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Hogfish Discard Mortality and Habitat Ecology on the West Florida Shelf

Robert D. Ellis[1], B. James Williams[1], Kerry Flaherty-Walia[2], and Philip Stevens[1]
[1] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
[2] Tampa Bay Estuary Program

ABSTRACT

Historically, the hogfish, *Lachnolaimus maximus* Walbaum 1792, fishery in the Gulf of America has been dominated by spearfishers, a group with limited discards and 100% mortality. However, recent data suggest a substantial increase in the number of hogfish landed via hook-and-line by the recreational and charter fishing sectors. This increase in hook-and-line landings necessitates accurate estimates of discard mortality for use in future stock assessments. Furthermore, hogfish found along the Florida Gulf coast are usually associated with hardbottom reefs and ledges, but to date there is little published information on fine-scale habitat use or individual home ranges. Such information can be useful for assessing the extent of hogfish habitat and in planning future artificial reefs. Here, we report on a pilot study that used acoustic telemetry to assess discard mortality rates and document the habitat ecology of hogfish on the West Florida Shelf. Between May 2019 and February 2025, we caught 46 hogfish ranging in size from 231–475 mm fork length using fishing techniques commonly used by the local recreational fishery. We tagged 36 hogfish externally with both a pressure-sensing acoustic tag and a dart tag and released them at the capture site. Post-release survival was assessed by inspecting detection data to determine if vertical movements in the water-column resumed and that such movements persisted for at least 48 hours after capture. Overall, short-term (48 hour) mortality totaled 23.8% but differed across depth strata and bottom temperature regimes. We have collected detection data beyond two weeks for 26 tagged hogfish, which has revealed intricate patterns of habitat use at the hardbottom ledges.

INTRODUCTION

Regulations for managing the harvest of reef fishes often include size and bag limits, the success of which relies on the assumption that most fish that are released will survive. However, the mortality rate for such regulatory discards may, at times, account for a significant portion of the total fishing mortality. Hogfish, *Lachnolaimus maximus*, is an economically important wrasse commonly found over hardbottom habitat throughout subtropical and tropical waters of the western North Atlantic Ocean, Gulf of America (hereafter, "Gulf"), and Caribbean Sea (Randall 1968; Hoese and Moore 1977). Historically, the recreational fishery for hogfish has been dominated by spearfishing, which has resulted in minimal discards. However, recreational hook-and-line anglers along the west coast of Florida have been increasingly targeting hogfish. Local and statewide media have published articles highlighting the hogfish hook-and-line fishery including details on how to target them (Chapman 2014, Sargeant 2016). In addition, fisheries-dependent monitoring (FDM) data on hogfish, suggest a substantial increase in hook-and-line landings and discards by the recreational and for-hire fisheries since 2010 (Addis et al. 2018; Cheshire and Green 2025; Eguia et al. 2025). Angling related discard mortality for hogfish is currently unknown, so a default 10% estimate for mortality was used in both the 2013 benchmark and 2017 update stock assessments (Cooper et al. 2014; Addis et al. 2018). Given the observed increase in both landings and discards, potentially exacerbated by regulatory changes to the minimum harvest size from 12” FL to 14” FL in late 2017, accurate discard mortality estimates are needed for this species.

Release mortality of reef fishes can be estimated using multiple data types and methods, including tag return data (Burns et al. 2008; McGovern et al. 2005; Sauls 2014), numerical and statistical models (Waters and Huntsman 1986; Ault et al. 2005), cage experiments (Overton et al. 2008; Flaherty-Walia et al. 2016), and acoustic telemetry (Curtis et al. 2015; Bohaboy et al. 2019). However, no studies addressing discard mortality of hogfish have been conducted, in part because such studies were previously thought unnecessary due to spearfishing as the primary mode of catch. Here, we describe a recent project designed to calculate discard mortality estimates and post-release behavior for hogfish using acoustic telemetry. Acoustic telemetry paired with hook and line sampling has been successful in documenting both short- (hours after release) and long-term (days to weeks) survival of released fish (Curtis et al. 2015; Runde and Buckel 2018; Bohaboy et al. 2019). Discard mortality estimates are determined by tracking movement patterns consistent with that species’ behavior (i.e., regular movements vs. no movement) or those indicative of emigration or predation events. Variability of hook-and-line data can be minimized by using standardized fishing gear, while much of the variability among anglers can be accounted for by including appropriate covariates (Flaherty-Walia et al. 2016). Acoustic telemetry has the added benefit of near-continuous monitoring of post-release behaviors, which also can provide insights into habitat ecology (e.g., home ranges, fine-scale habitat use). When combined with ongoing efforts to map the bottom of the Gulf, such information could be used to assess the extent of hogfish habitat to inform future species distribution modeling efforts.

For many reef species, species-specific discard mortality estimates are needed when evaluating the effects of new or modified regulations, since released fish can have high mortality rates due to stress from capture and handling, hooking injuries, barotrauma, higher water temperatures, and depredation (Rudershausen et al. 2013, Drymon et al. 2019, Runde et al. 2019, Kaemingk et al. 2020). Due to their physiology as a laterally compressed species, hogfish are more like gray triggerfish, *Balistes capriscus*, than they are to other snapper or grouper species. Recent studies investigating discard mortality of triggerfish with acoustic telemetry have found low rates of post-release survival: one study found that just 34% of tagged fish survived, while a second measured 77% survival (Runde et al. 2019; McKinzie and Szedlmayer 2022). However, while hogfish and gray triggerfish share a similar body type, the notoriously thick skin of triggerfish may further restrict expansion and exacerbate the effects of barotrauma. Thus, we may expect hogfish discard mortality to fall somewhere in between what has been measured in members of the snapper-grouper complex and gray triggerfish.

