Spiny Lobster Update Assessment Review Workshop Report

GMFMC/SAFMC/SEDAR Update Assessment Workshop

November 18-19, 2010

Key West, FL

Executive Summary

The stock assessment presented by the 2010 Spiny Lobster Assessment Workshop provided the Review Panel with outputs and results from two statistical assessment models. The primary assessment model was the Integrated Catch-at-Age (ICA) model, while a Modified DeLury model was considered secondary and used to provide a comparison of model results. After careful review and discussion the Review Panel concluded that there were sufficient concerns with the performance of the two assessment models to reject the assessment results and that the stock status of spiny lobster in the southeastern US was unknown. More importantly, new evidence indicating the southeastern US stock largely depends on external recruitment from upstream Caribbean populations precludes reliable estimation of management reference points. The US stock cannot be assessed in isolation and is not the appropriate geographical and biological scale needed to capture population-wide dynamics.

Introduction

The Southeast Data and Assessment Review (SEDAR) Spiny Lobster Update Assessment Review Workshop (RW) was held in Key West, November 18-19, 2010 to review the "Stock assessment of spiny lobster, *Panulirus argus*, in the southeast United States: Update Assessment Report" prepared by the Florida Fish and Wildlife Research Institute team of Drs. Robert Muller and Joseph Munyandorero, who incorporated alternative model scenario requests and advice from the SEDAR Lobster Update Assessment Workshop (AW) held in September, 2010 (Appendix A).

The Assessment Report was presented by Dr. Joseph Munyandorero, Florida Fish and Wildlife Research Institute. The Review participants included two Scientific and Statistical Committee (SSC) reviewers from each Council (Dr. Walter Keithly and Mr. Doug Gregory (Chair) from the Gulf of Mexico Fishery Management Council and Drs. John Hoenig and Luiz Barbieri from the South Atlantic Fishery Management Council) and one observer SSC member from the Gulf of Mexico Fishery Management Council (Dr. Rene Buesa). There were no specific Terms of Reference for the Lobster Update Review Workshop.

The AW Report discussed new genetics data documenting that the southeast US lobster population is largely if not wholly dependent on recruitment of post larval lobsters from spawning stocks throughout the Caribbean (Appendix A: Pages 14 and 27). Due to the importance of this new information relative to the critical issue of population structure, a more detailed summary of the new documentation available since SEDAR 8 was requested to be provided to the RW. Subsequently, a report on the most recent genetics study of *Panulirus argus* was provided (Hunt et al., 2009) and two presentations were arranged for the RW. Doctor Mark Butler of Old Dominion University presented a summary of physical and biological oceanographic information on the potential connectivity of the various lobster stocks in the

Western Central Atlantic, including an overview of the PaV1 lobster virus discovered in 1999. Also, Dr. Mike Tringali of the Florida Fish and Wildlife Research Institute presented microsatellite DNA analyses indicating that the Florida lobster stock represents a genetic mixture of a minimum of four different parental populations with little to no indication of self-sustaining recruitment. These presentations were influential in the subsequent evaluation of the population models presented from the AW and the final conclusions reached by the RW.

The Lobster Update Assessment, under existing SEDAR procedures for update assessments, was constrained to use the same population assessment models that were used in the last benchmark assessment, SEDAR 8, in 2005. The requirement to use the same models as in the last benchmark assessment (five years earlier) prevented the assessment team from employing more sophisticated modeling techniques developed in the interim. Qualitatively, the results from the update assessment were consistent with the original benchmark assessment. The major differences affecting interpretation of the 2010 update assessment were that the retrospective patterns worsened as more years of data were included and the genetic information indicated a predominant to total dependence of the southeastern US spiny lobster population recruitment on foreign sources.

The stock assessment review panel in 2005 concluded that overfishing was not occurring because the estimated current fishing mortality rate was below the $F_{20\%}$ SPR (spawning stock ratio) definition of overfishing established in Amendment 6 to the Fishery Management Plan. The 2005 panel also noted the inability to determine a stock-recruit relationship due to an unknown but potentially large proportion of recruitment coming from external sources and not from the South Florida lobster stock proper.

The new annual catch limit requirements had an obvious impact on interpretation of the Update Assessment results. Similar to the results of SEDAR 8, the population models indicated declining fishing mortality since 2000 (Appendix A: Figure 3.2.2.6.1; Page 110). The main difference between the update and the earlier benchmark assessments is that the observed retrospective patterns that emerged after 1999 worsened with time making the model results even more questionable (see Appendix A: Figure 3.2.2.9.1; Page 112). Also, given the requirement to base ABC (acceptable biological catch) on an estimated OFL (overfishing limit), the combination of retrospective patterns and the now well documented external recruitment phenomenon makes determination of the status of the South Florida lobster stock relative to standard population benchmarks even more problematic.

Assessment Review

The RW noted that there were sufficient concerns with the performance of the two assessment models used (i.e., the Modified DeLury and Integrated Catch-at-Age models) for spiny lobster to reject the assessment results, concluding the stock status of spiny lobster in the southeast US is essentially unknown. Furthermore, the magnitude of the dependency of the US stock recruitment on unknown upstream Caribbean population sources indicates that this and previous assessments were not conducted with the appropriate geographical and biological scales.

Diagnostically, the models exhibit clear lack-of-fit patterns to the residuals of the indices used (Appendix A: Figures 3.1.2.1; Page 92 and 3.2.2.1.2; Page 106) and retrospective inconsistencies in model outputs were extreme (Appendix A: Figures 3.1.2.9.1; Page 98 and

3.2.2.9.1; Page 112) despite various attempts to identify the source of the retrospective inconsistencies using modified inputs (Appendix A: Figures 3.2.2.9.4-3.2.2.9.5; Pages 115-116).

Conceptually, there are at least three main areas of uncertainty. First, there is uncertainty in the mortality effects that the PaV1 lobster virus might be having on juvenile lobster recruitment. This mortality occurs between the time the post-larvae recruitment index is obtained (at settlement) and the time the lobsters recruit to the fishery and may explain why the post-larvae recruitment index does not appear to be well estimated by the model. Alternatively, the lack-of-fit could be due to the limited geographic range of the larval samples. Indeed all the indices were very spatially limited. To date there is no evidence that the virus has increased in prevalence or virulence since its discovery; thus virus mortality may already be included in the estimated natural mortality rate.

Second, the age-length key used in the assessment is not year-specific and thus tends to preserve the estimated age composition from year to year, potentially invalidating total mortality values as well as masking more dynamic changes that may be occurring in the population.

Third, as the assessment team and AW acknowledged, there is a fundamental problem with determining biological reference points based on spawning biomass when an unknown but large fraction of the recruitment derives from upstream spawning biomasses, also of unknown magnitude. Thus, although a Beverton-Holt stock-recruitment curve is presented in the report it was rejected by the assessment team and AW as being invalid. The Panel heard strong genetic evidence that the southeast US lobster stock is dependent on at least four different external spawning stock sources. It is questionable how preserving the spawning biomass in the southeast US stock would benefit either the local stock or the broader Pan-Caribbean population since the southeast US is at the downstream end of the pertinent oceanographic regime responsible for larval distribution. It is conceivable that conservation of spawning biomass in the southeast US could provide recruitment to other possible downstream areas such as North Carolina and Bermuda, but, current genetic data is not robust enough to provide any such evidence (Tringali, personal communications).

The RW noted that, although theoretically possible, computing a value of F20% as a proxy for F_{MSY} using existing models would be impractical given the strong retrospective patterns.

The RW discussed using results from the Integrated Catch-at-Age model from the range of years for which the model had converged as an attempt at estimating biological reference points. This would assume that the converged portion is, in fact, giving correct answers (thus, it assumes for example that errors in catch-at-age and natural mortality may be minimal). Also, very little contrast occurred in the estimated biomass and recruitment (age-1 lobsters) over most of the years so that the stock-recruit relationship was not well determined. Therefore, it was not clear to the Panel how useful these results would be. This approach could be investigated with respect to uncertainty in the stock-recruit relationship. But, more fundamentally, since recruitment to the southeast US lobster stock appears to be largely derived from stocks outside of US waters, a stock-recruitment relationship based solely on southeast US data is meaningless. Thus, while the RW discussed the logic to constraining fishing mortality to achieve some larger (Pan-Caribbean) management objective or to achieve yield-per-recruit goals, it is not clear that a minimum spawning biomass in the southeast US can be specified in a meaningful manner.

Landings and fishing effort seem to be highly correlated and thus, the decline in landings during the last ten fishing seasons appears to be the result of a similar decline in overall fishing effort (see Tables 2.1.1 and 2.1.2; Appendix A).

The SSC should consider the spiny lobster fishery a "special case" given the Caribbean wide distribution of the stock and the extent of externally derived recruitment. Therefore, OFL is unknown or undetermined at this time.

Research Recommendations

The Update Review Panel endorses and recommends the following fourteen research recommendations, some of which were proposed by the Update Assessment Workshop.

1. Conduct fishery-independent surveys for juvenile lobsters in lobster nursery areas (e.g., Gulf of Mexico side of Florida Keys such as Great White Heron National Wildlife Refuge). This would lead to more accurate estimates of age-1 lobsters instead of applying the post-larvae index in assessment models.

2. Evaluate the methods used to estimate the number of "shorts' and legal lobsters used as attractants and their mortality in trap fisheries.

3. Integrate additional long-term post-larvae collector data from "second site" and only use data for first quarter of lunar phase (i.e., Day 7 of each lunar phase). The update included this item as a sensitivity run.

4. Conduct statistical research regarding the generation of the catch-at-age matrices used as input to the catch-at-age stock assessment algorithm. Specifically, several growth equations available for this purpose should be statistically assessed on the basis of their biological growth attributes and on how they might portray different mortality frames. In addition, an overall evaluation of the age-length key, including consideration of inverse age-length keys needs to be conducted.

5. Continue to evaluate the utility of developing either local or Pan-Caribbean spawner-recruit relationships where applicable.

6. Attempt to estimate natural mortality from tagging studies.

7. Evaluate all available maturity data to estimate size and age of maturity for both female and male lobsters, including maturity estimates for combined sexes.

8. Evaluate the utility of a commercial fishery-dependent index derived from the Florida trip ticket system and diver surveys to develop an index derived from the fullest extent of the fishery possible. The use of a trap based index is needed since traps provide more than 80% of the landings. Fishing trips alone are not the best measure of fishing effort because it does not account for more specific measures of effort such as the number of traps worked.

11. Evaluate the selectivity curve further, including what may be causing the observed dome-shaped pattern in fully recruited ages.

12. Conduct a full benchmark assessment at the appropriate geographic and biological scale for the southeastern US-Caribbean spiny lobster population.

13. Continue the oceanographic and genetic studies to identify the origin of spiny lobster recruitment to the southeast United States with one of the goals to develop an estimate of the proportion of recruitment that could derive from the local stock/fishery.

14. Evaluate the impact of recreational harvest, especially the 2-day mini-season, on lobster growth and discard mortality rates.

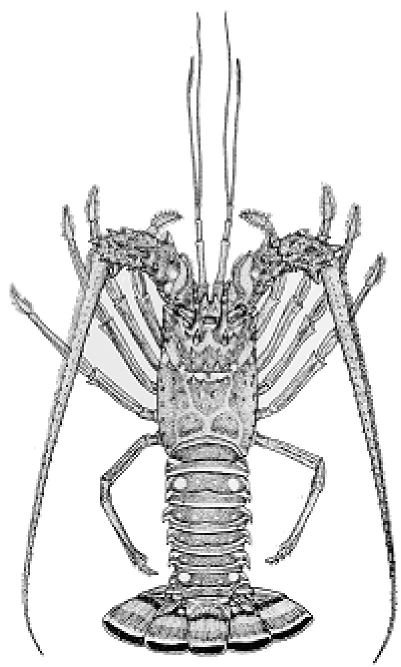
References

Hunt, J. H., W. Sharp, M. D. Tringali, R. D. Bertelsen, and S. Schmitt. 2009. Using microsatellite DNA analysis to identify sources of recruitment for Florida's spiny lobster (*Panulirus argus*) stock. Final Report to the NOAA Fisheries Service Marine Fisheries Initiative (MARFIN) Program, Grant no. NA05NMF4331076 from the Florida Fish & Wildlife Conservation Commission, Fish & Wildlife Research Institute, FWC/FWRI File Code: F2539-05-08-F. 52 p.

APPENDIX A

Stock assessment of spiny lobster, *Panulirus argus*, in the Southeast United States

SEDAR 8 Update Assessment Workshop Report



Prepared by

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2010

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1. Introduction

The condition of spiny lobsters in the Southeast US was previously assessed during SEDAR08 in 2005. Spiny lobsters are fished throughout the Caribbean and Mexico as well as in the southeastern United States (SE US). According to the FAO Fisheries and Aquaculture Statistics and Information Service (2010), the combined western Atlantic landings of the species were 62 million lb in 2008 (the most recent year available, Fig. 1). The US landings of spiny lobster comprised 5.6% of the regional landings. The 2005 assessment found that the spiny lobster fishery was not overfishing in the 2003-04 fishing year but was unable to evaluate the condition of the spawning stock of spiny lobsters without an international Caribbean-wide assessment, because of the potential influx of settling post-larvae from Caribbean and Mexican waters.

The key biological management measures in the SE US are a minimum size (3 inches or 76.2 mm carapace length), a closed season (April 1 – August 5) during most of the reproductive season, a prohibition on the taking of egg-bearing females, and various measures designed to reduce discard mortality (use of live wells on vessels transporting sub-legal lobsters; prohibition of spearing, etc). Commercial traps have to be removed from the water by April 5. The commercial fishery is also regulated through an effort management program designed to reduce the total number of traps used in the fishery to a total of 400,000 traps. Trap numbers have declined from more than 900,000 in 1991-92, just prior to the implementation of this program, to 481,000 in 2009-10. However, the commercial dive fishery expanded until a commercial dive license was required in 2003 and commercial dive vessels were subject to a 250 lobster limit. In addition, a moratorium on new commercial dive licenses was implemented from January 1 2005 until July 1 2010 which was extended in 2010 to July 1 2015. The recreational fishery has a special 2-day sport season that occurs on the last full weekend prior to August 1 each year and a regular season that occurs from August 6 through March 31. Recreational fishers have a 6-lobster daily bag limit in Monroe County (Florida Keys) and Biscayne National Park and a 12 lobster daily bag limit elsewhere in Florida.

The purpose of this assessment update is to determine the condition of the spiny lobster in the SE US using the landings, indices of abundance, and relevant biological information available up through the 2009-10 fishing year.

1.1 Workshop Time and Place

The SEDAR 8 Spiny lobster update stock assessment was conducted via a series of webinars between March and August 2010 and an in-person workshop held in Key West, Florida at the Key West Marriott Hotel from September 28-30, 2010.

1.2 Terms of Reference

1. Update the SEDAR 8 assessment of Southeastern US spiny lobster with

data through 2009-2010. Prepare a continuity scenario and consider

additional sensitivity runs to address assessment concerns raised since the benchmark.

2. Evaluate any relevant data and parameters to be included into the stock assessment model. This evaluation should be conducted with all relevant scientific input. Include life history, indices of abundance, and fishery data.

3. Evaluate the relative reliability of fishery dependent and independent data sources and adjust model input appropriately.

4. Update the approved SEDAR 8 Southeastern spiny lobster model base configuration with data through 2008-09 [the update assessment includes data through 2009-10]. Employ the SEDAR 8 SAR 3 statistical catch-at-age model (Integrated Catch-at-Age) as the base and the DeLury model as a check for consistency. The DeLury model used numbers of lobster and effort by fishing year extended back to the 1978-79 fishing year. Both models used fishery-dependent (observer and Biscayne National Park creel survey) and fishery-independent (puerulus and adult monitoring) tuning indices. 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. Document any changes in assessment methodology incorporated in the update.

5. Document any changes or corrections made to input datasets, all additional data added for the update, and any modifications applied to the additional data. Tabulate complete updated input datasets. Provide tables of commercial and recreational landings and discards in the units used in SEDAR 8, SAR 3. Specify units of measurement in all tables.

6. Estimate and provide complete updated tables of stock parameters.

7. Update measures of uncertainty and provide representative measures of precision for stock parameter estimates. If time, resources, and available information permit, conduct a P* analysis as needed to determine ABC.

8. Update estimates of stock status and SFA parameters; provide declarations of stock status relative to current SFA criteria. Provide clear statements of stock status relative to 'overfishing' and 'overfished'. If a status of 'overfished' or 'overfishing' is determined, run the standard range of projections.

9. Specify OFL, and may recommend a range of ABC for review by the SSC in compliance with ACL guidelines.

10. Evaluate and project future conditions for eleven years (2009-10

through 2019-20 inclusive) beyond the terminal year of the update (2008-2009). Run at least these three projection scenarios:

$$F = F_{current},\ F = F_{msy},\ \text{and}\ F = F_{oy}$$

11. Review the research recommendations from SEDAR 8 SAR 3 (2005), note any which have been completed, and make any necessary additions or clarifications. Focus on those items which will improve future assessment efforts. Provide details regarding sampling design, sampling strata and sampling intensity under current exploitation allowances that will facilitate collection of data that will resolve identified deficiencies and impediments in the 2005 assessment. Recommend sampling intensity in terms of the number of sampling events and appropriate elements in order to complete the ACCSP sampling design matrix.

12. Develop an update stock assessment workshop report in SEDAR outline to fully document the input data, methods, and results of the stock assessment update. Address these Terms of Reference. Submit the report to SEDAR no later than October 1, 2010. The report shall be provided to the GMFMC and the SAFMC no later than October 18, 2010.

1.3 List of Participants

See Appendix A for names and affiliation information

2. Data Issues and Deviations from Data Workshop Recommendations

Since there was not another Data Workshop associated with this update and the areas that were discussed in Section2 of the SEDAR08 Assessment Report are still relevant, i.e., the development of the catch–at-length (CAL) and catch-at-age (CAA) information, this section will present updated landings, age-length keys, CAL, CAA, and indices.

2.1 Landings

As noted in SEDAR08, both commercial and recreational gears are used to harvest and land spiny lobster in the SE US. Commercial landings were aggregated into three gear categories: traps, diving, and other (Table 2.1.1, Fig. 2.1.1). The other category includes spiny lobsters that were reported as coming from bully nets, shrimp trawls, and other gears reported on trip tickets. The recreational landings came from mail surveys to divers with lobster permits on their Saltwater Fishing licenses (Table 2.1.2, Fig. 2.1.2). In 1994, the Marine Fisheries Commission instituted a Special Recreational License that allowed those license holders to exceed the six-lobster bag limit and those landings are also included in the recreational landings in Table 2.1.2. The 1999-00 had the highest combined landings of commercial and recreational at 10.5 million lb and 2005-06 had the lowest at

4.2 million lb (Table 2.1.3). It should be noted that the Florida Keys were disrupted by two hurricanes in 2005: Katrina in August and Wilma in October.

2.2 Catch-at-length

The catches-at-length were developed by calculating raising factors (Gulland 1969) with landings and length frequencies from the NMFS's Trip Interview Program, Biscayne National Park's creel survey, FWC's observer program, and FWC's recreational creel survey. There were a total of 243,277 carapace measurements for spiny lobsters. The length frequencies were matched with landings by gear, region, fishing year, and season (Jul-Oct, Nov-Jan, and Feb-Mar; Table 2.2.1). For the purposes of matching lengths to landings, there were six geographic regions: Northeast (North Carolina to St. Lucie County Florida), Southeast (Martin-Dade Counties), the Upper Keys (Dade-Monroe County line to Marathon Key), Lower Keys (Marathon to Marquesas), Tortugas (West of the Marquesas), West Coast (Collier County to Texas) (Fig. 2.2.1). In the regional summaries, we combined the three Florida Keys' regions. More than 92% of the landings had direct matches by stratum with lengths. Most of those landings strata without matching lengths were from either regions other than the Florida Keys or from gears other than traps. We used the same strategy for estimating the lengths for those landings strata without these data that we used in SEDAR08; substituting lengths from other seasons and, for those landings still without matches, combining lengths across fishing years.

2.3 Catch-at-age

A challenge with assigning ages to spiny lobsters is that lobsters lack structures that record age in a manner similar to otoliths in bony fishes. The age-length keys for spiny lobsters from tagging that were presented at the SEDAR08 Data Workshop also were used in the update assessment. The keys were constructed from the original tagging growth trajectories. The age-length keys developed from the lipofuscin data and applied to lobsters collected from the fishery and from the Dry Tortugas were revised because of refinements in the lipofuscin analyses (Maxwell et al. 2007). Briefly, the age-length keys were developed from 1000 trajectories of growth for 15 years by month. We used Fogarty and Idoine's (1992) method to create a trajectory of growth for a spiny lobster that started at one year after settlement at a size of 46 mm carapace length (CL, SD = 5.0) and molted with a probability based on current size, sex, and season (summer or winter); if the lobster molted, then the growth increment was determined based on the same variables. The size at one year after settlement came from coded-wire tagging of post-larvae. The process was repeated each month until the lobster completed 180 months of growth. These growth trajectories were estimated for 1000 male spiny lobsters and 1000 female spiny lobsters. However, before one can assign ages based on these outcomes, mortality has to be included because for the same sized lobster there will be more two-year old lobsters than three year old lobsters. For the SEDAR08 assessment, we used trial total instantaneous mortality values of 0.34, 0.70, 1.00, and 1.30 per year to generate age-length keys that were applied to the catches-at-age and found the best fit to the assessment model, ICA, was with a total mortality rate of 1.0 per year. We used that rate in developing the tagging growth age-length keys and for the updated lipofuscin age-length keys from the fishery. The update AW decided that it would be inappropriate to use the lipofuscin ages from the Dry Tortugas to age the lobsters caught in the fishery because that fast growth pattern reflected more the potential growth rate of lobsters and not the rate that lobsters in the main part of the fishery experienced, where injuries and high mortality occurred.

Ages were assigned to catches-at-length by gear and sex using age-length keys (Table 2.3.1) and then combined into a single catch-at-age because the assessment program specified in Term of Reference (TOR) #4, Integrated Catch-at-Age (ICA), can only accommodate a single catch-at-age table (Table 2.3.2)..

The AW discussed whether to use the age data from the fishery derived from lipofuscin information as the base case but the decision of the group was to stay with the tag-based aging because, while the lipofuscin aging has potential, the fishery samples were only collected in one fishing season (2001-02) and the known-age lobsters from the laboratory did not include animals older than four years. The group included a sensitivity run using the lipofuscin aging method. Another aging method based on tagging was described by Ehrhardt (2008); this method used Munro's inter-molt period approach instead of the probability of molting in a given time interval and his method produced age estimates that were similar to the lipofuscin values. However, due to Dr. Ehrhardt's field work in Central America during the summer of 2010, he was unable to provide the necessary parameters and their precision for us to develop age-length keys. His method should be considered in future assessments.

Other data issues stemmed from discussions during the Stock Assessment webinars. For example, concern was expressed about the validity of the Biscayne National Park creel survey index because the increase in the catch rate coincided with the change in the allowable bag limit from 6 lobsters per person per day to 12 lobsters per person per day. The AW decided to calculate the fishing power under the different bag limits and standardize the catches to the catch rate when there was no bag limit (prior to July 1987). As was recommended at the 2004 AW, the post-larval index only used collectors from the Big Munson site and the response variable was the number of post-larvae per collector. Soak time was grouped into four categories: 1-7 days, 8-14 days, 15-28 days, and more than 28 days and used as a potential explanatory variable. Again, the two pre-recruitment indices included spiny lobsters down to 47 mm carapace length, CL (Table 2.3.3) because, when multiple molts were considered, these lobsters could molt into the fishery during the year. The procedure for estimating the sizes of spiny lobsters that could molt into the legal size class during a year was presented in the SEDAR08 Assessment Report. This procedure essentially used the probability of molting by carapace length and the cumulative probability of the growth increment and the growth was projected for each month. To corroborate this modeling exercise, we extracted all lobsters less than legal size from the tagging data that were free more than 180 days and were recaptured at a size larger than at tagging. Twenty-two of the 28 sub-legal lobsters were recaptured at legal sizes. The smallest lobster was tagged at 46 mm CL and recaptured at 76 mm CL, 288 days later, and there were two 51 mm CL lobsters, one was recaptured after 288 days with a carapace length of 79 mm CL and other lobster was 94 mm CL after 318 days. The values of the tuning indices that were used in subsequent analyses are shown in Table 2.3.4 and Figure 2.3.4. The associated coefficients of variation and number of observations are in Table 2.3.5.

3. Stock Assessment Models and Results

In the SEDAR08 assessment, a variety of models were presented and for the update two models were chosen (TOR #4): the modified DeLury model (Rosenburg et al 1990) and Integrated Catch-at-Age (Patterson 1998). The first model uses catch in numbers by sector, effort, indices, and natural mortality to estimate population sizes, recruitment, and fishing mortality rates while the second model uses the catch-at-age, indices, and natural mortality to estimate the population sizes at age, selectivity by age, fishing mortality rates by age, and spawning biomass.

3.1 Modified DeLury model.

3.1.1 Modified DeLury methods.

3.1.1.1 Overview

The Modified DeLury model (Rosenberg *et al*. 1990, Basson et al. 1996) is similar to a surplus production model except that the units are in numbers of lobsters instead of biomass and the population only increases by recruitment and is decremented by total mortality. The Modified DeLury was promoted at the FAO Caribbean spiny lobster workshops in 1997 and 1998 in the Western Atlantic (Restrepo 2001) and recently has been used for spiny lobster in Mexico (Sosa-Cordero, 2003), Cuba (González-Yáñez et al. 2006), and for Florida pompano (Muller et al. 2002). The model estimated population sizes and fishing mortality rates of the recreational and commercial sectors and for the bait used in traps by fishing year.

3.1.1.2 Data Sources

We used commercial and recreational landings and effort. However because the DeLury model uses the landings expressed in numbers of fish, we had to convert the commercial landings in biomass to numbers using the catches-at-length by fishing year and gear. The recreational landings in number were extended back to the 1978-79 fishing year using the August commercial landings.

The numbers of lobsters that were used as attractants were summarized in the Data Workshop Table 3.1.2 (1). The attractant usage in numbers was estimated in two steps. First we estimated the monthly number of trap hauls by combining monthly trap landings, and the monthly landings per trap from those trip tickets that included the number of traps back to July 1985. We then applied the average number of sub-legal sized lobsters and legal-sized lobsters used as attractants per trap hauled from the 1993-2001 observer data by month to the corresponding estimated monthly trap hauls. We used the average soak time by month from trip tickets and an attractant mortality rate of 26% per four weeks of confinement in traps (Hunt et al. 1986) for months prior to July 1987 when the live-well requirement was implemented and 10% per four weeks afterwards Matthews (2001). Since almost all of the commercial landings prior to the 1985-86 came from traps, we extended these estimates back to 1978-79 by regressing monthly trap hauls on landings which allowed us to calculate the trap hauls by month for the earlier period and to which we applied the same monthly average number of sub-legal and legal sized lobster per trap haul and the 26% mortality rate. This method of attractant estimation is biased high because it assumes that each short or legal lobster used as an attractants put into a traps was unique when fishers used the attractants from before if the shorts were still lively. The landings and effort data are shown in Table 3.1.1.2.

The goal of the extrapolations is to provide a historical perspective for the estimates of the later years when there are data, and to account for levels of removals from the population that otherwise would not have been included in the assessment. The extrapolated values were not included in fitting the model.

Data Workshop (DW) members identified six tuning indices for stock assessment: the number of legal-sized (CL > 76.2 mm) lobsters per trap from FWC's Observer program, the number of pre-recruit sized (47-75 mm CL) lobsters from the Observer program, the number of legal-sized (CL > 76.2 mm) lobsters per trap from FWC's Adult Monitoring program (timed surveys), the number of pre-recruit sized (47-75 mm CL) lobsters from FWC's Adult Monitoring program (timed surveys), the number of lobsters per recreational trip in Biscayne National Park, and the number of post-larvae per collector. The FWC Adult Monitoring program changed sampling protocols from timed underwater surveys (1997-2006) to transect surveys (2004 and later) and the update AW recommended including the transect indices as potential tuning indices. As noted above, the Biscayne National Park index was modified to account for the different bag limits in effect explicitly by year. The specifications of the eight final tuning indices are shown in Tables 2.3.4 and 2.3.5.

The DW and update AW concluded that the natural mortality rate for spiny lobster in southeastern U.S. should be between 0.3 and 0.4 per year. For consistency with SEDAR08 and previous assessments (Muller et al 1997), we used 0.34 per year for natural mortality.

3.1.1.3 Model Configuration and Equations

In the DeLury model, the number of fish at time *t+1* (N_{t+1}) is:

$$N_{t+1} = N_t \exp(-Z_t) + R_t \qquad (1)$$

where Z_t is the total instantaneous mortality rate during time *t* ($Z_t = F_t + M_t$) and R_t is the recruitment at the beginning of time *t*. Many spiny lobsters molt into legal sizes during the closed season. Thus, recruitment is considered to occur at the beginning of the fishing year, i.e. July. The predicted catch for a given sector is:

$$C_{s,t} = q_s E_{s,t} \overline{N_t} \qquad (2)$$

where $C_{s,t}$ is the catch during time, *t,* from sector *s; q_s* is the catchability coefficient that relates the mortality expended by one unit of effort in sector *s*; $E_{s,t}$ is the effort expended by sector, *s*, during time, *t;* and $\overline{N_t}$ is the average number of lobsters in the population during time, *t,* and the equation for $\overline{N_t}$ is :

$$\overline{N_t} = \frac{N_t}{Z_t}(1-\exp(-Z_t)) . \qquad (3)$$

To prevent the model from attempting to use negative recruitment values, the model solves for relative recruitment anomalies (Ra_t) in log space that are scaled by the recruitment in the first fishing year (R_1). The equation is:

$$R_t = R_1 \exp(Ra_t - 1) \qquad (4)$$

and R_1 is approximated by the number of lobsters dying during the first fishing year ($N_1(1\text{-}\exp(-Z_1))$).

Predicted index values, $\hat{I}$, for the legal-sized population were fit to either the beginning population size or the average population size during a fishing year depending upon whether the survey was only conducted in July and/or August or throughout the year:

$$\hat{I}_{j,t} = q_j \overline{N}_t \qquad (5)$$

where *j* refers to the index. These indices of legal-sized lobsters were from 1993-04 to 2000-01, the FWC adult monitoring number of lobsters per dive from 1997 to 2006 with timed surveys, the FWC adult monitoring number of lobsters per dive from 2004 through 2009 with transect surveys, and the number of lobsters per trip from Biscayne National Park's creel survey (1978 – 2009). The observer catch per trap was fit to the average population size (Eq. 5) because the observer program operated throughout the fishing year while the other surveys for legal-sized lobsters operated in July and/or August (Eq. 6).

$$\hat{I}_{j,t} = q_j N_t . \qquad (6)$$

We potentially used four indices to tune recruitment: the post-larvae index offset two years, the pre-recruit index from the observer program, and the pre-recruit indices from FWC's adult monitoring surveys. The predicted recruitment index values were calculated from:

$$\hat{I}_{j,t} = q_j R_t \qquad (7)$$

where *j* refers to the index and *t* refers to the fishing year.

The objective function was the sum of the lognormal likelihood terms for the landings by sector, the tuning indices, and the recruitment anomalies (Hilborn and Mangel 1997, Walters and Martell 2004). We used the full log-likelihood (*LL*) for each component:

$$LL_j = n(\ln(\sigma) + \frac{1}{2}\ln(2\Pi)) + \frac{1}{2\sigma^2}\sum_{i=1}^{n}(\ln(I_{j,i}) - \ln(\hat{I}_{j,i}))^2 \qquad (8)$$

where σ^2 is the variance of the log transformed values of the index or landings by fishery sector and these values were input to the model, *n* is the number of observations, $I_{j,i}$, is either the sector landings or index, *j*, and *i* refers to the fishing year. However since the $\frac{1}{2}\ln(2\Pi)$ term in Eq. 8 is constant for each component, this term was omitted in the minimization. In the case of the recruitment anomalies, σ^2 was set to 0.5 and the sum of squares for relative recruitment anomaly, SS_r, portion of equation (8) was

$$SS_r = \frac{\sum_{i=1}^{32}(Ra_i - 1)^2}{2\sigma^2} . \qquad (9)$$

3.1.1.4 Parameters Estimated

The DeLury model was developed and run using AD Model Builder (ADMB) software (ADMB Project, 2010). This software is a tool for developing and implementing nonlinear statistical models. The model parameters were the initial number of lobsters in the population, N_1, the catchability coefficients by sector or tuning index, and the annual recruitment deviations applied to the recruitment in the first year. Therefore, in this configuration, the model solves for a potential total of 44 parameters: N_1 (1 parameter); the fishery catchability coefficients for recreational (1), commercial (1), and attractant usage (1); coefficients for each of the eight tuning indices (8 parameters); and the recruitment anomalies by fishing year (32 parameters).

3.1.1.5 Uncertainty and Measures of Precision

We evaluated uncertainty with the modified DeLury model with: (1) likelihood profiles for the initial population size, the fishing mortality rate by sector in the final year, and the population size in the final year; and (2) re-running the model with alternative natural mortality rates of 0.25 and 0.43 per year as recommended by the AW. To simplify the results, we plotted relative likelihoods (along with relative normal approximations) which were the likelihood (or normal approximations) values divided by the maximum likelihood (normal) value We also reran the model using terminal fishing years back to 2003-04 to investigate any retrospective bias as a source of uncertainty that is not captured by the precision estimates.

3.1.2 Modified DeLury Results

3.1.2.1. Measures of Overall Model Fit

The fit of the DeLury model to the data was evaluated through the visual inspection of agreement between the observed and predicted values (Fig. 3.1.2.1) and by calculating the components of the objective function, along with the associated statistics (i.e., sum of squares, SS, mean sum of squares, MS = SS / number of degrees of freedoms; Table 3.1.2.1). These calculations were based on the log-transformed observed and predicted harvests and indices. Note that all components had the same weight (i.e., lambda = 1).

Visual inspections of the plots coupled with the magnitude of the MS values indicate that, of the components included in the objective function, the index for legal-sized lobsters generated from the FWC adult monitoring program with transect design, and indices for sub-legal lobsters developed from the FWC Adult Monitoring program with both timed and transect designs were generally poorly fitted. Note that the components which contributed most to the total likelihood (i.e., 96.3%) were the commercial (55%) and recreational (28.5%) sectors, the Biscayne National Park index component (8.9%), and the post-larval settlement index component (3.8%).

3.1.2.2. Parameter estimates

In the base run of the DeLury model (M = 0.34 $year^{-1}$), the initial population size (1978-79) was 11.5 million lobsters and the number at the beginning of the 2009-10 fishing year was estimated at 9.7 million lobsters with a biomass of 10.7 million lb.

3.1.2.3. Stock Abundance and Recruitment

The number of spiny lobsters and the recruitment at the beginning of each fishing year are shown in Table 3.1.2.3 and Fig. 3.1.2.3. The number of lobsters peaked in 1979-80, 88-90, and in the late 1990s. The marked decline in 1998-99 fishing year was consistent with low catch rates in August 1998 but was confounded by the scattering of traps and disruption of the fishery by Hurricane Georges in September 1998. The number of lobsters declined after the 1999-00 fishing year but remained generally stable at the levels similar to the earlier decline following the 1979-80 fishing year. In the 2000-01 fishing year, however, an unknown, regional environmental perturbation, possibly the juvenile lobster virus (Behringer and Butler IV, 2009), may have been responsible of the decline in the regional stock size that resulted in low landings throughout the region (Fig. 1). In the 2005-06 fishing year, the population size also declined but Hurricanes Katrina and Wilma produced the confounding effects similar to those observed in the 1998-99 fishing year. Recruitment did not help us answer this question because recruits comprise a large portion of the lobsters available to the fishery and so the pattern of recruitment mirrored that of abundance.

3.1.2.4. Stock Biomass (total and spawning stock)

The DeLury model does not distinguish between spawning lobsters and non-spawning. Biomass was estimated as the number of lobsters at the beginning of the fishing year times the average weight in that fishing year and so showed a pattern (Fig. 3.1.2.4) similar to the plot for numbers (Fig. 3.1.2.3.

3.1.2.5. Fishery Selectivity

Selectivity is not applicable in the DeLury model because the model is not age-structured and only estimates a single population value per year.

3.1.2.6. Fishing Mortality

Fishing mortality rates across gears have been variable over this period (Table 3.1.2.6, Fig. 3.1.2.6). After 1986-87, fishing mortality rates increased to a peak in the 1991-92 fishing year, the impacts of Hurricane Andrew on infrastructure in August 1992 lowered fishing mortality that year and then the Trap Reduction Program was implemented in July 1993 such that fishing mortality rates were generally declining after the 1991-92 fishing year. Initial catch rates in the 1998-99 were sluggish as evidenced by the drop in recreational fishing mortality rates and then Hurricane Georges in September 1998 disrupted the fishery by scattering traps. The fishing mortality rate in 2009-10 fishing year was 0.72 per year (recreational F was 0.21 per year, the commercial F was 0.46 per year and the bait mortality was 0.04 per year).

3.1.2.7. Stock-Recruitment Parameters

The scatter in the Stock-Recruit plot precludes identifying a unique curve (Fig. 3.1.2.7.1). The poor relationship between biomass and the resulting recruitment in Caribbean spiny lobster was expected because spiny lobsters have an extensive (six to nine months or longer) planktonic phase prior to settlement. Lyons et al. (1981) argued that the low variability in recruitment in Florida suggested that recruitment here was supplemented from sources outside of Florida. Spiny lobsters occur in many areas of the Caribbean and currents flow from the Caribbean Sea through the Yucatan Straits and form either the Loop Current going into the Gulf of Mexico or the Florida Current (Fig.3.1.2.7.2). The Loop current eventually recombines with the Florida Current to form the Gulf Stream. Morrison and Smith (1990) monitoring current flow in the Caribbean Sea observed a transport maximum in the eastern Caribbean (Aves Ridge) and detected a transport maximum in the Florida Straits approximately 90-100 days later. Florida's downstream location means that Florida could receive recruits from the Caribbean, Mexico, Cuba, or local sub-stock. Yeung and McGowan (1991) sampled lobster larvae off southern Florida and found that *Panulirus* was found further offshore in the Florida Current and concluded that the later stages of phyllosomes most likely came from foreign upstream sources. Silberman et al. (1994) collected a total of 259 lobsters from nine areas extending from Antigua and Martinique in the eastern Caribbean to Florida and Bermuda. They used mtDNA to examine genetic diversity and found 187 unique haplotypes and of those haplotypes, 168 were unique to single lobsters. They concluded that *P. argus* is a single genetic stock shared by many countries. Using micro satellite DNA on samples from Brazil to Bermuda and thought the Caribbean, a similar conclusion was reached by Hunt et al. (2009) who showed that (1) cohorts of spiny lobster that recruit in Florida Keys are admixtures of migrants from at least four different genetic sources; and (2) adult lobsters exhibit wide range with little evidence of isolation-by-distance over the range; this is due to very high gene flow/dispersal distances and, therefore, high connectivity. Sarver et al. (2000) found two specimens of the Brazilian sub-species of spiny lobster off Miami, Florida. Ehrhardt and Fitchett (2010) argue that recruitment in the SE US come from local production but that is based on their post-larval index which was the number of post-larvae per 29 day soak time and the researchers who collect the post-larval data recommend not standardizing the catch rates by soak time. . Therefore, we think that self-recruitment is indeterminate.

3.1.2.8. Measures of Parameter Uncertainty

As mentioned in Section 3.1.1.5, uncertainty was examined by developing likelihood profiles of the initial number, the fishing mortality rate by sector in 2009-10 and the stock size in 2009-10. All these likelihood profiles were dome-shaped (Fig. 3.1.2.8). The likelihood profile for the initial number of spiny lobsters in July 1978 indicated that there was very low likelihood that the number of lobsters was less than 4.2 million; however, while the maximum likelihood was at about 11.5 million, the likelihood declined slowly at higher initial numbers, just slightly at above 40 millions lobsters. The likelihood profile for the fishing mortality rate in 2009-10 had defined peaks at 0.21 per year for the recreational fishery, 0.46 for the commercial fishery, and 0.04 for the commercial bait fishery, which corresponded to the point estimates. There were low likelihoods that these fishing mortalities be less than 0.02, 0.04, and 0.004, respectively. After they peaked, the fishing mortality by sector declined with very low likelihoods that they could reach as high values as 2.23 for the recreational fishery, 4.79 for the commercial fishery, and 0.41 for the lobsters used as attractants. Concerning the likelihood values for the stock size in 2009-10, they peaked at 8.83 million lobsters, with low likelihoods to be less than 54 thousands and more than 25.8 millions. Note that the likelihood profiles are superimposed with the normal approximations and both statistics generally indicated similar distributions of the aforementioned parameters.

3.1.2.9. Retrospective and Sensitivity Analyses

Retrospective analyses of population numbers, recruitment, and fishing mortality rates were conducted by running the DeLury model with terminal fishing years of 2003-04 through 2009-10 (Fig. 3.1.2.9.1 and Fig. 3.1.2.9.2). The FWC Adult Monitoring Transect Survey index was omitted from the retrospective runs because it began in 2004 and we wanted to have the runs as comparable as possible. When necessary, we truncated the indices based on the terminal fishing year. We compared the results beginning with 2003-04 with those of 2009-10 using the average percent difference between the runs. The average populations estimated in 2009-10 were, on average, 17.8% higher when they were the terminal year and conversely for the recruitment estimates in 2009-10, which were on average 29% lower. At the same time, the 2009-10 recreational, commercial, attractant, and total fishing mortality rates were on average 30%, 19%, 24%, and 22 % lower when they were in the terminal year. Two-tailed, paired-t tests showed that these differences were significantly different from zero (P-value < 0.05), except for the recruitment (P-value $= 0.086$). This is indicative of a retrospective issue such that the estimated fishing mortality will be too high in the last year. Finally, note that the population was particularly high throughout the study timeframe when the terminal years were 2006-07 and 2009-10.

The SAW members recommended running the model with two alternate natural mortality rates, 0.25 per year and 0.43 per year as sensitivity runs. As expected, the population and recruitment estimates were higher as the natural mortality rate was increased and the fishing mortality rates were lower. The total mortality (Z) values for any fishing year were different. Differences ranged between 0.15 and 0.95 per year against an overall average magnitude of 1.64 per fishing year (Fig. 3.1.2.9.3 and Fig. 3.1.2.9.4; Table 3.1.2.3).

3.2 Age-structured models

Growth in spiny lobsters was estimated from two sources: tag returns and rate of accumulation of eye stalk lipofuscin. The lipofuscin technique has potential to provide ages but in this case the aging was based on 51 laboratory-raised spiny lobsters that spanned only four years. In addition to increase its utility, we need to identify the sources of variability in lipofuscin concentrations with the sex and habitat of spiny lobsters. For example, female lobsters had lower lipofuscin concentrations than did males of the same age and animals from the Dry Tortugas had lower concentrations than did lobsters from the Florida Keys. We ran the age-structured models with catches-at-age developed using both sources but chose to use the ages based on tagging for the base run.

