n	ln(a)	a	b	r2	
gutted wt (kg) vs TL (mm)	402	-17.3423	2.94E-08	2.941	0.941	
whole wt (kg) vs TL (mm)	66	-18.1507	1.31E-08	3.056	0.964	

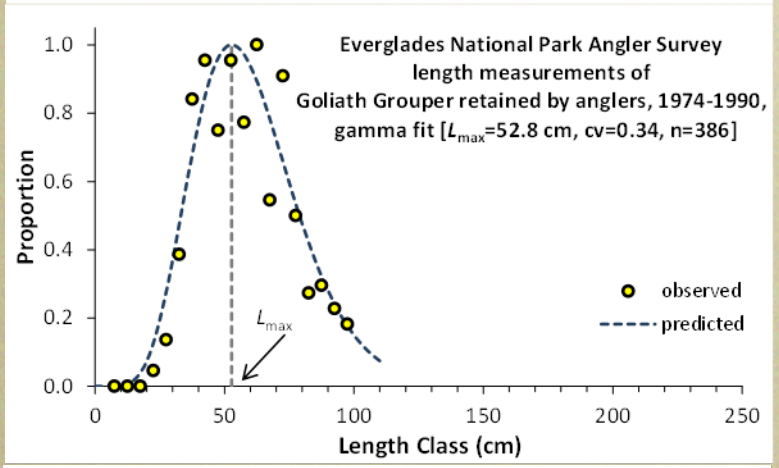


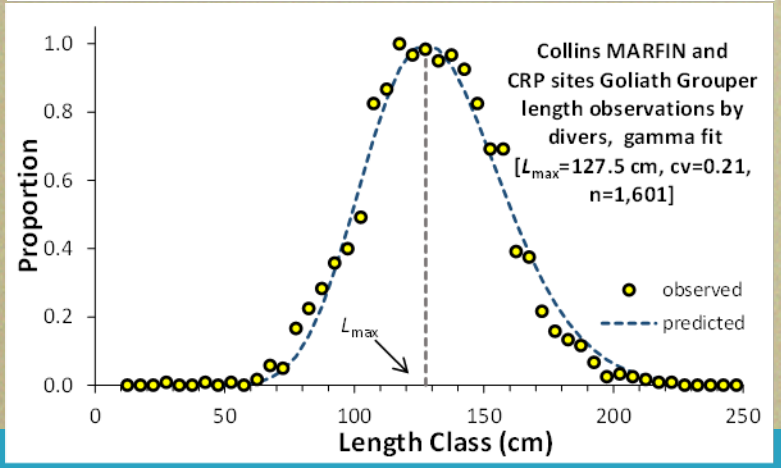
Other Topics

- Release mortality – thought to be low (~5%)
- Reproductive strategy – assumed gonochoristic. Protogyny suspected.
- Spawning – August-November, but chorusing activities may indicate that activity begins in July.
- Females mature at: 120-135 cm, ages 6-7
  Males mature at: 110-115 cm, ages 4-6
- Fecundity – only 2 specimens worked up.
- Sex ratio – appears to be 1:1 at any size/age.
- Spawning site fidelity may be high.
- Juveniles utilize mangrove habitats in estuaries.
- Adults/sub-adults move offshore to high-relief habitats (and wrecks often attract more individuals).

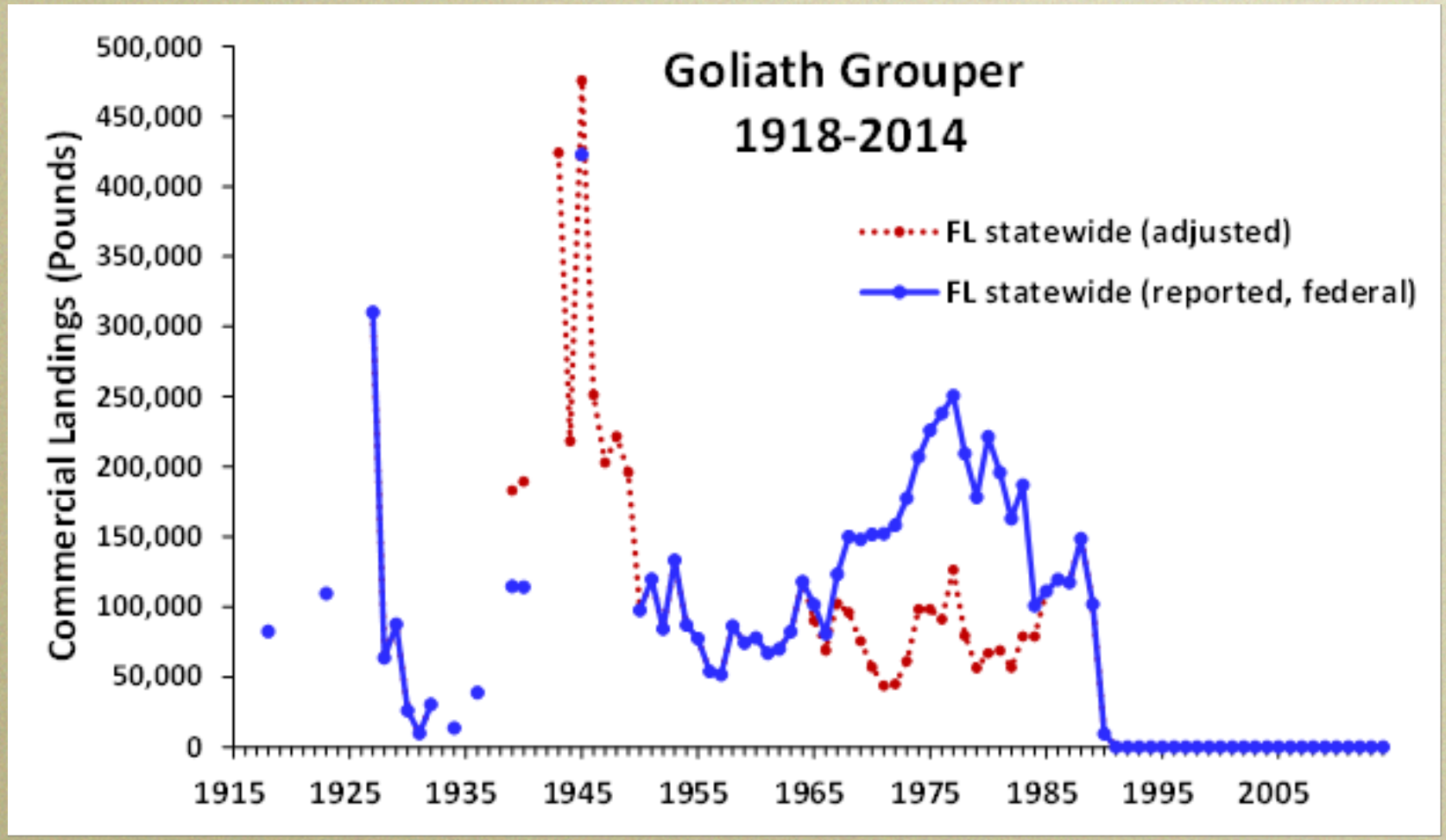
Length-frequencies







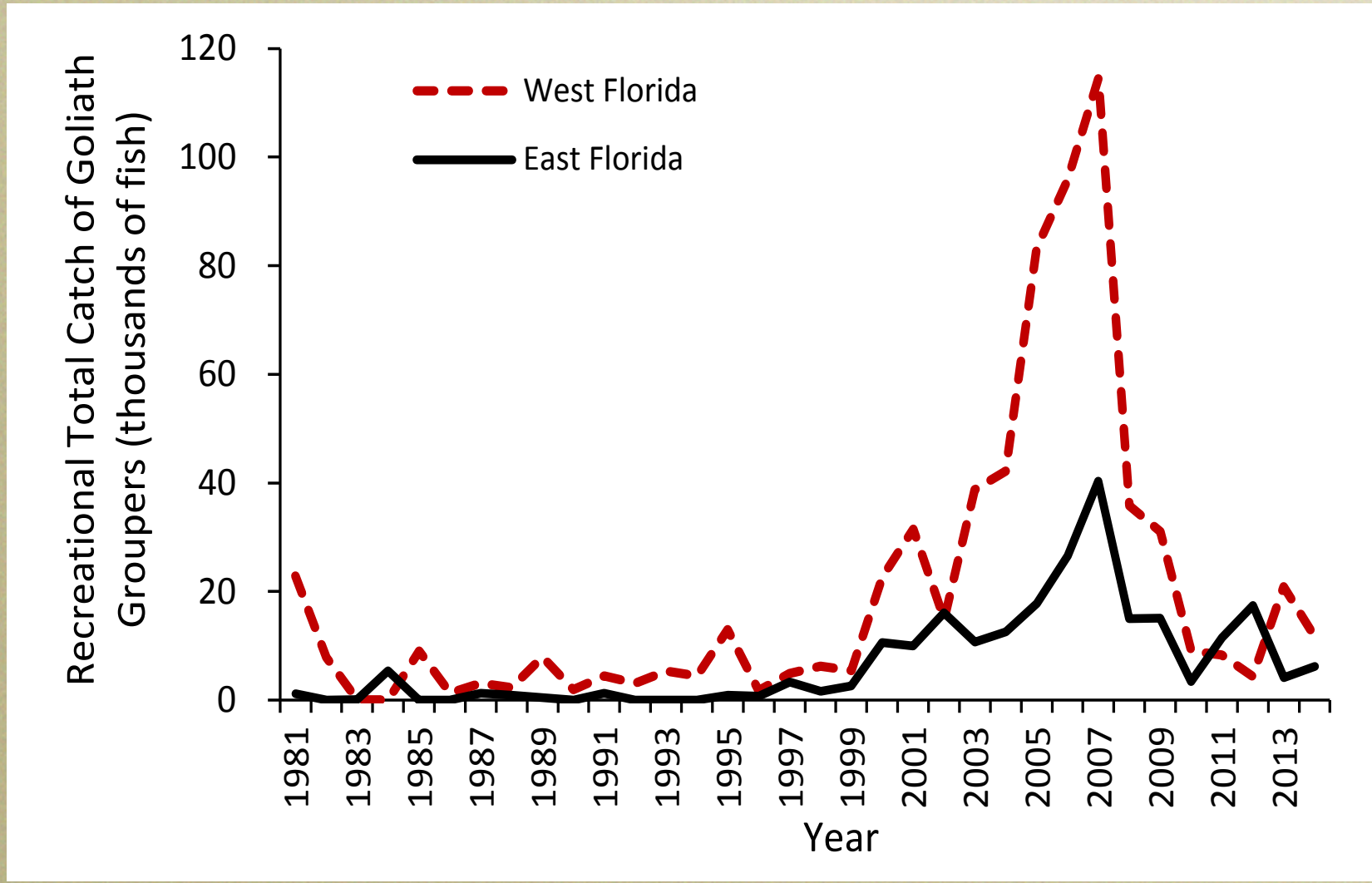
Reported U.S. commercial landings of Goliath Grouper



