2014 Florida Sea Grant: Developing a size-structured stock assessment model for the spiny lobster, *Panulirus argus*, in the southeast United States

Data and Statistics

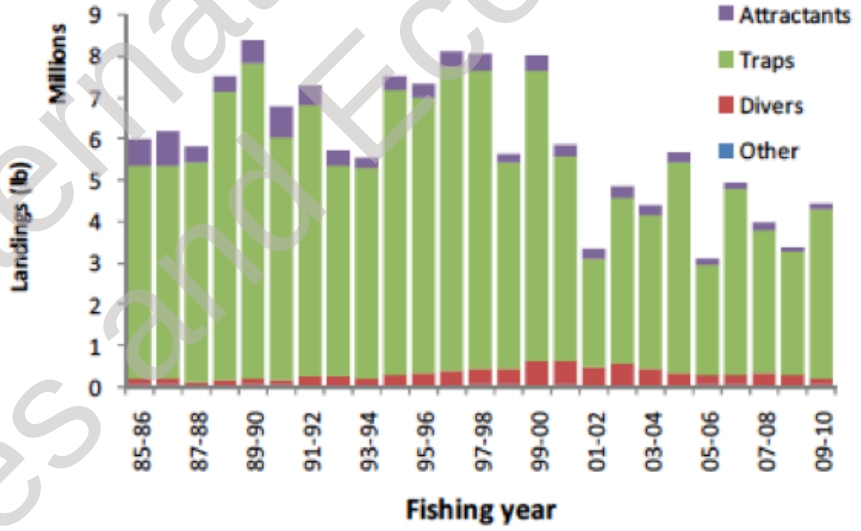
In the observational submodel, the predicted landings, the landing size compositions, the survey indices, the survey size compositions, as well as the efforts are related to the corresponding observed data from the spiny lobster fisheries. The predicted and observed data will be used to formulate the Bayesian likelihood functions, and to help optimize the parameters in the stock assessment model.

Landings of spiny lobster in the southeast US comes from two fisheries, commercial and recreational. It can also be aggregated into 4 categories, according to different gear used in fisheries. The gears used in the commercial fisheries are: attractants, traps, divers, and other (SEDAR, 2010). The "other" category includes spiny lobsters caught from other gears reported on trip tickets, such as bully nets, shrimp trawls, and so on. In the "attractant" fleet, commercial fishermen always use sublegal-size spiny lobsters in traps to attract other lobsters. The recreational landing is mostly caught by divers. Different fishing gear will have different selectivity labeled.

Table 1. 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%

Figure 1. Commercial landings in pounds by gear and fishing year for Southeast US spiny lobster.



Similar to the latest stock assessment model, 8 surveys have been conducted for spiny lobster, 4 for legal-size lobster (Fig. 2), 3 for sub-legal lobster (Fig. 3) and 1 for recruits (Fig. 4; SEDAR, 2010). The 4 legal-size lobster surveys include the observed legal-size indices (gear traps), the Florida Fish and Wildlife Conservation Commission (FLFWC) adult monitoring legal-sized indices (gear divers), the FLFWC transect legal-size indices, and the Biscayne National Park (BNP)'s creel survey. The 3 sub-legal surveys include observed pre-recruit indices (gear traps), the FLFWC adult monitory pre-recruit indices (gear divers), and FLFWC transect sublegal-size indices. The recruitment indices are extracted from the long-term pueres survey that have been conducted by FLFWC since 1993. However, the size of the lobster caught by the survey is 6 mm carapace length (CL). In our stock assessment model, the recruitment size is 46 mm CL. Therefore, the data presented cannot be applied to the model directly. We add a time lag into the recruitment indices. According to references, it will take ~12 months for the pueres to growth up to 46mm. Therefore, the data are only applied for the years from 1994 to 2009.

Figure 2. Legal-size survey indices used in the stock assessment model, a) Observer, b) FLFWC divers, c) FLFWC transect, and d) BNP.

