# Summary of commercial red grouper (*Epinephelus morio*) catch data based on fishery observer coverage of the Gulf of Mexico reef fish fishery

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# Summary of commercial red grouper (*Epinephelus morio*) catch data based on fishery observer coverage of the Gulf of Mexico reef fish fishery.

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**Abstract**

Fishery observer data collected on randomly selected reef fish vessels by the Galveston Observer Program from July 2006 through December 2013 were used in these analyses. Data was summarized for changes before and after the IFQ regulatory change, year, gear type, depth, and area fished. Fishery observers record the disposition code, barotraumatic stress indicators, and length for each fish captured as well as other environmental information. A total of 314,551 red grouper captures were observed on 752 trips for both bottom longline and vertical line gear types combined. For the duration of the study, 57% of red grouper were recorded as kept, 32% discarded alive, and 10% discarded dead. The retention rate has increased most years since the inception of the IFQ program in 2010. The majority (77%) of red grouper captures recorded were by vessels using bottom longline gear. The retention rate for each of the 18 to 21 in TL size classes increased after the initiation of the IFQ program as well. Red grouper size ranged from 4 in to 37 in TL with a mean of 20.45 in TL. Depth of capture ranged from 6.7 m to 220.4 m with the largest percentage (36%) of captures observed in the 40-49.99 m depth bin. Generally, the percentage of fish exhibiting barotraumatic stress indicators increased by depth of capture with a marked increase in an everted stomach in the 20-29.99 depth bin. The largest percentage (39.2%) of red grouper captures observed for gear types combined were in NMFS shrimp statistical zone 5.

## Introduction

In 2005, Amendment 22 to the Gulf of Mexico Fishery Management Council (GMFMC) Reef Fish Fishery Management Plan dictated mandatory observer coverage for the fishery (GMFMC, 2005). In July 2006, the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) began a mandatory observer program to characterize the commercial reef fish fishery in the Gulf of Mexico (Gulf) (Scott-Denton et al., 2011). Prior to that, the only observer coverage of the commercial reef fishery was a voluntary NMFS observer program conducted from 1993 through 1995. In terms of the mandatory component, Scott-Denton et al. (2011) and Scott-Denton and Williams (2013) provide a detailed review of the reef fish observer program's data collection efforts.

In the Gulf of Mexico reef fish fishery, vessels were randomly selected to carry an observer stratified by season, gear, and region. Vessels were selected quarterly each year using coastal logbook data to stratify sampling effort based on seasons and gears in the eastern and western Gulf. Beginning in February 2009, increased observer coverage levels were directed at the bottom longline fishery in the eastern Gulf due to concerns regarding sea turtle interactions. Additionally in 2011, increased "catch share" funding allowed enhanced coverage of both the vertical line and bottom longline fisheries through 2013. As a result of these actions, observer coverage levels did not remain consistent throughout the years, but varied depending on funding levels.

NMFS published a final rule implementing revising shallow-water grouper fishery on April 16, 2009 (GMFMC, 2008). The final rule published in the Federal Register became effective May 18, 2009. The rule reduced the commercial minimum size limit for red grouper (*Epinephelus morio*) from 20 in to 18 in total length (TL) to reduce bycatch in the fishery. It also ended the February 15 to March 15 seasonal closures in favor of a four-month closure (January–April) of "The Edges" that applies to both commercial and recreational fishing[1].

On August 31, 2009, a rule was published in the Federal Register establishing a commercial grouper and tilefish individual fishing quota (IFQ) program. The IFQ

[1] "The Edges" boundary defined by lines between the following corners: Northwest corner 28° 51' N, 85° 16' W; Northeast corner 28° 51' N, 85° 04' W; Southwest corner 28° 14' N, 84° 54' W; Southeast corner 28° 14' N, 84° 42' W.

program for these commercial fisheries became effective January 1, 2010. Permit holders were allocated IFQ shares based on average landings from 1999 through 2004 with an allowance for one year of landing to be removed. In 2012, there were a total of 569 shareholders in the red grouper IFQ program, down 18% from 692 shareholders at the initiation of the IFQ program (SERO, 2013).

NMFS published a final rule to implement Amendment 31 of the Fishery Management Plan for Reef Fish Resources in the Gulf of Mexico in the Federal Register on April 26, 2010 (GMFMC, 2010). These provisions became effective on May 26, 2010. The following measures applied to the bottom longline component of the reef fish fishery in the eastern Gulf of Mexico (east of 85° 30' W): prohibit the use of bottom longline gear shoreward of a line approximating the 35-fathom depth contour from June through August and restrict the number of hooks that may be possessed onboard each reef fish bottom longline vessel operating in the eastern Gulf of Mexico to a total of 1,000 hooks of which only 750 may be fished or rigged for fishing at any given time. These measures were primarily implemented to reduce sea turtle interactions in the fishery.

The purpose of this document is to provide a detailed summary red grouper catch data collected by the observer program for the vertical line and bottom longline gear components of the reef fish fishery. Changes in red grouper retention and discard mortality rates are compared across a number of variables including: pre and post-IFQ, NMFS statistical shrimp grids (as described by Patella, 1975), gear type, and depth. Special focus will be given to the 18–19.99-size class of red grouper that can now be retained in the fishery as of May 18, 2009. Finally, discarded red grouper will be summarized by post-release disposition and condition of capture codes as recorded by observers in 10-m depth bins. This should allow a more accurate analysis of discard mortality rates in the commercial red grouper fishery.

**Methods**

Fishery observer data collected from July 2006 through December 2013 were used for all analyses. Data was summarized prior to and after the IFQ regulatory change on January 1, 2010, as well by year. Notably, some data was collected after the size limit reduction to 18 in TL (May 9, 2009) but prior to the initiation of the IFQ program. Only data from the two primary gear types used in the fishery, bottom longline and vertical line (handline or bandit), were examined. A small number (< 1%) of red grouper not used in the analyses were captured using spearfishing or modified buoy gear. Data from 2007 and 2008 were aggregated together to maintain data confidentiality as specified by NOAA Administrative Order 216-100.

Disposition codes

Fishery observers on reef fish vessels assigned a disposition code as follows for each fish captured by the vessel: K - kept, B - used for bait, A - discarded alive, D - discarded dead, U - discarded unknown if dead or alive, and X - unknown if kept or discarded. For the discarded fish, the alive or dead determination is based on surface observation of the fish. If the fish is able to successfully swim down, even with barotraumatic stress indicators, it is recorded as alive. It is considered dead if unable to successfully swim down. Some fish are recorded with an unknown discarded disposition due to the difficultly in observing discards due to poor lighting, high seas, or other factors.

Retention and discard mortality rates

Retention rates were calculated using the number of fish kept divided by the number of fish kept plus the number discarded (code of A, D, or U). Fish used for bait (code B) or with an unknown disposition (code X) were not used in the retention rate calculations. Discard mortality rates were calculated by dividing the number of fish discarded dead (code D) by the total number of fish discarded (code of A, D, or U). This is to be considered an immediate discard mortality rate as none of the fish coded discarded dead are expected to survive. Discard mortality rates were calculated for a number of variables such as year, gear, and depth of capture.

Condition of capture

For all fish, observers also assigned a condition of capture code based on external

indicators. The condition codes were as follows: 1 - normal appearance, 2 - everted stomach (protrusion from the buccal cavity), 3 - exopthalmia (eyes bulging out of the socket), 4 - both everted stomach and exopthalmia, 5 - dead on arrival, 8 - damaged by predators, and 9 - unknown. These condition codes attempt to quantify the level of barotraumatic stress on the fish based on expansion of the swim bladder. The expansion of the swim bladder can force the stomach and/or eyes out of the body cavity. It is known that barotraumatic stress will likely have an implication on the survival of the discarded fish (Rudershausen et al., 2007). Observers also recorded if the fish was vented (air bladder punctured) prior to release by the vessel; however, no distinction on the quality of the technique observed is recorded.

Measurements

Most (>99%) of fishery observer length measurements were fork length (FL) to the nearest mm. A small amount (1,955) were recorded as TL and did not need to be converted to TL. No length data were obtained for 3,613 red grouper captured on observed trips. Fork length measurements were converted to total length using the following meristic regression.

$$TL = 1.05 * FL - 5.95$$

All measurements were then converted to inches and placed in size categories, e.g. 20.00–20.99 inches. Measurements were examined for overall differences prior to and post-IFQ regulations as well as by area, gear type, and depth. Detailed examinations of the fish in the 18–19.99 size class were given special consideration due to the 2009 regulatory change.

All depths were in feet using fishing vessel equipment, i.e. typically depth sounders. Fishing depths were converted to meters and summarized into 10-m bins, e.g. 10-19.99 m. For depth bins red grouper retention and discard mortality rates were examined for differences in summation as well as by gear type and IFQ regulatory changes. Tables do not include depth bins when a small number (<50) of red grouper were captured, i.e. uncommonly captured. Additionally, the relationship between barotraumatic stress (condition of capture codes) and depths were examined for each gear type and in summary

**Results and Discussion**

A total of 752 observed trips had at least one red grouper capture recorded (Table 1). One trip's effort was split between 2010 and 2011 based on the number of sets made in each year. The number of trips were not equally distributed by year or gear type, but based on program funding allocations that did not remain consistent from year to year. From 2006 through 2013, the observer program recorded 314,551 red grouper captures on vertical line and bottom longline gear types combined (Table 2). A much larger percentage (88%) of red grouper captured were recorded after the initiation of the IFQ program, this is due to enhanced coverage dictated by increased funding levels in recent years. For the entire duration of the program, 57% of red grouper were recorded as kept, 32% discarded alive, and 10% discarded dead. The retention rate has increased most years since the IFQ program was enacted in 2010 with the highest recorded rate in 2013 with 67.2% of red grouper captured being kept. Some increase in the retention rate can certainly be attributed to the reduction in the size limit to 18 in TL in 2009, but other factors may also be present such as increased fisher efficiency.

The observer program recorded 70,968 red grouper captured by vertical line gear, and 243,583 by bottom longline gear (Tables 3, 4). The majority (77%) of red grouper captured were by vessels using bottom longline gear. Both gear types show a similar trend with the retention rate increasing after the initiation of the IFQ program. Vessels using vertical line gear in 2013 had the highest retention rate of 73.7%. The smallest retention rate was observed was in the 2006 for vessels using bottom longline gear at 37.2%. Some variation can certainly be attributed to differences in observer coverage levels for the years for each gear type, i.e. lower coverage levels. Overall vessels fishing with vertical line gear consistently had a higher retention rate than vessels using bottom longline gear for all years except 2010. This may represent an altered fishing behavior by vertical line vessels after the initiation of the IFQ program or related to the Deepwater Horizon oil spill. Discard mortality rates have remained fairly consistent through the years for vessels using vertical line and bottom longline gear. However, the discard mortality rates were slightly higher overall post-IFQ for both gear types, possibly indicating reduced survival of the smaller sized discards.

