SEDAR 41 WP33: Size Distribution, Release Condition, and Estimated Discard Mortality of Red Snapper Observed in For-Hire Recreational Fisheries in the South Atlantic

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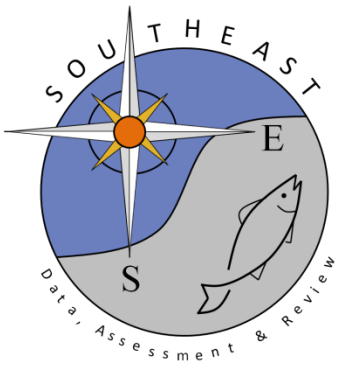

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Size Distribution, Release Condition, and Estimated Discard Mortality of Red Snapper Observed in For-Hire Recreational Fisheries in the South Atlantic

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Detailed information on the size and release condition of discarded fish is not collected in traditional dockside surveys of recreational fisheries. At-sea observer surveys provide valuable information on the size and condition of discarded fish. Such surveys have been conducted on headboat vessels in the south Atlantic since 2004. Coverage was expanded in 2013 to include charter vessels on the east coast of Florida. This report provides a summary of available information on the size, release condition, and disposition of red snapper collected from headboats and charter boats from the Atlantic coast of Florida through North Carolina.

Coverage

Fishery observer coverage for headboats and charter vessels operating in the South Atlantic is summarized in Table 1.

Headboat Coverage

In 2004, at-sea observer surveys were conducted on headboats from North Carolina and South Carolina, and coverage was extended to east Florida in 2005. In the Florida Keys, the at-sea headboat survey was funded by the Gulf Fisheries Information Network (Gulf FIN) from 2005 through 2007. In 2010, the state of Florida secured alternative funds to continue limited at-sea observer coverage for headboats in the Keys through 2013. There were no headboats sampled in the Keys in 2014 due to loss of funding.

Charter Vessel Coverage

In 2010, observer coverage in the Florida Keys was expanded to include charter vessels. In 2013, a MARFIN project that employs fishery observers on charter vessels on the entire Atlantic coast of Florida was initiated. The MARFIN project is funded through 2015.

Table 1. Fishery observer coverage for headboats (H) and charter vessels (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC	H	H	H	H	H	H	H	H	H	H	H
SC	H	H	H	H	H	H	H	H	H	H	H
GA	H	H	H	H	H	H	H	H	H	H	H
EFL		H	H	H	H	H	H	H	H	H, C	H, C
Keys		H	H	H			H, C	H, C	H, C	H, C	C

Cooperative vessels in each state were randomly selected each week for observer coverage. Sampling occurred year-round. The state of Florida was stratified into three regions: Northeast (Nassau through Brevard Counties, sub-region=5), Southeast (Indian River through Dade Counties, sub-region=4), and Keys (Monroe County, sub-region=3). Operators from selected vessels were contacted by state biologists and one or two observers were scheduled to sample a single trip in a selected week. For trips in Florida with 15 or less passengers, only one observer accompanied passengers during the scheduled trip.