In addition to their physiology that may make hogfish more susceptible to discard mortality, hogfish are monandric, protogynous reef fish with territorial males and female-biased harems (Colin 1982; Muñoz et al. 2010; Collins and McBride 2011). They are relatively long lived (maximum observed age = 23 years) and can reach over 800 mm in total length (McBride and Richardson 2007). Protogynous species like hogfish require special management considerations because the largest and often most targeted fish are the males. It is suspected that hogfish demonstrate strong site fidelity, especially during the spawning season, which means that harems may be susceptible to disruption by fishing pressure (Lindholm et al. 2006). Removal of the dominant male has the potential to decrease the reproductive potential of a population, which has occurred previously for hogfish in the South Atlantic (Bannerot et al. 1987; Muñoz et al. 2010). Initially, fishery regulations for hogfish included a minimum size limit (12 inches, 305 mm fork length [FL]) for both the commercial and recreational fisheries and a 5-fish/person bag limit for the recreational fishery (implemented in Florida state waters in 1994, south Atlantic federal waters in 1995, and Gulf federal waters in 1999; Cooper et al. 2014). This minimum size limit corresponded with the observed minimum length at sex change and was established in part to protect spawning-capable fish (Davis 1976). Corresponding with newly implemented regional management of hogfish in the Gulf and South Atlantic, the minimum size limits were increased in 2017 to 14 inches (356 mm) FL in the Gulf of Mexico, 16 inches (406 mm) FL along the Atlantic coast and the Keys, and 17 inches (432 mm) FL in the South Atlantic north of Florida to reduce the harvest rate, allow hogfish to grow larger, and have additional reproductive opportunities before being harvested.

The primary objective of the current study was to estimate survival of hook-and-line caught hogfish after release to inform discard mortality rates. Secondary objectives included developing and evaluating an external tagging method (i.e., will externally attached acoustic tags stay attached long enough to evaluate short- and long-term survival?), determining the efficacy of the specific tag and acoustic receiver design, and assessing hogfish residency at tag sites. Ideal outcomes would include discard mortality estimates, as well as information on hogfish site fidelity and behaviors on nearshore low-relief habitats of the West Florida Shelf.

METHODS

Hook-and-line fishing for hogfish and other economically important reef fish was conducted in nearshore waters of the West Florida Shelf offshore of Tampa Bay, FL (Figure 1). We targeted known hardbottom limestone ledge sites divided across two depth strata: shallow (≤ 15 m) and deep (> 15 m). Fishing methods were based on information obtained from articles published in popular media and conversations with recreational anglers. Light to medium action rods with spinning reels were rigged with straight shank circle hooks (2/0) and “knocker” rigs, where the terminal tackle is rigged with the weight directly above the hook, long (< 1 m) fluorocarbon leaders tied to a braided line, and baited with live or freshly dead shrimp (Chapman 2014, Sargeant 2016). For each trip, we recorded the time, date, location, and duration fished at each sampling site as well as habitat characteristics and water quality parameters. Fish length (mm) and catch specific data (e.g., angler ID, bait type, hook size, hooking location, hook removal effort) were recorded for all fish species caught. Directed hook-and-line sampling was conducted across two temperature regimes: during the “cool” season when surface waters were ≤ 24°C (November-April), and “warm” season when Gulf surface waters exceeded 24°C (May-October). Hogfish are more often targeted in the Gulf during the winter months, which also corresponds to peak spawning for hogfish in the study area (Collins and McBride 2015). Sampling effort was stratified across depth zones to assess the incidence of barotrauma in this species and to maximize our ability to evaluate impacts across multiple size classes of hogfish: shallow (≤ 15 m), typically smaller, sub-legal hogfish, versus deep (> 15 m), typically larger, legal hogfish.

In addition to catch-specific data outlined above, landed hogfish were quickly assessed on deck for any visible barotrauma and general condition. Fish that were dead upon capture or unresponsive were not tagged; otherwise, all hogfish were tagged regardless of external effects of barotrauma or hook position to best represent discards in the recreational fleet. All fish that died between landing to shortly after release were brought back to the laboratory for detailed necropsies to assess internal damage. A picture of each acoustic-tagged fish was taken along with the handling time, tag numbers, tagging biologist, and time released. Acoustic transmitter tags were externally attached (Figure 2), as this method has been found to reduce handling trauma and preserve barotrauma symptoms, thus improving estimates of barotrauma-related mortality (Curtis et al. 2015; Dance et al. 2016; Runde and Buckel 2018). Innovasea V9P-2H acoustic tags with a 120s nominal ping rate (80 – 160s randomized delay) and 234 or 288-day battery life were attached to a small Domeier nylon umbrella dart anchor with ~20 mm of 60 lb. braided fishing line that was then shrink wrapped to reduce abrasion. A specialized applicator was used to insert the dart anchor between the pterygiophores of the second to last dorsal spine on the left side of each hogfish so that the acoustic tag was secured externally with minimal movement. A dart tag was also inserted between the pterygiophores of the second and third dorsal spine for additional external identification.

