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Migrations and movements of Atlantic Tarpon revealed by two decades of satellite tagging

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Short running title: Migrations and movements of Atlantic Tarpon

Abstract

Understanding large-scale migratory behaviors, local movement patterns, and population connectivity are critical to determining the natural processes and anthropogenic stressors that influence population dynamics, and for developing effective conservation plans. Atlantic tarpon occur over a broad geographic range in the Atlantic Ocean where they support valuable subsistence, commercial and recreational fisheries. From 2001 through 2018 we deployed 292 satellite telemetry tags on Atlantic tarpon in coastal waters off three continents to document: (1) seasonal migrations and regional population connectivity; (2) freshwater and estuarine habitat utilization; (3) spawning locations; and, (4) shark predation across the southeastern United States, Gulf of Mexico, and northern Caribbean Sea. These results showed that some mature tarpon make long seasonal migrations over thousands of kilometers crossing state and national jurisdictional borders. Others showed more local movements and habitat use. The tag data also revealed potential spawning locations consistent with those inferred in other studies from observations of early life stage tarpon leptocephalus larvae. Our analyses indicated that shark predation mortality on released tarpon is higher than previously estimated, especially at ocean passes, river mouths, and inlets to bays. To date there has been no formal stock assessment of Atlantic tarpon, and regional fishery management plans do not exist. Our findings will provide critical input to these important efforts, and assist the multi-national community in the development of a stock-wide management information system to support informed decision-making for sustaining Atlantic tarpon fisheries.

Keywords: population connectivity, shark predation**,** spawning-habitats, sportfish

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APPENDIX Table A1

1. | INTRODUCTION

Atlantic tarpon (*Megalops atlanticus,* Megalopidae) has long been one of the most sought-after inshore marine game fishes with a long history in the US as the focus of an important recreational fishery (Aflalo, 1907; Ault & Luo, 2013; Babcock, 1921; Dimock & Dimock, 1912; Holder, 1903; Pinckney, 1888; Spotte, 2016), including participation by US Presidents, as recorded in many publications (Mares, 1999; Mill, 2010; Stilwell, 2011). The US fishery today has an annual economic impact of more than $6 billion, providing thousands of jobs (Ault, 2008; Steinback et al., 2004). Sport fishing for tarpon is also very popular in other countries, where numerous records have been recorded for large fish caught in Venezuela, Sierra Leone, Guinea-Bissau, Mexico, Brazil, and Cuba (IGFA, 2018). While tarpon fishing in the US is predominately catch-and-release, artisanal subsistence and commercial harvests of tarpon occurs in many countries outside the USA (Adams et al., 2014; Anyanwu & Kusemiju, 2008; Anyanwu et al., 2009).

Despite the history and importance of recreational catch-and-release fishing for tarpon in the USA, the paucity of data and models on population dynamics and migrations limits opportunities for developing an effective regional management plan to sustain this valuable resource (Ault et al., 2008). Atlantic tarpon are now threatened throughout their range by recreational fishing release mortality, directed commercial harvests, intensive harvesting of key prey species, and degradation of habitats for both predator and prey (Ault, 2008; Boesch et al., 1994; Polidoro et al., 2010; Waycott et al., 2009). A recent IUCN assessment classified Atlantic tarpon as *vulnerable* (Adams et al., 2014).

A principal impediment to sustaining highly migratory marine species is the lack of scientific understanding of the locations, attributes, and migratory connectivity of important habitats (Runge et al., 2014; Webster et al., 2002). Without such knowledge, regional management strategies are difficult to conceptualize, develop and implement (Hansson & Akesson, 2014). To improve this understanding, we employed satellite telemetry technologies in an intensive multiyear (2001-2018) study of Atlantic tarpon over three continents with focus on the coastal waters of the southeastern USA, Gulf of Mexico and northern Caribbean Sea. Our specific objectives were to reveal: (1) seasonal migrations and regional population connectivity; (2)

utilization of freshwater and estuarine habitats; (3) potential spawning locations; and, (4) predation mortality by sharks.

2. | MATERIALS AND METHODS

2.1 | Tagging

Electronic satellite telemetry tags from several manufacturers were deployed on Atlantic tarpon from 2001 to 2018 in coastal waters of the western central Atlantic Ocean, Gulf of Mexico (GOM), and Caribbean Sea including the USA (i.e., Florida, Alabama, Mississippi, Louisiana, Texas, North Carolina, South Carolina, and Georgia), Mexico, Belize, Nicaragua, and Trinidad (Table A.1, Fig. 1). The total of 292 deployed tags included: 199 Pop-up Archival Transmitting (PAT) and 88 Smart Position and Temperature (SPOT) tags from Wildlife Computers, Inc. (wildlifecomputers.com; Redmond, Washington); 1 PAT tag from Lotek Wireless, Inc. (lotek.com; Ontario, Canada); and 4 PAT tags from Microwave Telemetry, Inc. (microwavetelemetry.com; Columbia, Maryland). Each tag bore a fixed label containing our international toll-free phone number, email address, and a request for return of the tag.

Tarpon were captured with standard hook-and-line gears on chartered recreational fishing vessels, using the heaviest tackle feasible to minimize fight time. During the tagging process, tarpon at boat side were kept completely in the water to prevent injury by either: (1) guiding the fish into a specially designed sling; or, (2) using a lock-jaw gaff and tailer. Once secure, fork length (FL) and girth (G) were measured in cm. Body weight (kg) was computed with the algorithm of Ault and Luo (2013). Satellite tags were secured to tarpon via a tether (a 30 cm stainless steel wire encased in a medical grade Tygon tube) that was attached to a titanium anchor dart (**Fig. 1**). Anchor darts were coated with an antibiotic cream. Two scales were removed from anterior of the first dorsal fin about one third of the distance to the head. The dart was then inserted approximately 8 cm deep at a 45^{o} angle towards the head into the tissue where the scales had been removed.

PAT tags deployed on tarpon were pre-programmed to collect high-resolution data at either 1, 10 or 30 sec intervals. Environmental variables collected were: water depth (via pressure); ambient water temperature; light level (for determining location of the tagged fish); salinity (estimated from the wet/dry sensor (Luo & Ault, 2012)); and clock time, for deployment periods that ranged from 4 to 8 months. Tags were also pre-programmed to release from the fish at specified dates and times. Upon release, tags floated to the ocean surface where they transmitted their stored summary data to the orbiting Argos satellite network, which were transmitted to us. Tag contact transmission time with orbiting satellites was restricted by the tag's limited battery capacity and the quantity of data that could actually be transmitted at any one time. This limitation was particularly evident with large datasets from tags that recorded at short intervals for long monitoring periods. To contend with this problem, transmitted data were averaged and summarized at 3-hour intervals into 14 user-defined temperature (from 20 to 32 at 1 ^{o}C interval) and depth (from 0 to 50 at 5 m interval, then 50-75, 75-100, and >100 m) bins. This provided a constrained representation of the animal's actual activities, and minimized the potential loss of temporal blocks of data when transmission events failed or were otherwise corrupted.

We were able to physically recover some tags by either traveling to pop-up locations with a handheld Argos receiver that aided in finding tags, or through recovered tags returned to us by citizen scientists, enabling us to obtain the entire dataset. SPOT tags did not archive data, but rather transmitted radio signals to the satellite network when a fish surfaced, exposing the wet-dry sensor to air. The Argos System (www.argos-system.org) determined their geolocations by Doppler-shift calculations when two or more messages were received during a limited time window of satellites passing overhead.

2.2 | Data analyses

For PAT tags, light-level geolocation data were processed using WC-DAP and WC-GPE2 software (Wildlife Computers, Redmond, WA, USA), and a sea surface temperature corrected Kalman filter (KF-SST; (Lam et al., 2008; Nielsen et al., 2006). A custom bathymetry filter was then applied to relocate any points that were on land or in shallow water, based on 2 x 2 minute gridded ETOPO2 bathymetry data (Anon., 2006) and the daily maximum depth recorded by the tag. For points where maximum daily depth exceeded the bathymetric depth, all grid cells were selected along the longitude where bathymetric depth was greater than the daily maximum depth within ±1 degree of latitude of the previous day's location. A final location was then assigned to a single cell selected randomly from that group (Hoolihan & Luo, 2007).

Tag sea surface temperature (SST) and ocean heat content (OHC) were estimated based on 3-hour binning of summarized profiles of depth and temperature (PDT), and depth and temperature histograms of all PAT tags. Daily multi-scale ultra-high resolution (MUR, 0.01^{o}) SST data were used to calculate mean SST of April and November, 2008 (http://mur.jpl.nasa.gov) to demonstrate the position of thermal contours during periods of known seasonal migrations.

KF-SST tracks were further refined with the fine-scale geolocation method of Luo et al. (2015) which incorporated OHC estimated from Hybrid Coordinate Ocean Model (HYCOM) and a genetic algorithm (GA-OHC). The concept of the OHC method, originally developed for use in hurricane intensity forecasts, integrates the thermal energy from the depths associated with the 26 °C isotherm (D26) to the ocean surface following the equation of Palmen (1948)

$$OHC = c_p\rho\int_{D26}^{0}\left(T_z \quad 26^o\right)dz \qquad (1)$$

where, c_p is the specific heat constant of water, ρ is sea water density, and T_z is water temperature at depth *z* (Luo et al., 2015). In fisheries applications, the 26 °C isotherm can be modified to any water temperature range, specifically by the lower bound of an animal's thermal range, such as the 20 °C isotherm that we used in this study for tarpon since 99% of temperatures recorded by the tags were above this isotherm (Luo & Ault, 2012).

To improve location accuracy of SPOT tags, all Doppler-derived data were processed with the Argos system's Kalman filtering (KF) method. Argos provided the following radius of error for each KF-derived location class (LC): LC 3, < 250 m; LC 2, <500 m; and, LC 1, < 1000 m. Argos states that the median error for LC classes 0, A and B ranges from 1 to 3 km (Bernard & Belbeoch, 2010). Class Z indicates that the location process failed and estimates of position are highly inaccurate. All transmitted locations were filtered to remove positions with LC Z, those on land, and those exceeding a speed of 2 m/s following Weng et al. (2005).

To make SPOT location data compatible with the GA-OHC refined PAT location data, and to further meet the requirements for kernel density metric estimates (De Solla et al., 1999; Kie, 2013; Worton, 1989), the irregular sampling intervals of SPOT-derived raw data were standardized to a 3-hour interval. We employed the piecewise Bézier interpolation method of Tremblay et al. (2006), but modified with the Lars Jenson algorithm (http://ljensen.com/bezier/) to eliminate unnatural loops in the tracks. To minimize uncertainty, we did not interpolate track sections with temporal data gaps that exceeded three days following Weng et al. (2008).

We employed utilization distributions (UD) to quantify the core regions of occupancy within an animal's home range or activity space (Worton, 1995). UD were calculated for all tarpon using 12-hour interval (mid-night and noon) location data as the grouped species' habitat utilization for dry (Jan-Apr) and wet (May-Dec) seasons (Domeier & Nasby-Lucas, 2008; Hammerschlag, Luo, et al., 2012; Weng et al., 2008). To avoid possible biases from short tracks, we excluded tarpon that were tracked for < 10 days (Hoolihan, Luo, Abascal, et al., 2011). To mitigate individual tarpon from biasing the results, we created a 0.5° x 0.5° spatial grid and counted the total number of 12-hour locations from all tarpon within each cell for each season, and then multiplied that value by the number of unique tarpon within the cell. The resulting grid was used as a weighting factor where the UD were weighted more heavily towards areas that were frequented by many individuals. To achieve the final UD for each season, we set all portions that overlapped land to 0 and normalized all values so that the summation of all cells equaled 1 (Vaudo et al., 2017).