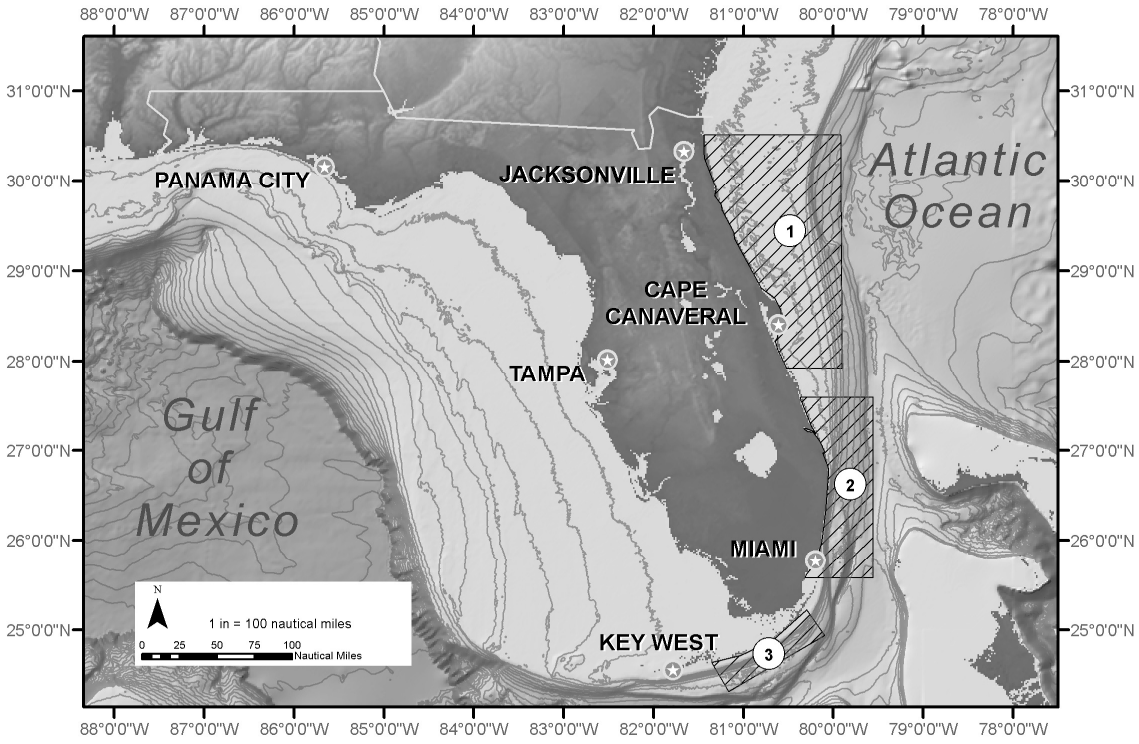

Figure 1. Areas in Florida with at-sea observer coverage. Area 1 is the northeast region, area 2 is the southeast region, and area 3 is the Key West Region.

Data Elements:

All sampled trips
Trip level data are available for all regions and years of observer coverage (Table 1). Trip level information for each sampled trip includes:

- Year, month and day of trip
- area where the majority of fishing took place,
    - coded as 3 miles or less from shore or more than 3 miles from shore
- duration of fishing (to the nearest half hour)
- total number of anglers on board
- number of anglers observed
- minimum and maximum depths fished (collected in Florida only)

A brief interview with each angler observed during a trip was also conducted to collect information on primary and secondary target species, angler avidity, and state and county of residence (discontinued in Florida when new methods were implemented, discussed in next section).

For each angler observed during a sampled trip, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each fish caught by an observed angler during a sampled trip, biologists recorded:

- species
- size (fork length in mm)
- disposition, coded as:
    - 1: thrown back alive, legal
    - 2: thrown back alive, not legal
    - 3: plan to eat
    - 4: used for bait or plan to use for bait
    - 5: sold or plan to sell
    - 6: thrown back dead or plan to throw away
- Release condition, collected in Florida only, coded as:
    - 1 = Good, fish swam toward bottom immediately upon entry into the water
    - 2 = Fair, fish was disoriented upon release and slowly swam towards the bottom
    - 3 = Poor, fish was very disoriented upon release and remained at the surface
    - 4 = Dead, fish was either dead or unresponsive upon entering the water
    - 5 = Eaten, fish was eaten by a bird, another fish, or a marine mammal
    - 9 = Unobserved, unable to observe or not applicable (fish retained)

Florida only
Data collection methods were modified in Florida to collect more detailed station-level information beginning in 2010 in the Keys and 2011 on the east coast of Florida (Table 2).

For each location fished during a sampled trip, the following station-level information was recorded:

- latitude and longitude (degrees and minutes)
- fishing zone and subzone (same as commercial zones)
- depth (meters)
- up to three target species and percentage of time targeting each

For each angler observed at a given station, the following information was collected:

- total number of fish retained by species
- total number of fish discarded alive by species
- total number of fish discarded dead by species

For each rod fished by an observed angler at a given station, the following information was recorded:

- leader type and strength
- hook type (circle hook, J hook, kahle hook, treble hook, other)
- hook offset (yes or no)
- hook size (using a standard hook sizing chart)
- bait type (live, whole dead fish, cut fish, squid, cocktail, artificial)

For each fish observed from a given rod at a given station, the following information was recorded:

- species
- mid-line length (mm)
- disposition (same as above)
- release condition (same as above)
- anatomical location of embedded hooks (lip, mouth, throat, gill, gut, eye, external)
- method of hook removal (easy or difficult; by hand, dehooking tool, pliers, or left in place)
- presence of barotrauma symptoms (inflated bladder, everted stomach, extruded intestines, exopthalmia)
- venting method (released without venting, bladder vented, stomach vented)
- presence of gill injury (visible bleeding from gills)

Table 2. Availability of detailed station level data for headboats (H) and charter trips (C).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NC											
SC											
GA											
EFL								H	H	H, C	H, C
Keys							H, C	H, C	H, C	H, C	C

Sample Weights:

Headboat vessels report fishing effort in logbook trip reports, and effort data were provided by the NMFS Southeast Fisheries Science Center in Beaufort, NC. To generate weighting factors for sampled headboat trips throughout the survey area, fishing effort for the years 2005 through 2013 was used to calculate proportional fishing effort by state or region (for Florida). Sample weights were calculated as:

$$W_{ay} = (N_{ay}/N_y) / (n_{ay}/n_y) \qquad \text{Equation 1}$$

Where N_{ay} /N is the total number of headboat trips reported from area a (state or region) during year y divided by total number of trips reported in the South Atlantic, and n_{ay}/n is the number of trips sampled in area a during year y, divided by the total number of sampled trips in the South Atlantic. Areas with $W_{ay} < 1$ are down weighted to account for higher sampling effort and areas with $W_t > 1$ are upweighted to account for undersampling.

Numbers of headboat trips sampled in each state/region are provided in Table 3, and calculated sample weights are provided in Table 4.

Table 3. Headboat at-sea observer trips sampled by state/region and year.

