Stock Assessment Summary Report for Southeast United States Spiny Lobster

SEDAR 08 Stock Assessment Panel

2 May 2005

1. Introduction

This document summarizes the stock assessment report entitled "Assessment of spiny lobster, *Panulirus argus*, in the Southeast United States" prepared by the SEDAR 08 U.S. Spiny Lobster Stock Assessment Panel. By necessity, this summary also includes material from the Data Workshop Report. This document should be viewed as a brief overview of the assessment report and the reader is referred to that document for more detailed information.

2. Data

Relevant data on spiny lobsters was compiled at the Data Workshop that was held 25-27 January 2005 in Marathon, Florida under the auspices of the Florida Fish and Wildlife Conservation Commission. These data included life history information such as stock identification, growth estimates from tagging and lipofuscin concentrations, reproduction, natural mortality rates, as well as fishery characteristics.

Briefly, Caribbean spiny lobsters spend 6-9 months after hatching as larvae (phyllosoma) in the plankton after which they settle onto suitable substrate and metamorphose into juveniles. They spend about 18 months to two years in nursery areas before they migrate to the offshore reefs where spawning occurs. Oceanographic features such as the Caribbean Current, the Loop Current, and the Florida Current have the potential to transport the larvae from the eastern Caribbean to the Florida Straits in approximately 90-100 days. Not surprisingly, genetic studies have shown very high diversity in spiny lobsters such that no geographic differences could be inferred other than that the spiny lobster in Brazil could be a separate sub-species but the Brazilian form has been collected off Miami, Florida. What this means for stock assessment is that recruitment in Southeast United States probably includes animals from upstream of Florida in addition to local production making the spawning stock undefined.

The fishery for spiny lobster in the Southeast United States began in Florida in the late 1800s and the earliest recorded landings were in 1897 from Key West (Fig. 1). The fishery originated as an artisanal and bait fishery for finfish; later with the advent of the railroad providing access to markets, spiny lobster became a food fishery. Traps became the dominant gear in the 1920s and the fishery first exceeded a million pounds in 1941 with landings of 2.1 million pounds (947 metric tons). In 1965, the minimum carapace size was reduced to 3 inches (76.2 mm) that reduction opened Florida Bay to fishing adjacent to the nursery areas. After an adjustment

period, annual commercial landings have varied around an average of 2500 mt (5.5 million pounds) since 1969.

Data from fishery-dependent and -independent sampling programs were presented. The fishery-dependent sampling included length samples from the commercial and recreational fisheries through interviews and trap length composition and catch rates through observers. Fishery-independent sampling included monitoring puerulus settlement (the first non-planktonic stage), more than 20 years of juvenile and recruitment studies, as well as diver and trap based sampling. Commercial landings came from NMFS General Canvass and Florida's Marine Resources Information System (trip tickets). Recreational landings have been estimated from mail-surveys since 1992 and landing reports from the Special Recreational Crawfish license holders since 1994. Traps were the dominant gear followed by the recreational divers (Fig. 2). These data were presented in the Data Workshop Report and appropriate data were included in the Stock Assessment Report.

Catch-at-length and catch-at-age matrices were unavailable at the Data Workshop but these were presented in the Stock Assessment Workshop. Also, panel members at the Stock Assessment Workshop made suggestions on improving the tuning indices and those changes were implemented in the assessment.

3. Stock Assessment

The Stock Assessment Workshop was held 15-17 March 2005 in Marathon, Florida. From the variety of models that were presented at the workshop, the panel members chose two assessment models: a simple, modified DeLury model and a statistical catch-at-age model (Integrated Catch-at-Age). The age-structured model was the base model and the DeLury model was a check for consistency. The DeLury model used numbers of fish and effort by fishing year extended back to the 1978-79 fishing year (Table 1). Both models used fishery-dependent (observer and Biscayne National Park creel survey) and fishery-independent (puerulus and adult monitoring) tuning indices (Table 2). Sensitivity runs included running the age-structured model with two lipofuscin growth curves and with two alternative natural mortality rates. Retrospective analysis compared patterns in fishing mortality rates, recruitment, and population sizes in terminal years from 1997-98 to 2002-03 to the base run results.

