Fisheries-independent data for red snapper from reef-fish surveys on the West Florida Shelf, 2008-2011

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Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 8th Avenue SE, St. Petersburg, FL 33701

Introduction:

Reef fishes, including red snapper, support extensive commercial and recreational fisheries along the West Florida Shelf (WFS). Historically, the assessment and management of reef fishes in the Gulf of Mexico has relied heavily on data from fisheries-dependent sources, although limitations and biases inherent to these data are admittedly a major source of uncertainty in current stock assessments. The accuracy of harvest estimates, particularly on the recreational side, has been challenged in recent years. Additionally, commercial, headboat, and recreational landings data are restricted to harvestable-sized fish, and thus are highly influenced by regulatory changes (i.e., size limits, recreational bag limits, and seasonal closures). These limitations render it difficult to forecast potential stock recovery associated with strong year classes entering the fishery. There has been a renewed emphasis in recent years to increase the availability of fisheries-independent data on reef fish populations in the Gulf of Mexico that reflect the status of fish populations as a whole, rather than just the portion of the population taken in the fishery. To meet the emerging needs of fisheries-independent data for reef fishes, the Florida Fish and Wildlife Conservation Commission (FWC) has been working collaboratively with scientists from the National Marine Fisheries Service (NMFS) to expand regional monitoring capabilities and provide timely fisheries-independent data for a variety of state- and federally-managed reef fishes. Results are summarized from a fisheries-independent reef fish survey initiated by FWC in 2008 to complement ongoing NMFS surveys of reef habitats along the shelf break (NMFS – Pascagoula) and in the northeastern Gulf of Mexico (NMFS – Panama City).

Survey Design, Sampling Methods, and Analyses:

The FWC reef fish survey includes a portion of the WFS bounded by 26^{o} and 28^{o} N latitude and depths from 10 – 110 m (Figure 1). The boundaries of the WFS sampling universe were chosen to compliment ongoing NMFS reef-fish surveys. To assure adequate spatial coverage of sampling effort, the WFS survey area is subdivided into four sampling zones comprised of two NMFS statistical zones (Tampa Bay: NMFS statistical zone 5; Charlotte Harbor: NMFS statistical zone 4) and two depth zones (Nearshore: 10 – 37 m; Offshore: 37 – 110 m). Prior to conducting exploratory sampling in 2008, the WFS survey area was subdivided into 1km x 1km sampling units. Results from 2008 indicated that 1km x 1km spatial scale was too large in relation to the small-scale habitat features characteristic of the WFS; accordingly, from 2009 onward the WFS survey area was subdivided into 0.1nm x 0.3 nm sampling units. Overall sampling effort (annual goal of n = 200 sampling units) was proportionally allocated among the four sampling zones based on habitat availability (TBN: Tampa Bay Nearshore; TBO: Tampa Bay Offshore; CHN: Charlotte Harbor Nearshore; CHO: Charlotte Harbor Offshore), and specific sampling units were selected randomly within each sampling zone.

Very little is known regarding the fine-scale distribution of reef habitat throughout much of the WFS, and due to anticipated cost and time requirements, mapping the entire WFS survey area was not feasible prior to initiating the WFS reef fish survey. For the 2008 reef fish survey, the identification of sampling units with an increased probability of containing reef habitat (and inclusion in the sampling frame for the reef-fish survey) was based on bottom rugosity calculated from 100m-resolution interpolated bathymetry data. An examination of results from the 2008 survey indicated that a high proportion of sampling effort occurred at sites with no reef habitat (i.e., unconsolidated sediment). Accordingly, the sampling universe was updated in 2009 to include habitat information provided by commercial fishermen as well as published literature. Further, we implemented an adaptive strategy where a three-pass acoustic survey was conducted covering an area of 1nm to the east and west of the pre-selected sampling unit prior to sampling. In 2009 and part of 2010, the acoustic survey was conducted using the research vessel echosounder, while for part of 2010 and all of 2011 the acoustic survey was conducted using an L3- Klein 3900 side scan sonar. Based on results from these acoustic surveys, sampling effort was relocated to a nearby sampling unit should evidence of reef habitat be identified.