UD values are cumulated from the highest to lowest density areas to create kernel density contours. Thus, the 25% contours represent areas of the top 25% highest densities, 50% contours represent areas of the top 50% highest densities, etc. We defined the core habitat utilization area (CHUA) as the areas of top 50% UD (da Anadón et al., 2011; Graham et al., 2016). These metrics were calculated according to the equations provided by Worton (1995) and plotted using Interactive Data Languages (IDL, www.harris.com) software.

Rate of movement (ROM) was calculated at 12-hour intervals to determine whether a tarpon was migrating, or simply at residence. To estimate the residence period of each tarpon track where days at liberty > 10 days we examined three ROM criteria (ROM < 5, 7, 10 km d^{-1}) for > 3 consecutive days. To examine variability of migratory behavior among individual tarpon, the proportion of time in residence was calculated as the residence period divided by total days at liberty. Distance from the tagging location was estimated using great-circle distance for each 12-hour location and these were plotted as a function of days at liberty.

Shark predation on tarpon was determined by two methods: (1) from tooth marks observed on recovered PAT and SPOT tags; and, (2) from data recorded by recovered PAT tags that showed reduced light levels with fluctuations of depth and temperature, similar to the environment inside of sharks (Cosgrove et al., 2015; Kerstetter et al., 2004). Data from recovered PAT tags were also used to determine possible spawning activity based on deep dive behaviors around new and full moon periods.

Tarpon estuarine and riverine habitat utilization were determined for both SPOT tags and recovered PAT tags with archived wet/dry data and track duration > 10 days. For SPOT tags, this was done by counting the period when the locations occurred in inland waters. For PAT tags where the geolocation method was limited to ocean waters, salinity was estimated from wet/dry sensor data using the Luo et al (2008) algorithm. We defined "rivers" as inland waters that included lagoons, rivers, and lakes where salinity values were < 25 PSU. The proportion of time in inland waters was calculated as the number of days in rivers divided by the number of days at liberty. This proportion was then compared by tag types, regions and seasons using t-tests carried out with R statistical software.

3. | RESULTS

3.1 | Tag deployments

Detailed information on the 292 satellite tags (204 PAT and 88 SPOT) deployed from 2001 to 2018 on tarpon are presented in **Table A1**; tagging efforts varied annually (**Fig. 2a**). The body weight of tarpon tagged ranged from 14.9 kg to 99 kg, with a mode of 50 kg (**Fig. 2b**), with the majority (96.5%) ≥ 30 kg. Of the 204 total PAT tags deployed, 19% (39) did not transmit any data to the Argos System (black bar in first column of **Fig 2c**), while 23 PAT and 33 SPOT tags remained on fish for ≤ 10 days. These relatively short tag deployments generally resulted from either tether failure, post-release mortality from failed resuscitation after tagging, or predation by sharks. There were 68 PAT and 28 SPOT tags that remained on tarpon between 10 and 50 days due to pin breaks for PAT tags, or fishing line entanglements for SPOT tags, and 73 PAT and 27 SPOT remained on tarpon over 50 days. Tag deployments and pop-off (or final for SPOT) locations are summarized by regions in **Table 1** and **Figures 1** and **2d**. Geographically, most of our tagging efforts (93 PAT, 51 SPOT tags) occurred in waters around Florida, USA, mostly in the Florida Keys and Florida Bay (38 PAT, 9 SPOT), followed by Texas, USA (29 PAT, 14 SPOT), and Mexico (31 PAT).

3.2 | Seasonal migrations and distribution

We were able to generate 154 (83 PAT, 71 SPOT) tarpon tracks from the 292 deployed tags. Of those, 29 (19%) tarpon travelled ≥ 600 km during their deployment periods, 81 (52%) tarpon travelled from 100-600 km, and 44 (29%) tarpon travelled < 100 km **(Table 2**). The distance travelled from tagging location as a function of days at liberty **(Fig. 3**) indicated different modes of movement (i.e., residence and migration). ROM were generated from 140 (78 PAT, 62 SPOT) tarpon tracks that were >10 days. Distribution of tagged tarpon as function of percent of time tarpon spent at residence and ROM criteria are summarized in **Table 3**, which indicates most tarpon spent <50% time as residence for all ROM criteria tested. In addition, most residence locations (red dots) were near river mouths (**Fig. 4**). Examples of individual tarpon tracks can be found in supplemental materials.

The monthly frequency distribution of 3-hour mean temperatures from all PAT tags (**Fig. 5a**) indicated that from November to April Atlantic tarpon spent most of their time in waters where temperatures were between 20 and 26 ^{o}C, and from May to October above 26 ^{o}C. April and November are transition periods with temperatures centered around 26 ^{o}C, which has been reported by tarpon anglers as preferred migratory temperature (Babcock, 1951; Spotte, 2016; White & Brennan, 2010). The mean monthly temperature ranged from 22.5 ^{o}C in December-January, to 29.5 ^{o}C in August (solid line **Fig. 5a**). The overall minimum was 14.9 ^{o}C, and maximum temperature was 35 ^{o}C. However, in December and January, tarpon spent 29% and 36% of their respective time at temperatures ranging from 16-20 ^{o}C (**Fig. 5a**).

In April, as the water temperatures warm to 26 ^{o}C, tarpon aggregate annually in Florida Bay and the Florida Keys (Luo, 2009; Mill, 2010). The spatial map of mean SST in April 2008, indicated that 26 ^{o}C waters were south of Veracruz, Mexico in the western GOM, and around the Florida Keys and south Florida in the eastern GOM (**Fig. 5b**). Typically, as the 26 ^{o}C isotherm moved north along the US southeastern and GOM coasts, tarpon followed. In the fall, as the 26 ^{o}C isotherm moved south (**Fig. 5c**), tarpon did the same.

Two tags (T118 and T187) deployed on tarpon in Florida popped up near Newfoundland (**Fig 6**). It is not known if these reflect tarpon movements or post-detachment tag drifting. Based on reports in the literature (Banon, 2019; Twomey & Byrne, 1985), such movements would not be unprecedented (**Fig. 6**).

Core habitat utilization area (CHUA) is represented by the top 50% of kernel density area. During the dry season on the eastern US coast, CHUAs were all located from south of Fort Lauderdale to the Florida Keys/Everglades (**Fig. 7a**), with some minor low kernel density areas north of Fort Lauderdale up to Cape Canaveral, FL. The CHUA distribution is a reflection of the SST distribution during this period (**Fig. 7a** inset). During the wet season, as the water temperatures warm (**Fig 7b** inset), tarpon habitats expanded northward to the Chesapeake Bay with a small portion of the CHUAs extending to South Carolina. The majority of CHUAs remained in the area from the Florida Keys to south of Cape Canaveral (**Fig. 7b**).

Similar seasonal habitat utilization patterns occurred in the GOM. During the dry season, in the eastern GOM most of the CHUAs are located in Florida Keys and western Everglades. For tarpon tagged in the western GOM, all the CHUAs were located south of the US border with Mexico (**Fig. 8a**), reflected by the winter SST distribution **(Fig. 8b)**. During the wet season in east GOM, CHUAs expanded north to the area between Boca Grande and Apalachicola, and west to the mouth of Mississippi River (**Fig. 8c**), when the SST was > 26 ^{o}C for the entire GOM (**Fig 8c** insert). Similarly, in west GOM, the majority of CHUAs expanded to US waters extending from Port Isabel to Galveston, TX during the wet season. Only small portions of CHUAs are in Mexican waters (**Fig. 8d**). In the north, CHUAs extended to the mouth of the Mississippi River, where they overlapped with CHUAs of tarpon tagged in the eastern GOM (**Fig. 8c**).

3.3 | Estuarine and riverine utilization

Majority of tagged tarpon (51.1% PAT, 59.6% SPOT) used estuarine and riverine habitat (**Table 4**). The mean proportion of time for SPOT tags (0.5407) was significantly higher than that for PAT tags (0.3979) at α=0.05 (**Table 4**), which suggests that SPOT wags were better at discerning river use compared to PAT tags salinity based method. For geographic comparison, we grouped the tags into four regions (**Table 4**), and analysis of variance indicated no significant difference of the mean proportion of time tarpon utilized rivers between any of the regions. For seasonal comparison, the mean proportion of time tarpon in rivers was significantly greater in the dry season than the wet season (**Table 4**). Examples of the detailed individual tarpon utilizing estuarine habitat can be found in supplemental materials.

3.4 | Spawning habitats

Possible spawning activity during the known tarpon spawning season (April-July) was inferred from deep diving behavior identified from individual depth data around new and full moon periods for 6 of 90 recovered PAT tags (**Fig. 9**). We compared the dates of these dives with migration track locations of each individual to determine presumed spawning sites (**Fig. 10**). Interestingly, most sites were clustered in two locations: (1) northeast of Veracruz, Mexico (western Gulf of Mexico); and (2) south of Florida Keys on the deep coral reef track proximal to the Straits of Florida. Additionally, we had one PAT pop-off and two SPOT tagged tarpon in an area about 200 km west of Boca Grande, Florida in the GOM (**Fig. 10**), which has been suggested as a spawning site based on the presence of early life stage leptocephali larvae of the Atlantic tarpon (Crabtree, 1995; Crabtree et al., 1992; Smith, 1980). Tarpon started the deep diving at dusk and the activity continued until 4 am (**Fig. 11**). In addition, the temperature range from surface to 90 m depth was within 1 degree Celsius (26.5-27.5 ^{o}C). The presumed spawning sites described here are all continental slope habitats with depths ranging from 100 to 200 m. The salinities at these sites were around 36 PSU. The surface temperatures were 26 ± 2 ^{o}C with a mixed layer extending from 50 to 100 m.

3.5 | Predation by sharks

Shark predation was evident on 25 of the 90 recovered PAT tags (27.8%), and 8 of the 29 recovered SPOT tags (27.6%). Seventeen of the 25 PAT tags were ingested by sharks evidenced by reduced light level values (**Figs. 12a-b**), and these tags were transported inside of the shark for periods ranging from 2 to 27 d (mean=8.06, sd=6.6 d) after which they were regurgitated. The other incidents of predation were based on observed tooth marks left on recovered PAT and SPOT tags (**Figs. 12c-d**). It is well known that sharks regurgitate indigestible items by eversion of the stomach (Brunnschweiler et al., 2005). Eight PAT tags that were dislodged from tarpon prematurely had teeth marks indicating shark attacks. Most (>90%) shark attacks on tarpon occurred within three hours post-release. However, one tarpon was attacked by a shark 44 d after the deployment (**Fig. 12e**).