Recruitment of lobsters one year after settlement has varied over the time series (Fig. 3). The spawning biomass in Florida has increased over time especially in the three most recent fishing years (Fig. 4). Fishing mortality rates have varied without trend until the recent drop in fishing mortality after 2000 (Fig. 5). Older lobsters appear to be less available to the fishery as reflected in the dome-shaped selectivity curve (Fig. 6). Both assessment models interpreted the lower landings after the 1999-00 fishing year as decreased effort. The DeLury model estimated a lower population size with correspondingly higher fishing mortality rates than did ICA but when the DeLury was adjusted for selectivity, the results were similar (Fig. 7). We did not fit stock-recruit relationships to either model because the spawning biomass in Florida forms an unknown portion of the spawning stock

that produced the recruits reaching Florida. The retrospective analyses indicated that fishing mortality rates from ICA were initially underestimated by an average of 37%.

4. Stock Status

Amendment 6 of the Spiny Lobster FMP defined overfishing as fishing at a rate in excess of that associated with a static SPR value of 20% (F20%). With the current life history values and fishery practices, the fishing mortality rate on fully recruited lobsters (age-3) at a static SPR of 20% was 0.49 per year. The spiny lobster fishery in Southeast United States has fluctuated at SPR values around the 20% objective until the three most recent years (Fig. 8) and was deemed to not be overfishing because the fishing mortality rate on age-3 in 2003-04 (0.26 per year) was below the Council's Fmsy proxy of F20%. Even when the fishing mortality rate was adjusted for retrospective bias (0.36 per year), the fishing mortality rate in 2003-04 was still below the Council's management objective. As noted above, without a Caribbean-wide stock assessment, we were unable to determine the status of the stock with regard to the spawning biomass at MSY (Bmsy) or the Minimum Stock Size Threshold.

Table 1. The landings, in numbers, and effort by sector and fishing year used in the DeLury model.

Fishing Season	Recreational Landings	Commercial Landings	Bait Landings	Total Landings	Recreational Person-days	Commercial Trips
1978-79	1032818	4712160	1489053	7234031	298427	32833
1979-80	1332146	6384958	1766902	9484006	384930	44488
1980-81	1653054	5074434	1450653	8178140	479513	35357
1981-82	1438200	4673563	1389579	7501342	416247	32564
1982-83	1487598	5192189	1440506	8120294	430799	36177
1983-84	1114641	3516013	1205460	5836114	322088	24498
1984-85	1218015	5077610	1458513	7754138	350689	35379
1985-86	1176734	4586067	932611	6695412	339625	32351
1986-87	1098768	3955795	1321591	6376154	317518	31082
1987-88	1305427	4657778	521939	6485144	377255	34407
1988-89	1743948	6381104	499015	8624067	505243	36431
1989-90	1718020	6650042	587191	8955253	497125	40276
1990-91	1496810	5154258	1061504	7712572	433092	40537
1991-92	1990623	5784865	662668	8438156	578003	45773
1992-93	1242648	4567343	565406	6375396	481276	35818
1993-94	1787054	4662274	422617	6871945	518641	31568
1994-95	1751298	6229495	492439	8473232	550898	32554
1995-96	1673330	5666412	513035	7852777	472707	32830
1996-97	1778889	6646664	583692	9009244	545809	32849
1997-98	2186058	6796320	621140	9603518	323006	34087
1998-99	1185036	4522375	275976	5983388	337574	26198
1999-00	2292304	6581944	498148	9372396	560140	28142
2000-01	1848447	4469964	423038	6741450	470467	26248
2001-02	1091022	2307262	323096	3721380	370026	19669
2002-03	1223197	3818081	347857	5389136	345777	24186
2003-04	1142960	3419929	329668	4892558	359214	22232

Table 2. Tuning indices and the ages that they were applied to in the age-structured models used in assessment analyses. The Biscayne National Park creel survey, observer and adult monitoring pre-recruit, and puerulus indices were recalculated based on recommendations from the Data Workshop and the Stock Assessment Workshop.