At each sampling station, two types of sampling gears were utilized: stationary underwater camera arrays (SUCA) and chevron traps. Gear deployments and collection and processing of field data followed established NMFS protocols. At each station, 1-2 SUCAs were deployed that consisted of a pair of stereo imaging system (SIS) units positioned at an angle of 180º from one another to maximize the total field of view. Each SIS unit consisted of an underwater housing containing a digital camcorder to record video and a pair of stereo cameras to capture still images at a rate of one per second. Each SUCA was baited (generally Atlantic mackerel) and deployed for thirty minutes to assure that twenty minutes of continuous video and stereo images were recorded. Video data from one SIS per SUCA deployment were processed to quantify the relative abundance of red snapper observed (MaxN, or the maximum number of red snapper observed on a single video frame). In addition, 1-4 chevron traps were baited (generally Atlantic mackerel) and deployed for ninety minutes prior to retrieval; all red snapper collected were identified, enumerated, and measured. All individual gear deployments (SUCA and chevron traps) were spaced a minimum of 100 m apart. In addition to data on red snapper, geographic coordinates, depth, physiochemical conditions (e.g., temperature, salinity, dissolved oxygen, pH), and time of day were recorded at each specific sampling site.

Preliminary examination of semivariograms for red snapper indicated that the 100m spacing resulted in observations that were generally independent. Nevertheless, all data from a given sampling site were first averaged to avoid potential pseudoreplication. For each year and sampling zone, frequency of occurrence as well as mean (± SE) relative abundance of red snapper was calculated across stations for both SUCA and chevron trap data. For SUCA videos, relative abundance was calculated as the average MaxN, whereas for chevron traps, relative abundance was calculated as the average number of red snapper per trap set. For chevron trap data only, annual size-frequency distributions were also calculated.