4. | DISCUSSION

4.1 | Tag deployments

We deployed 292 tags from 2001-2018 averaging 30 tags yr^{-1}, spanning 3 continents, 6 countries, and 8 US states, the largest tagging effort for tarpon since the inception of satellite telemetry technology (Block et al., 1998; Block et al., 2016; Block et al., 2011; Lutcavage et al., 1999; Rooker et al., 2019; Wilson et al., 2015). The size distribution of tagged tarpon reflected our objective of tagging sexually mature tarpon (>35 kg, (Crabtree et al., 1997)) which are believed capable of taking long seasonal migrations (Crabtree et al., 1992). The amount of time that tags stayed on fish can be used as an index of tagging success. Causes of tagging failure included equipment malfunctions (i.e., defective battery, pin or rigging, etc.), human error (inexperienced tagger), and post-release mortality. Hoolihan, Luo, Abascal, et al. (2011) showed behavioral modifications from satellite tagging of large pelagic fishes. We believe that tagging may have had similar effects on Atlantic tarpon, possibly making tagged fish more susceptible to predation.

4.2 | Seasonal migrations and distributions

Previously, Atlantic tarpon seasonal migrations were largely unknown or inferred from their seasonal distributions. In the central western Atlantic, tarpon commonly range from Virginia to Florida, Bermuda, Gulf of Mexico, the Caribbean Sea to Brazil (Wade, 1962), and infrequently from Nova Scotia to Argentina. Holder (1903) had speculated on tarpon migrations, believing they moved from Mexico to Texas and then to Louisiana in the western GOM. In the eastern GOM, he postulated movements from Key West up the Florida Keys, and then bifurcating to both west and east coasts of Florida. His early speculations were relatively consistent with our findings. In fall, we found that tarpon from east of the Mississippi River migrated southeastward to Florida, and tarpon from west of the Mississippi River migrated southwestward to Mexico. Based on our data, we have not yet seen a tarpon from east of the Mississippi River migrate west of Louisiana, or vice versa.

In contrast to the 29 long-distance migrators, many of the tarpon in this study traveled moderate to relatively short distances. Termed "partial migration", intra-specific variation in migration behavior has been observed in many fishes (Chapman, Skov, et al., 2012; Hansson & Akesson, 2014). Partial migration results from individual differences in behavior, i.e., a kind of animal personality (Nilsson et al., 2014). Partial migrations have been observed for many satellite tagged species, for example: yellowfin tuna (*Thunnus albacares*, Scombridae (Hoolihan et al., 2014)); bluefin tuna (*Thunnus thynnus*, Scombridae (Block et al., 2005; Cermeño et al., 2015; Wilson et al., 2005); sailfish (*Istiophorus platypterus*, Istiophoridae (Hoolihan, Luo, Goodyear, et al., 2011)); blue marlin (*Makaira nigricans*, Istiophoridae (Goodyear et al., 2008)); white marlin (*Kajikia albida*, Istiophoridae (Hoolihan et al., 2015)); swordfish (*Xiphias gladius*, Xiphiidae (Dewar et al., 2011)); tiger shark (*Galeocerdo cuvier*, Carcharhinidae (Hammerschlag, Gallagher, et al., 2012)); and, acoustically tracked common snook (*Centropomus undecimalis*, Centropomidae (Trotter et al., 2012)). Partial migration is one of the major factors that could potentially account for spatial and temporal variations in population abundance, and hence, is a powerful force shaping ecosystem dynamics and trophic effects (Chapman et al., 2011; Chapman, Hulthén, et al., 2012). Partial migration may confer some evolutionary benefits to species because it provides a natural buffer against extinction, given that multiple contingents of individuals within the same population simultaneously use a range of different habitats and resources. Tarpon, in the evolutionary record for >100 million years (Carroll, 1988; Jordan, 1919; Nature, 1971; Sepkoski, 2002), may have benefited from many advantageous aspects of partial migration.

Utilization distribution (UD) estimates summarized the seasonality of tarpon regional distributions, indicating that in the wet season the range of tarpon distribution is twice as large as that in the dry season. In the western GOM during the dry season, the distribution is almost exclusively south of the USA-Mexico border, while along the eastern GOM and USA southeastern coasts, their distribution was almost exclusively restricted to southern Florida. Our migration tracks and UD maps clearly showed that tarpon migrated beyond state borders along the USA east coast from Virginia to Florida, and along coast of USA GOM from Florida to Texas, and to Mexico. Genetic studies are consistent with our research and have shown no genetic differences among locations in the central western Atlantic and east Atlantic (Ault & Luo, 2013; Ward et al., 2004; Ward et al., 2008; Ward et al., 2005).

4.3 | Estuarine and riverine utilization

Juvenile and adult life stages of tarpon inhabit estuarine bays and freshwater rivers (Ault, 2008; Babcock, 1921; Dimock & Dimock, 1912; Goode, 1887; Pinckney, 1888). Tarpon are found in freshwater Lake Nicaragua that sits some 195 km from its connection to the ocean via Rio San Juan (Gill & Bransford, 1877; Koenig et al., 1976; Simmons, 1900). Local Nicaraguans believe that tarpon in the Lake are a resident population, living and breeding in the Lake. However, our 3 PAT tags deployed in the Rio San Juan, about 30 km east of Lake Nicaragua and 145 km west of the Caribbean Sea, all popped off in the Caribbean Sea.

Despite the well-documented presence of mature adult tarpon in freshwaters (Babcock, 1921; Dimock & Dimock, 1912; Koenig et al., 1976), much of the scientific literature describes adult tarpon habitat as mainly shallow coastal waters, bays and estuaries, with only an occasional reference to freshwaters (Moyle & Cech, 1988; Robins & Ray, 1986). A recent study based on elements and isotopic ratios in tarpon scales (Seeley & Walther, 2018) showed that tarpon spent on average $42 \pm 34\%$ of life histories within oligohaline habitats, while another study using tarpon eye lens showed 100% juvenile habitat in upper estuarine habitat (Kurth et al., 2019). Our study reinforced this concept by showing that some adult tarpon used freshwaters extensively (supplemental materials), while others rarely traveled to freshwater. This individual variation is similar to the concept of partial seasonal migration previously discussed. Matich et al. (2017) showed that food availability might govern tarpon distribution in the Shark River estuary, Everglades National Park. Gillworms have been found on both Indo-Pacific and Atlantic tarpon (Bunkley-Williams & Williams, 1994; Hutton & Sogandares-Bernal, 1960; Mendoza-Franco et al., 2004; Williams & Jones, 1994), and rapid movements between freshwaters and ocean environments may reduce the infections of pathogens (Westerdahl et al., 2014). Babcock (1951) stated that tarpon might use the freshwater habitat to get rid of remoras and sea-lice (*Nerocila acuminate*, Cymothoidae) since the remoras and sea-lice cannot survive the freshwater.

4.4 | Spawning habitats

To date, no one has directly observed tarpon spawning, other than some *ad hoc* observations of presumed pre-spawning activities (Baldwin & Snodgrass, 2008; Crabtree et al., 1992), and *post hoc* predictions of spawning sites from the capture of leptocephalus larvae (Crabtree, 1995; Crabtree et al., 1992; Crabtree et al., 1997; Smith, 1980). In the early 20th century, Babcock (1921) suggested that tarpon spawned in freshwater rivers, based on his observations of juvenile tarpon captured in those habitats. Subsequently as larval samples were collected in ocean environments it was determined that tarpon spawned in offshore waters (Babcock, 1951; Wade, 1962). Smith (1980) and Crabtree et al. (1992) found young leptocephali offshore, further suggesting offshore spawning. Locations identified as spawning areas from our study (**Fig. 10**) matched spawning areas previously identified in the western GOM ((Smith, 1980) and in the eastern GOM and Straits of Florida (Crabtree, 1995; Crabtree et al., 1992). Our observations of purported spawning dives occurring within a few days of new and full moons matched estimates of spawning near full and new moons by Crabtree et al (1997). Based on our tagging results and the occurrences of tarpon leptocephalus larvae, we think that tarpon spawning could occur around continental slope areas where depths range from 100 to 200 m, temperatures are near 26 $\pm$ 2 ^{o}C, and salinity is around 36 PSU during spawning season, within 24 hours of travel distance from inshore coastal habitats.

Our observations of deep diving behavior corresponded with seasonality of tarpon spawning (April – July in Florida; Crabtree et al. 1997), and with the likelihood of spawning in deep water based on egg characteristics (Babcock 1921b). The deep diving behaviors we observed were from May to June (**Fig. 9**), well within the reported tarpon spawning season. Thus, we are very confident these observed deep diving behaviors were related to spawning activity. Many studies have shown spawning behavior of numerous fishes involves a rapid ascent from the substrate toward the surface using the change of hydrostatic pressure to force the release of gametes (Domeier & Colin, 1997; Graham & Castellanos, 2005; Whaylen et al., 2004). Similar rapid oscillatory dive patterns have also been observed for satellite tagged bluefin tuna in the GOM and Mediterranean Sea, and these were considered to be spawning behaviors (Aranda et al., 2013; Cermeño et al., 2015; Teo et al., 2007). A related species, bonefish (*Albula vulpes*, Albulidae), also spawns offshore at night near full moons and descends to ~60m to spawn (Danylchuk et al., 2019).

4.5 | Predation by sharks

Shark predation on tarpon has been well documented by anglers and in the scientific literature (Ault, 2010; Ault et al., 2008; Churchill, 1907; Dimock & Dimock, 1912; Guindon, 2011; Hammerschlag, Luo, et al., 2012; Tuma, 1976). Holder (1913) recorded his tarpon fishing results in Aransas Pass, Texas, during June 1909, and reported 26.3% of hooked tarpon mortality was due to shark predation.

Guindon (2011), using acoustic tags, estimated a 13% rate for tarpon catch-and-release mortality, due to a variety of reasons. Of those total mortalities, 8.3% were due to shark predation. Our study using recovered PAT and SPOT tags indicated a much higher shark predation mortality: 27.8% and 27.6%, respectively. The fact that two different tag types produced nearly identical results gives us confidence that our mortality estimates are accurate. We believe that Guindon (2011) may have underestimated catch-and-release mortality due to two key criteria used: (1) lack of acoustic tag movement; and, (2) a relatively short time window (6 hr) of observation to make this determination. Using Guindon's (2011) criteria on our data, the 17 PATs inside shark stomachs would have been considered alive, when in fact they were dead and consumed by the predator. Only the 8 dislodged PAT tags of the 25 recovered, using Guindon's criteria, would have been considered dead resulting in an 8.9% mortality estimate (8 out of 90). This is very close to Guindon's estimate of 8.3%. Our study showed that sharks preyed upon tarpon after 6 hours and up to 44 days after release. However, this post-release mortality by sharks may not apply to tarpon released without a satellite tag. The electrical field from the tag may attract unwanted attention from sharks, as their sensory systems are capable of detecting weak electrical fields (Adair et al., 1998; Kalmijn, 1971, 1982). Another tagging study (Kerstetter et al., 2004) showed increased shark predation on satellite tagged billfish. In addition, the tagging process added handling time as compared to normal catch-and-release, thus may further weaken the tarpon when released. Since most of the shark predation in our study occurred near passes and areas known with high shark density (Hammerschlag, Luo, et al., 2012), this mortality estimate might not apply more broadly.

5 | IMPLICATIONS FOR FISHERY MANAGEMENT

Improved understanding of tarpon movement ecology has significant resource management implications for fisheries and coastal habitats. Our results suggest a single, interconnected tarpon "unit stock" that from a fishery perspective—a closed population comprised of the full life cycle of spawning adults, eggs, larvae, and juveniles—may, at a minimum, stretch from the US Atlantic coast throughout the Gulf of Mexico.