	Fishery dependent						Fishery independent					
Fishing year	Legal-sized Observer Ages 3+ Number/trap	CV	Pre-recruit Observer Age 2 Number/trap	CV	Biscayne National Park Ages 2+ Number/trip	CV	Legal-sized Adult Monitoring Ages 3+ Number/dive	CV	Pre-recruit Adult Monitoring Age 2 Number/dive	CV	Puerulus Age 1 Number/collector	CV
1978-79					20.24	1.161						
1979-80					16.43	1.443						
1980-81					16.65	1.255						
1981-82					13.72	1.526						
1982-83					12.52	1.448						
1983-84					10.86	2.154						
1984-85					11.17	2.430						
1985-86					8.99	3.903						
1986-87					6.63	2.658						
1987-88					7.29	3.519					12.53	6.76
1988-89					7.43	3.509					13.41	6.85
1989-90					7.51	3.379					19.47	5.92
1990-91					6.76	2.409					13.59	7.12
1991-92					10.33	1.853					12.05	5.93
1992-93					7.84	3.298					12.46	7.99
1993-94	0.70	0.852	2.11	0.478	13.26	1.757					13.14	5.72
1994-95	1.14	0.920	2.24	0.636	10.13	1.947					14.36	6.12
1995-96	1.00	0.815	2.16	0.601	13.10	1.986					14.12	5.74
1996-97	1.08	0.930	2.60	0.604	11.01	1.689					8.57	6.77
1997-98	1.27	0.876	2.71	0.578	17.04	1.363	11.21	7.01	11.15	7.02	14.59	6.19
1998-99	1.08	0.964	3.15	0.601	13.53	1.634	11.45	6.72	4.91	10.12	18.20	5.31
1999-00	0.93	1.539	2.60	0.865	22.97	1.604	21.88	4.87	14.58	5.97	11.16	6.06
2000-01	0.86	1.162	2.31	0.725	12.69	1.559	23.05	4.96	11.01	7.13	13.31	5.84
2001-02					8.90	2.161	17.36	5.46	5.12	9.91	10.55	6.09
2002-03					12.98	1.926	14.32	5.82	6.26	8.69	11.42	6.18
2003-04					10.01	1.917	19.60	5.12	5.01	9.96	8.80	6.62
2004-05					12.30	1.812						

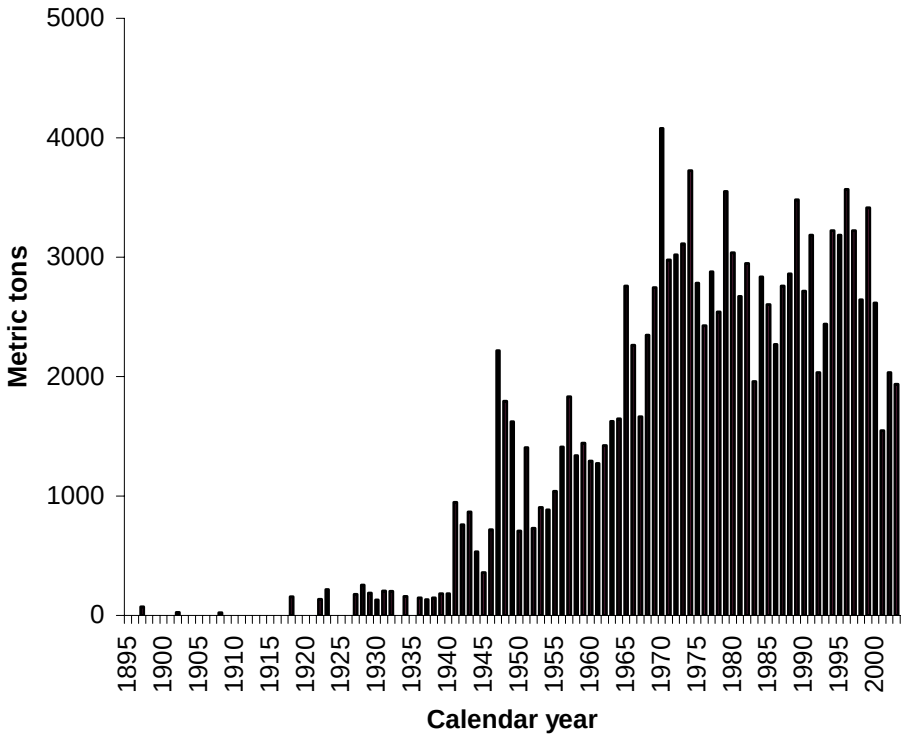


Figure 1. Commercial landings of spiny lobster in the United States.