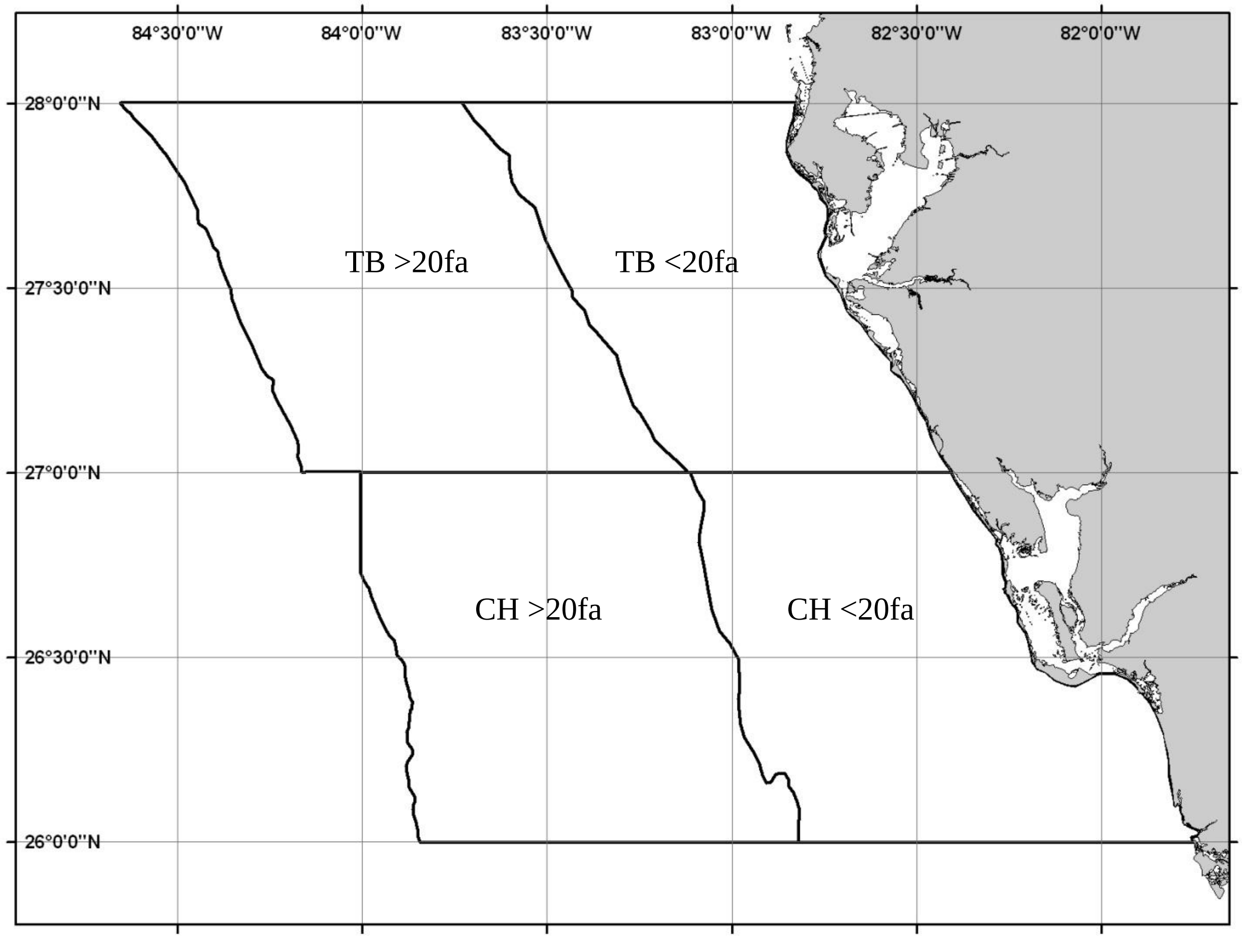

Figure 1. The West Florida Shelf survey area. The 20fa (37m) contour separates nearshore (i.e., TBN and CHN) and offshore (TBO and CHO) sampling zones. The sampling area includes waters 10m – 110m.

Results / Discussion:

From 2008 – 2011, a total of 484 stations were sampled; all stations were sampled with chevron traps, whereas only 457 stations were sampled using SUCA (Table 1). The reduced number of stations sampled using SUCA was attributable to instances where the cameras malfunctioned or weather conditions prevented sampling. Due to weather and mechanical issues, planned effort of n = 200 sampling stations was only achieved in 2011; from 2008 – 2010 total sampling effort varied from 73 – 117 stations. Although all four spatial zones were sampled each year, allocation of completed sampling effort varied significantly; accordingly, data were summarized independently for each zone.

Analyses of SUCA (Figures 2 and 3) and chevron trap data (Figures 4 and 5) indicated that red snapper were never observed within the Charlotte Harbor – Nearshore zone, and only rarely observed in the Tampa Bay – Nearshore zone. In the offshore zones, red snapper were generally more frequently observed off Tampa Bay in both SUCA and chevron traps. Overall there has been a marked increase in both the frequency of occurrence and relative abundance of red snapper in both the Tampa Bay – Offshore and Charlotte Harbor – Offshore zones (Figures 2 – 5). The one notable exception to this trend is the frequency of occurrence and relative abundance of red snapper from chevron traps in the Charlotte Harbor – Offshore zone (Figures 4 and 5). In 2009, red snapper were collected at exceptionally high abundances (n > 25 red snapper per station) at two stations. Insufficient length data were available from the SUCA to make any meaningful comparisons, but red snapper collected in chevron traps ranged from 150 – 500 mm SL, although most individuals ranged from 300 – 450 mm SL (Figure 6). No marked changed in size frequency were evident through time.

It is apparent that red snapper are becoming common in the offshore waters (20 – 60 fa) off the WFS, as they were observed at nearly 30% of all stations off of Tampa Bay and 20% of all stations off of Charlotte Harbor in 2011. At present, it is impossible to reconcile whether the increasing trends through time result from increased abundance of red snapper, increased survey efficiency, or a combination of the two. Survey efficiency has undoubtedly increased through time, and the proportion of stations sampled that actually contained reef habitat has increased significantly. A more appropriate examination of trends through time would require detailed post-stratification where sites that did not contain reef habitat were excluded from these analyses. At present we do not have sufficient habitat data for prior survey years (especially 2008 and 2009) to satisfactorily post-stratify these data, although ongoing mapping efforts targeting previously-sampled stations will improve our ability to post-stratify data in the future.