Overfishing and habitat loss are two obvious threats to sustainability of the US Atlantic-Gulf of Mexico tarpon stock (Adams et al., 2014; Ault et al., 2008; Spotte, 2016; Stilwell, 2011). Tarpon are fished throughout this geographical region, and are targeted by both recreational and commercial fisheries at different locations. In general, the United States has only recreational fisheries for tarpon (primarily catch and release), while commercial, subsistence and recreational fisheries occur elsewhere. (Ault et al., 2008; Ault & Luo, 2013; Browder et al., 1981; Dailey & Landry, 2008; Spotte, 2016).

Both harvest and catch-and-release fisheries incur some level of fishing mortality. Our tagging studies showed that the survival rate of released tarpon is substantially lower than 100% due to a variety of factors, of which predation by sharks may also be a significant unintended fishing mortality factor associated with a thriving recreational fishery. Thus, for the sake of tarpon conservation and fishery sustainability, we highly recommend stopping tarpon fishing in areas where shark attacks on tarpon occur, and moving the angling effort to alternative fishing sites.

Substantial loss of tarpon habitat, particularly mangrove wetlands, has undoubtedly occurred along the southeastern US and Gulf of Mexico coastlines over the past 50 or more years due to coastal development (Valiela et al., 2001). Loss of tarpon habitat is perhaps a more insidious threat to sustainability than fishing mortality. Adverse effects of overfishing on the reproductive capacity of the tarpon stock can be alleviated by relaxing fishing pressure. In contrast, loss of habitat area is irreversible and potentially limits overall stock carrying capacity, and thus, maximum tarpon stock abundance. The impact of habitat loss may be especially damaging to tarpon because of their use of coastal and riverine waters in all life stages. It is well known that juvenile tarpon inhabit freshwater tributaries (Ault, 2008; Babcock, 1921; Dimock & Dimock, 1912; Goode, 1887; Pinckney, 1888). Our study has shown that at times adult tarpon also inhabit small freshwater creeks (see supplemental materials).

This study has shown that tarpon can travel long distances and cross international borders; thus, in the long term, any local depletion in the tarpon stock, via fishing mortality or habitat loss, will likely affect the tarpon population as a whole in the Atlantic Ocean. This spatially expansive view of the US Atlantic-Gulf of Mexico tarpon stock suggests that achieving long-term sustainability will require a high degree of coordination among scientists and managers from numerous Atlantic and Gulf coast states as well as Mexico. The most pressing need in the short term is to gather synoptic data to develop a stock-wide shared information system to support informed management decision-making focusing on three general areas: (i) fishery science and biological data for determining stock sustainability status; (ii) ecological and mapping data for determining the location and amount of viable tarpon habitat; and (iii) resource economics data for determining the monetary value of the tarpon stock.

Controlling tarpon fishing mortality through coordinated management is at least conceivable, and has precedent with intergovernmental management organizations for highly migratory tunas and billfishes in the Atlantic and Pacific Oceans (e.g., Inter-American Tropical Tuna Commission, International Commission for the Conservation of Atlantic Tunas, International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean). Atlantic tarpon should be considered a highly migratory species managed federally and internationally like bluefin tuna and billfishes. With sufficient scientific information, sustainable levels of fishing effort could be determined and allocated among individual states and Mexico. In contrast, interstate and international management of tarpon coastal habitats is almost inconceivable at present. It is difficult to imagine, for example, a water management or urban development project in sensitive tarpon habitat in one state being blocked by another state, let alone another country. However, with sufficient ecological and resource economic information, the potential economic losses to the entire tarpon fishery resulting from coastal development projects could be quantified and the risks weighed against the economic benefits. Framing the tradeoffs in economic terms may at least give the fish a fighting chance.

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Data Availability Statement and Disclaimer

Tarpon migration and movement tracks are available on request to the corresponding author. The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect those of NOAA or the Department of Commerce.

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Table 1. Summary of tag deployment region and pop-off or end locations. The abbreviation for each region is given in parentheses in the first column; the number of tags in pop-off or end regions are given in parentheses. A zero region indicates the number of tags that did not report. The Florida Bay (FB) region included waters in Florida Bay and around the Florida Keys from Key Largo to Key West. The Everglades (EG) region included waters of Everglades National Park, and the nearshore GOM. The Boca Grande-Tampa (BT) region included waters in the estuaries and nearshore GOM from Naples to Tampa, FL. The Miami (MI) region included waters from Biscayne Bay to Ft. Lauderdale. The St. Lucie-Augustine (SL) region extended from St. Lucie to St. Augustine, FL. The regions of countries and other US states are defined by their names.

Region Deployed	PAT	SPOT	Total	Pop-off or End Region
Florida Bay (FB), FL	38	9	47	0(7), FB(22), EG(4), SL(10), GA(1), SC(1), NC(1), VA(1)
Everglades (EG), FL	9	8	17	0(3),EG(10), FB(1), BT(2), NC(1)
Boca Grande-Tampa (BT), FL	34	10	44	0(10), BT(24), EG(1), FB(8), LA(1)
Apalachicola (AP), FL	6	28	34	0(1), AP(10), AL (4), LA(12), BT (4), FB(3)
Miami (MI), FL	6	6	12	0(2), MI(7), SL(2), GA(1)
St. Lucie_Augustine (SL), FL	11	0	11	0(1), SL(8), FB(2)
Texas (TX)	29	14	43	0(6), TX(28), MX(9)
Louisiana (LA)	3	1	4	LA(3), FB(1)

Alabama (AL)	1	0	1	FB(1)
Georgia (GA)	1	0	1	SL(1)
South Carolina (SC)	5	2	7	SC(5), MI(2)
North Carolina (NC)	1	0	1	NC(1)
Mexico (MX)	31	0	31	0(8), MX(9), TX(10), LA(4)
Belize (BZ)	10	4	14	BZ(14)
Nicaragua (NI)	3	0	3	Caribbean Sea (3)
Trinidad (TR)	14	4	18	TR (17), St Kitts & Nevis (1)
Angola, Africa (AN)	4	0	4	AN(4)
TOTALS	**206**	**86**	**292**	

Table 2. Number of tags at maximum distance (km) from tagging location in different regions.

	Maximum Distance (km)			Total
	<100	100-600	>600	Tags
Mexico	0	4	10	14
Texas	5	12	3	20
NE GOM	10	15	4	29
SE GOM	18	30	7	55
Atlantic US	5	10	2	17
Other Countries	6	10	3	19
All regions	44	81	29	154

Table 3. Distribution of tagged tarpon as function of residence time and rates of movement (ROM) over 3 consecutive days. Zero percent of time as residence (0%) indicates a tarpon's ROM was greater than the speed limits for the entire duration of the deployment; 100% means a tarpon's ROM was less than the speed limits for the entire duration of the deployment; 1-49% and 50-99% mean percent of time when ROM was greater than the speed limits.

speed limit in 3 days	Percent of time as residence 0%	1-49%	50-99%	100%
	Number of tagged tarpon			
<5 km/day	30	88	17	5
<7 km/day	20	88	26	6
<10 km/day	12	87	33	8

Table 4. Comparison of tarpon estuarine and riverine utilization by tag types, tagging regions, and seasons, showing the number (and percentage) of tagged tarpon that used rivers, the mean number of days spent in rivers, and the mean proportion of time spent in rivers; SD is standard deviation. The proportion of time in rivers is the total number of days spent in rivers divided by the days at liberty. Student-t tests were performed on the mean proportion of time in rivers for SPOT vs PAT, Atlantic US vs SE GOM, and Dry vs Wet.

	Used Rivers	Number of Days in Rivers		Proportion of Time in Rivers			
Comparison	N (%)	Mean	SD	Mean	SD	t	P
Tag type						2.0615	0.044*
SPOT	31(59.6)	35.97	34.75	0.5407	0.2868		
PAT	23(51.1)	32.33	31.17	0.3979	0.2221		
Region							
Atlantic US	15(79.4)	27.53	22.96	0.4245	0.2589	1.3943	0.1731
SE GOM	21(56.8)	39.43	33.83	0.5481	0.2744		
NE GOM	14(56.0)	28.29	32.00	0.4362	0.2589		
West GOM	4(25.0)	62.25	56.06	0.5434	0.2469		
Season						3.186	0.0047***
Dry	12(60.0)	47.00	42.97	0.6711	0.2298		
Wet	42(54.5)	31.48	29.34	0.4252	0.2555		

Figure Legends

Figure 1. Bathymetric map of the western central Atlantic, Gulf of Mexico, and Caribbean Sea overlain with satellite tag deployment (red dots) and pop-off detachment locations (white crosses). Depths from 0 to 6000 m are denoted by the color bar. The photo inset shows PAT tag setup and anchor dart placement location on tarpon.

Figure 2. Numbers of satellite telemetry tags (PAT, dark bars; SPOT, open bars) deployed on Atlantic tarpon dependent on: (a) year; (b) tarpon weight; (c) days at liberty; and, (d) geographic location. The black bar in panel (c) shows the number of deployed tags that never reported to us via the Argos System.

Figure 3. Distance from tarpon satellite tagging location as a function of days at liberty: (a) western GOM; tarpon tagged in Mexico (black line) and Texas (blue line); (b) eastern GOM; tarpon tagged in northeast GOM (black line) and southeast GOM (blue line); (c) US east coast and elsewhere; tarpon tagged in US east coast (black line) and other countries (blue line). The red dots in all panels indicate residence time with the rate of movement criteria < 5 km d^{-1} for 3 consecutive days.

Figure 4. Composite of all 12-hour locations overlain on bathymetry and rivers. Orange dots indicate locations in dry season (Jan-Apr) for all regions; green + symbols indicate locations in wet season for tarpon tagged west of the Mississippi River; blue + symbols indicate locations in wet season for tarpon tagged east of Mississippi River. The red dots indicate residence locations with the rate of movement criteria < 5 km d^{-1} for 3 consecutive days.

Figure 5. (a) Three-hour mean sea surface temperatures (SST) recorded by all PAT tags (dots), associated monthly frequency distribution (red histogram bars), and monthly mean SST (solid line). Monthly sample sizes are shown. Mean SST maps for: (b) April 2008; and, (c) November 2008. Color scale bar indicates SST values from 14 to 30 ^{o}C. The 26-27 ^{o}C isotherm is the yellow portion of the spectrum.

Figure 6. HCYOM derived SST on August 20, 2010, for the north Atlantic Ocean overlain with historic tarpon capture locations (solid white dots) (Banon, 2019), a PAT tag pop-off location (T118, pink dot), and a SPOT tag location (T187, gray dot). There were 11 tarpon captured in Long Island pound nets in the summer of 1981, one tarpon in Cork, Ireland, on October 28, 1981, 7 tarpon in Bay of Biscay from 1981-2003, and 4 tarpon in Azores from 1973 to 2011.

Figure 7. Seasonal tarpon habitat utilization maps as represented by kernel density contours calculated from locations of all tags from Florida Keys to Maryland: (a) January to April (Dry season) with inset of HYCOM SST on February 15; and, (b) May to December (Wet season) with inset of HYCOM SST on August 15. Colored contours indicate cumulative kernel density values from high density to low density (i.e., 50% indicates the highest 50% of all kernel density values which denotes core habitat utilization areas, CHUA).