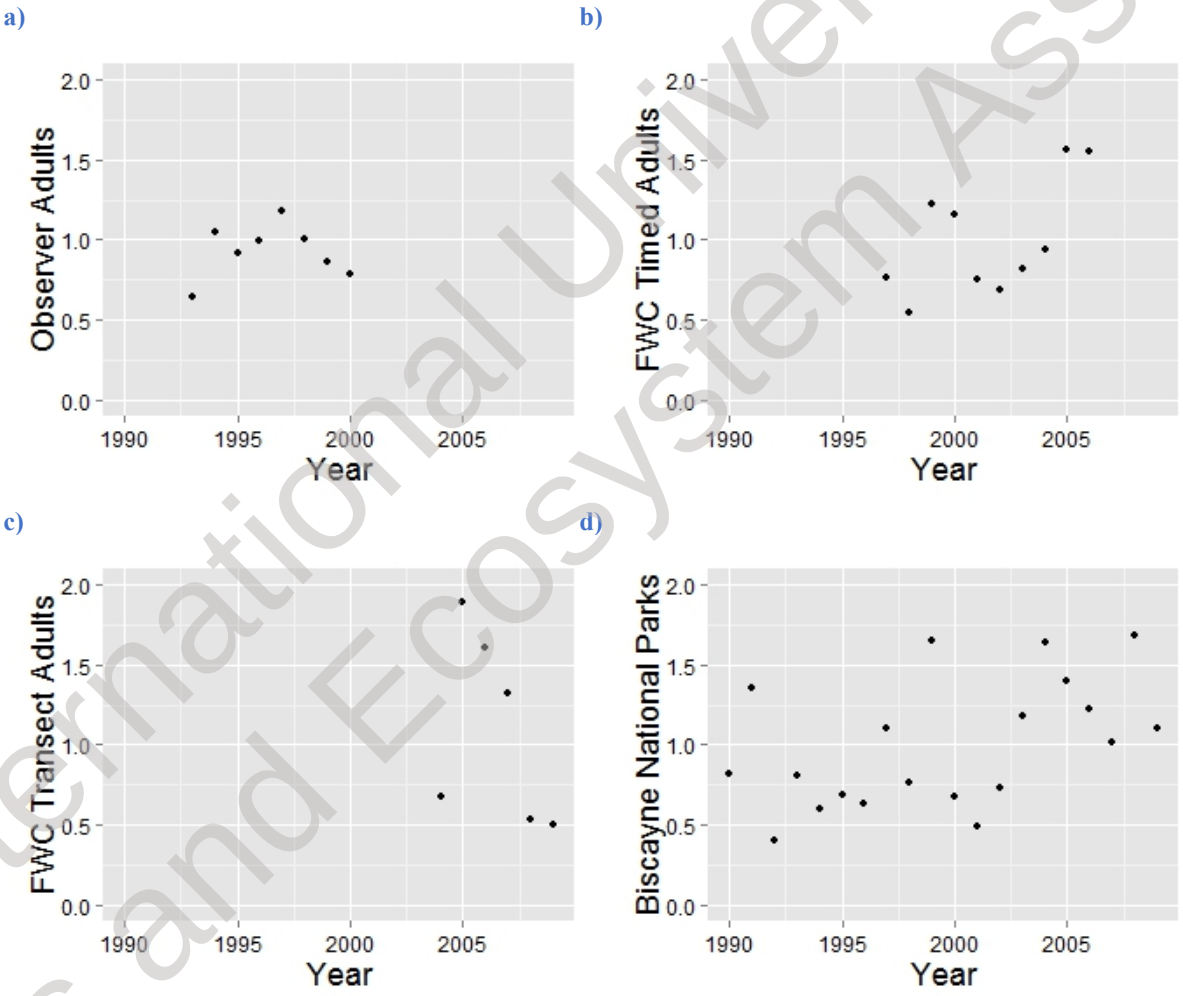
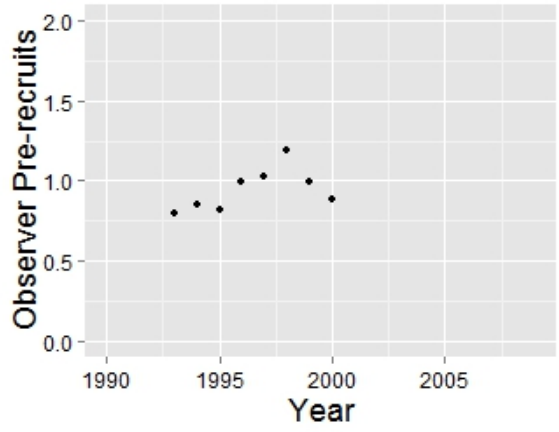
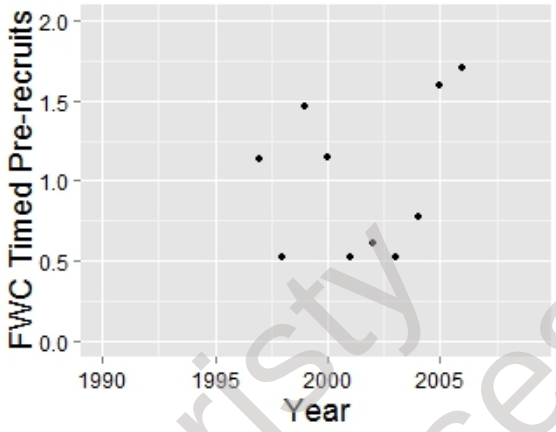