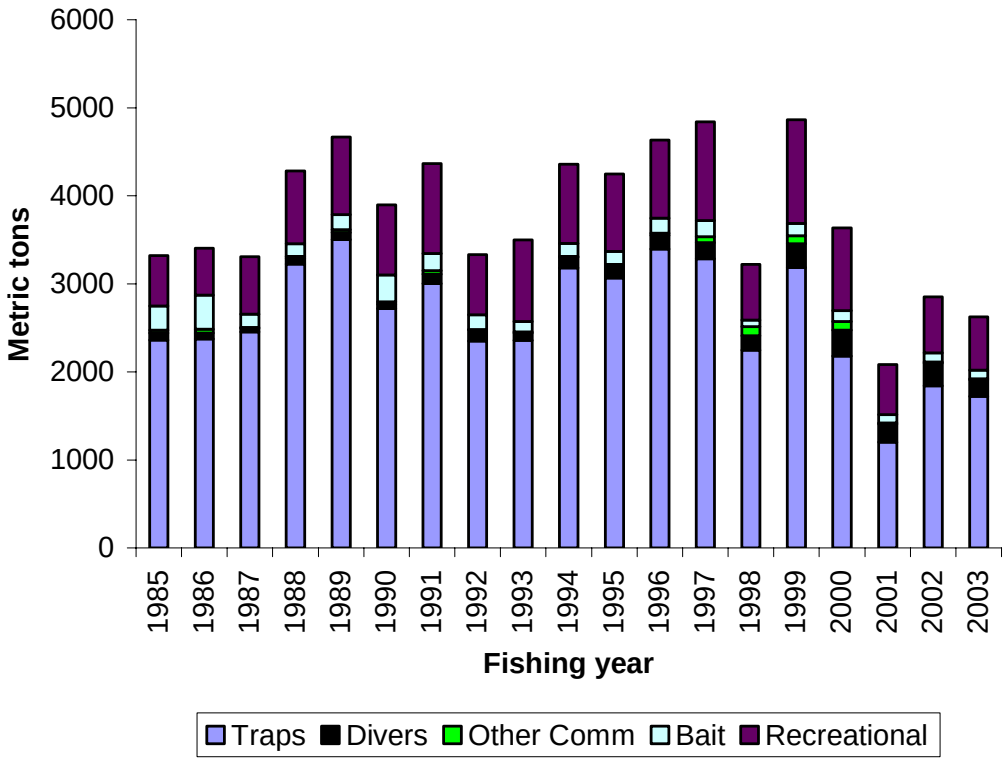


Figure 2. Harvest of spiny lobster in Southeast United States by gear and fishing year.