Table 2. Summary of annual stationary underwater camera array (SUCA) sampling effort by spatial zone from 2008 – 2011. Values represent total number of sampling stations, while values in parentheses represent the total number of individual gear deployments (1 – 2 arrays deployed per station).

Region	2008	2009	2010	2011	Total
TBN	5 (10)	25 (34)	16 (24)	56 (122)	102 (190)
TBO	18 (33)	33 (66)	25 (50)	49 (72)	125 (221)
CHN	20 (38)	28 (43)	23 (46)	35 (60)	106 (187)
CHO	24 (48)	30 (60)	29 (56)	41 (55)	124 (219)
Total	67 (129)	116 (203)	93 (176)	181 (309)	457 (817)

Table 3. Summary of chevron trap sampling effort by spatial zone from 2008 – 2011. Values represent total number of sampling stations, while values in parentheses represent the total number of individual gear deployments (1 – 4 chevron traps deployed per station).

Region	2008	2009	2010	2011	Total
TBN	8 (32)	25 (84)	18 (60)	63 (141)	114 (317)
TBO	18 (72)	33 (132)	26 (78)	49 (70)	126 (352)
CHN	21 (84)	29 (102)	23 (69)	35 (40)	108 (295)
CHO	26 (104)	30 (120)	31 (93)	49 (65)	136 (382)
Total	73 (292)	117 (438)	98 (300)	196 (316)	484 (1346)

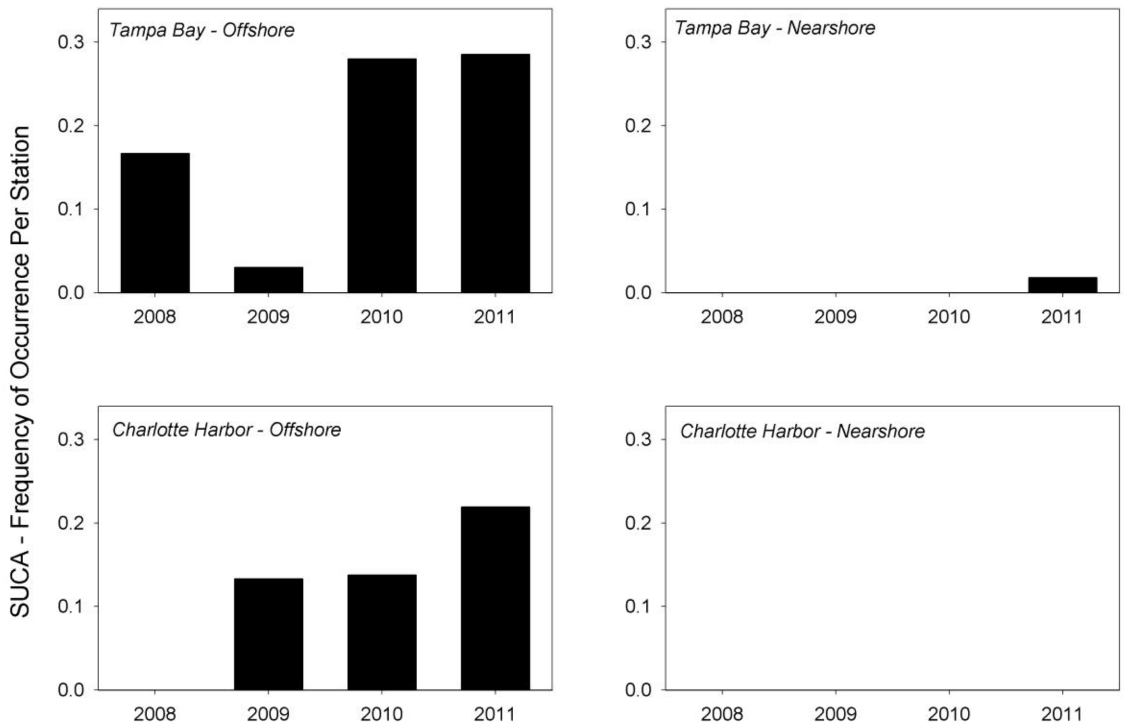

Figure 2. Annual frequency of occurrence of red snapper observed during stationary underwater camera array (SUCA) surveys by spatial zone from 2008 – 2011.