Figure 8. Seasonal tarpon habitat utilization maps as represented by kernel density contours calculated from locations of all tags in the Gulf of Mexico: (a) January to April (Dry season); (b) HYCOM SST on February 15, 2008; (c) East GOM from May to December (Wet season) with inset of HYCOM SST on August 15, 2008; and, (d) West GOM from May to December.

Figure 9. Depth and temperature profiles from six recovered PAT tags showing deep diving (presumed spawning) behaviors of Atlantic tarpon: (a) T-30, (b) T-43, and (c) T-69 were tagged in Veracruz, Mexico on May 11, 2004, May 28, 2006, and May 29, 2007, respectively; and, (d) T-53, (e) T-60, and (f) T-106 were tagged in Florida Bay, Florida on June 11, 2007, April 29, 2007, and May 4, 2008, respectively. The scale bar at the bottom represents the temperatures from 16 to 30 (^{o}C). The arrows in each panel indicate dates of new and full moons.

Figure 10. Bathymetric map of GOM and Florida Straits overlaid with locations where deep diving behaviors were recorded by the recovered PAT tags (solid red dots) from Fig. 9, and offshore movement locations reported from SPOT tags (open green triangles). The solid yellow line ellipses are predicted spawning areas based on the tagging data, and the dashed yellow line ellipses are other potential spawning habitat locations. The solid pink dots are presumed

spawning locations from Smith (1980), the pink rectangular boxes are spawning areas noted by Crabtree (1995).

Figure 11. A close up of the deep dive from T-60 (**Fig. 9e**) from 16:00 on May 14 to 04:00 on May 15, 2007 showing depth (a), light level (b), and temperature (c). The arrow in panel (b) indicates the time of sunset.

Figure 12. Light level (a) and depth (b) data recorded by PAT tag (T-117) deployed on a tarpon between September 8 and 16th, 2007, indicating predation occurred about 2 hours after deployment. Examples of recovered PAT (c) and SPOT (d) tags that bore tell-tale teeth marks of shark predation. (e) Light level data recorded by PAT tag (T-234) indicated predation occurred 44 days after deployment.

APPENDIX

Table A1. Date and location of the start and end of each PAT and SPOT tag deployment on Atlantic Tarpon (*Megalops atlanticus*). PAT tags are indicated by the expected pop-off date and SPOT tags are indicated by SPOT5 in the same column. Reporting date and location refers to the point at which a PAT tag transmitted its first location, or the last location of SPOT tag transmission while still attached to the fish.

Tag Count	Tag Name	Tagging Date	Release Location	Fish Wt(kg)	Release Lat-Lon Lat(dd)	Lon(dd)	Expected Pop-off date	Reporting Date	Reporting Lat-Lon Lat(dd)	Lon(dd)	Tag Recover	Days at Liberty	Distance (km)	Speed (km/day)
1	T-01	09/06/01	Hilton Head, SC	38.6	32.331	-80.749	01/03/02	01/03/02	28.006	-80.174	NO	119	484.6	4.07
2	T-02	09/03/01	Oriental, NC	45.5	35.049	-76.533	03/04/02	03/04/02	35.001	-76.551	NO	182	5.6	0.03
3	T-03	09/21/01	Savannah, GA	36.4	31.702	-81.080	11/04/01	11/04/01	27.800	-80.500	YES	44	438	9.95
4	T-04	09/28/01	Stuart, FL	34.1	27.001	-80.140	02/15/02	not heard	no loc		NO		0	
5	T-05	05/18/02	Islamorada, FL	40.9	24.842	-80.771	08/05/02	08/05/02	28.180	-80.630	YES	79	371.9	4.71
6	T-06	05/28/02	Long Key, FL	34.1	24.798	-80.868	12/02/02	not heard	no loc		YES		0	
7	T-07	05/28/02	Long Key, FL	34.1	24.798	-80.868	10/24/02	not heard	no loc		NO		0	
8	T-08	06/13/02	Boca Grande, FL	61.4	26.699	-82.258	12/15/02	not heard	no loc		NO		0	
9	T-09	06/25/02	Tampa Bay, FL	79.5	27.607	-82.765	12/15/02	not heard	no loc		NO		0	
10	T-11	06/27/02	Tampa Bay, FL	40.9	27.605	-82.764	06/15/03	not heard	no loc		NO		0	
11	T-12	06/06/03	Boca Grande, FL	36.4	26.699	-82.270	09/01/03	not heard	no loc		NO		0	
12	T-13	06/07/03	Boca Grande, FL	45.5	26.699	-82.270	10/01/03	07/01/03	26.529	-82.270	YES	24	18.9	0.79
13	T-14	09/04/03	Venice, LA	38.6	28.962	-89.200	11/10/03	09/22/03	28.720	-90.840	NO	18	162.2	9.01
14	T-15	05/11/04	Veracruz, Mexico	90.0	19.366	-96.274	07/14/04	06/08/04	21.350	-96.617	YES	28	223.7	7.99
15	T-16	05/10/04	Veracruz, Mexico	90.0	19.341	-96.287	08/11/04	08/11/04	29.087	-92.246	NO	93	1159.6	12.47
16	T-17	05/10/04	Veracruz, Mexico	85.0	19.377	-96.289	07/21/04	07/10/04	19.375	-96.289	NO	61	0.2	0.00
17	T-18	06/12/03	Veracruz, Mexico	65.9	19.320	-96.271	08/15/03	07/09/03	26.789	-96.873	NO	27	833.7	30.88

18	T-19	06/15/03	Veracruz, Mexico	61.4	19.318	-96.256	12/15/03	not heard	no loc		NO		0	
19	T-20	05/10/04	Veracruz, Mexico	78.0	19.377	-96.289	07/28/04	not heard	no loc		NO		0	
20	T-21	05/28/05	Veracruz, Mexico	75.6	19.328	-96.294	07/15/05	not heard	no loc		NO		0	
21	T-22	05/29/05	Veracruz, Mexico	60.5	19.360	-96.290	07/31/05	07/08/05	29.303	-94.818	NO	40	1116.8	27.92
22	T-23	05/29/05	Veracruz, Mexico	84.4	19.360	-96.290	08/15/05	not heard	no loc		NO		0	
23	T-24	05/10/04	Veracruz, Mexico	55.0	19.377	-96.289	09/08/04	09/08/04	28.092	-96.788	YES	121	971.5	8.03
24	T-25	05/10/04	Veracruz, Mexico	78.0	19.377	-96.289	08/18/04	not heard	no loc		NO		0	
25	T-26	09/04/03	Venice, LA	34.1	28.960	-89.204	11/10/03	11/10/03	28.991	-88.939	NO	67	26	0.39
26	T-27	09/04/03	Venice, LA	27.3	28.945	-89.200	02/10/04	02/10/04	24.698	-81.996	NO	159	857.4	5.39
27	T-28	05/29/05	Veracruz, Mexico	84.6	19.360	-96.290	08/31/05	07/07/05	21.693	-97.463	NO	39	287.1	7.36
28	T-30	05/11/04	Veracruz, Mexico	80.0	19.366	-96.274	09/01/04	06/06/04	26.255	-97.291	YES	26	773.9	29.77
29	T-31	05/10/06	Ocean Reef, FL	31.8	25.333	-80.267	10/30/06	06/05/06	24.839	-80.802	NO	26	77	2.96
30	T-32	05/28/05	Veracruz, Mexico	77.4	19.323	-96.277	09/15/05	09/07/05	28.931	-91.014	NO	102	1195.3	11.72
31	T-33	05/29/05	Veracruz, Mexico	49.7	19.360	-96.290	09/30/05	08/28/05	29.196	-92.733	NO	91	1152.7	12.67
32	T-34	05/30/07	Veracruz, Mexico	50.0	19.360	-96.290	06/30/07	no heard	no loc		NO		0	
33	T-35	05/15/06	Bahia Honda, FL	37.4	24.658	-81.263	10/01/06	05/20/06	24.392	-81.370	NO	5	31.5	6.30
34	T-36	05/15/06	Bahia Honda, FL	20.9	24.658	-81.263	10/01/06	06/07/06	24.864	-80.504	NO	23	80.1	3.48
35	T-37	08/05/06	Galveston, Texas	44.0	29.176	-94.913	12/25/06	10/12/06	28.122	-96.781	NO	68	216.9	3.19
36	T-38	06/01/06	Key Largo, FL	44.0	25.276	-80.290	10/04/06	07/01/06	29.020	-80.911	NO	30	421.3	14.04
37	T-39	05/27/06	Veracruz, Mexico	84.9	19.347	-96.291	10/20/06	not heard	no loc		NO		0	
38	T-40	08/05/06	Galveston, Texas	50.3	29.176	-94.913	01/08/07	08/13/06	28.225	-96.634	NO	8	198.6	24.83
39	T-41	05/28/06	Veracruz, Mexico	40.8	19.371	-96.295	11/03/06	not heard	no loc		NO		0	
40	T-42	05/28/06	Veracruz, Mexico	62.7	19.344	-96.296	11/10/06	11/11/06	27.502	-97.265	YES	167	913.5	5.47
41	T-43	05/28/06	Veracruz, Mexico	77.5	19.370	-96.294	11/06/06	11/11/06	27.352	-97.322	YES	167	894.7	5.36
42	T-44	05/28/06	Veracruz, Mexico	57.7	19.369	-96.295	11/15/06	09/09/06	29.666	-93.500	YES	104	1180.6	11.35
43	T-45	08/15/06	Trinidad, BWI	36.4	10.686	-61.714	04/02/07	09/26/06	13.316	-63.271	NO	42	338.3	8.05
44	T-46	08/15/06	Trinidad, BWI	55.4	10.678	-61.721	02/05/07	09/18/06	12.696	-63.529	NO	34	298.8	8.79
45	T-47	08/16/06	Trinidad, BWI	41.4	10.689	-61.711	05/02/07	not heard	no loc		NO		0	
46	T-48	09/10/06	Port O'Connor, TX	54.7	28.406	-96.395	01/08/07	11/30/06	28.404	-96.411	YES	81	1.6	0.02
47	T-49	09/30/06	Coatzacoalcos, Mexico	43.8	18.187	-94.436	01/22/07	11/26/06	18.194	-94.206	NO	57	24.3	0.43
48	T-50	09/30/06	Coatzacoalcos, Mexico	42.7	18.187	-94.431	02/12/07	11/22/06	18.016	-94.548	NO	53	22.7	0.43
49	T-51	09/30/06	Coatzacoalcos, Mexico	44.5	18.182	-94.436	02/26/07	11/21/06	21.676	-97.464	NO	52	501.7	9.65
50	T-52	10/16/06	Jensen Beach, FL	64.2	27.165	-80.174	01/29/07	10/22/06	27.227	-80.297	YES	6	14	2.33
51	T-53	06/11/07	Florida Bay, FL	47.3	24.841	-80.749	07/15/07	07/15/07	25.953	-80.125	YES	34	138.8	4.08
52	T-54	10/16/06	Jensen Beach, FL	51.8	27.196	-80.208	03/12/07	11/20/06	27.466	-80.303	YES	35	31.5	0.90
53	T-55	05/13/07	Florida Bay, FL	70.8	24.837	-80.751	06/16/07	05/29/07	27.177	-80.157	YES	16	267.2	16.70
54	T-56	05/21/07	Florida Bay, FL	48.2	24.843	-80.753	07/01/07	07/01/07	28.373	-80.581	YES	41	393.3	9.59
55	T-57	05/14/07	Florida Bay, FL	44.1	24.858	-80.746	07/01/07	07/01/07	24.788	-81.449	YES	48	71.5	1.49
56	T-58	05/13/07	Florida Bay, FL	43.5	24.852	-80.753	06/15/07	05/26/07	24.709	-81.109	YES	13	39.3	3.02
57	T-59	05/14/07	Florida Bay, FL	53.2	24.852	-80.753	07/16/07	07/16/07	24.736	-80.988	YES	63	27	0.43
58	T-60	04/29/07	Florida Bay, FL	57.6	24.837	-80.751	07/02/07	07/02/07	25.387	-81.178	YES	64	74.8	1.17
59	T-61	04/29/07	Florida Bay, FL	34.6	24.837	-80.751	07/03/07	05/28/07	28.448	-80.535	YES	29	402.6	13.88
60	T-62	06/11/07	Bahia Honda, FL	30.5	24.652	-81.290	07/31/07	07/05/07	27.990	-80.019	NO	24	392.6	16.36
61	T-63	04/29/07	Florida Bay, FL	55.1	24.841	-80.749	07/03/07	not heard	no loc		NO		0	
62	T-64	07/24/07	Hutchinson Island, FL	40.9	27.205	-80.166	09/10/07	09/10/07	30.224	-81.414	NO	48	357.5	7.45
63	T-65	07/23/07	St Lucie, FL	46.2	27.169	-80.180	09/10/07	09/10/07	27.244	-80.225	YES	49	9.5	0.19
64	T-66	05/21/07	Florida Bay, FL	43.5	24.844	-80.771	08/29/07	07/11/07	25.698	-81.181	YES	51	103.6	2.03