The retention rate in each of the 18 to 21 in TL size classes has increased after the

initiation of the IFQ program (Table 5). This is most likely due to the decrease in the legal size limit from 20 in TL to 18 in TL in the year prior to enactment of the IFQ program. The 18–18.99 size class retention rate increased from 4% to 35.6%. The reason this may not be higher is the belief held by fisherman that fish will shrink once placed on ice, thus only fish typically greater than the size limit by a specific margin will be retained, e.g. only fish 18.5 in TL being retained. The possibility of a price differential for smaller sized fish by fish houses may also account for some legal sized fish not being retained by vessels. The 19–19.99 size class saw the largest increase in retention rates from 18.8% to 80.4%. Additionally, due to the belief in fish shrinkage, the 20–20.99 size class was examined and it also showed an increase from 72.6% to 94.4% for the retention rate. The discard mortality rates increased for each size class of fish post-IFQ, the reason for this unknown. One speculation is that it may indicate that damaged fish not typically retained constitute a larger percent of the overall discards thus reducing overall survivability.

Red grouper sizes ranged from 4 in to 37 in TL with a mean of 20.45 in TL (Figure 1). However, only 65 individual red grouper recorded were <10 in TL and only 46 were ≥35 in TL. Figure 2 compares size composition between vertical line and bottom longline gear types. Figure 3 compares size composition for red grouper kept pre and post-IFQ with the mean and median both decreasing post-IFQ, once again likely due to the lowering on the size limit to 18 in TL. Figure 4 comparing size compositions of discarded red grouper also shows a decrease in the mean and median post-IFQ. Figures 5 and 6 summarize red grouper size composition by year from 2006 through 2013. Figures 7 and 8 have the difference in densities of red grouper length by year and gear type. Figure 9 shows an overall trend of increasing red grouper size the deeper the depth of capture.

Depths were recorded for all but 317 red grouper captures. Depth of capture ranged from 6.7 m to 220.4 m. Tables 6, 7, and 8 summarize red grouper disposition for depth bins by gear type and in summary. Only 28 red grouper were captured in depths ≥ than 120 m and not included in the tables. The largest percentage (36%) of red grouper captures observed was in the 40–49.99 m depth bin. Generally, the retention rate increased with depth fished, i.e. larger fish encountered in deeper depths. The discard

mortality rate increased consistently with depth fished for both gear types. The largest percentage (26%) of fish captured by vessels using vertical line gear was in the 30–39.99 m depth bin. Red grouper captured on vertical line gear had a lower discard mortality rate than bottom longline gear captures for all comparable depth bins. No bottom longline captures were recorded <30 m due to the regulation prohibiting gear usage inside the 20-fathom contour in the Gulf. The highest percentage (41%) of fish captured by vessels using bottom longline gear was in the 40–49.99 m depth bin. A discard mortality rate >20% was recorded for all depths fished by vessels using bottom longline gear. The highest (>47%) discard mortality rates were observed in depths ≥90 m for vessels using bottom longline gear.

Figures 10 and 11 have the frequency of red grouper disposition observed for each depth bin. Generally, a smaller proportion of red grouper were discarded alive in deeper depths for each gear type and gear types combined. Tables 9 and 10 give a summary of red grouper disposition by depth before and after the initiation of the IFQ program. The retention rate was higher in almost all depth bins post-IFQ observed. In the four depth bins from 20–59.99 m, red grouper discard mortality rates were higher post-IFQ possibly due to the decreased survival of smaller sized fishes being discarded.

Table 11 and Figure 12 summarize the percentage and frequency of red grouper released alive (successfully swam down) with barotraumatic stress indicators by depth recorded by observers. Generally, the percentage of fish with no barotraumatic stress indicators recorded decreased with depth as to be expected. The percentage of red grouper with an everted stomach increased markedly in the 20–29.99 m depth bin and then decreased at 50 m most likely due to those fish also exhibiting exopthalmia and being placed in the most severe stress category of both an everted stomach and exopthalmia. The percentage of red grouper with exopthalmia remained fairly consistent in depths >30 m. The percentage of red grouper with the most severe condition code of both an everted stomach and exopthalmia increased consistently from a very small percentage (<2%) in depths less than 30 m to 30% of red grouper captured in the 80–89.99 m depth bin.

Tables 12 and 13 compare barotraumatic stress indicators by depth for vertical line and bottom longline gear types. For depths with captures recorded by both gear

types, red grouper captured by bottom longline vessels had a higher percentage with a normal appearance. The only exception was depths >80 m were only a small number (14) of vertical line red grouper captures were recorded. Table 14 and Figure 13 summarize the percentage and frequency of red grouper released dead (immediate mortality) with barotraumatic stress indicators by depth recorded by observers. The percentage of red grouper discarded dead with a normal appearance was consistently lower for all comparable depth bins to those released alive in Table 11. Interestingly, red grouper discarded dead had a smaller percentage with an everted stomach compared to those released alive. However, the discarded dead red grouper had higher percentages of exopthalmia and the most severe category of an everted stomach and exopthalmia for all comparable depth bins.

Table 15 summarizes the percentage of discarded red grouper with their air bladder punctured (vented) prior to release for each barotraumatic stress indicator. Vessels fishing with bottom longline gear consistently vented a larger percentage of discarded red grouper prior to release than vessels using vertical gear for each stress category. The smallest percentage (41.3%) of red grouper discards vented was those with a normal appearance captured by vessels using vertical line gear. The largest percentage (93.7%) of red grouper discards vented prior to release was those captured by vessels using bottom longline gear with a condition code of an everted stomach recorded by the observer program.

Table 16 examines any differences in retention and discard mortality rates by area using NMFS statistical shrimp grids. The highest retention rate was in statistical zone 2 with >73% of red grouper captured being kept, conversely it also had the highest discard mortality rate of >35%. The lowest retention rates were observed in statistical zones 5 and 7 which were both slightly greater than 51%. Table 17 has the percentage of overall red grouper captures observed for each statistical zone by the observer program. The largest percentage (39.2%) of red grouper captured with gear types combined was in statistical zone 5. Statistical zones 4, 5, and 6 accounted for >85% of all red grouper captures observed. Statistical zone 6 accounts for nearly 50% of all vertical line gear captures and statistical zone 5 almost 40% of all red grouper captures observed with bottom longline gear.

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**Tables**

Table 1. Number of trips with red grouper captures recorded based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Time Frame | Vertical Line | Bottom Longline | Combined |
|---|---|---|---|
| 2006 | 20 | 12 | 32 |
| 2007 & 2008[1] | 96 | 11 | 107 |
| 2009 | 33 | 22 | 55 |
| 2010 | 34.4[2] | 39 | 73.4[2] |
| 2011 | 73.6[2] | 72 | 145.6[2] |
| 2012 | 182 | 15 | 197 |
| 2013 | 74 | 68 | 142 |
| Pre-IFQ | 149 | 45 | 194 |
| Post-IFQ | 364 | 194 | 558 |
| All Years | 513 | 239 | 752 |

[1] Data from 2007 and 2008 were combined to conform to data confidentiality rules.
[2] Effort for one vertical line trip was allocated by the number of sets fished for years 2010 and 2011.

Table 2. Summary of all red grouper by disposition code and year captured with gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

* Pre-IFQ range is 2006 through 2009; post-IFQ range is 2010 through 2013 for all tables. For all tables, retention rate is the number of red grouper kept divided by the total number kept and discarded. Discard mortality rate is the number of red grouper discarded dead by the total number discarded.

| Time Frame | Total Number Captured | Number Kept | Total Number Discarded | Discarded Dead | Discarded Alive | Discarded Unknown | Bait | Unknown Kept or Discarded | Retention Rate | Discard Mortality Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 8,471 | 3,314 | 5,157 | 821 | 4,055 | 281 | 0 | 0 | 39.1% | 15.9% |
| 2007 & 2008 | 14,886 | 7,553 | 7,329 | 1,091 | 5,378 | 860 | 3 | 1 | 50.8% | 14.9% |
| 2009 | 15,883 | 7,806 | 8,069 | 1,889 | 6,143 | 37 | 0 | 8 | 49.2% | 23.4% |
| 2010 | 40,462 | 18,485 | 21,972 | 6,524 | 14,791 | 657 | 1 | 4 | 45.7% | 29.7% |
| 2011 | 101,736 | 55,469 | 46,186 | 10,367 | 34,623 | 1,196 | 2 | 79 | 54.6% | 22.4% |
| 2012 | 56,744 | 35,350 | 21,387 | 3,862 | 17,177 | 348 | 5 | 2 | 62.3% | 18.1% |
| 2013 | 76,369 | 51,307 | 25,036 | 7,315 | 17,498 | 223 | 26 | 0 | 67.2% | 29.2% |
| Pre-IFQ | 39,240 | 18,673 | 20,555 | 3,801 | 15,576 | 1,178 | 3 | 9 | 47.6% | 18.5% |
| Post-IFQ | 275,311 | 160,611 | 114,581 | 28,068 | 84,089 | 2,424 | 34 | 85 | 58.4% | 24.5% |
| All Years | 314,551 | 179,284 | 135,136 | 31,869 | 99,665 | 3,602 | 37 | 94 | 57.0% | 23.6% |

Table 3. Summary of all red grouper by disposition code and year captured with vertical line gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Time Frame | Total Number Captured | Number Kept | Total Number Discarded | Discarded Dead | Discarded Alive | Discarded Unknown | Bait | Unknown Kept or Discarded | Retention Rate | Discard Mortality Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 1,963 | 895 | 1,068 | 171 | 892 | 5 | 0 | 0 | 45.6% | 16.0% |
| 2007 & 2008 | 7,719 | 4,395 | 3,321 | 273 | 3,029 | 19 | 2 | 1 | 57.0% | 8.2% |
| 2009 | 3,507 | 1,951 | 1,554 | 235 | 1,309 | 10 | 0 | 2 | 55.7% | 15.1% |
| 2010 | 5,102 | 2,071 | 3,030 | 336 | 2,674 | 20 | 1 | 0 | 40.6% | 11.1% |
| 2011 | 13,572 | 8,286 | 5,280 | 636 | 4,628 | 16 | 2 | 4 | 61.1% | 12.0% |
| 2012 | 30,210 | 21,035 | 9,170 | 1,277 | 7,869 | 24 | 5 | 0 | 69.6% | 13.9% |
| 2013 | 8,895 | 6,533 | 2,337 | 233 | 2,104 | 0 | 25 | 0 | 73.7% | 10.0% |
| Pre-IFQ | 13,189 | 7,241 | 5,943 | 679 | 5,230 | 34 | 2 | 3 | 54.9% | 11.4% |
| Post-IFQ | 57,779 | 37,925 | 19,817 | 2,482 | 17,275 | 60 | 33 | 4 | 65.7% | 12.5% |
| All Years | 70,968 | 45,166 | 25,760 | 3,161 | 22,505 | 94 | 35 | 7 | 63.7% | 12.3% |

Table 4. Summary of all red grouper by disposition code and year captured with bottom longline gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from August 2006 through December 2013.