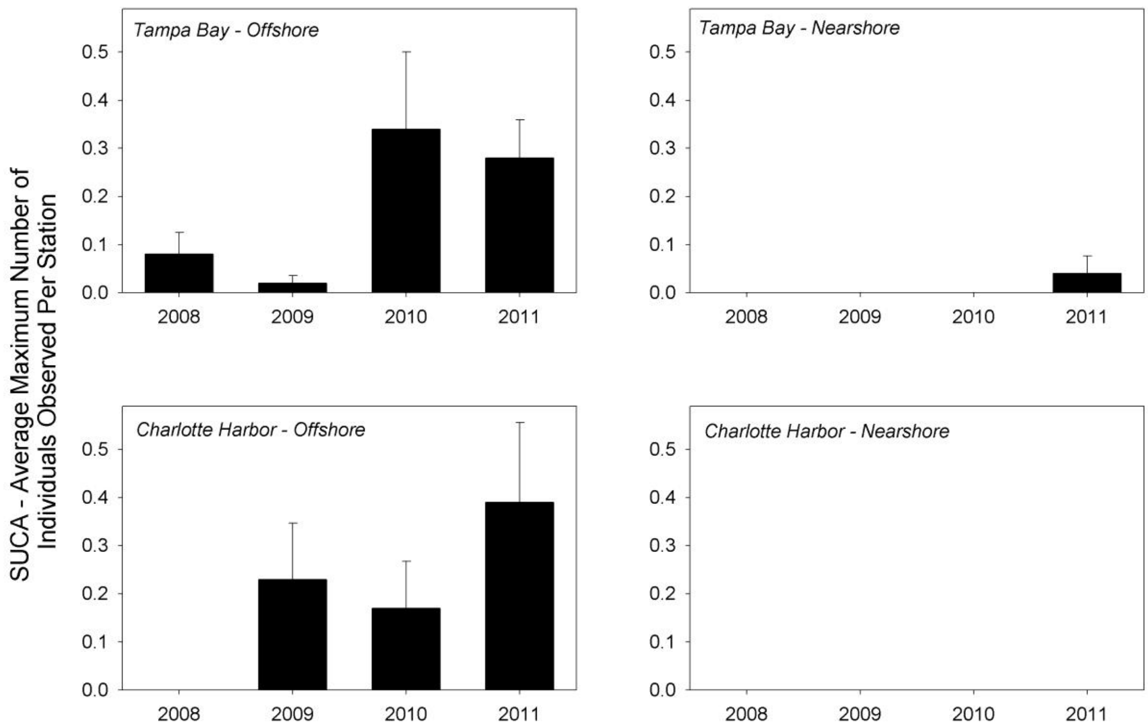

Figure 3. Mean (± SE) annual relative abundance of red snapper observed during stationary underwater camera array (SUCA) surveys by spatial zone from 2008 – 2011.