Figure 3. Sublegal-size survey indices used in the stock assessment model, a) Observer, b) FLFWC divers, and c) FLFWC transect.

a)



b)



c)

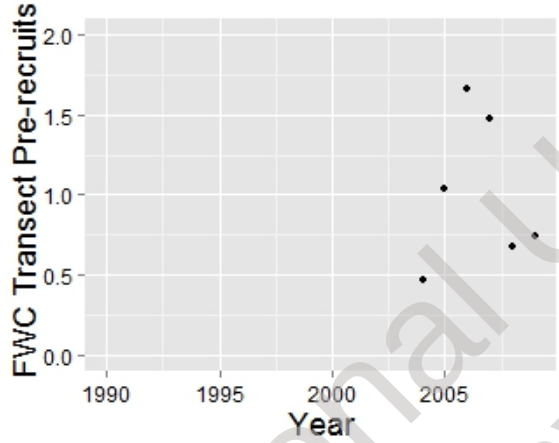
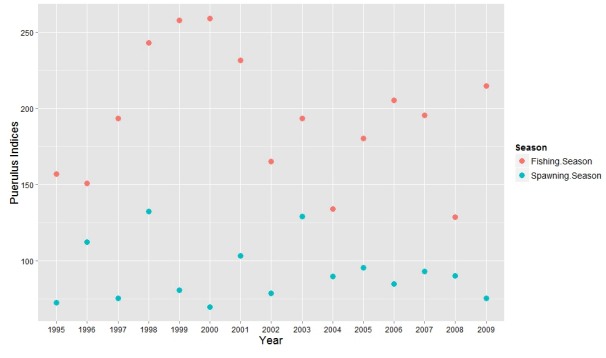


Figure 4. Recruitment survey indices used in the stock assessment model, a) Dry and Wet seasons, and b) Fishing and Spawning seasons.

a)

b)