U.S. Bureau of Commercial Fisheries, NMFS Commercial Landings,
Florida State Board of Conservation, FL Fish and Wildlife Conservation Commission

Fig. 3.1.1

Estimated U.S. recreational catch of Goliath Grouper. Most of the catch, particularly after 1989, was released.



NMFS Marine Recreational Fishery Statistics Survey, 1981-2003,

NMFS Marine Recreational Information Program 2004-2014

Fig. 3.3.1

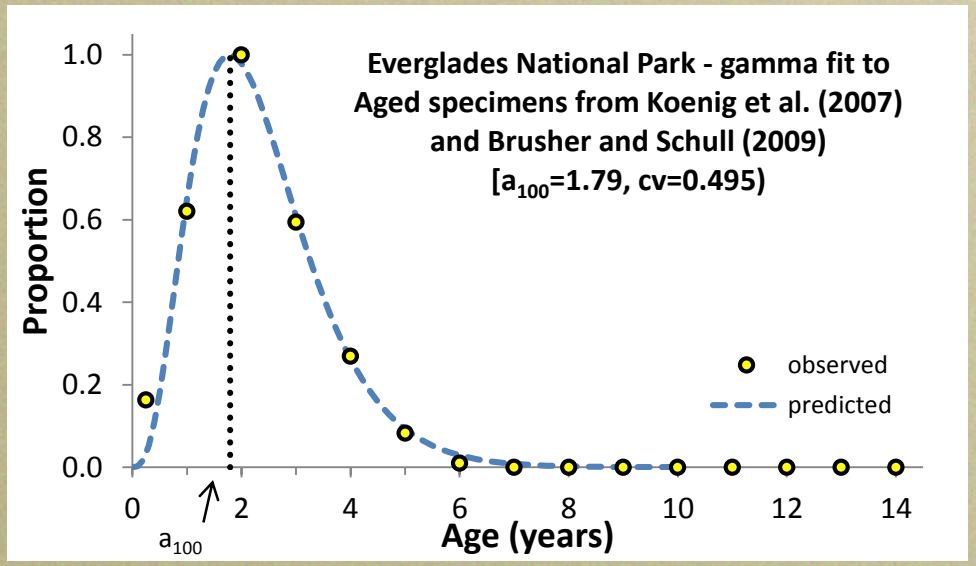
Estimating harvests

- Commercial landings: The SRA model may solve better using a longer time series of removals. We used the time series back to 1950 which was easily available. There was concern over reports from a particular seafood dealer, and we developed adjustment factors to reduce the influence of this dealer's reports from 1978-1984, and to reduce the influence of the county landings from 1964-1977 on the Florida West Coast.
- Commercial discards: not estimated.

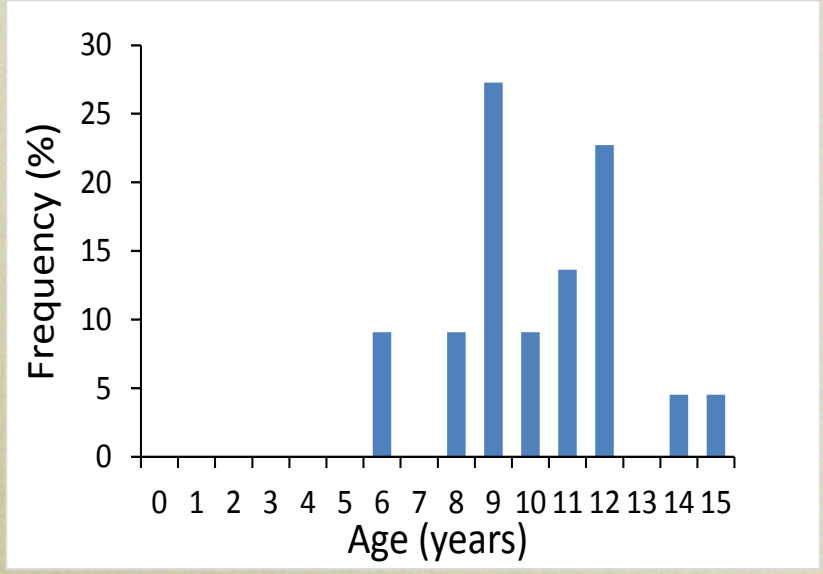
Estimating harvests

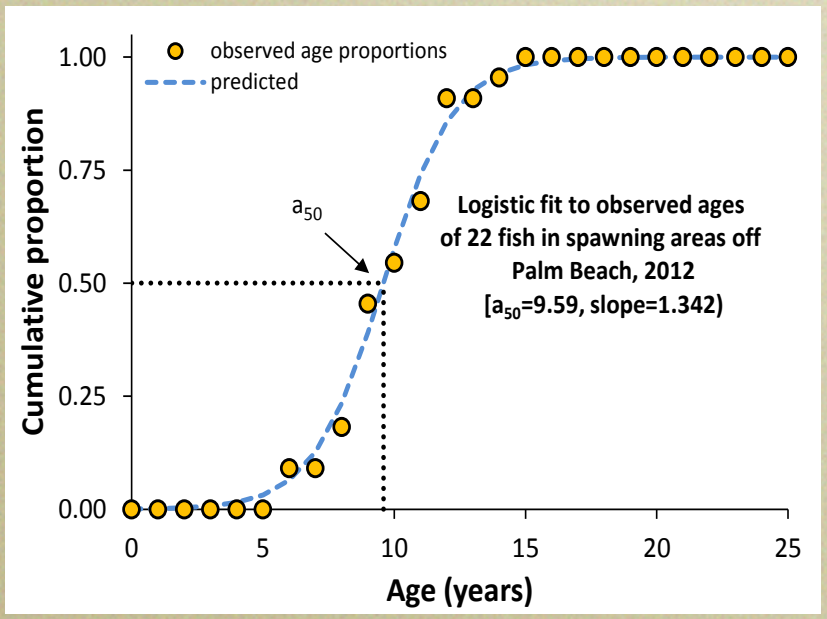
- Recreational catches: catch was divided by area fished. Juvenile fish live in estuarine habitats particularly where there are mangroves. Larger, adult fish are typically found offshore in areas of high relief, though they may also be caught around bridges and other areas they find suitable.
- Recreational landings by area (1981-1989): the avg. weight for estuarine fish used the observed size structure in the Everglades. Avg. weights for offshore fish in 1984-1988 were used for missing weight data or to substitute for outliers.
- Recreational releases by area: Weights of estuarine fish released used the estimated juvenile size structure. Adult size structure in the released catch is not known. A small sample of aged fish from a research study was used as a proxy. A 5% release mortality was assumed in order to estimate this portion of the harvest.