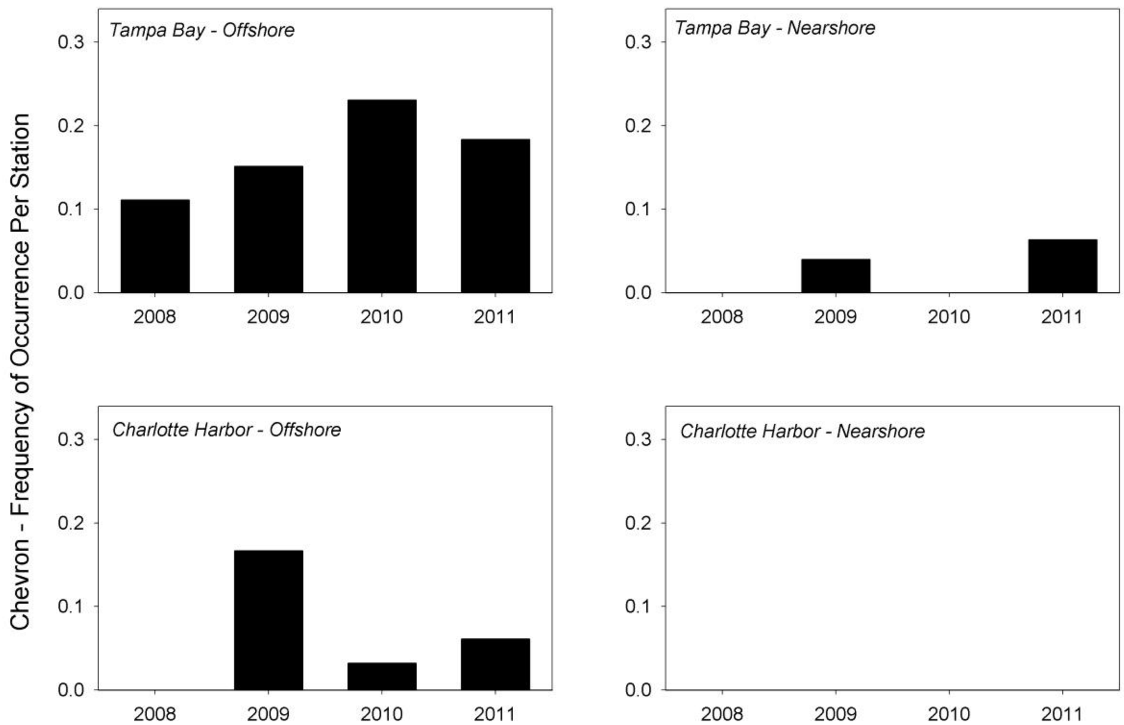

Figure 4. Annual frequency of occurrence of red snapper collected during chevron trap surveys by spatial zone from 2008 – 2011.

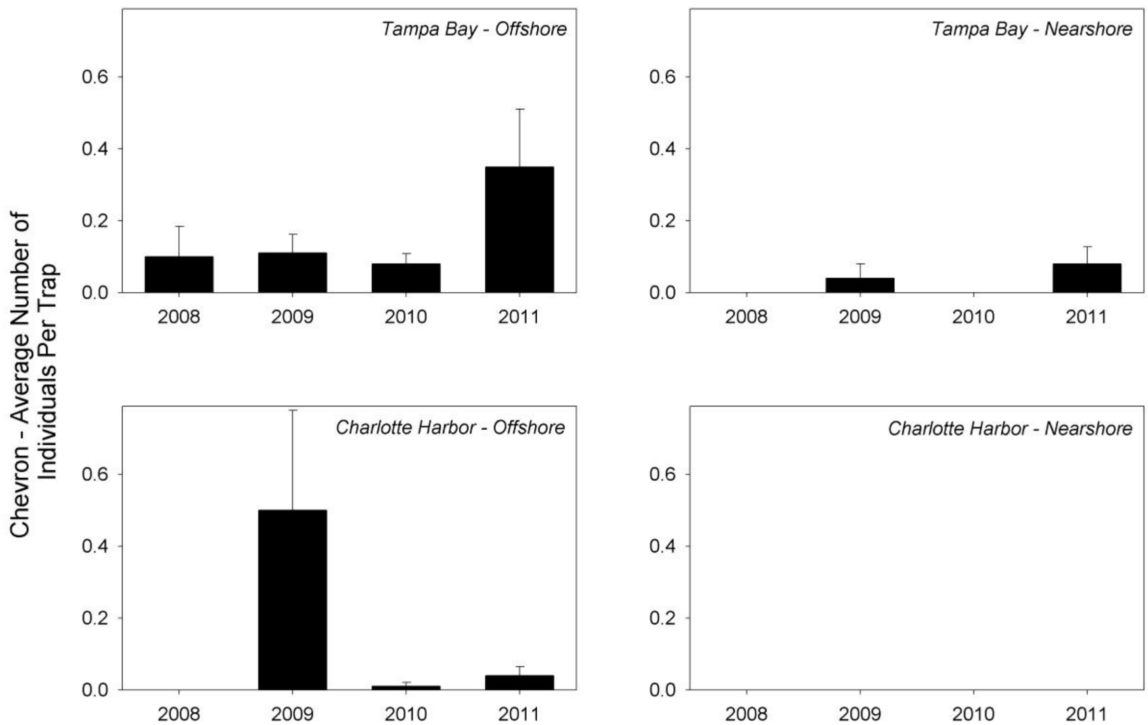

Figure 5. Mean (± SE) annual relative abundance of red snapper collected during chevron trap surveys by spatial zone from 2008 – 2011.