3.2.1. Integrated Catch-at-Age

3.2.1.1. Integrated Catch-at-Age Overview

Integrated Catch-at-Age (ICA) is a statistical catch-at-age (CAA) model that solves for the numbers at age in the most recent year, in this case the 2009-10 fishing year, the numbers in the oldest age before the plus group, the age-specific selectivities, and the catchability coefficients for the tuning indices. The program has been evaluated and meets the International Council for the Exploration of the Sea (ICES) Quality Control specifications and is available from ICES. The two things that make this model different from other statistical catch-at-age models are: 1) the model runs backward from the oldest ages in the most recent years instead of solving for recruitment directly and 2) the model allows for the selectivities to be applied only to a portion of the catch history. As a result ICA is a hybrid between statistical catch-at-age models and tuned virtual population assessment (VPA) models such as ADAPT. However, like the traditional VPA approaches, ICA uses a combined CAA, i.e., a CAA aggregated across all sexes and all available fisheries. ICA model assumes separability of the fishing mortality at age between an annual effect (fully selected fishing mortality) and an age effect (selectivity schedule) over the most recent fifteen years (an ICA limit), in this case across the 1995-06 and 2009-10 fishing years. The model solves for the numbers and fishing mortality rates for the earlier fishing years in a manner similar to ADAPT using the information from the 1994-95 fishing year as the starting point for those earlier years.

3.2.1.2. Data Sources

As noted in the SEDAR08 Data Workshop section on age and growth (pages 7-24), growth was estimated from tagging studies and from the relationship of lipofuscin concentrations to known ages of laboratory raised spiny lobsters. ICA used a single, combined gears CAA matrix based on tagging growth model in the base run (Table 3.2.1.2.1), average weights at age and fishing year in the harvest that came from converting the catches-at-length using Matthews et al.'s (2003) length-weight equation (Table 3.2.1.2.2), average weight at age and fishing year in the population that we approximated with the mean size at age from the growth trajectories converted to biomass with the same equation (Table 3.2.1.2.3). All lobsters that were 12 years old and older were combined into a single group (age-12+). Inputs on age-specific life history information are shown in Table 3.2.1.2.4. The program allows for natural mortality rates by age and year although, due to lack of specific information, we used 0.34 per year for all ages and fishing years in the base run. The maturity schedule by age was approximated as 0.0 at age-1, 0.5 at age-2, 0.75 at age-3, and 1.0 for ages 4+ (J. Hunt, personal communication). An alternate maturity schedule was developed for female lobsters spawning in the fishery area (Upper Keys, Middle Keys, Lower Keys, and West of Key West) using biological samples collected by MARFIN program during the months of April-June. This process consisted of two steps. First, females of different CL classes (with 5 mm class intervals) with eggs, spermatophores, or both were considered mature, otherwise immature. The proportions of mature females were then calculated and fitted with a logistic function:

$$M_i = \frac{1}{1+e^{\alpha(l_i - l_{50})}} \quad (1)$$

where M_i is the probability mature for females in CL length class i; l_i is mid length class; and α and l_{50} are parameters. This model led to values of -0.179 and 66.7 mm for α and l_{50}, respectively (Fig. 3.2.1.2.1a). Second, a probabilistic aging method was applied to assign ages after settlement to lobsters based on the carapace lengths and the probabilities of age by length from the tagging growth trajectories (Fig. 3.2.1.2.1b). The estimated maturity schedule by age suggests that its assumed counterpart underestimates the contribution of age-1 to age-3 female lobsters to the overall spawning potential.

The spiny lobster fishery begins in late July with the recreational two-day Sport Season and ends on March 31 of the following year; therefore, all of the fishing occurs before the spawning season (spring and summer with the peak in late May in the Florida Keys (Bertelsen and Matthews 2001)) while only eight months of natural mortality have occurred before the spawning season. In addition to the fishery data, we used the same eight tuning indices that were used in the DeLury model: observer pre-recruit (Age-2) and legal-sized (Age-3 and older) numbers per trap, FWC Adult Monitoring pre-recruit (Age-2) and legal-sized (Age-3 and older) numbers per dive (timed sampling design), the number of post-larvae per collector offset one year and applied to Age-1, and the number of lobsters per trip from Biscayne National Park's creel survey (Age-2 and older). Again, the update AW recommended including the transect indices as potential tuning indices, namely the FWC Adult Monitoring pre-recruit (Age-2) and legal-sized (Age-3 and older) from the transect survey protocol.

3.2.1.3. Model Configuration and Equations

Integrated Catch-at-Age uses a backward projection instead of the more familiar forward projection method; thus, ICA solves for the population numbers in the most recent fishing year (2009-10) and the number of age-11 lobsters which together with the selectivity and annual fishing mortality rates allows the calculation of the numbers of lobsters by age and year and the corresponding predicted catch-at-age.

In a separable model, the fishing mortality on any age and year, $F_{a,y}$, is:

$$F_{a,y} = Sel_a F\_full_y \qquad (1)$$

where Sel_a is the selectivity for a given age, *a*, and $F\ full_y$ is the fishing mortality on fully recruited ages for a given fishing year, *y*. The number of lobsters at age and year, $N_{a,y}$, is solved backward from the most recent year using the fishing mortality by age and year, $F_{a,y}$, and the natural mortality rate, $M_{a,y}$, from

$$N_{a-1,y-1} = N_{a,y} \exp(F_{a-1,y-1} + M_{a-1,y-1}) \qquad (2)$$

and the average population during the fishing year , $\overline{N_{a,y}}$, is given by

$$\overline{N_{a,y}} = \frac{N_{a,y}}{(F_{a,y} + M_{a,y})}(1 - \exp(-F_{a,y} - M_{a,y})) \,. \qquad (3)$$

Therefore, the predicted catch-at-age, $\hat{C}_{a,y}$, is

$$\hat{C}_{a,y} = F_{a,y}\overline{N_{a,y}} \,. \qquad (4)$$

Predicted index values are calculated from the estimated number of lobsters of the appropriate ages and the catchability coefficient, q_j. For an aged index, I_j, the number of lobsters at age is summed across the ages that the index applies to and the catchability, q_j, or

$$\hat{I}_{a,y,j} = q_j \sum_a N_{a,y} \exp(Fraction_j(-F_{a,y} - M_{a,y})) \qquad (5)$$

where $Fraction_j$ accounts when the survey is conducted during the fishing year.

The objective function minimized the differences between the observed and predicted catches-at-age and between the observed and predicted indices. Assuming that the errors in the catch-at-age and in the indices had lognormal distributions, the objective function, *SS*, was

$$SS = \sum_{a}\sum_{y}\lambda_{a,y}\ln(\frac{C_{a,y}}{\hat{C}_{a,y}})^2 + \sum_{a}\sum_{y}\sum_{j}\lambda_j \ln(\frac{I_{a,y,j}}{\hat{I}_{a,y,j}})^2 \qquad (6)$$

where the first term minimizes the differences between the catches at age and year and λ is the age-year weight. The second term in equation (6) minimizes the differences between the indices based on numbers and the appropriate ages and λ_j is the weight given to index, I_j. In the case of spiny lobsters, all of the components were weighted equally at 1.0.

3.2.1.4. Parameters Estimated

Given the inputs, the model solved for 56 parameters including the fishing mortality rates on reference age-3 (the earliest age believed to be fully recruited) for 1995-06 through 2009-10 (15 parameters), the selectivities by age for this same period (9 parameters, the reference age of age-3 was fixed as 1.0 and the selectivity in the last age before the plus group (1.0) was specified during the run), the 2009-10 population size in numbers (11 parameters), the number of lobsters at age-11 for the other fishing years in the constant selectivity period (14 parameters), and the catchability coefficients for each of the tuning indices (7 parameters in the base run).

3.2.1.5. Uncertainty and Measures of Precision

This model initially evaluated uncertainty as follows. First, the model used a Monte Carlo process involving 1000 reruns with random draws for the parameters from the covariance matrix. From the 1000 solutions, we developed box-and-whisker plots of spawning biomass, recruitment and fishing mortality rates by fishing year. Second, the model was rerun with alternative natural mortality rates of 0.25 and 0.43 per year as recommended by the AW. Finally, retrospective analyses were conducted over a range of terminal fishing years (2003-04 to 2009-10) by starting with the final run configuration of ICA and sequentially removing the terminal year's data from the catch-at-age and tuning indices. As with the retrospective analysis for the DeLury model, the FWC Adult Monitoring Transect Survey index was omitted from the retrospective runs

3.2.2. Integrated Catch-at-age Results

3.2.2.1. Measures of Overall Model Fit

The measures of fit for ICA are the fit to the catches-at-age (Fig. 3.2.2.1.1) and the fits to the tuning indices (Fig. 3.2.2.1.2). An analysis of variance table with the sources, sum of the squared residuals, numbers of data points, degrees of freedom, and the mean squares is included as Table 3.2.2.1). Except the component for the legal-sized lobster index developed from the FWC Adult Monitoring program, transect sampling design, the components for other indices were significant; so, only the FWC Adult Monitoring Transect age 3+ index was excluded from the final base model run.

3.2.2.2. Parameter estimates

For each of the 56 parameters that ICA solved for, the program presents the maximum likelihood value, the coefficient of variation, the 95% confidence interval, and the mean estimate. The parameters are listed in Table 3.2.2.2. As expected the CV values are higher in the recent fishing years and in the population estimates.

3.2.2.3. Stock Abundance and Recruitment

The estimated number of lobsters by fishing year varied from 37.7 million in 1985-86 to 25.9 million in 2003-04 and, for 2009-10, the estimate at 53.8 million lobsters was the highest (Fig. 3.2.2.3.a). The estimated numbers of spiny lobsters by fishing year and age are included in Table 3.2.2.3. Recruitment expressed as age-1 lobsters was bimodal during 1985-2003 with an early increase in 1987-88 (19 million) and then a decline and another increase in 1993-94 (14.6 million) through 1998-99 then dropped reaching lows in early 2000s (11-12 million) and then a gradual increase afterward with 28 million in 2009-10 (Fig. 3.2.2.3b).

3.2.2.4. Stock Biomass (total and spawning stock)

Total biomass generally showed trends similar to those of estimated numbers (Fig. 3.2.2.4a). The total biomass ranged from 27.3 million pounds in 1985-86 to 18 million pounds in 2003-04 and was 37 million pounds at the beginning of 2009-10. Spawning biomass generally showed trends similar to those of the total biomass and number of lobsters. Spawning biomass has peaked at 10.4 million pounds in 1988-89, declined thereafter at lowest levels in the early 2000s, and rebounded since then to reach a level of 12.4 million pounds in 2009-10 (Fig. 3.2.2.4b). Note that the small error bars in the years prior to 1995-96 reflect that the covariance matrix was determined only for the fishing years 1995-96 and later and the decreasing variability in the early years illustrates that VPAs converge.

3.2.2.5. Fishery Selectivity

Selectivity in spiny lobsters is dome-shaped with fewer age-1 lobsters available to the fishery, many of which were used as attractants, lobsters became fully available at age-3 and then fewer at older ages (Fig. 3.2.2.5). Note that the selectivity of ages 2 through 5 is above 0.8 and these ages comprise and average of 73% of the total kill (age-1 comprises an average 24% of the total kill). A possible explanation for the decreasing availability of older lobsters could be movement away from the areas where the fishery is concentrated.

3.2.2.6. Fishing Mortality

Fishing mortality rates on age-3 (fully recruited) by fishing year have been variable but without trend prior to 1996-97; they then increased to a peak of 0.8 per year in 2000-01 and declined steadily thereafter (Fig. 3.2.2.6.1; Table 3.2.2.6). ICA also calculates the average fishing mortality rate of selected ages, in this case, we chose ages 1 through 5. The pattern of the average fishing mortality rates is similar to that on the fully recruited but lower because of the dome-shaped selectivity (Figure 3.2.2.6.2).

3.2.2.7. Stock-Recruitment Parameters

The comments made in Section 3.1.2.7 are valid here. Thus, given the possible pan-Caribbean nature of recruitment with the unknown spawning biomass, we would not expect to see a tight relationship between the spawning biomass in US waters and subsequent recruitment and, if we do, it would rather be a statistical artifact. To account for the age at settlement in the stock-recruit plot, we plotted the spawning stock (in terms of eggs and biomass weighed by the sex-ratio for females and the average number of broods by female and spawning season) versus the number of age-1 lobsters offset by two years from the spawning biomass instead of one year (Fig. 3.2.2.7). Two years is the same offset that we used in the DeLury model. The issue is not whether we can identify a unique curve but rather defining the spawning biomass that contributes to the spiny lobster populations in the SE U.S.; we know that the spawning biomass is greater than what occurs in Florida but we have no idea how much greater.

3.2.2.8. Measures of Parameter Uncertainty

Measures of parameter uncertainty were presented in Table 3.2.2.2 that includes the maximum likelihood estimate, the coefficient of variation, the 95% confidence interval, and the mean estimate. However, see the following retrospective section below for uncertainty that exceeds these usual measures of precision. As will be shown below in Section 6.4, the fishery is not overfishing and, therefore, a P* analysis was not conducted (TOR #7).

3.2.2.9. Retrospective and Sensitivity Analyses

The retrospective analyses indicate that the model underestimates fishing mortality (Fig. 3.2.2.9.1). For example, running the model with the data through 2007-08, the fishing mortality rate in 2007-08 was estimated at 0.147 per year but when the 2007-08 fishing mortality rate was estimated using data through 2009-10, the value was 0.323 per year (120% higher) and when we average the differences across the terminal years in the retrospective runs then fishing mortality rates were on average 139% (CV = 28%) lower. For example, if we look at the precision of the 2007-08 fishing mortality rate estimate in Table 3.2.2.2, the 95% confidence interval of the

0.32 per year extends from 0.24 to 0.44 per year and does not include the estimate with the terminal year of 2007-08 (0.147 per year). Recruitment was overestimated by an average of 92% (CV = 8%) and the spawning biomass was overestimated by an average of 82% (CV = 10%). As with the DeLury model, we tested the significance of these differences with two-tailed, paired t-tests and all of the differences were significant at α=0.05. Mohn (1999) noted that the retrospective bias stems from the changing catchability coefficients and spiny lobster is consistent with his conclusion (Fig. 3.2.2.9.2). The catchability was estimated by standardizing the recreational effort with the commercial effort using the DeLury fleet catchabilities to get the combined effort, E_y, and then the annual catchability, q_y, is:

$$q_y = \frac{F\_full_y}{E_y} \tag{7}$$

where F_full_y is the fishing mortality on fully recruited ages for a given fishing year, y. The drop in catchability in the most recent three years probably reflects the retrospective bias in F. The AW decided not to make any catchability-related adjustment but rather to note that a retrospective bias presents another source of uncertainty in the assessment that is not incorporated into the precision estimates.

Initially, sensitivity runs included runs with higher (0.43 per year) and lower (0.25 per year) natural mortality rates. These runs yielded predictable results (Fig. 3.2.2.9.3; Table 3.2.2.9.1): lower natural mortality resulted in higher fishing mortality and lower population size and recruitment, and conversely for higher natural mortality. Additional sensitivity runs included repeating the entire analyses with the lipofuscin based age-length keys (LALK) developed for the Florida Keys, where fishing takes place (i.e., LALK developed for the Dry Tortugas were not considered). The using LALK led to slightly lower fishing mortality rates during 2000-2007 (Fig. 3.2.2.9.4a) and slightly higher recruitment (Fig. 3.2.2.9.4c) during the entire timeframe, but these parameters were generally comparable for the two aging methods. The main difference between the two aging methods was the magnitude of the spawning biomass: the LALK yielded higher spawning biomass (Fig. 3.2.2.9.4b) and this was apparently due to different selectivity patterns estimated from the tagging age-length keys and LALK (Fig. 3.2.2.9.4d). Even though the selectivity estimates from both aging-based analyses were dome-shaped, they were similar up to age-2 lobsters, then selectivity declined markedly for older lobsters with the LALK based analyses.

Behringer and Butler (2009) suggested that the marked decrease in landings after 2000 was related to the PAV1 lobster virus that primarily attacked juvenile spiny lobsters. In the ICA model, the post-larvae index is offset by one year and assigned to age-1 lobsters because we considered the recruitment to occur one year after settlement because we have no information on natural mortality on post-larvae. Because the virus attacks juveniles and the index reflects post-larval settlement, AW members asked for some additional sensitivity runs using variations to the post-larval index. The requested runs included 1) deleting the index, 2) using the index only for the years 1988-1998 (in order to exclude the post-virus years), 3) creating a different index using the settlement data from both Big Munson and Long Key but only including the years from 1993-2009 because of the standardized sampling protocols, and 4) increasing the natural mortality rate (M) on age-1 lobsters to account for an average of 36% decrease in landings after the 2000-01 fishing year. The latter request translated into an M value on age-1 lobsters of 0.8 per year; the run involving this M value is henceforth referred to as "base-virus run".

The results from these runs are summarized in Table 3.2.2.9.2 and Fig. 3.2.2.9.5., along with those from base run for comparison, i.e., using original indices and M = 0.34 by year and age. The estimates from all these runs were similar over specific time-windows: 1985-1998 for the total biomass and recruitment; 1985-2002 for the spawning biomass and fishing mortality, especially for base run and base-virus run. After these periods, total biomass, spawning biomass, and recruitment estimated without the post-larvae index or with this index over 1988-1998 increased sharply, with higher and nearly equal values that increasingly and positively diverged over time from those estimated using base run. Recruitment estimates from base-virus run were similar to those derived from runs using the previous index configuration until 2003-04; they then declined gently but at levels still higher than those of the recruitment from base run. Except for the spawning biomass, the base run yielded the lowest total biomass and recruitment estimates after those derived from the run that included the post-larvae index based on data from Big Munson and Long Key sites during 1993-2009. The estimates from the latter ICA configuration also diverged from base run values, increasingly and negatively over time. As usual, the fishing mortality rates had opposite trends to those of the biomass and recruitment estimates.

Three aspects are worth noticing about the ICA sensitivity runs following the treatment of the post-larvae index and the values of M on age-1 lobsters. First, including or ignoring the index in question had no effects on ICA behavior and estimates prior to1995-96, because separability for the ICA model operated only from the 1995-96 fishing year onward. Without any guidance in the last ten years, recruitment became higher because there was no guidance from any other index. This is probably the reason why ICA particularly handled quasi-equivalently the fact of deleting the index or keeping it with values from 1988 through 1998, whereby the effects of the 1996-1998 index values were minimal. Second, the aforementioned configurations of the post-larvae index and base-virus run acted like input guesses of the terminal F in standard VPA runs, upon which the resulting estimates converge backward in time starting from a given year. Finally, ICA runs based on the post-larvae index over 1993-2009 also showed retrospective patterns.

4. Models Comparison

4.1. Compare and Contrast Models Considered

The two models retained for this assessment update used the same landings converted to numbers and the same tuning indices. Differences between the models were that the DeLury model used fishery effort in addition to the tuning indices while the age-structured model, ICA, used the numbers of lobsters landed by age and fishing year to gain additional insights into the stock dynamics. Both models showed little trend in fishing mortality rates until the late-1990s and these rates generally declined simultaneously afterwards. The fishing mortality rates in the DeLury were on average 2.8 times higher than those estimated from ICA (Fig. 4.1); however, one of the Stock Assessment Workshop members pointed out that the lower rates from ICA probably reflected the dome-shaped selectivity curve (Fig. 3.2.2.5) estimated in the age-structured model. The dome-shaped selectivity curve reduced the number of lobsters available to the fishery while the DeLury model assumed that the harvests were comprised of homogeneous lobsters that are all equally available to fishers. Another possible reason is that the DeLury model considers a blended recruitment, consisting of animals of any ages that become available to fishermen instead of only age-1 lobsters. Finally, both models showed significant retrospective patterns.

4.2. Preferred Model Recommendation

Term of reference number 4 states: "Update the approved SEDAR 8 Southeastern spiny lobster model base configuration with data through 2008-09. Employ the SEDAR 8 SAR 3 statistical catch-at-age model (Integrated Catch-at-Age) as the base and the DeLury model as a check for consistency." The AW decided in an initial conference call in February 2010, that the 2009-10 landings data would be available and to extend the analyses through the 2009-2010 fishing year. The AW members concurred with the model recommendations.

5. Population Modeling

5.1. Yield per Recruit Models

5.1.1. Methods

We calculated the yield-per-recruit (YPR) empirically with the natural mortality rate of 0.34 per year across ages, the selectivity from the ICA model, and the average catch weight by age. The values of these inputs by age are shown in Table 5.1.1 (along with inputs specific to the computation of the spawning potential ratio, SPR)

5.1.2. Results

With the life history parameters of spiny lobster, the yield-per-recruit curve did not reach a maximum at a realistic fishing mortality rate but the maximum yield would be about 0.72 lbs per recruit; the YPR at the current fishing mortality of 0.21 per year (geometric mean of the last three years' fishing mortality on fully recruited lobsters) was 0.36 lb; in 2009-10, YPR was 0.28 lbs at a fishing mortality rate on fully recruited lobsters (age-3) of 0.15 per year (Figure 5.1.2). The YPR at the $F_{20\%}$ MSY proxy discussed below was 0.50 lbs at a fishing mortality rate of 0.42 per year.

5.2. Stock-Recruitment Models

As noted in Sections 3.1.2.7 and 3.2.2.7, the spawning stock occurs in the Caribbean as well as in the SE US but we have no idea how much of SE US's recruitment comes from outside spawning activity and, without estimates of the spawning stock in the western Atlantic, we were unable to determine a valid stock-recruit relationship. The Beverton-Holt Stock-recruit figure shown earlier (Fig. 3.2.2.7) only included the spawning biomass in the number of eggs from SE US lobsters and ignored any contribution of post-larvae from upstream in the Caribbean.

6. Biological Reference Points (SFA Parameters)

6.1. Existing Definitions and Standards

The existing definition for overfishing was defined in Amendment 6 of the Spiny Lobster FMP (SAFMC 1998) as a fishing mortality rate (F) in excess of the fishing mortality rate at 20% static SPR ($F_{20\%}$). Static SPR is the equilibrium value associated with any particular fishing and natural mortality rates, selectivity, maturity, and biomass (Mace et al. 1996). Optimum Yield (OY) was defined in Amendment 6 of the spiny lobster FMP as the amount of harvest taken by U.S. fishers while maintaining the Spawning Potential Ratio at or above 30% static SPR. While Maximum Sustainable Yield (MSY) is unknown in this fishery, the Council concluded that the best available data supports using 20% static SPR as a proxy for MSY.

6.2. Estimation Methods

The estimation of Static SPR in terms of eggs per recruit ratio follows the procedures in Gabriel et al. (1989) for calculating spawning stock biomass per recruit with the substitution of the number of eggs per spawning as a function of age for average weight-at-age. Bertelsen and Matthews (2001) gave an expression for the number of eggs as a function of carapace length:

$$E = 91.88 * CL^2 - 231212 \qquad (1)$$

Here, CL is the female's mean carapace length at age (in mm) obtained from the tagging growth model. Thus, under equilibrium conditions, the egg per recruit is:

$$EPR = \sum_{a=1}^{15} Ns_a E_a B_a Mat_a SR_a \qquad (2)$$

where E_a is the fecundity or number of eggs produced by a female at age, *a;* B_a is the average number of broods per female by age in a spawning season, one brood for less than 80 mm CL and two for larger female lobsters (Lipcius 1985; Cruz and Bertelsen, 2008); Mat_a represents the assumed maturity schedule as described in Section (3.1.1.2); SR_a is the sex-ratio for reproducing females (i.e., length ≥ 76 mm CL), approximated to be 0.5; and Ns_a is the number of lobsters at age expected at the beginning of the spawning season the following March, from a number at-age, N_a, expected at the onset of the fishing year. $Ns_a = N_a e^{-Z_a * O}$, where $N_a = N_{a-1} e^{-Z_{a-1}}$, Z is the total mortality rate, and o is the spawning offset (August – March) with a value of 0.67 (note that N_1.was set to 1 female lobster). The egg per recruit ratio, *ER*, for a given fishing mortality, *F*, is then:

$$ER = \frac{EPR_F}{EPR_{F=0}} . \qquad (3)$$

The previous calculations relate to base Static SPR estimation. They were repeated for sensitivity analysis using the estimated maturity schedule (see section (3.1.1.2). The inputs by age specifically used to calculate the static SPR (average number of eggs, number of broods, proportion mature, average weight in the population from the tagging growth model, and proportion of females) are given along with those used in YPR analyses (natural mortality, and selectivity from ICA model run) in Table 5.1.1.

6.3. Results

Using eggs per recruit as the basis for calculating the static SPR values associated with the estimated fishing mortality rates since 1985-86, the fishing mortality rates exceeded the $F_{20\%}$ in 1989-90 through 1991-92, 1994-95 through 1997-98, 1999-00 through 2004-05, and in 2006-07; touched $F_{20\%}$ in 1998-99; and have been lower in other years (Table 6.3.1, Fig. 6.3). Lower values of fishing mortality estimated during the 2008-09 and 2009-10 fishing years were associated with static SPR greater than 40%. However, the most recent years are the most uncertain as this has been particularly revealed by the retrospective analyses. In fact, ICA tends to underestimate the fishing mortality rates especially since the 1999-00 fishing year and with such fishing mortality rates the static SPR would most likely be lower than their estimated values. Note that, even though the estimated maturity schedule suggests that younger female lobsters can significantly contribute to the spawning potential (Fig. 3.2.1.2.1b), the resulting static SPR only increased by 4% relative to the static SPR obtained using the assumed maturity schedule.

For management perspectives, various benchmarks derived from the previous SPR analyses are summarized in Table 6.3.2. These benchmarks generally were insensitive to the maturity schedule used, except for the current spawning stock biomass, and the ratios $F_{current}/F_{20SPR}$ and $SSB_{current}/SSB_{F20SPR}$.

6.3.1. Overfishing Definitions and Recommendations

The existing overfishing definition is that fishing mortality rates should be no higher than the fishing mortality rate associated with a 20% static SPR ($F_{20\%}$). The fishing mortality rate corresponding to 20% static SPR was 0.45 per year for fully selected lobsters and this rate was similar to the 0.49 per year in SEDAR08. The full fishing mortality rate since 2005-06 has only exceeded 0.45 per year one time and that value was 0.46 per year and the fishing mortality rates on the fully selected lobsters was less than 0.45 per year for 11 out of the 25 fishing years included in the ICA analyses. The geometric mean for the fully selected fishing rate for the past three fishing years, 2007-08 through 2009-10, was 0.21 per year and the stock is considered to not be undergoing overfishing. However, these results illustrate a difficulty with a limit that is close to the long term average in that the limit will be exceeded frequently.

6.3.2. Overfished Definitions and Recommendations

The estimation of conservation and management benchmarks for whether the stock of spiny lobster is overfished in SE US cannot be done reliably using only the data from the stock assessment, alone. The reason for this is threefold:

1) Estimation of long term productivity measures such as maximum sustainable yield requires some understanding of the relationship of future recruitment levels with spawning stock biomass, i.e. the stock-recruitment relationship. In particular one needs to know the curvature of this relationship and at what stock levels recruitment declines. Unfortunately, in this assessment there are no indications of much variation in recruitment trends from the data. Therefore, we cannot estimate benchmarks such as spawning biomass at MSY (SSB_{msy}) or the fishing mortality rate that produces SSB_{msy} (F_{msy}) directly from the data.

2) Even if we could estimate SSB_{msy} from the data, the question remains whether this is appropriate because cohorts of spiny lobster that recruit in the SE US partly come from other areas throughout the Caribbean (Hunt et al., 2009) and, indeed, SE US may contribute recruitment to other areas. Due to high connectivity between spiny lobsters inhabiting various

areas in the Caribbean, self-recruitment is indeterminate; therefore, the SE US population may not be considered as a separate breeding population.

3) The degree of "leakage" of lobsters outside of the traditional fishery caused by migration, behavior, gear selection or some combination makes the estimates of fishing mortality rates and, subsequently, F_{msy}, to be somewhat uncertain.

Note that by using $F_{20\%}$ as a surrogate to F_{msy}, the AW, following SEDAR08, is avoiding the debate on whether recruitment arises from within or without the SE US area. We only are assuming that there is a breeding population of spiny lobsters of which the lobsters in the SE US are part. Then if fishing occurs at F_{msy} throughout the stock, including the SE US component, then it is expected that SSB_{msy} for the entire breeding stock would be achieved. While current management only controls the U. S. component of the fishery, a F_{msy} strategy for this component would be consistent with overall MSY goals for the stock wherever it occurs. This discussion concurs with Amendment 6 of the spiny lobster FMP that states that MSY is unknown for this species.

6.3.3. Control Rule and Recommendations

A control rule based on spawning stock cannot be developed until the spawning biomass of the stock is assessed.

6.4. Status of Stock Declarations

The fishing mortality rates on fully recruited spiny lobsters during the last ten years only have been less than $F_{20\%}$ (i.e., 0.45 per year) in 2005-06 and from 2007-08 through 2009-10, when they ranged between 0.15 and 0.38 per year with associated static SPR of 23% -53%. In these years, especially in 2009-10, these values suggest that the U.S. fishery is not overfishing. However, the retrospective results from ICA model runs with various configurations call for cautions and prudent management options because fishing mortality rates were probably underestimated in recent years (the DeLury has the opposite retrospective bias).

As noted in Sections 6.3.2, a Caribbean-wide stock assessment is needed. This assessment would weigh various local, biological and technical interactions, and perhaps help better understand and determine the exploitation and stock conditions for the Caribbean spiny lobster.

7. Projections and Management Impacts

Term of Reference #10 states "Evaluate and project future conditions for eleven years (2010-11 through 2020-21 inclusive) beyond the terminal year of the update (2009-10). Run at least these three projection scenarios: $F = F_{current}$, $F = F_{msy}$, and $F = F_{oy}$"

To provide a context for the projection duration, the initial step was to determine the mean generation times. A simple equation for average generation time, *GT*, is to weight age by the eggs per recruit (Section 6.2, Equation 2; Krebs 1972), and the equation is:

$$GT = \frac{\sum_{a=1}^{15} a Ns_a E_a B_a Mat_a SR_a}{\sum_{a=1}^{15} Ns_a E_a B_a Mat_a SR_a}. \qquad (1)$$

Equation (1) predicts a mean generation time of 4.43 years but that is time after post-larval settlement so including the time while in the plankton as a phyllosome, the mean generation time would be 5.26 years (4.43 + 0.83) and 1.5 times the mean generation time would be 7.9 years; hence the 10 year projection horizon.

The stochastic projections used variation of the model developed for black grouper (SEDAR19 2010) and incorporates the geometric mean of the number of fish by age in 2007-08 through 2009-10 and the standard errors of the numbers of fish by age from the ICA run, the average weight of spawning females by age, the maturity schedule by age, the number of broods by age, and the sex ratio by age, the fishing mortality rates for 2007-08 through 2009-10 from the 1000 bootstraps to estimate $F_{current}$, the recruitment for 2007-08 through 2009-10 from the 1000 bootstraps to estimate recruitment deviations, and the estimates of $F_{20\%SPR}$ and $F_{30\%SPR}$. This model also used the assumption that the combined selectivities for the directed fishery and the attractants would remain the same over the projection period.

For the purposes of developing projections, we fit a Beverton-Holt stock-recruit relationship (Fig. 3.2.2.7) with a two year offset to the spawning biomass in southeast US waters expressed in eggs at time, *t* (SSB_t)and the number of recruits two years later (R_{t+2}). The equation was:

$$R_{t+2} = \frac{1.64{*}10^7 {*} SSB_t}{7.29{*}10^{10} + SSB_t} \qquad (2)$$

The corresponding steepness for the stock-recruit curve was 0.97 which means that only at very low spawning biomass would recruitment decrease as indicated by the β term in the equation is approximately 3% of the geometric mean of the 2007-08 through 2009-10 spawning biomass ($2.24\text{x}10^{12}$ eggs). The geometric mean fishing mortality rate from 2007-08 through 2009-10 fishing years or 0.21 per year for $F_{current}$. As noted in Section 6.3.1, the F_{msy} proxy ($F_{20\%}$) was equal to 0.42 per year, and Amendment 6 specified $F_{30\%}$ for optimum yield and that translates to a fishing mortality rate of 0.30 per year. The trajectories of spawning biomass and landings for the three fishing mortality scenarios are shown in Figure 7.1. It must be noted that at the beginning of the 2010-11 fishing year, the age-structure was not in equilibrium with the fishing mortality rates because the fishing mortality rates were higher previously. For example, the current geometric mean spawning biomass expressed in eggs was 1,980 billion eggs but the equilibrium biomass associated with $F_{current}$ was approximately 4,000 billion eggs. The projections indicate that this level would be reached by the 2015-16 fishing year. The peak in landings in 2011-12 results from the mean recruitment in the last three fishing years being higher than the asymptotic recruitment.

Fishing at either $F_{20\%SPR}$ or $F_{30\%SPR}$ would be expected to achieve lower spawning biomass ten years out because both of those rates are higher than $F_{current}$. Given the retrospective bias such that $F_{current}$ could be as high as 0.41 per year, the fishery would still be operating below F_{msy} but possibly at a higher rate than F_{oy}.

8. Research Recommendations

Participants in the 2010 spiny lobster assessment update workshop expressed a variety of research and data needs including fishery-independent surveys for age-1 lobsters, attractant or "short" mortality, proper use of the post-larvae index, the development of the catch at age matrices, and controls on fishing mortality. Specifically, they recommended:

8.1. Conduct fishery-independent surveys for juvenile lobsters in lobster nursery areas (e.g., Gulf of Mexico side of Florida Keys such as Great White Heron National Wildlife Refuge). This would lead to more accurate estimates of age-1 lobsters instead of applying the post-larvae index in assessment models.

8.2. Critically evaluating the methods used to estimate the number of "shorts' and legal lobsters used as attractants and their mortality in trap fisheries.

8.3. Integrating additional long-term post-larvae collector data from "second site" and only use data for first quarter of lunar phase (i.e., Day 7 of each lunar phase). The update included this item as a sensitivity run.

8.4. Conducting statistical research regarding the generation of the catch-at-age matrices used as input to the catch-at-age stock assessment algorithm. Specifically, several growth equations available for this purpose should be statistically assessed on the basis of their biological growth attributes and on how they might portray different mortality frames.

8.5 Given a spawning-recruit relationship that has already been suggested by Ehrhardt and Fitchett (2010), research regarding controls of fishing mortality should be considered based on SPR, other mortality reference points, or both.

In SEDAR08, the AW panel members expressed the need for geographically robust adult and juvenile monitoring programs that could provide tuning indices that can be connected to each other and the fishery. Towards this end, FWC has re-examined their Adult Monitoring Survey and changed the sampling protocols from timed surveys to transect surveys. That index is short only beginning in 2004 but with time it will become a valuable index. The weakness of that index now is that it is only conducted in the lower Keys and additional funding is necessary to expand the geographical scope of the survey.

The other main research recommendation in SEDAR08 concerned age and growth of spiny lobsters in the SE US. Discussions of the AW, focused on the lack of growth data from larger (>100 mm CL) lobsters and that the lipofuscin aging only included known age animals up to four years. What is needed is to develop a tag-recapture program in the Dry Tortugas where larger animals are available and also in the Florida Keys which is the center of the fishery. This program will require the cooperation of the industry and recreational divers, Any such studies will require refining existing tagging techniques.

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10. List of Tables

10. List of Tables (Continued)

11. List of Figures

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Table 2.1.1. Commercial landings in pounds by gear, attractants, and the total number trips by fishing year.

Fishing Year	Traps	Diving	Other	Total Directed	Attractants	Total Pounds	Trips
85-86	5,145,623	149,866	67,581	5,363,070	645,646	6,008,716	32,307
86-87	5,149,983	130,441	89,742	5,370,166	783,945	6,154,111	31,064
87-88	5,329,820	76,694	21,665	5,428,179	392,035	5,820,214	34,406
88-89	7,001,015	124,820	36,897	7,162,732	350,768	7,513,500	36,396
89-90	7,616,620	156,695	66,026	7,839,341	525,680	8,365,021	40,276
90-91	5,898,611	97,896	49,484	6,045,991	743,936	6,789,927	40,536
91-92	6,601,749	191,536	42,529	6,835,814	427,430	7,263,244	45,777
92-93	5,124,870	223,277	20,038	5,368,185	351,664	5,719,849	35,821
93-94	5,109,472	175,991	22,202	5,307,665	237,050	5,544,715	31,568
94-95	6,895,235	252,931	27,320	7,175,486	309,951	7,485,437	32,554
95-96	6,681,978	307,682	24,996	7,014,656	306,119	7,320,775	32,830
96-97	7,363,065	333,905	45,095	7,742,065	360,302	8,102,367	32,848
97-98	7,184,737	393,764	57,292	7,635,793	405,152	8,040,945	34,088
98-99	5,002,650	351,243	86,655	5,440,548	187,863	5,628,411	26,198
99-00	7,024,265	582,153	40,250	7,646,668	367,572	8,014,240	28,141
00-01	4,934,255	569,395	55,417	5,559,067	287,605	5,846,672	26,249
01-02	2,606,418	441,997	29,065	3,077,480	234,030	3,311,510	19,670
02-03	3,988,225	547,499	29,131	4,564,855	258,588	4,823,443	24,131
03-04	3,727,484	391,876	29,744	4,149,104	231,342	4,380,446	22,196
04-05	5,096,404	304,936	38,758	5,440,098	244,197	5,684,295	20,369
05-06	2,644,214	258,536	54,668	2,957,418	146,627	3,104,045	14,990
06-07	4,494,587	243,484	53,324	4,791,395	159,627	4,951,022	18,247
07-08	3,449,322	286,182	40,270	3,775,774	185,125	3,960,899	18,987
08-09	2,987,879	240,955	35,974	3,264,808	97,860	3,362,668	15,273
09-10	4,084,450	151,707	67,481	4,303,638	138,774	4,442,412	14,335

Table 2.1.2. Recreational and Special Recreational License landings in pounds and numbers and the number of person-days by fishing year. The effort for the Special Recreational License is expressed in person-day equivalents. Note that the shaded cells in the table are not observations but estimated values.

	Recreational			Special Recreational License			Total recreational landings		
Fishing Year	Pounds	Number	Person Days	Pounds	Number	Eq. Person Days	Pounds	Number	Person Days
85-86	1,432,438	1,296,276	339,625				1,432,438	1,296,276	339,625
86-87	1,453,954	1,315,747	317,518				1,453,954	1,315,747	317,518
87-88	1,797,036	1,626,217	377,255				1,797,036	1,626,217	377,255
88-89	2,032,970	1,839,724	505,243				2,032,970	1,839,724	505,243
89-90	2,060,736	1,864,851	497,125				2,060,736	1,864,851	497,125
90-91	1,820,800	1,647,722	433,092				1,820,800	1,647,722	433,092
91-92	1,476,571	1,336,214	578,003				1,476,571	1,336,214	578,003
92-93	1,352,400	1,203,309	477,756				1,352,400	1,203,309	477,756
93-94	1,883,199	1,746,451	515,006				1,883,199	1,746,451	515,006
94-95	1,831,140	1,682,413	544,438	74,980	68,809	22,267	1,906,120	1,751,222	566,705
95-96	1,863,545	1,615,134	467,265	67,145	58,194	16,836	1,930,690	1,673,328	484,101
96-97	1,868,021	1,728,370	541,729	54,612	50,530	15,838	1,922,633	1,778,900	557,567
97-98	2,254,165	2,138,068	624,074	50,096	47,517	13,870	2,304,261	2,185,585	637,944
98-99	1,253,186	1,139,986	332,391	49,493	45,022	13,127	1,302,679	1,185,008	345,518
99-00	2,400,461	2,235,278	554,953	61,449	57,219	14,206	2,461,910	2,292,497	569,159
00-01	1,910,957	1,803,471	477,776	38,096	35,953	9,525	1,949,053	1,839,424	487,301
01-02	1,218,734	1,111,874	387,570	32,291	28,702	10,005	1,251,025	1,140,576	397,575
02-03	1,410,893	1,262,318	367,089	44,466	39,785	11,570	1,455,359	1,302,103	378,659
03-04	1,372,518	1,203,645	385,656	38,981	34,185	10,953	1,411,499	1,237,830	396,609
04-05	1,238,561	1,124,806	413,005	34,136	32,108	11,789	1,272,697	1,156,914	424,794
05-06	1,104,603	1,045,966	440,354	26,427	25,025	10,536	1,131,030	1,070,991	450,890
06-07	1,277,592	1,113,758	376,722	26,974	23,516	7,954	1,304,566	1,137,274	384,676
07-08	1,194,191	1,068,435	432,148	20,929	18,726	7,574	1,215,120	1,087,161	439,722
08-09	1,246,951	1,130,507	373,115	16,612	15,061	4,971	1,263,563	1,145,568	378,086
09-10	1,116,033	998,510	373,863	10,727	9,598	3,594	1,126,760	1,008,108	377,457

Table 2.1.3. Commercial, recreational, total landings, and percent recreation landings by fishing year.