All tagged hogfish were recompressed using a descending device, either a lip grip (e.g., Seaqualizers) or inverted hook (e.g., Roy's Fish Saver), in part to reduce discard mortality (Sauls et al. 2016; Brownscombe et al. 2017; Bohaboy et al. 2019). Although widely accepted as a barotrauma mitigation tool in the Pacific West Coast rockfish fishery (Chen 2012; Bellquist et al. 2019), descending devices are not yet in widespread use among the Gulf recreational sector (Crandall et al. 2018, Crouch et al. 2018; Curtis et al. 2019; Equia et al. 2025). Current management regulations in the Gulf require a venting tool or descending device is onboard and rigged and ready for use when targeting reef fish, but available FDM data from the At-Sea Observer Program suggest that most hogfish are surface released with no barotrauma mitigation (Eguia et al. 2025).

At least one Innovasea VR2Tx acoustic receiver was deployed at each tagging site. Receiver bases were constructed from one of two designs used to anchor receivers in this environment: a concrete base with vertical PVC sleeve, or a steel weight with cable and subsurface buoy. Acoustic receivers were downloaded every six months, and batteries were changed annually. In addition, after successfully tagging and releasing a hogfish, a hydrophone and deck box receiver (Innovasea brand VR100-300) were used to listen for at least 60 minutes at the surface to record initial release behaviors. Detection files were downloaded from receivers using the program VUE (Innovasea, v.2.12.5) and then uploaded to the FACT Network data node. The FACT Network data node, hosted by the Ocean Tracking Network, is a semi-automated data sharing platform that allows acoustic telemetry researchers to share quality-controlled detection data (Young et al. 2020). In addition to matching detections of tags belonging to other researchers, the node also creates detection extract files of target tags that standardize and filter any detections that preceded tagging or were erroneously duplicated during the collection process. After downloading these detection extracts, the detection data was further filtered for any solitary detections within a single hour bin, usually indicative of a "false" detection that can be caused by background noise or tag "collisions" that happen when two tags ping at the same time (Simpfendorfer et al. 2015). Summary statistics were calculated for each tagged fish, including the number of total validated detections, the number of detection days (DD), defined here as the number of days with at least one validated detection for each tagged fish, and the number and identify of all stations where each tagged fish was detected.

Short-term discard mortality was determined by investigating vertical movements of tagged hogfish within the water column for the first 48 hours post-release; previous studies have shown that most discard related mortality occurs within this period (Bugley and Shepard 1991; Matlock et al. 1993; Murphy et al. 1995; Taylor et al. 2001; Overton et al. 2008). Movements within the water column were also used to assess long-term survival at two weeks post-release, and for the disposition of the fish over the entire span of detections. Examining vertical changes in detection data beyond the first two weeks was done to collect information about foraging behaviors, home range size, and intraspecific habitat use patterns. Site fidelity by tagged hogfish to the tag site was determined by calculating a residency index that compared the number of detection days to the total days at large (difference between the tag date and the date of the last detection) with the equation,

$$Residency = \frac{Detection\ days}{Days\ at\ large}$$

Logistic regression was used to examine the influence of fish length, capture depth, and surface temperature on the probability of short term (48h) hogfish mortality. Capture depth and surface temperatures were binned as above and recorded as continuous variables at each tagging event for use in statistical analysis. Additional categorical and continuous variables that were collected during the study, including hook position, barotrauma presence and type, handling time, and dissolved oxygen measured at the capture location, were not included here due to time constraints. The probability of mortality, P(M) was estimated as,

$$P(M) = \frac{e^{\mu}}{(1 + e^{\mu})}$$

where e is the base of natural logarithms and μ is the linear function of the independent variables. All detection filtering and statistical analyses were performed in R version 4.5.0 (R Core Team, 2025).

RESULTS

Between May 2019 and February 2025, we conducted 45 sampling trips to ledge habitats on the West Florida Shelf targeting hogfish. A total of 1,424 individual fishes from 42 species were caught, including multiple managed reef fishes: gray snapper, *Lutjanus griseus,* lane snapper, *L. synagris*, yellowtail snapper, *Ocyurus chrysurus*, red grouper, *Epinephelus morio*, gag *Mycteroperca microlepis*, scamp *M. phenax*, and gray triggerfish. A total of 46 hogfish were landed, ranging in size from 231 to 475 mm fork length (FL; mean ± SE = 325.9 ± 8.7). The legal minimum size to keep a hogfish in the Gulf is 356 mm FL (14”); 31 of the landed hogfish (67.4%) were below the minimum size limit, while 15 landed hogfish (32.6%) were larger than the minimum size limit. Hogfish caught at deep sites (358 ± 12.1 mm FL) were significantly larger than those caught at shallow sites (295 ± 9.2 mm FL; $t_{40} = 3.92$, $p < 0.001$; Table 1). We did not test for hogfish size differences between combined depth / temperature bins due to low sample sizes (n = [8, 12]; Table 1).