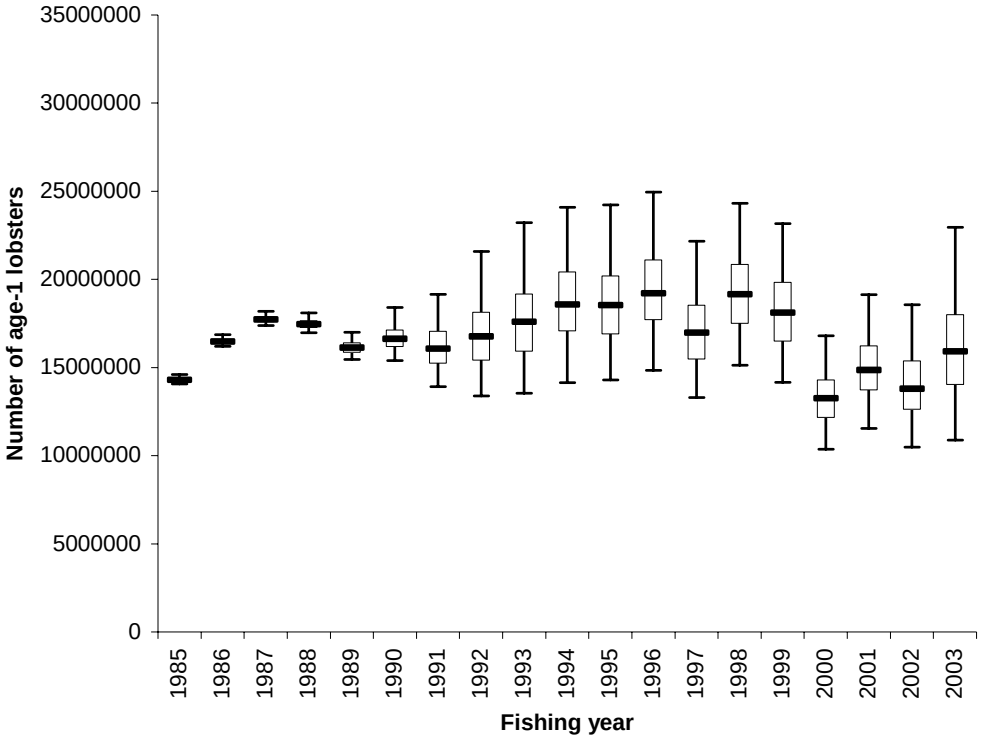


Figure 3. The number of age-1 recruits based on 1000 Monte Carlo runs using the covariance matrix. The vertical lines are the 95% confidence intervals, the boxes are the inter-quartiles (25 to 75 percentiles) and the horizontal lines are the medians.

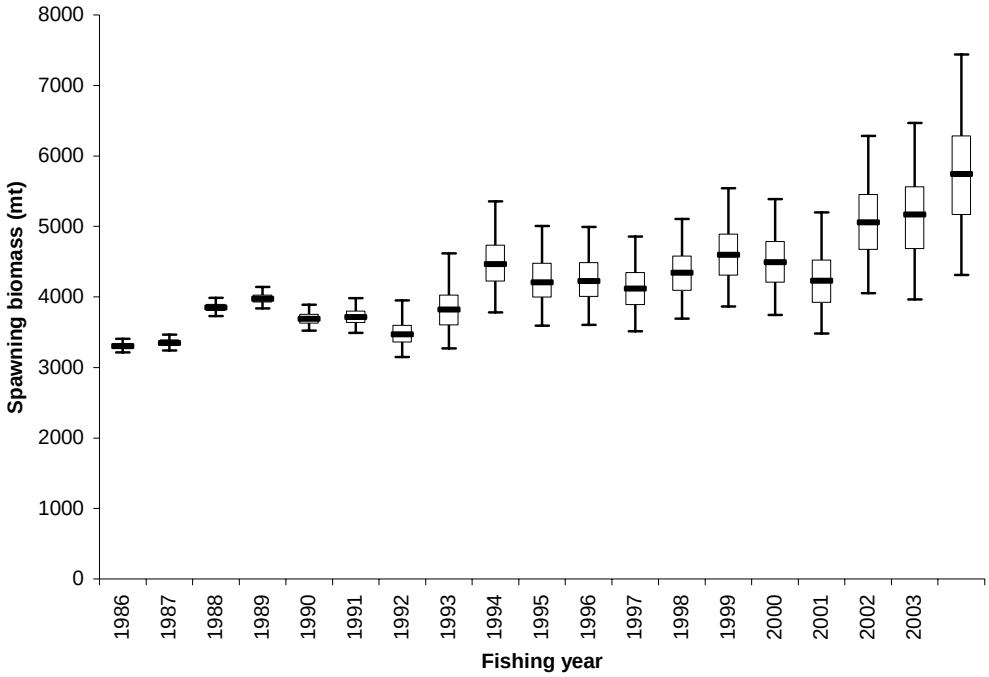
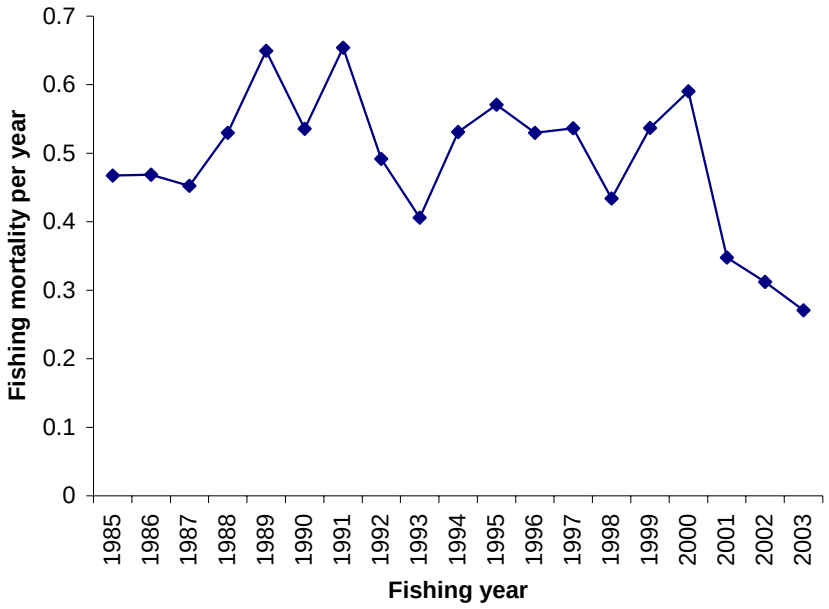