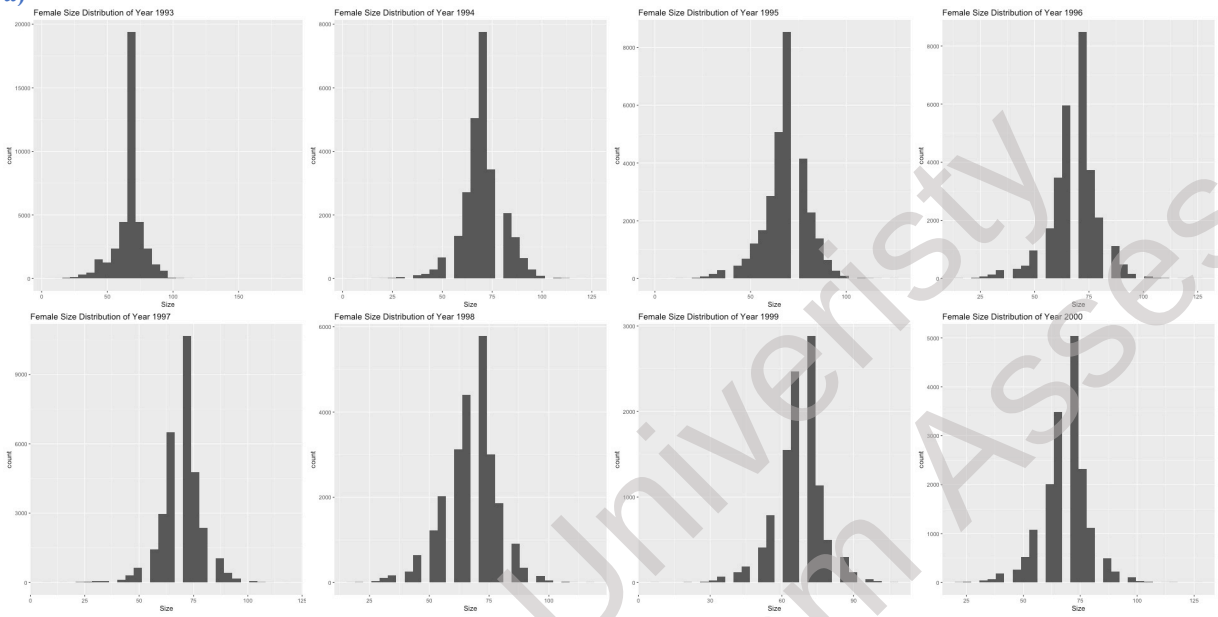


Four length frequency indices were used. They are commercial length frequencies from observers (Fig. 5), commercial length frequencies from the Trip Interview Program (TIP; Fig. 6), Fisheries independent length frequencies from a MARFIN reproduction-related project (Personal

communication with Tom Matthews; Fig. 7), and recreational length frequencies measured by FLFWC (Fig. 8). Potential length frequencies include the one collected by FLFWC in the marine reserve areas.

Figure 5. Commercial length frequencies from observers, a) female from 1993 to 2000, b) male from 1993 to 2000.

a)



b)