Of the 46 total hogfish landed, 38 were tagged with both acoustic and dart tags, four were only tagged with dart tags, and four were determined to be fatally injured during or immediately following the initial post-capture examination. In one such case, a hogfish was determined to be substantially injured but was tagged and recompressed only to float immediately back to the surface where it was recovered and brought back to the lab for necropsy. A second individual was also determined to be substantially injured but was also tagged (dart tag only) and recompressed. This second individual stayed at the bottom for approximately 3 minutes before floating back to the surface; attempts to recover it were not successful. The remaining two hogfish showed abnormally limited activity during the tagging procedure and so were held onboard in a live well until all movement stopped and they were determined to be dead; these two fish were also returned to the laboratory for necropsy. Neither of the detailed necropsies were able to identify any specific indicators of barotrauma related death.

Survival of tagged hogfish was evaluated by examining the variability in detection depth following release. As of July 2025, we have data to estimate 48-hour survival for 42 total hogfish: 36 of 38 acoustic tagged hogfish, the four hogfish that died during or immediately after tagging, and two of the dart tagged hogfish. The acoustic receiver recording detection data for two acoustic tagged hogfish was lost during hurricanes that came across the West Florida Shelf in fall 2024. Based on the available data, 32 of 42 hogfish (76.2%) survived for at least 48-hours after release, equivalent to a post-release discard mortality rate of 23.8%. We observed what we determined to be two predation events within the first 48 hours after tagging; both events were characterized by limited vertical movements initially by the hogfish, followed by a brief period of frenzied activity and then detections from higher in the water column. In one case these mid water-column detections at the tag site lasted less than an hour before resuming at another site multiple kilometers away, matching the expected movement patterns of a highly mobile predator like a shark.

Of the 36 hogfish with acoustic tags that survived tagging and initial recompression, most were detected making vertical movements in the water column within 24 hours after capture. Overall, we observed that tagged hogfish released in good condition rapidly resumed movements along the ledge moving between the sand (deeper) and hardbottom (shallower) and that these movements were detectable by visually examining changes in the vertical location of the fish over time (Figure 3). In contrast, detection data from mortality events or shed tags showed anomalous or restricted vertical movements, such as those caused by tidal flux. Two hogfish were later re-captured but not released, presumably harvested by recreational anglers, within the first two weeks after tagging, and a third hogfish was captured approximately 50 days after tagging. A plot of the vertical position of this fish over time is shown in Figure 3, where it survived the initial capture and tagging event and was then recaptured 50 days later. Detection data following the second capture reflects the approximate change in water column depth caused by tidal flux, which would result from a tag laying on the bottom, however, we cannot conclusively determine if the tag was still attached to a dead fish or if it was removed by the angler and discarded following the second capture event. Nevertheless, this example illustrates how 1) survival can be determined by visually examining depth plots, and 2) that changes in depth data over time can show subsequent capture events.

The available acoustic and dart-tag data also allowed us to calculate delayed release mortality for 36 hogfish that survived the initial catch-tag-recompression event. Two hogfish that were harvested within the first two weeks after tagging were censored from the data for calculating delayed mortality. Of the hogfish that survived 48 hours and were not harvested within two weeks, only one acoustic tagged hogfish exhibited signs of delayed mortality. This fish initially resumed vertical movements quickly after release but gradually decreased its vertical movements before stopping completely on the third day post-release. Across all 40 tagged hogfish with available data, 29 tagged hogfish (72.5%) survived for at least two weeks, equivalent to a 27.5% discard mortality rate.

Survival of tagged hogfish varied across both temperature regimes and depth zones: hogfish survival was highest at shallow sites with cooler surface temperatures (90.9% survived), lowest at deep sites with warmer surface temperatures (63.6%), and intermediate at both shallow sites in warm conditions and deep sites in cool conditions (75%; Table 1). Across depth zones, 84.2% of hogfish released at shallow sites < 15m survived, equal to a 15.8% discard mortality rate, while 69.5% of hogfish released at deep sites > 15m survived, equal to a 30.5% discard mortality rate. Across temperature regimes, 82.6% of hogfish released when surface temperatures were below 24°C survived, equal to a 17.4% discard mortality rate, while 68.4% of hogfish survived when released while surface temperatures were above 24°C, equal to a 18.6% discard mortality rate. In addition to examining post-release survival across different binned depth zones and temperature regimes, we examined survival across continuous depth and temperature, and hogfish size (FL, mm) at capture with logistic regression. Only hogfish size was significantly correlated with short-term mortality (Wald $\chi^2 = 2.083$, $p = 0.037$).

We recorded 1,429,976 total validated detections from the acoustic tagged hogfish, with the average number of detections at 40,856 (range = 59 – 143,250 detections). On average, acoustic tagged hogfish were detected for 136 days (range = 1 – 288 days), with 26 tagged hogfish detected for longer than 2 weeks, 13 tagged hogfish detected for more than 200 days, and 9 tagged hogfish detected for more than 36 weeks or near the maximum expected life of the tags (Figure 4). Movements of hogfish away from the tagging site were generally not observed. In fact, we detected only two instances of a tagged hogfish moving between monitored sites. In one case, described above, we suspect a predation event had occurred based on the observed vertical movement patterns. In the second case, the tagged hogfish was detected at the tag site for five hours, from approximately 10AM to 3PM local time, followed by a 14-hour gap with no detections before detections resumed at an artificial reef located 3.25 km away. Vertical movements of this tag at the artificial reef site matched those of other tagged hogfish, suggesting that this fish survived its move away from the tag site. All other tagged hogfish were detected only at the tag site, and showed very high residency – that is, they were almost constantly detected – at the tag sites. Only hogfish that survived and were detected for more than two weeks were included in the residency calculation; the mean residency of these 26 hogfish was 0.962 ± 0.017, with a range of [0.618, 1].