Year	NC (n_i)	SC (n_i)	GA-NEFL (n_i)	SEFL (n_i)	Sum (n)
2005	97	57	49	93	296
2006	88	45	45	71	249
2007	91	52	57	69	269
2008	78	39	55	74	246
2009	69	34	61	76	240
2010	83	26	51	72	232
2011	79	22	51	68	220
2012	78	36	62	64	240
2013	55	41	61	79	236
2014	70	41	68	79	258

Table 4. Sample weights (W_{ay}).

Year	NC	SC	GA-NEFL	SEFL
2005	0.229	0.588	0.708	1.489
2006	0.146	0.772	0.564	1.399
2007	0.180	1.024	0.705	1.732
2008	0.164	1.320	0.859	1.217
2009	0.210	1.493	0.889	1.025
2010	0.184	2.030	0.823	1.169
2011	0.162	2.485	0.718	1.136
2012	0.178	1.444	0.587	1.450
2013	0.213	0.970	0.563	1.367
2014	0.198	1.186	0.511	2.034

Length Frequency

Raw, unweighted sample sizes for red snapper lengths are provided in Table 5. Fork length (in mm) was converted to maximum total length using the equation provided by the SEDAR41 Life History Workgroup (TL_{max} = 2.22 + 1.07FL). Individual fish were then assigned to one cm length bin categories (40 cm bin = fish 39.5 cm to 40.4 cm). The numbers of fish in each length bin category were summed by area (state or region), year and disposition (harvested, released), and multiplied by appropriate sample weights. Weighted values for each area within a length bin were then summed so that weighted proportions of fish in each length bin could be calculated (Figure 2).

Table 5. Raw (unweighted) sample sizes for red snapper lengths.

Year	Disposition	NC	SC	GA-NEFL	SEFL	Total
2005	Discard	0	0	366	48	414
	Harvest	1	4	106	4	115
2006	Discard	0	0	672	0	672
	Harvest	1	0	50	0	51
2007	Discard	13	2	1,450	34	1,499
	Harvest	1	2	59	0	62
2008	Discard	23	1	1,626	28	1,678
	Harvest	5	2	234	1	242
2009	Discard	3	0	425	8	436
	Harvest	1	0	186	0	187
2010	Discard	7	0	325	14	346
	Harvest	0	0	0	0	0
2011	Discard	8	0	307	0	315
	Harvest	0	0	0	0	0
2012	Discard	18	1	635	3	657
	Harvest	3	0	12	0	15
2013	Discard	28	0	472	1	501
	Harvest	4	0	9	0	13
2014	Discard	7	0	606	0	613
	Harvest	0	0	0	0	0