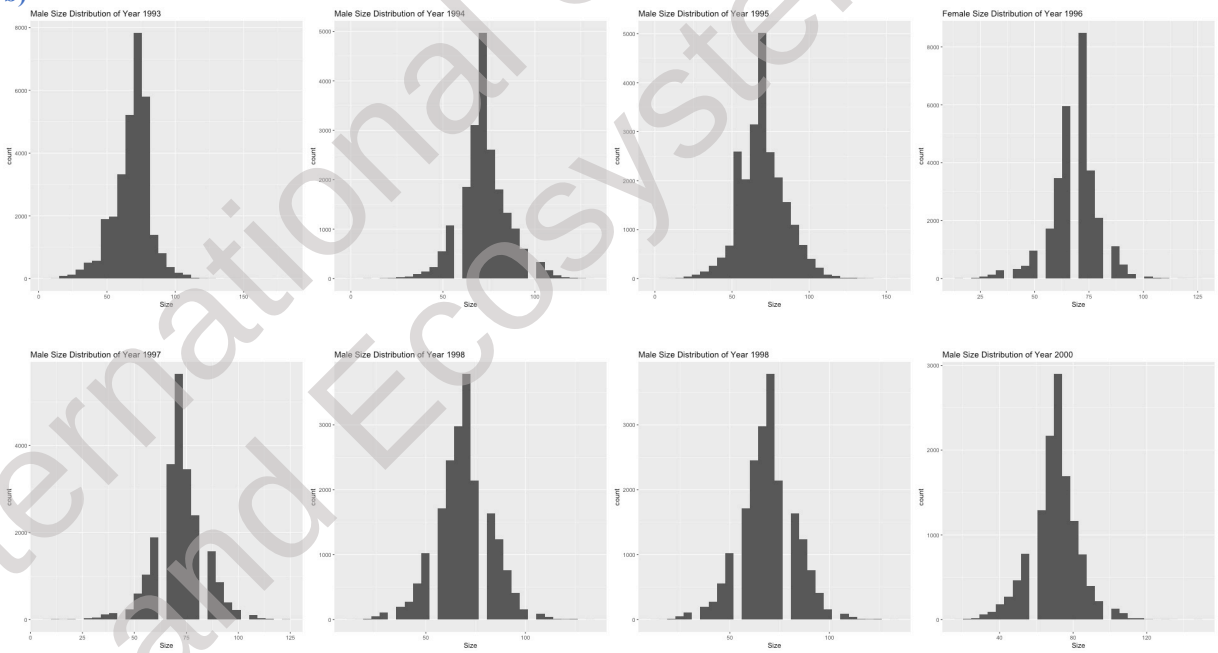
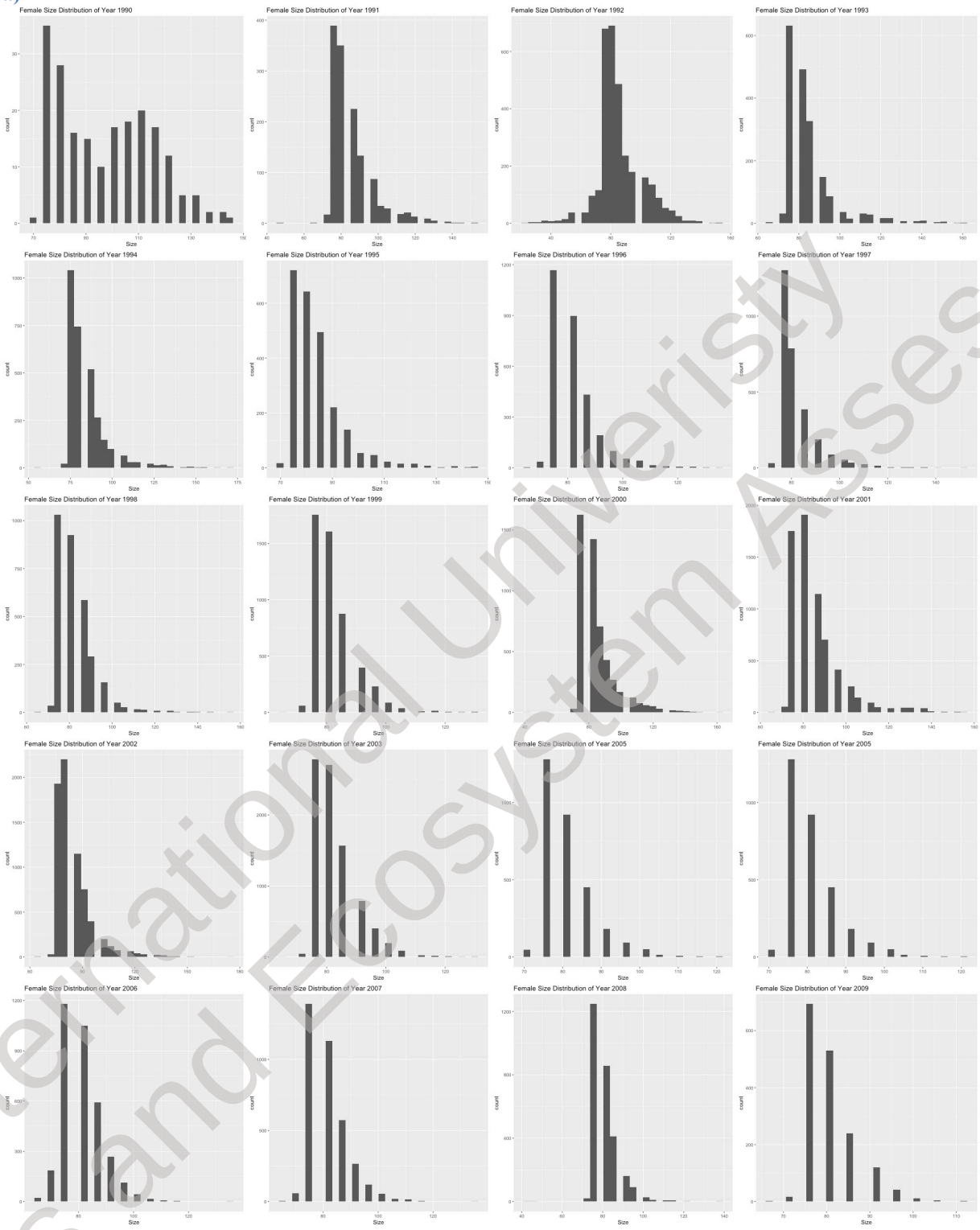


Figure 6. Commercial length frequencies from TIP, a) female from 1985 to 2009, b) male from 1985 to 2009.

a)



b)