DISCUSSION

This study provides the first estimates of angling related discard mortality, here measured at 23.8% overall, for hogfish; these estimates are much higher that what was used in previous hogfish stock assessments but are in line with estimates for other reef fish, including species in the snapper–grouper complex (Collins 1991; Bartholomew and Bohnsack 2005; McGovern et al. 2005; Overton et al. 2008; Campbell et al. 2014; Sauls 2014). For example, Collins (1991) reported an overall estimate of 19% discard mortality across 19 reef fish species. A more recent review of red snapper discard mortality studies by Campbell et al. (2014), found that discard mortality ranged widely across a variety of study conditions and contingent on multiple factors including depth of capture, release method, and fishery type. In the present study, temperature, depth, and hogfish size all appear to influence hogfish mortality, but our preliminary analyses only support size as a significant factor. However, we also found that size varied significantly between depth bins which corroborates previous research that found a similar correlation between hogfish size and capture depth (Collins and McBride 2011). We suspect that this correlation, combined with the relatively small sample size of our pilot study, obscures the true relationship between discard mortality and capture depth in the preliminary analyses presented here. Further analysis may help determine the significance of capture depth and other measured factors known to influence discard mortality in other species (e.g., barotrauma type, hook position, etc.) on the discard mortality of hogfish. Based on the discard mortality estimates measured here, along with the observed increase in hook-and-line landings over the past decade, efforts to estimate discard mortality for hogfish are long overdue.

In addition to producing discard mortality estimates, this project successfully showed the applicability of using acoustic telemetry to assess discard mortality for hogfish. We verified that both the chosen tag size and attachment method can be successfully used to examine discard mortality and post-release behaviors for this species. Our results confirm that the external tagging method was successful and that the tags stayed attached long enough to evaluate both short- and long-term survival. The acoustic tags chosen proved detectable within our array design and confirmed that a single receiver per site was sufficient to detect hogfish at a resolution sufficient to determine survival. Most surviving hogfish were almost continuously detected at the tagging site, in some cases for the entire battery life of the tag. We did not explicitly test the detection range of these tags for this project, however a previous range test in this area found 50% detection efficiency exceeded 400m (Ellis et al. 2019). The hardbottom ledges used as tagging sites were generally linear features that varied in length between 100 to 300m. The high residency estimates measured here, with detections over 96% of total days at large, suggest that hogfish have high site fidelity to these features and do not venture far either along or away from ledges. In addition, we observed subsequent catch-and-release events by other anglers that were clearly captured by the detection data (see Fig. 3), as well as predation events signified by an obvious change in swimming speed and distance from the seafloor, both of which further support the efficacy of the tag selection and array design.

Our preliminary work with hogfish has some important caveats, foremost being the fact that all tagged hogfish were released using a descending device to aid in returning the fish to the bottom. When developing this project, we decided to follow the best practices recommended by the Gulf Council to minimize reef fish discard mortality, which is the use of descending devices when releasing all reef fish. Recent FDM data from the recreational for-hire sector, however, suggests that descending devices may be rarely used in practice: from 2021 to 2023 just 10.3% of hogfish caught were recompressed via descending device, while 14.7% were vented and the remaining 74.9% were released without barotrauma mitigation (Eguia et al. 2025). Given these data, we suspect that our estimates of discard mortality may still be underestimating the true value of discard mortality in hook-and-line caught hogfish and thus is worthy of additional study. Although the sample size of this pilot study was relatively small, the resulting discard mortality rate estimate was over twice the estimated rate used in past stock assessments, and further, the data suggest seasonal differences in mortality rates that could be critical for evaluating future management decisions.

Reef fishes support important recreational and commercial fisheries in the Gulf and South Atlantic and are highly valued as food and game fish. Many exploited reef fishes in the southeastern United States are undergoing overfishing, due in part to increasing recreational fishing effort in recent decades (Ault et al. 2022). Many exploited reef fishes are especially susceptible to the effects of overfishing due to unique life-history characteristics such as depth and habitat preferences, longevity, and the tendency to form spawning aggregations (Coleman et al. 1999; Burton et al. 2005). Because of such unique life-history characteristics, including species-specific physiological traits, traditional management practices such as restrictive size and bag limits have proven to be problematic in managing reef fisheries due to the high probability of discard mortality for released individuals (Bartholomew and Bohnsack 2005). Accordingly, overfishing of exploited reef fishes may be manifested in a variety of population-level responses, including declining abundances and reduced sizes (Coleman et al. 1996; Ault et al. 2005; Ault et al. 2022). Beyond estimating survival of released hogfish, acoustic telemetry allows us to collect detailed behavioral data and generate novel insights on hogfish ecology that may ultimately improve hogfish management overall.

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Table 1. Hogfish size, numbers landed, and post-release mortality of hogfish across temperature regimes and depth zones.