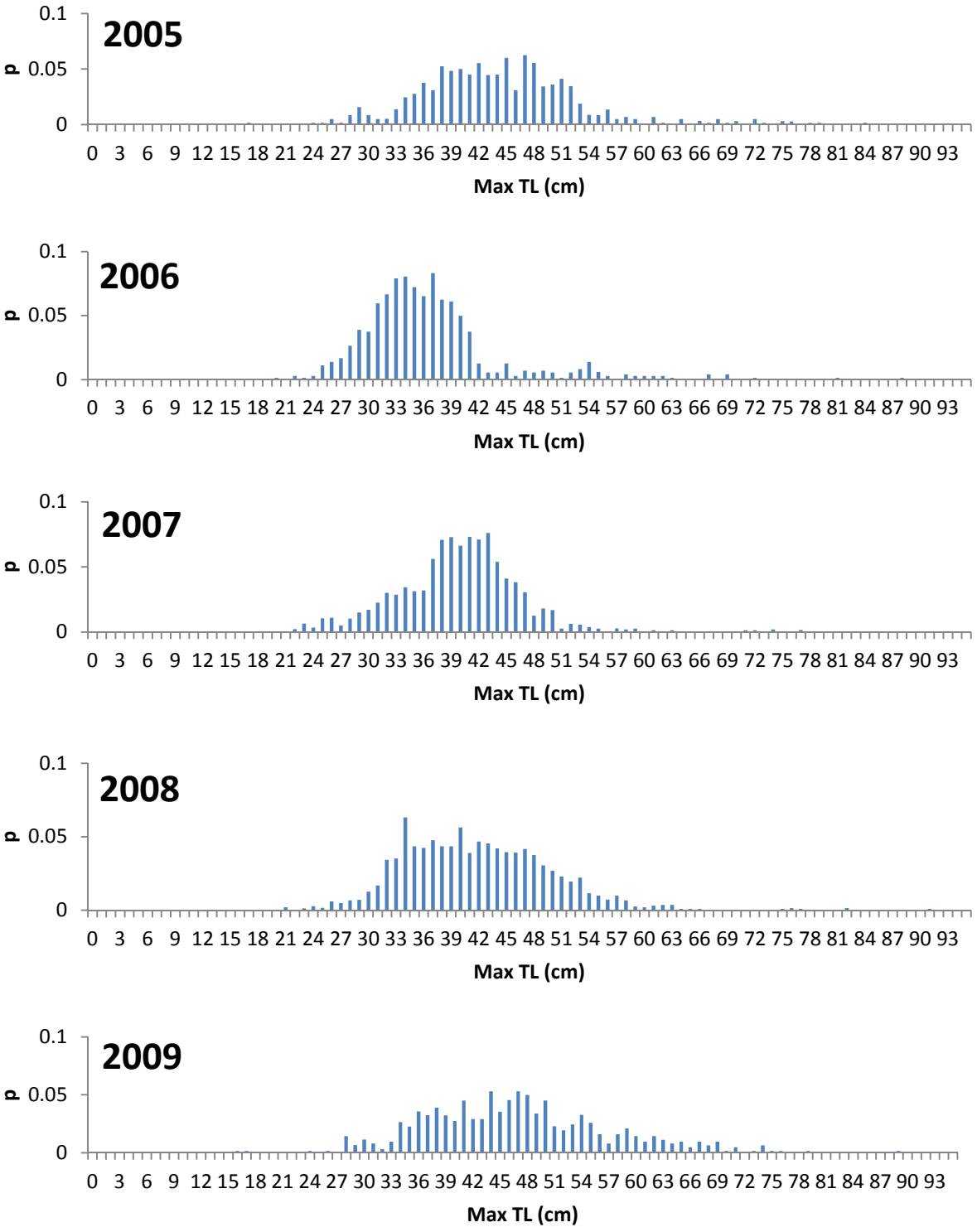

Figure 2. Weighted length frequency of red snapper discards. Continued on next page.

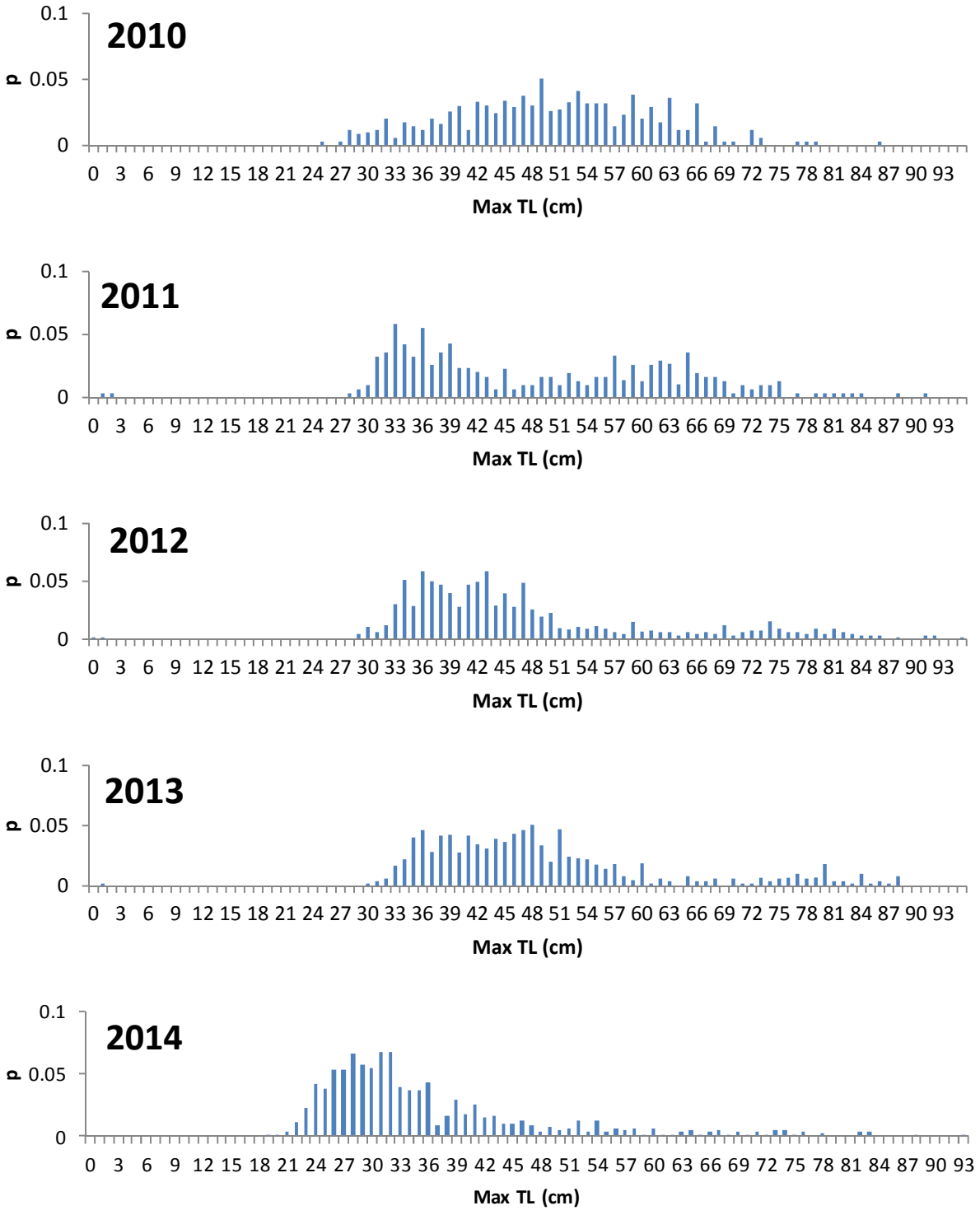

Figure 2. Continued.