Fishing Year	Recreational	Commercial	Total Pounds	% rec
85-86	1,432,438	6,008,716	7,441,153	19%
86-87	1,453,954	6,154,111	7,608,065	19%
87-88	1,797,036	5,820,214	7,617,250	24%
88-89	2,032,970	7,513,500	9,546,470	21%
89-90	2,060,736	8,365,021	10,425,756	20%
90-91	1,820,800	6,789,927	8,610,727	21%
91-92	1,476,571	7,263,244	8,739,815	17%
92-93	1,352,400	5,719,849	7,072,249	19%
93-94	1,883,199	5,544,715	7,427,914	25%
94-95	1,906,120	7,485,437	9,391,557	20%
95-96	1,930,690	7,320,775	9,251,465	21%
96-97	1,922,633	8,102,367	10,025,000	19%
97-98	2,304,261	8,040,945	10,345,206	22%
98-99	1,302,679	5,628,411	6,931,090	19%
99-00	2,461,910	8,014,240	10,476,150	24%
00-01	1,949,053	5,846,672	7,795,725	25%
01-02	1,251,025	3,311,510	4,562,535	27%
02-03	1,455,359	4,823,443	6,278,802	23%
03-04	1,411,499	4,380,446	5,791,945	24%
04-05	1,272,697	5,684,295	6,956,991	18%
05-06	1,131,030	3,104,045	4,235,075	27%
06-07	1,304,566	4,951,022	6,255,588	21%
07-08	1,215,120	3,960,899	5,176,019	23%
08-09	1,263,563	3,362,668	4,626,231	27%
09-10	1,126,760	4,442,412	5,569,172	20%

Table 2.2.1. Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Traps Females

Len cat	Fishing year																								
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	7,191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	18,216	0	865	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	1,426	0	0	0	18,216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	4,780	2,243	5,015	1,646	1,230	1,918	3,170	47,234	23	1,390	1,197	5,498	1,206	1,455	676	0	212	531	194	744	0	6,295	1,055	0	1,042
71	93,129	126,377	82,467	79,307	48,558	41,040	39,877	62,329	22,900	22,768	25,061	42,576	29,484	14,247	23,693	9,310	7,085	6,077	7,295	14,007	18,534	58,534	18,635	10,951	16,263
76	617,945	608,328	686,030	1,013,295	982,804	750,517	760,000	447,710	680,418	888,394	797,036	1,151,785	1,120,962	655,891	938,933	628,573	281,114	418,195	483,113	796,478	609,214	577,531	560,403	543,067	660,652
81	597,887	500,603	521,588	925,597	854,669	607,297	717,625	451,474	539,300	679,279	699,306	912,597	713,380	549,263	789,074	539,614	295,263	484,629	471,114	634,880	382,727	534,902	435,354	365,091	495,961
86	344,716	380,936	407,045	475,026	641,364	389,170	412,196	296,248	337,105	457,549	500,953	446,280	356,382	343,983	441,105	260,376	170,954	258,000	263,498	311,953	166,198	308,352	217,394	169,039	223,081
91	208,826	181,578	229,319	205,016	287,055	248,898	211,560	139,035	138,162	236,591	205,290	212,106	170,922	158,405	207,945	151,176	98,926	156,315	133,976	164,115	63,676	139,453	99,925	59,702	111,950
96	85,505	109,186	121,340	101,487	143,743	91,218	110,264	91,694	64,803	112,921	121,921	98,903	71,670	82,205	133,680	85,124	55,519	76,627	65,953	82,956	33,428	56,720	44,396	28,575	37,917
101	21,650	31,065	55,538	35,707	58,781	36,888	43,039	77,113	24,936	62,790	46,640	52,941	49,344	23,571	51,843	45,990	31,695	35,435	32,487	41,942	17,516	21,558	19,476	8,364	9,984
106	7,624	17,261	12,638	13,245	23,080	24,761	29,850	59,163	6,536	31,099	41,755	39,364	35,807	16,305	21,693	35,725	16,623	20,654	13,395	18,443	4,787	8,312	7,760	3,256	4,602
111	2,591	5,041	8,682	1,372	4,845	36,982	20,236	42,280	11,258	15,467	23,470	15,336	26,643	9,606	5,751	20,589	11,800	11,969	4,139	4,489	2,966	3,661	5,708	1,027	2,770
116	4,273	1,888	8,092	290	2,459	14,878	23,234	20,002	13,336	13,346	12,753	10,309	16,584	7,091	10,293	17,315	5,110	9,625	1,971	3,458	1,718	1,386	1,362	1,043	0
121	275	147	4,078	177	191	10,977	14,478	19,809	2,260	10,302	13,858	7,567	6,658	4,617	3,724	13,418	4,205	5,773	908	377	1,172	0	0	155	0
126	447	0	138	125	121	6,354	8,120	11,550	4,388	5,573	7,275	4,968	3,914	4,164	2,058	8,106	3,578	4,132	160	0	0	0	0	0	0
131	238	1,197	74	1,492	65	7,869	4,992	3,626	719	5,516	2,042	1,619	4,501	905	3,551	6,365	3,678	3,614	514	753	0	0	0	0	0
136	760	1,197	234	212	1,185	5,066	2,826	4,503	195	2,366	4,986	1,045	3,283	1,358	111	4,337	2,850	2,479	0	377	0	490	412	155	0
141	447	0	138	125	121	1,408	804	2,740	1,676	125	4,333	0	1,310	905	65	3,803	1,082	1,110	0	0	0	0	0	0	0
146	89	0	28	25	24	711	1,283	756	23	835	4,084	0	2	1,177	13	1,598	579	814	0	0	0	0	0	0	0
151	0	0	0	0	0	0	615	697	0	718	0	0	1,302	0	0	935	508	284	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	453	0	0	0	0	0	0	0	0	0	0	0
161	89	0	28	25	24	24	51	62	23	743	0	0	2	0	13	128	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,991,271	1,967,047	2,142,472	2,855,595	3,050,319	2,275,976	2,404,220	1,821,648	1,848,061	2,548,637	2,511,960	3,002,894	2,613,356	1,875,601	2,634,221	1,832,482	990,781	1,496,358	1,478,717	2,074,972	1,301,936	1,717,194	1,411,880	1,190,425	1,564,222

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Traps Males

Len cat (mm)	Fishing year 85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	14,381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	14,381	0	718	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	28,320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	312	1,322	292	1,713	317	317	508	28,624	23	356	290	320	1,181	725	676	0	212	177	0	0	328	1,908	0	138	1,042
71	21,369	37,058	15,231	43,730	24,441	21,496	9,792	49,001	7,552	15,443	7,655	13,701	21,834	7,658	5,864	2,839	5,390	3,635	3,353	3,685	10,822	33,278	6,858	4,381	13,983
76	469,910	465,963	427,423	861,035	683,135	593,728	511,496	351,965	627,250	708,149	496,451	696,090	881,279	478,808	740,053	418,909	219,551	300,538	353,350	569,774	546,730	418,736	476,888	528,517	692,973
81	611,094	505,358	428,300	933,262	731,157	586,117	641,531	376,968	668,510	731,521	562,659	844,000	894,520	543,215	842,417	498,449	244,891	438,894	426,419	590,912	463,745	487,902	463,226	477,239	581,934
86	495,695	460,488	440,371	629,105	614,166	446,484	580,609	297,299	463,837	532,076	510,235	672,255	654,542	446,560	663,623	368,670	179,384	334,871	322,588	447,570	268,279	421,232	312,866	265,421	389,747
91	335,101	326,744	378,677	427,591	518,970	344,245	416,512	230,535	305,575	344,141	364,789	461,568	389,984	321,258	411,904	250,420	138,920	238,453	235,548	268,343	150,178	305,364	183,425	140,512	214,234
96	216,307	217,106	293,198	243,305	311,646	179,167	242,007	149,069	139,914	238,863	216,791	226,362	233,124	168,527	238,044	157,967	84,482	148,383	139,076	190,640	79,905	203,078	83,821	73,157	119,601
101	94,860	123,792	125,092	83,411	181,065	116,148	146,124	85,752	63,588	150,901	131,653	111,460	120,187	86,287	140,028	117,224	56,320	70,784	83,636	113,567	41,489	101,995	51,005	27,484	57,264
106	66,668	84,623	42,953	46,340	102,008	57,122	72,096	51,776	30,388	92,215	75,500	42,267	66,753	58,027	81,378	51,349	22,247	37,001	36,346	39,543	21,451	54,375	27,483	14,950	22,259
111	17,887	23,661	21,553	21,982	38,133	35,352	35,744	38,126	24,056	45,431	53,295	31,410	29,993	23,173	33,917	30,370	18,667	25,037	20,302	27,781	8,604	27,630	13,676	7,660	11,095
116	11,187	8,275	11,232	9,806	14,431	16,773	16,353	34,349	14,199	22,695	21,245	30,153	23,511	16,914	27,509	24,705	9,895	11,054	8,157	13,973	6,166	10,563	6,248	3,952	1,850
121	774	12,518	7,482	2,042	9,710	16,407	11,360	24,488	16,601	21,909	18,386	13,043	17,347	11,802	13,562	14,268	5,693	7,289	2,867	10,117	2,121	5,087	4,377	1,645	920
126	4,114	1,418	3,242	1,232	4,399	12,762	12,537	25,256	11,061	19,244	22,134	5,674	11,940	12,647	9,137	15,273	6,173	6,039	1,291	2,588	1,854	2,627	2,462	1,668	0
131	305	3,740	192	1,451	2,213	10,985	7,526	20,853	6,450	11,141	14,759	7,432	10,784	2,624	5,248	9,345	3,499	6,225	868	3,361	1,023	1,386	0	2,076	0
136	454	2,542	3,199	227	2,197	7,452	14,667	16,792	3,479	8,973	13,803	5,705	9,265	7,936	2,055	9,815	3,946	4,526	514	1,613	366	1,517	0	1,392	0
141	313	1,197	96	1,469	1,064	5,072	14,067	13,128	4,538	5,446	12,812	1,045	10,641	3,168	709	5,383	4,376	5,545	583	0	0	0	0	309	0
146	358	1,197	110	100	1,076	3,795	6,159	11,117	2,557	4,593	5,850	2,196	6,544	1,358	715	2,264	2,041	2,775	354	744	0	0	0	464	0
151	648	1,345	298	281	1,271	2,181	5,323	7,783	2,111	1,180	9,804	2,821	4,062	3,832	2,260	3,497	1,378	1,854	194	0	0	0	264	309	0
156	164	0	51	46	44	730	4,202	10,822	5,793	2,584	5,233	1,213	890	2,263	876	2,139	1,523	1,583	388	0	0	0	0	0	0
161	179	1,197	55	50	48	48	3,533	6,694	3,959	770	3,192	1,045	3	905	1,363	1,863	1,764	921	160	0	0	0	0	0	0
166	0	0	0	0	0	0	615	4,838	4,160	811	3,495	1,045	0	0	0	1,668	551	189	0	0	0	0	0	0	0
171	0	0	0	0	0	0	551	1,050	658	1,674	3,192	1,045	887	905	0	342	508	271	0	0	0	0	0	0	0
176	89	0	28	25	24	24	51	2,325	23	24	2,042	2,661	2	0	13	66	382	95	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	3	0	1,528	589	0	0	0	0	195	325	95	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113	95	0	0	0	0	0	0	0
191	89	0	28	25	24	24	51	62	23	24	0	0	2	0	13	0	0	19	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,347,877	2,279,544	2,199,103	3,308,228	3,241,539	2,456,429	2,753,414	1,895,757	2,406,305	2,962,410	2,555,854	3,174,511	3,389,275	2,198,592	3,221,364	1,987,020	1,012,231	1,646,348	1,635,994	2,284,211	1,603,061	2,076,678	1,632,599	1,551,274	2,106,902

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Diving Females

Len cat	Fishing year																							
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	45	68	60	61	39	66	204	403	314	63	293	419	448	395	382	605	84	545	365	229	287	385	339	255	213
71	13,717	1,967	829	992	978	933	1,379	2,230	1,455	993	488	2,372	3,559	1,884	5,958	2,030	1,762	2,087	1,411	6,080	1,107	1,336	2,017	963	1,229
76	12,546	15,434	6,790	11,801	15,514	8,895	17,948	19,751	12,232	28,696	20,967	41,347	49,186	35,114	71,884	51,269	16,491	39,084	26,280	111,165	18,774	80,927	24,505	23,819	12,425
81	16,396	12,115	7,006	11,000	13,646	8,765	20,751	17,540	11,873	13,081	45,088	37,622	34,000	36,777	51,932	47,766	22,244	51,916	29,656	22,963	17,452	29,655	21,786	21,986	11,493
86	8,872	6,190	4,801	7,296	8,866	5,922	10,745	14,992	8,371	10,008	21,211	16,305	20,569	23,557	31,731	29,460	18,985	23,101	21,511	199	16,590	8,029	14,251	14,164	7,628
91	4,656	9,964	3,290	5,498	7,069	4,236	6,533	5,881	6,244	5,434	5,163	7,403	10,786	11,094	11,333	17,721	16,426	24,876	15,057	3,043	9,500	2,550	11,403	10,902	5,883
96	810	4,622	1,661	2,551	3,102	2,061	4,840	3,263	3,318	2,186	5,912	5,303	8,775	3,391	13,036	14,981	15,283	17,831	12,562	401	3,563	1,833	5,373	4,215	2,890
101	264	1,489	819	1,620	2,242	1,148	785	1,398	1,156	1,568	1,410	1,642	2,673	2,061	4,994	13,612	10,062	7,484	7,188	498	3,240	1,074	4,089	2,800	2,052
106	153	230	380	689	902	514	550	1,039	598	1,354	1,388	1,040	1,533	1,039	3,634	3,431	5,746	2,888	4,781	496	1,624	911	2,003	1,412	1,058
111	101	162	172	230	240	205	372	691	976	595	404	686	1,155	721	663	1,031	1,619	2,069	1,059	313	586	590	757	515	443
116	105	174	179	235	245	211	346	618	734	700	1,036	593	590	396	384	606	1,442	1,050	1,002	229	481	483	666	421	391
121	46	70	62	63	40	69	217	432	660	578	322	452	486	435	420	666	888	600	614	252	315	419	368	280	230
126	47	70	75	96	91	89	222	442	616	492	332	463	498	448	432	686	1,634	618	626	259	389	430	455	344	271
131	18	20	24	29	14	31	173	383	298	601	376	431	490	513	494	786	1,508	708	474	297	372	437	378	331	229
136	42	65	56	56	37	61	173	334	379	406	226	341	360	303	293	464	730	675	280	175	220	307	271	195	172
141	8	9	11	13	6	14	80	177	298	172	173	199	226	237	228	363	196	327	219	137	172	202	175	153	106
146	6	7	8	10	5	10	58	128	181	258	125	144	163	171	165	262	267	236	158	99	124	146	126	110	76
151	7	8	10	12	6	13	71	157	248	86	154	177	201	210	203	323	339	291	195	122	153	179	155	136	94
156	5	5	6	7	4	8	44	98	50	258	96	110	126	132	127	202	196	182	122	76	95	112	97	85	59
161	5	6	7	9	4	10	53	118	99	0	116	133	151	158	152	242	0	218	146	91	114	134	116	102	71
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	3	3	4	4	2	5	27	59	0	86	58	66	75	79	76	121	0	109	73	46	57	67	58	51	35
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	57,852	52,678	26,250	42,272	53,052	33,266	65,571	70,134	50,100	67,615	105,338	117,248	136,050	119,115	198,521	186,627	115,902	176,895	123,779	147,170	75,215	130,206	89,388	83,239	47,048

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Diving Males

Len cat (mm)	Fishing year 85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	31	53	42	39	29	43	71	108	66	63	4	87	72	1	2	0	0	120	0	0	1	49	48	0	36
71	3,646	614	540	601	555	589	856	1,308	801	705	75	1,393	1,797	315	4,179	1,360	421	1,290	1,995	2,848	1,200	634	960	301	617
76	24,830	8,358	4,535	8,068	10,734	6,006	17,066	20,675	7,865	34,716	13,094	33,968	31,582	16,907	51,820	37,606	14,612	24,311	16,405	76,846	14,539	6,887	16,940	13,729	8,520
81	22,290	6,455	6,446	11,330	14,980	8,489	17,382	19,111	15,245	36,361	31,599	35,015	45,630	34,601	67,476	57,679	19,758	46,682	26,670	39,931	21,730	16,257	23,675	20,767	11,959
86	12,323	5,337	5,454	8,732	10,964	6,882	14,194	15,370	9,651	24,464	31,064	24,548	27,517	29,490	54,645	39,492	16,663	35,761	24,350	14,353	22,459	16,183	17,423	16,662	9,114
91	2,842	6,180	5,934	8,851	10,628	7,260	13,243	17,808	10,325	12,368	30,423	18,895	19,163	27,219	28,893	32,768	18,313	29,241	18,625	8,624	18,016	4,871	16,953	13,477	9,141
96	11,362	6,882	3,532	5,926	7,638	4,554	7,726	6,136	5,345	10,817	7,128	13,323	14,503	12,931	26,853	23,498	15,122	19,925	19,374	174	9,190	10,655	12,213	9,455	6,283
101	1,066	4,040	2,023	2,834	3,249	2,411	3,320	4,032	3,469	3,464	4,593	5,842	7,299	6,324	12,614	11,896	13,577	16,209	11,996	180	3,982	1,987	5,376	3,073	2,995
106	457	1,843	1,427	2,765	3,823	1,971	2,508	1,762	1,804	1,231	1,030	2,617	8,067	3,769	4,478	13,007	10,212	14,060	8,577	186	5,508	962	6,190	4,005	3,049
111	286	2,638	742	1,333	1,776	989	1,405	1,132	1,792	722	1,698	1,286	2,215	1,194	6,922	1,666	5,602	6,839	4,203	147	2,155	643	2,954	1,854	1,496
116	185	2,472	447	767	990	585	1,052	909	1,009	429	328	834	1,245	1,413	484	3,434	3,609	2,616	3,839	245	1,373	629	1,846	1,187	965
121	130	198	256	397	462	326	546	1,063	1,388	705	737	1,404	1,157	1,850	1,350	2,369	3,663	1,637	1,807	572	1,169	988	1,411	1,025	795
126	52	74	102	164	192	132	240	483	519	410	374	508	551	501	485	767	2,601	811	462	290	557	476	648	489	365
131	88	132	162	244	275	204	364	709	947	729	492	728	772	745	638	1,009	3,034	1,029	608	381	737	659	890	647	507
136	32	27	66	132	168	96	205	457	410	955	455	510	583	607	588	929	2,244	837	560	351	634	518	679	557	376
141	59	78	93	137	145	117	267	544	473	585	436	575	628	581	562	888	2,913	801	535	336	551	544	630	485	365
146	24	24	40	65	66	55	195	434	350	347	428	487	554	579	559	887	2,350	800	535	335	485	494	505	429	294
151	10	11	13	15	8	17	93	206	368	172	202	232	264	276	266	423	854	381	255	160	200	235	204	178	123
156	12	13	16	19	9	21	115	256	488	172	251	287	326	342	329	524	854	472	316	198	248	291	252	221	153
161	18	20	24	29	14	31	173	383	298	429	376	431	490	513	494	786	281	708	474	297	372	437	378	331	229
166	3	4	4	5	3	6	31	69	187	0	67	77	88	92	89	141	267	127	85	53	67	78	68	59	41
171	8	6	19	40	54	28	45	100	322	4	100	111	127	132	128	202	570	182	122	76	161	113	175	140	94
176	5	5	6	7	4	8	44	98	198	0	96	110	126	132	127	202	196	182	122	76	95	112	97	85	59
181	5	6	7	9	4	10	53	118	99	86	116	133	151	158	152	242	141	218	146	91	114	134	116	102	71
186	4	5	6	7	3	7	40	88	111	0	87	99	113	118	114	181	88	163	109	69	86	101	87	76	53
191	3	3	4	4	2	5	27	59	50	0	58	66	75	79	76	121	141	109	73	46	57	67	58	51	35
196	3	3	4	4	2	5	27	59	0	0	58	66	75	79	76	121	141	109	73	46	57	67	58	51	35
201																									
206	3	3	4	4	2	5	27	59	50	0	58	66	75	79	76	121	0	109	73	46	57	67	58	51	35
Total	79,777	45,484	31,948	52,528	66,779	40,852	81,315	93,536	63,630	129,934	125,427	143,698	165,245	141,027	264,475	232,319	138,227	205,729	142,389	146,957	105,800	65,138	110,892	89,487	57,805

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Other Females

Len cat	Fishing year																							
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	8,311	11,075	2,691	4,544	8,132	6,095	7,625	2,393	2,703	2,485	3,170	5,632	7,286	5,890	5,480	7,224	3,762	2,869	3,057	4,999	8,491	7,366	5,354	4,814	8,715
81	7,903	10,643	2,654	4,308	7,709	5,777	8,239	2,460	2,966	2,563	3,566	5,778	8,060	9,174	7,704	8,551	4,313	5,130	5,638	5,667	15,351	10,313	6,803	6,242	9,958
86	6,117	8,122	1,956	3,347	5,991	4,491	3,731	1,714	1,887	2,208	2,191	4,035	5,070	7,981	3,390	4,883	2,578	1,722	3,141	3,444	4,372	4,568	3,499	3,114	5,983
91	1,115	1,462	347	601	1,075	805	366	423	450	1,594	405	727	890	68	541	784	415	23	54	559	339	620	545	478	975
96	446	585	139	240	430	322	281	169	180	26	162	291	356	27	216	314	166	9	425	224	136	248	218	191	390
101	1,103	1,451	345	599	1,072	803	319	358	381	1,190	380	710	861	45	493	773	414	679	36	557	326	611	530	463	967
106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	24,995	33,338	8,132	13,639	24,409	18,293	20,561	7,517	8,567	10,066	9,874	17,173	22,523	23,185	17,824	22,529	11,648	10,432	12,351	15,450	29,015	23,726	16,949	15,302	26,988

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Other Males

Len cat	Fishing year																								
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	5,892	7,798	1,863	3,227	5,776	4,330	2,384	1,609	1,728	1,321	1,985	3,791	4,627	10,305	2,701	4,322	2,317	4,143	2,591	3,110	2,563	3,650	2,982	2,623	5,384
81	8,315	11,093	2,704	4,544	8,132	6,096	5,035	2,417	2,751	2,926	3,237	5,685	7,424	16,074	5,780	7,428	3,851	5,643	4,744	5,110	9,364	7,764	5,561	5,015	8,918
86	7,855	10,391	2,479	4,303	7,701	5,773	3,592	2,138	2,288	1,360	2,625	5,037	6,123	7,824	3,501	5,695	3,059	4,821	4,239	4,110	3,126	4,734	3,907	3,430	7,111
91	4,383	5,827	1,410	2,393	4,282	3,209	3,250	1,303	1,453	1,811	1,645	2,944	3,767	400	2,723	3,672	1,920	1,717	2,321	2,557	3,883	3,612	2,691	2,410	4,455
96	3,509	4,627	1,100	1,915	3,427	2,568	1,574	1,043	1,107	2,015	1,176	2,243	2,707	10,195	1,500	2,458	1,322	37	490	1,780	1,022	1,941	1,670	1,458	3,083
101	662	871	207	360	643	482	281	215	228	408	228	426	516	2,549	296	464	248	9	22	334	196	367	318	278	580
106	1,103	1,451	345	599	1,072	803	543	358	381	808	380	710	861	2,567	493	773	414	15	36	557	326	611	530	463	967
111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	446	585	139	240	430	322	56	169	180	408	162	291	356	27	216	314	166	9	22	224	136	248	218	191	390
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	32,165	42,643	10,247	17,581	31,463	23,583	16,715	9,252	10,116	11,057	11,438	21,127	26,381	49,941	17,210	25,126	13,297	16,394	14,465	17,782	20,616	22,927	17,877	15,868	30,888

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Attractants Females

Len cat (mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
	Fishing year																								
51	25,274	31,799	15,649	14,231	21,313	29,849	17,133	14,146	10,030	10,475	17,267	14,800	10,919	12,575	16,252	11,521	0	2,457	642	680	409	442	513	269	378
56	45,168	56,829	27,967	25,433	38,089	53,345	30,620	25,282	18,425	20,965	23,930	26,218	24,684	20,945	32,198	23,789	16,199	4,913	12,846	13,598	8,189	8,848	10,269	5,380	7,569
61	87,792	110,458	54,359	49,433	74,033	103,685	59,515	49,139	35,056	42,575	41,551	52,724	51,677	32,722	64,014	44,768	58,495	14,739	45,604	48,272	29,070	31,411	36,455	19,100	26,872
66	161,862	203,650	100,221	91,139	136,494	191,163	109,727	90,597	60,802	79,315	74,114	90,300	113,751	46,515	101,833	78,279	71,994	73,697	70,654	74,787	45,039	48,665	56,480	29,592	41,632
71	252,469	317,649	156,322	142,157	212,900	298,173	171,150	141,312	92,289	121,953	125,773	128,800	186,310	61,035	118,773	113,676	57,595	93,349	65,515	69,348	41,763	45,125	52,373	27,440	38,604
76	11,860	8,772	5,668	3,911	5,934	9,979	5,818	4,533	1,946	4,585	3,648	7,779	3,821	2,474	3,471	3,271	1,208	1,216	766	725	382	564	636	443	762
81	6,609	4,888	3,158	2,179	3,307	5,561	3,242	2,526	1,047	2,754	2,174	4,403	1,916	1,518	1,536	1,577	931	645	508	481	253	374	422	294	506
86	3,646	2,697	1,743	1,202	1,824	3,068	1,789	1,394	497	1,721	1,459	2,409	839	742	895	676	772	223	334	316	167	246	278	193	333
91	1,717	1,270	821	566	859	1,445	842	656	210	871	772	1,087	338	284	416	317	436	74	174	165	87	128	145	101	173
96	711	526	340	235	356	599	349	272	67	378	373	390	138	131	183	151	277	0	97	92	49	72	81	56	97
101	278	205	133	92	139	234	136	106	29	128	152	171	47	34	74	37	40	0	14	13	7	10	12	8	14
106	96	71	46	32	48	81	47	37	11	24	62	76	12	13	16	19	20	0	7	7	3	5	6	4	7
111	46	34	22	15	23	39	23	18	4	15	27	52	3	2	16	3	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	597,528	738,848	366,449	330,625	495,319	697,221	400,391	330,018	220,413	285,759	291,302	329,209	394,455	178,990	339,677	278,084	207,967	191,313	197,161	208,484	125,418	135,890	157,670	82,880	116,947

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Attractants Males

Len cat											Fishing year														
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	22,528	28,344	13,949	12,685	18,998	26,607	15,272	12,610	9,422	8,619	16,019	11,813	10,276	10,570	12,657	10,270	900	4,913	1,927	2,040	1,228	1,327	1,540	807	1,135
56	36,958	46,499	22,883	20,810	31,165	43,648	25,054	20,686	15,668	17,017	21,222	20,638	17,966	17,691	24,512	17,161	13,499	22,109	15,415	16,317	9,827	10,618	12,323	6,456	9,083
61	61,504	77,383	38,082	34,631	51,865	72,638	41,694	34,425	26,290	29,222	29,246	36,984	32,842	25,601	42,026	28,968	48,596	24,566	41,108	43,513	26,204	28,314	32,861	17,217	24,222
66	101,218	127,350	62,672	56,992	85,355	119,541	68,616	56,654	41,240	48,788	45,931	59,123	62,422	31,658	74,224	49,070	54,895	51,588	52,669	55,751	33,574	36,277	42,103	22,059	31,035
71	154,963	194,970	95,949	87,254	130,676	183,016	105,050	86,736	61,829	78,136	72,881	84,265	98,666	40,458	91,470	66,099	50,396	93,349	60,377	63,909	38,487	41,586	48,265	25,288	35,576
76	8,611	6,369	4,115	2,839	4,308	7,245	4,224	3,291	1,547	3,469	2,169	5,922	2,808	1,867	3,740	2,415	654	1,936	773	731	385	569	642	447	769
81	6,069	4,489	2,900	2,001	3,037	5,107	2,977	2,320	999	2,408	1,779	4,050	1,972	1,442	2,215	1,745	436	2,135	752	711	375	553	625	435	748
86	4,289	3,172	2,050	1,414	2,146	3,609	2,104	1,639	614	1,782	1,406	3,029	1,303	1,063	1,399	1,200	574	918	460	435	229	338	382	266	457
91	2,851	2,109	1,363	940	1,426	2,399	1,399	1,090	360	1,342	1,081	2,021	715	653	849	644	594	546	362	343	180	266	301	210	360
96	1,576	1,166	753	520	788	1,326	773	602	163	812	733	1,006	330	356	531	374	1,030	521	508	481	253	374	422	294	506
101	904	669	432	298	452	761	444	346	81	454	488	473	194	141	244	216	535	347	286	270	142	210	237	165	284
106	451	334	216	149	226	380	221	173	39	221	273	184	94	78	162	135	634	472	355	336	177	261	295	206	353
111	202	149	96	66	101	170	99	77	15	87	134	99	35	41	85	37	257	273	167	158	83	123	139	97	166
116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	402,124	493,003	245,460	220,599	330,543	466,447	267,927	220,649	158,267	192,357	193,362	229,607	229,623	131,619	254,114	178,334	173,000	203,673	175,159	184,995	111,144	120,816	140,135	73,947	104,694

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Recreational Females

Len cat	Fishing year																								
(mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	617	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
61	1,581	1,605	1,959	2,271	4,224	949	0	0	1,059	0	0	0	0	0	0	0	967	132	0	0	0	0	0	0	0
66	3,162	3,209	3,919	4,543	0	1,898	457	0	2,119	1,850	0	479	0	615	969	0	483	409	0	0	0	1,408	626	0	777
71	30,036	30,487	29,389	52,239	21,119	22,780	19,174	4,962	3,178	5,550	3,810	10,064	7,706	3,692	6,785	8,412	4,351	8,190	10,667	7,955	5,658	3,660	3,756	2,405	12,177
76	211,040	214,210	240,993	327,062	295,673	243,931	202,235	162,509	234,661	250,967	238,775	288,017	324,611	187,042	332,485	261,707	166,324	181,154	156,596	147,361	110,337	126,708	137,421	132,863	126,953
81	154,921	157,248	182,215	233,940	268,218	241,084	171,649	160,028	249,493	213,970	228,614	219,008	330,390	203,039	311,159	196,280	152,302	172,923	173,236	154,558	120,710	128,961	141,491	164,726	128,507
86	60,862	61,776	90,128	70,409	109,821	130,033	68,020	81,875	90,051	94,344	92,716	77,635	111,736	85,522	104,689	78,512	64,789	70,859	85,765	74,627	53,754	48,994	60,728	85,369	69,435
91	17,389	17,650	29,389	15,899	38,015	41,763	15,978	38,456	19,599	21,582	15,876	17,252	26,007	24,611	33,927	15,889	13,054	20,311	23,895	21,593	30,806	19,710	26,295	17,435	23,577
96	5,533	5,616	11,756	2,271	16,896	10,441	5,935	7,443	5,827	8,016	3,810	3,355	6,743	7,383	7,755	5,608	2,417	5,724	8,107	6,061	6,916	6,195	10,643	6,914	6,995
101	2,371	2,407	3,919	2,271	2,112	4,746	1,826	3,722	3,708	1,233	635	958	0	1,846	5,816	3,739	0	1,992	1,280	1,136	1,886	2,253	2,504	2,705	2,591
106	0	0	0	0	0	949	913	1,241	530	617	635	479	963	615	0	935	0	615	0	1,515	629	282	2,817	301	518
111	0	0	0	0	0	949	457	0	1,059	1,233	0	0	0	0	0	0	0	469	853	379	1,572	282	313	902	259
116	1,581	1,605	1,959	2,271	0	0	0	0	0	0	0	0	0	0	0	0	0	73	0	0	314	0	313	0	259
121	0	0	0	0	0	0	457	1,241	0	0	0	0	0	0	0	0	0	44	0	379	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	615	0	0	0	15	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	488,476	495,813	595,626	713,176	756,078	699,523	487,101	461,477	611,284	599,979	584,871	617,247	808,156	514,980	803,585	571,082	404,687	462,925	460,399	415,564	332,582	338,453	386,907	413,620	372,048

Table 2.2.1 (continued). Numbers of spiny lobster by gear, sex, carapace length, and fishing year.

Recreational Males

Len cat (mm)	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10
	Fishing year																								
51	0	0	0	0	0	949	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
56	0	0	0	0	0	949	0	1,241	0	0	0	0	963	0	0	935	0	58	0	0	0	0	0	0	0
61	790	802	0	2,271	2,112	1,898	0	0	2,119	0	0	0	0	0	0	0	0	132	0	379	0	0	0	0	0
66	6,323	6,418	0	18,170	0	4,746	0	0	3,708	617	0	479	963	1,846	0	0	0	776	427	0	943	1,689	313	1,202	0
71	25,293	25,673	25,471	43,154	16,896	21,830	14,152	3,722	7,946	7,400	1,270	9,105	2,890	7,383	1,939	4,673	1,934	7,340	8,534	4,167	8,802	3,097	6,574	2,405	10,104
76	275,063	279,195	329,162	408,828	283,001	180,338	186,714	96,761	262,736	280,565	168,920	307,665	288,008	108,287	330,546	309,375	155,687	181,524	131,421	135,617	148,688	130,087	161,838	117,833	112,962
81	244,237	247,906	307,610	345,232	259,770	203,118	237,387	212,130	339,014	343,461	349,271	381,467	435,383	173,506	485,641	411,253	221,926	252,616	224,013	216,306	208,729	222,443	215,679	217,931	172,293
86	150,178	152,434	219,441	177,159	270,329	245,829	230,083	203,446	260,617	271,316	286,403	265,014	345,802	185,196	371,258	282,269	192,433	206,148	193,718	183,727	168,492	192,596	161,838	194,786	144,052
91	56,910	57,765	78,372	72,680	173,180	157,559	110,933	132,736	153,616	159,707	184,796	132,747	197,464	113,825	176,420	159,828	96,700	116,600	128,434	111,752	100,278	139,660	84,832	117,232	112,703
96	28,455	28,882	31,349	45,425	63,358	78,779	41,086	55,824	68,332	58,580	66,679	44,568	77,059	48,606	71,731	71,969	48,350	46,718	58,883	52,656	48,724	68,985	40,068	47,795	54,667
101	13,437	13,639	27,430	6,814	27,455	32,271	15,065	17,367	22,777	17,882	22,861	14,377	16,375	19,689	28,111	19,628	12,087	16,952	21,335	20,835	25,462	28,157	14,713	19,839	19,172
106	4,742	4,814	7,837	4,543	6,336	11,390	5,478	7,443	7,416	3,700	3,810	3,355	9,632	3,076	11,632	5,608	3,868	5,533	7,254	6,819	12,574	8,166	8,139	4,208	6,477
111	790	802	1,959	0	6,336	5,695	3,652	4,962	3,708	3,700	1,270	958	0	7,383	5,816	2,804	967	2,633	2,133	4,925	8,487	2,816	4,695	4,208	2,591
116	790	802	0	2,271	0	1,898	1,826	1,241	1,589	1,233	1,905	958	963	0	3,877	0	483	966	853	1,894	2,829	1,126	0	2,405	518
121	0	0	0	0	0	0	1,370	0	1,589	1,233	0	958	963	615	969	0	483	497	0	1,894	2,515	0	313	1,503	259
126	790	802	1,959	0	0	0	913	1,241	0	617	1,270	0	963	0	969	0	483	278	427	0	1,257	0	939	301	0
131	0	0	0	0	0	0	457	0	0	617	0	0	0	615	0	0	483	102	0	379	629	0	0	0	0
136	0	0	0	0	0	949	0	0	0	617	0	0	0	0	0	0	0	44	0	0	0	0	313	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	259
146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	301	0
151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	1,241	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	1,241	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	1,241	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	807,798	819,934	1,030,590	1,126,547	1,108,773	948,198	849,116	741,837	1,135,167	1,151,245	1,088,455	1,161,651	1,377,428	670,027	1,488,909	1,268,342	735,884	839,184	777,432	741,350	738,409	798,822	700,254	731,949	636,057

Table 2.3.1. Numbers of spiny lobster by gear, sex, age, and fishing year.

Traps Female

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	201,134	789,973	563,217	260,664	104,874	40,169	16,881	6,941	2,806	1,269	905	423	215	117	59	1,989,648	1,623	1,991,271
86-87	208,309	758,496	543,643	260,824	111,637	46,492	20,110	8,563	3,643	1,621	731	329	154	70	32	1,964,653	2,394	1,967,047
87-88	206,029	805,731	593,506	296,140	131,412	55,767	26,830	12,326	5,386	3,565	2,182	1,240	942	585	330	2,141,970	502	2,142,472
88-89	288,566	1,193,433	812,874	346,191	130,646	49,820	19,440	7,583	2,965	1,221	568	227	104	52	25	2,853,716	1,879	2,855,595
89-90	262,702	1,182,960	885,142	421,037	174,308	70,920	29,996	12,548	5,201	2,237	1,047	453	207	97	44	3,048,900	1,419	3,050,319
90-91	201,001	860,967	622,811	301,590	132,486	56,249	32,241	17,627	9,071	7,767	8,841	4,409	2,906	1,883	1,046	2,260,898	15,078	2,275,976
91-92	208,776	920,235	665,738	312,268	133,655	57,495	35,322	18,777	9,122	8,721	10,716	5,392	3,669	2,412	1,351	2,393,649	10,571	2,404,220
92-93	218,680	601,912	442,470	234,398	121,133	63,945	43,588	25,135	13,118	12,398	15,004	7,406	4,969	3,275	1,832	1,809,264	12,384	1,821,648
93-94	173,521	752,825	522,639	228,545	88,638	34,016	19,127	9,844	4,659	2,933	4,480	2,054	1,094	688	363	1,845,425	2,636	1,848,061
94-95	223,804	980,202	706,336	336,004	145,786	63,698	34,161	16,986	7,959	6,753	7,636	3,797	2,575	1,690	946	2,538,334	10,303	2,548,637
95-96	206,672	947,449	703,992	336,146	145,908	64,390	35,223	18,074	8,858	8,359	9,779	4,866	3,344	2,212	1,244	2,496,515	15,445	2,511,960
96-97	299,727	1,241,691	825,395	354,036	142,664	61,239	32,207	15,988	7,609	5,846	6,556	3,169	2,041	1,326	735	3,000,230	2,664	3,002,894
97-98	274,143	1,093,259	694,218	290,983	118,940	52,453	32,290	17,759	8,999	6,463	6,334	3,172	2,005	1,253	684	2,602,956	10,400	2,613,356
98-99	166,090	744,996	533,066	242,251	98,457	39,823	19,599	9,332	4,317	3,382	4,621	2,171	1,337	878	484	1,870,803	4,798	1,875,601
99-00	238,396	1,053,290	742,672	337,278	140,359	59,004	29,164	13,452	5,884	3,730	3,409	1,690	1,085	681	374	2,630,468	3,753	2,634,221
00-01	156,684	699,920	489,625	229,414	103,877	48,850	31,184	17,006	8,468	8,115	10,224	5,055	3,396	2,243	1,255	1,815,316	17,166	1,832,482
01-02	74,307	358,667	274,379	138,895	64,715	30,023	16,588	8,574	4,186	3,238	4,143	1,948	1,202	786	433	982,084	8,697	990,781
02-03	110,830	555,456	425,157	209,043	92,506	40,668	22,410	11,338	5,395	4,270	5,168	2,503	1,600	1,041	576	1,487,962	8,396	1,496,358
03-04	123,439	583,938	426,961	198,241	82,341	34,444	15,540	6,886	2,993	1,573	891	438	273	159	85	1,478,203	514	1,478,717
04-05	197,739	856,151	581,254	254,950	103,602	43,478	20,147	9,037	3,940	1,849	884	423	224	111	55	2,073,842	1,130	2,074,972
05-06	149,437	581,750	353,663	134,723	48,035	18,331	8,185	3,680	1,616	1,054	605	342	262	162	92	1,301,936	0	1,301,936
06-07	174,593	703,511	488,937	214,320	82,056	31,214	12,780	5,331	2,241	961	432	194	84	35	15	1,716,704	490	1,717,194
07-08	143,165	598,316	396,209	166,054	63,310	24,721	10,808	4,862	2,192	991	469	218	96	41	17	1,411,468	412	1,411,880
08-09	131,740	533,385	331,635	125,728	42,638	14,978	5,910	2,382	967	453	223	112	65	35	18	1,190,270	155	1,190,425
09-10	165,040	684,910	440,850	175,871	62,180	22,004	8,086	3,119	1,265	525	222	93	37	14	6	1,564,222	0	1,564,222

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Traps Male

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	556,508	984,427	479,989	193,109	76,728	30,772	13,303	5,844	2,652	1,204	583	518	223	125	54	2,346,037	1,840	2,347,877
86-87	531,289	905,524	469,351	205,093	88,222	38,668	16,533	7,496	3,393	2,219	2,171	2,486	1,153	695	315	2,274,608	4,936	2,279,544
87-88	464,409	869,323	496,440	216,008	86,800	35,087	14,738	6,642	3,094	1,448	698	2,177	830	528	215	2,198,437	666	2,199,103
88-89	932,093	1,424,879	605,054	214,890	77,943	29,337	11,798	4,960	2,118	1,146	930	547	294	162	79	3,306,232	1,996	3,308,228
89-90	744,431	1,296,041	679,587	295,505	124,124	52,767	22,752	10,173	4,614	2,453	1,754	2,077	919	549	242	3,237,988	3,551	3,241,539
90-91	619,958	982,950	464,433	191,587	82,369	40,696	21,087	11,345	6,104	5,031	5,712	7,042	3,308	2,014	918	2,444,555	11,874	2,456,429
91-92	593,591	1,104,917	569,062	239,243	99,965	45,579	22,217	11,217	5,803	4,171	4,206	10,529	4,378	2,790	1,196	2,718,862	34,552	2,753,414
92-93	492,718	648,466	326,832	149,302	73,686	44,706	28,064	17,054	9,947	8,908	10,571	14,795	6,806	4,189	1,890	1,837,935	57,822	1,895,757
93-94	655,245	1,020,466	424,468	149,587	58,471	29,306	15,890	9,103	5,118	3,797	3,768	3,817	1,845	1,096	506	2,382,483	23,822	2,406,305
94-95	740,194	1,167,315	552,400	238,401	108,317	55,335	29,324	15,884	8,601	6,314	6,339	8,229	3,782	2,304	1,038	2,943,776	18,634	2,962,410
95-96	549,268	987,349	509,204	222,440	100,268	51,930	28,433	15,637	8,616	6,997	7,758	11,721	5,291	3,271	1,462	2,509,645	46,209	2,555,854
96-97	783,313	1,348,849	615,585	229,795	89,740	40,447	20,030	10,514	5,403	3,928	4,091	5,223	2,400	1,462	660	3,161,440	13,071	3,174,511
97-98	916,485	1,406,123	606,567	230,478	94,330	44,742	22,832	12,227	6,520	5,175	5,715	8,089	3,680	2,264	1,016	3,366,244	23,031	3,389,275
98-99	524,771	902,757	430,542	172,793	71,863	34,507	18,189	9,877	5,387	3,163	2,245	5,688	2,304	1,459	615	2,186,161	12,431	2,198,592
99-00	801,773	1,341,387	618,289	247,166	103,706	48,146	23,835	12,230	6,244	3,929	3,393	2,772	1,378	795	372	3,215,415	5,949	3,221,364
00-01	459,325	781,556	382,568	166,050	75,140	39,118	21,727	12,128	6,703	5,045	5,193	8,171	3,633	2,249	997	1,969,603	17,417	1,987,020
01-02	237,731	396,320	196,319	84,625	37,488	18,694	9,911	5,324	2,859	2,040	2,006	3,245	1,430	886	391	999,270	12,961	1,012,231
02-03	365,025	677,408	334,930	136,162	56,808	26,174	12,838	6,540	3,356	2,742	3,170	4,126	1,919	1,175	533	1,632,906	13,442	1,646,348
03-04	391,903	679,526	330,640	135,131	55,066	23,050	9,897	4,363	1,934	991	690	607	282	162	74	1,634,315	1,679	1,635,994
04-05	590,330	945,185	435,226	174,571	72,502	32,447	14,783	7,144	3,440	2,211	2,046	1,885	913	536	248	2,283,467	744	2,284,211
05-06	520,660	688,121	252,107	84,889	31,595	13,085	5,932	2,820	1,364	811	673	522	262	150	70	1,603,061	0	1,603,061
06-07	489,506	842,399	429,118	180,679	74,977	31,849	13,914	6,278	2,858	1,516	1,085	1,374	602	362	159	2,076,678	0	2,076,678
07-08	479,732	703,536	280,425	99,013	38,154	16,657	7,695	3,744	1,837	863	383	173	76	33	14	1,632,335	264	1,632,599
08-09	507,642	680,084	239,803	74,589	25,841	10,215	4,526	2,136	1,038	856	1,025	1,290	606	371	169	1,550,192	1,082	1,551,274
09-10	665,030	911,400	348,731	116,919	41,062	14,957	5,503	2,058	771	292	112	43	16	6	2	2,106,902	0	2,106,902