Temperature / depth zone	Hogfish size (FL, mm)	Surface temp (mean ± SE)	Depth (mean ± SE)	Total number	Number that died	Percent mortality
Cool / shallow	302 ± 12.2	20.0 ± 0.6	13.2 ± 0.4	11	1	9.1
Cool / deep	357 ± 12.7	20.1 ± 0.3	16.5 ± 0.3	12	3	25.0
Warm / shallow	285 ± 13.0	30.3 ± 0.3	12.2 ± 0.9	8	2	25.0
Warm / deep	359 ± 21.1	27.4 ± 0.5	16.9 ± 0.4	11	4	36.3
Cool combined	331 ± 10.5	20.0 ± 0.3	14.9 ± 0.4	23	4	17.3
Warm combined	328 ± 15.8	28.6 ± 0.4	14.9 ± 0.7	19	6	31.6
Shallow combined	295 ± 9.2	24.4 ± 1.2	11.8 ± 0.3	19	3	15.8
Deep combined	358 ± 12.1	23.6 ± 0.8	16.7 ± 0.4	23	7	30.4
Overall	329 ± 9.2	23.9 ± 0.7	14.9 ± 0.4	42	10	23.8

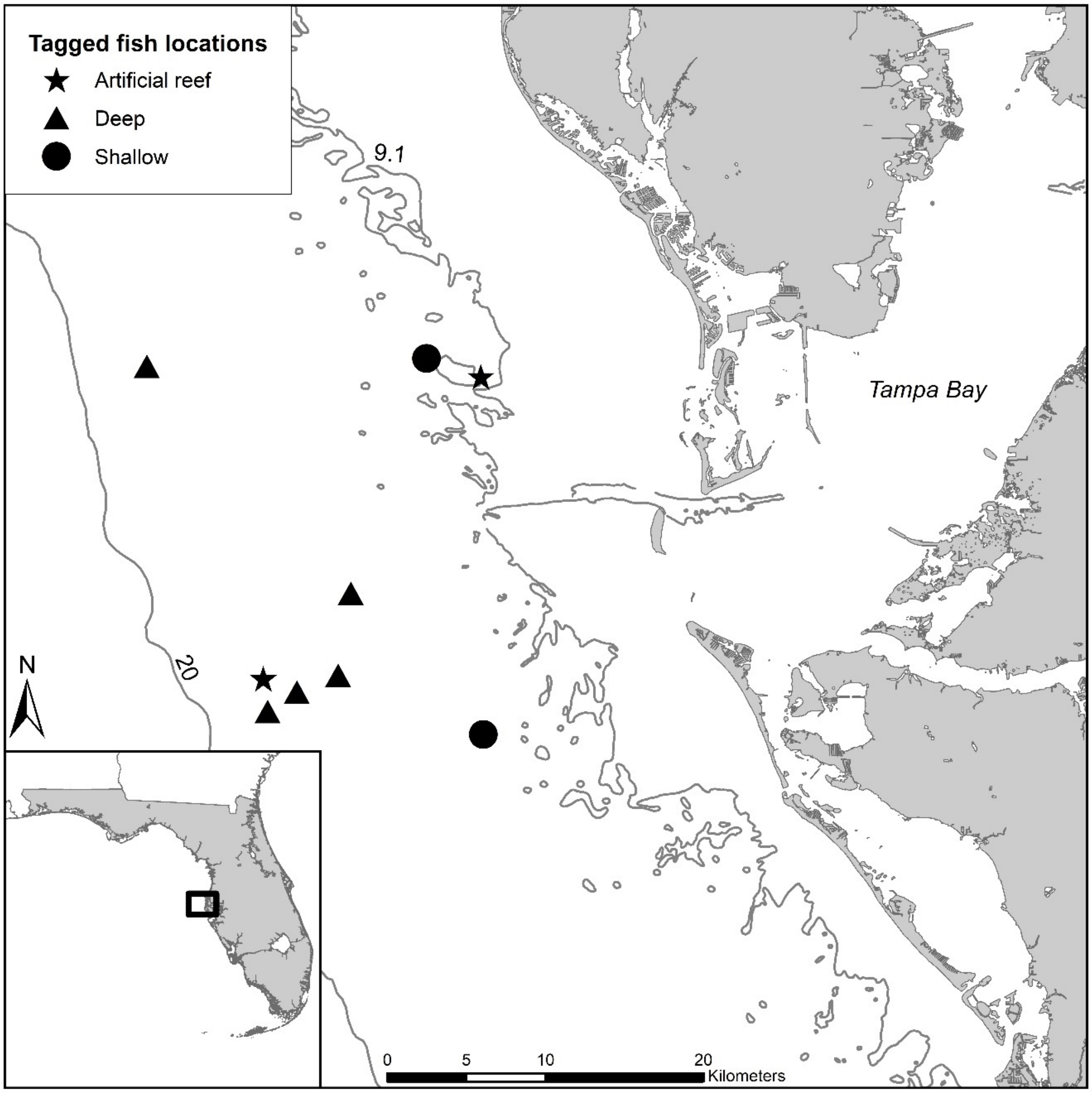

Figure 1. Map of study area on the West Florida Shelf indicating where hogfish were tagged from 2019–2025 at deep (triangles) and shallow (circles) depth bins. The locations of two artificial reefs are also included, one where a presumed predator was detected (southern star) and one where a hogfish was detected moving shortly after being released (northern star).