Figure 4. Spawning biomass in Florida by fishing year. The vertical lines are the 95% confidence intervals, the boxes are the inter-quartiles (25 to 75 percentiles) and the horizontal lines are the medians.

a. Fishing mortality per year on age-3 lobsters



b. Average fishing mortality on ages 1-5

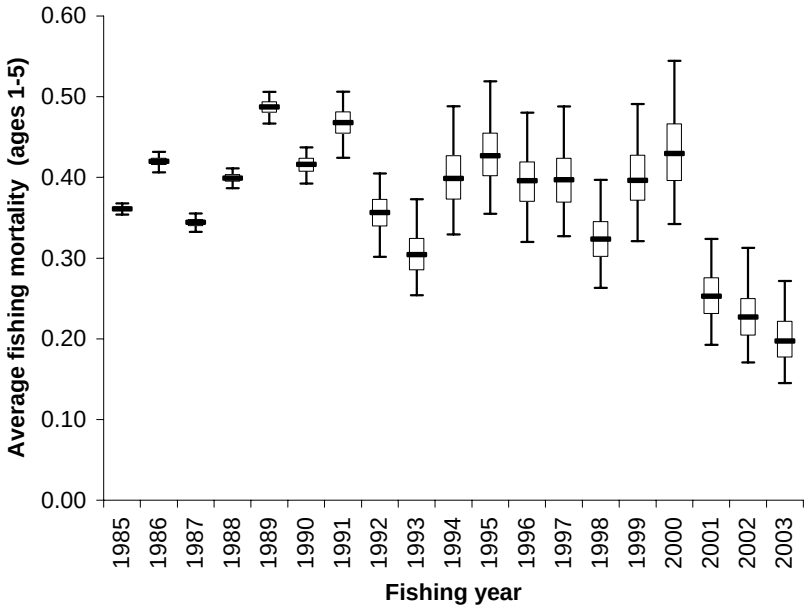


Figure 5. Fishing mortality rates estimated by ICA. The uncertainty in the average fishing mortality rates is based on 1000 Monte Carlo runs using the covariance matrix. The vertical lines are the 95% confidence intervals, the boxes are the inter-quartiles (25 to 75 percentiles) and the horizontal lines are the medians.