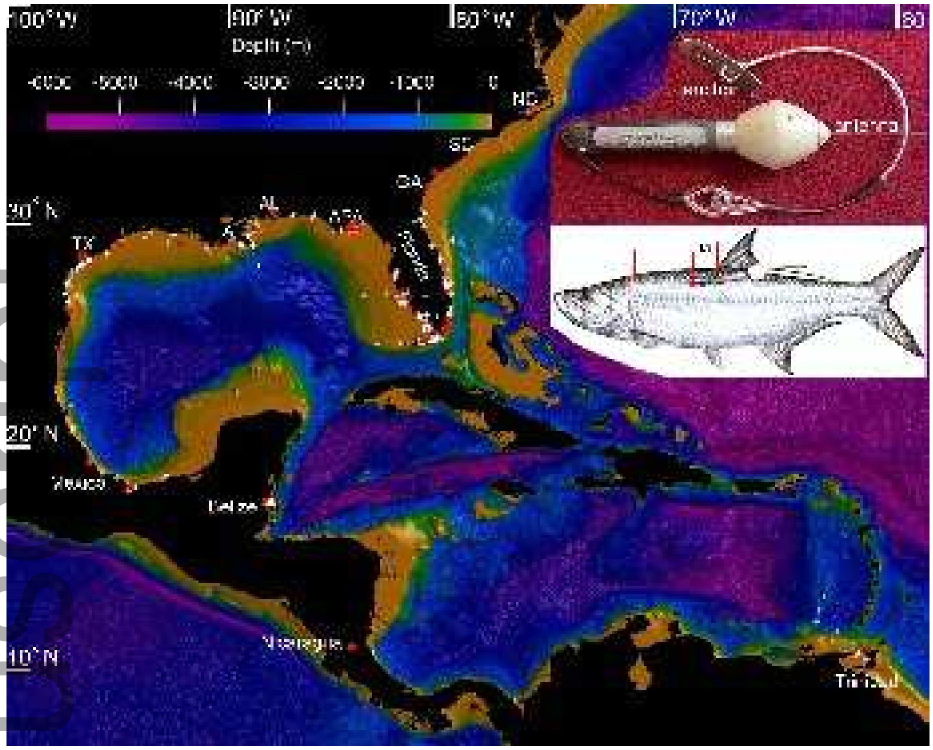
65	T-67	05/30/07	Veracruz, Mexico	55.7	19.370	-96.288	09/05/07	09/05/07	28.898	-89.372	NO	98	1271.5	12.97
66	T-68	05/12/07	Florida Bay, FL	22.9	24.844	-80.771	09/13/07	09/13/07	24.749	-80.980	YES	124	23.6	0.19
67	T-69	05/30/07	Veracruz, Mexico	76.3	19.378	-96.283	09/05/07	09/05/07	28.414	-90.151	YES	98	1183.2	12.07
68	T-70	05/30/07	Veracruz, Mexico	50.2	19.368	-96.292	09/05/07	09/05/07	18.551	-91.779	NO	98	483.7	4.94
69	T-71	05/30/07	Veracruz, Mexico	40.8	19.375	-96.296	09/05/07	08/27/07	29.552	-94.375	NO	89	1149.4	12.91
70	T-72	05/30/07	Veracruz, Mexico	46.8	19.378	-96.283	09/05/07	09/05/07	18.702	-92.855	NO	98	368.5	3.76
71	T-73	08/04/07	Galveston, TX	49.6	29.091	-95.014	11/26/07	08/21/07	29.017	-95.223	YES	17	21.9	1.29
72	T-74	08/04/07	Galveston, TX	51.2	29.097	-94.988	11/26/07	08/17/07	29.716	-93.562	YES	13	154.5	11.88
73	T-75	08/04/07	Galveston, TX	51.3	29.096	-94.993	12/06/07	10/08/07	28.419	-96.343	YES	65	151.8	2.34
74	T-76	09/05/07	Mobile Bay, AL	40.9	30.565	-87.982	01/10/08	12/03/07	25.385	-81.036	YES	89	893.4	10.04
75	T-77	08/15/07	Trinidad, BWI	44.0	10.681	-61.705	12/15/07	11/05/07	11.352	-62.261	NO	82	96.3	1.17
76	T-78	10/20/07	Port Isabel, TX	52.0	26.067	-97.145	02/20/08	11/01/07	24.459	-97.492	NO	12	182.4	15.20
77	T-79	09/08/07	Port O'Connor, TX	32.4	28.568	-96.628	01/15/08	09/17/07	28.158	-96.730	YES	9	46.7	5.19
78	T-80	09/08/07	Port O'Connor, TX	44.5	28.571	-96.626	01/15/08	09/16/07	27.563	-97.406	YES	8	135.9	16.99
79	T-81	05/27/09	Bahia Honda, FL	48.5	24.656	-81.289	08/25/09	not heard	no loc		NO		0	
80	T-82	09/08/07	Port O'Connor, TX	48.5	28.335	-96.384	01/30/08	01/28/08	20.631	-97.092	NO	142	860.6	6.06
81	T-83	08/15/07	Trinidad, BWI	37.4	10.697	-61.759	02/11/08	11/06/07	16.998	-62.294	NO	83	740	8.92
82	T-84	08/14/07	Trinidad, BWI	47.3	10.697	-61.759	02/04/08	08/29/07	11.763	-62.711	NO	15	157.8	10.52
83	T-85	10/11/07	Naples, FL	56.7	25.897	-81.638	02/05/08	10/23/07	25.951	-81.510	YES	12	14.2	1.18
84	T-86	09/08/07	Port O'Connor, TX	50.3	28.587	-96.596	01/15/08	01/15/08	20.888	-97.064	NO	129	858.4	6.65
85	T-87	01/22/09	San Juan, Nicaragua	47.4	11.038	-84.474	07/20/09	05/18/09	9.922	-82.549	NO	116	244.6	2.11
86	T-88	01/23/09	San Juan, Nicaragua	66.0	11.031	-84.463	07/20/09	03/02/09	10.780	-83.583	NO	38	100.2	2.64
87	T-89	09/06/08	Port O'Connor, TX	33.1	28.293	-96.478	03/01/09	09/26/08	27.835	-97.067	NO	20	77.1	3.86
88	T-90	09/08/07	Port O'Connor, TX	43.5	28.559	-96.607	03/15/08	09/12/07	28.106	-96.801	YES	4	53.9	13.48
89	T-91	01/20/09	San Juan, Nicaragua	60.3	11.041	-84.476	07/20/09	02/24/09	10.811	-83.586	NO	35	100.6	2.87
90	T-92	06/16/08	Boca Grande, FL	52.0	26.712	-82.263	11/15/08	06/30/08	26.776	-82.531	YES	14	27.6	1.97
91	T-94	02/23/08	Angola, West Africa	79.3	-9.383	13.125	05/26/08	04/17/08	-9.356	13.152	NO	54	2086	38.63
92	T-96	01/19/08	South Beach, FL	39.3	25.897	-80.119	03/02/08	not heard	no loc		NO		0	
93	T-97	02/24/08	Angola, West Africa	77.4	-9.383	13.125	05/26/08	03/28/08	-9.024	12.502	NO	33	79.3	2.40
94	T-98	05/04/08	Florida Bay, FL	58.3	24.853	-80.750	09/10/08	05/10/08	24.800	-80.650	NO	6	30	5.00
95	T-99	05/25/08	Veracruz, Mexico	63.6	19.370	-96.288	09/25/08	09/11/08	29.406	-93.779	NO	109	1145.7	10.51
96	T-100	06/09/08	Boca Grande, FL	61.6	26.712	-82.263	09/25/08	07/01/08	26.760	-82.259	YES	22	5.4	0.25
97	T-101	06/09/08	Boca Grande, FL	57.6	26.712	-82.263	09/25/08	07/01/08	26.760	-82.259	YES	22	5.4	0.25
98	T-102	06/09/08	Boca Grande, FL	70.7	26.712	-82.263	09/25/08	06/30/08	26.712	-82.263	YES	21	0	0.00
99	T-103	05/05/08	Florida Bay, FL	32.3	24.853	-80.750	09/15/08	09/16/08	30.500	-81.230	YES	134	630.4	4.70
100	T-104	05/05/08	Florida Bay, FL	37.9	24.853	-80.750	09/15/08	07/13/08	25.857	-81.512	YES	69	135.5	1.96
101	T-105	05/04/08	Florida Bay, FL	50.2	24.853	-80.750	09/15/08	09/15/08	34.999	-76.910	YES	134	1188.4	8.87
102	T-106	05/05/08	Florida Bay, FL	54.4	24.853	-80.750	09/15/08	09/15/08	33.168	-79.271	YES	133	936.7	7.04
103	T-107	05/05/08	Florida Bay, FL	38.0	24.853	-80.750	09/20/08	06/17/08	24.973	-80.660	YES	43	16.2	0.38
104	T-108	06/09/08	Boca Grande, FL	57.0	26.712	-82.263	09/25/08	not heard	no loc		NO		0	
105	T-109	05/10/08	Florida Bay, FL	60.2	24.853	-80.750	09/15/08	08/07/08	32.611	-79.998	YES	89	866.7	9.74
106	T-110	06/16/08	Boca Grande, FL	63.5	26.712	-82.263	09/15/08	not heard	no loc		NO		0	
107	T-111	05/20/08	Bahia Honda, FL	40.8	24.658	-81.287	09/15/08	06/24/08	24.705	-81.186	YES	35	11.5	0.33
108	T-112	08/02/08	Galveston, TX	31.0	29.171	-94.926	03/02/09	08/14/08	29.490	-92.511	YES	12	237	19.75
109	T-113	05/11/08	Florida Bay, FL	41.9	24.853	-80.750	09/15/08	not heard	no loc		NO		0	
110	T-114	03/13/09	Whitewater Bay, FL	49.5	25.231	-80.968	09/15/08	not heard	no loc		NO		0	
111	T-115	05/19/08	Bahia Honda, FL	52.0	24.658	-81.287	09/15/08	not heard	no loc		YES		0	
112	T-116	05/11/08	Florida Bay, FL	46.2	24.853	-80.750	09/15/08	09/15/08	36.615	-75.821	YES	127	1391.1	10.95