| Time Frame | Total Number Captured | Number Kept | Total Number Discarded | Discarded Dead | Discarded Alive | Discarded Unknown | Bait | Unknown Kept or Discarded | Retention Rate | Discard Mortality Rate |
|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 6,508 | 2,419 | 4,089 | 650 | 3,163 | 276 | 0 | 0 | 37.2% | 15.9% |
| 2007 & 2008 | 7,167 | 3,158 | 4,008 | 818 | 2,349 | 841 | 1 | 0 | 44.1% | 20.4% |
| 2009 | 12,376 | 5,855 | 6,515 | 1,654 | 4,834 | 27 | 0 | 6 | 47.3% | 25.4% |
| 2010 | 35,360 | 16,414 | 18,942 | 6,188 | 12,117 | 637 | 0 | 4 | 46.4% | 32.7% |
| 2011 | 88,164 | 47,183 | 40,906 | 9,731 | 29,995 | 1,180 | 0 | 75 | 53.6% | 23.8% |
| 2012 | 26,534 | 14,315 | 12,217 | 2,585 | 9,308 | 324 | 0 | 2 | 54.0% | 21.2% |
| 2013 | 67,474 | 44,774 | 22,699 | 7,082 | 15,394 | 223 | 1 | 0 | 66.4% | 31.2% |
| Pre-IFQ | 26,051 | 11,432 | 14,612 | 3,122 | 10,346 | 1,144 | 1 | 6 | 43.9% | 21.4% |
| Post-IFQ | 217,532 | 122,686 | 94,764 | 25,586 | 66,814 | 2,364 | 1 | 81 | 56.4% | 27.0% |
| All Years | 243,583 | 134,118 | 109,376 | 28,708 | 77,160 | 3,508 | 2 | 87 | 55.1% | 26.2% |

Table 5. Retention and discard mortality rates for size classes of red grouper affected by regulation changes captured with gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Size Class | Time Frame | Total Number Observed | Total Number Kept | Retention Rate | Discard Mortality Rate |
|---|---|---|---|---|---|
| 18.00 – 18.99" | Pre-IFQ | 3,980 | 161 | 4.0% | 18.1% |
| | Post- IFQ | 29,166 | 10,383 | 35.6% | 28.5% |
| 19.00 – 19.99" | Pre-IFQ | 3,744 | 705 | 18.8% | 20.4% |
| | Post- IFQ | 26,721 | 21,483 | 80.4% | 32.8% |
| 20.00 – 20.99" | Pre-IFQ | 4,017 | 2,916 | 72.6% | 20.4% |
| | Post- IFQ | 24,229 | 22,870 | 94.4% | 33.9% |
| 18.00 – 20.99" combined | Pre-IFQ | 11,741 | 3,782 | 32.2% | 19.3% |
| | Post- IFQ | 80,116 | 54,736 | 68.3% | 29.7% |

Table 6. Disposition of red grouper by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Depth Range (m) | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 | 100-109.99 | 110-119.99 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kept | 886 | 10,145 | 28,782 | 56,843 | 33,055 | 23,502 | 19,784 | 5,342 | 507 | 143 | 78 |
| Discarded Alive | 1,100 | 7,224 | 16,216 | 41,960 | 17,069 | 7,323 | 6,802 | 1,793 | 41 | 6 | 4 |
| Discarded Dead | 22 | 580 | 3,740 | 12,664 | 6,352 | 3,415 | 3,967 | 1,052 | 37 | 8 | 12 |
| Discard Unknown | 2 | 16 | 685 | 1742 | 595 | 234 | 274 | 50 | 0 | 0 | 0 |
| Kept for Bait | 0 | 5 | 11 | 17 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| Unknown Kept or Discarded | 0 | 1 | 2 | 27 | 43 | 17 | 4 | 0 | 0 | 0 | 0 |
| Total Number | 2,010 | 17,971 | 49,436 | 113,253 | 57,117 | 34,492 | 30,831 | 8,237 | 585 | 157 | 94 |
| Total Number Discarded | 1,124 | 7,820 | 20,641 | 56,366 | 24,016 | 10,972 | 11,043 | 2,895 | 78 | 14 | 16 |
| Retention Rate | 44.1% | 56.5% | 58.2% | 50.2% | 57.9% | 68.2% | 64.2% | 64.9% | 86.7% | 91.1% | 83.0% |
| Discard Mortality Rate | 2.0% | 7.4% | 18.1% | 22.5% | 26.4% | 31.1% | 35.9% | 36.3% | 47.4% | 57.1% | 75.0% |

Table 7. Disposition of red grouper by depth captured with vertical line gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Depth Range (m) | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 |
|---|---|---|---|---|---|---|---|---|
| Kept | 886 | 10,145 | 12,326 | 7,368 | 8,847 | 4,659 | 821 | 31 |
| Discarded Alive | 1,100 | 7,224 | 5,469 | 3,763 | 3,811 | 961 | 86 | 14 |
| Discarded Dead | 22 | 580 | 667 | 724 | 858 | 260 | 41 | 5 |
| Discard Unknown | 2 | 16 | 37 | 20 | 16 | 1 | 2 | 0 |
| Kept for Bait | 0 | 5 | 11 | 15 | 3 | 1 | 0 | 0 |
| Unknown Kept or Discarded | 0 | 1 | 2 | 1 | 3 | 0 | 0 | 0 |
| Total Number | 2,010 | 17,971 | 18,512 | 11,891 | 13,538 | 5,882 | 950 | 50 |
| Total Number Discarded | 1,124 | 7,820 | 6,173 | 4,507 | 4,685 | 1,222 | 129 | 19 |
| Retention Rate | 44.1% | 56.5% | 66.6% | 62.0% | 65.4% | 79.2% | 86.4% | 62.0% |
| Discard Mortality Rate | 2.0% | 7.4% | 10.8% | 16.1% | 18.3% | 21.3% | 31.8% | 26.3% |

Table 8. Disposition of red grouper by depth captured with bottom longline gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from August 2006 through December 2013.

| Depth Range (m) | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 | 100-109.99 | 110-119.99 |
|---|---|---|---|---|---|---|---|---|---|
| Kept | 16,456 | 49,475 | 24,208 | 18,843 | 18,963 | 5,311 | 499 | 133 | 78 |
| Discarded Alive | 10,747 | 38,197 | 13,258 | 6,362 | 6,716 | 1,779 | 41 | 6 | 4 |
| Discarded Dead | 3,073 | 11,940 | 5,494 | 3,155 | 3,926 | 1,047 | 37 | 8 | 12 |
| Discard Unknown | 648 | 1,722 | 579 | 233 | 272 | 50 | 0 | 0 | 0 |
| Kept for Bait | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown Kept or Discarded | 0 | 26 | 40 | 17 | 4 | 0 | 0 | 0 | 0 |
| Total Number | 30,924 | 101,362 | 43,579 | 28,610 | 29,881 | 8,187 | 577 | 147 | 94 |
| Total Number Discarded | 14,468 | 51,859 | 19,331 | 9,750 | 10,914 | 2,876 | 78 | 14 | 16 |
| Retention Rate | 53.2% | 48.8% | 55.6% | 65.9% | 63.5% | 64.9% | 86.5% | 90.5% | 83.0% |
| Discard Mortality Rate | 21.2% | 23.0% | 28.4% | 32.4% | 36.0% | 36.4% | 47.4% | 57.1% | 75.0% |

Table 9. Pre-IFQ red grouper disposition by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2009.

| Depth Range (m) | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 |
|---|---|---|---|---|---|---|---|---|---|
| Kept | 6 | 2,200 | 4,893 | 7,012 | 2,111 | 1,361 | 665 | 128 | 217 |
| Discarded Alive | 77 | 1,421 | 4,046 | 7,481 | 1,774 | 470 | 237 | 24 | 18 |
| Discarded Dead | 0 | 101 | 764 | 1,988 | 476 | 227 | 200 | 23 | 19 |
| Discard Unknown | 0 | 2 | 492 | 551 | 124 | 7 | 1 | 0 | 0 |
| Kept for Bait | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| Unknown Kept or Discarded | 0 | 0 | 2 | 6 | 1 | 0 | 0 | 0 | 0 |
| Total Number | 83 | 3,724 | 10,198 | 17,039 | 4,486 | 2,066 | 1,103 | 175 | 254 |
| Total Number Discarded | 77 | 1,524 | 5,302 | 10,020 | 2,374 | 704 | 438 | 47 | 37 |
| Retention Rate | 7.2% | 59.1% | 48.0% | 41.2% | 47.1% | 65.9% | 60.3% | 73.1% | 85.4% |
| Discard Mortality Rate | 0.0% | 6.6% | 14.4% | 19.8% | 20.1% | 32.2% | 45.7% | 48.9% | 51.4% |

Table 10. Post-IFQ red grouper disposition by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2009.

| Depth Range (m) | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 | 100-109.99 | 110-119.99 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kept | 880 | 7,945 | 23,889 | 49,831 | 30,944 | 22,141 | 19,119 | 5,214 | 290 | 126 | 69 |
| Discarded Alive | 1,023 | 5,803 | 12,170 | 34,479 | 15,295 | 6,853 | 6,565 | 1,769 | 23 | 6 | 4 |
| Discarded Dead | 22 | 479 | 2,976 | 10,676 | 5,876 | 3,188 | 3,767 | 1,029 | 18 | 7 | 12 |
| Discard Unknown | 2 | 14 | 193 | 1,191 | 471 | 227 | 273 | 50 | 0 | 0 | 0 |
| Kept for Bait | 0 | 5 | 10 | 16 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown Kept or Discarded | 0 | 1 | 0 | 21 | 42 | 17 | 4 | 0 | 0 | 0 | 0 |
| Total Number | 1,927 | 14,247 | 39,238 | 96,214 | 52,631 | 32,426 | 29,728 | 8,062 | 331 | 139 | 85 |
| Total Number Discarded | 1,047 | 6,296 | 15,339 | 46,346 | 21,642 | 10,268 | 10,605 | 2,848 | 41 | 13 | 16 |
| Retention Rate | 45.7% | 55.8% | 60.9% | 51.8% | 58.8% | 68.3% | 64.3% | 64.7% | 87.6% | 90.6% | 81.2% |
| Discard Mortality Rate | 2.1% | 7.6% | 19.4% | 23.0% | 27.2% | 31.0% | 35.5% | 36.1% | 43.9% | 53.8% | 75.0% |

Table 11. Percentage of barotraumatic stress indicators by depth for red grouper discarded alive for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013[2].

* Reference Table 6 for summary of red grouper fates by depth.

| Depth Range (m) | 0–9.99 | 10–19.99 | 20–29.99 | 30–39.99 | 40–49.99 | 50–59.99 | 60–69.99 | 70–79.99 | 80–89.99 | 90–99.99 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number Observed | 21 | 1,100 | 7,224 | 16,216 | 41,960 | 17,069 | 7,323 | 6,802 | 1,793 | 41 |
| Normal Appearance | 100.0% | 85.5% | 46.9% | 31.4% | 25.0% | 25.5% | 24.7% | 24.0% | 19.7% | 31.7% |
| Everted Stomach | 0.0% | 13.2% | 46.8% | 49.5% | 48.5% | 39.7% | 36.9% | 34.6% | 34.9% | 41.5% |
| Exopthalmia | 0.0% | 0.5% | 4.2% | 12.0% | 11.8% | 15.3% | 14.4% | 14.4% | 13.7% | 12.2% |
| Everted Stomach & Exopthalmia | 0.0% | 0.1% | 1.5% | 5.8% | 10.4% | 17.2% | 22.4% | 26.2% | 30.0% | 14.6% |
| Unknown Condition | 0.0% | 0.7% | 0.6% | 1.3% | 4.2% | 2.3% | 1.5% | 0.7% | 1.7% | 0.0% |

[2] Percentages may not be equal to 100% due to rounding.