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Diving Females

Fishing							Ages										
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	42,229	12,450	2,299	471	157	72	46	26	13	19	18	10	8	6	3	57,826	26	57,852
86-87	30,111	15,365	5,005	1,390	404	147	75	39	20	28	25	14	12	8	5	52,649	29	52,678
87-88	15,284	7,350	2,201	734	292	130	75	41	21	26	24	14	11	7	4	26,215	35	26,250
88-89	24,621	11,805	3,644	1,232	465	191	100	52	26	29	27	15	12	8	4	42,230	42	42,272
89-90	30,995	14,825	4,637	1,564	565	216	98	48	23	21	17	10	8	5	3	53,031	21	53,052
90-91	19,348	9,294	2,827	953	373	161	91	49	25	30	28	16	12	8	5	33,220	46	33,266
91-92	40,033	17,617	4,680	1,401	559	272	220	134	70	86	108	55	40	27	15	65,318	253	65,571
92-93	42,004	18,150	4,772	1,744	896	487	435	270	143	171	225	114	80	53	30	69,574	560	70,134
93-94	27,072	13,197	4,142	1,704	993	596	490	305	165	196	313	149	97	65	37	49,522	578	50,100
94-95	42,441	15,214	4,087	1,747	977	553	565	357	187	216	254	133	96	63	36	66,927	688	67,615
95-96	65,396	27,967	6,394	2,139	993	517	438	264	134	133	195	95	61	41	23	104,789	549	105,338
96-97	77,727	27,428	6,302	2,080	965	502	460	287	152	178	244	122	84	56	31	116,618	630	117,248
97-98	85,945	33,327	9,146	3,117	1,343	643	537	325	169	192	269	134	91	60	34	135,334	716	136,050
98-99	75,168	31,021	7,051	2,092	926	466	466	294	156	170	261	127	82	55	30	118,365	750	119,115
99-00	127,714	48,064	13,262	4,616	1,762	705	518	301	154	165	252	123	79	53	29	197,798	723	198,521
00-01	102,972	50,433	18,566	7,170	2,676	1,048	790	468	242	261	400	195	126	84	47	185,477	1,150	186,627
01-02	46,568	35,081	16,629	7,564	3,432	1,552	1,414	892	474	462	435	241	177	113	64	115,100	802	115,902
02-03	93,903	50,821	18,132	6,517	2,569	1,115	820	473	239	317	421	215	155	104	59	175,859	1,036	176,895
03-04	61,661	35,969	14,085	5,824	2,461	1,066	701	397	202	184	254	123	78	51	28	123,085	694	123,779
04-05	122,872	19,733	1,927	651	392	229	258	167	89	98	151	73	48	32	18	146,736	434	147,170
05-06	41,369	21,409	6,626	2,426	1,055	485	398	242	126	129	192	94	60	40	22	74,672	543	75,215
06-07	100,516	21,817	3,283	1,273	740	421	425	270	144	165	236	117	78	52	29	129,568	638	130,206
07-08	50,056	24,174	8,063	3,100	1,342	613	463	276	143	152	210	104	69	46	26	88,836	552	89,388
08-09	48,299	22,821	6,773	2,321	956	430	353	214	112	115	171	83	53	35	20	82,755	484	83,239
09-10	26,184	12,678	4,221	1,645	737	348	274	165	86	94	129	64	43	29	16	46,713	335	47,048

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Diving Males

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	26,507	32,459	12,952	4,713	1,785	644	248	106	48	38	45	39	20	12	6	79,620	157	79,777
86-87	8,401	13,947	9,704	5,875	3,325	1,824	1,032	553	275	147	104	61	31	17	8	45,303	181	45,484
87-88	5,982	11,744	7,096	3,452	1,625	797	396	203	101	77	85	78	39	23	11	31,708	240	31,948
88-89	10,129	19,368	11,350	5,581	2,706	1,344	675	344	170	124	131	138	66	40	18	52,183	345	52,528
89-90	13,128	24,739	14,235	7,039	3,464	1,724	865	437	214	149	152	168	79	48	22	66,463	316	66,779
90-91	7,742	15,019	8,952	4,377	2,090	1,033	517	265	132	99	108	106	52	31	14	40,537	315	40,852
91-92	18,463	31,294	16,300	7,163	3,205	1,563	798	422	216	169	190	208	100	60	28	80,178	1,137	81,315
92-93	21,851	35,879	18,060	7,423	3,128	1,625	876	505	281	273	347	431	204	124	57	91,063	2,473	93,536
93-94	11,523	22,568	12,476	5,783	2,906	1,762	1,006	597	334	344	455	454	227	136	64	60,636	2,994	63,630
94-95	36,119	54,221	22,471	7,931	2,994	1,337	651	352	193	231	334	715	309	196	86	128,139	1,795	129,934
95-96	21,946	54,434	28,640	10,399	3,649	1,572	733	382	202	191	241	379	171	106	48	123,094	2,333	125,427
96-97	35,988	56,751	26,961	10,897	4,562	2,216	1,101	604	327	299	367	471	220	135	61	140,958	2,740	143,698
97-98	38,410	64,168	31,212	14,031	6,596	3,232	1,589	806	404	333	391	523	242	148	67	162,153	3,092	165,245
98-99	25,151	56,591	30,963	12,830	5,378	2,672	1,358	763	414	346	395	540	247	151	68	137,867	3,160	141,027
99-00	62,647	106,310	52,042	21,634	9,442	4,401	1,990	932	437	318	342	503	226	139	62	261,427	3,048	264,475
00-01	47,030	87,619	47,214	22,299	10,589	5,283	2,687	1,431	739	541	563	803	361	222	99	227,480	4,839	232,319
01-02	17,654	37,473	27,689	17,079	9,896	6,180	3,671	2,152	1,212	1,169	1,482	2,009	933	574	260	129,431	8,796	138,227
02-03	35,043	72,793	44,099	23,368	12,065	6,186	3,078	1,527	740	528	555	745	340	208	94	201,368	4,361	205,729
03-04	23,003	47,540	31,383	17,305	9,112	4,832	2,532	1,344	679	431	385	503	225	137	61	139,471	2,918	142,389
04-05	63,608	61,606	14,491	2,847	721	416	272	189	119	135	182	291	132	82	37	145,128	1,829	146,957
05-06	19,479	40,017	22,172	10,102	4,791	2,519	1,339	730	385	322	377	546	248	153	69	103,250	2,550	105,800
06-07	11,678	25,241	13,534	5,541	2,401	1,258	689	409	235	243	319	453	209	129	58	62,398	2,740	65,138
07-08	20,816	39,271	22,771	11,395	5,782	3,118	1,670	911	478	395	457	610	281	173	78	108,206	2,686	110,892
08-09	17,208	33,788	18,301	8,314	3,960	2,090	1,119	617	328	280	330	480	218	135	60	87,228	2,259	89,487
09-10	10,658	20,307	11,928	5,954	3,003	1,631	880	485	257	219	258	340	158	97	44	56,218	1,587	57,805

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Other Females

Fishing Year	Ages 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	2,051	10,147	7,466	3,277	1,220	487	206	89	35	12	4	1	0	0	0	24,995	0	24,995
86-87	2,739	13,564	9,964	4,356	1,615	642	271	117	46	16	5	2	1	0	0	33,338	0	33,338
87-88	669	3,323	2,433	1,056	388	154	65	28	11	4	1	0	0	0	0	8,132	0	8,132
88-89	1,121	5,541	4,075	1,786	663	264	112	48	19	7	2	1	0	0	0	13,639	0	13,639
89-90	2,006	9,916	7,293	3,196	1,187	473	200	86	34	12	4	1	0	0	0	24,409	0	24,409
90-91	1,503	7,432	5,466	2,395	890	354	150	64	25	9	3	1	0	0	0	18,293	0	18,293
91-92	1,931	9,205	6,122	2,263	687	224	81	31	12	4	1	0	0	0	0	20,561	0	20,561
92-93	600	3,011	2,236	1,006	389	160	68	29	12	4	1	0	0	0	0	7,517	0	7,517
93-94	687	3,474	2,556	1,127	427	172	73	31	12	4	1	0	0	0	0	8,567	0	8,567
94-95	623	3,390	2,881	1,667	800	384	184	85	34	12	4	1	0	0	0	10,066	0	10,066
95-96	810	4,095	2,965	1,256	451	175	73	31	12	4	1	0	0	0	0	9,874	0	9,874
96-97	1,411	7,046	5,143	2,218	811	319	134	57	22	8	3	1	0	0	0	17,173	0	17,173
97-98	1,854	9,349	6,767	2,860	1,022	395	164	70	27	10	3	1	0	0	0	22,523	0	22,523
98-99	1,631	9,761	7,679	3,036	823	198	43	10	3	1	0	0	0	0	0	23,185	0	23,185
99-00	1,476	7,691	5,410	2,133	699	250	99	41	16	6	2	1	0	0	0	17,824	0	17,824
00-01	1,866	9,487	6,795	2,800	968	364	149	63	25	9	3	1	0	0	0	22,529	0	22,529
01-02	965	4,884	3,509	1,457	508	193	79	34	13	5	2	1	0	0	0	11,648	0	11,648
02-03	827	4,504	3,121	1,214	419	183	91	44	18	7	2	1	0	0	0	10,432	0	10,432
03-04	890	5,230	3,969	1,568	481	147	45	14	5	1	0	0	0	0	0	12,351	0	12,351
04-05	1,279	6,465	4,652	1,939	679	258	106	45	18	6	2	1	0	0	0	15,450	0	15,450
05-06	2,457	13,257	8,949	3,139	846	242	80	30	11	4	1	0	0	0	0	29,015	0	29,015
06-07	1,982	10,307	7,216	2,807	897	314	122	51	20	7	2	1	0	0	0	23,726	0	23,726
07-08	1,406	7,218	5,127	2,070	698	257	103	43	17	6	2	1	0	0	0	16,949	0	16,949
08-09	1,271	6,540	4,633	1,858	621	227	91	38	15	5	2	1	0	0	0	15,302	0	15,302
09-10	2,234	11,302	8,128	3,382	1,183	449	185	78	31	11	4	1	0	0	0	26,988	0	26,988

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Other Males

Fishing Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	7,144	13,809	6,749	2,650	1,046	413	191	91	42	18	7	3	1	0	0	32,165	0	32,165
86-87	9,482	18,329	8,942	3,502	1,380	544	251	120	55	23	9	3	1	0	0	42,643	0	42,643
87-88	2,282	4,413	2,146	837	329	130	60	28	13	6	2	1	0	0	0	10,247	0	10,247
88-89	3,909	7,553	3,688	1,445	570	225	103	49	23	10	4	1	1	0	0	17,581	0	17,581
89-90	6,997	13,518	6,600	2,586	1,019	402	185	88	41	17	7	2	1	0	0	31,463	0	31,463
90-91	5,245	10,133	4,946	1,938	764	301	139	66	30	13	5	2	1	0	0	23,583	0	23,583
91-92	3,481	7,401	3,685	1,380	494	171	64	24	9	4	1	0	0	0	0	16,715	0	16,715
92-93	1,997	3,913	1,957	799	328	135	65	32	15	7	3	1	0	0	0	9,252	0	9,252
93-94	2,193	4,303	2,132	861	351	144	70	34	16	7	3	1	0	0	0	10,116	0	10,116
94-95	1,901	4,072	2,556	1,325	636	284	146	75	36	15	6	2	1	0	0	11,057	0	11,057
95-96	2,541	4,952	2,386	926	364	144	67	32	15	6	3	1	0	0	0	11,438	0	11,438
96-97	4,700	9,110	4,420	1,723	677	267	124	59	27	12	5	2	1	0	0	21,127	0	21,127
97-98	5,886	11,441	5,499	2,123	828	326	151	72	33	14	6	2	1	0	0	26,381	0	26,381
98-99	12,134	19,526	10,021	4,814	2,182	826	295	98	31	10	3	1	0	0	0	49,941	0	49,941
99-00	3,882	7,644	3,530	1,305	493	191	89	43	20	8	3	1	0	0	0	17,210	0	17,210
00-01	5,649	10,996	5,208	1,973	757	294	135	64	30	12	5	2	1	0	0	25,126	0	25,126
01-02	2,988	5,806	2,760	1,050	404	157	72	34	16	7	3	1	0	0	0	13,297	0	13,297
02-03	4,851	8,098	2,724	587	105	21	5	2	1	0	0	0	0	0	0	16,394	0	16,394
03-04	3,570	7,058	2,838	755	178	44	13	5	2	1	0	0	0	0	0	14,465	0	14,465
04-05	3,993	7,755	3,694	1,408	543	211	97	46	21	9	4	1	0	0	0	17,782	0	17,782
05-06	4,877	9,754	4,045	1,280	411	141	60	28	13	5	2	1	0	0	0	20,616	0	20,616
06-07	5,230	10,257	4,683	1,697	626	238	107	51	23	10	4	1	1	0	0	22,927	0	22,927
07-08	4,032	7,877	3,688	1,380	525	203	93	44	20	9	4	1	0	0	0	17,877	0	17,877
08-09	3,585	7,009	3,268	1,217	461	178	81	39	18	8	3	1	0	0	0	15,868	0	15,868
09-10	6,934	13,476	6,415	2,445	942	367	168	80	37	15	6	2	1	0	0	30,888	0	30,888

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Attractants Females

Fishing Year	Ages 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	393,998	170,735	27,121	3,965	1,065	387	152	61	25	11	4	2	1	0	0	597,528	0	597,528
86-87	494,319	209,146	30,549	3,550	807	286	112	45	19	8	3	1	1	0	0	738,848	0	738,848
87-88	243,573	104,171	15,819	2,064	515	185	73	29	12	5	2	1	0	0	0	366,449	0	366,449
88-89	221,219	93,585	13,663	1,585	360	128	50	20	8	3	1	1	0	0	0	330,625	0	330,625
89-90	331,324	140,228	20,507	2,392	546	194	76	31	13	5	2	1	0	0	0	495,319	0	495,319
90-91	464,407	197,931	29,691	3,741	909	326	128	52	21	9	4	2	1	0	0	697,221	0	697,221
91-92	266,588	113,694	17,094	2,168	530	190	74	30	12	5	2	1	0	0	0	400,391	0	400,391
92-93	220,050	93,624	13,957	1,727	414	148	58	24	10	4	2	1	0	0	0	330,018	0	330,018
93-94	149,995	60,910	8,469	822	144	45	17	7	3	1	0	0	0	0	0	220,413	0	220,413
94-95	188,539	81,846	12,734	1,838	505	184	70	27	10	4	2	1	0	0	0	285,759	0	285,759
95-96	194,847	81,576	12,411	1,680	469	185	78	33	14	6	3	1	0	0	0	291,302	0	291,302
96-97	219,318	91,418	14,968	2,410	675	246	99	42	19	8	4	2	1	0	0	329,209	0	329,209
97-98	257,608	118,186	16,725	1,562	253	77	28	10	4	1	1	0	0	0	0	394,455	0	394,455
98-99	127,130	44,235	6,478	844	199	66	24	9	3	1	0	0	0	0	0	178,990	0	178,990
99-00	239,610	86,668	11,703	1,264	273	96	38	15	6	3	1	0	0	0	0	339,677	0	339,677
00-01	189,184	76,619	10,816	1,128	220	73	27	10	4	2	1	0	0	0	0	278,084	0	278,084
01-02	150,532	49,925	6,277	832	247	96	37	13	5	2	1	0	0	0	0	207,967	0	207,967
02-03	121,667	60,775	8,165	628	62	12	3	1	0	0	0	0	0	0	0	191,313	0	191,313
03-04	139,152	51,045	6,234	564	107	37	14	5	2	1	0	0	0	0	0	197,161	0	197,161
04-05	147,274	53,944	6,538	569	103	35	13	5	2	1	0	0	0	0	0	208,484	0	208,484
05-06	88,678	32,431	3,899	326	55	18	7	2	1	0	0	0	0	0	0	125,418	0	125,418
06-07	95,853	35,196	4,320	400	78	27	10	4	1	0	0	0	0	0	0	135,890	0	135,890
07-08	111,242	40,830	5,001	459	89	31	11	4	1	1	0	0	0	0	0	157,670	0	157,670
08-09	58,309	21,504	2,698	275	60	21	8	3	1	0	0	0	0	0	0	82,880	0	82,880
09-10	82,066	30,394	3,895	431	103	37	14	5	2	1	0	0	0	0	0	116,947	0	116,947

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Attractants Males

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	346,204	47,899	5,436	1,621	606	229	84	30	10	3	1	0	0	0	0	402,124	0	402,124
86-87	431,592	54,854	4,628	1,215	449	169	62	22	7	2	1	0	0	0	0	493,003	0	493,003
87-88	213,273	28,184	2,763	779	290	109	40	14	5	2	1	0	0	0	0	245,460	0	245,460
88-89	193,139	24,535	2,066	542	200	75	28	10	3	1	0	0	0	0	0	220,599	0	220,599
89-90	289,305	36,813	3,121	821	303	115	42	15	5	2	1	0	0	0	0	330,543	0	330,543
90-91	406,262	53,026	4,972	1,375	510	193	71	25	8	3	1	0	0	0	0	466,447	0	466,447
91-92	233,251	30,516	2,886	801	298	112	41	15	5	2	1	0	0	0	0	267,927	0	267,927
92-93	192,411	24,958	2,286	625	232	88	32	11	4	1	0	0	0	0	0	220,649	0	220,649
93-94	140,239	16,705	1,037	193	61	21	7	3	1	0	0	0	0	0	0	158,267	0	158,267
94-95	165,600	23,014	2,502	773	296	111	40	14	5	2	1	0	0	0	0	192,357	0	192,357
95-96	169,265	20,722	2,145	724	306	125	48	18	6	2	1	0	0	0	0	193,362	0	193,362
96-97	196,674	27,911	3,487	1,005	346	122	42	14	5	2	1	0	0	0	0	229,607	0	229,607
97-98	200,403	26,709	1,904	400	133	48	17	6	2	1	0	0	0	0	0	229,623	0	229,623
98-99	116,921	12,886	1,279	345	120	43	16	5	2	1	0	0	0	0	0	131,619	0	131,619
99-00	224,054	27,101	2,113	527	197	77	29	11	4	1	0	0	0	0	0	254,114	0	254,114
00-01	156,754	19,335	1,602	406	149	56	20	7	2	1	0	0	0	0	0	178,334	0	178,334
01-02	153,914	15,882	1,605	823	442	202	84	32	11	4	1	0	0	0	0	173,000	0	173,000
02-03	176,229	24,297	1,927	630	324	156	68	27	10	4	1	0	0	0	0	203,673	0	203,673
03-04	155,746	17,270	1,235	469	246	115	49	19	7	2	1	0	0	0	0	175,159	0	175,159
04-05	164,773	18,142	1,220	445	233	108	46	18	6	2	1	0	0	0	0	184,995	0	184,995
05-06	99,174	10,837	679	235	123	57	24	9	3	1	0	0	0	0	0	111,144	0	111,144
06-07	107,310	11,953	886	345	181	84	36	14	5	2	1	0	0	0	0	120,816	0	120,816
07-08	124,526	13,844	1,011	389	205	95	40	16	6	2	1	0	0	0	0	140,135	0	140,135
08-09	65,353	7,430	640	270	143	66	28	11	4	1	0	0	0	0	0	73,947	0	73,947
09-10	92,081	10,675	1,040	462	245	114	48	19	7	2	1	0	0	0	0	104,694	0	104,694

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Recreational Females

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	67,976	223,867	130,130	45,368	13,527	4,111	1,907	856	355	163	100	60	33	16	7	488,476	0	488,476
86-87	68,997	227,230	132,085	46,050	13,731	4,173	1,936	869	360	166	102	61	33	16	8	495,813	0	495,813
87-88	75,916	262,743	162,781	61,928	20,335	6,666	2,963	1,276	513	226	132	77	41	20	9	595,626	0	595,626
88-89	107,324	338,707	185,231	58,579	15,298	4,085	2,044	980	424	207	135	83	46	22	11	713,176	0	713,176
89-90	86,146	336,303	214,413	81,089	26,098	8,267	2,592	810	251	76	23	7	2	1	0	756,078	0	756,078
90-91	73,823	301,091	202,938	81,269	26,879	8,747	2,966	1,094	428	171	71	29	12	5	2	699,523	0	699,523
91-92	58,387	223,064	135,816	48,127	14,375	4,447	1,494	554	222	224	141	86	79	53	31	487,101	0	487,101
92-93	42,746	195,526	135,578	56,529	19,627	6,667	2,295	808	291	465	316	202	203	139	83	461,477	0	461,477
93-94	63,301	277,918	178,249	64,035	18,840	5,703	1,928	754	318	135	60	26	11	4	2	611,284	0	611,284
94-95	65,378	272,244	172,291	62,532	18,817	5,662	1,837	690	293	129	60	27	11	5	2	599,979	0	599,979
95-96	60,823	270,094	171,269	59,920	16,499	4,471	1,240	368	120	43	15	5	2	1	0	584,871	0	584,871
96-97	73,528	291,950	172,615	57,571	15,606	4,244	1,196	359	117	40	14	5	2	1	0	617,247	0	617,247
97-98	84,866	374,552	235,336	81,893	22,759	6,243	1,747	509	162	58	21	7	3	1	0	808,156	0	808,156
98-99	49,644	228,488	152,445	57,849	17,897	5,485	1,715	556	187	65	394	145	53	38	19	514,980	0	514,980
99-00	85,788	368,693	230,498	82,648	24,732	7,561	2,431	825	278	90	29	9	3	1	0	803,585	0	803,585
00-01	65,992	265,687	160,070	55,439	16,194	5,025	1,697	615	229	86	31	11	4	1	0	571,082	0	571,082
01-02	44,060	186,093	117,644	41,452	11,441	2,993	751	188	48	12	3	1	0	0	0	404,687	0	404,687
02-03	49,094	208,366	133,570	49,424	15,179	4,697	1,572	576	226	105	59	28	16	9	5	462,925	0	462,925
03-04	44,945	200,272	136,531	53,637	17,133	5,263	1,657	580	224	90	40	18	7	3	1	460,399	0	460,399
04-05	40,880	181,755	122,297	47,549	15,185	4,861	1,644	599	240	212	128	75	67	45	26	415,564	0	415,564
05-06	30,714	139,699	97,312	41,304	14,862	5,119	1,992	853	385	177	90	45	20	9	4	332,582	0	332,582
06-07	34,519	149,471	97,983	37,823	12,402	4,072	1,388	498	185	69	27	11	4	2	1	338,453	0	338,453
07-08	36,724	165,249	112,294	45,927	16,419	6,060	2,467	1,009	423	187	84	37	16	7	3	386,907	0	386,907
08-09	35,842	178,380	125,964	49,821	15,843	4,988	1,679	642	265	111	49	21	9	4	1	413,620	0	413,620
09-10	38,126	158,911	108,311	44,047	14,865	4,922	1,766	663	254	101	46	21	10	4	2	372,048	0	372,048

Table 2.3.1 (continued). Numbers of spiny lobster by gear, sex, age, and fishing year.

Recreational Males

Fishing Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	289,083	354,554	116,129	32,444	9,825	3,359	1,340	572	274	125	51	24	11	5	2	807,798	0	807,798
86-87	293,426	359,880	117,874	32,932	9,973	3,409	1,360	581	278	127	52	24	11	5	2	819,934	0	819,934
87-88	343,436	458,803	158,158	46,277	14,539	5,300	2,214	964	485	231	95	47	24	11	5	1,030,590	0	1,030,590
88-89	432,571	486,964	150,359	39,584	11,379	3,508	1,283	526	224	91	37	13	5	2	1	1,126,547	0	1,126,547
89-90	303,403	489,163	212,940	70,349	22,154	7,209	2,378	790	259	86	28	10	3	1	0	1,108,773	0	1,108,773
90-91	229,903	405,749	199,474	73,093	25,256	8,772	3,160	1,164	432	158	57	573	211	140	56	948,198	0	948,198
91-92	227,088	388,271	159,404	48,772	15,082	5,537	2,346	1,119	557	349	299	140	83	44	22	849,116	0	849,116
92-93	154,351	337,512	162,191	55,296	18,012	6,284	2,513	1,073	498	223	90	41	19	9	4	738,114	3,723	741,837
93-94	309,824	512,018	212,421	67,605	21,410	7,334	2,657	1,085	460	200	90	39	15	6	3	1,135,167	0	1,135,167
94-95	318,118	526,699	212,143	63,894	18,832	6,202	2,297	987	458	324	338	518	231	143	63	1,151,245	0	1,151,245
95-96	247,893	510,682	227,268	71,294	20,768	6,398	2,338	974	466	213	88	40	19	9	4	1,088,455	0	1,088,455
96-97	346,326	539,950	198,510	54,805	14,980	4,546	1,503	589	248	109	50	22	9	4	1	1,161,651	0	1,161,651
97-98	357,586	642,074	264,583	79,302	22,735	6,934	2,407	979	451	210	92	43	20	9	4	1,377,428	0	1,377,428
98-99	150,620	301,077	143,387	49,106	16,225	5,725	2,041	760	285	222	287	133	86	48	25	670,027	0	670,027
99-00	398,837	690,552	273,731	83,172	26,192	9,410	3,866	1,727	802	358	151	65	28	12	5	1,488,909	0	1,488,909
00-01	355,935	583,329	230,585	69,349	20,399	6,088	1,844	564	172	53	16	5	2	1	0	1,268,342	0	1,268,342
01-02	188,870	340,190	142,745	43,982	13,075	4,104	1,424	561	249	200	239	112	72	40	21	735,884	0	735,884
02-03	221,435	383,548	159,934	50,165	15,467	5,131	1,847	729	306	149	94	68	32	18	8	838,932	252	839,184
03-04	181,185	350,684	162,884	55,623	17,934	5,849	2,035	746	296	118	45	19	8	3	1	777,432	0	777,432
04-05	176,352	333,107	150,782	51,612	17,708	6,687	2,637	1,159	515	300	254	116	67	35	18	741,350	0	741,350
05-06	184,380	320,454	143,669	52,510	20,218	8,801	4,028	1,954	957	565	449	209	121	63	32	738,409	0	738,409
06-07	176,807	354,882	173,330	62,338	20,939	6,933	2,345	810	286	101	35	12	4	1	0	798,822	0	798,822
07-08	191,108	315,779	128,771	41,656	13,945	5,116	2,039	849	381	170	69	215	82	52	21	700,254	0	700,254
08-09	166,589	335,080	152,340	50,508	16,513	6,083	2,461	1,122	525	241	108	47	20	8	3	731,648	301	731,949
09-10	149,000	279,467	134,787	48,252	16,155	5,353	1,800	628	224	82	31	12	4	2	1	635,798	259	636,057

Table 2.3.2. Numbers of spiny lobster (sexes and gears combined) by age after settlement and fishing year.

Fishing							Ages											
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Aged	Unaged	Total
85-86	1,932,834	2,640,320	1,351,488	548,283	210,833	80,643	34,356	14,616	6,260	2,862	1,718	1,080	513	281	131	6,826,217	3,646	6,829,863
86-87	2,078,664	2,576,336	1,331,745	564,788	231,542	96,355	41,741	18,405	8,095	4,357	3,203	2,981	1,398	812	370	6,960,792	7,540	6,968,332
87-88	1,570,852	2,555,784	1,443,344	629,275	256,525	104,324	47,454	21,552	9,640	5,589	3,222	3,635	1,888	1,175	574	6,654,834	1,443	6,656,277
88-89	2,214,692	3,606,371	1,792,004	671,415	240,231	88,978	35,632	14,573	5,980	2,839	1,836	1,026	528	286	138	8,676,528	4,262	8,680,790
89-90	2,070,435	3,544,506	2,048,474	885,578	353,768	142,286	59,184	25,026	10,656	5,058	3,034	2,729	1,220	701	312	9,152,967	5,307	9,158,274
90-91	2,029,193	2,843,592	1,546,510	662,318	272,526	116,833	60,548	31,751	16,278	13,289	14,831	12,180	6,502	4,082	2,041	7,632,475	27,313	7,659,788
91-92	1,651,590	2,846,214	1,580,788	663,587	268,849	115,590	62,657	32,322	16,029	13,735	15,666	16,411	8,350	5,386	2,644	7,299,818	46,513	7,346,331
92-93	1,387,408	1,962,950	1,110,338	508,849	237,846	124,245	77,996	44,941	24,320	22,453	26,560	22,990	12,281	7,790	3,896	5,574,863	76,962	5,651,825
93-94	1,533,599	2,684,384	1,368,590	520,263	192,242	79,100	41,266	21,763	11,086	7,617	9,170	6,540	3,289	1,997	973	6,481,880	30,030	6,511,910
94-95	1,782,718	3,128,216	1,690,402	716,113	297,959	133,750	69,275	35,456	17,778	14,000	14,973	13,423	7,005	4,400	2,171	7,927,639	31,420	7,959,059
95-96	1,519,461	2,909,321	1,666,674	706,925	289,674	129,906	68,671	35,812	18,444	15,956	18,083	17,110	8,889	5,640	2,780	7,413,345	64,536	7,477,881
96-97	2,038,711	3,642,103	1,873,387	716,540	271,025	114,149	56,896	28,514	13,929	10,430	11,332	9,016	4,757	2,984	1,489	8,795,260	19,105	8,814,365
97-98	2,223,186	3,779,188	1,871,957	706,748	268,938	115,092	61,761	32,763	16,773	12,457	12,832	11,972	6,041	3,736	1,806	9,125,253	37,239	9,162,492
98-99	1,249,259	2,351,336	1,322,911	545,960	214,070	89,813	43,746	21,705	10,785	7,362	8,207	8,804	4,110	2,630	1,242	5,881,938	21,139	5,903,077
99-00	2,184,176	3,737,401	1,953,248	781,743	307,856	129,841	62,058	29,577	13,846	8,608	7,583	5,165	2,800	1,682	843	9,226,427	13,473	9,239,900
00-01	1,541,393	2,584,980	1,353,049	556,030	230,968	106,199	60,260	32,356	16,613	14,125	16,437	14,243	7,523	4,800	2,399	6,541,373	40,572	6,581,945
01-02	917,589	1,430,320	789,554	337,759	141,647	64,194	34,031	17,805	9,074	7,138	8,314	7,558	3,815	2,400	1,169	3,772,368	31,256	3,803,624
02-03	1,178,904	2,046,067	1,131,760	477,738	195,504	84,343	42,731	21,256	10,291	8,121	9,471	7,687	4,062	2,555	1,275	5,221,764	27,487	5,249,251
03-04	1,125,495	1,978,532	1,116,760	469,117	185,060	74,846	32,483	14,359	6,344	3,392	2,306	1,708	874	515	251	5,012,041	5,805	5,017,846
04-05	1,509,099	2,483,842	1,322,082	536,542	211,667	88,731	40,002	18,409	8,390	4,822	3,651	2,867	1,451	842	401	6,232,798	4,137	6,236,935
05-06	1,141,225	1,857,727	893,122	330,934	121,988	48,798	22,043	10,348	4,860	3,069	2,390	1,759	974	578	289	4,440,103	3,093	4,443,196
06-07	1,197,993	2,165,033	1,223,290	507,221	195,298	76,411	31,816	13,715	5,998	3,073	2,142	2,164	982	582	263	5,425,982	3,868	5,429,850
07-08	1,162,809	1,916,096	963,360	371,443	140,468	56,870	25,391	11,757	5,499	2,774	1,678	1,359	622	352	159	4,660,637	3,914	4,664,551
08-09	1,035,838	1,826,021	886,056	314,902	107,035	39,277	16,256	7,204	3,273	2,070	1,911	2,035	972	588	272	4,243,710	4,281	4,247,991
09-10	1,237,353	2,133,521	1,068,304	399,407	140,474	50,182	18,724	7,300	2,934	1,343	809	576	269	152	70	5,061,418	2,181	5,063,599

Table 2.3.3. Carapace lengths, number of lobsters that molted, mean growth increments, standard deviations of growth increments, and the number of molts per year for pre-recruit sized spiny lobsters.

CL (mm)	N	Mean Increment (mm)	St. dev.	Molts
47	5	6.20	1.10	5
48	8	6.88	2.90	5
49	6	7.93	3.09	4
50	5	7.76	4.00	4
51	16	6.28	1.68	4
52	8	6.10	1.16	4
53	13	6.31	1.52	4
54	15	6.30	1.58	4
55	15	6.19	1.94	4
56	18	6.99	2.65	4
57	17	6.84	2.66	4
58	16	6.59	1.67	4
59	18	6.47	2.54	4
60	29	6.86	1.76	4
61	22	7.07	2.37	4
62	21	6.60	2.12	4
63	40	6.55	2.14	4
64	19	7.12	2.40	4
65	35	6.10	2.23	3
66	35	6.55	1.88	3
67	39	7.58	1.84	3
68	29	6.86	2.06	3
69	35	6.76	1.77	3
70	39	6.62	2.05	3
71	29	6.38	2.16	3
72	37	6.22	1.81	3
73	40	6.44	2.67	3
74	38	6.37	2.76	3
75	41	6.80	2.56	3

Table 2.3.4. 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 and post-larvae indices were recalculated based on recommendations from the webinar discussions and the Stock Assessment Workshop.

	Estimated indices								Indices scaled to their means							
Fishing	Post-larvae	FWC Adult	FWC Adult			Biscayne	Observer	Observer	Post-larvae	FWC Adult	FWC Adult			Biscayne	Observer	Observer
year	Age-1	Age-2	Ages 3+	Age-2	Ages 3+	Ages 2+	Age-2	Ages 3+	Age-1	Age-2	Ages 3+			Ages 2+	Age-2	Ages 3+
1978-79						30.35								1.64		
1979-80						24.25								1.31		
1980-81						23.86								1.29		
1981-82						17.51								0.94		
1982-83						13.85								0.75		
1983-84						15.92								0.86		
1984-85						13.20								0.71		
1985-86						7.13								0.38		
1986-87						6.48								0.35		
1987-88	10.20					15.86			0.64					0.85		
1988-89	10.89					15.40			0.69					0.83		
1989-90	15.07					15.71			0.95					0.85		
1990-91	11.91					14.86			0.75					0.80		
1991-92	12.80					23.05			0.81					1.24		
1992-93	13.59					11.62			0.86					0.63		
1993-94	17.79					20.73	2.11	0.70	1.12					1.12	0.85	0.69
1994-95	20.08					15.70	2.24	1.14	1.27					0.85	0.90	1.13
1995-96	17.97					19.87	2.16	1.00	1.14					1.07	0.87	0.99
1996-97	11.35					17.65	2.60	1.08	0.72					0.95	1.05	1.07
1997-98	17.79	11.86	23.28			26.95	2.71	1.29	1.12	1.14	0.77			1.45	1.09	1.27
1998-99	23.02	5.36	16.60			20.87	3.15	1.09	1.46	0.52	0.55			1.12	1.27	1.07
1999-00	15.71	15.20	36.75			35.06	2.60	0.93	0.99	1.46	1.22			1.89	1.05	0.92
2000-01	19.22	11.95	35.15			19.72	2.31	0.85	1.21	1.15	1.16			1.06	0.93	0.85
2001-02	14.30	5.54	22.54			14.47			0.90	0.53	0.75			0.78		
2002-03	16.65	6.37	20.89			20.24			1.05	0.61	0.69			1.09		
2003-04	11.61	5.43	24.70			16.10			0.73	0.52	0.82			0.87		
2004-05	15.74	8.15	28.54	0.47	2.13	19.73			0.99	0.78	0.94	0.47	0.68	1.06		
2005-06	15.79	16.55	47.10	1.05	5.94	17.74			1.00	1.59	1.56	1.04	1.89	0.96		
2006-07	17.50	17.73	46.81	1.68	5.02	16.79			1.11	1.70	1.55	1.66	1.60	0.90		
2007-08	16.78			1.49	4.14	13.29			1.06			1.47	1.32	0.72		
2008-09	19.88			0.69	1.69	22.04			1.26			0.68	0.54	1.19		
2009-10	14.92			0.75	1.58	14.14			0.94			0.74	0.50	0.76		

Table 2.3.5. Coefficients of variation and number of observations associated with the tuning indices

	CVs								Number of observations							
Fishing	Post-larvae	FWC Adul	FWC Adult			Biscayne	Observer	Observer	Post-larvae	FWC Adul	FWC Adult			Biscayne	Observer	Observer
year	Age-1	Age-2	Ages 3+			Ages 2+	Age-2	Ages 3+	Age-1	Age-2	Ages 3+			Ages 2+	Age-2	Ages 3+
1978-79						0.04								159		
1979-80						0.06								96		
1980-81						0.05								124		
1981-82						0.07								144		
1982-83						0.09								152		
1983-84						0.11								94		
1984-85						0.13								97		
1985-86						0.50								20		
1986-87						0.24								134		
1987-88	0.04					0.10			43					91		
1988-89	0.05					0.12			36					81		
1989-90	0.03					0.11			46					88		
1990-91	0.06					0.08			39					200		
1991-92	0.06					0.04			31					241		
1992-93	0.07					0.13			19					97		
1993-94	0.03					0.06	0.00	0.01	44					208	22282	22282
1994-95	0.04					0.06	0.01	0.01	44					236	11499	11499
1995-96	0.03					0.06	0.01	0.01	50					175	13760	16526
1996-97	0.06					0.05	0.01	0.01	40					299	11810	12346
1997-98	0.03	0.06	0.03			0.04	0.01	0.01	36	18	18			268	11499	11499
1998-99	0.04	0.14	0.05			0.04	0.01	0.01	43	18	18			262	9627	9627
1999-00	0.04	0.04	0.04			0.04	0.01	0.02	51	18	18			154	4539	4726
2000-01	0.03	0.07	0.03			0.05	0.01	0.01	52	18	18			288	8203	8257
2001-02	0.04	0.10	0.05			0.07			46	18	18			250		
2002-03	0.04	0.08	0.05			0.06			49	18	18			202		
2003-04	0.04	0.10	0.05			0.06			52	18	18			256		
2004-05	0.04	0.09	0.04	0.24	0.13	0.06			50	18	18	40	40	199		
2005-06	0.04	0.05	0.03	0.16	0.08	0.05			31	18	18	39	39	245		
2006-07	0.05	0.05	0.03	0.16	0.09	0.06			49	18	18	40	40	289		
2007-08	0.09			0.10	0.06	0.07			18			70	70	300		
2008-09	0.03			0.18	0.10	0.04			41			60	60	205		
2009-10	0.05			0.12	0.10	0.07			27			80	80	297		

Table 3.1.1.2. The landings, in numbers, and effort by sector and fishing year that were used in the DeLury model.

	Observed Catch (numbers)				Effort	
Fishing year	Recreational	Commercial	Attractants	Total	Rec person days	Commercial trips
78-79	1,032,818	4,712,160	1,489,053	7,234,031	298,427	32,833
79-80	1,332,146	6,384,958	1,766,902	9,484,006	384,930	44,488
80-81	1,653,054	5,074,434	1,450,653	8,178,141	479,513	35,357
81-82	1,438,200	4,673,563	1,389,579	7,501,342	416,247	32,564
82-83	1,487,598	5,192,189	1,440,506	8,120,293	430,799	36,177
83-84	1,114,641	3,516,013	1,205,460	5,836,114	322,088	24,498
84-85	1,218,015	5,077,610	1,458,513	7,754,138	350,689	35,379
85-86	1,296,274	4,533,937	999,652	6,829,863	339,625	32,351
86-87	1,315,747	4,420,734	1,231,851	6,968,332	317,518	31,082
87-88	1,626,216	4,418,152	611,909	6,656,277	377,255	34,406
88-89	1,839,723	6,289,843	551,224	8,680,790	505,243	36,431
89-90	1,864,851	6,467,561	825,862	9,158,274	497,125	40,276
90-91	1,647,721	4,848,399	1,163,668	7,659,788	433,092	40,537
91-92	1,336,217	5,341,796	668,318	7,346,331	578,003	45,777
92-93	1,203,314	3,897,844	550,667	5,651,825	477,756	35,821
93-94	1,746,451	4,386,779	378,680	6,511,910	515,006	31,568
94-95	1,751,224	5,729,719	478,116	7,959,059	544,438	32,554
95-96	1,673,326	5,319,891	484,664	7,477,881	467,265	32,830
96-97	1,778,898	6,476,651	558,816	8,814,365	541,729	32,848
97-98	2,185,584	6,352,830	624,078	9,162,492	624,074	34,088
98-99	1,185,007	4,407,461	310,609	5,903,077	332,391	26,198
99-00	2,292,494	6,353,615	593,791	9,239,900	554,953	28,141
00-01	1,839,424	4,286,103	456,418	6,581,945	477,776	26,249
01-02	1,140,571	2,282,086	380,967	3,803,624	387,570	19,670
02-03	1,302,106	3,552,156	394,986	5,249,248	367,089	24,131
03-04	1,237,831	3,407,695	372,320	5,017,846	385,656	22,196
04-05	1,156,914	4,686,542	393,479	6,236,935	413,005	20,369
05-06	1,070,991	3,135,643	236,562	4,443,196	440,354	14,990
06-07	1,137,275	4,035,869	256,706	5,429,850	376,722	18,247
07-08	1,087,161	3,279,585	297,805	4,664,551	432,148	18,987
08-09	1,145,569	2,945,595	156,827	4,247,991	373,115	15,273
09-10	1,008,105	3,833,853	221,641	5,063,599	373,863	14,335

Table 3.1.2.1. Components of the objective function from the ADMB run of the DeLury model for spiny lobster off the SE US. All statistics were calculated on log-transformed values.

Components	Residual SS	DF	MS	Likelihood	%
Recreational	0.37	17	0.02	-4511.02	28.48%
Commercial	0.41	24	0.02	-8726.33	55.09%
Commercial bait	0.13	7	0.02	-88.54	0.56%
Observer legal-sized	0.21	7	0.03	-87.93	0.56%
FWCtimedadults	0.93	9	0.10	-132.49	0.84%
FWCtransectadult	1.81	5	0.36	-35.64	0.22%
Bayscane National Park	2.44	31	0.08	-1415.06	8.93%
Post-larvae	2.06	21	0.10	-601.10	3.79%
Obsever pre-recruits	0.33	7	0.05	-86.96	0.55%
FWC timed pre-recruits	2.80	9	0.31	-117.09	0.74%
FWC transect pre-recruits	1.12	5	0.22	-41.13	0.26%
Recruitment anomalies	2.07	31	0.07	2.06	-0.01%
TOTAL	14.67			-15840.70	100.00%

Table 3.1.2.3. Runs of the DeLury model with alternative natural mortality rates of 0.25 per year and 0.43 per year as well as the final run value of 0.34 for comparison.