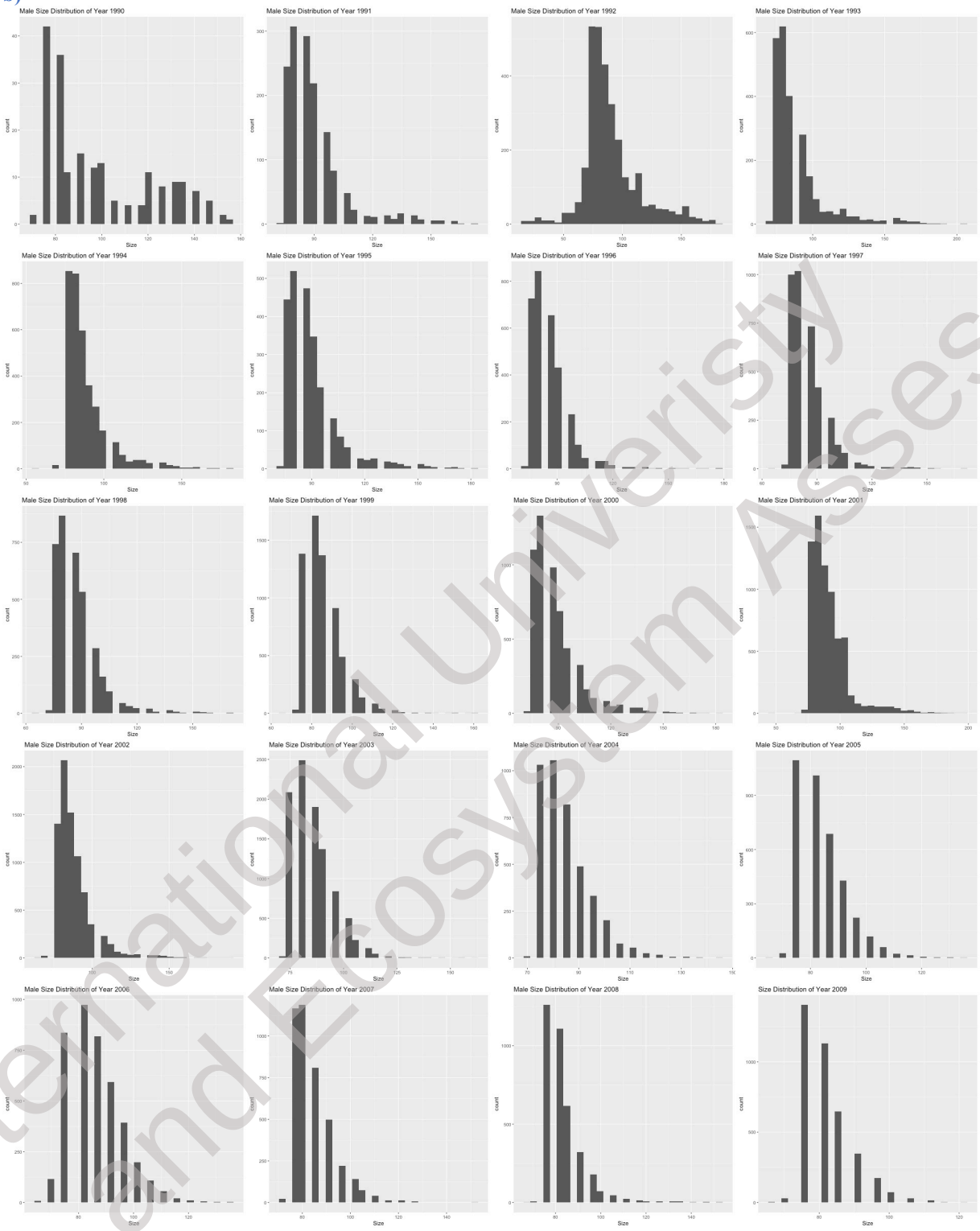


Figure 7. MARFIN length frequencies, a) female in 1997 and 1998, b) male in 1997 and 1998.