Hook Type Usage in the For-Hire Fishery

Circle hooks have been required in the South Atlantic since 3/3/2011 when fishing for species in the snapper-grouper management group north of 28 degrees north latitude (the boundary between Brevard and Indian River Counties in Florida). Among trips sampled off the Atlantic coast of Florida, the prevalence of circle hook use on headboats and charter vessels varied north and south of this demarcation (Figures 3 and 4).

On headboat trips in the SE region of Florida, non-offset (flat) J hooks were used almost exclusively, although there was a slight increase during 2014 in the use of offset circle hooks (Figure 3). In the NE region, where circle hooks are required when fishing for snapper and grouper, offset circle hooks and offset J hooks were equally prevalent on headboats (Figure 3).

On charter trips, in the SE region of Florida, both offset and non-offset J hooks were prevalent. Non-offset circle hooks was the most prevalent gear used on charter trips observed in the NE region (Figure 4).

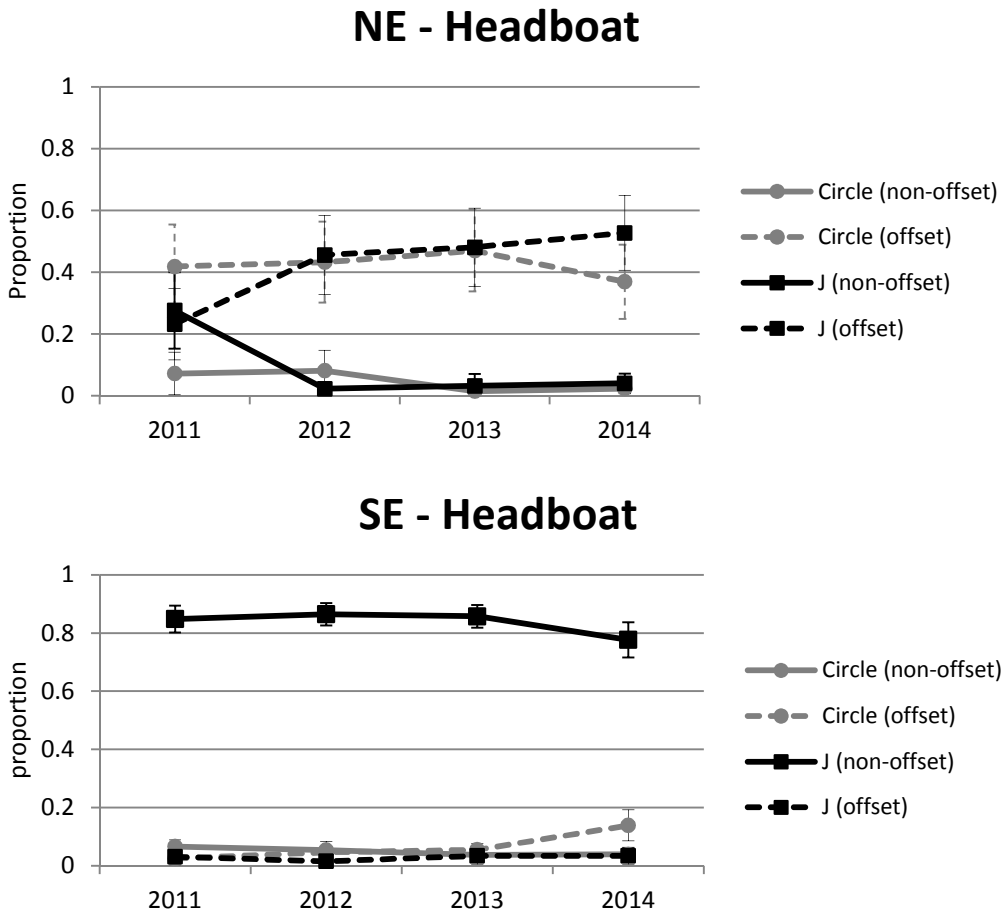

Figure 3. Mean proportion of fishing rigs by hook type observed during headboat trips sampled on the Atlantic coast of Florida for regions north (top panel) and south (bottom panel) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