113	T-117	05/19/08	Bahia Honda, FL	52.6	24.658	-81.287	09/15/08	07/01/08	24.642	-81.324	YES	43	4.1	0.10
114	T-118	03/17/09	Whitewater Bay, FL	44.6	25.292	-81.014	09/15/09	09/15/09	40.400	-54.501	NO	182	2977.2	16.36
115	T-119	04/01/09	Angola, West Africa	70.0	-9.345	13.152	09/21/09	09/30/09	-9.415	13.181	NO	182	8.4	0.05
116	T-120	04/02/09	Angola, West Africa	75.0	-9.342	13.149	03/03/09	04/08/09	-9.352	13.152	YES	6	1.2	0.20
117	T-121	03/16/09	Whitewater Bay, FL	37.9	25.291	-81.016	09/15/09	09/15/09	25.294	-81.024	YES	183	0.9	0.00
118	T-122	06/15/09	Boca Grande, FL	55.0	26.761	-82.252	09/15/09	06/15/09	26.761	-82.252	YES	0	0	
119	T-123	06/04/09	Veracruz, Mexico	54.5	19.368	-96.292	09/15/09	06/28/09	19.369	-96.293	YES	24	0.2	0.01
120	T-124	08/20/09	St. Lucie, FL	40.8	27.171	-80.152	02/15/10	10/19/09	25.938	-81.148	YES	60	169.3	2.82
121	T-125	09/20/09	Port O'Connor, TX	67.6	28.371	-96.363	03/02/10	11/29/09	21.883	-97.109	NO	70	726.1	10.37
122	T-126	09/08/07	Port O'Connor, TX	50.1	28.559	-96.607	SPOT5	09/16/07	27.269	-97.108	NO	8	151.8	18.98
123	T-127	05/13/09	Bahia Honda, FL	49.8	24.672	-81.287	SPOT5	05/15/09	24.627	-81.379	NO	2	10.6	5.30
124	T-128	08/29/09	Port O'Connor, TX	74.5	28.395	-96.462	02/15/10	not heard	no loc		NO		0	
125	T-129	08/29/09	Port O'Connor, TX	66.4	28.394	-96.461	02/15/10	not heard	no loc		NO		0	
126	T-130	08/30/09	Port O'Connor, TX	41.1	28.262	-96.517	02/15/10	11/07/09	26.916	-97.370	YES	69	171.9	2.49
127	T-131	09/20/09	Port O'Connor, TX	56.9	28.371	-96.362	02/15/10	not heard	no loc		NO		0	
128	T-132	09/20/09	Port O'Connor, TX	83.9	28.371	-96.363	01/10/10	09/28/09	27.623	-97.196	YES	8	116.8	14.60
129	T-133	03/26/10	Belize River, Belize	37.9	17.528	-88.231	08/01/10	04/06/10	17.534	-88.249	YES	11	2	0.18
130	T-134	08/11/09	Trinidad, BWI	54.8	10.707	-61.698	01/25/10	09/22/09	12.150	-63.644	NO	42	359.3	8.55
131	T-135	08/14/09	St. Lucie, FL	60.9	27.169	-80.169	01/25/10	01/25/10	24.901	-81.570	NO	164	288.8	1.76
132	T-136	08/13/09	St. Lucie, FL	65.3	27.167	-80.168	02/09/10	08/18/09	27.207	-80.254	YES	5	9.6	1.92
133	T-137	08/20/09	St. Lucie, FL	47.8	27.171	-80.181	12/01/09	09/11/09	27.433	-80.312	YES	22	31.9	1.45
134	T-138	03/28/10	Belize River, Belize	46.2	17.535	-88.237	08/15/10	04/07/10	17.231	-88.304	YES	10	34.6	3.46
135	T-139	09/20/09	Port O'Connor, TX	79.8	28.269	-96.524	02/15/10	not heard	no loc		NO		0	
136	T-140	04/12/10	Whitewater Bay, FL	56.4	25.291	-81.016	09/01/10	05/11/10	25.453	-81.154	YES	29	22.8	0.79
137	T-141	03/27/10	Belize River, Belize	46.6	17.528	-88.231	09/01/10	04/12/10	17.516	-88.216	YES	16	2.1	0.13
138	T-142	04/10/10	Whitewater Bay, FL	57.6	25.291	-81.016	09/01/10	05/29/10	27.629	-82.565	YES	49	302.6	6.18
139	T-143	04/11/10	Whitewater Bay, FL	36.5	25.291	-81.016	09/01/10	05/31/10	24.800	-80.900	YES	50	55.9	1.12
140	T-144	06/28/10	Florida Bay, FL	30.9	24.828	-80.758	07/27/10	not heard	no loc		NO		0	
141	T-145	05/25/10	Boca Grande, FL	43.5	26.616	-82.211	08/25/10	06/20/10	26.500	-82.200	NO	26	13	0.50
142	T-146	05/26/10	Boca Grande, FL	52.0	26.906	-82.108	09/08/10	09/08/10	26.704	-82.083	YES	105	22.6	0.22
143	T-147	05/26/10	Boca Grande, FL	60.8	26.514	-82.205	09/01/10	06/08/10	26.612	-82.537	NO	13	67.4	5.18
144	T-148	05/26/10	Boca Grande, FL	67.0	26.514	-82.205	09/15/10	06/10/10	26.404	-82.146	NO	15	106.2	7.08
145	T-149	06/03/10	Boca Grande, FL	34.1	26.410	-82.065	09/15/10	06/10/10	26.500	-82.360	NO	7	31.1	4.44
146	T-150	06/09/10	Florida Bay, FL	43.0	24.843	-80.752	09/29/10	09/29/10	24.837	-80.797	YES	112	4.6	0.04
147	T-151	06/09/10	Florida Bay, FL	52.6	24.843	-80.752	09/29/10	06/20/10	24.843	-80.752	YES	11	0	0.00
148	T-152	06/27/10	Florida Bay, FL	28.2	24.828	-80.758	09/29/10	07/08/10	24.820	-80.801	YES	11	4.4	0.40
149	T-153	06/10/10	Florida Bay, FL	50.8	24.843	-80.752	09/15/10	09/19/10	24.759	-80.986	NO	101	25.4	0.25
150	T-154	09/10/10	Long Cay, Belize	21.3	17.604	-88.063	02/01/11	10/29/10	17.647	-88.136	NO	49	220	4.49
151	T-155	10/05/10	Hog Island, FL	56.4	26.956	-82.186	01/20/11	01/08/11	24.663	-82.366	YES	95	255.9	2.69
152	T-156	10/05/10	Peace River, FL	56.4	26.937	-82.060	02/15/11	not heard	no loc		NO		0	
153	T-157	01/29/11	St. Lucie, FL	50.2	27.357	-80.233	04/05/11	02/23/11	27.250	-80.210	YES	25	12.1	0.48
154	T-158	08/23/11	Long Cay, Belize	14.9	17.604	-88.063	01/10/12	not heard	no loc		NO		0	
155	T-159	09/09/10	Charlotte Harbor, FL	43.2	26.892	-82.103	12/13/10	12/13/10	24.687	-81.553	NO	95	251.6	2.65
156	T-160	09/10/10	Charlotte Harbor, FL	44.8	26.898	-82.110	01/10/11	01/10/11	24.666	-81.924	YES	122	249.2	2.04
157	T-161	10/05/10	Peace River, FL	45.5	26.937	-82.060	01/17/11	01/31/11	24.644	-81.461	YES	118	262.2	2.22
158	T-162	09/23/10	Hog Island, FL	60.2	26.956	-82.186	01/24/11	01/24/11	no loc		YES	123	0	
159	T-163	01/22/11	St. Lucie, FL	49.1	27.348	-80.234	04/05/11	02/11/11	27.353	-80.074	YES	20	15.8	0.79
160	T-164	09/17/10	Georgetown, SC	53.2	33.181	-79.139	03/01/11	11/11/10	29.945	-81.301	YES	55	414.5	7.54
161	T-165	08/17/11	Long Cay, Belize	20.1	17.604	-88.063	02/15/12	not heard	no loc		NO		0	