Selectivity curves for recreational catches



Estuarine Fish





Offshore Fish

Figs. 3.3.7, 3.3.8, 3.3.9

Estimated Total Harvest

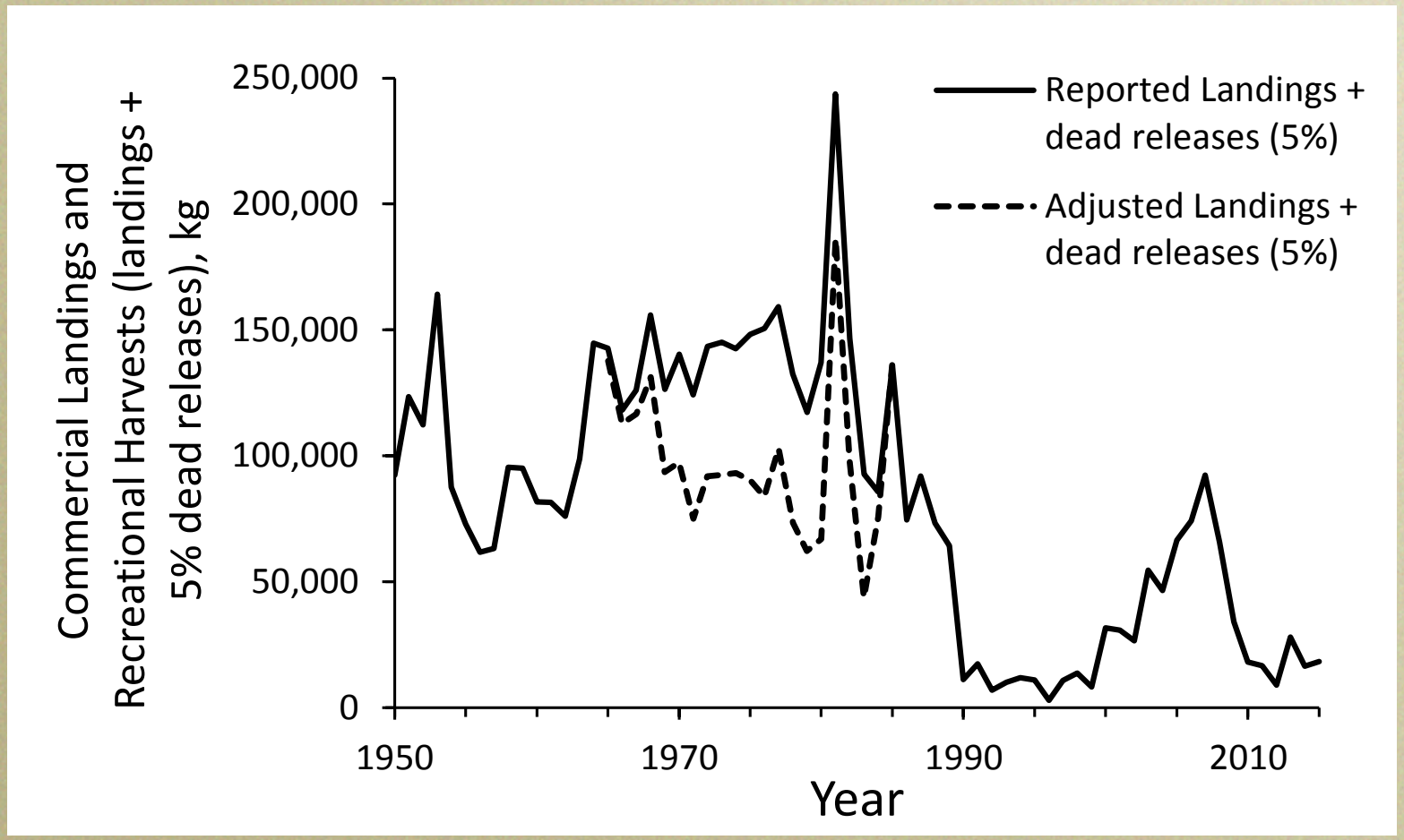


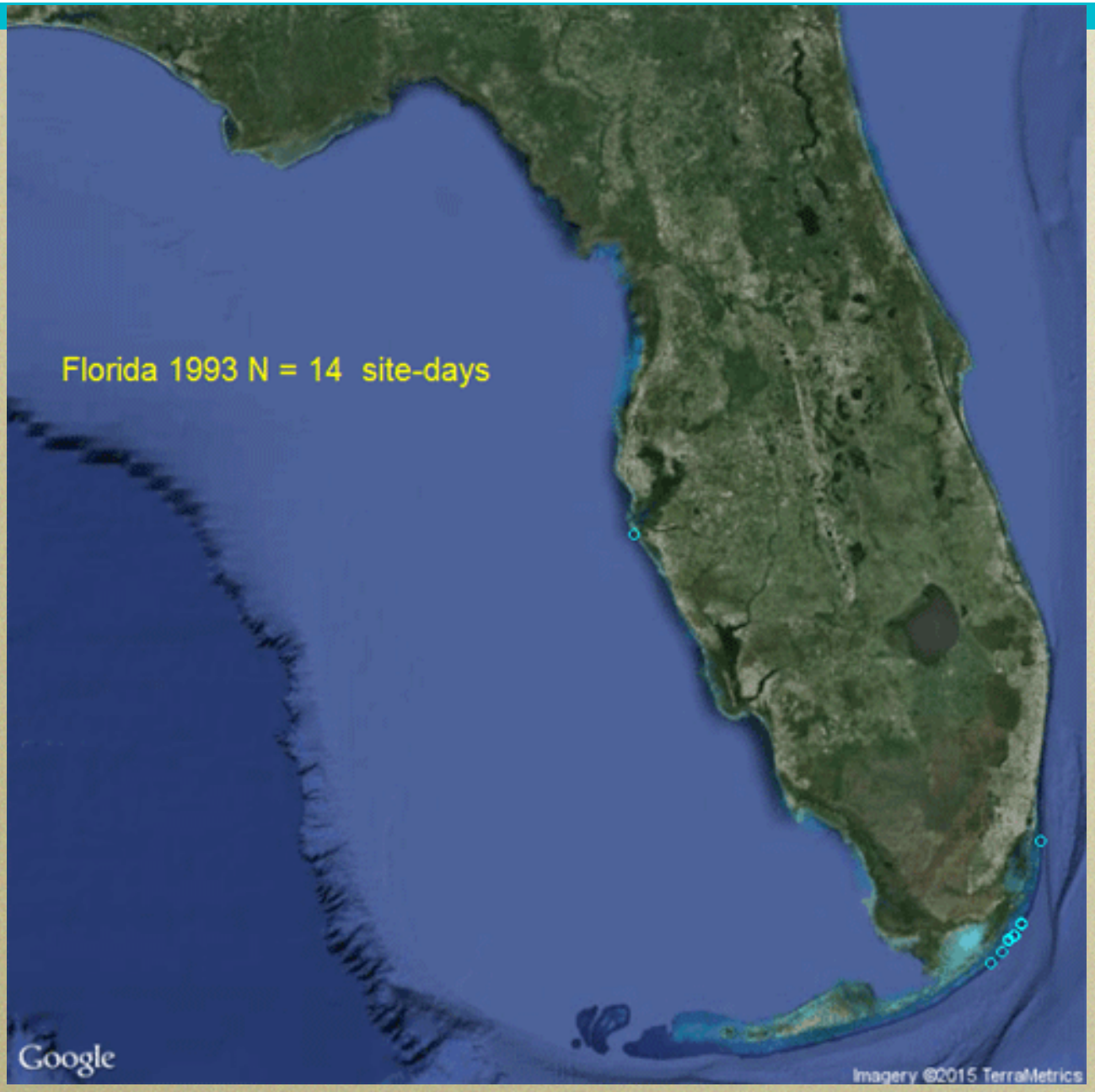
Fig. 3.4.1

Indices used in various assessments

Index	SEDAR 6	SEDAR 23	FWC Update	SEDAR 47
DeMaria	√			
Interviews	√			
ENP	√	√	√	√
REEF SE	√	√	√	
REEF SW		√		
REEF (both, GGGC added)				√
MRFSS (PR, % positives)		√		
MRFSS (WFL, offshore bt)			√	
MRFSS (EFL, offshore bt)			√	
MRFSS (WFL, estuarine)			√	
MRFSS (EFL, estuarine)			√	
MRFSS (offshore bt)				√
MRFSS (estuarine)				√

Table 4.1.1

REEF Index



open blue circles: sites without Goliaths
yellow dots: sites with Goliaths at least once in a year.

REEF Index

Classification of habitats for the REEF surveys.

Habitat description	REEF Habitat Code	Hab[a]	New_Hab[b]
Unknown	0	0	0*
Mixed	1	1	5
High profile reef, coral structures 4' or more above bottom	2	2	2
Low profile reef, coral structures < 4' above bottom	3	3	3
Sloping drop-off into open water	4	1	3
Wall - a shear drop-off of over 25' facing open water	5	2	2
Ledge - a single or few sharp drops in bottom topography of 3' or more	6	2	2
Seagrass	7	1	1
Sand	8	1	1
Rubble	9	1	1
Artificial	10	4	4
Open water	11	1	1

[a] re-classification of habitat score used for REEF SE index in SEDAR 6 and REEF SE and SW in SEDAR 23

[b] re-classification of habitat score used for REEF FL index in SEDAR 47[b] re-classification of habitat score used for REEF FL index in SEDAR 47

Table 4.1.1

REEF Index

Table 4.1.2 b. Number of REEF sites with survey data using various criteria.

	1994-2014	
Criteria	East Florida and Florida Keys	West Florida
All sites* with 6 or more years of surveys	173	41
All sites* with 6-9 years of surveys	46	23
SEDAR 23 sites dropped (<10 yrs of record)**	7	9
SEDAR 23 and SEDAR 47 sites (10+ yrs of record)	53	8
Additional sites with 10+ yrs of record for SEDAR 47	67	1
SEDAR 47 Total Sites in index (10+yrs of record)	120	9
Index time period	***1994-2014***	***1999-2014***

***Sites must have had at least one survey with a Goliath Grouper sighting over the index period.**

**** The SEDAR 23 Southeast FL index was comprised of 1994-2009 survey data for 60 sites, and the Southwest FL index used 1999-2009 survey data from 17 sites.**

REEF Index

Table 4.1.2 d. REEF sites in West Florida where Goliath Grouper have been observed at least once and with 6 or more years where surveys were recorded over the 1994-2014 time period. Index included sites with 10 or more years where surveys were conducted for the ***1999-2014*** time period.