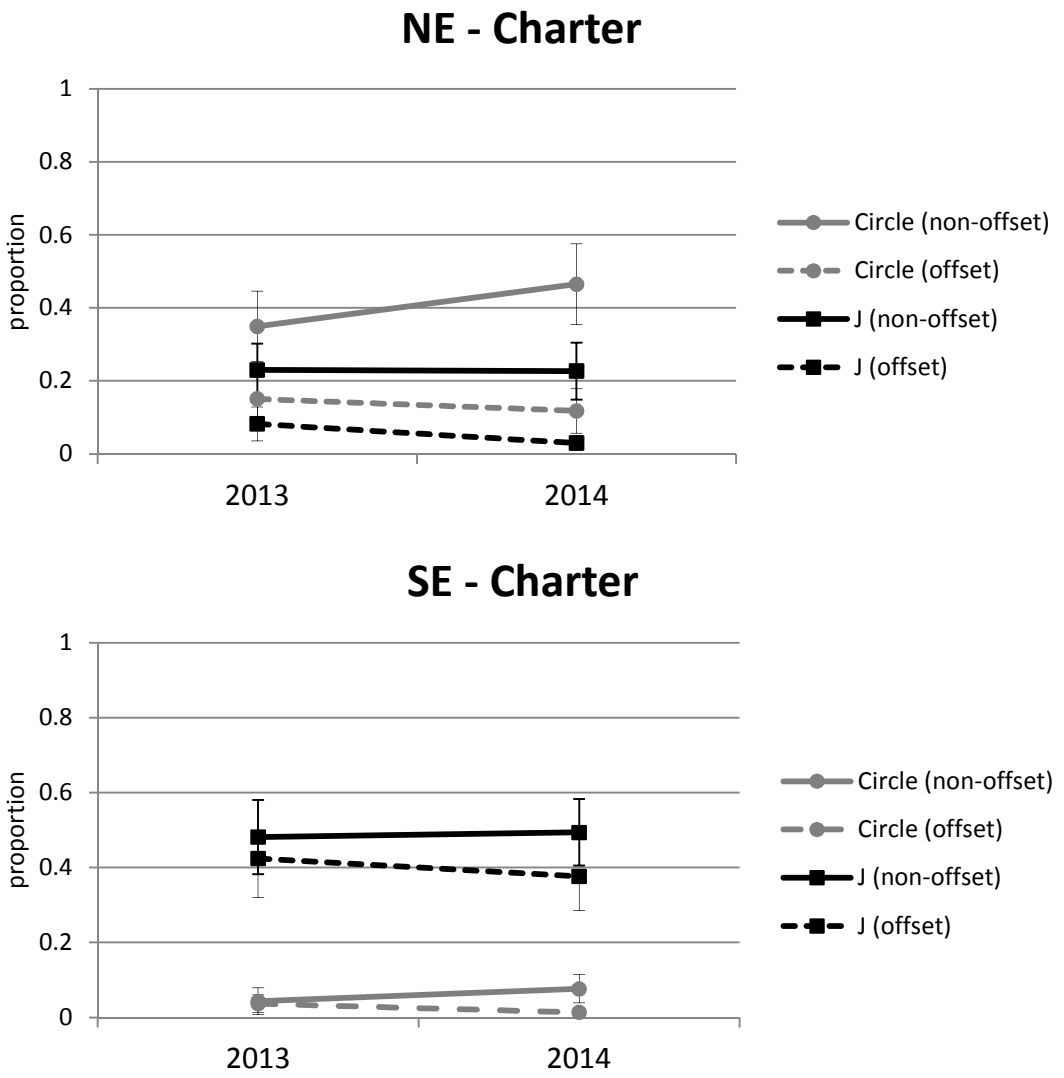

Figure 4. Mean proportion of fishing rigs by hook type observed during charter trips sampled on the Atlantic coast of Florida for regions north (top panel) and south (bottom panel) of 28 degrees north latitude. Circle hooks were required after 3/3/2011 when fishing for snapper and grouper north of 28 degrees north latitude.

Hook Injuries

Out of 3,116 red snapper observed on the Atlantic coast of Florida, 65% were caught with circle hooks, 35% were caught with J hooks, and <1% were caught with kahle or treble hooks. Among red snapper caught with circle hooks, 66% were caught with offset hooks; and among those caught with J hooks, 85% were caught on offset hooks. The overall percentage of potentially lethal hook locations (including eyes, gills, esophagus and gut) was lowest among red snapper caught with non-offset circle hooks (Table 6). Logistic regression was used to test the significance of hook type on the probability that hooks embed in a potentially lethal location (versus in the lip or jaw). When compared to flat non-offset circle hooks, circle hooks with an offset were 1.6 times more likely to embed in potentially lethal locations, flat non-offset J hooks

were 2.4 times more likely, and offset J hooks performed the worst and were 4.8 times more likely to embed internally in a harmful location (Table 7). Offset circle hooks and flat non-offset J hooks performed similarly, and offset J hooks performed worse than all other hook types (Table 7).

Table 6. Numbers of red snapper observed by hook-type and location where the hook was embedded, and percent of red snapper with potentially lethal hook injuries.

Hook-type	Lip or jaw	Potentially lethal location	Percent potentially lethal
Non-offset circle hook	652	31	4.54
Offset circle hook	1,245	96	7.16
Non-offset J hook	141	16	10.19
Offset J hook	743	170	18.62
Other (kahle, treble)	19	3	13.64

Table 7. Results of a logistic regression that modeled the probability for hooks to embed in potentially lethal locations. For odds ratios >1.0, confidence intervals that do not overlap with 1.0 indicate a significantly higher probability for potentially lethal hook injuries.