Table 12. Percentage of barotraumatic stress indicators by depth for red grouper discarded alive captured with vertical line gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Depth Range (m) | 0-9.99 | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 |
|---|---|---|---|---|---|---|---|---|---|
| Number Observed | 21 | 1,100 | 7,224 | 5,469 | 3,763 | 3,811 | 961 | 86 | 14 |
| Normal Appearance | 100.0% | 85.5% | 46.9% | 24.8% | 19.9% | 18.9% | 18.0% | 19.8% | 28.6% |
| Everted Stomach | 0.0% | 13.2% | 46.8% | 57.2% | 46.2% | 42.1% | 41.9% | 45.3% | 28.6% |
| Exopthalmia | 0.0% | 0.5% | 4.2% | 9.9% | 15.3% | 16.6% | 15.8% | 16.3% | 35.7% |
| Everted Stomach & Exopthalmia | 0.0% | 0.1% | 1.5% | 5.8% | 16.4% | 20.7% | 23.0% | 17.4% | 7.1% |
| Unknown Condition | 0.0% | 0.7% | 0.6% | 2.3% | 2.2% | 1.7% | 1.2% | 1.2% | 0.0% |

Table 13. Percentage of barotraumatic stress indicators by depth for red grouper discarded alive captured with bottom longline gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from August 2006 through December 2013.

| Depth Range (m) | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 |
|---|---|---|---|---|---|---|---|
| Number Observed | 10,747 | 38,197 | 13,258 | 6,362 | 6,716 | 1,779 | 41 |
| Normal Appearance | 34.8% | 25.5% | 27.4% | 25.7% | 24.1% | 19.6% | 31.7% |
| Everted Stomach | 45.6% | 48.8% | 39.0% | 36.1% | 34.5% | 35.0% | 41.5% |
| Exopthalmia | 13.1% | 11.5% | 14.9% | 14.2% | 14.4% | 13.5% | 12.2% |
| Everted Stomach & Exopthalmia | 5.8% | 9.8% | 16.2% | 22.3% | 26.3% | 30.2% | 14.6% |
| Unknown Condition | 0.8% | 4.4% | 2.5% | 1.6% | 0.7% | 1.7% | 0.0% |

Table 14. Percentage of barotraumatic stress indicators by depth for red grouper discarded dead for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

* Reference Table 6 for summary of red grouper fates by depth.

| Depth Range (m) | 10-19.99 | 20-29.99 | 30-39.99 | 40-49.99 | 50-59.99 | 60-69.99 | 70-79.99 | 80-89.99 | 90-99.99 |
|---|---|---|---|---|---|---|---|---|---|
| Number Observed | 22 | 580 | 3,740 | 12,664 | 6,352 | 3,415 | 3,967 | 1,052 | 37 |
| Normal Appearance | 59.1% | 41.4% | 27.2% | 21.4% | 16.8% | 9.8% | 11.1% | 10.1% | 24.3% |
| Everted Stomach | 27.3% | 39.5% | 34.1% | 31.8% | 24.9% | 18.3% | 14.1% | 15.6% | 8.1% |
| Exopthalmia | 13.6% | 11.4% | 20.0% | 19.9% | 25.6% | 28.3% | 26.5% | 21.1% | 24.3% |
| Everted Stomach & Exopthalmia | 0.0% | 7.1% | 10.5% | 17.3% | 26.3% | 38.4% | 42.2% | 49.5% | 32.4% |
| Dead on Arrival | 0.0% | 0.7% | 6.7% | 6.9% | 5.3% | 4.5% | 5.4% | 3.3% | 10.8% |
| Unknown Condition | 0.0% | 0.0% | 1.5% | 2.6% | 1.1% | 0.7% | 0.7% | 0.4% | 0.0% |

Table 15. Percentage of red grouper discards with air bladders punctured for each barotraumatic stress indicator for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013. * For example, 93.7% of red grouper captured on longline gear with an everted stomach condition code had their air bladders punctured prior to release.

| | Normal Appearance | Everted Stomach | Exopthalmia | Everted Stomach & Exopthalmia | Unknown Condition |
|---|---|---|---|---|---|
| Vertical Line | 41.3% | 81.6% | 73.8% | 92.7% | 12.3% |
| Bottom Longline | 75.4% | 93.7% | 90.8% | 93.5% | 35.7% |
| Combined | 67.4% | 91.1% | 88.3% | 93.4% | 33.4% |

Table 16. Disposition of red grouper captured with gear types combined by NMFS statistical shrimp grid based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Statistical Zone | Kept | Discarded Alive | Discarded Dead | Discarded Unknown | Bait | Unknown Kept or Discarded | Total Number | Retention Rate | Discard Mortality Rate |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 2,414 | 496 | 314 | 73 | 0 | 0 | 3,297 | 73.2% | 35.6% |
| 3 | 16,135 | 8,222 | 2,739 | 201 | 2 | 2 | 27,301 | 59.1% | 24.5% |
| 4 | 43,742 | 25,935 | 9,568 | 1,643 | 13 | 2 | 80,903 | 54.1% | 25.8% |
| 5 | 63,929 | 43,664 | 14,751 | 1,048 | 2 | 11 | 123,405 | 51.8% | 24.8% |
| 6 | 42,757 | 17,689 | 3,747 | 519 | 19 | 29 | 64,760 | 66.1% | 17.1% |
| 7 | 2,916 | 2,432 | 304 | 34 | 0 | 1 | 5,687 | 51.3% | 11.0% |
| 8 | 7,067 | 1,171 | 411 | 82 | 1 | 49 | 8,781 | 80.9% | 24.7% |
| 9 | 227 | 38 | 15 | 1 | 0 | 0 | 281 | 80.8% | 27.8% |
| 10 | 89 | 18 | 20 | 0 | 0 | 0 | 127 | 70.1% | 52.6% |
| 11 | 6 | 0 | 0 | 1 | 0 | 0 | 7 | 85.7% | N/A |

Table 17. Percentage of overall red grouper captured by NMFS statistical shrimp grid based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

| Statistical Zone | Vertical Line | Bottom Longline | Gear Types Combined |
|---|---|---|---|
| 2 | 0.7% | 1.2% | 1.1% |
| 3 | 6.5% | 9.3% | 8.7% |
| 4 | 11.9% | 29.7% | 25.7% |
| 5 | 20.0% | 44.8% | 39.2% |
| 6 | 49.5% | 12.2% | 20.6% |
| 7 | 7.9% | 0.0% | 1.8% |
| 8 | 2.8% | 2.8% | 2.8% |
| 9 | 0.4% | N/A | 0.1% |
| 10 | 0.2% | N/A | 0.0% |
| 11 | 0.0% | 0.0% | 0.0% |

**Figures**

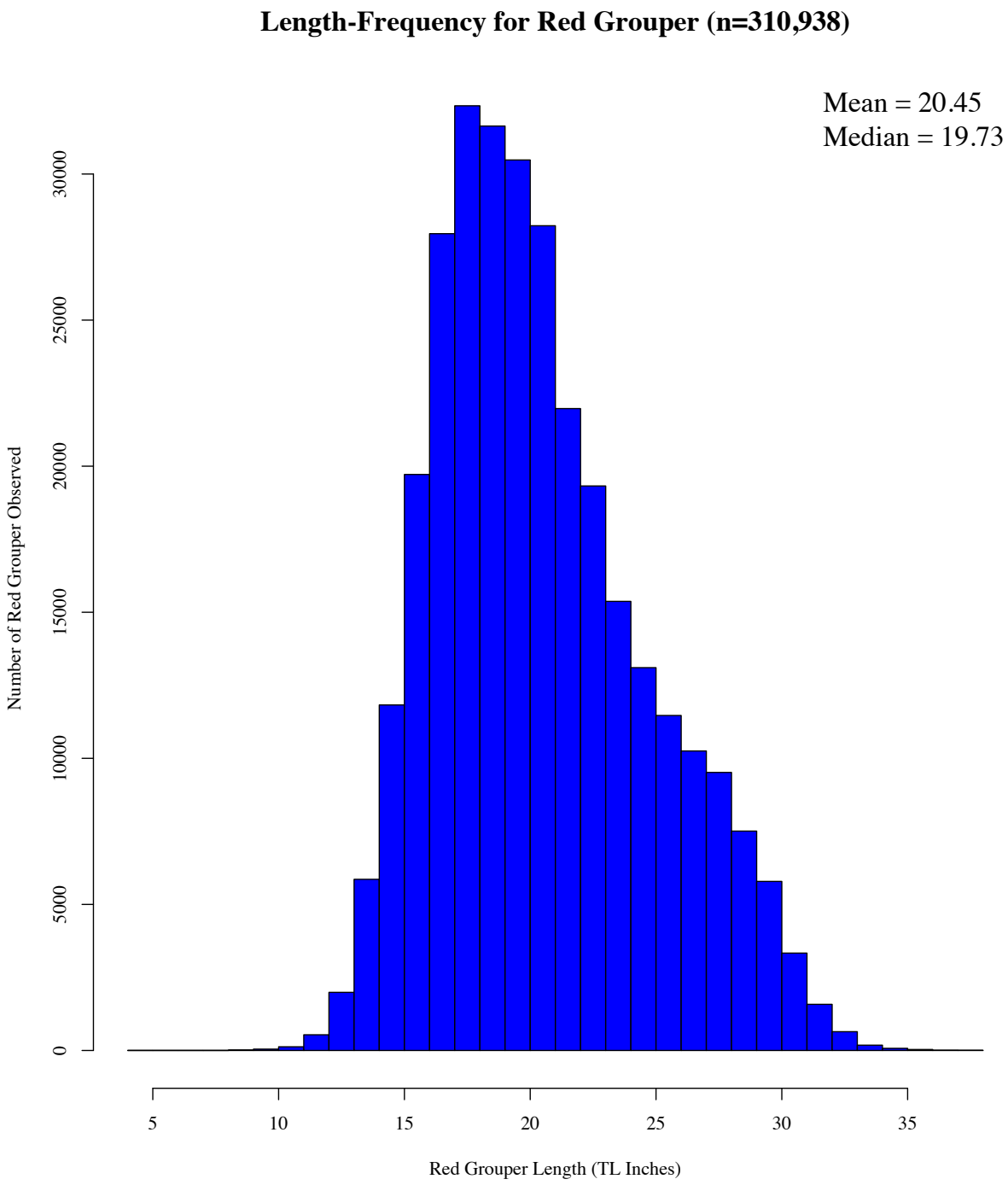


Figure 1. Size composition for all red grouper based on observer coverage for gear types combined of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