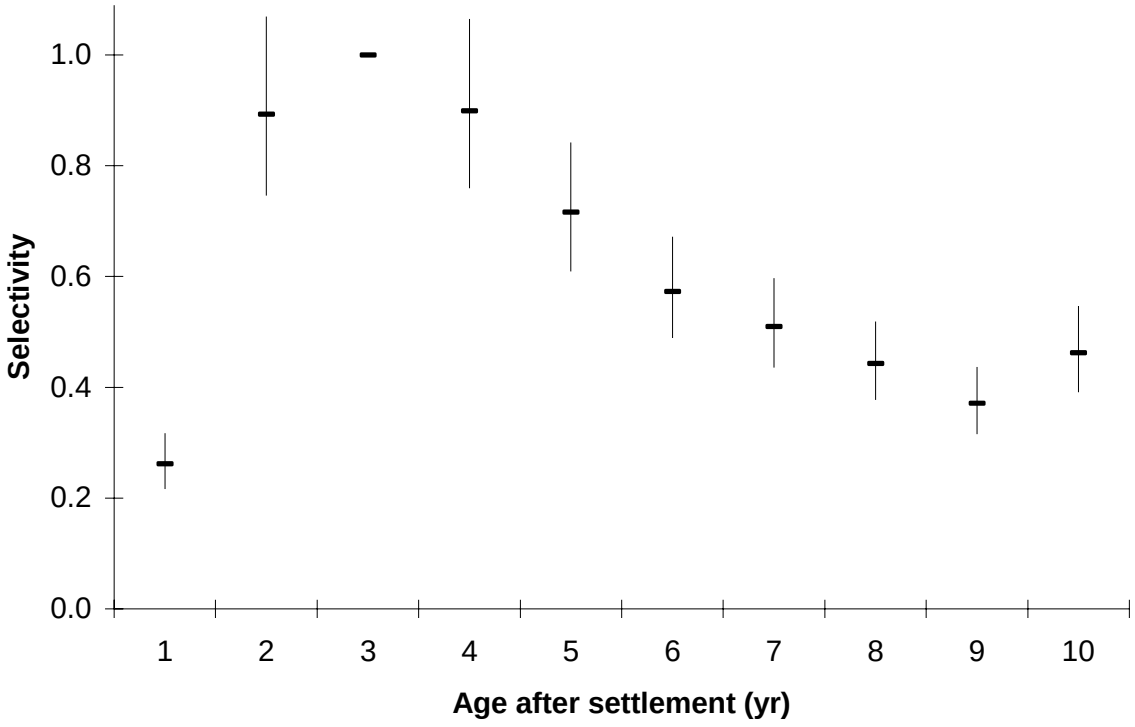


Figure 6. Selectivity by age for the period 1993-94 and later. The vertical lines are the 95% confidence interval and the horizontal lines are the maximum likelihood point estimates.