	M = 0.25			M = 0.34			M = 0.43		
Fishing year	Population	Recruitment	Fishing mortality	Population	Recruitment	Fishing mortality	Population	Recruitment	Fishing mortality
1978-79	9,724,200	13,269,782	1.74	11,471,000	14,403,762	1.32	19,619,000	16,207,749	0.99
1979-80	14,606,000	11,911,323	2.34	16,588,000	12,994,022	1.77	17,976,000	14,606,833	1.33
1980-81	13,012,000	8,016,400	1.99	14,996,000	8,632,114	1.51	13,368,000	9,597,373	1.13
1981-82	9,398,200	6,927,434	1.81	10,989,000	7,452,052	1.38	11,403,000	8,301,942	1.03
1982-83	8,123,000	6,635,868	1.99	9,428,300	7,496,899	1.51	11,133,000	8,745,064	1.13
1983-84	7,500,300	6,107,328	1.37	8,976,200	6,602,771	1.04	10,753,000	7,429,729	0.78
1984-85	7,591,600	6,280,750	1.89	8,860,700	6,899,779	1.44	10,235,000	7,849,811	1.08
1985-86	7,170,100	6,058,665	1.75	8,402,500	6,689,168	1.32	10,132,000	7,663,658	0.99
1986-87	7,031,800	6,401,225	1.67	8,281,300	6,983,076	1.27	10,460,000	7,912,861	0.95
1987-88	7,432,800	9,388,537	1.87	8,646,200	10,334,517	1.42	14,146,000	11,792,803	1.06
1988-89	10,284,000	9,202,631	2.06	11,823,000	9,899,551	1.56	13,843,000	10,995,537	1.17
1989-90	10,223,000	6,602,771	2.23	11,663,000	7,025,100	1.69	10,228,000	7,694,374	1.27
1990-91	7,461,800	7,702,072	2.19	8,556,100	8,227,560	1.66	10,988,000	9,074,692	1.25
1991-92	8,347,600	6,858,505	2.54	9,383,500	7,542,015	1.93	10,234,000	8,554,774	1.45
1992-93	7,368,600	8,170,168	2.01	8,510,300	9,101,957	1.52	12,628,000	10,501,199	1.14
1993-94	8,942,400	8,868,356	1.84	10,420,000	9,732,681	1.40	13,966,000	11,083,854	1.05
1994-95	9,970,800	8,877,229	1.91	11,570,000	9,732,681	1.45	14,119,000	11,050,652	1.09
1995-96	10,023,000	9,578,198	1.86	11,664,000	10,490,703	1.41	15,082,000	11,899,417	1.06
1996-97	10,785,000	10,282,973	1.92	12,505,000	11,184,059	1.46	15,879,000	12,597,387	1.09
1997-98	11,511,000	7,834,127	2.04	13,251,000	8,797,692	1.55	13,452,000	10,221,460	1.16
1998-99	9,002,100	9,879,772	1.46	10,802,000	10,907,923	1.11	16,313,000	12,497,010	0.83
1999-00	11,513,000	8,048,530	1.71	13,448,000	8,815,305	1.30	14,024,000	10,029,086	0.98
2000-01	9,658,500	5,277,695	1.57	11,417,000	5,944,637	1.19	10,700,000	6,962,158	0.89
2001-02	6,845,900	6,388,436	1.20	8,416,000	7,181,365	0.91	11,926,000	8,410,572	0.68
2002-03	7,998,900	6,230,705	1.39	9,593,600	7,039,164	1.05	11,804,000	8,285,355	0.79
2003-04	7,782,500	6,649,153	1.31	9,418,200	7,557,115	1.00	12,582,000	8,948,532	0.75
2004-05	8,280,000	5,509,586	1.25	10,032,000	6,299,621	0.95	11,528,000	7,511,908	0.71
2005-06	7,355,500	6,556,713	1.02	9,063,200	7,504,399	0.78	13,166,000	8,975,417	0.58
2006-07	8,618,900	5,632,140	1.12	10,476,000	6,394,827	0.85	12,115,000	7,602,594	0.64
2007-08	7,809,500	5,832,755	1.20	9,570,300	6,769,921	0.91	12,176,000	8,194,715	0.68
2008-09	7,661,500	5,576,099	0.99	9,510,200	6,484,985	0.75	12,399,000	7,873,396	0.56
2009-10	7,805,900	6,218,256	0.94	9,693,300	7,025,100	0.72	12,399,000	8,260,536	0.54

Table 3.1.2.6. Total and sector-specific fishing mortality by fishing year obtained from the Delury model base run (M = 0.34 $year^{-1}$)

Fishing year	Recreational	Commercial	Bait	Total
1978-79	0.17	1.06	0.09	1.32
1979-80	0.22	1.43	0.12	1.77
1980-81	0.28	1.14	0.10	1.51
1981-82	0.24	1.05	0.09	1.38
1982-83	0.25	1.16	0.10	1.51
1983-84	0.19	0.79	0.07	1.04
1984-85	0.20	1.14	0.10	1.44
1985-86	0.20	1.04	0.09	1.32
1986-87	0.18	1.00	0.08	1.27
1987-88	0.22	1.11	0.09	1.42
1988-89	0.29	1.17	0.10	1.56
1989-90	0.29	1.30	0.11	1.69
1990-91	0.25	1.30	0.11	1.66
1991-92	0.33	1.47	0.13	1.93
1992-93	0.27	1.15	0.10	1.52
1993-94	0.30	1.02	0.09	1.40
1994-95	0.31	1.05	0.09	1.45
1995-96	0.27	1.06	0.09	1.41
1996-97	0.31	1.06	0.09	1.46
1997-98	0.36	1.10	0.09	1.55
1998-99	0.19	0.84	0.07	1.11
1999-00	0.32	0.91	0.08	1.30
2000-01	0.27	0.84	0.07	1.19
2001-02	0.22	0.63	0.05	0.91
2002-03	0.21	0.78	0.07	1.05
2003-04	0.22	0.71	0.06	1.00
2004-05	0.24	0.66	0.06	0.95
2005-06	0.25	0.48	0.04	0.78
2006-07	0.22	0.59	0.05	0.85
2007-08	0.25	0.61	0.05	0.91
2008-09	0.21	0.49	0.04	0.75
2009-10	0.21	0.46	0.04	0.72

Table 3.2.1.2.1. Catch-at-age, in numbers of fish, by fishing year of both sexes and all gears.

Fishing	Age after settlement											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	1932834	2640320	1351488	548283	210833	80643	34356	14616	6260	2862	1718	5651
1986	2078664	2576336	1331745	564788	231542	96355	41741	18405	8095	4357	3203	13101
1987	1570852	2555784	1443344	629275	256525	104324	47454	21552	9640	5589	3222	8715
1988	2214692	3606371	1792004	671415	240231	88978	35632	14573	5980	2839	1836	6239
1989	2070435	3544506	2048474	885578	353768	142286	59184	25026	10656	5058	3034	10269
1990	2029193	2843592	1546510	662318	272526	116833	60548	31751	16278	13289	14831	52119
1991	1651590	2846214	1580788	663587	268849	115590	62657	32322	16029	13735	15666	79304
1992	1387408	1962950	1110338	508849	237846	124245	77996	44941	24320	22453	26560	123919
1993	1533599	2684384	1368590	520263	192242	79100	41266	21763	11086	7617	9170	42829
1994	1782718	3128216	1690402	716113	297959	133750	69275	35456	17778	14000	14973	58420
1995	1519461	2909321	1666674	706925	289674	129906	68671	35812	18444	15956	18083	98954
1996	2038711	3642103	1873387	716540	271025	114149	56896	28514	13929	10430	11332	37350
1997	2223186	3779188	1871957	706748	268938	115092	61761	32763	16773	12457	12832	60794
1998	1249259	2351336	1322911	545960	214070	89813	43746	21705	10785	7362	8207	37924
1999	2184176	3737401	1953248	781743	307856	129841	62058	29577	13846	8608	7583	23963
2000	1541393	2584980	1353049	556030	230968	106199	60260	32356	16613	14125	16437	69536
2001	917589	1430320	789554	337759	141647	64194	34031	17805	9074	7138	8314	46198
2002	1178904	2046067	1131760	477738	195504	84343	42731	21256	10291	8121	9471	43066
2003	1125495	1978532	1116760	469117	185060	74846	32483	14359	6344	3392	2306	9152
2004	1509099	2483842	1322082	536542	211667	88731	40002	18409	8390	4822	3651	9697
2005	1141225	1857727	893122	330934	121988	48798	22043	10348	4860	3069	2390	6692
2006	1197993	2165033	1223290	507221	195298	76411	31816	13715	5998	3073	2142	7859
2007	1162809	1916096	963360	371443	140468	56870	25391	11757	5499	2774	1678	6406
2008	1035838	1826021	886056	314902	107035	39277	16256	7204	3273	2070	1911	8148
2009	1237353	2133521	1068304	399407	140474	50182	18724	7300	2934	1343	809	3249

Table 3.2.1.2.2. Average weight (lb) of harvested spiny lobsters by age after settlement and fishing year.

Fishing	Age after settlement											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	0.805	1.058	1.246	1.438	1.616	1.784	2.046	2.255	2.433	2.628	2.989	3.370
1986	0.780	1.050	1.260	1.471	1.672	1.867	2.071	2.255	2.402	2.736	3.198	3.740
1987	0.839	1.078	1.274	1.464	1.643	1.821	2.088	2.292	2.449	2.752	2.959	3.610
1988	0.868	1.059	1.217	1.392	1.578	1.759	1.968	2.140	2.277	2.561	3.059	3.412
1989	0.842	1.085	1.270	1.458	1.645	1.829	2.022	2.193	2.341	2.590	3.010	3.670
1990	0.794	1.066	1.258	1.463	1.685	1.931	2.265	2.482	2.621	3.023	3.417	3.688
1991	0.848	1.086	1.263	1.464	1.683	1.922	2.284	2.494	2.630	3.034	3.418	3.763
1992	0.787	1.079	1.276	1.517	1.795	2.096	2.412	2.579	2.688	3.094	3.463	3.729
1993	0.883	1.077	1.232	1.412	1.638	1.935	2.328	2.567	2.719	3.041	3.463	3.683
1994	0.881	1.079	1.260	1.472	1.701	1.968	2.281	2.492	2.646	3.046	3.434	3.739
1995	0.873	1.095	1.264	1.462	1.695	1.974	2.306	2.517	2.666	3.081	3.457	3.765
1996	0.880	1.073	1.225	1.416	1.649	1.909	2.206	2.403	2.530	2.939	3.394	3.681
1997	0.881	1.068	1.228	1.432	1.679	1.957	2.298	2.502	2.631	2.993	3.392	3.743
1998	0.880	1.094	1.258	1.445	1.658	1.920	2.244	2.478	2.650	2.971	3.417	3.814
1999	0.877	1.081	1.247	1.450	1.671	1.905	2.181	2.382	2.536	2.879	3.313	3.581
2000	0.873	1.079	1.256	1.480	1.727	1.993	2.317	2.506	2.633	3.030	3.432	3.711
2001	0.830	1.085	1.270	1.484	1.718	1.973	2.265	2.458	2.598	3.005	3.464	3.759
2002	0.875	1.093	1.268	1.469	1.687	1.913	2.207	2.404	2.542	2.977	3.428	3.700
2003	0.863	1.093	1.268	1.459	1.658	1.852	2.066	2.237	2.370	2.668	3.121	3.517
2004	0.875	1.073	1.242	1.441	1.658	1.886	2.116	2.305	2.446	2.792	3.231	3.651
2005	0.879	1.060	1.221	1.420	1.645	1.884	2.153	2.364	2.524	2.889	3.283	3.592
2006	0.871	1.093	1.268	1.455	1.649	1.847	2.068	2.263	2.424	2.724	3.191	3.754
2007	0.866	1.066	1.228	1.423	1.640	1.869	2.121	2.324	2.484	2.689	3.058	3.551
2008	0.880	1.065	1.211	1.380	1.580	1.811	2.083	2.313	2.492	2.927	3.400	3.834
2009	0.880	1.069	1.228	1.401	1.578	1.747	1.928	2.100	2.247	2.503	3.009	3.495

Table 3.2.1.2.3. Estimated average weight (lb) in the population from the tagging growth trajectories of spiny lobsters.

Fishing	Age after settlement											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1985	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1986	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1987	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1988	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1989	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1990	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1991	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1992	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1993	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1994	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1995	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1996	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1997	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1998	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
1999	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2000	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2001	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2002	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2003	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2004	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2005	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2006	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2007	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2008	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579
2009	0.381	0.780	1.097	1.349	1.575	1.745	1.904	2.050	2.190	2.296	2.395	2.579

Table 3.2.1.2.4. Age-specific life history information used in ICA model (M = natural mortality; wt = weight; Mat = maturity) for the spiny lobster population off SE-US.

		Tagging ages		Lipofuscin ages	
Age	M ($year^{-1}$)	Wt (lbs)	Mat	Wt (lbs)	Mat
1	0.34	0.381	0	0.418	0
2	0.34	0.780	0.5	1.096	0.5
3	0.34	1.097	0.75	1.513	0.75
4	0.34	1.349	1	1.726	1
5	0.34	1.575	1	1.829	1
6	0.34	1.745	1	1.878	1
7	0.34	1.904	1	1.909	1
8	0.34	2.050	1	1.924	1
9	0.34	2.190	1	1.940	1
10	0.34	2.296	1	1.946	1
11	0.34	2.395	1	1.940	1
12+	0.34	2.579	1	1.948	1

Table 3.2.2.1. Analysis of variances from components in the objective function for ICA model.

a) ICA run with all indices included

SOURCES	SSQ	Data	Parameters	d.f.	Variance	Chi-sq	Prob Ho
Total for model	19.0392	260	57	203	0.0938		
Catches at age	5.7027	165	49	116	0.0492	2.7847	0.0000
Obs Pre-recruit Age 2	0.2415	8	1	7	0.0345	0.2694	0.0001
Obs Adult Age 3+	0.4270	8	1	7	0.0610	0.1790	0.0000
Puerulus 1988-2009	1.5096	22	1	21	0.0719	0.5539	0.0000
FWC Adult Mon Pre-recruit Timed	1.3915	10	1	9	0.1546	0.6202	0.0001
FWC Adult Mon Legal Timed	1.5568	10	1	9	0.1730	0.4574	0.0000
Biscayne National Park	4.5673	25	1	24	0.1903	1.5913	0.0000
FWC Adult Mon Pre-recruit Transect	1.1825	6	1	5	0.2365	0.5350	0.0092
FWC Adult Mon Legal Transect	2.4603	6	1	5	0.4921	2.2269	0.1831

b) Final ICA base run without the component for FWC Adult Monitoring Legal sizes Transect, which was not significant

SOURCES	SSQ	Data	Parameters	d.f.	Variance	Chi-sq	Prob Ho
Total for model	16.1104	254	56	198	0.0814		
Catches at age	5.6143	165	49	116	0.0484	2.7788	0.0000
Obs Pre-recruit Age 2	0.2285	8	1	7	0.0326	0.2545	0.0001
Obs Adult Age 2+	0.4165	8	1	7	0.0595	0.1746	0.0000
Puerulus 1988-2009	1.4938	22	1	21	0.0711	0.5517	0.0000
FWC Adult Mon Pre-recruit Timed	1.2778	10	1	9	0.1420	0.5688	0.0001
FWC Adult Mon Legal Timed	1.3895	10	1	9	0.1544	0.4085	0.0000
Biscayne National Park	4.5450	25	1	24	0.1894	1.6001	0.0000
FWC Adult Mon Pre-recruit Transect	1.1450	6	1	5	0.2290	0.5111	0.0083

Table 3.2.2.2. The parameters in the ICA model with their maximum likelihood values, CV, 95% confidence intervals, and the mean estimate.

Fishing mortality on age-3 spiny lobsters					
Fishing year	Max like	CV	Low 95%	Upper 95%	Mean
1995	0.4879	10	0.3966	0.6003	0.4907
1996	0.4903	10	0.4007	0.5999	0.4929
1997	0.6039	9	0.4978	0.7326	0.6069
1998	0.4236	10	0.3458	0.5188	0.4258
1999	0.6547	9	0.5413	0.7918	0.6578
2000	0.7846	9	0.6529	0.9429	0.788
2001	0.4745	10	0.3875	0.5811	0.4771
2002	0.6407	9	0.5269	0.779	0.6439
2003	0.4793	10	0.3886	0.5913	0.4821
2004	0.6228	10	0.5037	0.77	0.6265
2005	0.3816	12	0.2993	0.4866	0.3846
2006	0.4603	13	0.3513	0.6032	0.4647
2007	0.3231	15	0.2361	0.442	0.3272
2008	0.1975	17	0.14	0.2785	0.2005
2009	0.1462	18	0.1018	0.2101	0.1488

Population at age 11 (numbers in thousands)					
Fishing year	Max like	CV	Low 95%	Upper 95%	Mean
1995	53	30	29	96	55
1996	36	22	23	57	37
1997	28	19	19	41	29
1998	23	17	16	33	23
1999	20	16	14	27	20
2000	18	15	13	25	18
2001	15	15	11	20	15
2002	14	14	10	19	14
2003	10	15	7	14	10
2004	10	15	7	13	10
2005	9	16	6	12	9
2006	9	16	6	13	9
2007	8	18	5	12	8
2008	10	19	7	16	11

Table 3.2.2.2 (continued). The parameters in the ICA model with their maximum likelihood values, CV, 95% confidence intervals, and the mean estimate.

Selectivity by age

Age	Max like	CV	Low 95%	Upper 95%	Mean
1	0.2474	10	0.2008	0.3047	0.2488
2	0.8825	9	0.7263	1.0725	0.8869
3	1	**Fixed : Reference age**			
4	0.9743	9	0.8092	1.1732	0.9787
5	0.8279	9	0.6931	0.989	0.8313
6	0.7119	8	0.599	0.8461	0.7146
7	0.6683	8	0.5639	0.7919	0.6708
8	0.6021	8	0.5086	0.7127	0.6043
9	0.5063	8	0.4256	0.6024	0.5083
10	0.569	9	0.4747	0.6819	0.5714
11	1	**Fixed : Last true age (INPUT)**			

Population (number in thousands) in 2009-10 fishing year by age

Age	Max like	CV	Low 95%	Upper 95%	Mean
1	28368	22	18141	44360	29115
2	12665	16	9114	17600	12845
3	6838	16	4938	9469	6933
4	3267	17	2312	4616	3318
5	1527	18	1064	2191	1553
6	638	19	437	929	649
7	250	19	169	369	255
8	108	20	73	160	110
9	52	20	35	77	53
10	23	20	16	35	24
11	12	20	8	19	13

Catchability coefficients for the tuning indices

Index	Max like	CV	Low 95%	Upper 95%	Mean
Obs Pre-recruit (age-2)	3.71E-04	10	3.35E-04	5.07E-04	4.15E-04
Obs legal sizes (age 3+)	1.71E-03	10	1.55E-03	2.33E-03	1.91E-03
Puerulus (age-1)	1.22E-03	6	1.15E-03	1.50E-03	1.32E-03
FWC pre-recruits (age-2; timed)	1.31E-03	0	1.31E-03	1.31E-03	1.31E-03
FWC legal sizes (age 3+; timed)	4.13E-03	9	3.78E-03	5.43E-03	4.55E-03
BNP (age 2+)	9.54E-04	6	8.98E-04	1.15E-03	1.02E-03
FWCpre-recruits (age-2; transect)	9.81E-04	14	8.58E-04	1.49E-03	1.14E-03

Table 3.2.2.3. Estimated number (in thousands) of lobsters at the beginning of the fishing year and age from Integrated Catch-at-Age.

	Age after settlement											
Fishing year	1	2	3	4	5	6	7	8	9	10	11	12+
1985-86	17682	10319	4935	2704	1162	586	150	68	38	20	7	22
1986-87	18388	10969	5150	2390	1468	651	350	78	36	22	12	49
1987-88	18940	11349	5664	2559	1231	852	383	214	40	19	12	32
1988-89	18088	12166	5951	2832	1298	663	519	233	134	21	9	31
1989-90	16132	11023	5667	2749	1457	724	397	340	154	91	12	42
1990-91	15626	9752	4909	2340	1223	743	396	233	221	100	60	212
1991-92	14942	9426	4581	2212	1116	644	431	232	140	143	60	305
1992-93	16430	9254	4348	1952	1024	570	362	254	138	86	91	423
1993-94	16223	10533	4952	2172	967	531	303	192	144	78	43	199
1994-95	15915	10264	5265	2388	1113	528	312	181	119	93	49	191
1995-96	16151	9837	4711	2347	1106	545	265	164	99	70	54	298
1996-97	16357	10189	4552	2058	1038	525	274	136	87	55	38	112
1997-98	14630	10312	4705	1984	909	493	264	141	72	48	30	156
1998-99	16994	8968	4308	1831	784	392	228	125	70	38	24	128
1999-00	15171	10893	4392	2007	862	393	207	122	69	40	21	58
2000-01	11938	9184	4351	1624	755	357	176	95	59	35	20	148
2001-02	12635	6998	3271	1413	538	281	145	74	42	28	16	142
2002-03	12033	7997	3277	1448	633	259	143	75	40	24	15	105
2003-04	13018	7309	3234	1229	552	265	117	66	36	20	12	28
2004-05	14609	8230	3408	1425	548	264	134	60	35	20	11	24
2005-06	16446	8913	3381	1301	553	233	121	63	29	18	10	25
2006-07	16455	10651	4530	1643	639	287	126	67	36	17	10	25
2007-08	17407	10452	5050	2035	747	310	147	66	36	20	9	27
2008-09	18687	11438	5594	2602	1057	407	176	84	39	22	12	53
2009-10	28369	12667	6839	3268	1528	639	252	110	53	25	14	28

Table 3.2.2.6. Estimated fishing mortality per year by fishing year and age from Integrated Catch-at-Age.

	Age after settlement											
Fishing year	1	2	3	4	5	6	7	8	9	10	11	12+
1985-86	0.14	0.35	0.39	0.27	0.24	0.18	0.31	0.29	0.21	0.18	0.37	0.37
1986-87	0.14	0.32	0.36	0.32	0.20	0.19	0.15	0.32	0.30	0.27	0.38	0.38
1987-88	0.10	0.31	0.35	0.34	0.28	0.16	0.16	0.13	0.33	0.42	0.38	0.38
1988-89	0.16	0.42	0.43	0.32	0.24	0.17	0.08	0.08	0.05	0.18	0.27	0.27
1989-90	0.16	0.47	0.54	0.47	0.33	0.26	0.19	0.09	0.09	0.07	0.34	0.34
1990-91	0.17	0.42	0.46	0.40	0.30	0.20	0.20	0.17	0.09	0.17	0.34	0.34
1991-92	0.14	0.43	0.51	0.43	0.33	0.24	0.19	0.18	0.14	0.12	0.36	0.36
1992-93	0.10	0.29	0.35	0.36	0.32	0.29	0.29	0.23	0.23	0.36	0.42	0.42
1993-94	0.12	0.35	0.39	0.33	0.27	0.19	0.17	0.14	0.10	0.12	0.29	0.29
1994-95	0.14	0.44	0.47	0.43	0.37	0.35	0.30	0.26	0.19	0.19	0.44	0.44
1995-96	0.12	0.43	0.49	0.48	0.40	0.35	0.33	0.29	0.25	0.28	0.49	0.49
1996-97	0.12	0.43	0.49	0.48	0.41	0.35	0.33	0.30	0.25	0.28	0.49	0.49
1997-98	0.15	0.53	0.60	0.59	0.50	0.43	0.40	0.36	0.31	0.34	0.60	0.60
1998-99	0.10	0.37	0.42	0.41	0.35	0.30	0.28	0.26	0.21	0.24	0.42	0.42
1999-00	0.16	0.58	0.65	0.64	0.54	0.47	0.44	0.39	0.33	0.37	0.65	0.65
2000-01	0.19	0.69	0.78	0.76	0.65	0.56	0.52	0.47	0.40	0.45	0.78	0.78
2001-02	0.12	0.42	0.47	0.46	0.39	0.34	0.32	0.29	0.24	0.27	0.47	0.47
2002-03	0.16	0.57	0.64	0.62	0.53	0.46	0.43	0.39	0.32	0.36	0.64	0.64
2003-04	0.12	0.42	0.48	0.47	0.40	0.34	0.32	0.29	0.24	0.27	0.48	0.48
2004-05	0.15	0.55	0.62	0.61	0.52	0.44	0.42	0.37	0.32	0.35	0.62	0.62
2005-06	0.09	0.34	0.38	0.37	0.32	0.27	0.26	0.23	0.19	0.22	0.38	0.38
2006-07	0.11	0.41	0.46	0.45	0.38	0.33	0.31	0.28	0.23	0.26	0.46	0.46
2007-08	0.08	0.29	0.32	0.31	0.27	0.23	0.22	0.19	0.16	0.18	0.32	0.32
2008-09	0.05	0.17	0.20	0.19	0.16	0.14	0.13	0.12	0.10	0.11	0.20	0.20
2009-10	0.04	0.13	0.15	0.14	0.12	0.10	0.10	0.09	0.07	0.08	0.15	0.15

Table 3.2.2.9.1. Comparison of total biomass, spawning biomass, recruitment, and fishing mortality per year on the fully recruited ages estimated with three natural mortality rates: 0.25, 0.34, and 0.43 per year.

	M = 0.25				M = 0.34				M = 0.43			
	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing
Fishing year	Total	Spawning	Millions	mortality	Total	Spawning	Millions	mortality	Total	Spawning	Millions	mortality
1985-86	20.33	6.14	13.075	0.51	27.33	8.87	17.682	0.39	41.33	14.45	26.513	0.26
1986-87	21.73	6.78	13.914	0.47	28.99	9.64	18.388	0.36	43.01	15.31	26.395	0.25
1987-88	23.31	7.40	14.603	0.46	30.57	10.28	18.94	0.35	44.05	15.78	26.367	0.24
1988-89	24.91	7.89	14.12	0.54	31.84	10.64	18.088	0.43	44.34	15.76	24.859	0.32
1989-90	24.02	7.19	12.573	0.68	30.36	9.71	16.132	0.54	41.62	14.30	22.129	0.40
1990-91	22.00	7.07	12.077	0.57	27.96	9.41	15.626	0.46	38.43	13.60	21.675	0.34
1991-92	21.07	6.60	11.334	0.64	26.80	8.77	14.942	0.51	36.75	12.61	21.06	0.38
1992-93	20.76	6.76	12.624	0.44	26.51	8.87	16.43	0.35	36.29	12.53	22.695	0.26
1993-94	21.80	7.14	12.716	0.48	27.29	9.09	16.223	0.39	36.43	12.43	21.867	0.30
1994-95	22.61	6.78	12.48	0.57	27.79	8.56	15.915	0.47	36.36	11.61	21.468	0.36
1995-96	21.96	6.43	12.583	0.59	26.97	8.07	16.151	0.49	35.26	10.90	21.929	0.38
1996-97	21.25	6.01	12.761	0.59	26.00	7.48	16.357	0.49	33.89	10.04	22.193	0.38
1997-98	20.80	5.30	11.447	0.72	25.28	6.67	14.63	0.60	32.76	9.12	19.721	0.47
1998-99	19.54	5.66	13.421	0.50	23.90	6.94	16.994	0.42	31.19	9.26	22.631	0.33
1999-00	20.83	4.91	12.089	0.77	24.93	6.06	15.171	0.65	31.86	8.24	20.136	0.51
2000-01	18.04	3.76	9.428	0.94	21.65	4.84	11.938	0.78	28.07	7.00	16.224	0.59
2001-02	14.66	3.93	9.911	0.58	18.10	5.00	12.635	0.47	24.51	7.21	17.446	0.34
2002-03	15.26	3.45	9.422	0.79	18.70	4.50	12.033	0.64	25.32	6.79	16.863	0.45
2003-04	14.23	3.58	10.058	0.60	17.78	4.69	13.018	0.48	24.94	7.13	18.699	0.33
2004-05	15.54	3.22	11.111	0.81	19.56	4.46	14.609	0.62	27.89	7.27	21.564	0.41
2005-06	15.67	3.98	12.16	0.52	20.51	5.55	16.446	0.38	30.68	8.97	25.044	0.24
2006-07	17.96	4.26	11.767	0.67	23.85	6.38	16.455	0.46	36.00	10.75	25.771	0.27
2007-08	18.15	5.14	12.183	0.49	25.42	7.90	17.407	0.32	39.66	13.22	27.385	0.19
2008-09	20.33	7.08	13.124	0.29	28.87	10.48	18.687	0.20	44.64	16.59	28.793	0.12
2009-10	26.83	9.77	20.342	0.21	37.11	13.58	28.369	0.15	54.90	20.02	41.967	0.10

Table 3.2.2.9.2. Comparison of total biomass, spawning biomass, recruitment, and fishing mortality per year on the fully recruited age estimated with a natural mortality rate (M) of 0.34 per year. Results relate to base run, runs with variations of the post-larvae index (i.e., 1988-98 time series; excluded; and 1993-2009 time series with data from both Big Munson and Long Key sites), and base run with M = 0.8 per year on age-1 lobsters over 1999-09.

	Base (with full post-larvae)				**Post-larvae: 1988 - 1998**				**No post-larvae**				**Post-larvae: 1993-2009 (Long Key and Big Munson sites)**				**Base run with $M = 0.8*year^{-1}$ on age-1 lobsters , 1999-09**			
	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing	Biomass (millions lbs)		Recruitment	Fishing
Fishing year	Total	Spawning	Thousands	mortality	Total	Spawning	Thousands	mortality	Total	Spawning	Thousands	mortality	Total	Spawning	Thousands	mortality	Total	Spawning	Thousands	mortality
1985-86	27.33	8.87	17682	0.39	27.28	8.84	17660	0.39	27.29	8.85	17660	0.39	27.31	8.85	17670	0.39	27.30	8.85	17660	0.39
1986-87	28.99	9.64	18388	0.36	28.95	9.61	18370	0.36	28.96	9.62	18380	0.36	28.97	9.63	18370	0.36	28.97	9.63	18370	0.36
1987-88	30.57	10.28	18940	0.35	30.53	10.25	18930	0.35	30.54	10.26	18930	0.35	30.55	10.27	18930	0.35	30.54	10.26	18920	0.35
1988-89	31.84	10.64	18088	0.43	31.80	10.62	18080	0.43	31.81	10.62	18080	0.43	31.81	10.63	18070	0.43	31.80	10.62	18070	0.43
1989-90	30.36	9.71	16132	0.54	30.32	9.68	16120	0.55	30.34	9.69	16130	0.54	30.33	9.69	16120	0.55	30.32	9.68	16120	0.55
1990-91	27.96	9.41	15626	0.46	27.93	9.38	15630	0.46	27.94	9.39	15630	0.46	27.93	9.39	15620	0.46	27.93	9.38	15620	0.46
1991-92	26.80	8.77	14942	0.51	26.79	8.75	14980	0.51	26.80	8.76	14970	0.51	26.77	8.75	14930	0.51	26.78	8.75	14960	0.51
1992-93	26.51	8.87	16430	0.35	26.55	8.86	16530	0.35	26.55	8.87	16520	0.35	26.47	8.85	16400	0.35	26.52	8.85	16490	0.35
1993-94	27.29	9.09	16223	0.39	27.44	9.12	16430	0.39	27.42	9.12	16390	0.39	27.23	9.07	16170	0.39	27.37	9.10	16350	0.39
1994-95	27.79	8.56	15915	0.47	28.14	8.65	16340	0.46	28.08	8.64	16230	0.46	27.64	8.53	15660	0.47	27.98	8.61	16120	0.46
1995-96	26.97	8.07	16151	0.49	27.58	8.15	16660	0.50	27.27	8.13	16070	0.50	26.57	8.02	15600	0.49	27.27	8.10	16370	0.49
1996-97	26.00	7.48	16357	0.49	26.74	7.60	16840	0.50	26.24	7.53	16410	0.49	25.36	7.39	15590	0.49	26.37	7.52	16490	0.50
1997-98	25.28	6.67	14630	0.60	26.02	6.79	14880	0.61	25.65	6.73	14920	0.61	24.74	6.58	14630	0.60	25.61	6.69	14620	0.62
1998-99	23.90	6.94	16994	0.42	24.54	7.07	17310	0.43	24.30	7.03	16950	0.43	23.57	6.86	16610	0.43	24.12	6.94	16990	0.43
1999-00	24.93	6.06	15171	0.65	28.34	6.21	22690	0.66	28.05	6.18	22520	0.65	24.36	5.97	14390	0.67	28.06	6.08	22920	0.66
2000-01	21.65	4.84	11938	0.78	23.95	4.97	17870	0.76	23.79	4.96	17780	0.76	21.08	4.71	11780	0.80	23.81	4.81	17880	0.79
2001-02	18.10	5.00	12635	0.47	20.51	5.14	18920	0.45	20.41	5.12	18820	0.45	17.48	4.83	11850	0.49	20.34	4.94	19090	0.48
2002-03	18.70	4.50	12033	0.64	21.07	4.71	18450	0.60	20.97	4.69	18360	0.60	18.02	4.27	11930	0.66	20.68	4.42	18060	0.64
2003-04	17.78	4.69	13018	0.48	20.82	5.00	20390	0.44	20.71	4.97	20260	0.44	16.94	4.41	12010	0.51	19.96	4.58	19560	0.48
2004-05	19.56	4.46	14609	0.62	23.86	5.00	24530	0.55	23.70	4.95	24360	0.55	18.55	4.03	14360	0.67	21.90	4.34	21790	0.62
2005-06	20.51	5.55	16446	0.38	26.52	6.49	28250	0.32	26.28	6.41	27990	0.33	19.17	4.96	15280	0.43	23.15	5.36	24580	0.39
2006-07	23.85	6.38	16455	0.46	31.36	7.98	29630	0.37	31.02	7.86	29310	0.37	21.71	5.39	14840	0.55	26.13	6.09	24220	0.47
2007-08	25.42	7.90	17407	0.32	35.09	10.37	32270	0.25	34.64	10.20	31880	0.25	21.64	6.35	14060	0.40	27.53	7.44	25420	0.33
2008-09	28.87	10.48	18687	0.20	41.43	14.00	36840	0.15	40.82	13.75	36320	0.15	23.55	8.01	15930	0.26	30.65	9.74	26970	0.21
2009-10	37.11	13.58	28369	0.15	66.50	18.49	85060	0.10	65.11	18.15	82860	0.10	27.39	10.16	17160	0.20	39.02	12.46	38680	0.16

Table 5.1.1. Age specific natural mortality rates, selectivities, average female weight, proportion mature, number of broods per spawning season, average number of eggs produced per spawn; and sex-ratio for females. See section3.2.1.2 for estimated proportion mature-at-age.

			Catch (both sexes)	Female population	Proportion mature				
Age	M	Selectivity	Weight (lbs)	Weight (lbs)	Assumed	Estimated	Broods	Eggs	Sex ratio
1	0.34	0.247	0.890	0.381	0.00	0.54	1	70983	0.50
2	0.34	0.883	1.073	0.780	0.50	0.80	1	270292	0.50
3	0.34	1.000	1.232	1.097	0.75	0.93	1	406946	0.50
4	0.34	0.974	1.416	1.349	1.00	0.98	1	507239	0.50
5	0.34	0.828	1.619	1.575	1.00	0.99	1	592776	0.50
6	0.34	0.712	1.832	1.745	1.00	1.00	1	654809	0.50
7	0.34	0.668	2.071	1.904	1.00	1.00	2	711260	0.50
8	0.34	0.602	2.272	2.050	1.00	1.00	2	761798	0.50
9	0.34	0.506	2.434	2.190	1.00	1.00	2	809349	0.50
10	0.34	0.569	2.746	2.296	1.00	1.00	2	844449	0.50
11	0.34	1.000	3.188	2.395	1.00	1.00	2	877102	0.50
12	0.34	1.000	3.636	2.483	1.00	1.00	2	905947	0.50
13	0.34	1.000	3.615	2.583	1.00	1.00	2	938062	0.50
14	0.34	1.000	3.704	2.655	1.00	1.00	2	960976	0.50
15+	0.34	1.000	3.692	2.732	1.00	1.00	2	985381	0.50

Table 6.3.1. Fishing mortality rates on fully recruited spiny lobsters (Age-3) and static SPR values based on eggs per recruit by fishing year. Static SPR was calculated using assumed and estimated maturity schedules (mat_a).

Fishing year	Fishing mortality (yr^{-1})	Static SPR eggs assumed mat_a	estimated mat_a
1985	0.385	24%	28%
1986	0.3595	26%	30%
1987	0.3533	26%	30%
1988	0.4322	21%	25%
1989	0.5446	16%	20%
1990	0.4571	19%	24%
1991	0.5129	17%	21%
1992	0.3541	26%	30%
1993	0.3893	24%	28%
1994	0.468	19%	23%
1995	0.4879	18%	22%
1996	0.4903	18%	22%
1997	0.6039	13%	18%
1998	0.4236	21%	26%
1999	0.6547	12%	16%
2000	0.7846	9%	13%
2001	0.4745	19%	23%
2002	0.6407	12%	17%
2003	0.4793	18%	23%
2004	0.6228	13%	17%
2005	0.3816	24%	28%
2006	0.4603	19%	24%
2007	0.3231	29%	33%
2008	0.1975	44%	48%
2009	0.1462	54%	57%

Table 6.3.2. Management benchmarks for the spiny lobster off SE US calculated using assumed (a) and estimated (b) maturity schedules.

a

Criterion	Description	Definition	Value from Assessment
MSST	Minimum Spawning Stock Threshold	Bmsy*(1-M) or 0.5Bmsy	1.150×10^{12} eggs
MFMT	Maximum Fishing Mortality Threshold	Fmsy = F20%SPR	0.45 per year
MSY	Maximum Sustainable Yield	Yield @ F20%SPR	7,950,000 lb
BMSY	Biomass at MSY	Biomass @ F20%SPR	1.743×10^{12} eggs
FOY	Fishing Mortality at Optimum Yield	F30%SPR	0.31 per year
OY	Optimum Yield	Yield @ F30%SPR	6,940,000 lb
	Fcurrent	GM 2007-2009	0.21 per year
	Fcurrent/F20%SPR		0.47
	SSBcurrent	GM 2007-2009	2.240×10^{12} eggs
	SSBcurrent/SSB F20%SPR		1.29

b

Criterion	Description	Definition	Value from Assessment
MSST	Minimum Spawning Stock Threshold	Bmsy*(1-M) or 0.5Bmsy	1.190×10^{12} eggs
MFMT	Maximum Fishing Mortality Threshold	Fmsy = F20%SPR	0.54 per year
MSY	Maximum Sustainable Yield	Yield @ F20%SPR	8,020,000 lb
BMSY	Biomass at MSY	Biomass @ F20%SPR	1.803×10^{12} eggs
FOY	Fishing Mortality at Optimum Yield	F30%SPR	0.36 per year
OY	Optimum Yield	Yield @ F30%SPR	7,260,000 lb
	Fcurrent	GM 2007-2009	0.21 per year
	Fcurrent/F20%SPR		0.39
	SSBcurrent	GM 2007-2009	3.110×10^{12} eggs
	SSBcurrent/SSB F20%SPR		1.72

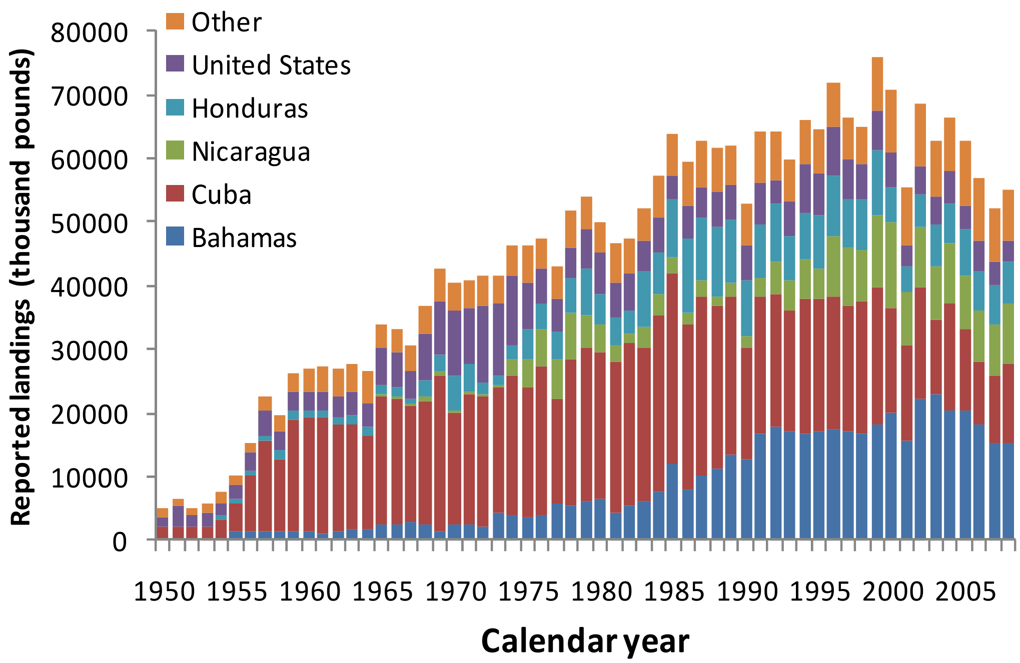


Figure 1. Reported landings (thousand pounds) of the Caribbean spiny lobster in the western central Atlantic, 1950 – 2008 (Source: FAO Fisheries and Aquaculture Statistics and Information Service. 2010).

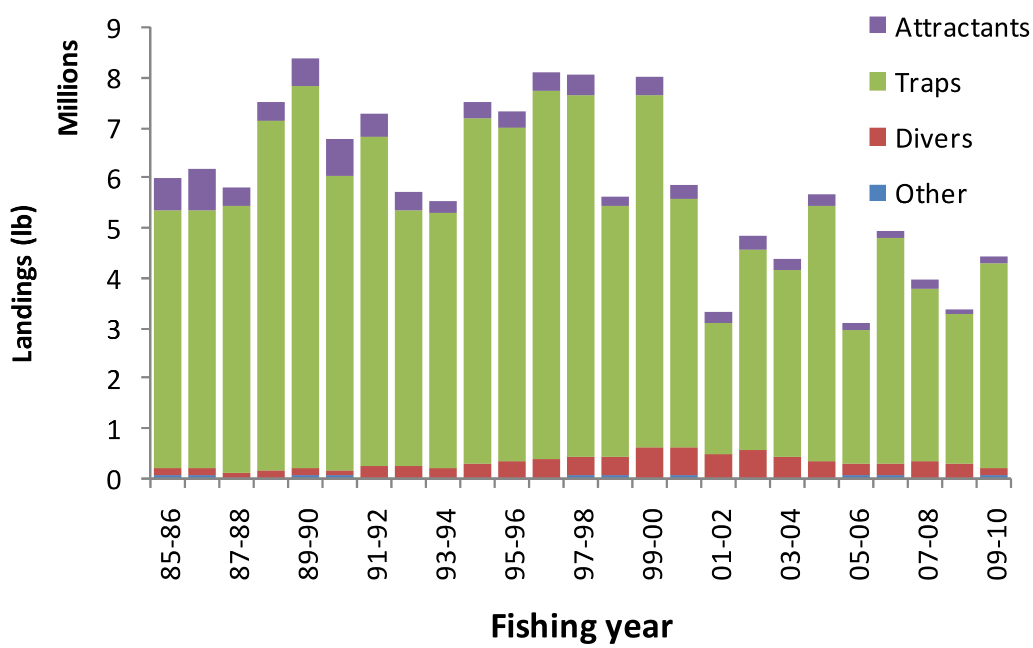


Figure 2.1.1. Commercial landings in pounds by gear and fishing year for spiny lobster off the Southeastern Unites States.