				Years surveyed and max. abundance rank[2]	Abundance Ranks and no. surveys by rank						
Location	REEF geozone	years with surveys[1]	Number of surveys	1 1 2 2 2 2 9 9 0 0 0 0 9 9 0 0 1 1 3 5 0 5 0 4	0: None seen	1: One seen	2: 2-10 seen	3: 11-100 seen	4: 101+ seen	Latitude DD	Longitude DD
Black Bart (Panama City)	21010008	9	33	---0--1-0000-0-0-----1	30	3	0	0	0	30.0607	-85.8238
Bridge Span 14 (Panama City)	21010009	7	13	---0--0--00--0-0-----2	11	1	1	0	0	30.0715	-85.8146
Miss Louise Tugboat (Destin)	21010027	6	13	------00-0-10-------0-	6	7	0	0	0	30.3717	-86.4215
USS Oriskany	21010060	8	21	----------02000000-	20	0	1	0	0	30.0426	-87.0066
Clearwater Wreck	23010007	12	45	---1--0-2323211-10--1-	15	9	19	2	0	27.9532	-83.1217
Dunedin Reef	23010009	6	9	--0-0----------2100	6	2	1	0	0	28.0570	-82.9108
Cable Barge (aka Indian Shores)	23010013	8	15	----1-22210------1-1--	8	4	3	0	0	27.8567	-83.0292
Masthead Ledge	23010014	7	14	----0---001---01-0----	11	3	0	0	0	28.0623	-83.1907
Tug Sheridan	23010016	10	25	----0---222-----221212	8	5	12	0	0	27.8760	-83.1863
Rube Allen (Pinellas #1)	23010018	13	43	----0-0-1221-22221-02-	19	11	13	0	0	27.9267	-83.0233

REEF Index

Source	levels	Df	Deviance	Mean Deviance	Δ Mean Deviance	% change	Cum %	Full Log likelihood	Δ log likelihood	-2 Δ log likelihood	df	Prob Ho	AIC	AICc
intercept	1	21024	15090.0	0.7177				-9803.2	-9803.2	36125.1	21024	<0.0001	19608.5	19608.5
Year	21	21004	13441.4	0.6399	0.07781	10.84%		-8978.9	-824.3	1648.6	20	<0.0001	17999.9	17999.9
Geozone	129	20896	7363.8	0.3524	0.36535	50.90%	50.90%	-5940.1	-3863.1	7726.2	128	<0.0001	12138.3	12139.9
New_hab	4	21021	13245.3	0.6301	0.08765	12.21%		-8880.9	-922.3	1844.6	3	<0.0001	17769.8	17769.8
Season	2	21023	15024.3	0.7147	0.00309	0.43%		-9770.4	-32.8	65.6	1	<0.0001	19544.8	19544.8
Experience	2	21023	14718.0	0.7001	0.01766	2.46%		-9617.3	-186.0	371.9	1	<0.0001	19238.5	19238.5
Region	2	21023	13843.3	0.6585	0.05927	8.26%		-9179.9	-623.3	1246.7	1	<0.0001	18363.8	18363.8
with Geozone														
Year	21	20876	6977.4	0.3342	0.01817	2.53%	53.43%	-5747.0	-193.2	386.3	20	<0.0001	11791.9	11794.1
New_hab	4	20893	7249.3	0.3470	0.00543	0.76%		-5882.9	-57.2	114.5	3	<0.0001	12029.8	12031.4
Season	2	20895	7360.9	0.3523	0.00012	0.02%		-5938.7	-1.4	2.8	1	0.0924	12137.4	12139.1
Experience	2	20895	7355.4	0.3520	0.00038	0.05%		-5936.0	-4.2	8.3	1	0.0039	12131.9	12133.6
Region	2	20895	7363.8	0.3524	-0.00002	0.00%		-5940.1	0.0	0.0	1	1.0000	12140.3	12141.9
with Geozone, Year														
New_hab	4	20873	6887.0	0.3299	0.00428	0.60%	54.03%	-5701.7	-45.2	90.4	3	<0.0001	11707.5	11709.7
Season	2	20875	6976.8	0.3342	0.00001	0.00%		-5746.6	-0.3	0.6	1	0.4307	11793.3	11795.5
Experience	2	20875	6976.4	0.3342	0.00003	0.00%		-5746.4	-0.5	1.0	1	0.3121	11792.9	11795.1
Region	2	20875	6977.4	0.3342	-0.00002	0.00%		-5747.0	0.0	0.0	1	1.0000	11793.9	11796.1
with Geozone, Year, New_hab														
Experience	2	20872	6886.7	0.3299	0.00000	0.00%		-5701.6	-0.1	0.3	1	0.5918	11709.2	11711.5
Region	2	20872	6886.0	0.3299	0.00003	0.00%		-5701.2	-0.5	1.0	4	0.9046	11708.5	11710.7

Table 4.1.3

REEF index

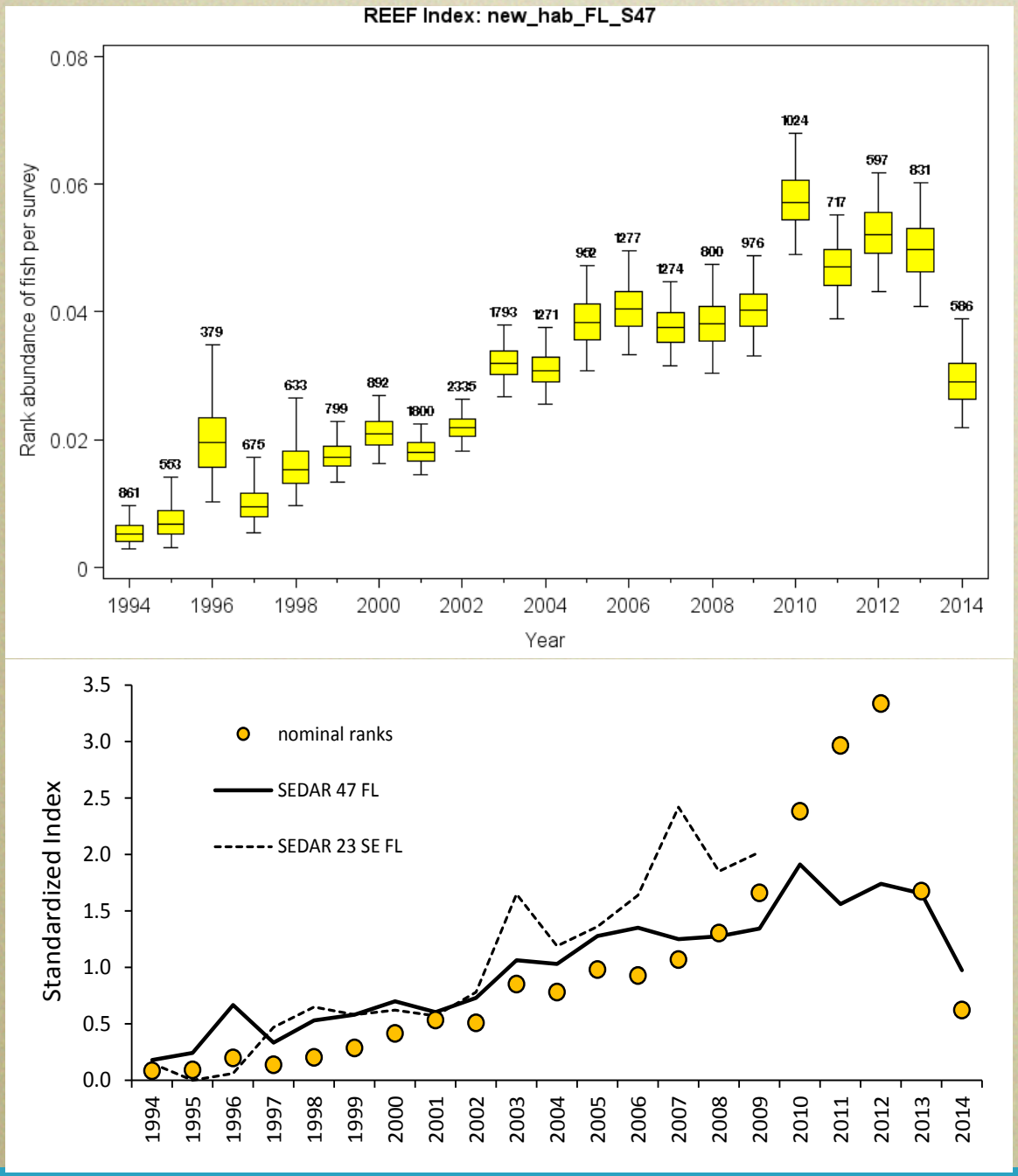


Fig. 4.1.1 a,b

Abundance Index – Everglades National Park Angler Survey
(hurdle model – binomial and lognormal submodels)

Deviance table for the binomial sub-model of the proportion positive catches of Goliaths in the ENP.