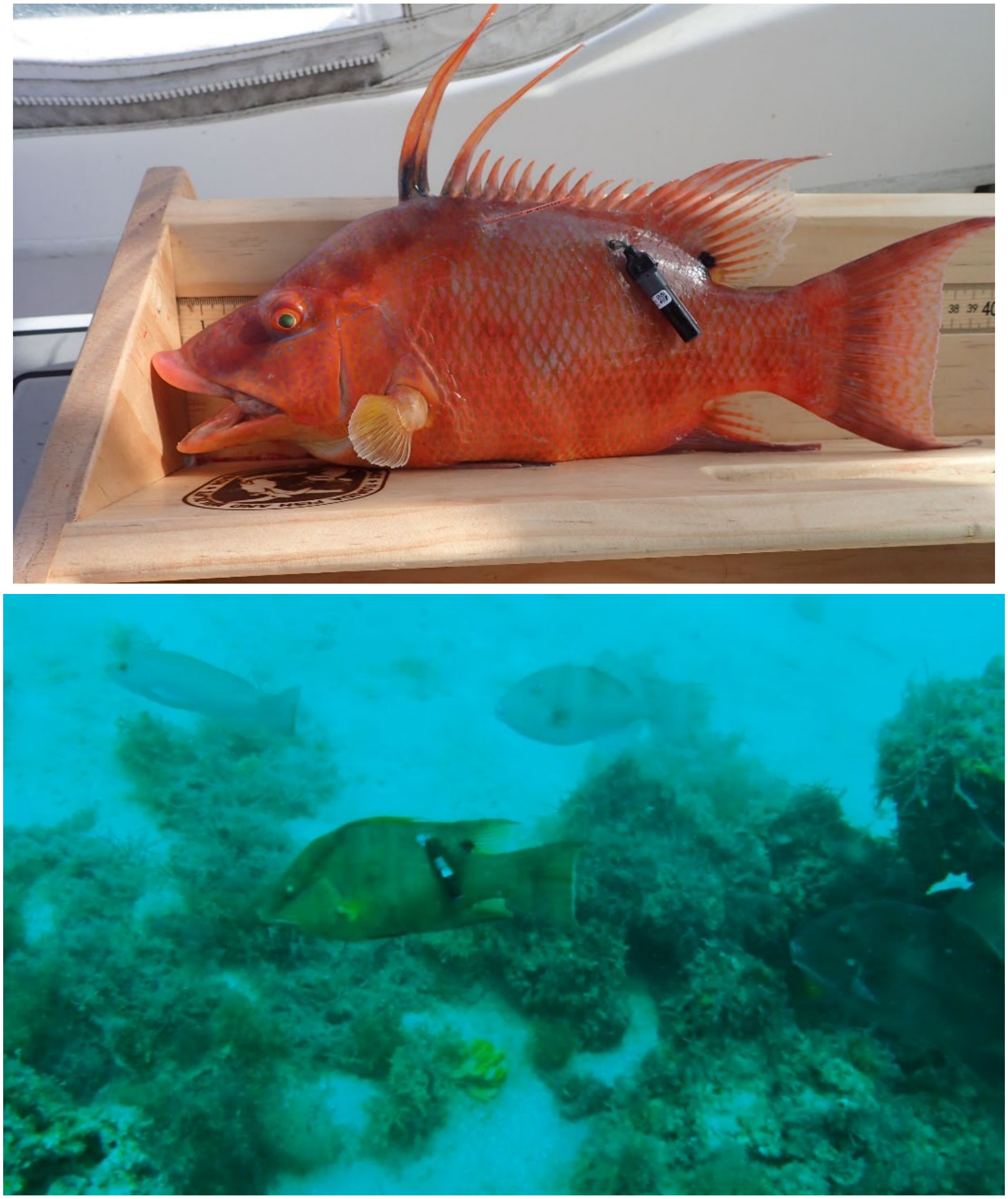

Figure 2. Pictures of hogfish during (top) and after (bottom) the capture-tag-release procedure. The top image shows a hogfish in a tagging cradle with both external tags attached immediately prior to release. The bottom image is a still-frame of a video taken during an acoustic receiver maintenance dive, approximately 19 days after this fish was tagged and released at the site.