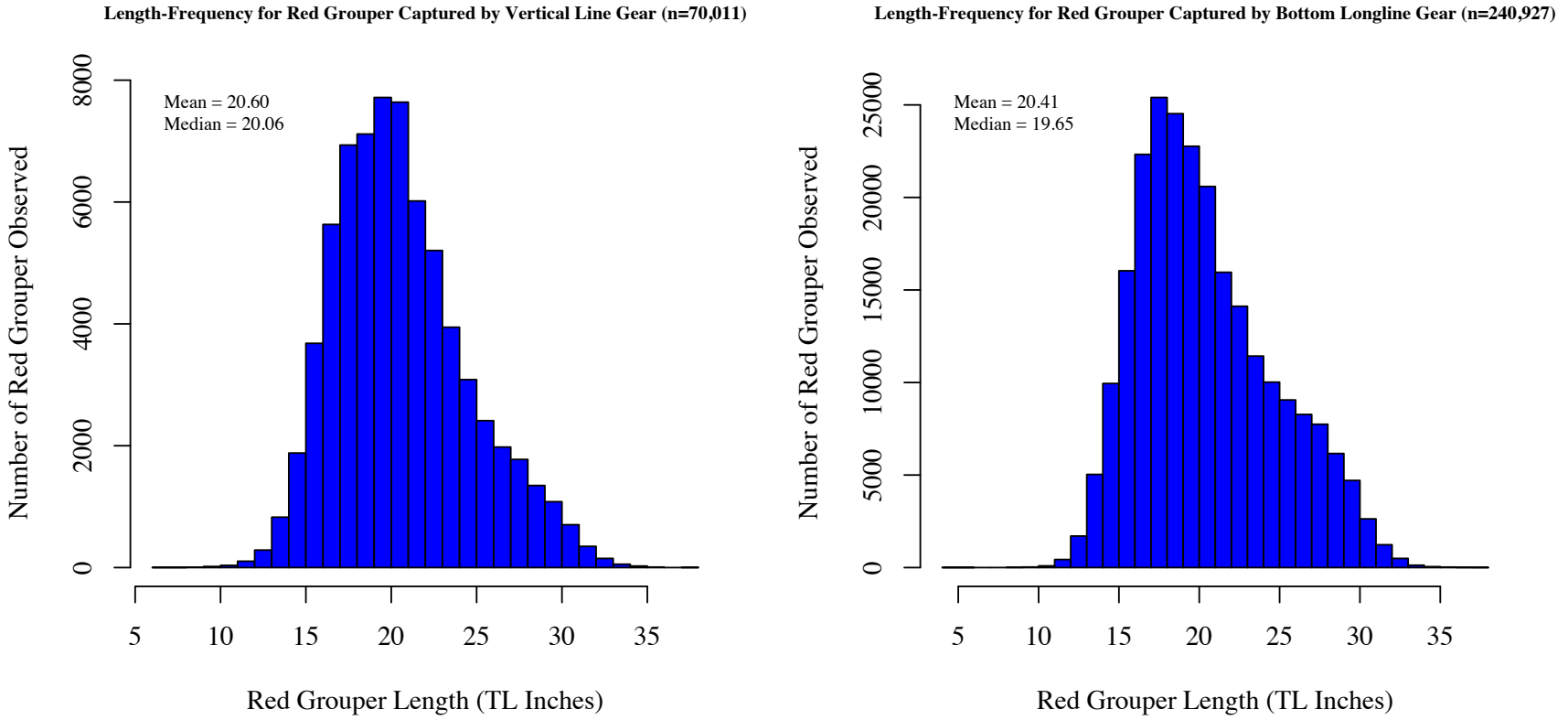


Figure 2. Size composition for all red grouper captured with vertical line and bottom longline gear types based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

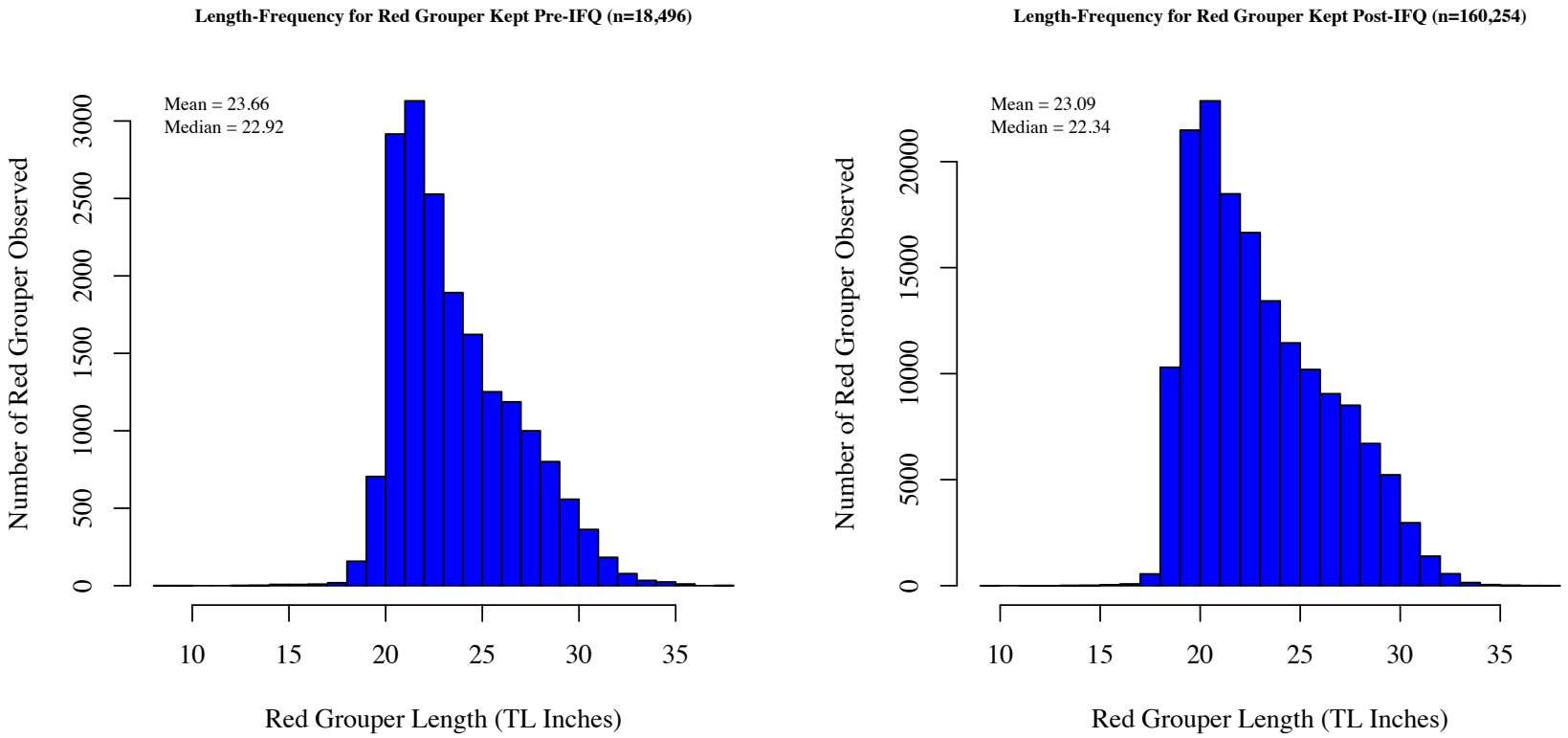


Figure 3. Size composition for all red grouper kept pre- and post-IFQ for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

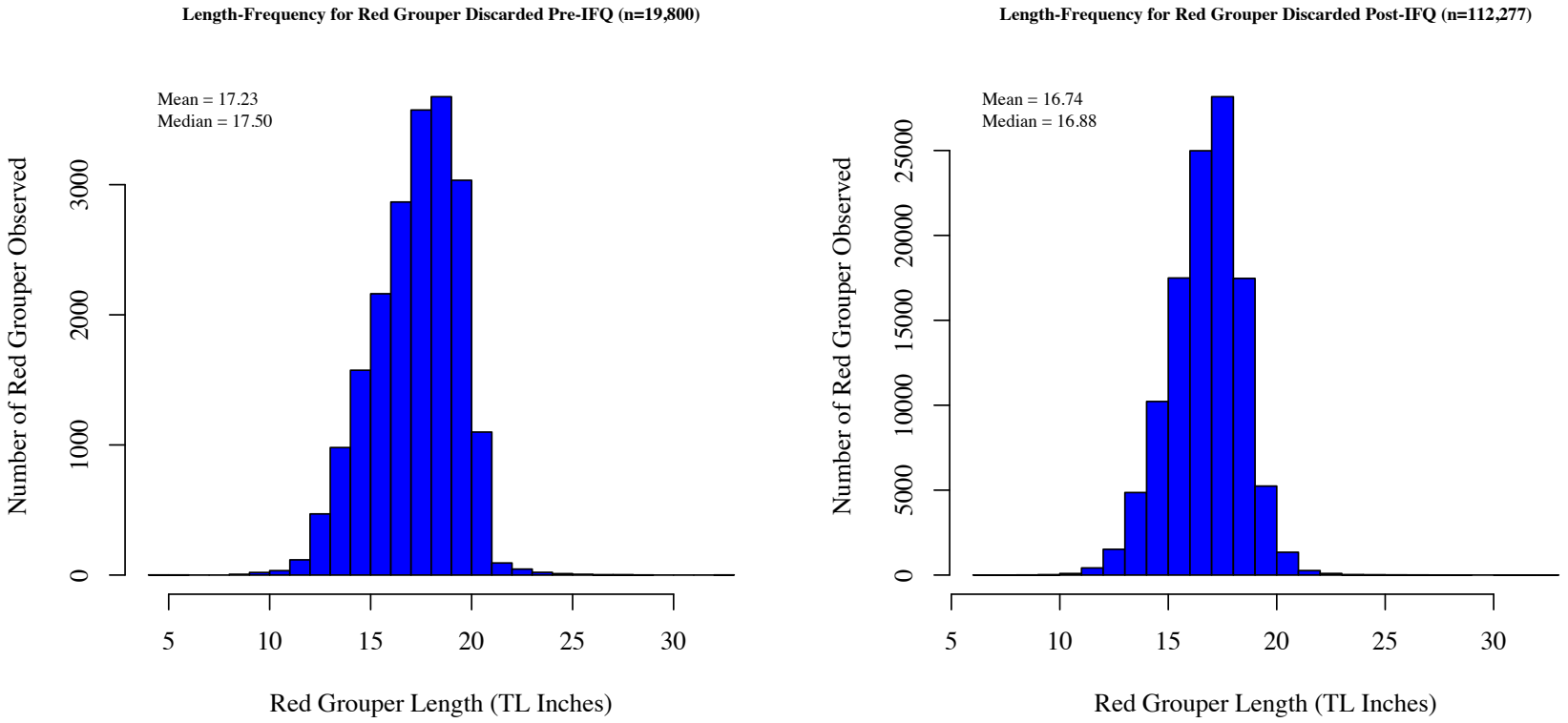


Figure 4. Size composition for all red grouper discarded pre- and post-IFQ for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