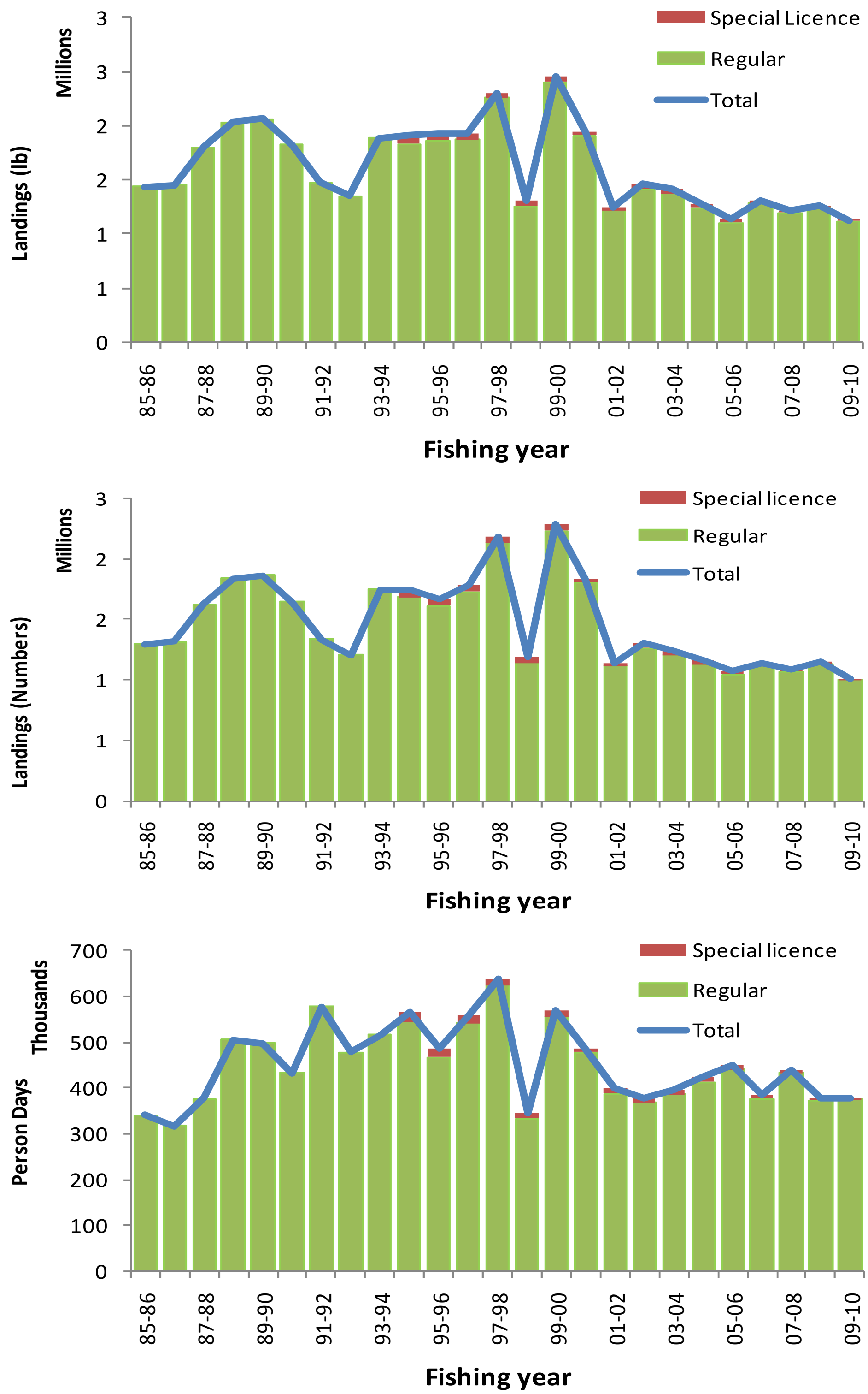


Figure 2.1.2. Recreational and Special Recreational License landings in pounds (top) and numbers (middle) and the number person-days (bottom) by fishing year. The effort for the Special Recreational License is expressed in person-day equivalents. Note that values prior to 1992-93 fishing year were not observations but rather estimates.

Figure 2.2.1. Geographic regions for spiny lobster in the southeastern U.S.

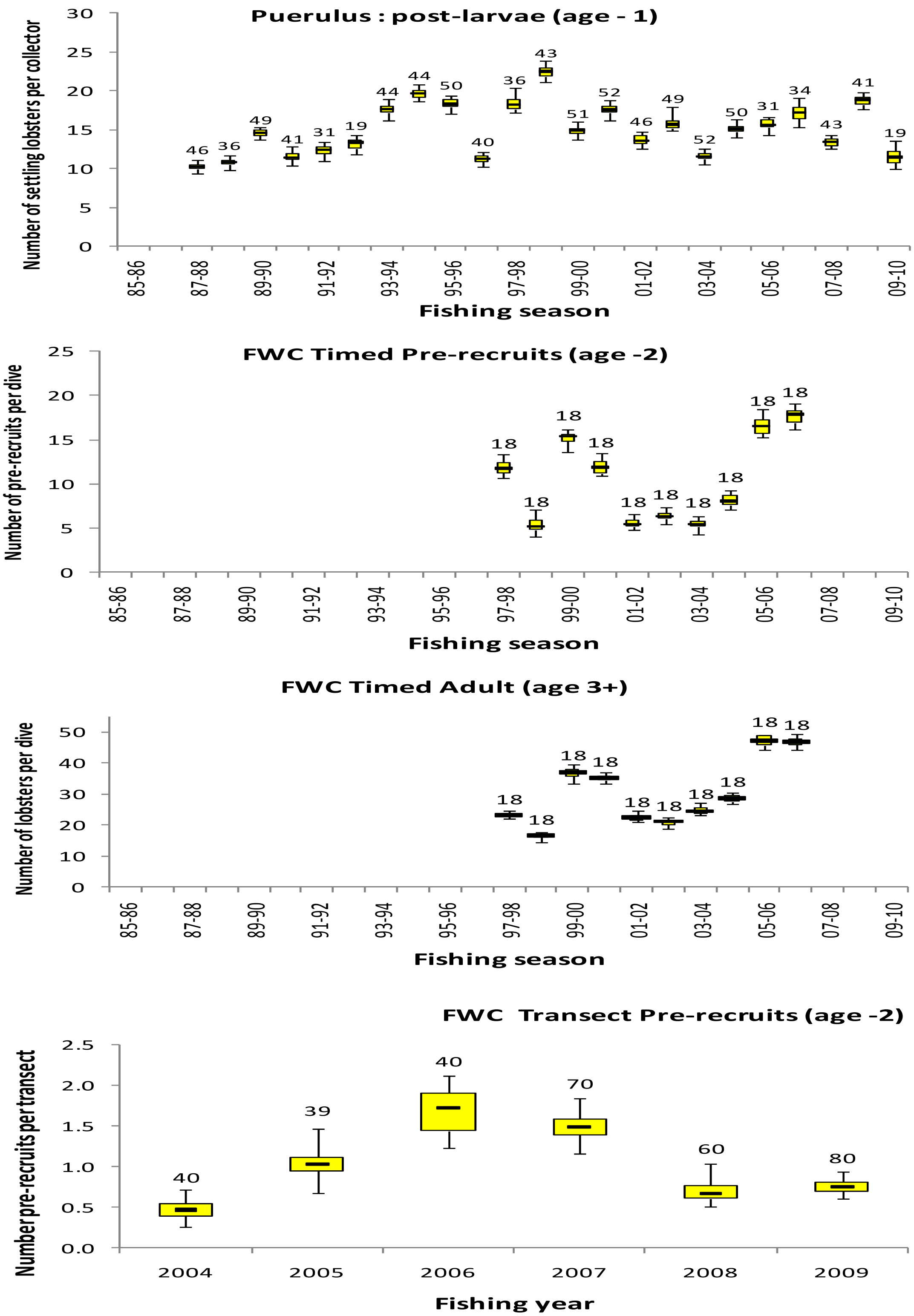


Figure 2.3.4 . Tuning indices by fishing year. The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

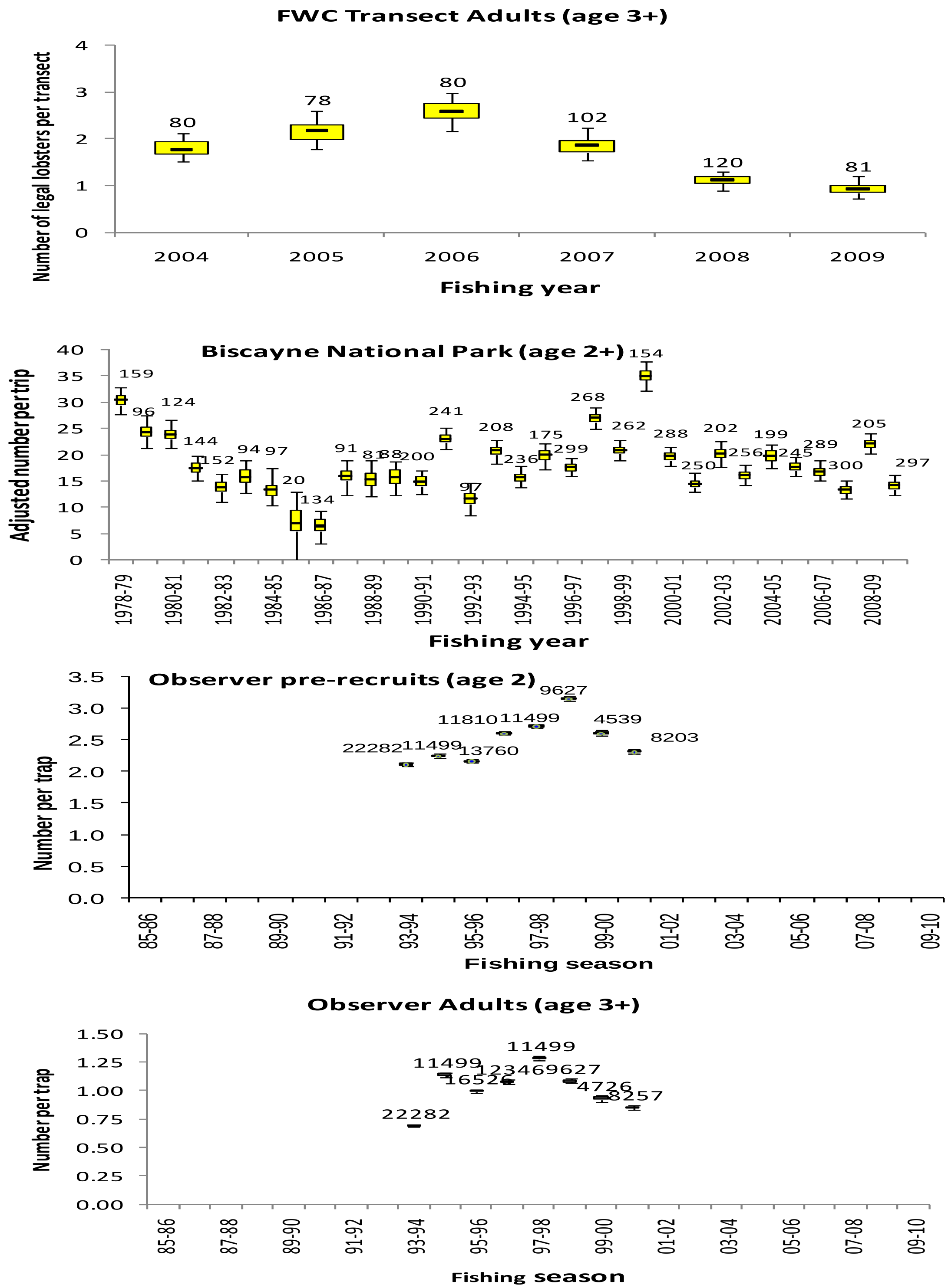


Figure 2.3.4 (Continued). Tuning indices by fishing year. The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

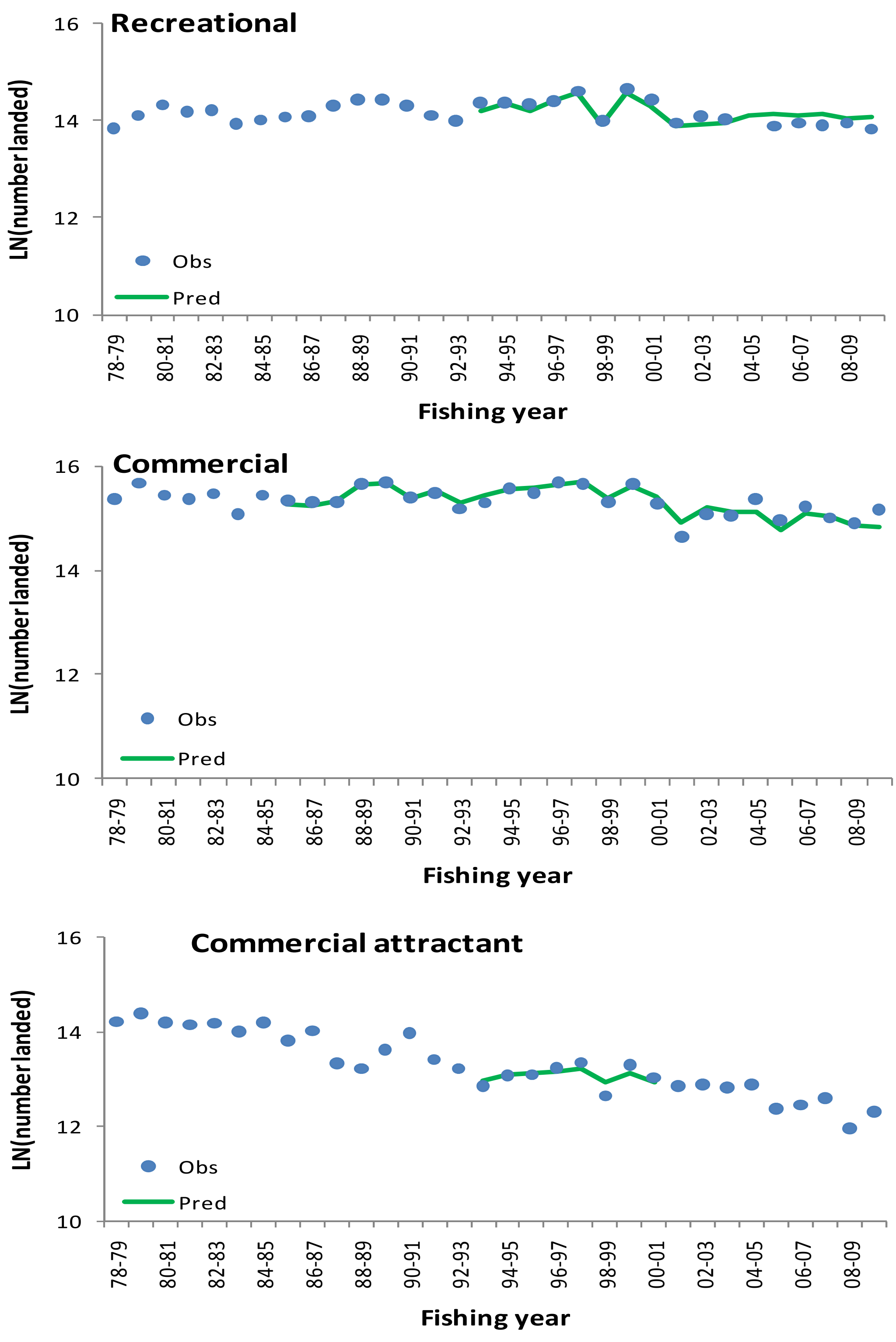


Figure 3.1.2.1. Fit of DeLury model run to harvests by fishery sector. Estimated values of landings were not considered in the model fit.

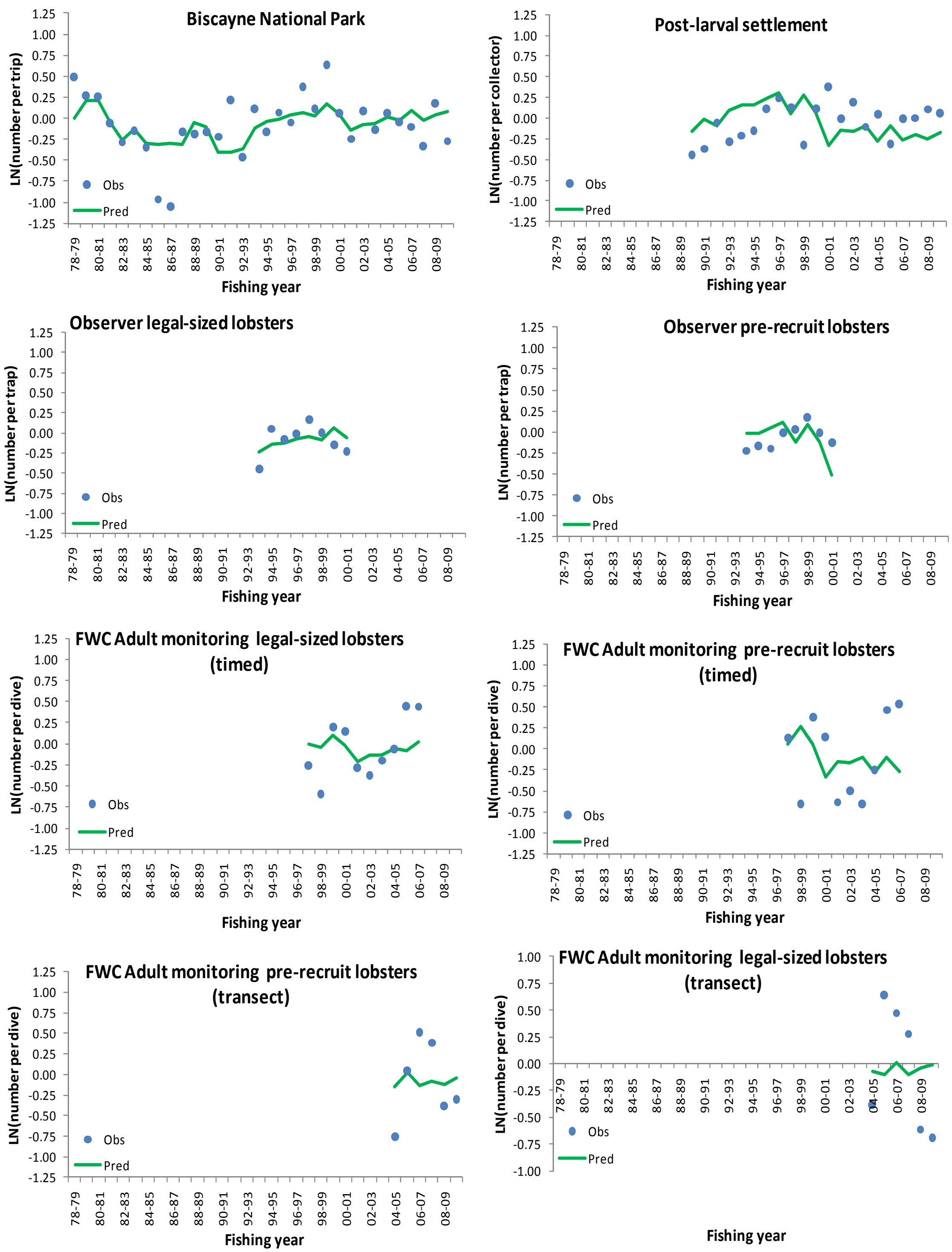
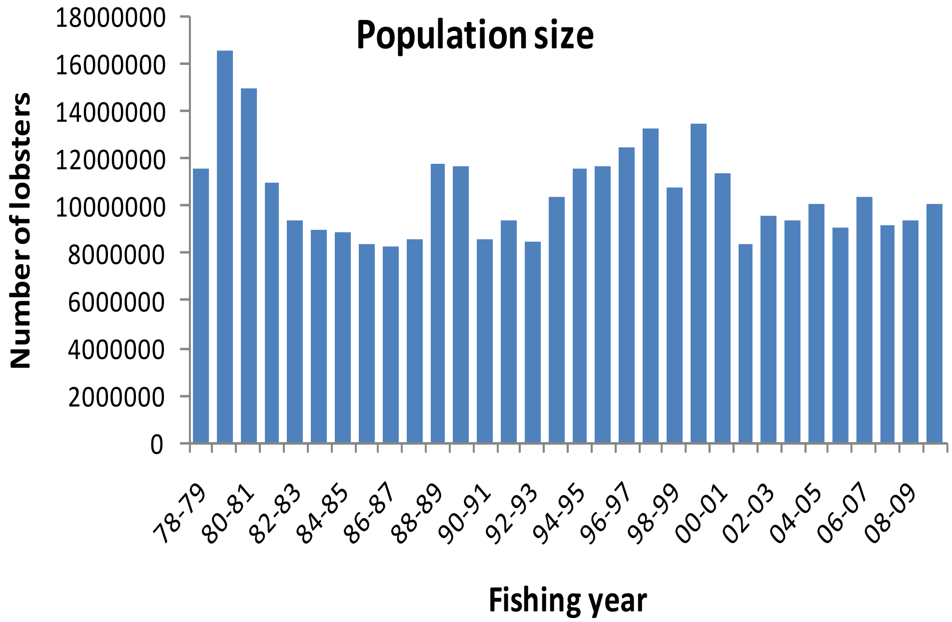


Figure 3.1.2.1 (continued). Fit of DeLury model run to indices. See their designations in the corresponding plots.



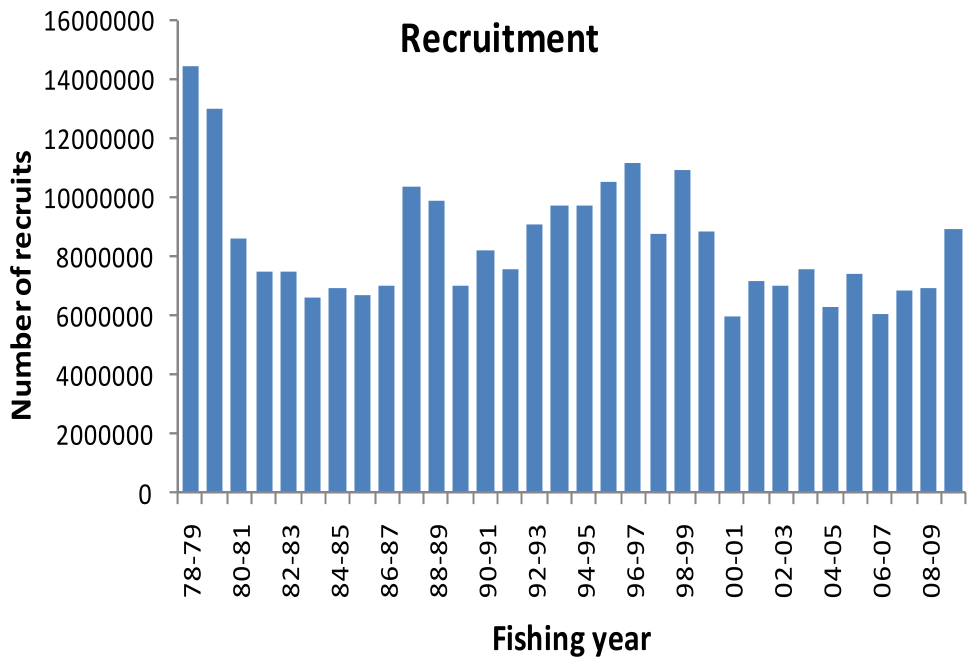


Figure 3.1.2.3. Estimated number of lobsters and recruitment at the beginning of the fishing year from the DeLury model.

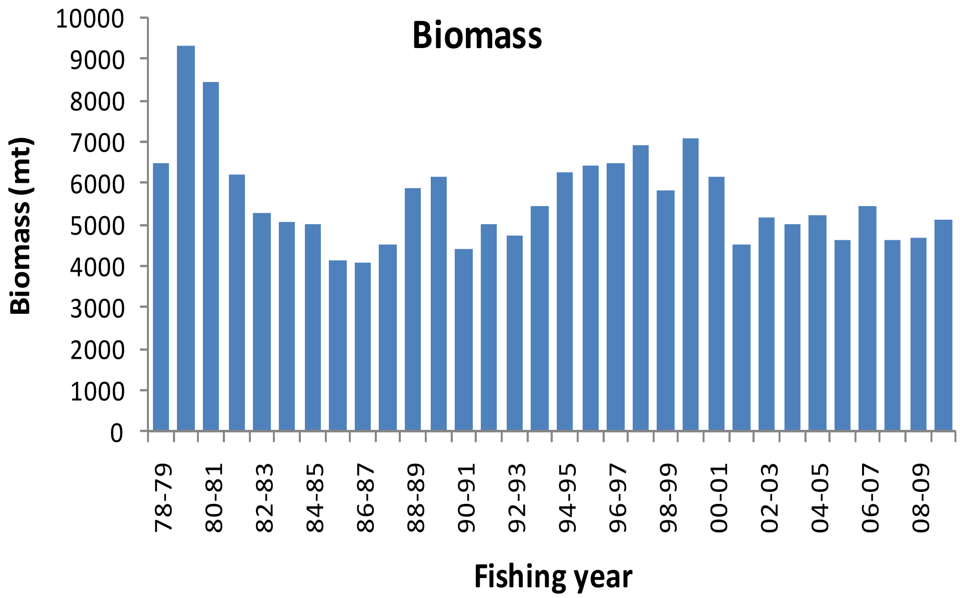


Figure 3.1.2.4. Biomass of lobsters at the beginning of the fishing year.

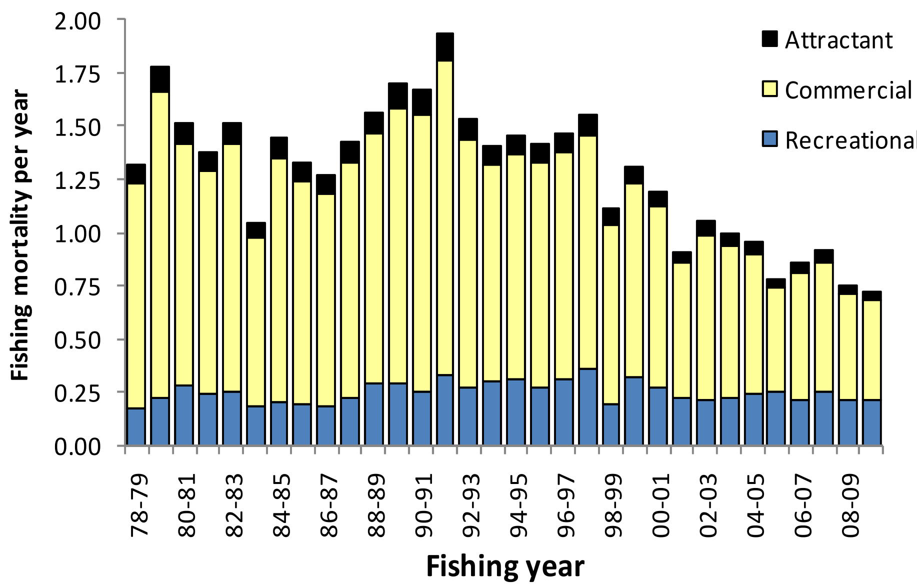


Figure 3.1.2.6. Fishing mortality per year by fishing year for the recreational fishery (blue bars), commercial fishery (yellow bars), and attractant fishery (black bars).

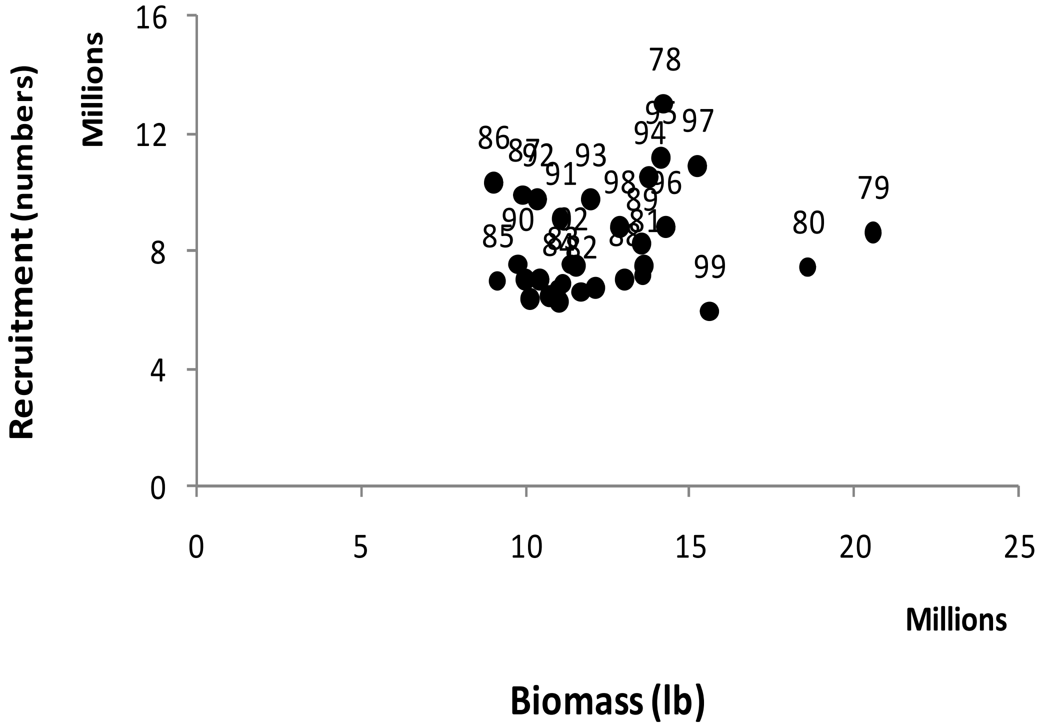
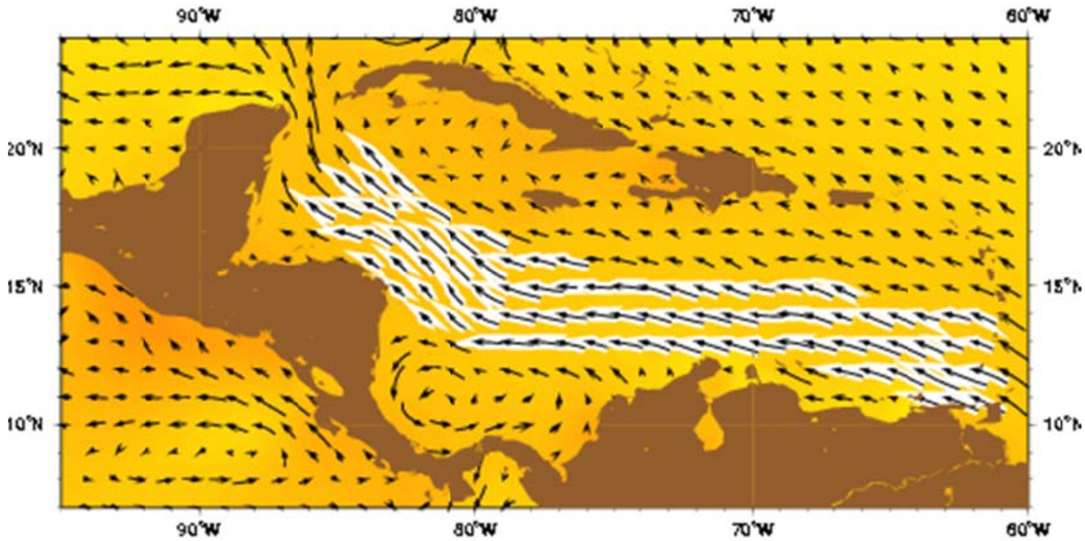


Figure 3.1.2.7.1. Stock in biomass and recruitment two years later. Some numbers above the points are some of the biomass years (78-07), the other years were too close to each other to be distinguished.

a. Caribbean Current



b. Loop Current

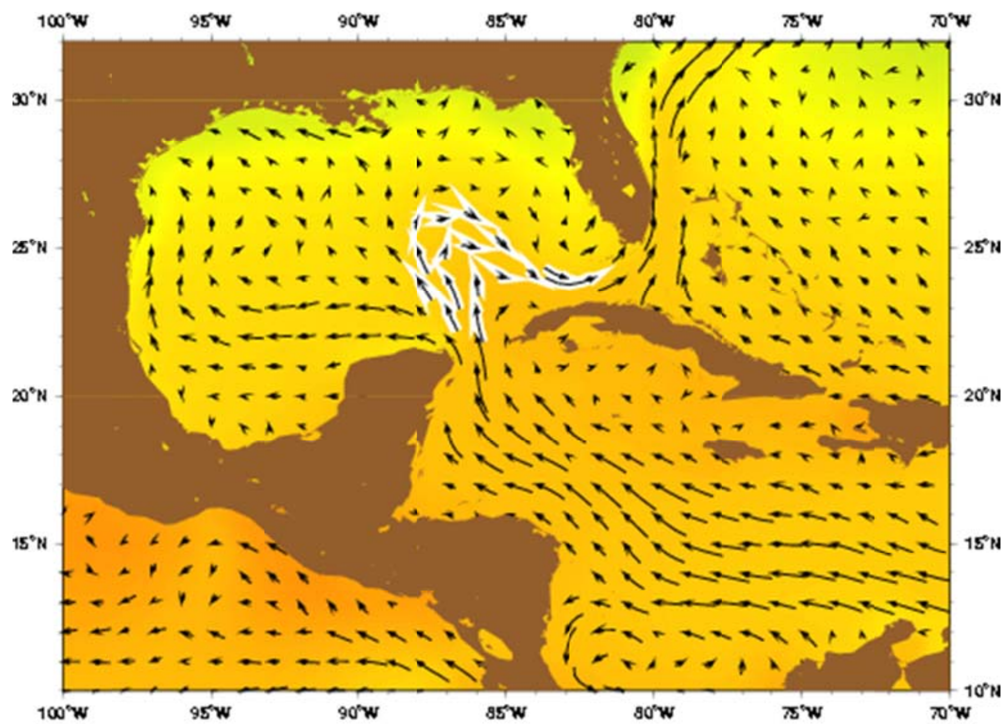


Figure 3.1.2.7.2. The Caribbean Current (a, Gyory et al. undated a) and the Loop Current b, Gyory et al. undated b)
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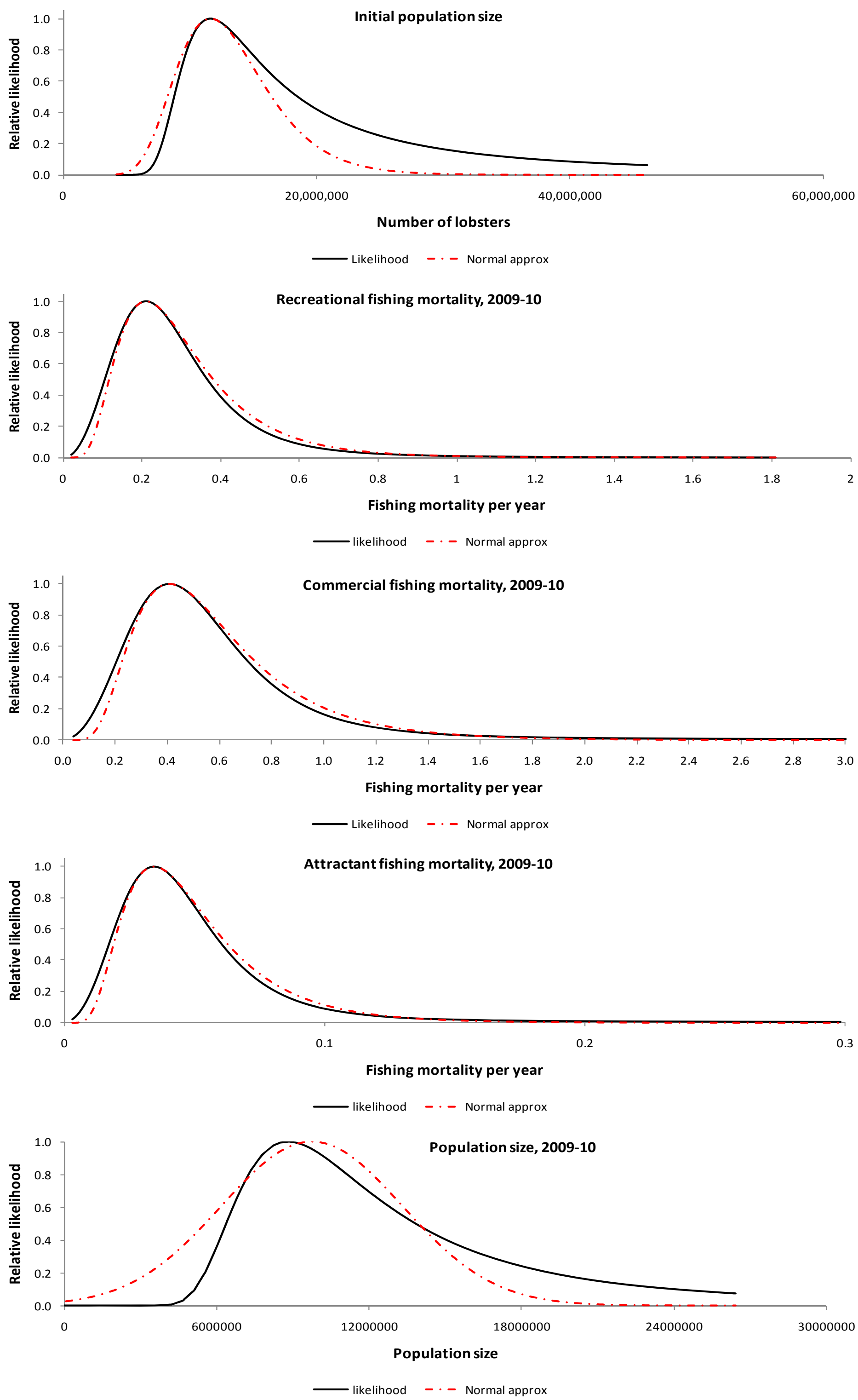


Figure 3.1.2.8. Likelihood profiles and normal approximation for the DeLury model about the initial population size, fishing mortality by sector, and current population size.

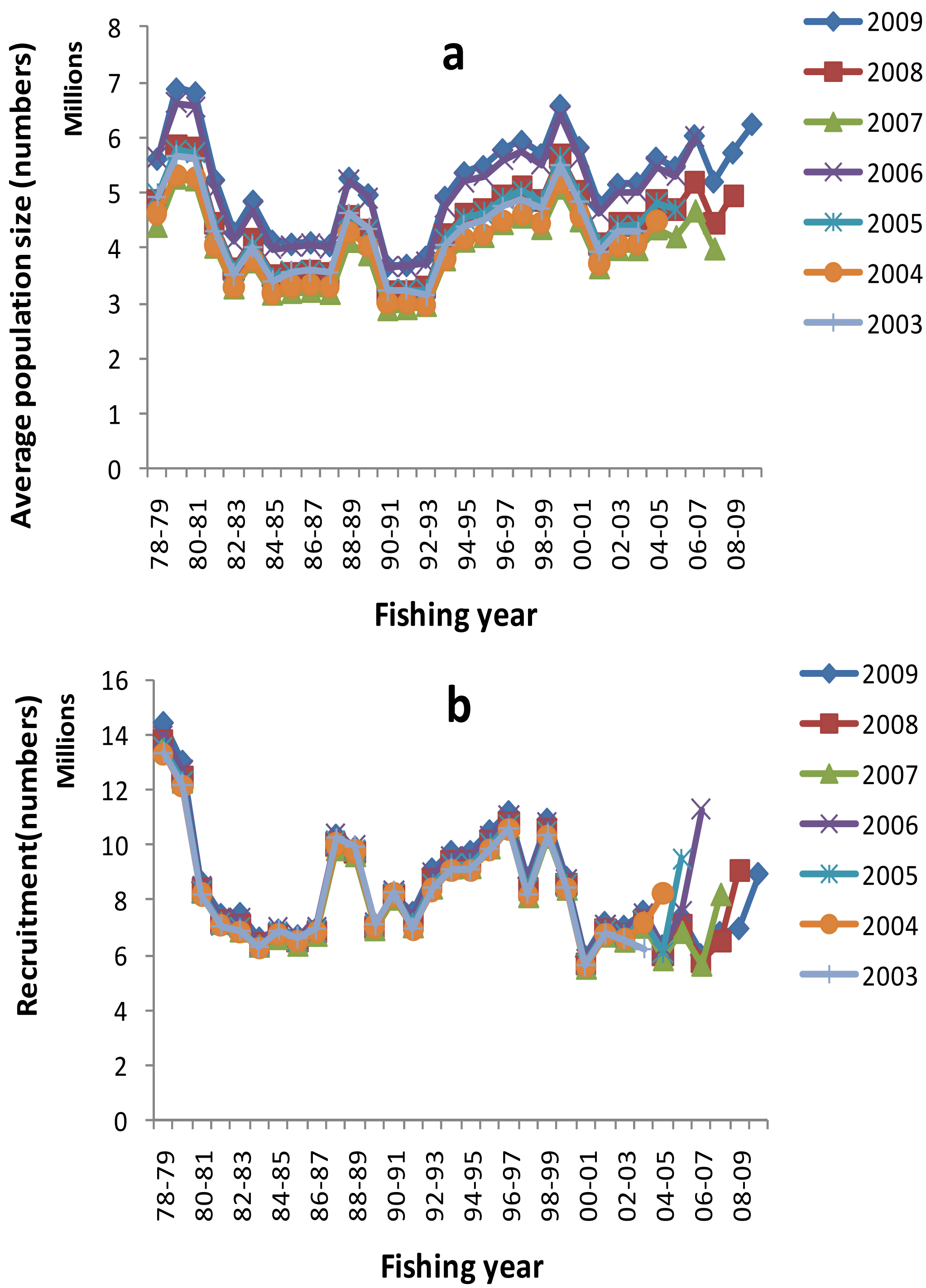


Figure 3.1.2.9.1 Retrospective analyses of average population size (a) and recruitment (b) from the DeLury model with ending fishing years 2003-04 through 2009-10.