Variable	df	full log likelihood	Δ log likelihood	Chi-sq	Chi-sq df	Prob Ho	AIC	Δ AIC	deviance	Mean Dev	Δ Mean Dev	% change
	193,576	-29573.1					59,148.3		59146.3	0.3055		
Year	193,536	-26385.9	3187.2	6374.5	40	<0.0001	52,853.8	-6294.5	52771.8	0.2727	0.033	10.8%
Area fished	193,532	-25500.0	885.9	1771.9	4	<0.0001	51,089.9	-1763.9	50999.9	0.2635	0.009	3.0%
Hours fished	193,529	-25171.5	328.4	656.9	3	<0.0001	50,439.0	-650.9	50343.0	0.2601	0.003	1.1%
Season	193,526	-24991.6	179.9	359.8	3	<0.0001	50,085.3	-353.8	49983.3	0.2583	0.002	0.6%
Skill level	193,525	-24898.4	93.2	186.5	1	<0.0001	49,900.8	-184.5	49796.8	0.2573	0.001	0.3%
Num_anglers	193,522	-24797.9	100.5	201.0	3	<0.0001	49,705.8	-195.0	49595.8	0.2563	0.001	0.3%
										cumulative%		15.5%

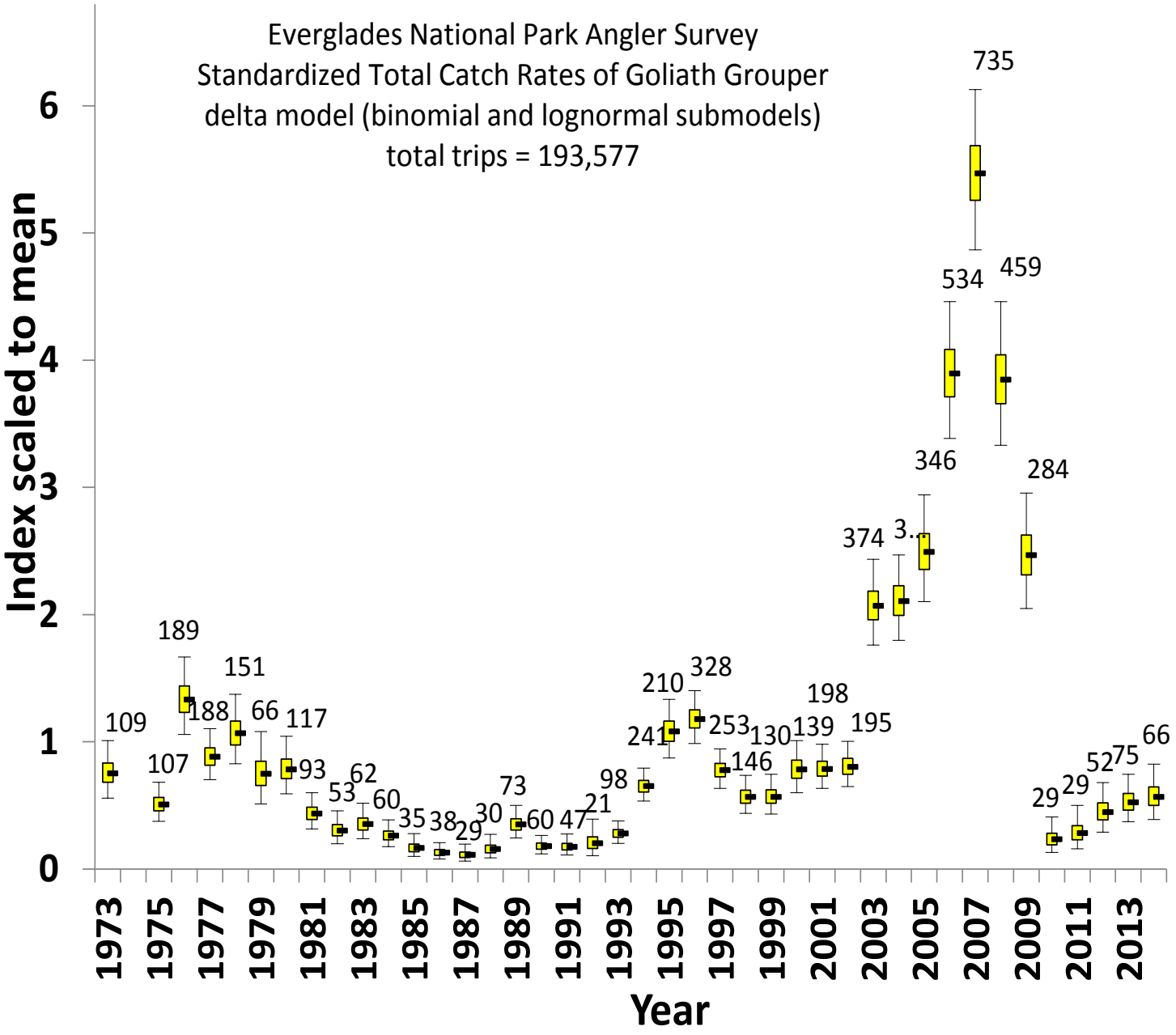
Deviance table for the lognormal (positives) sub-model for catches of Goliaths in the ENP.

Variable

	df	full log_like	Δ log likelihood	Chi-sq	Chi-sq df	Prob Ho	AIC	Δ AIC	deviance	Mean Dev	Δ Mean Dev	% change
	6,836	-7392.2					14,788.3		3479.4	0.5090		
Year	6,796	-7277.5	114.7	229.3	40	<0.0001	14,639.0	-149.3	3364.7	0.4951	0.014	2.7%
Season	6,793	-7256.9	20.6	41.3	3	<0.0001	14,603.7	-35.3	3344.4	0.4923	0.003	0.5%
Num_anglers	6,790	-7243.4	13.4	26.9	3	<0.0001	14,582.8	-20.9	3331.3	0.4906	0.002	0.3%
Area fished	6,786	-7232.1	11.4	22.7	4	0.0001	14,568.1	-14.7	3320.2	0.4893	0.001	0.3%
Skill level	6,785	-7231.3	0.7	1.4	1	0.2302	14,568.7	0.6	3319.5	0.4892	0.000	0.0%
										cumulative%		3.9%

Table 4.2.1 a,b

Abundance Index – Everglades National Park Angler Survey



MRFSS/MRIP Index

Estuarine		Offshore	
East Florida (Nassau-Miami-FL Keys)	West Florida (Collier-Levy)	East Florida (Nassau-Miami-FL Keys)	West Florida (Collier-Levy)
GOLIATH GROUPER	GOLIATH GROUPER	GOLIATH GROUPER	GOLIATH GROUPER
COMMON SNOOK	COMMON SNOOK	GAG	GAG
GRAY SNAPPER	GRAY SNAPPER	GRAY SNAPPER	GRAY SNAPPER
RED DRUM	RED DRUM	RED GROUPER	RED GROUPER
GAG	GAG	WHITE GRUNT	WHITE GRUNT
SPOTTED SEATROUT	SPOTTED SEATROUT	SPANISH MACKEREL	SPANISH MACKEREL
CREVALLE JACK	CREVALLE JACK	COMMON SNOOK	COMMON SNOOK
LADYFISH	LADYFISH	CREVALLE JACK	CREVALLE JACK
PINFISH	PINFISH	SPOTTED SEATROUT	SPOTTED SEATROUT
HARDHEAD CATFISH	HARDHEAD CATFISH	BLUE RUNNER	BLUE RUNNER
	GAFFTOPSAIL CATFISH	LADYFISH	LADYFISH
SHEEPSHEAD	SHEEPSHEAD	LANE SNAPPER	LANE SNAPPER
SPANISH MACKEREL	SPANISH MACKEREL	RED DRUM	RED DRUM
	SCALED SARDINE	PINFISH	PINFISH
BLUEFISH		COBIA	COBIA
PIGFISH		KING MACKEREL	KING MACKEREL
BLACK DRUM		GREAT BARRACUDA	GREAT BARRACUDA
		YELLOWTAIL SNAPPER	YELLOWTAIL SNAPPER
		MUTTON SNAPPER	
		BLACK GROUPER	
		TARPON	
		NURSE SHARK	
		BLUEFISH	
		SHEEPSHEAD	

MRFSS/MRIP Index - Estuarine

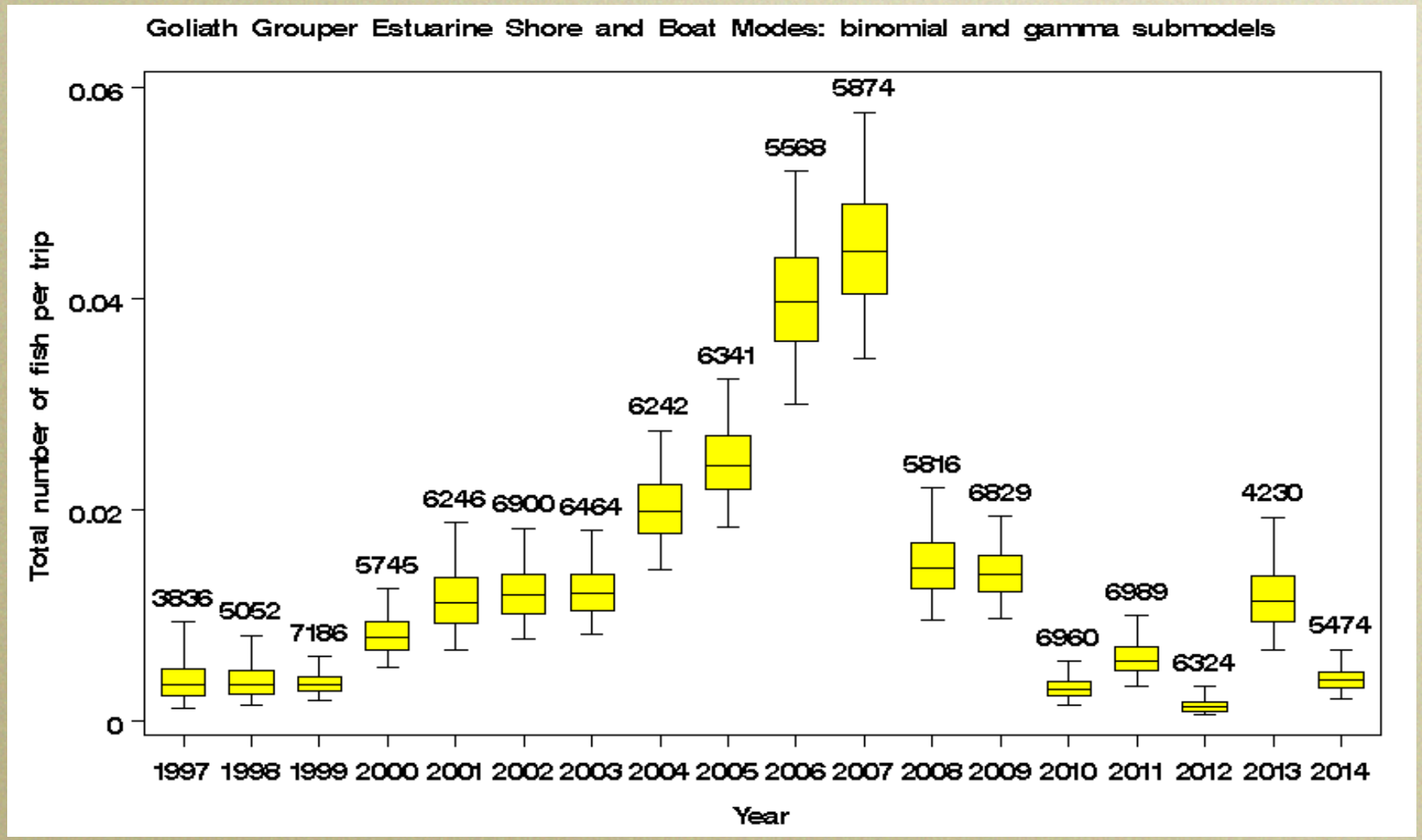
Deviance table for the binomial sub-model of the proportion positive catches of Goliaths.