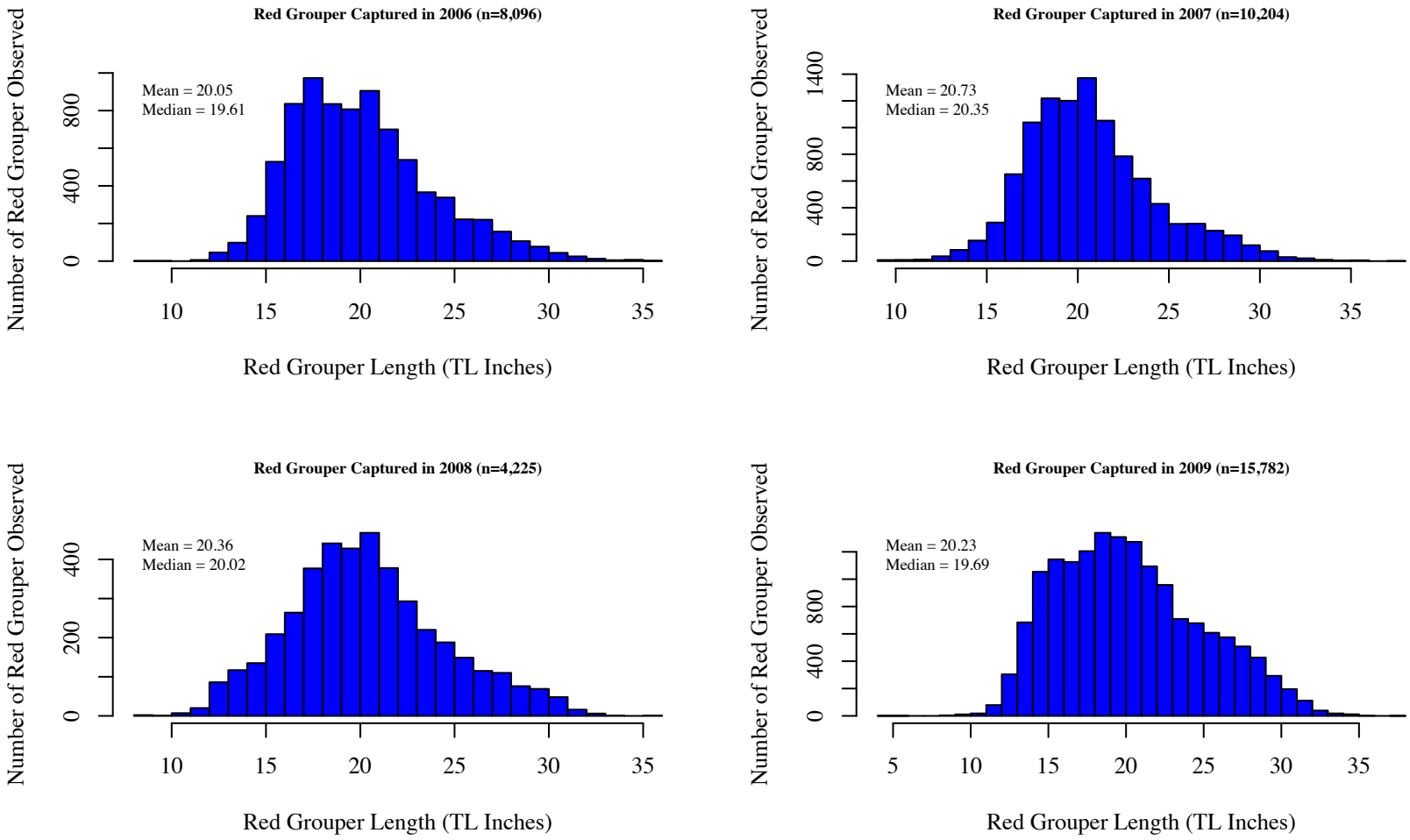


Figure 5. Size composition for all red grouper captured by year for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2009.

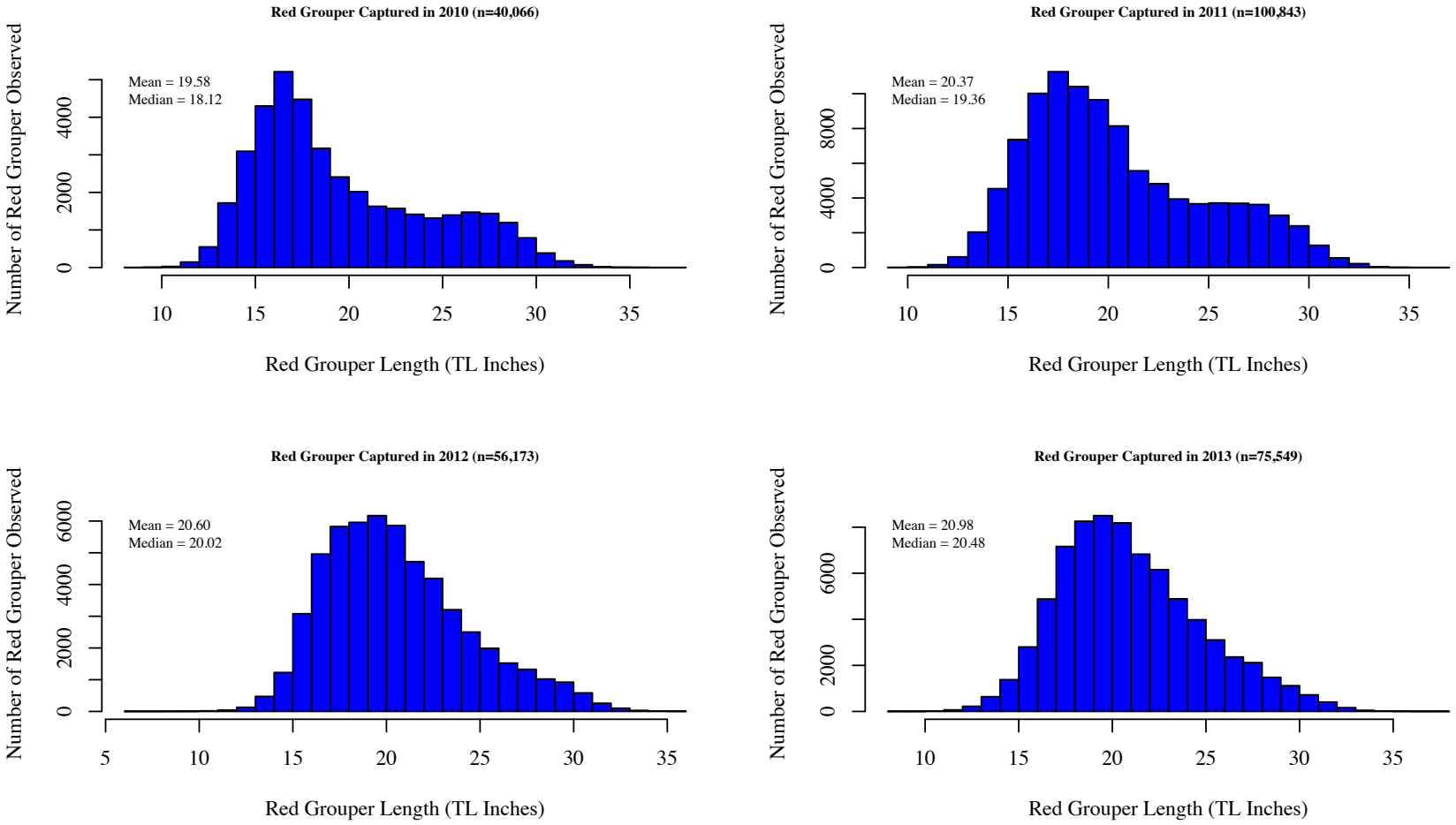


Figure 6. Size composition for all red grouper captured by year for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from January 2010 through December 2013.

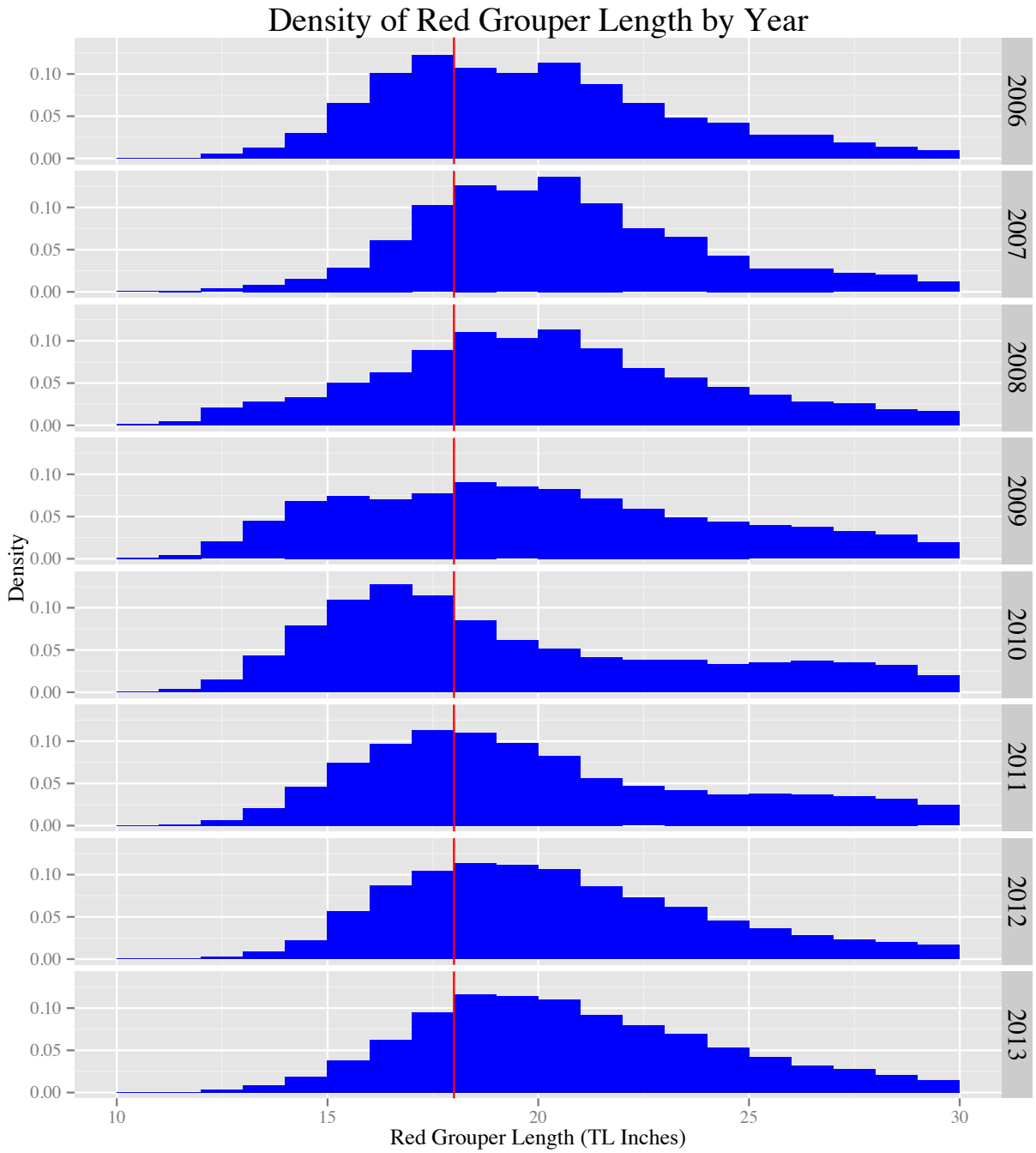


Figure 7. Density of red grouper lengths by year for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