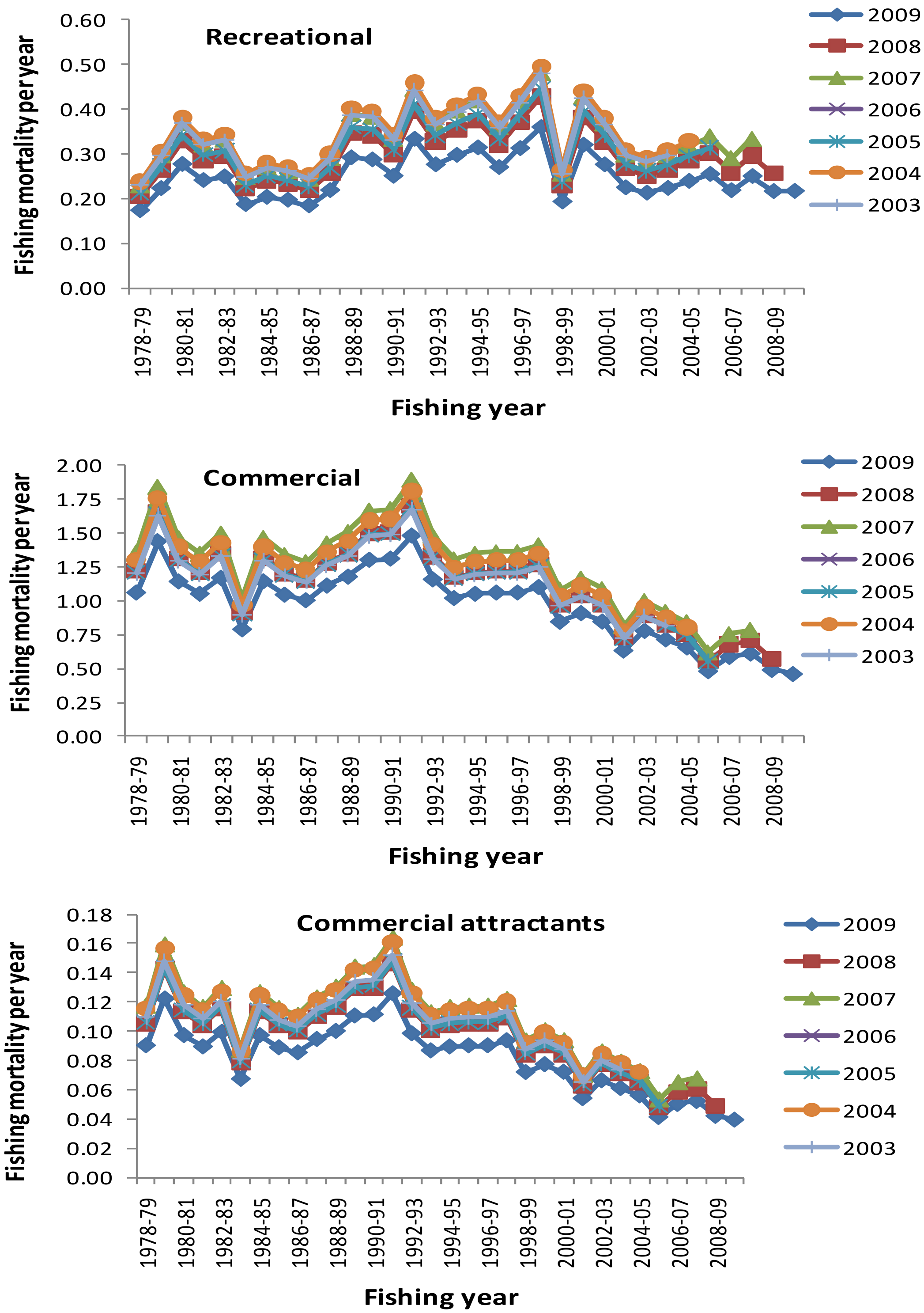


Figure 3.1.2.9.2. Retrospective analyses of fishing mortality by sector from the DeLury model with ending fishing years 2003-04 through 2009-10

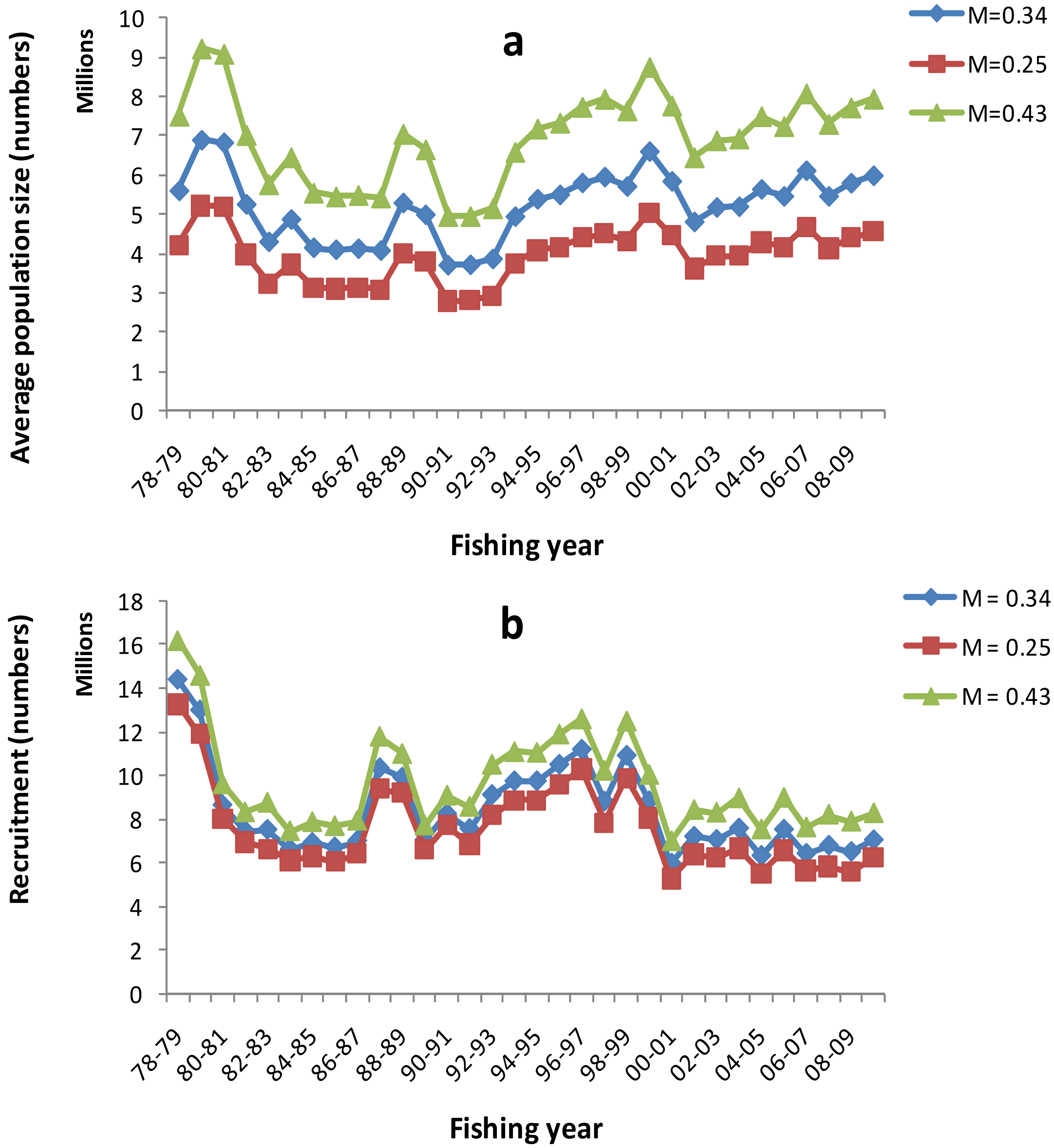


Figure 3.1.2.9.3. Average population size (a) and recruitment trajectories from the DeLury model runs with alternative natural mortality rates of 0.25 per year and 0.43 per year as well as the final run value of 0.34 per year for comparison

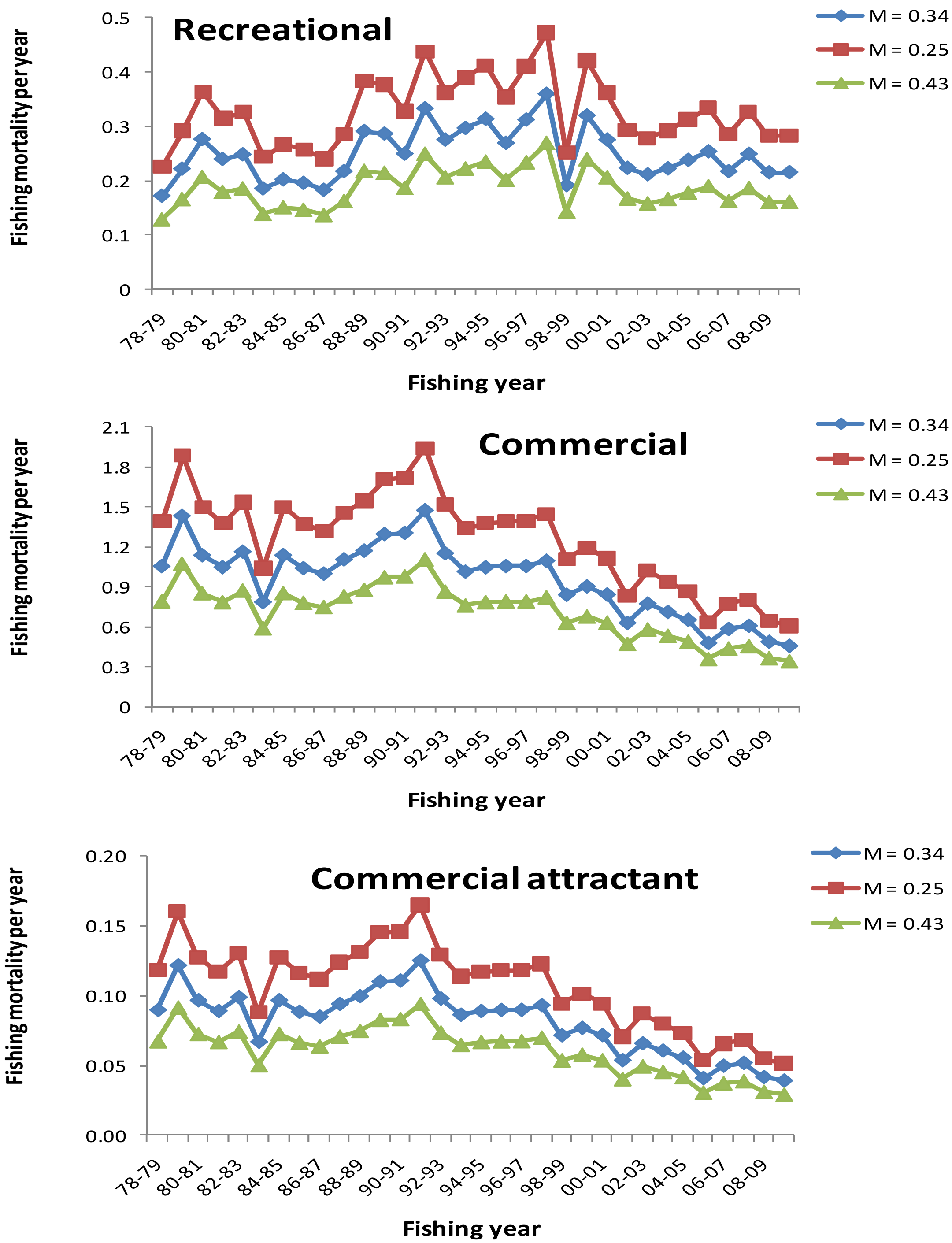


Figure 3.1.2.9.4. Fishing mortality by sector from the DeLury model runs with alternative natural mortality rates of 0.25 per year and 0.43 per year as well as the final run value of 0.34 per year for comparison

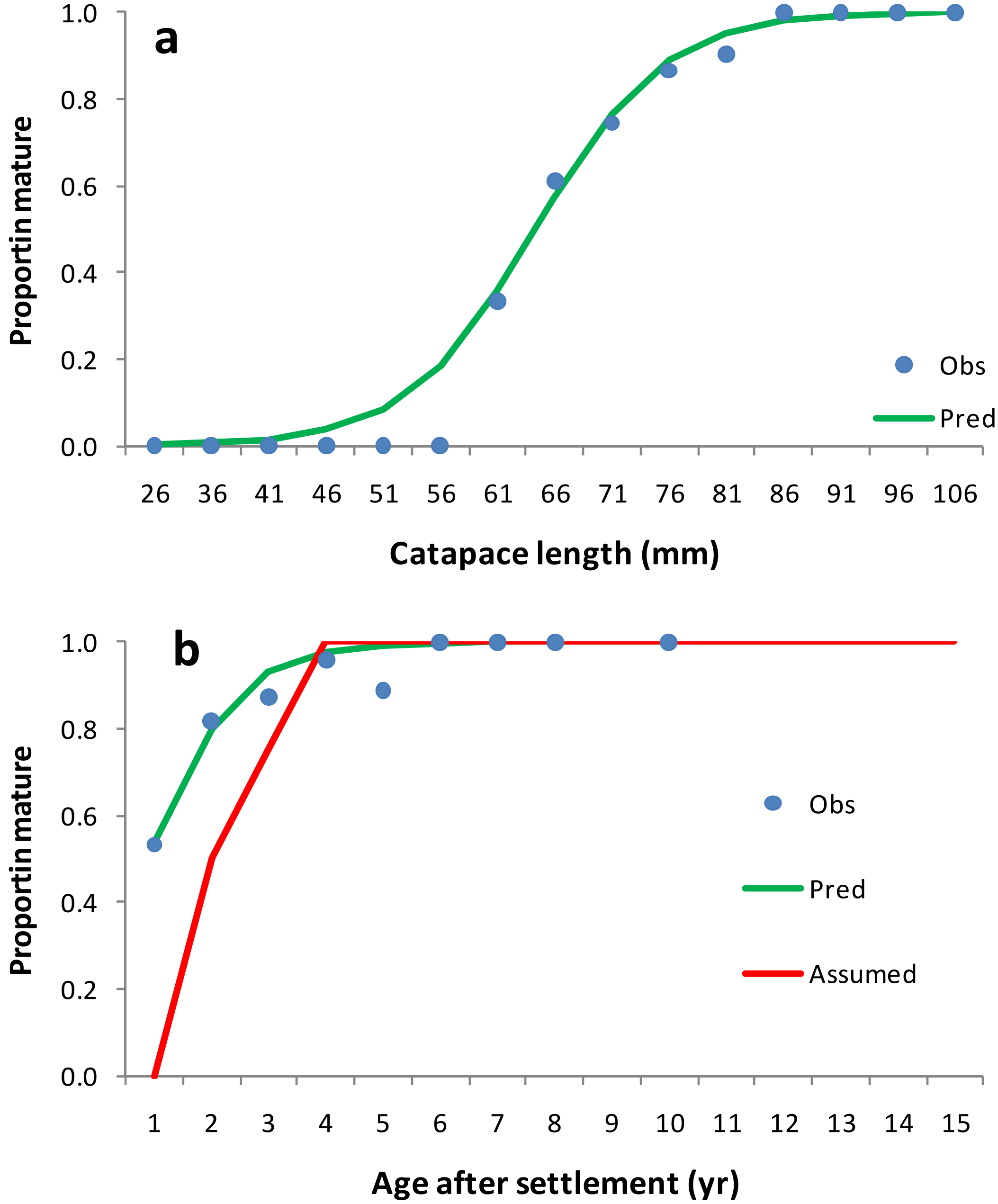


Figure 3.2.1.2.1 - Maturity-at-length (a) and maturity-at-age (b) for female lobsters in the fishery area (Florida Keys) off the Southeastern US. The estimated maturity-at-age is superimposed with the assumed maturity schedule for comparison (the latter was used as a base case scenario while the estimated maturity schedule was used for sensitivity in spawning biomass-per-recruit analyses). .

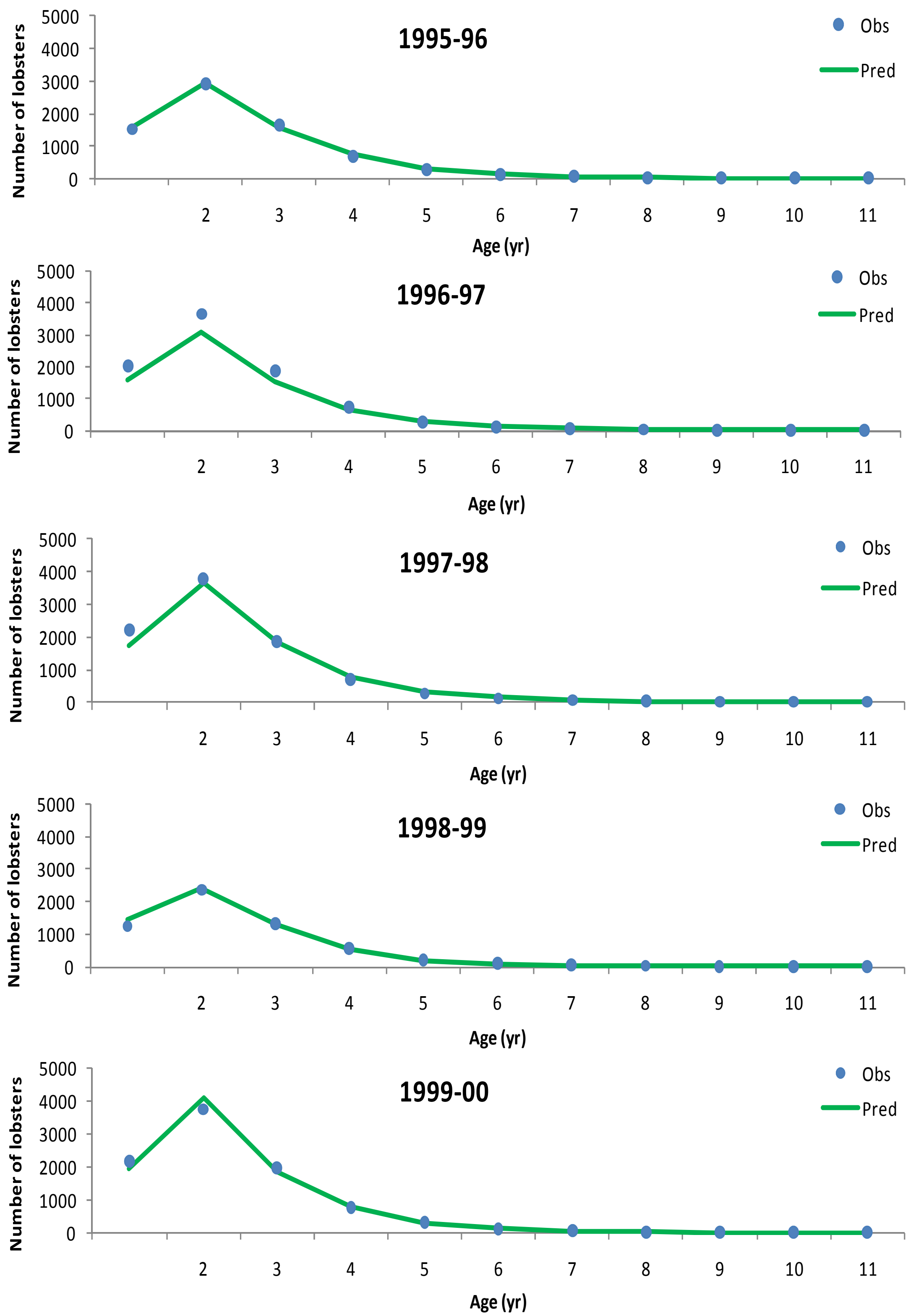


Figure 3.2.2.1.1. Fits of the catches-at-age in the ICA model by fishing year.

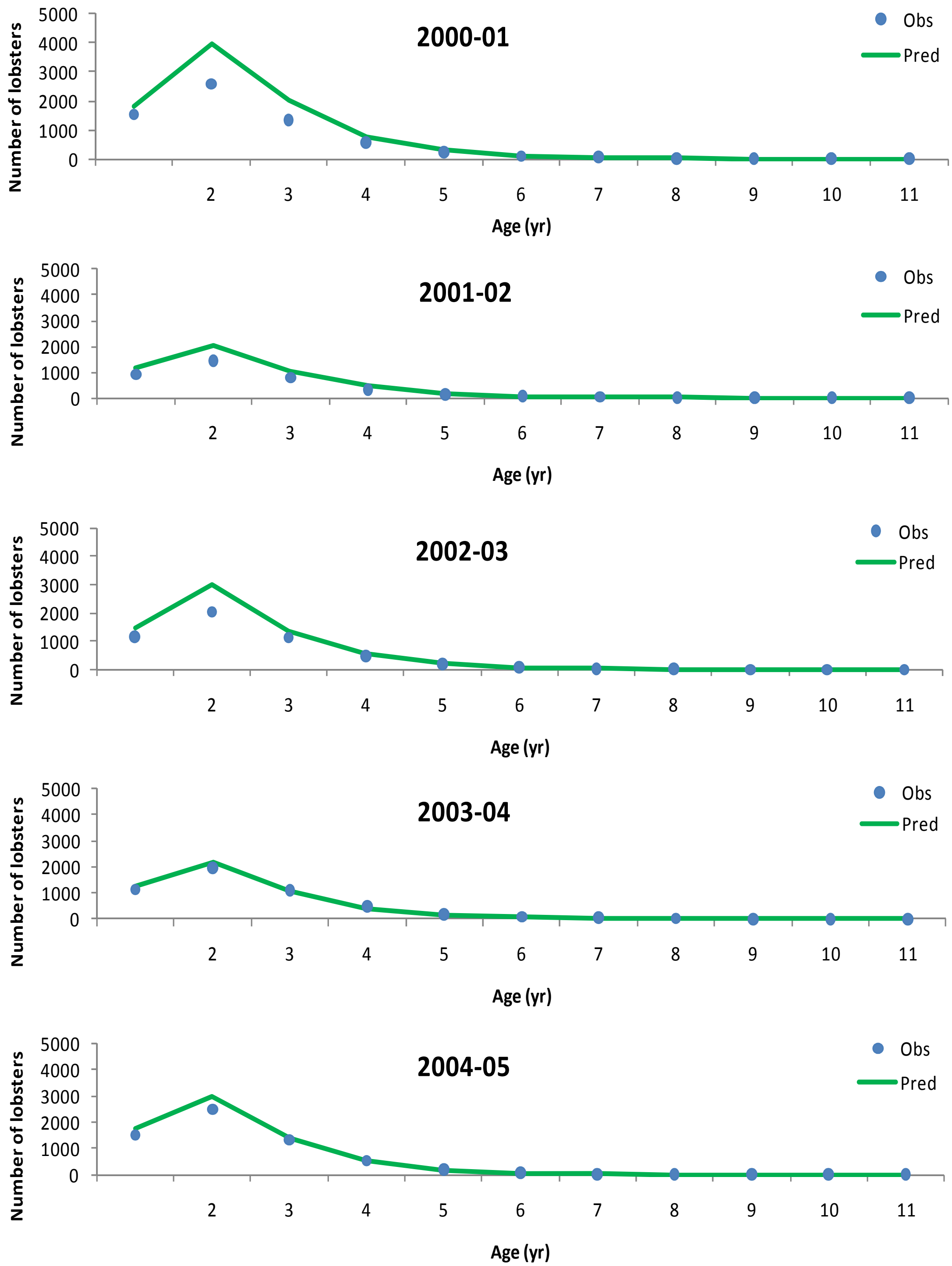


Figure 3.2.2.1.1 (continued). Fits of the catches-at-age in the ICA model by fishing year.

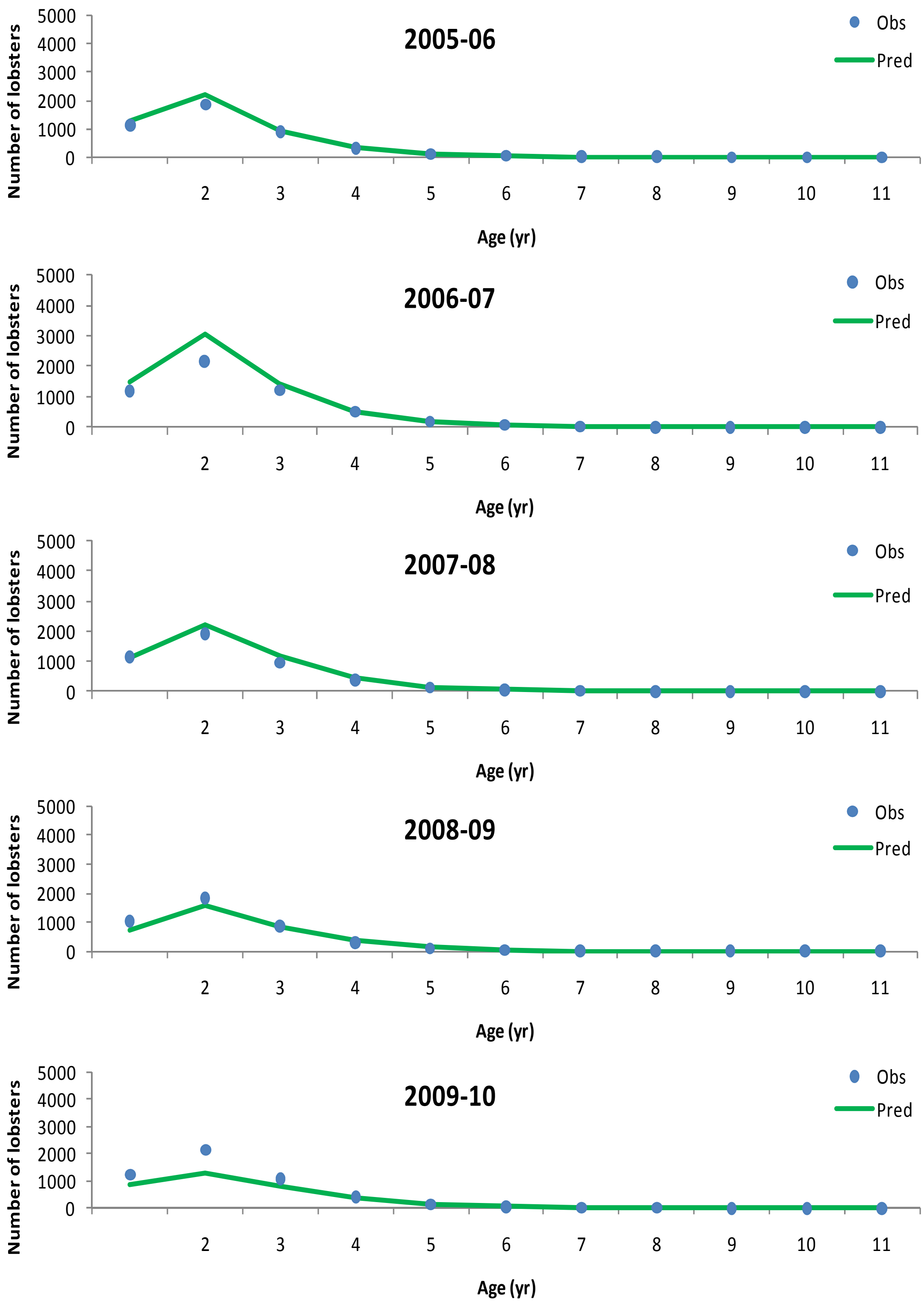


Figure 3.2.2.1.1 (continued). Fits of the catches-at-age in the ICA model by fishing year.

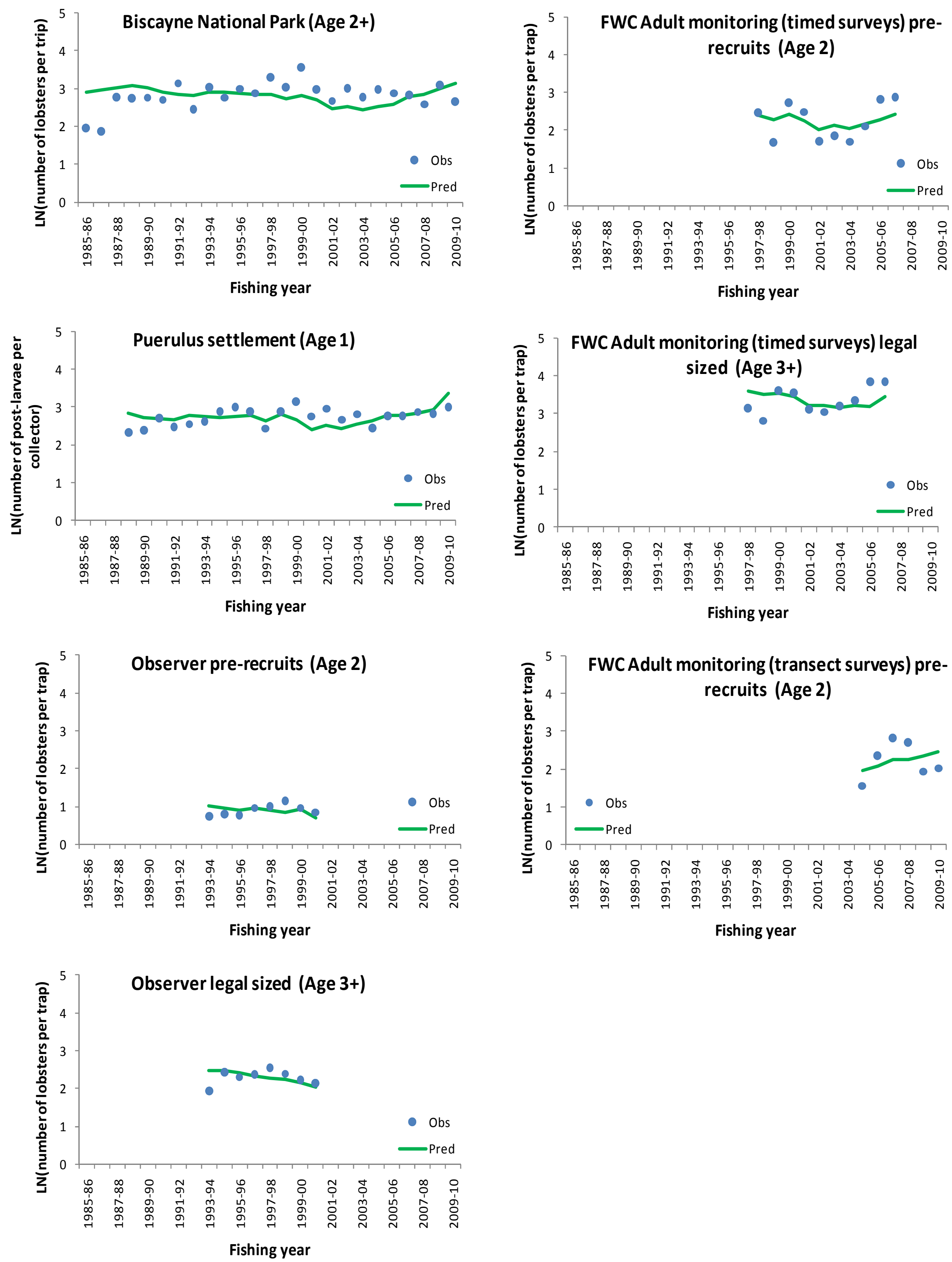
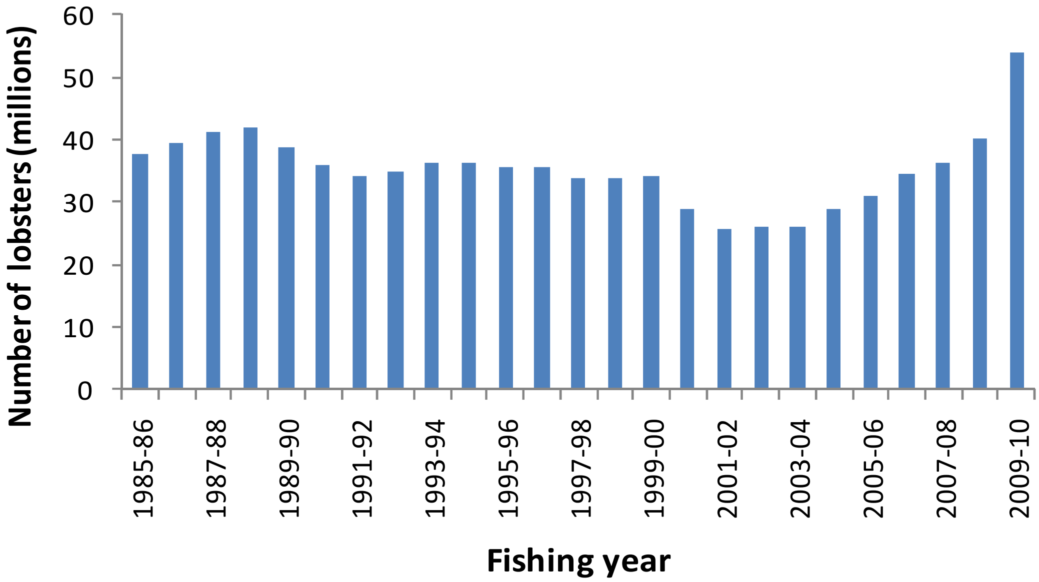


Figure 3.2.2.1.2. Fits of the tuning indices to ICA model.

a. Population



b. Recruitment of Age-1 lobsters

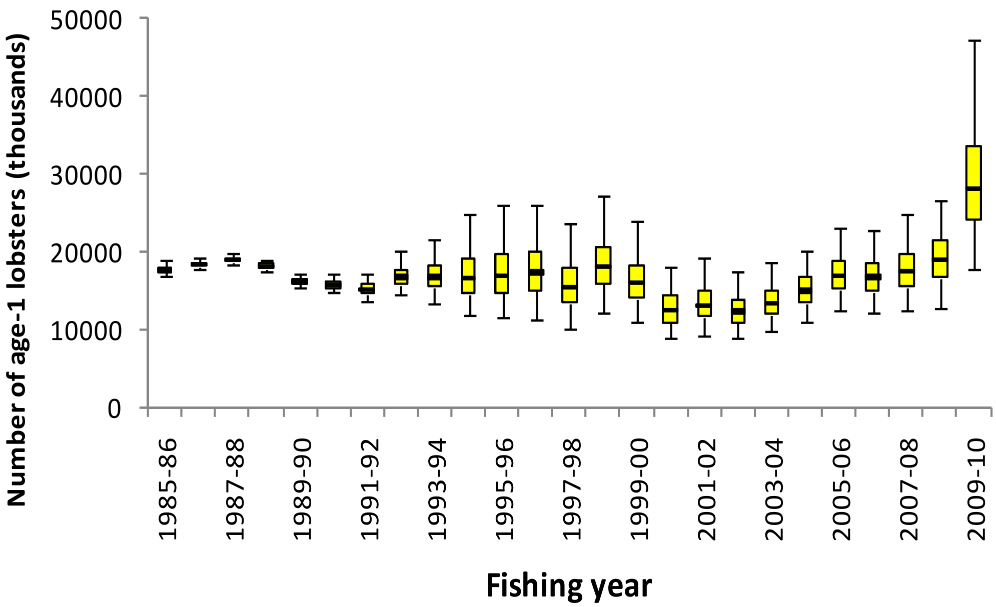
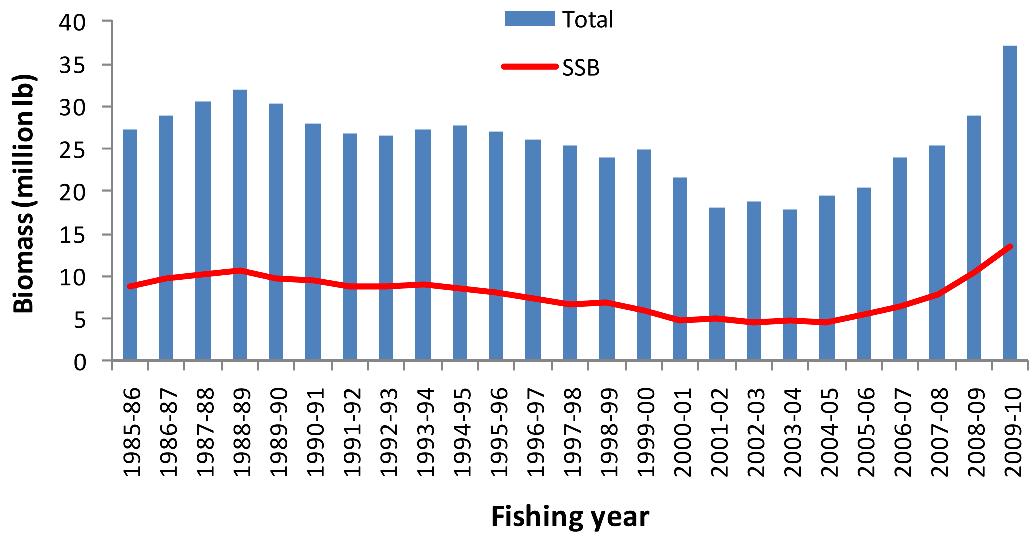


Figure 3.2.2.3. The total number of lobsters by fishing year (a) and the number of age-1 recruits based on 1000 Monte Carlo runs using the covariance matrix (b). The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

a. **Total biomass**



b. **Spawning biomass in Florida**

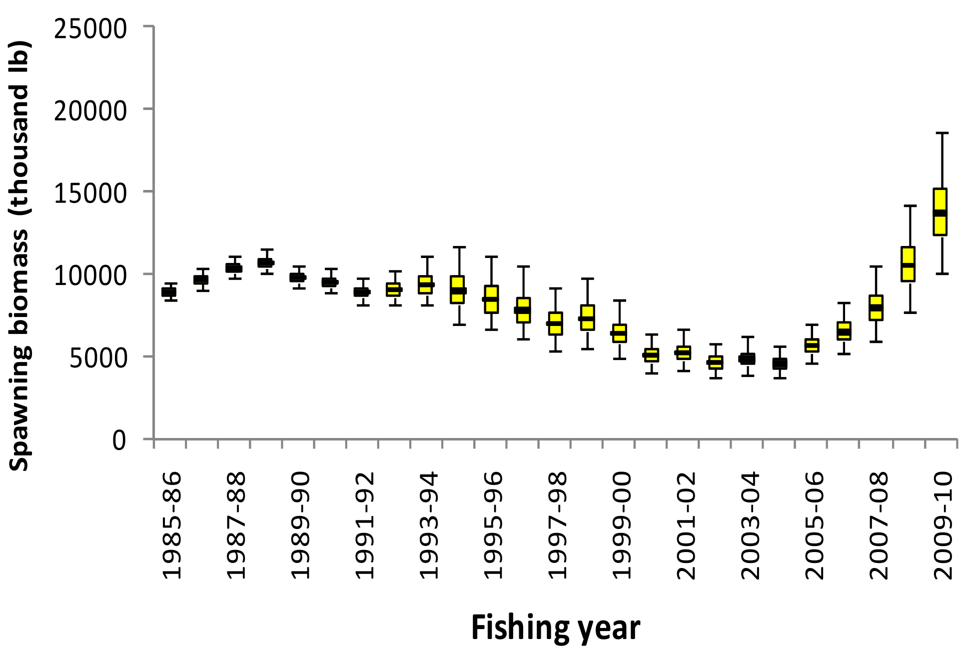


Figure 3.2.2.4. Total biomass and spawning biomass in SE US by fishing year. The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

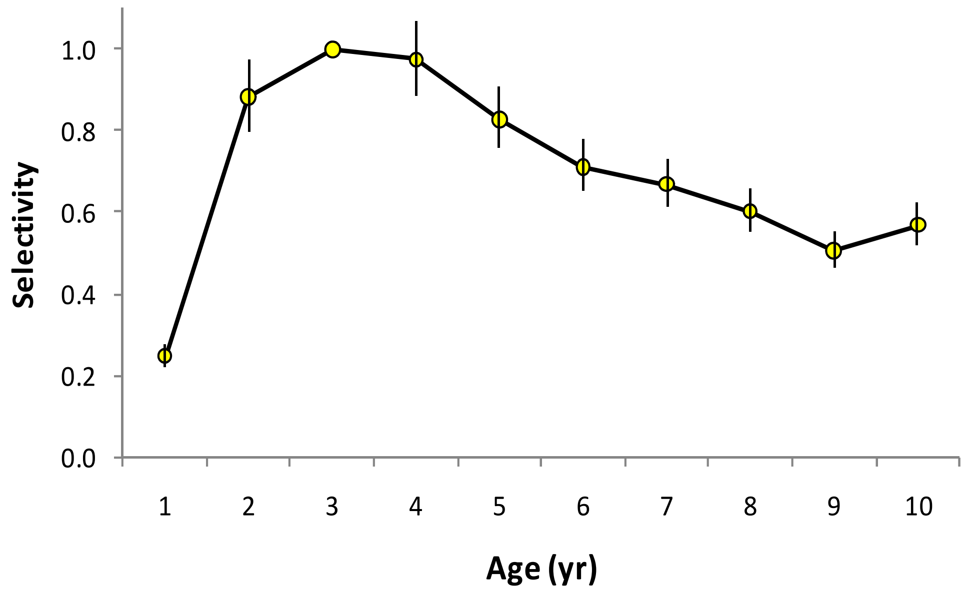


Figure 3.2.2.5. Selectivity by age for the period 1995-96 and later. The vertical lines are the 95% confidence intervals and the horizontal line is the maximum likelihood point estimate.