Variable	levels	DF	Deviance	Mean Deviance	%deviance reduction	Cum %	Full Likelihood	Chi-Square	Chi-square DF	Pr>ChiSq	AIC
	1	108075	6502.3	0.06017	.		-3251.15	.	.	.	6504.3
year	1	108058	6200.7	0.05738	4.62	4.6	-3100.34	301.6	17	<.0001	6236.7
year mode_fx	2	108056	6086.3	0.05633	1.76	6.4	-3043.16	114.4	2	<.0001	6126.3
year mode_fx hr_fish	3	108053	6040.2	0.05590	0.71	7.1	-3020.1	46.1	3	<.0001	6086.2
year mode_fx hr_fish avidity	4	108048	6010.7	0.05563	0.45		-3005.34	29.5	5	<.0001	6066.7
year mode_fx hr_fish num_angl	4	108048	6018.2	0.05570	0.33		-3009.11	22.0	5	0.0005	6074.2
year mode_fx hr_fish season	4	108052	6020.1	0.05572	0.31		-3010.06	20.1	1	<.0001	6068.1
year mode_fx hr_fish coast	4	108052	6022.5	0.05574	0.27		-3011.26	17.7	1	<.0001	6070.5

Deviance table for the gamma sub-model of the positive catches of Goliaths.

Variable	levels	DF	Deviance	Mean Deviance	%deviance reduction	Cum %	Full Likelihood	Chi-Sq	Chi-DF	PrChiSq	AIC
	1	511	230.8	0.45165	.		-713.25	510.0	.	.	1430.5
year	1	494	209.5	0.42409	6.10	6.1	-686.84	52.8	17	<.0001	1411.7
year mode_fx	2	492	202.0	0.41064	2.98	9.1	-676.97	19.7	2	<.0001	1395.9
year mode_fx coast	3	491	199.9	0.40720	0.76	9.8	-674.13	5.7	1	0.0172	1392.3
year mode_fx coast avidity	4	486	196.7	0.40471	0.55		-669.69	8.9	5	0.1139	1393.4
year mode_fx coast num_angl	4	486	197.4	0.40615	0.23		-670.65	7.0	5	0.2233	1395.3
year mode_fx coast season	4	490	199.3	0.40673	0.11		-673.26	1.7	1	0.1873	1392.5
year mode_fx coast hr_fish	4	488	198.8	0.40743	-0.05		-672.63	3.0	3	0.3892	1395.3

MRFSS/MRIP Index - Estuarine



MRFSS/MRIP Index - Offshore

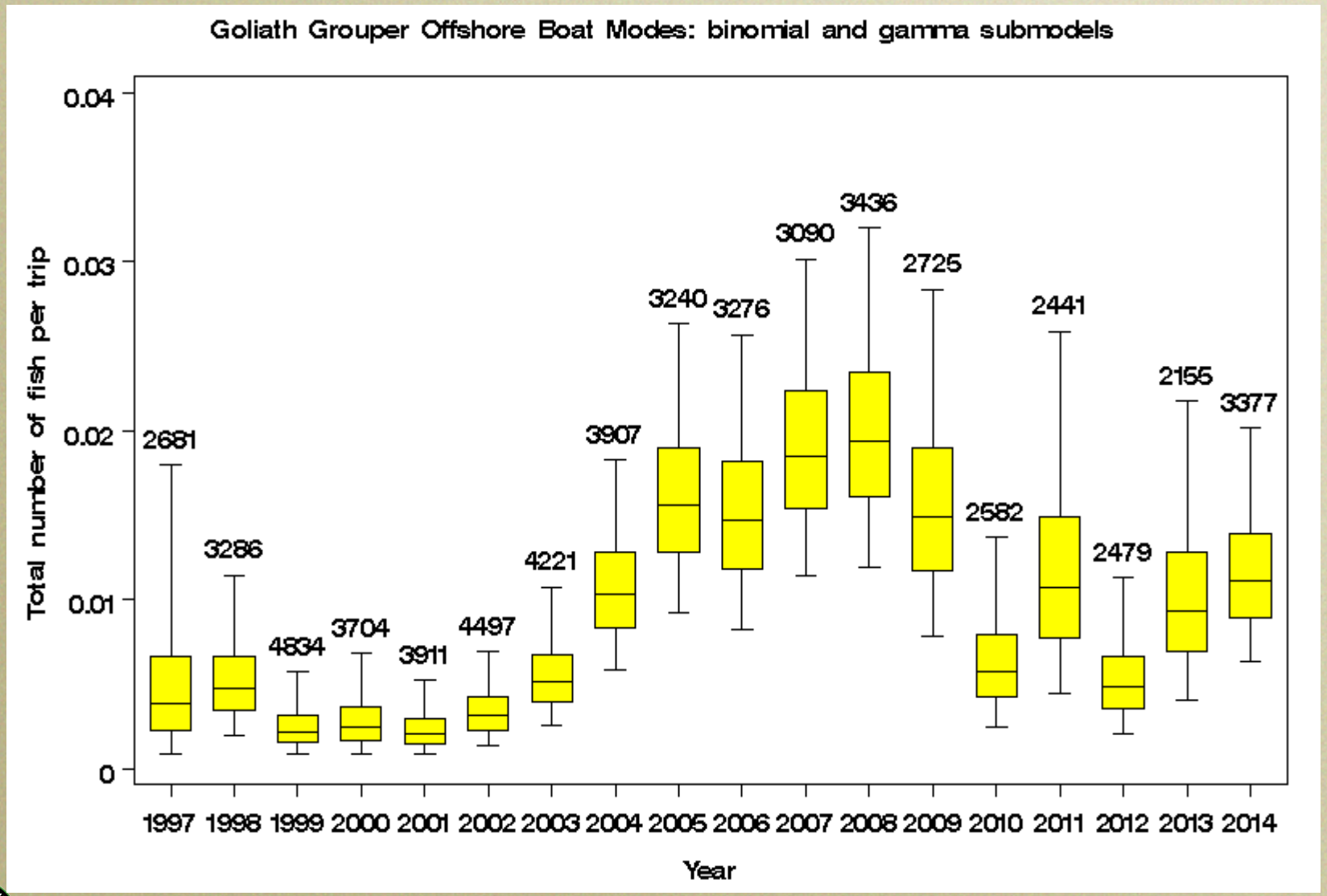
Deviance table for the binomial sub-model of the proportion positive catches of Goliaths.

Variable	levels	DF	Deviance	Mean Deviance	%deviance reduction	Cum %	Full Likelihood	Chi-Square	Chi-square DF	Pr>ChiSq	AIC
	1	59841	4338.1	0.07249	.		-2169.03	.	.	.	4340.1
year	1	59824	4190.0	0.07004	3.39	3.4	-2095.01	148.0	17	<.0001	4226.0
year mode_fx	2	59823	4041.0	0.06755	3.44	6.8	-2020.49	149.0	1	<.0001	4079.0
year mode_fx num_angl	3	59818	3994.5	0.06678	1.07	7.9	-1997.24	46.5	5	<.0001	4042.5
year mode_fx num_angl hr_fish	4	59815	3977.3	0.06649	0.39		-1988.64	17.2	3	0.0006	4031.3
year mode_fx num_angl avidity	4	59813	3980.5	0.06655	0.32		-1990.24	14.0	5	0.0156	4038.5
year mode_fx num_angl coast	4	59817	3992.8	0.06675	0.04		-1996.4	1.7	1	0.1959	4042.8
year mode_fx num_angl season	4	59817	3993.9	0.06677	0.01		-1996.93	0.6	1	0.4302	4043.9