Hook-type Comparison	Odds Ratio	95% Confidence Interval
Offset circle vs. non-offset circle	1.621	1.070, 2.457
Non-offset J vs. non-offset circle	2.386	1.271, 4.481
Non-offset J vs. offset circle	1.472	0.843, 2.569 (not significant)
Offset J vs. non-offset circle	4.811	3.235, 7.155
Offset J vs. offset circle	2.967	2.274, 3.873
Offset J vs. non-offset J	2.016	1.171, 3.471

Implications of Circle Hook Requirement for Discard Mortality

Data on hook type were not collected from at-sea surveys in Florida until the first year that circle hook use was required in the South Atlantic; therefore, characteristics of the fishery prior to the circle hook requirement are not available. However, some inferences can be made. The four year time series for headboats in the NE region of Florida (the area north of 28 degrees latitude where the circle hook requirement is in effect) indicates an increasing trend in offset circle hook use and a decrease in flat non-offset J hooks since 2011 when the circle hook rule went into effect (Figure 3, top panel). Circle hook use is not required in the SE region and non-offset J hooks were used almost exclusively across all four years. Assuming the NE region shifted to offset circle hooks as a result of the circle hook requirement, no net conservation benefit is expected, since performance for this hook type is similar to non-offset J hooks. If the NE region was using offset J hooks prior to 2011, a potential net benefit could be expected, since this gear performed the worst among all hook types (Table 7). However, the prevalence of offset J hooks increased over the four years of observation (Figure 3, top panel); although this has not led to a noticeable decline in the proportion of red snapper observed on headboats that were hooked in the lip or jaw over the time series (Figure 5).

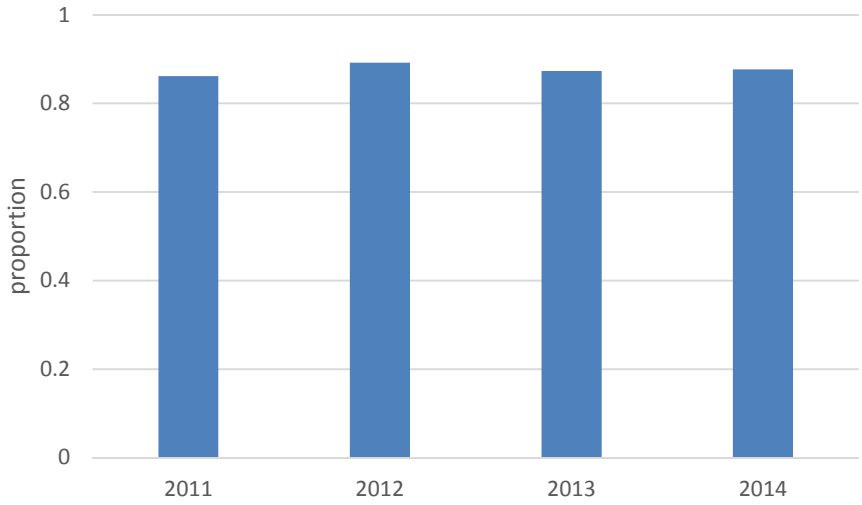

Figure 5. Proportion of red snapper observed on headboats each year that were hooked in the mouth or jaw.

On charter boat trips sampled in the NE region, non-offset circle hooks were the most frequently observed hook type in both years, and this gear also had the lowest incidence of deep hooking. Like the headboat fishery, J hooks are most prevalent on charter trips in the SE region, where circle hooks are not required. Assuming J hooks were used more frequently prior to 2011 in the NE charter fishery, there is a potential net conservation benefit from a shift to non-offset circle hooks in this segment of the recreational fishery.

Condition of Red Snapper Discards in Florida

Immediate mortality percentages for red snapper observed from for-hire vessels in the Gulf of Mexico adjacent to Florida are reported to be low (<1%, SEDAR41-RD16). On the Atlantic coast of Florida, no dead discards were recorded by fishery observers on for-hire vessels (all discards observed were released alive).

Live red snapper discards observed from the Atlantic coast of Florida were assigned to one of three release condition categories used to model relative survival of red snapper discards in the Gulf of Mexico (described in Table 8 and SEDAR41-RD16). The majority of red snapper discards observed from headboats were captured from depths of 30 meters or less; whereas, a higher portion of red snapper observed from charter boats were captured in depths of 31-40 meters and 41-50 meters (Figure 6). In both fisheries, the majority (67.4%) of red snapper were vented prior to release and did not exhibit obvious impairments (Figure 6). Among fish that were classified as impaired (16.3% of all fish observed), the majority were due to hook injury rather than swimming impairments associated with barotrauma and other stressors.

In the Gulf, survival percentages for fish released in each condition category were estimated from a model that was derived from gag grouper discarded during for-hire recreational trips and marked with conventional tags prior to release (Sauls 2014). The same model was also applied to

red snapper that were tagged prior to discarding in the Gulf of Mexico (SEDAR41-DW16, percentages provided in Table 9). When these percentages are applied to red snapper observed on the Atlantic coast of Florida, the overall portion of discards that suffer mortality is estimated to be approximately 27-28% for charter boats and headboats, respectively (Table 10). This result is comparable to overall discard mortality estimates in the Gulf (Table 9).