a) **b)**

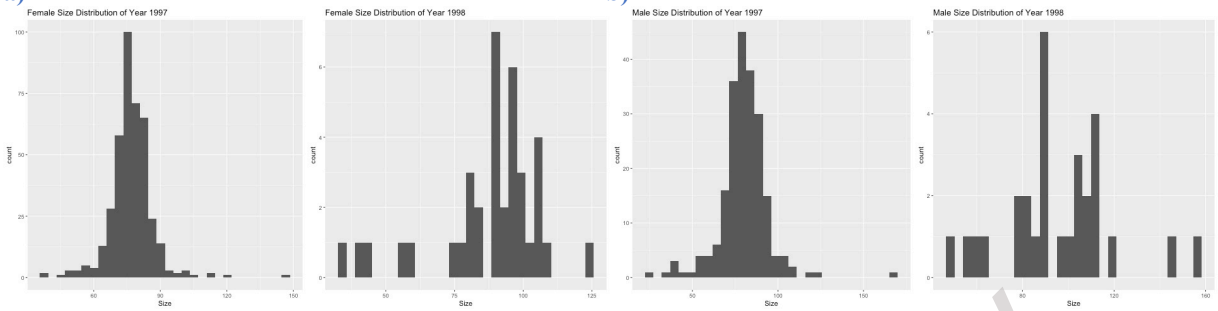
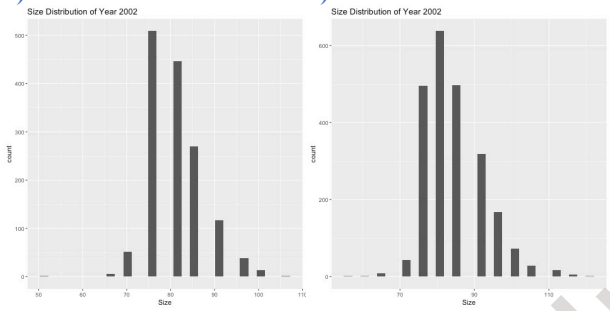


Figure 8. FLFWC recreational length frequencies, a) female in 2002, b) male in 2002.

a) **b)**



Commercial efforts are calculated as the product of gear quantity and soak time. However, there are a lot of data missing in the early 1990s (Fig. 9). The annual averages were used to replace the missing data. The standardized commercial efforts have been shown in Figure 10.

Figure 9. Percentage of missing data in the a) gear quantity and b) soak time records.

a) **b)**

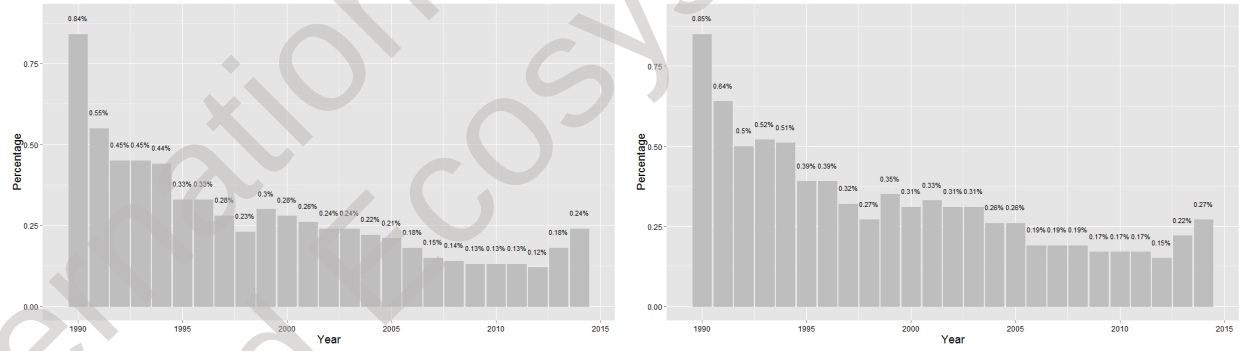
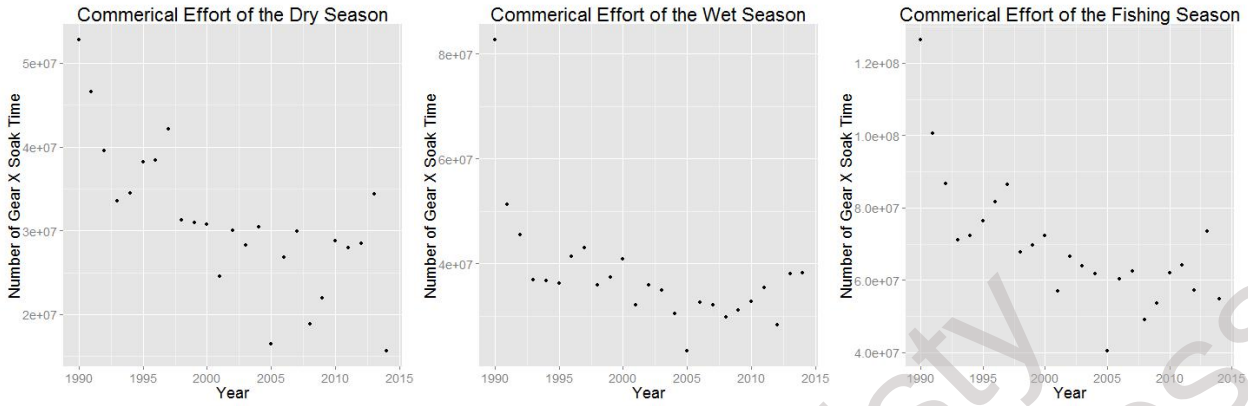