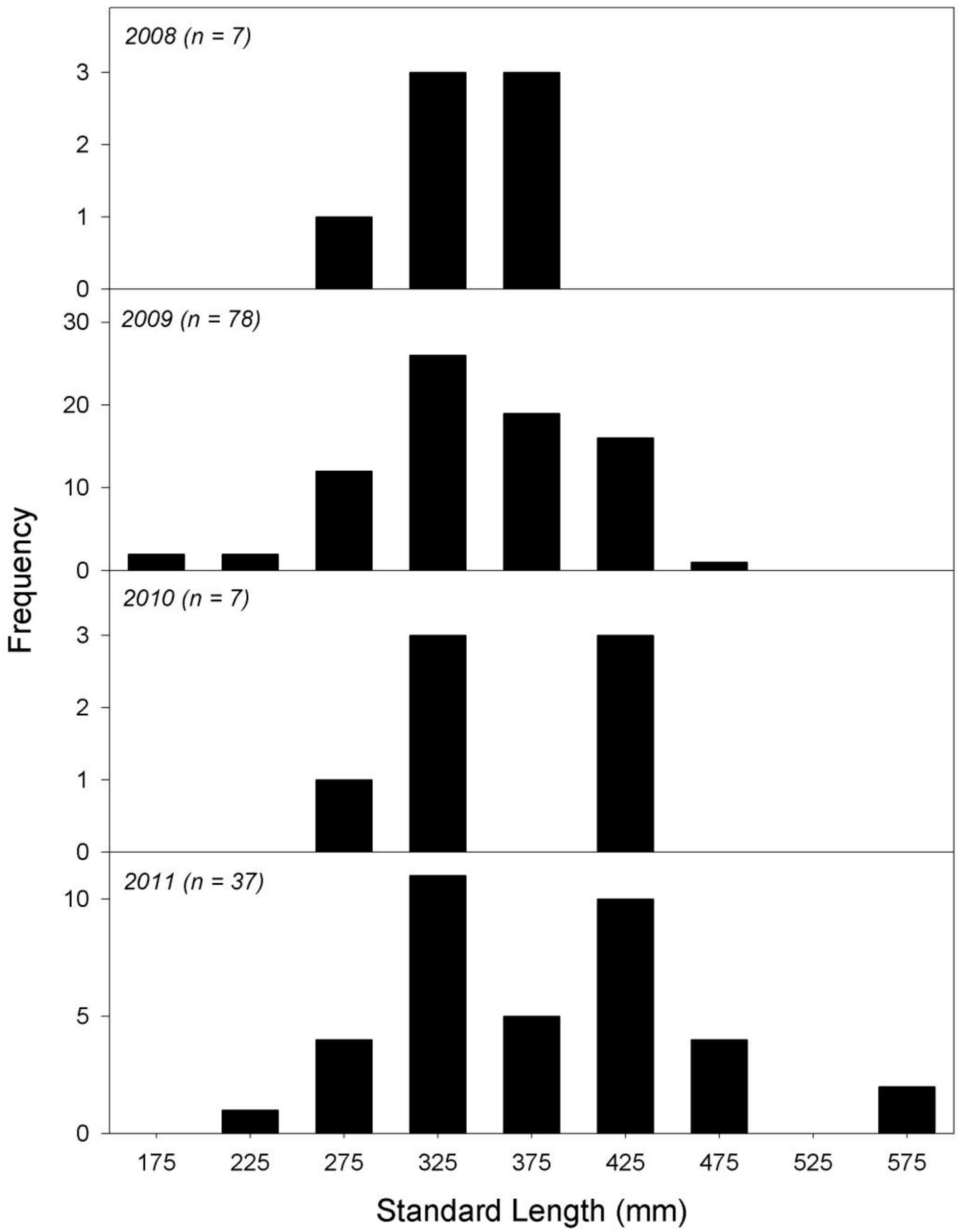

Figure 6. Annual size-frequency distribution of red snapper collected during chevron trap surveys by spatial zone from 2008 – 2011.