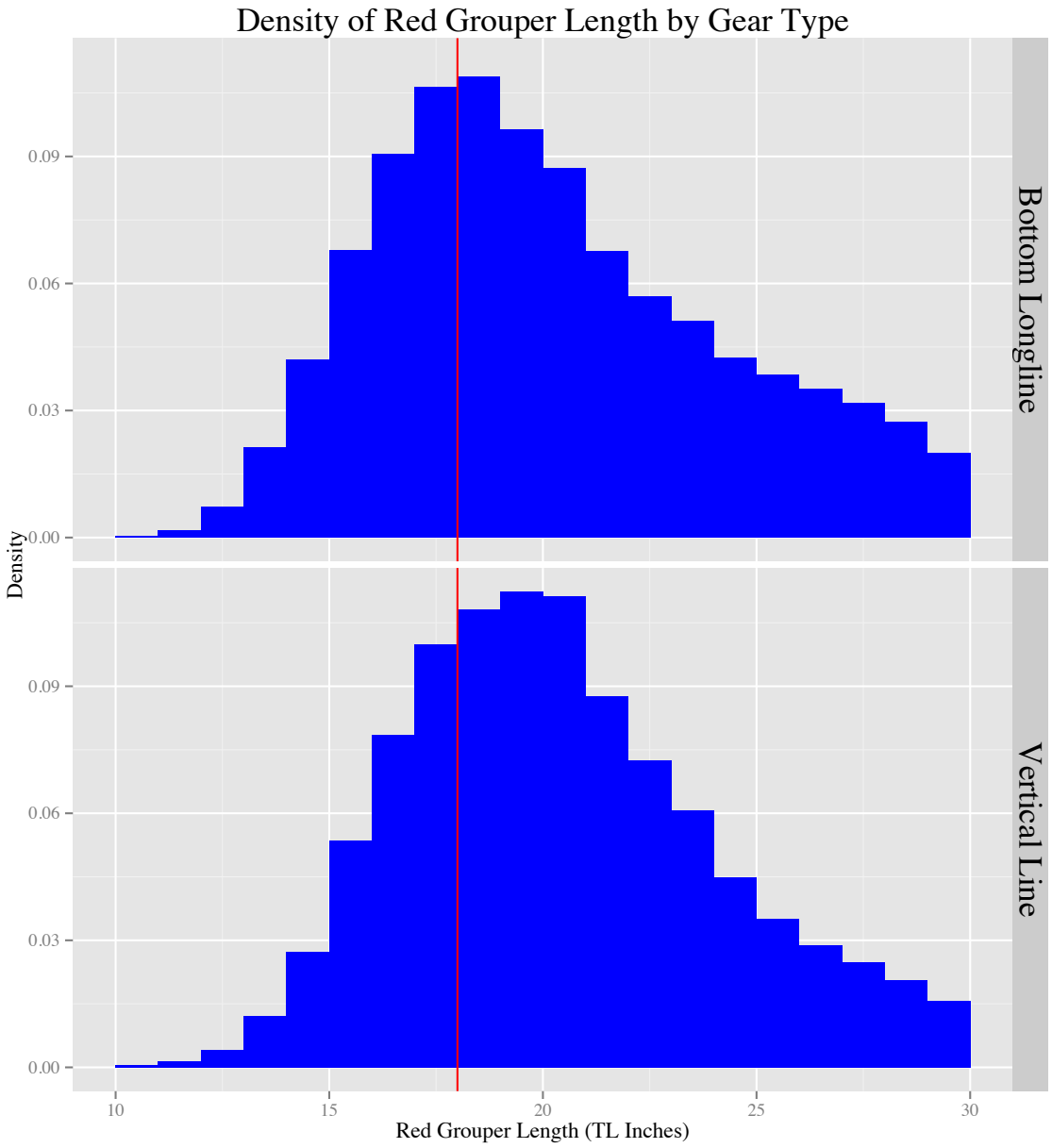


Figure 8. Density of red grouper lengths by gear type based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

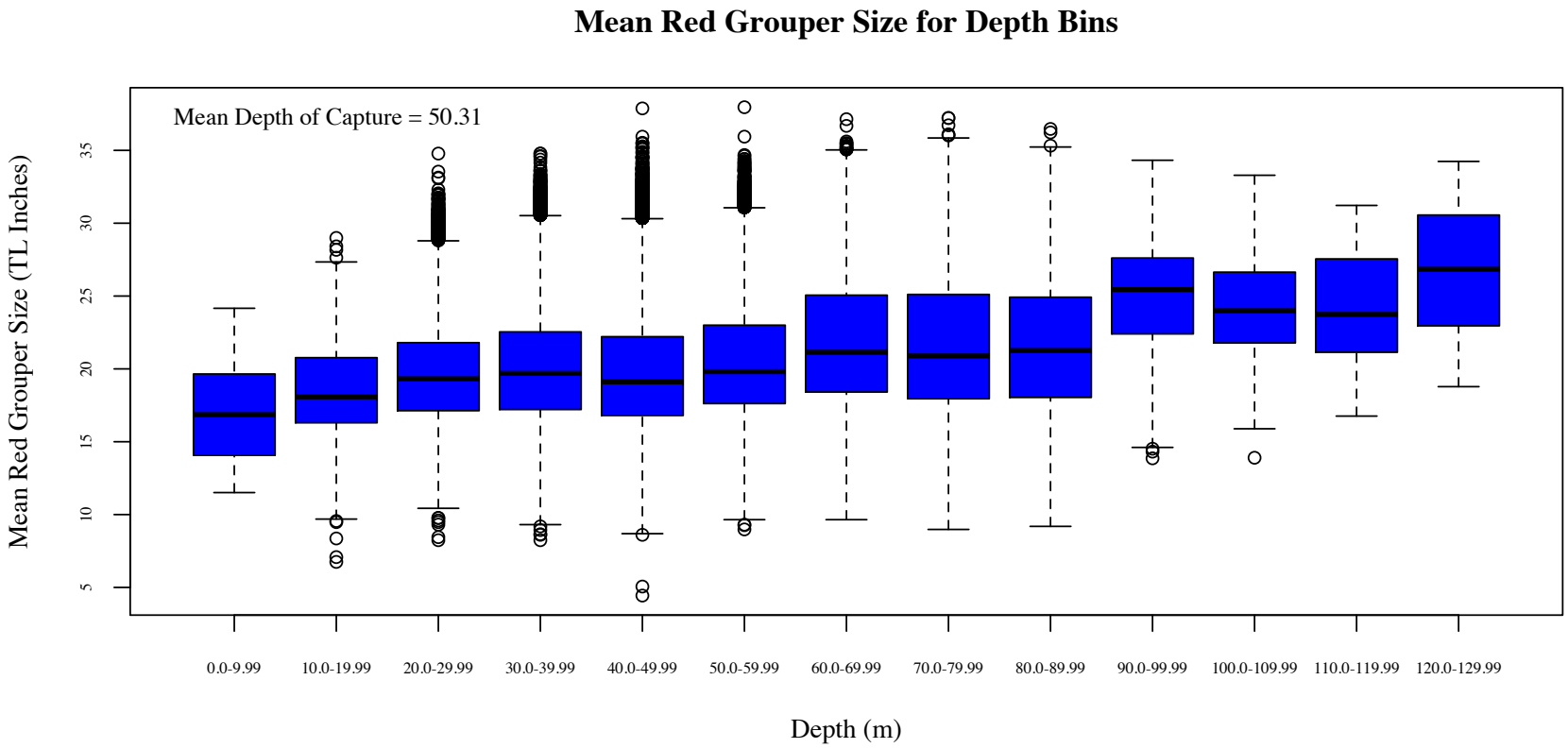


Figure 9. Mean red grouper size by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

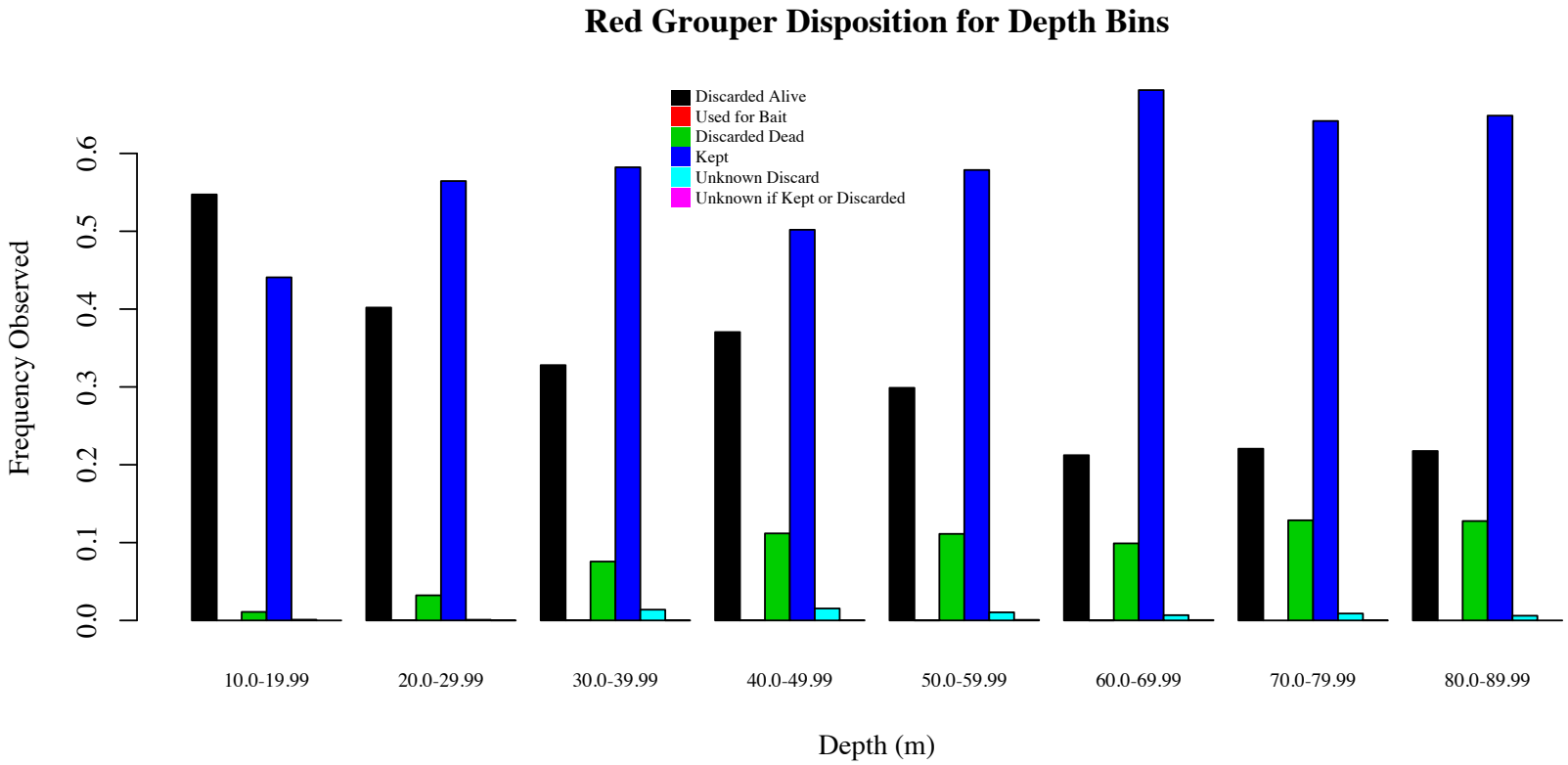


Figure 10. Frequency of red grouper disposition for most common depth bins for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