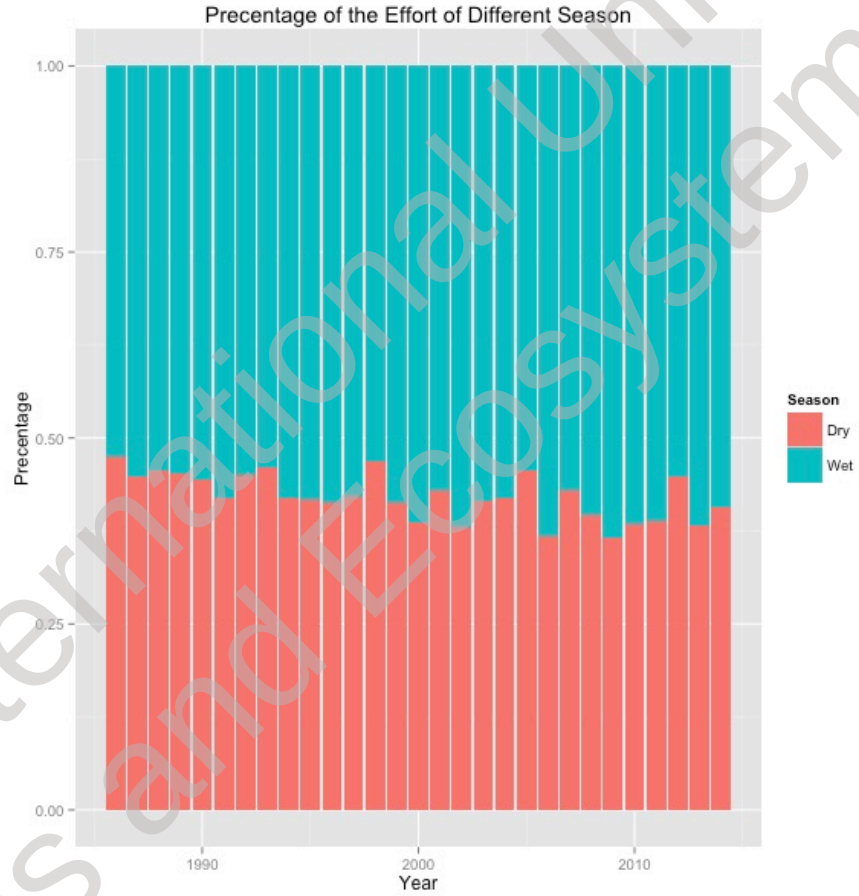
Figure 10. Commercial efforts in a) Dry season, b) Wet season, and c) Fishing season.

a) **b)** **c)**



The Seasonal commercial effort data shows that the effort in the Wet season occupied more than that in Dry season (Fig. 11). Regarding that the Wet season contains more non-fishing season. The ratio can be applied to split the annual fishing mortality.

Figure 11. Percentage of commercial efforts in Dry and Wet seasons.



Recreational efforts are counted as person-day per fishing year (Fig. 12). The effort estimation comes from FLFWC mail survey (Personal Communication with Steve Brown).

Figure 12. Recreational efforts for regular and special fishing seasons.