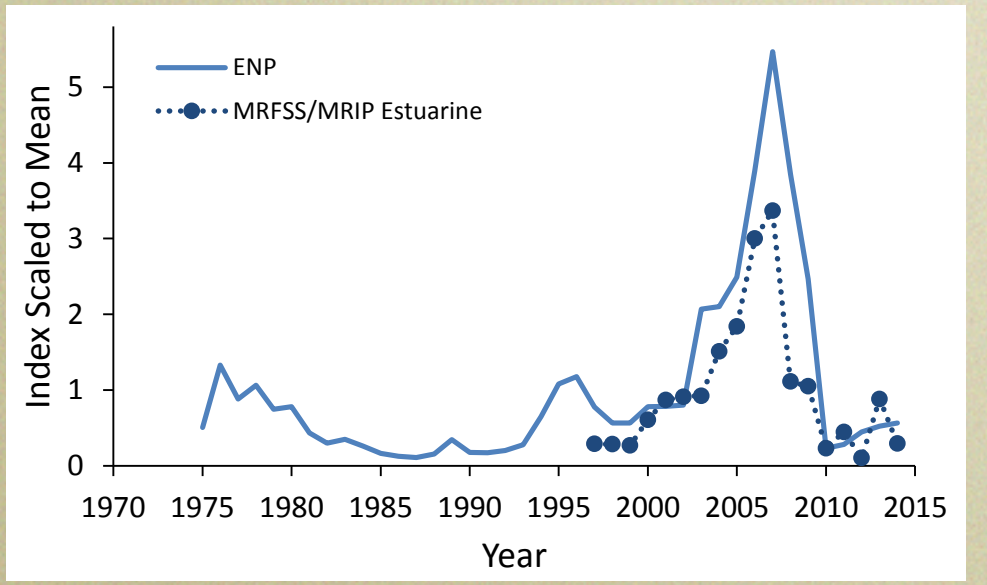
Deviance table for the gamma sub-model of the positive catches of Goliaths.

Variable	levels	DF	Deviance	Mean Deviance	%deviance reduction	Cum %	Full Likelihood	Chi-Square	Chi-square DF	Pr>ChiSq	AIC
	1	353	131.1	0.37140	.		-426.84	379.0	.	.	857.7
year	1	336	117.4	0.34951	5.89	5.9	-406.29	41.1	17	0.0009	850.6
year avidity	2	331	112.3	0.33920	2.78	8.7	-397.93	16.7	5	0.0051	843.9
year avidity coast	3	330	109.4	0.33159	2.05	10.7	-393.15	9.6	1	0.002	836.3
year avidity coast hr_fish	4	327	107.4	0.32840	0.86		-389.66	7.0	3	0.0727	835.3
year avidity coast num_angl	4	325	107.0	0.32920	0.64		-388.98	8.4	5	0.1379	838.0
year avidity coast season	4	329	108.7	0.33031	0.35		-391.87	2.6	1	0.1094	835.7
year avidity coast mode_fx	4	329	108.9	0.33088	0.19		-392.19	1.9	1	0.166	836.4