Table 8. Description of live release condition categories for reef fishes observed during recreational hook-and-line fishing (SEDAR41-RD16).

Condition category	Description
1. Not impaired, not vented	Fish immediately submerged without the assistance of venting and did not suffer internal hook injuries or visible injury to the gills.
2. Not impaired, vented	Fish was vented first and submerged immediately, and did not suffer internal hook injuries or visible injury to the gills.
3. Impaired	Fish was either initially disoriented before it submerged or remained floating at the surface (regardless of whether it was vented), suffered internal hook injuries, suffered visible injury to the gills, or any combination of the three impairments.

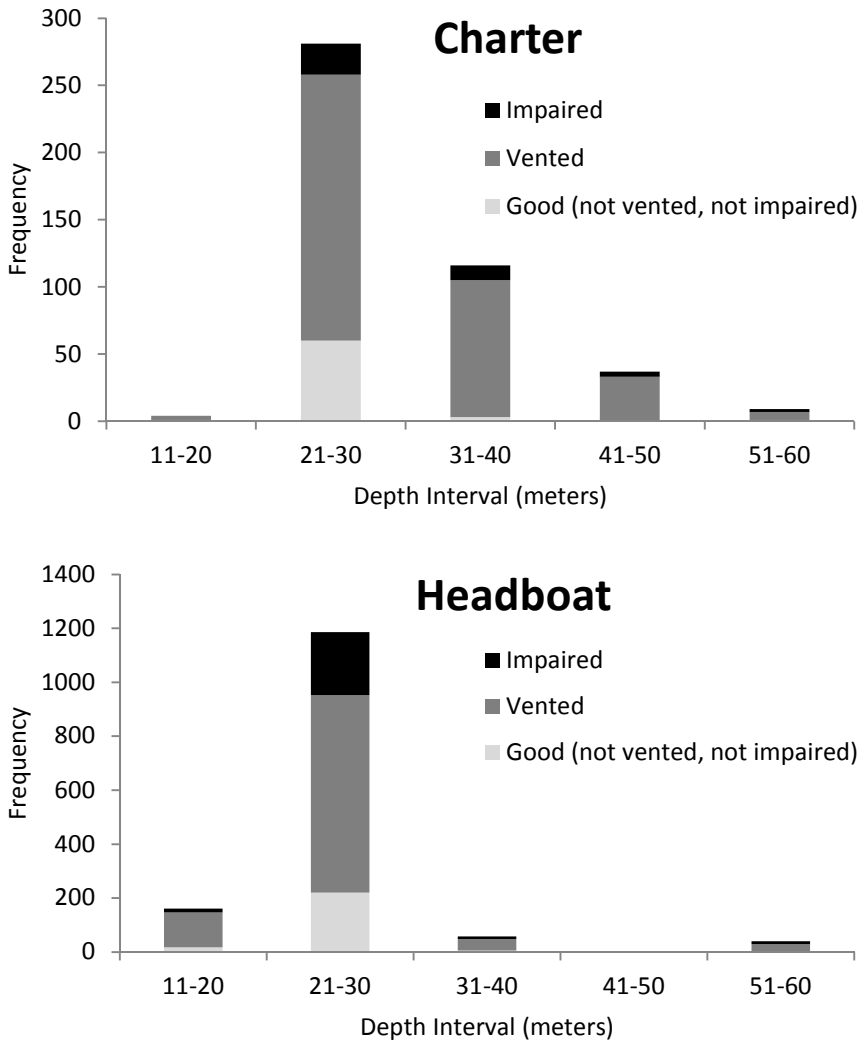

Figure 6. Release conditions for red snapper observed from charter boats (top) and headboats (bottom), by depth of capture.

Table 9. Proportion of live discarded red snapper caught with recreational hook-and-line gear in the eastern Gulf of Mexico estimated to survive catch-and-release, by release condition category (SEDAR41-RD16).

Release Condition Category	Estimated Survival Portion	Overall estimated discard mortality
1, not impaired, not vented	0.925 (range 0.85, 1.0)	Point estimate range 0.207 to 0.257
2, not impaired, vented	0.724 (95% CI 0.652, 0.804)	
3, impaired	0.495 (95% CI 0.391, 0.599)	

Table 10. Numbers of red snapper discards observed off the Atlantic coast of Florida by release condition category, estimated number of discard mortalities (based on estimated percent survival in Table 9), and overall proportion estimated to suffer mortality.

Vessel Type	Release Condition Category	Discards observed	Estimated mortalities	Estimated mortality proportion
Headboat	1, not impaired, not vented	237	17.8 (0, 35.6)	
	2, not impaired, vented	1,103	304.4 (216.2, 383.8)	
	3, impaired	327	165.1 (131.1, 199.1)	
	Total	1,667	487.3 (347.3, 618.5)	0.292 (0.208, 0.360)
Charter	1, not impaired, not vented	81	6.1 (0, 12.2)	
	2, not impaired, vented	610	168.4 (119.6, 212.3)	
	3, impaired	92	46.5 (36.9, 56.0)	
	Total	783	221.0 (156.5, 280.5)	0.282 (0.200, 0.358)

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