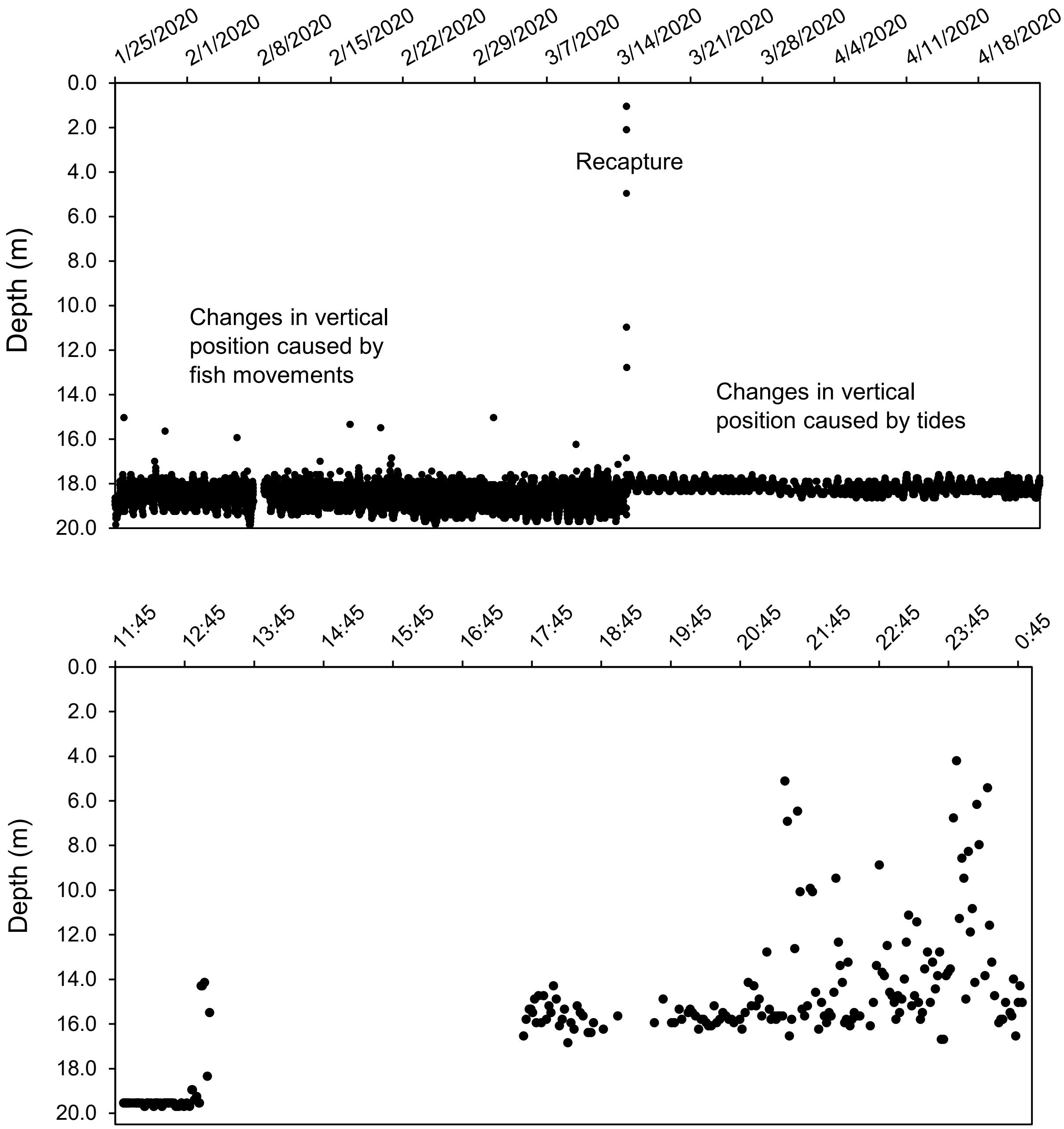

Figure 3. Example detection time series from tagged hogfish. Top panel shows daily vertical movements of the hogfish following its initial capture and tagging on 1/25/2020 and a recapture event on 3/14/2020 followed by more limited vertical movements (tidal signal only). In this case, we suspect the fish was harvested and the tag thrown back but are unable to confirm between a mortality event or a shed tag with the detection data alone. The bottom panel shows a predation event that occurred on 5/22/2019 where the tagged hogfish was not detected off the bottom for approximately one hour before it was detected in the water column; after the gap in detections, the tag was detected at an artificial reef site located approximately three km from the tag site.

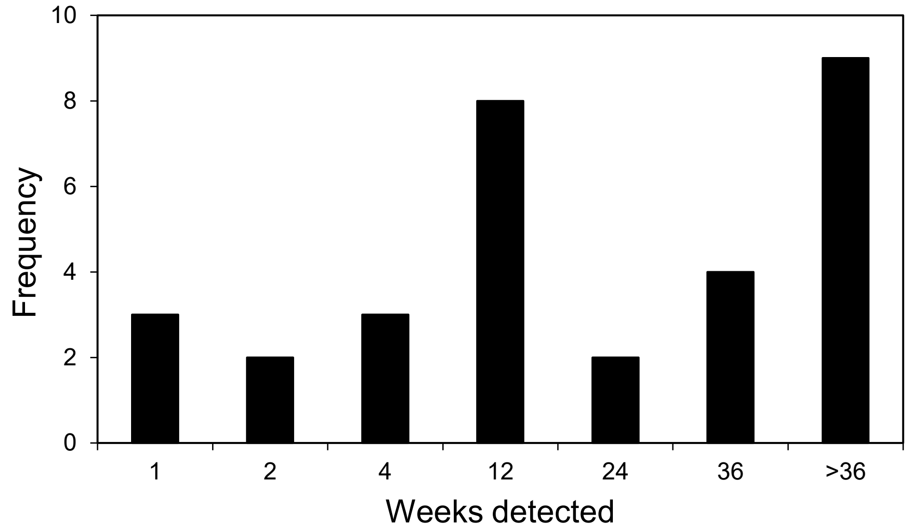

Figure 4. Distribution of detection periods, in weeks, of acoustic tagged hogfish, 2019-2024.