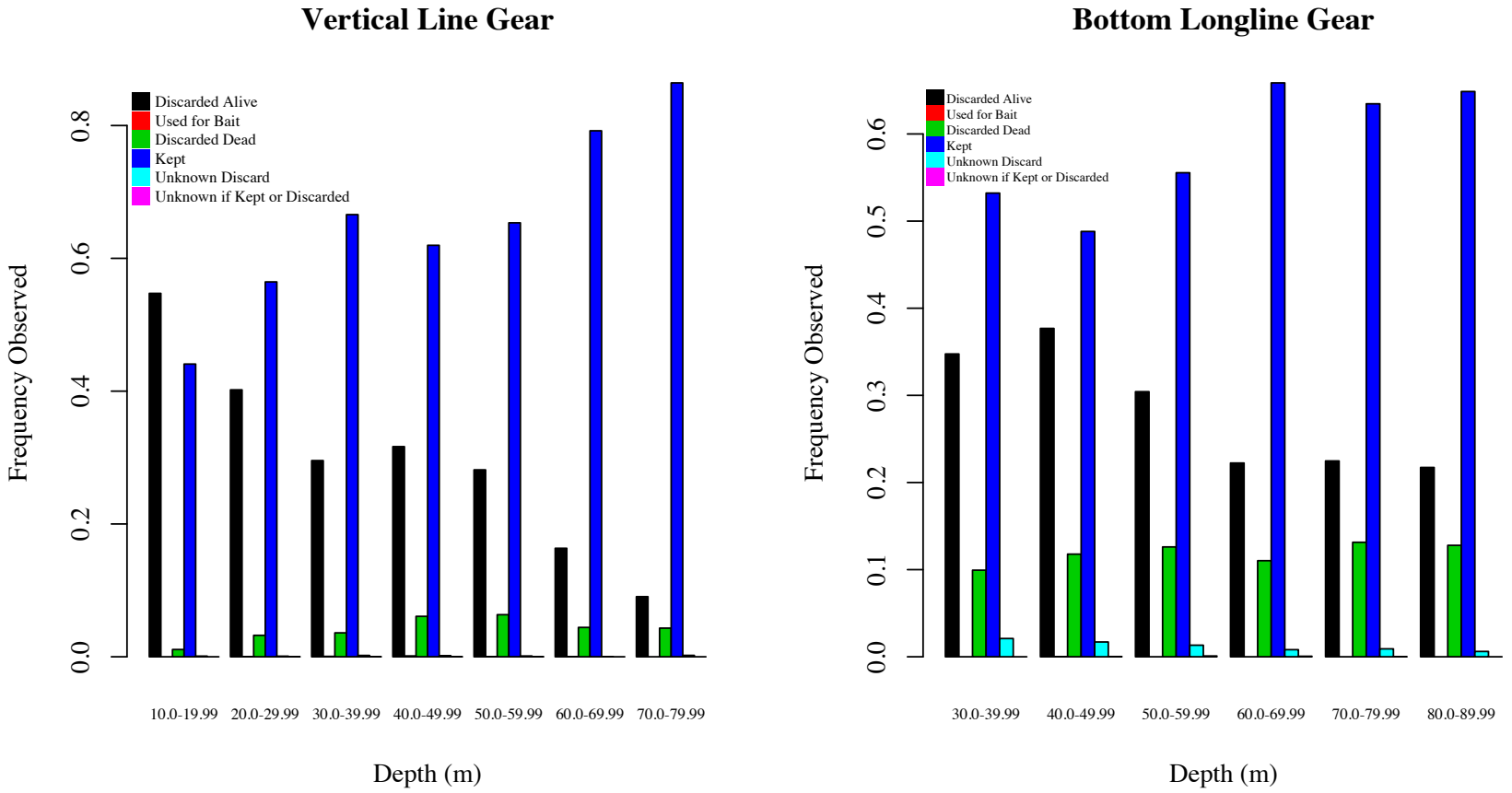


Figure 11. Frequency of red grouper disposition by depth for vessels using vertical line and bottom longline gear based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

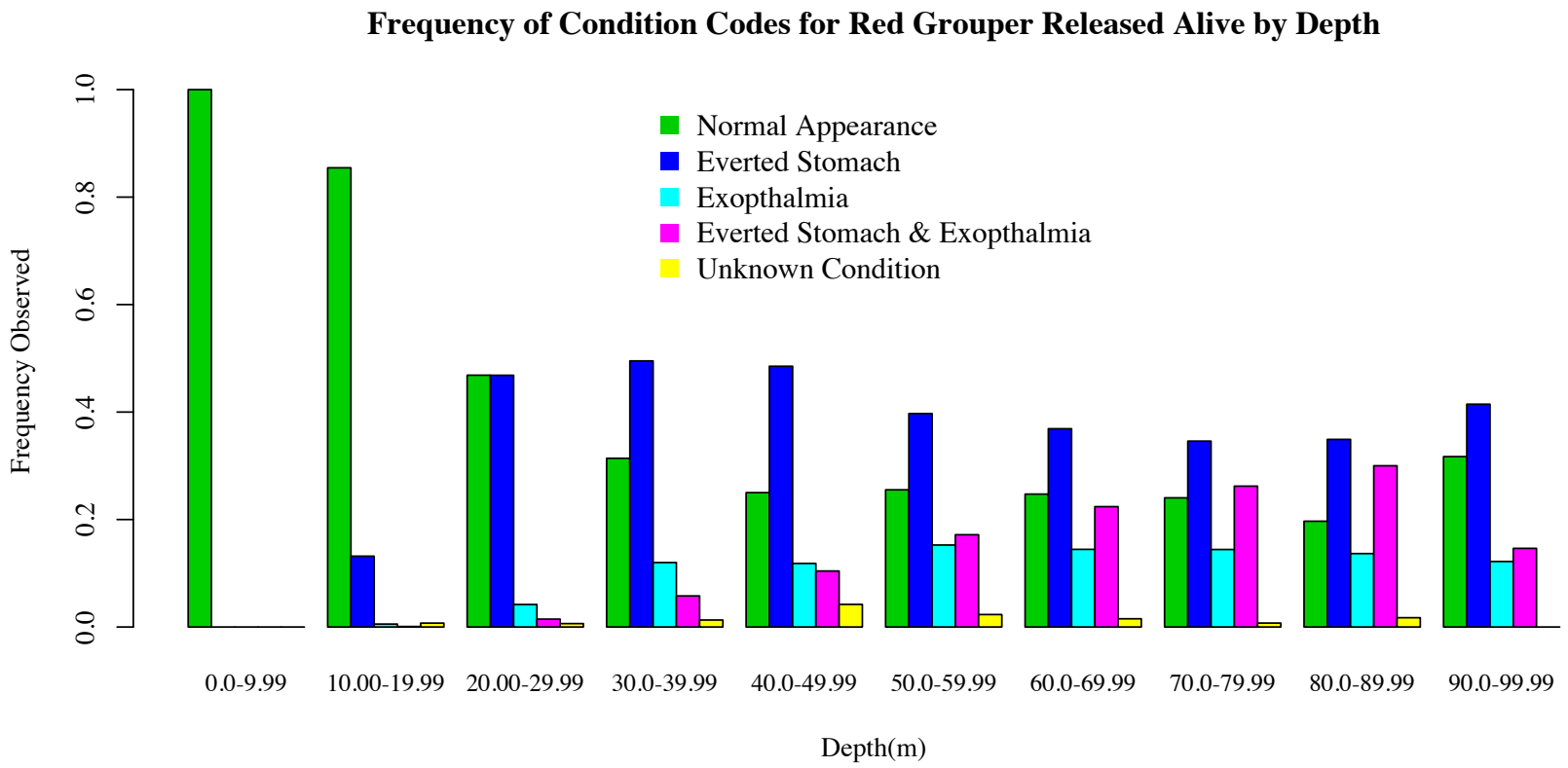


Figure 12. Frequency of condition codes observed for red grouper released alive by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.

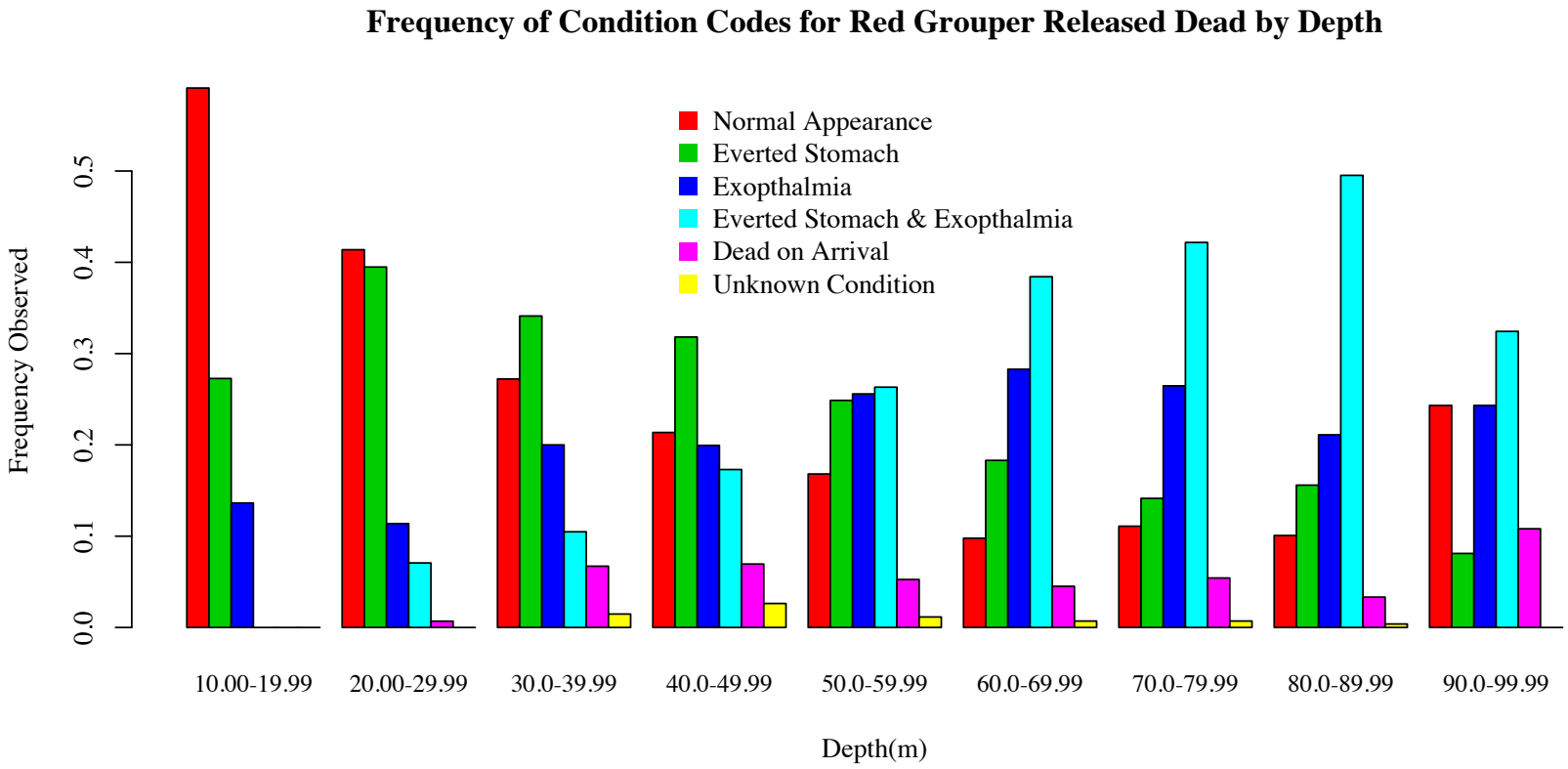


Figure 13. Frequency of condition codes observed for red grouper released dead by depth for gear types combined based on observer coverage of the U.S. Gulf of Mexico commercial reef fish fishery from July 2006 through December 2013.