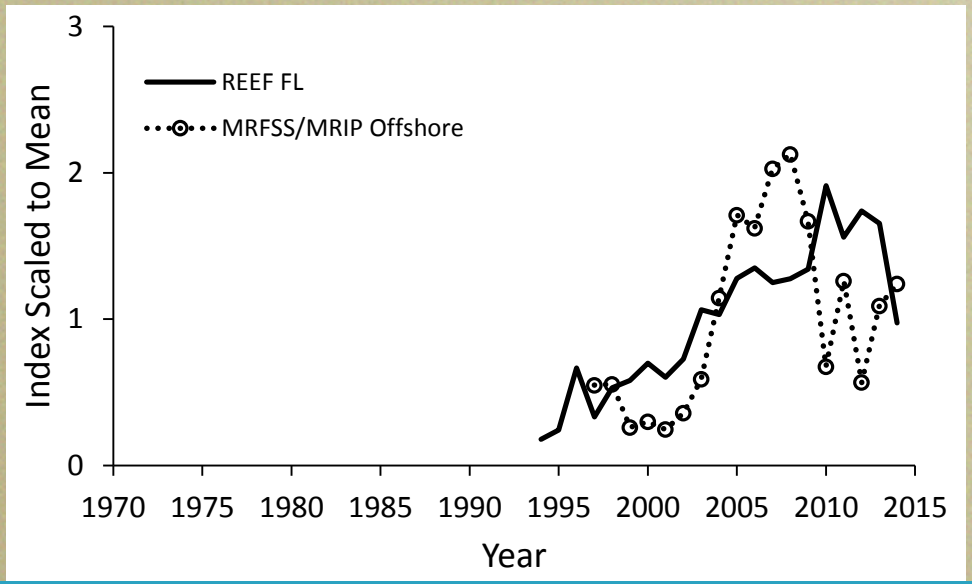
MRFSS/MRIP Index - Offshore



The indices scaled to their means



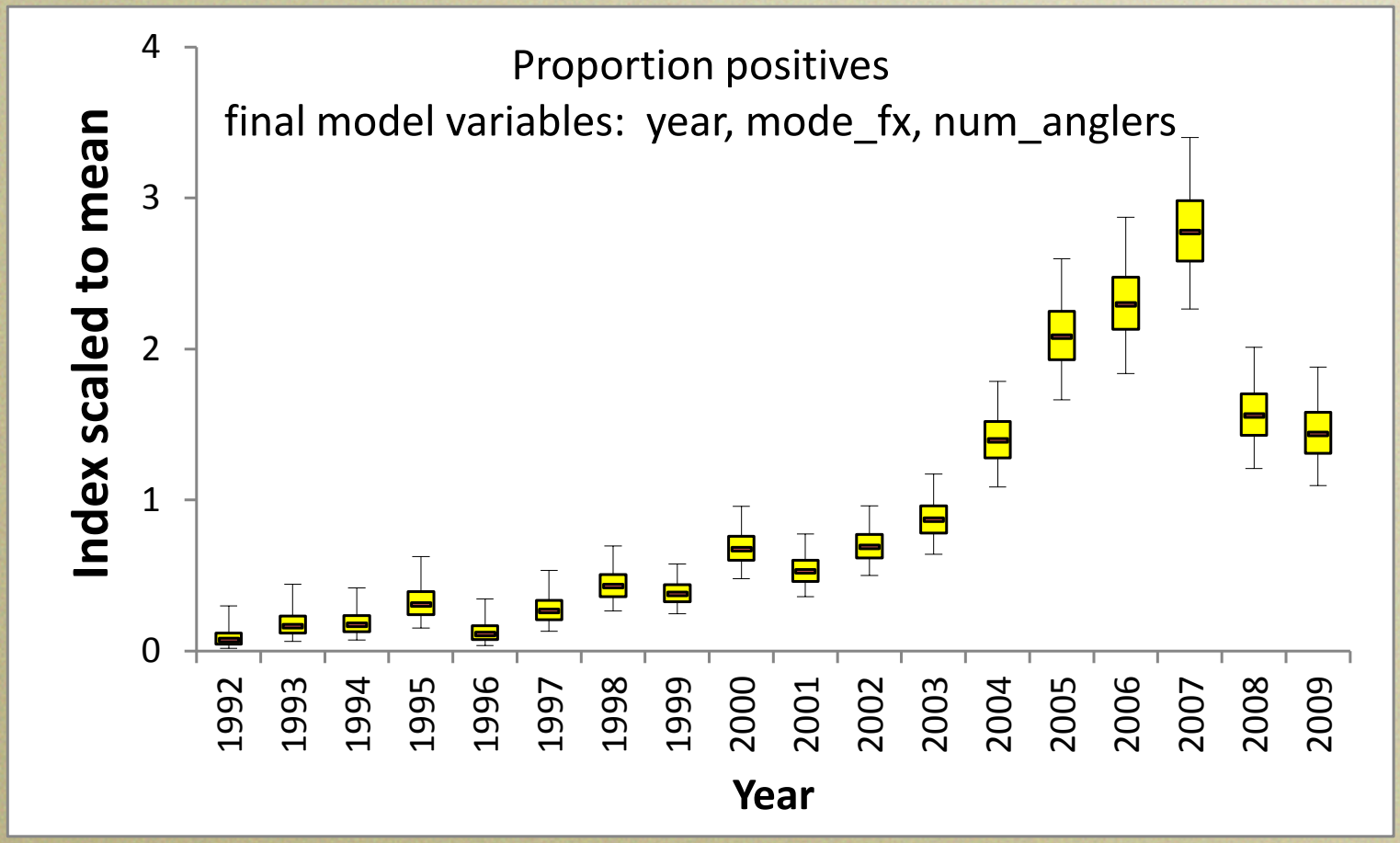
Estuarine Indices



Offshore Indices

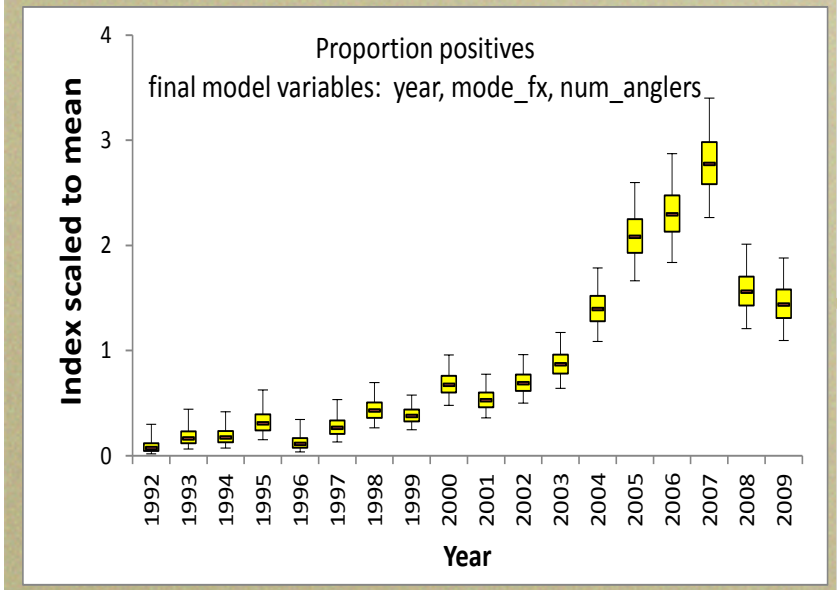
Fig. 4.4.1 a,b

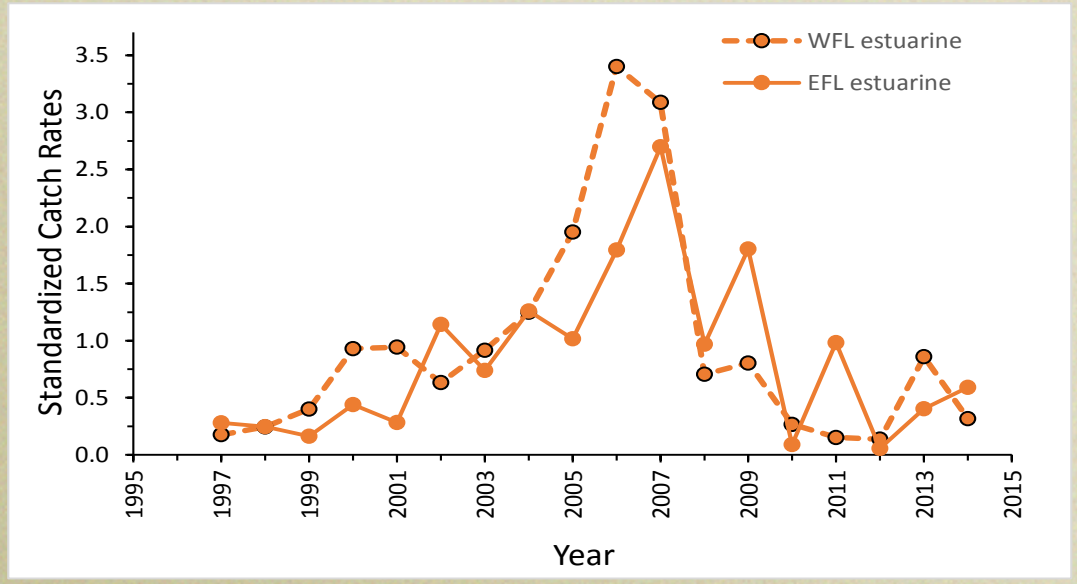
MRFSS Index, SEDAR 23

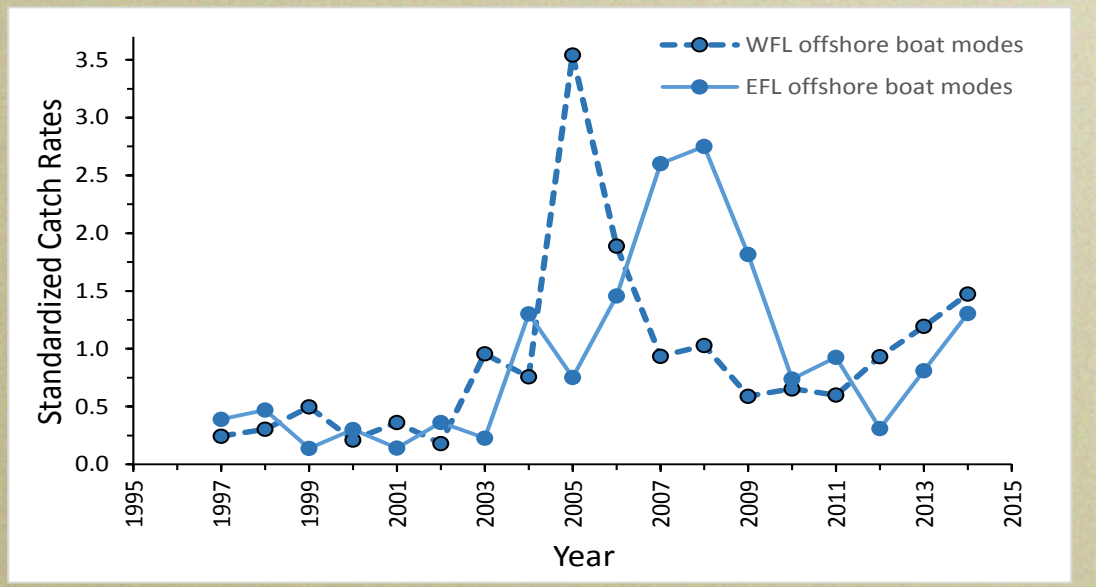


MRFSS Index, FWC update (hurdle model)

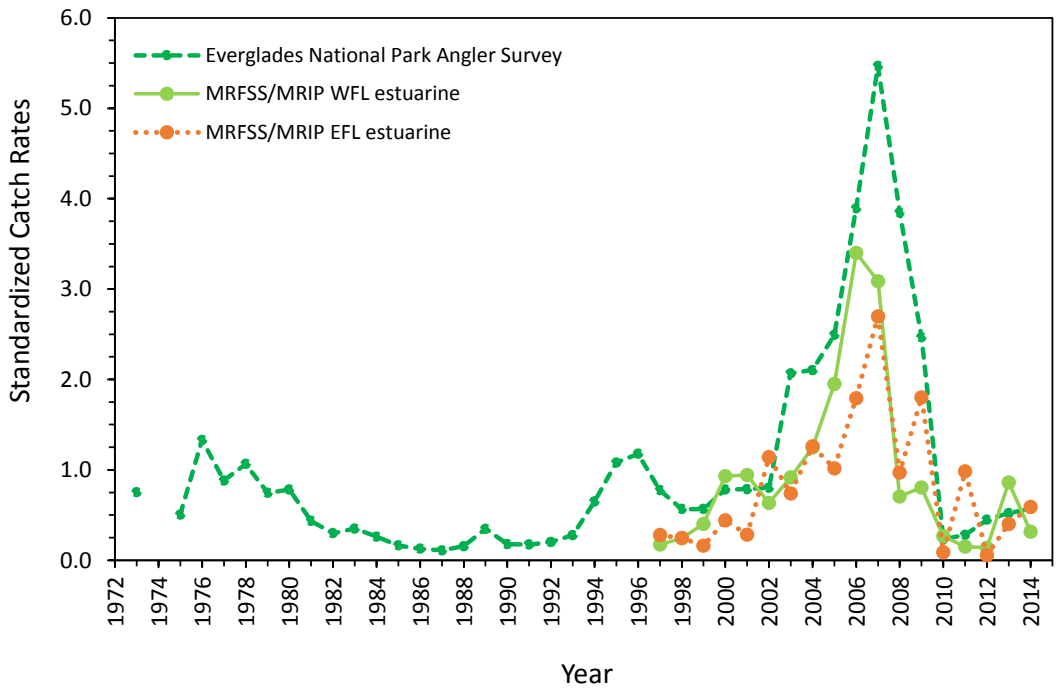
SEDAR 23 MRFSS Index, proportion positives

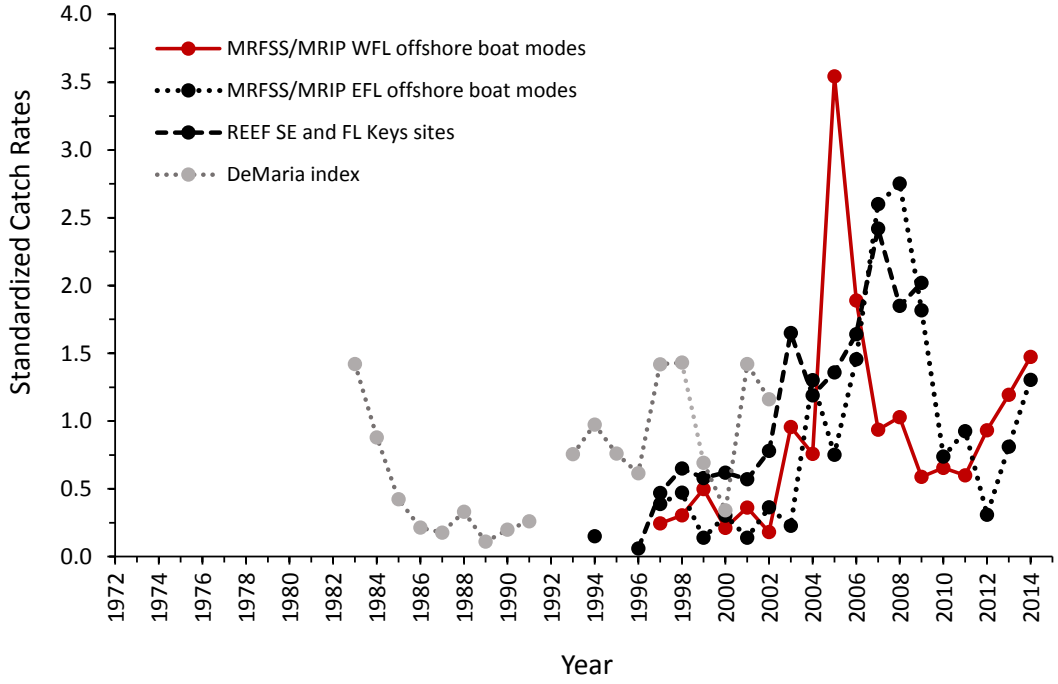






MRFSS Index comparison, FWC update





MRFSS Index, replacement (combined coasts)