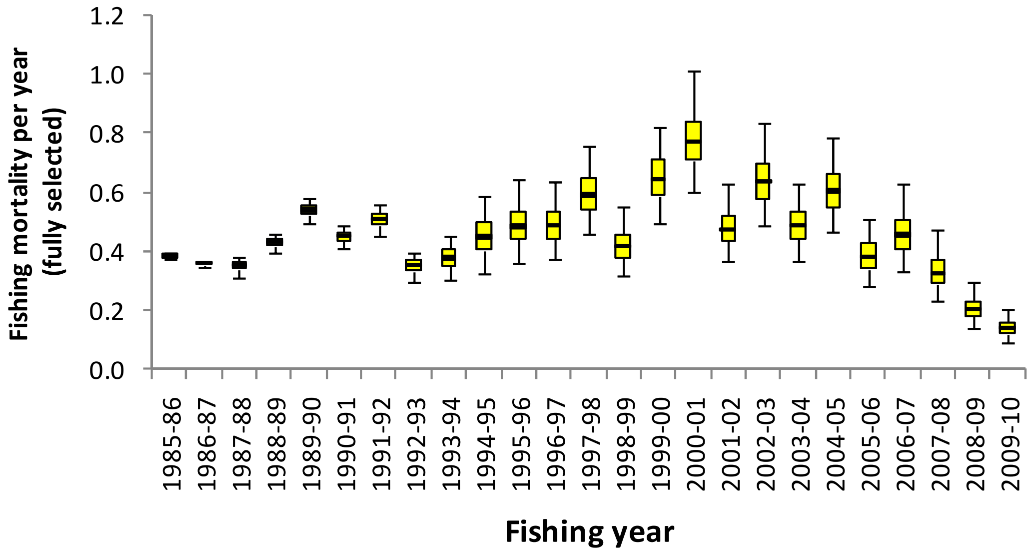


Figure 3.2.2.6.1. Fishing mortality rates on age-3 (fully selected) lobsters estimated by ICA. The uncertainty in the average fishing mortality rates is based on 1000 Monte Carlo runs using the covariance matrix. The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

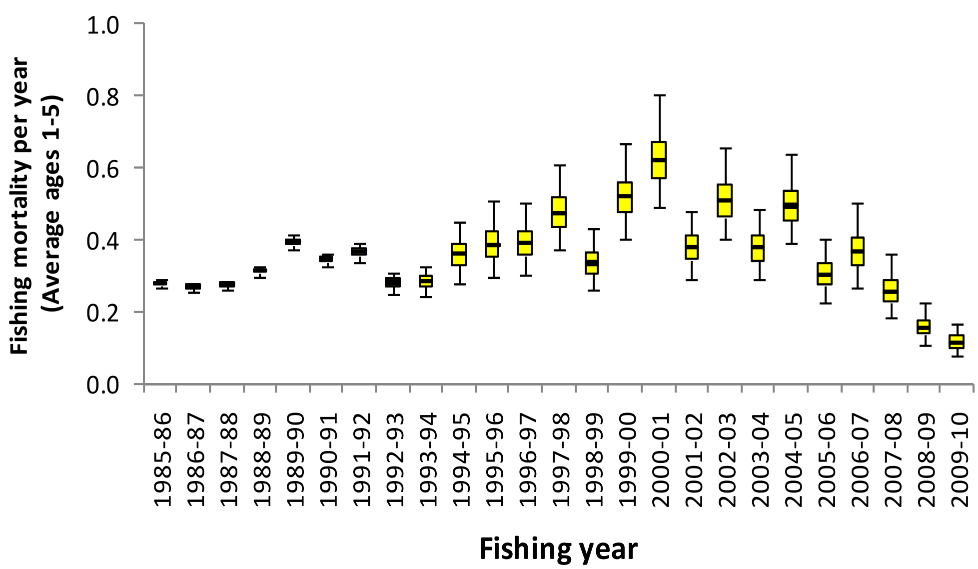


Figure 3.2.2.6.2. Average fishing mortality rates (ages 1 – 5) estimated by ICA. The uncertainty in the average fishing mortality rates is based on 1000 Monte Carlo runs using the covariance matrix. The vertical line is the 95% confidence interval, the box is the inter-quartiles (25 to 75 percentiles) and the horizontal line is the median.

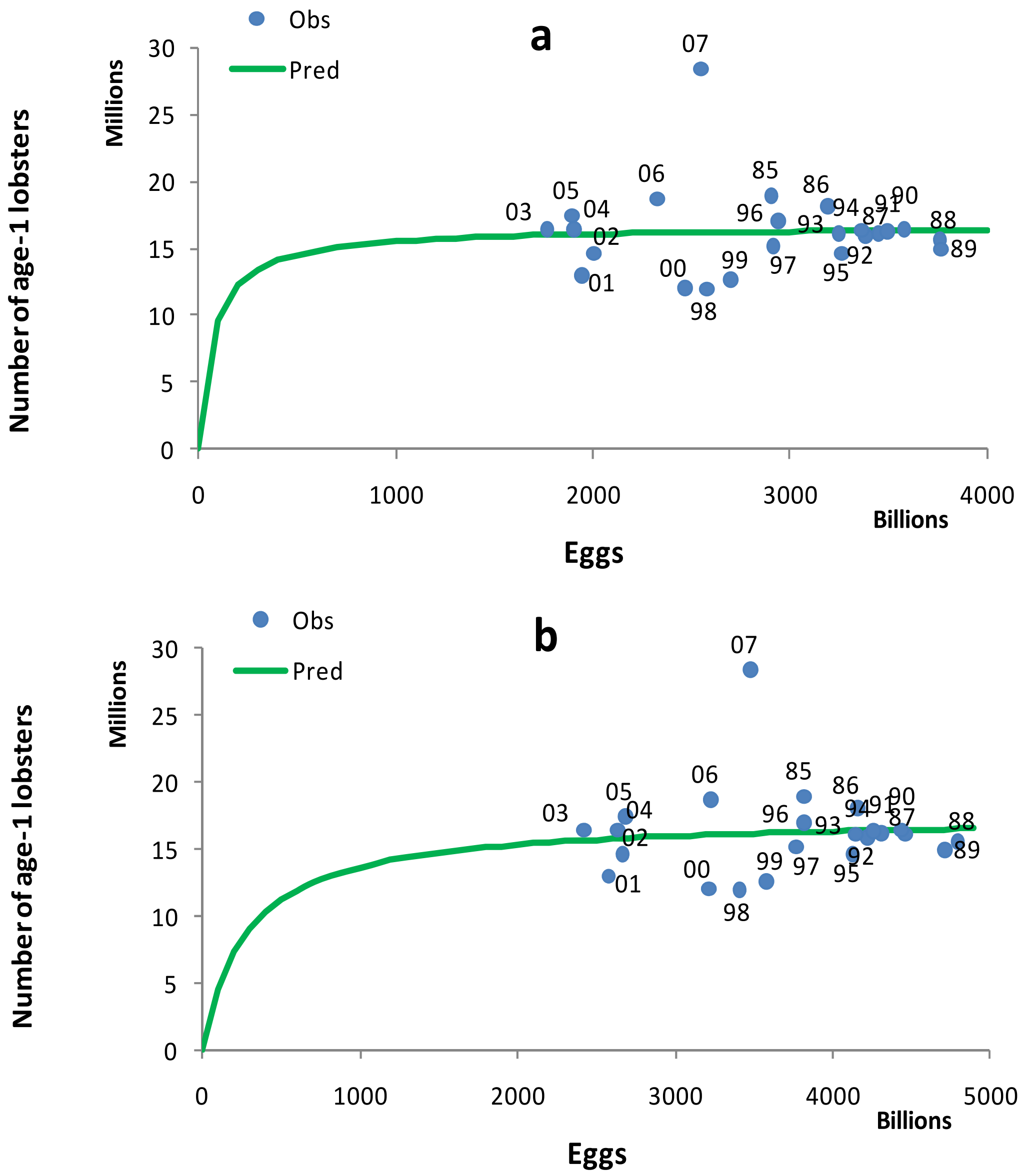


Figure 3.2.2.7. Relationships between spawning biomass, expressed as the number of eggs (a and b, using assumed and estimated maturity schedules, respectively) and the number of age-1 lobsters two years later. The spawning biomass accounted for the sex-ratio for females and the average number of broods by female in a spawning season. Ages are the time after settlement which occurs when lobsters are about ten months old so that an age-1 lobster actually is almost two years old.

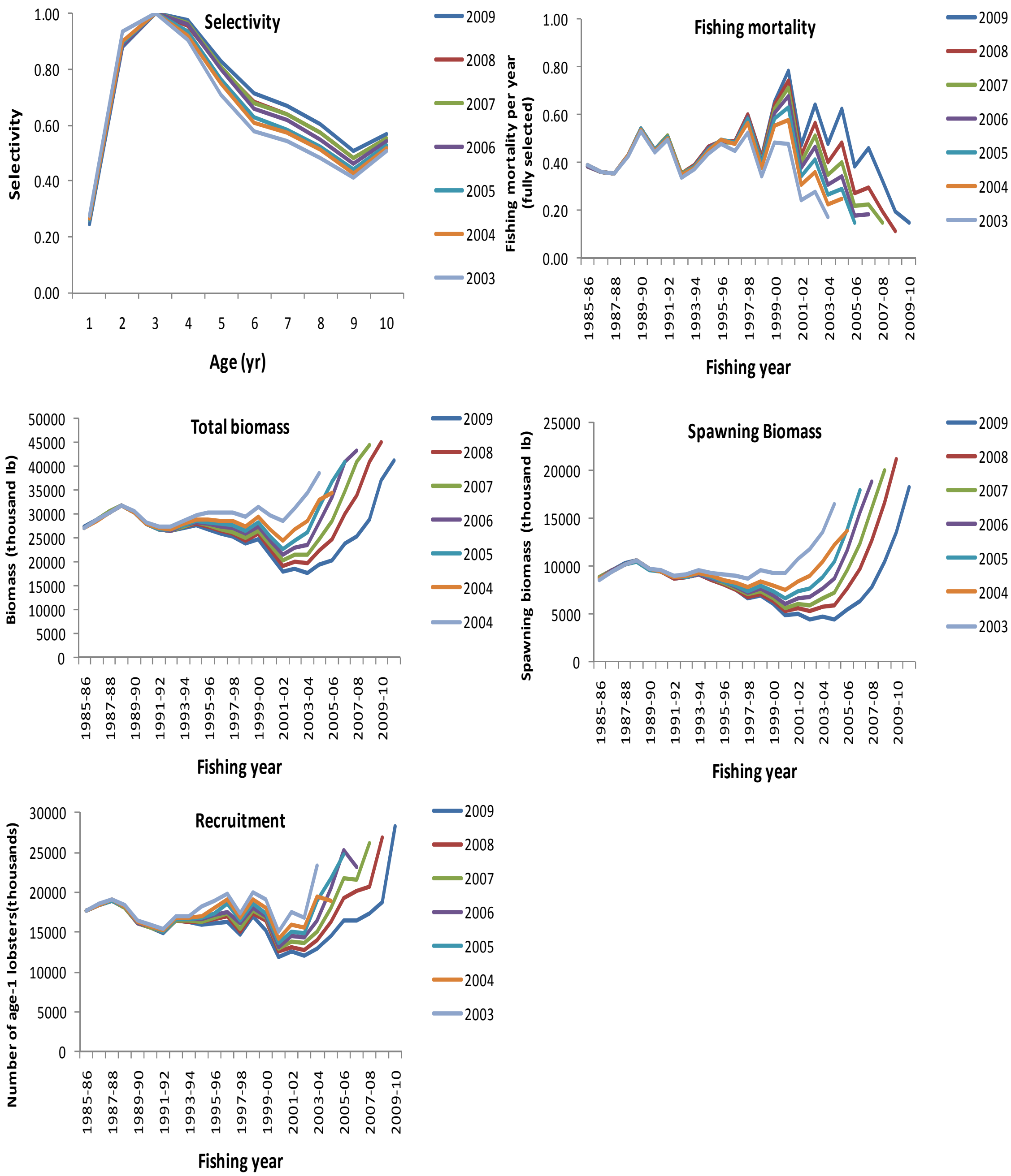


Figure 3.2.2.9.1. Retrospective analyses for the 1997-98 fishing year and later of different population parameters.

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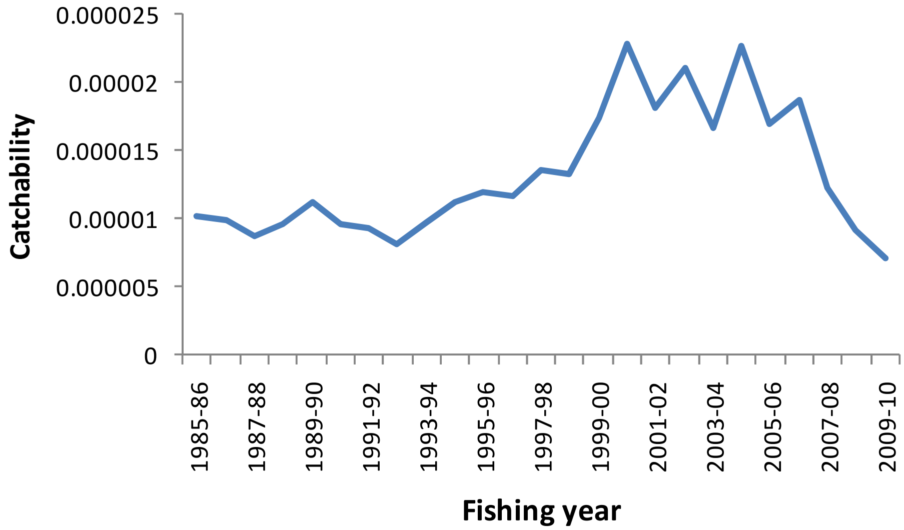

Figure 3.2.2.9.2. Annual variations in the estimates of catchability coefficients for the spiny lobster fishery off the SE U.S., 1985 -2009.
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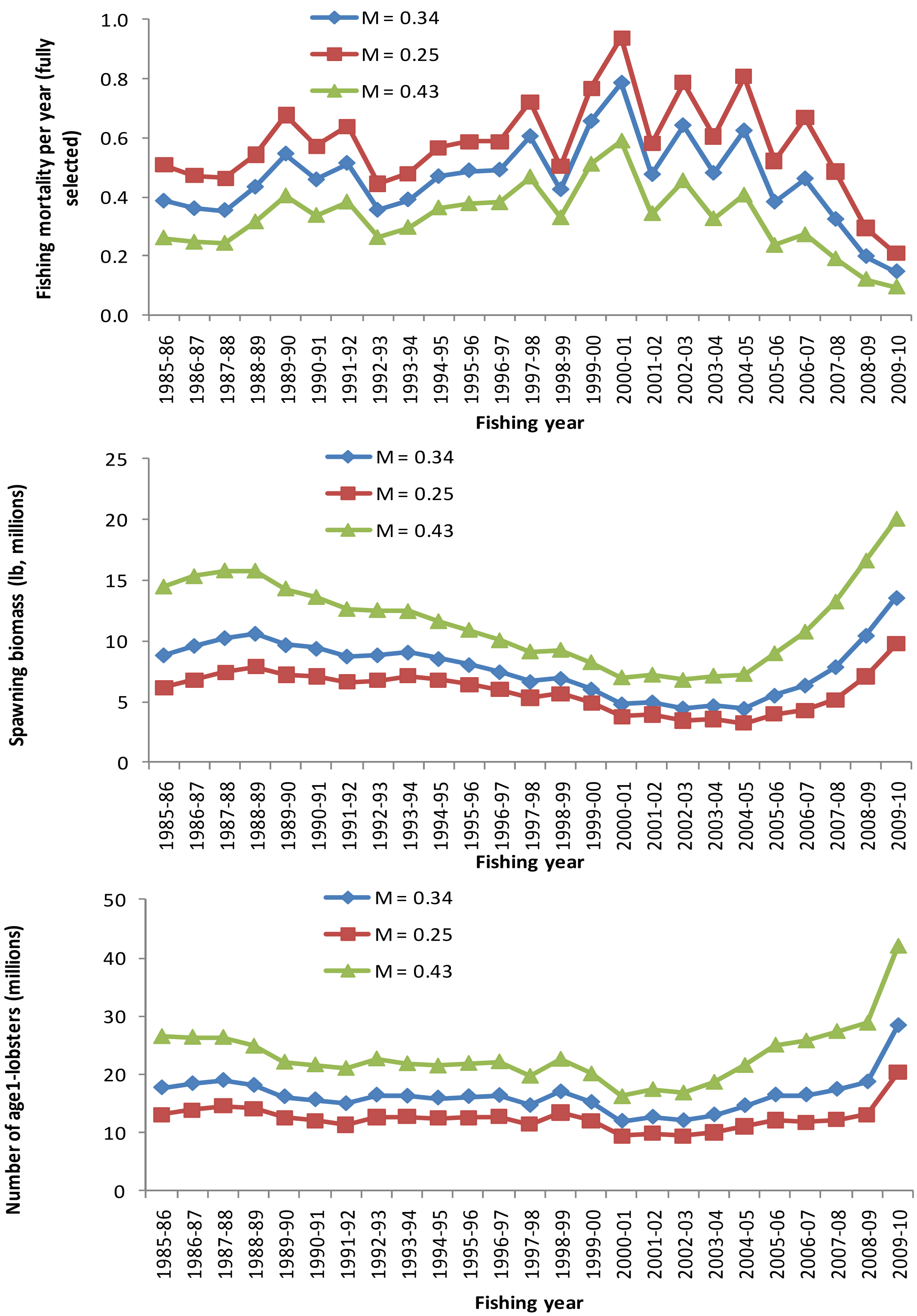


Figure 3.2.2.9.3. Comparison of fishing mortality per year on the fully recruited ages, spawning biomass, and recruitment estimated with three natural mortality rates: 0.25, 0.34, and 0.43 per year.

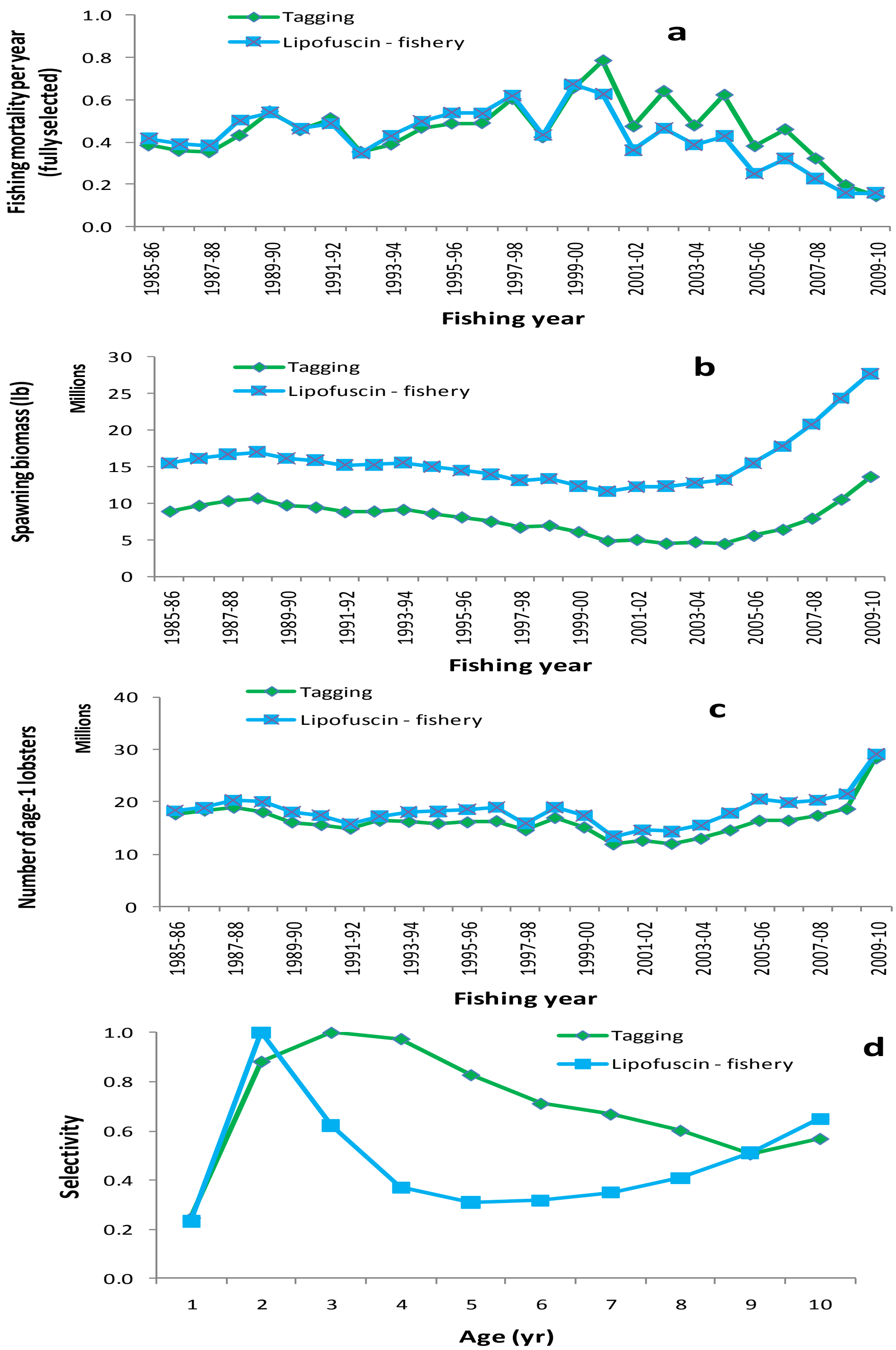


Figure 3.2.2.9.4. Comparison of fishing mortality per year on the fully recruited ages (a), spawning biomass (b), recruitment (c), and selectivity (d) estimated by ICA base run using tagging based age-length keys and lipofuscin based age-length keys that were developed for Florida Keys (i.e., for the fishery)

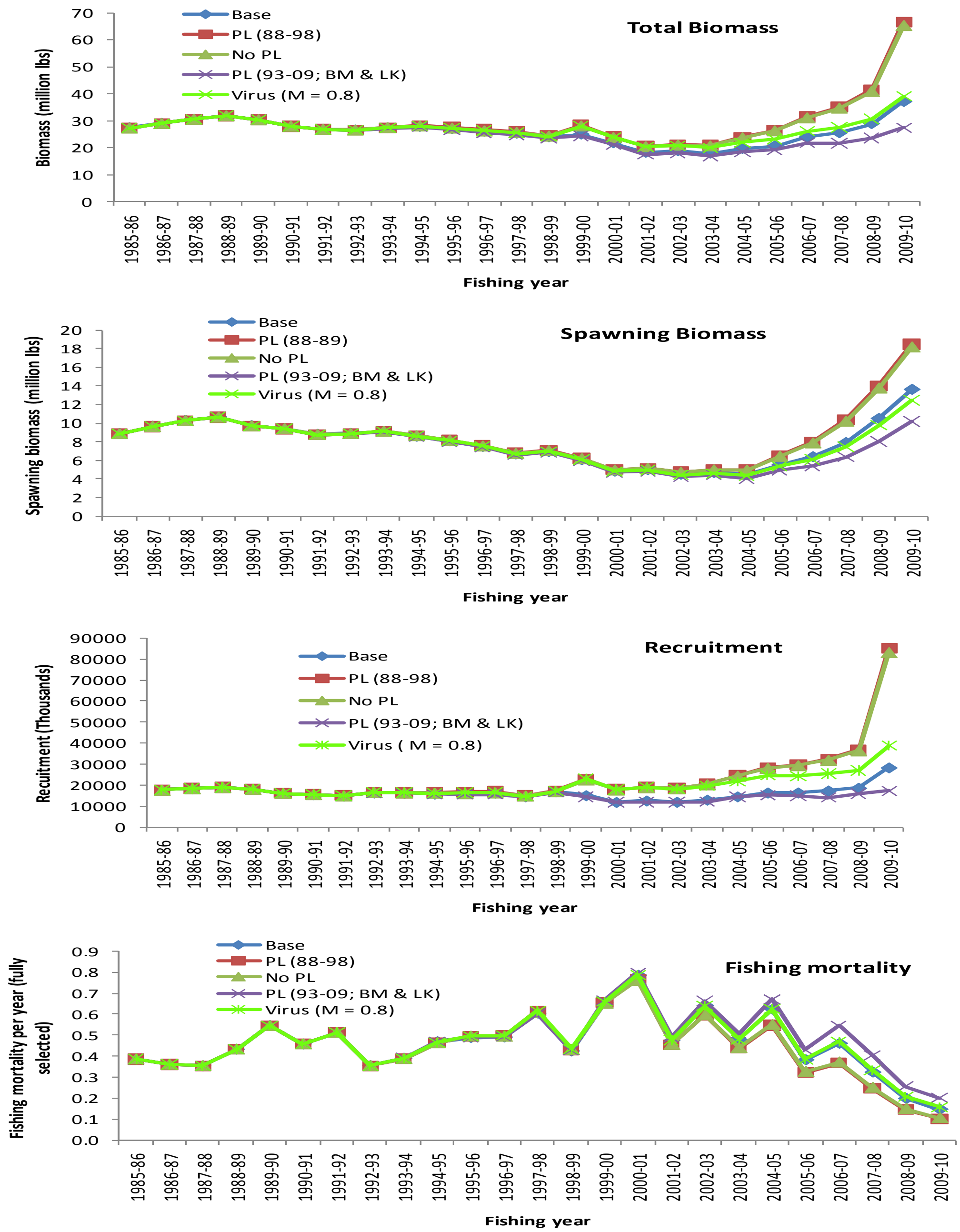


Figure 3.2.2.9.5. Comparison of total biomass, spawning biomass, recruitment, and fishing mortality per year on the fully recruited age of lobsters, estimated with a natural mortality rate of 0.34 per year in base run and runs with variations of the post-larvae index: 1988-98 time series (PL (88-89)), excluded (No PL), and 1993-2009 time series with data from both Big Munson and Long Keys sites (PL (93-09; BM & LK)); and with a natural mortality of 0.8 per year in base run, adjusted to account for an average of 36% decline in landings over 1999-09.

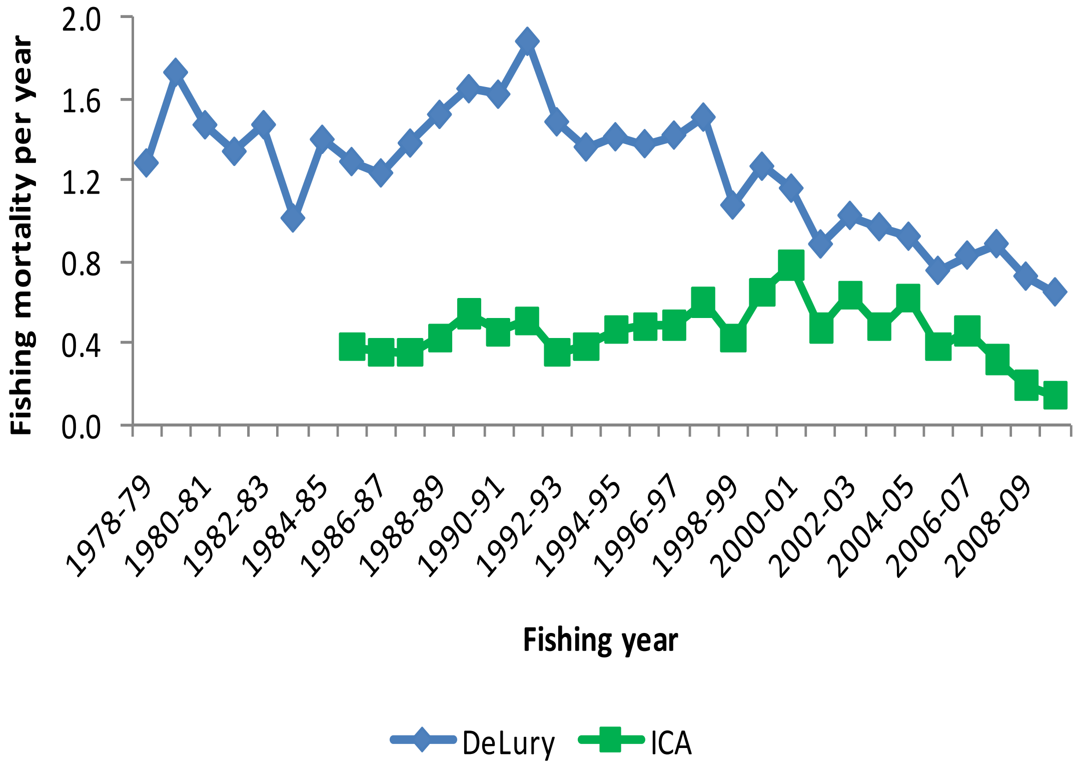
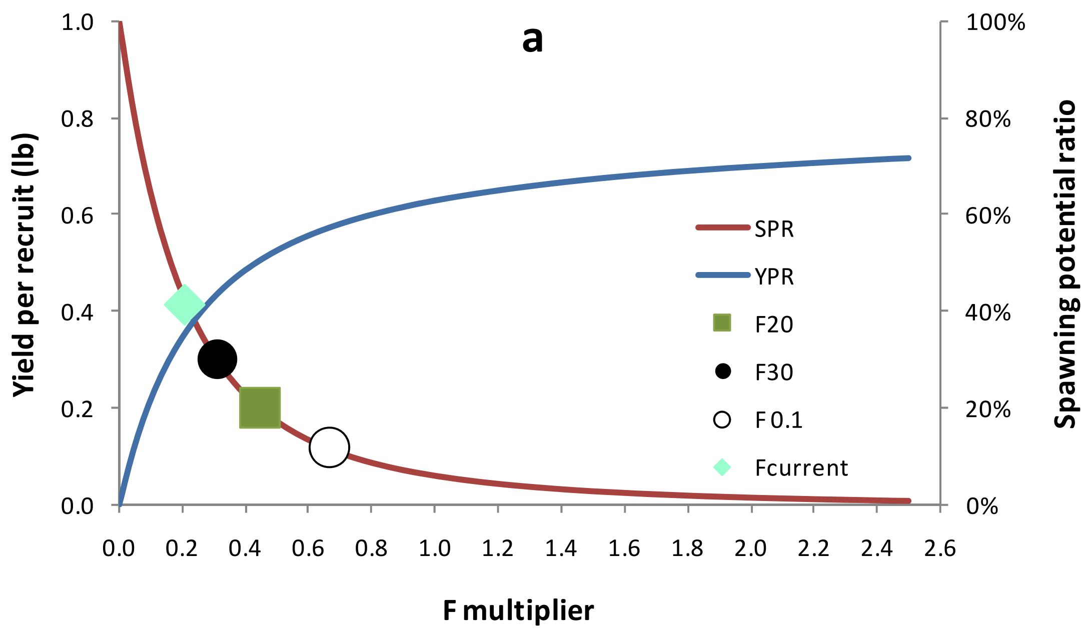


Figure 4.1. Comparison of the fishing mortality rates from the selectivity adjusted DeLury model and the age-structured model ICA.



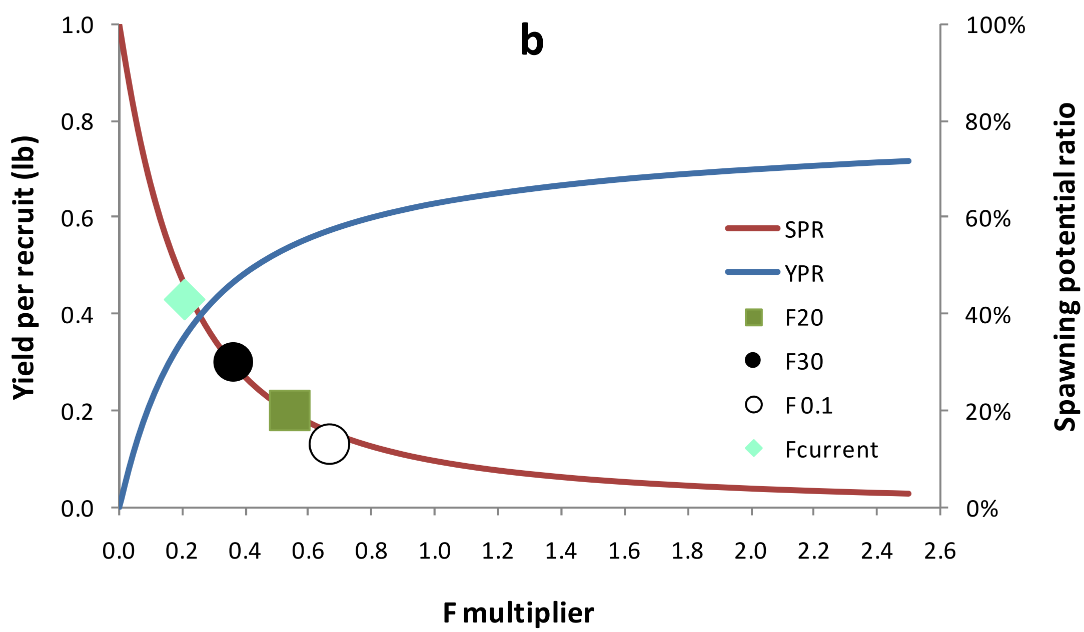


Figure 5.1.2. Yield-per-recruit and Spawning potential ratio (SPR; Static eggs per recruit) by fishing mortality rates on fully recruited spiny lobsters off SE US. Various reference points are also included. The SPR was calculated using assumed (a) and estimated (b) maturity schedules.

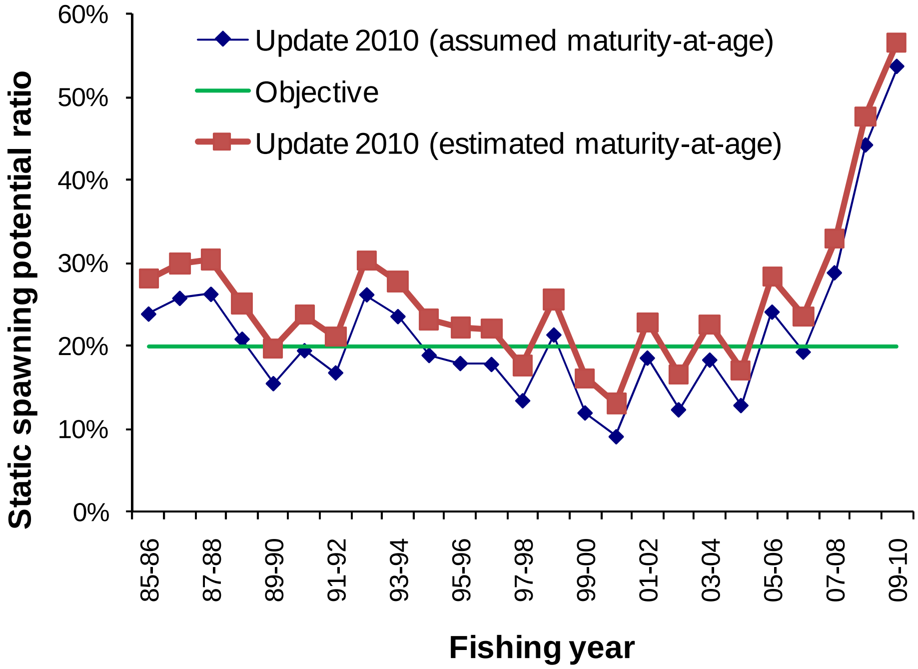
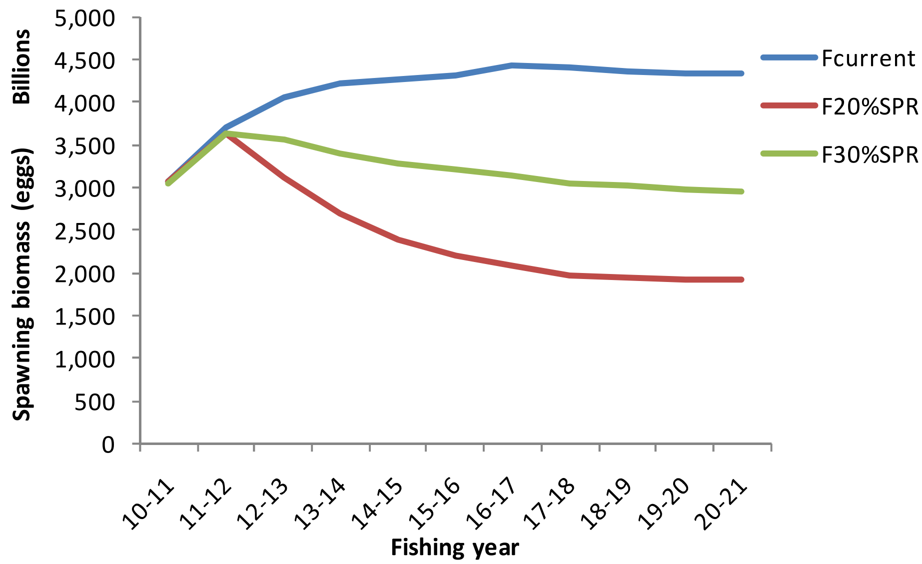


Figure 6.3. Static spawning potential ratios by fishing year (established using the assumed and estimated maturity schedules) and the current management objective of 20%.

a. Spawning biomass



b. Landings

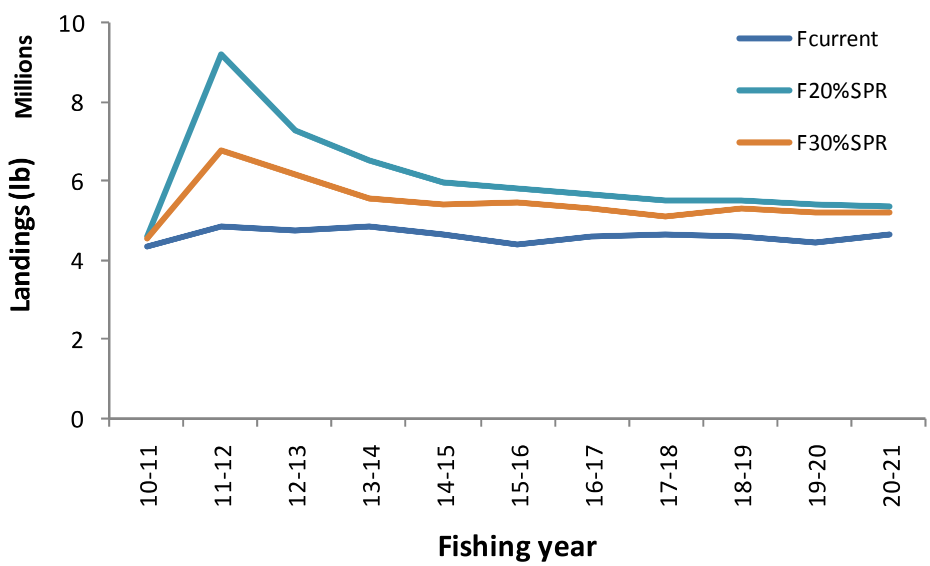
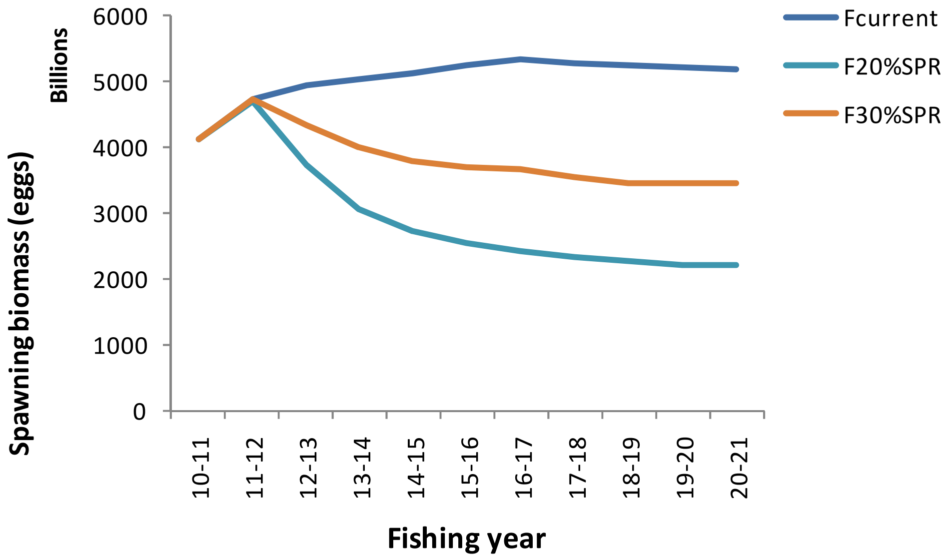


Figure 7.1.1. Projected biomass levels (a) and landings (b) for various fishing mortality rates including $F_{current}$, $F_{20\%SPR}$, and F_{oy} ($F_{30\%SPR}$), when the maturity schedule is assumed.

a. Spawning biomass



b. Landings

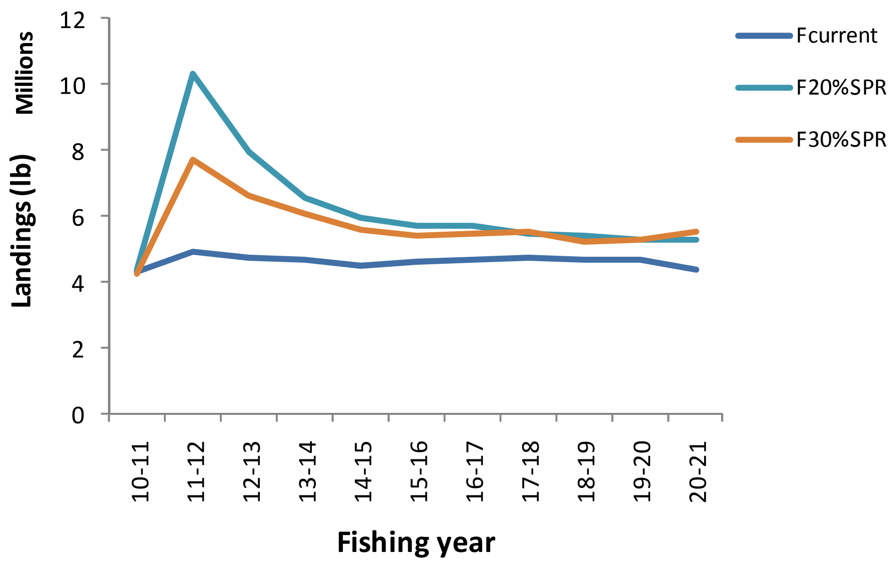


Figure 7.1.2. Projected biomass levels (a) and landings (b) for various fishing mortality rates including $F_{current}$, $F_{20\%SPR}$, and F_{oy} ($F_{30\%SPR}$), when the maturity schedule is estimated.

Appendix A – Southeast Spiny Lobster Update Stock Assessment Participants

Assessment Panel	
Doug Gregory	GMFMC SSC
John Hunt	GMFMC SL SSC
Anne Lange	SAFMC SSC
David Eggleston	SA, Researcher
Jerry Sansom	GMFMC SL AP
Simon Stafford	GMFMC SL AP
Nelson Ehrhardt	RSMAS
Analytic Team†	
Robert Muller, Lead Analyst	FWRI
Joseph Munyandorero, Analyst	FWRI
Appointed Observers	
Mark Robson	SAFMC Council Member
Bill Teehan	GMFMC Council Member
Sue Gerhart	SERO
Kate Michie	SERO
Staff	
Carrie Simmons	GMFMC Staff
Gregg Waugh	SAFMC Staff
John Froeschke	GMFMC Staff
Julie A Neer	SEDAR
Tina O'Hern	GMFMC Staff
Patrick Gilles	NOAA/NMFS/SEFSC
Observers	
Tom Matthews	FWC/FWRI
Bill Sharp	FWC/FWRI
Bill Kelly	FKCFA
Ken Blackburn	NOAA Enforcement
Dennis O'Hern	FRA
Edward Little	NOAA/NMFS
Dave Hawtof	FWC Volunteer
Jesus Diaz	Commercial fisherman
Richard Diaz	Commercial fisherman
Manuel Ravels	Commercial fisherman
Ruben Ravels	Commercial fisherman
Mimi Stafford	FKCFA
George Geiger	SAFMC
Aaron Podey	FWC
Rodney Bertelsen	FWC