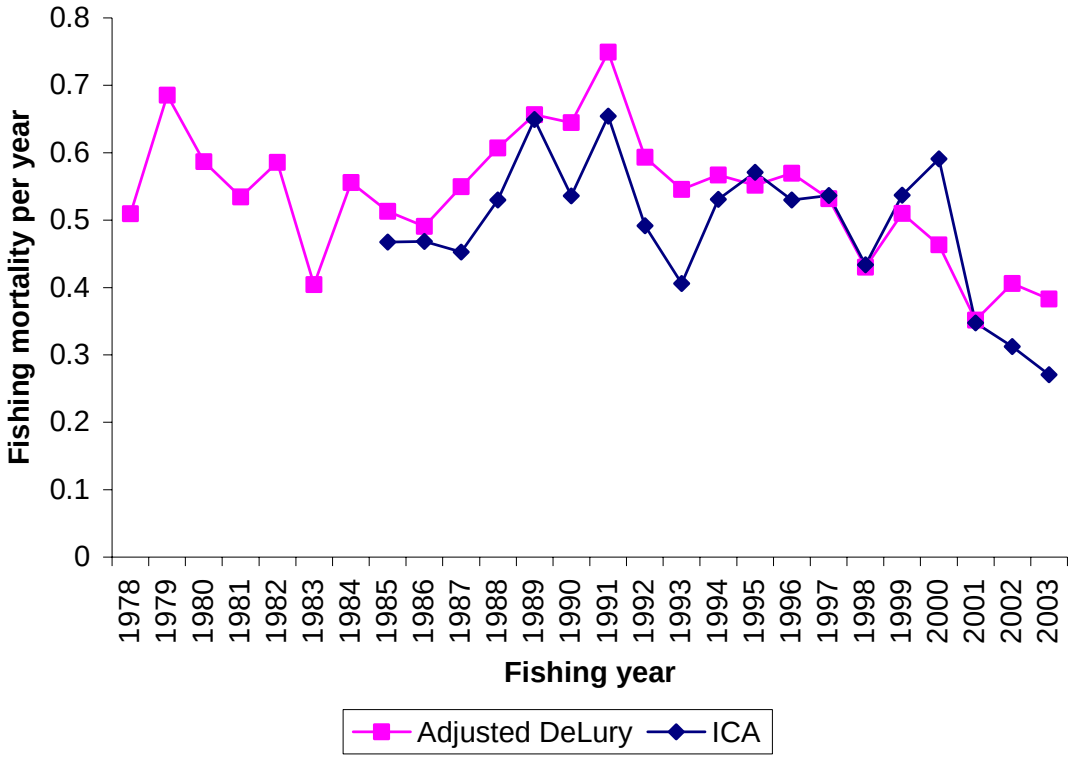


Figure 7. Comparison of the fishing mortality rates from the selectivity adjusted DeLury model and the age-structured model ICA.

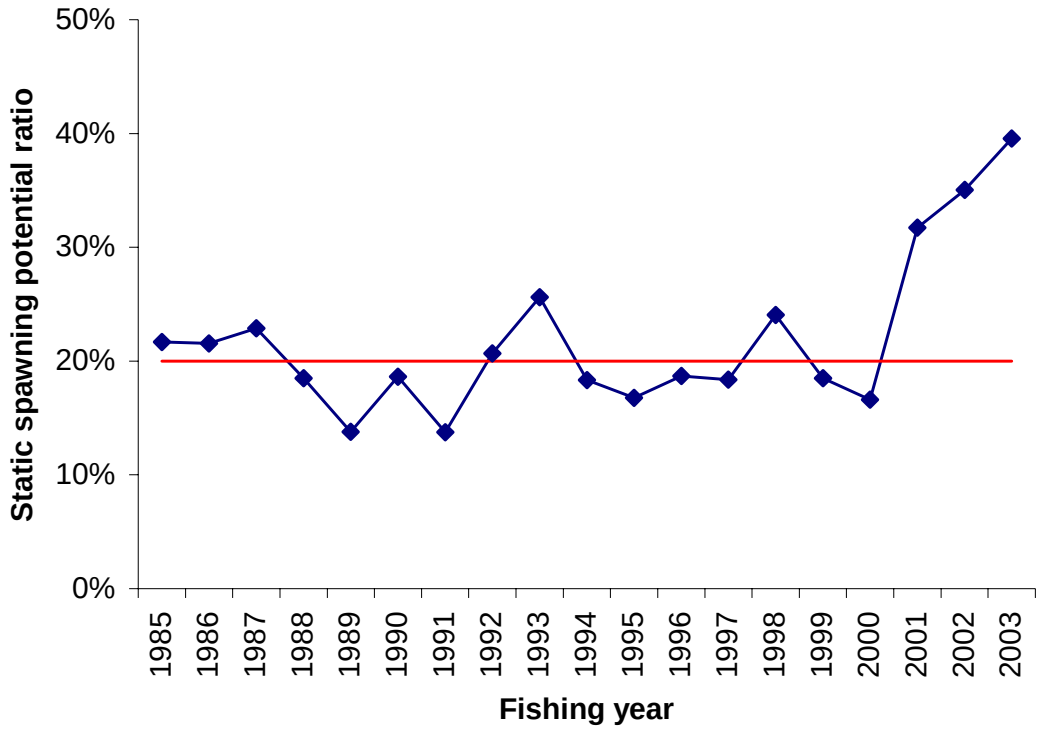


Figure 8. Static spawning potential ratios by fishing year and the current management objective of 20%.