162	T-166	10/15/14	Port O'Connor, TX	89.9	28.339	-96.365	12/12/14	12/12/14	18.608	-92.932	NO	58	1138.4	19.63
163	T-168	02/28/11	Whitewater Bay, FL	36.5	25.290	-81.015	09/12/11	not heard	no loc		NO		0	
164	T-169	03/01/11	Ponce de Leon Bay, FL	40.9	25.360	-81.130	09/12/11	03/05/11	25.299	-81.267	YES	4	15.4	3.85
165	T-170	03/01/11	Ponce de Leon Bay, FL	39.4	25.370	-81.130	09/12/11	not heard	no loc		NO		0	
166	T-171	08/14/11	Boca Grande, FL	35.4	26.711	-82.258	01/15/12	08/25/11	26.591	-82.126	YES	11	18.7	1.70
167	T-172	03/18/11	Belize River, Belize	47.9	17.520	-88.229	09/19/11	04/27/11	17.525	-88.237	NO	40	1	0.03
168	T-173	03/15/11	Whitewater Bay, FL	24.3	25.293	-81.011	SPOT5	03/16/11	25.291	-81.016	NO	1	0.5	0.50
169	T-174	04/02/11	Florida Bay, FL	47.9	24.841	-80.749	SPOT5	04/04/11	25.883	-80.666	YES	2	116.3	58.15
170	T-175	04/02/11	Florida Bay, FL	65.0	24.847	-80.751	SPOT5	04/04/11	25.882	-80.676	YES	2	115.5	57.75
171	T-176	04/09/11	Florida Bay, FL	79.8	24.847	-80.751	SPOT5	05/02/11	24.687	-81.313	YES	23	59.5	2.59
172	T-177	04/02/11	Florida Bay, FL	45.6	24.841	-80.750	SPOT5	04/08/11	24.883	-80.683	YES	6	8.2	1.37
173	T-178	03/19/11	Whitewater Bay, FL	59.0	25.291	-81.016	SPOT5	03/28/11	25.857	-81.596	NO	9	85.8	9.53
174	T-179	04/27/11	Broad Key, FL	70.8	25.352	-80.260	SPOT5	07/08/11	31.400	-81.550	YES	72	685	9.51
175	T-180	04/28/11	Broad Key, FL	45.0	25.352	-80.260	SPOT5	05/19/11	27.617	-80.327	YES	21	252.2	12.01
176	T-181	06/15/11	Boca Grande, FL	59.5	26.750	-82.158	SPOT5	07/31/11	26.980	-82.002	YES	46	29.9	0.65
177	T-182	05/23/11	Boca Grande, FL	36.0	26.632	-82.237	SPOT5	05/29/11	24.900	-80.884	NO	6	235.7	39.28
178	T-183	08/21/11	Boca Grande, FL	60.5	26.711	-82.258	01/15/12	08/29/11	26.940	-82.050	YES	8	32.8	4.10
179	T-184	05/17/11	Bahia Honda, FL	54.5	24.658	-81.287	SPOT5	07/31/11	25.864	-81.539	NO	75	136.6	1.82
180	T-185	05/16/11	Bahia Honda, FL	47.1	24.658	-81.287	SPOT5	05/17/11	24.658	-81.287	YES	1	0	0.00
181	T-186	05/23/11	Boca Grande, FL	35.0	26.631	-82.237	SPOT5	05/29/11	24.914	-80.869	NO	6	235.2	39.20
182	T-187	06/03/11	Apalachicola, FL	87.4	29.899	-84.478	SPOT5	07/11/11	29.385	-89.847	NO	38	522.6	13.75
183	T-188	06/08/11	Miami, FL	38.3	25.758	-80.129	SPOT5	06/13/11	28.399	-80.621	NO	5	298	59.60
184	T-189	09/16/11	Trinidad, BWI	53.3	10.663	-61.628	02/15/12	10/24/11	10.233	-61.550	YES	38	48.6	1.28
185	T-190	09/18/11	Trinidad, BWI	54.5	10.663	-61.628	03/15/12	11/12/11	10.758	-61.433	YES	55	23.8	0.43
186	T-191	09/18/11	Trinidad, BWI	72.9	10.663	-61.628	03/15/12	09/28/11	10.763	-61.723	NO	10	30	3.00
187	T-192	12/08/11	Trinidad, BWI	79.2	10.663	-61.628	04/15/12	12/19/11	10.713	-61.799	NO	11	19.5	1.77
188	T-193	05/24/11	Boca Grande, FL	42.5	26.630	-82.235	09/30/11	06/03/11	26.686	-82.746	YES	10	51.2	5.12
189	T-194	05/19/12	Boca Grande, FL	77.2	26.667	-82.264	SPOT5	08/08/12	26.689	-81.829	YES	81	43.3	0.53
190	T-195	09/16/11	Trinidad, BWI	67.1	10.663	-61.628	SPOT5	10/31/11	10.633	-61.533	NO	45	10.9	0.24
191	T-196	07/23/11	Apalachicola, FL	64.2	29.901	-84.257	SPOT5	08/18/11	30.367	-87.181	NO	26	351.3	13.51
192	T-197	05/10/12	Trinidad, BWI	72.9	10.702	-61.675	SPOT5	06/08/12	10.687	-61.696	NO	29	2.8	0.10
193	T-198	09/18/11	Trinidad, BWI	83.8	10.663	-61.628	SPOT5	09/22/11	10.458	-61.376	YES	4	35.8	8.95
194	T-199	09/28/11	Georgetown, SC	48.5	33.190	-79.147	02/15/12	11/25/11	28.499	-80.543	YES	58	539	9.29
195	T-200	12/29/11	Trinidad, BWI	79.2	10.694	-61.709	05/15/12	02/24/12	10.644	-61.864	NO	57	17.8	0.31
196	T-201	07/21/11	Apalachicola, FL	50.2	29.901	-84.257	02/15/12	08/12/11	29.944	-88.141	NO	22	440.8	20.04
197	T-202	02/14/12	North Miami Beach, FL	38.9	25.901	-80.108	08/15/12	04/10/12	26.081	-80.112	YES	56	20	0.36
198	T-203	09/28/11	Georgetown, SC	58.9	33.190	-79.147	03/01/12	11/10/11	25.948	-80.129	YES	43	811.8	18.88
199	T-204	09/28/11	Georgetown, SC	60.7	33.190	-79.147	02/15/12	01/27/12	26.094	-80.104	YES	121	795.3	6.57
200	T-205	03/25/13	Belize River, Belize	33.6	17.515	-88.121	09/16/13	03/30/13	17.517	-88.121	NO	5	0.2	0.04
201	T-206	03/26/12	Belize River, Belize	46.6	17.534	-88.403	08/30/12	04/05/12	17.523	-88.233	NO	10	18.1	1.81
202	T-207	09/08/12	Charlotte Harbor, FL	45.2	26.876	-82.108	04/15/13	10/04/12	25.812	-81.412	NO	26	137.3	5.28
203	T-208	05/19/12	Boca Grande, FL	66.0	26.633	-82.262	09/10/12	09/04/12	25.172	-80.748	NO	108	222.3	2.06
204	T-209	09/08/12	Charlotte Harbor, FL	71.0	26.909	-82.109	04/15/13	10/18/12	26.934	-82.068	NO	40	4.9	0.12
205	T-210	02/03/14	Miami beach, FL	50.0	25.767	-80.107	02/15/13	04/15/14	25.774	-80.118	YES	71	1.3	0.02
206	T-211	09/08/12	Charlotte Harbor, FL	40.0	26.908	-82.116	04/15/13	11/13/12	24.635	-83.356	NO	66	281.9	4.27

207	T-212	10/15/14	Port O'Connor, TX	60.7	28.339	-96.365	03/03/15	03/03/15	18.615	-95.049	NO	139	1090.8	7.85
208	T-213	01/20/12	North Miami Beach, FL	62.7	25.902	-80.109	03/15/12	01/21/12	25.945	-80.136	NO	1	5.5	5.50
209	T-214	09/08/12	Boca Grande, FL	33.6	26.733	-82.233	04/15/13	09/08/12	26.761	-81.191	YES	0	0	
210	T-215	10/20/12	Venice, LA	54.3	28.960	-89.181	SPOT5	05/24/13	29.093	-89.550	NO	216	38.9	0.18
211	T-216	09/30/11	Georgetown, SC	34.6	33.190	-79.147	SPOT5	11/07/11	30.097	-81.655	NO	38	418.3	11.01
212	T-217	05/13/13	Apalachicola, FL	69.4	29.871	-84.503	SPOT5	10/05/13	29.858	-89.269	NO	145	460.1	3.17
213	T-218	07/29/12	Florida Bay, FL	44.0	24.856	-80.757	SPOT5	10/24/12	29.900	-81.277	NO	87	563.8	6.48
214	T-219	09/08/12	Boca Grande, FL	43.0	26.733	-82.233	SPOT5	04/17/13	27.071	-82.011	YES	221	43.6	0.20
215	T-220	05/08/12	Apalachicola, FL	62.2	29.861	-84.599	SPOT5	07/17/12	29.270	-89.945	NO	70	521.7	7.45
216	T-221	12/08/11	Trinidad, BWI	87.3	10.691	-61.761	SPOT5	12/08/11	10.691	-61.761	NO	0	0	
217	T-222	12/29/11	Trinidad, BWI	52.5	10.691	-61.761	SPOT5	12/29/11	10.691	-61.761	NO	0	0	
218	T-223	09/15/12	Georgetown, SC	66.0	33.168	-79.176	SPOT5	12/07/12	29.271	-79.972	NO	83	440.4	5.31
219	T-224	01/19/12	North Miami Beach, FL	62.9	25.902	-80.109	SPOT5	01/25/12	26.089	-80.109	NO	5.875	20.8	3.54
220	T-225	06/14/12	Apalachicola, FL	43.7	29.921	-84.328	SPOT5	07/27/12	29.093	-89.420	YES	43	501.8	11.67
221	T-226	06/14/12	Apalachicola, FL	43.2	29.910	-84.334	SPOT5	06/19/12	30.312	-86.315	NO	5	195.9	39.18
222	T-227	05/23/12	Trinidad, BWI	55.8	10.689	-61.726	SPOT5	06/03/12	10.639	-61.979	NO	11	28.2	2.56
223	T-228	06/14/12	Apalachicola, FL	36.9	29.947	-84.329	01/10/13	not heard	no loc		NO		0	
224	T-229	03/23/12	North Miami Beach, FL	30.1	25.896	-80.117	09/15/12	not heard	no loc		NO		0	
225	T-231	09/08/12	Boca Grande, FL	19.3	26.733	-82.233	12/15/12	not heard	no loc		NO		0	
226	T-232	07/15/12	Miami, FL	37.8	25.773	-80.142	09/15/12	09/16/12	25.772	-80.141	YES	63	0.1	0.00
227	T-233	09/08/12	Boca Grande, FL	41.2	26.875	-82.146	12/15/12	not heard	no loc		NO		0	
228	T-234	05/01/15	Apalachicola, FL	81.3	29.871	-84.503	11/15/15	06/26/15	26.792	-83.980	YES	56	346.6	6.19
229	T-235	09/21/12	Port O'Connor, TX	49.7	28.326	-96.380	03/15/13	11/10/12	27.674	-97.157	YES	50	105.4	2.11
230	T-236	09/21/12	Port O'Connor, TX	52.6	28.326	-96.380	03/15/13	not heard	no loc		NO		0	
231	T-237	09/07/12	Port O'Connor, TX	58.9	28.297	-96.390	03/15/13	09/10/12	28.379	-96.370	NO	3	9.3	3.10
232	T-238	06/21/15	Apalachicola, FL	63.8	29.871	-84.503	01/10/16	06/30/15	30.019	-88.826	NO	9	417.3	46.37
233	T-239	09/21/12	Port O'Connor, TX	51.1	28.339	-96.365	02/05/13	10/02/12	28.685	-95.488	NO	11	94	8.55
234	T-240	09/07/12	Charlotte Harbor, FL	43.1	26.861	-82.098	SPOT5	09/20/12	26.884	-82.181	YES	13	8.6	0.66
235	T-241	06/14/12	Apalachicola, FL	43.7	29.915	-84.318	SPOT5	11/27/12	24.795	-81.493	YES	166	634.6	3.82
236	T-242	06/22/12	Apalachicola, FL	49.7	29.896	-84.481	SPOT5	07/04/12	29.743	-85.001	NO	12	53	4.42
237	T-243	01/14/14	Miami Beach, FL	61.8	25.884	-80.088	SPOT5	03/22/14	25.908	-80.130	YES	67	5	0.07
238	T-244	06/14/12	Apalachicola, FL	46.4	29.908	-84.446	SPOT5	06/21/12	29.611	-84.606	NO	7	36.5	5.21
239	T-245	08/15/14	Belize River, Belize	49.9	17.533	-88.235	SPOT5	08/16/14	17.330	-88.270	NO	1	22.9	22.90
240	T-246	06/21/12	Apalachicola, FL	48.1	29.896	-84.481	SPOT5	06/28/12	29.669	-84.326	NO	7	29.4	4.20
241	T-247	06/21/12	Apalachicola, FL	48.2	29.896	-84.481	SPOT5	06/30/12	30.149	-89.114	YES	9	447.4	49.71
242	T-248	09/07/12	Boca Grande, FL	51.2	26.861	-82.098	SPOT5	10/21/12	25.839	-81.471	NO	44	129.8	2.95
243	T-249	09/08/12	Boca Grande, FL	55.8	26.896	-82.111	SPOT5	12/11/12	26.687	-81.797	NO	94	38.9	0.41
244	T-250	09/21/12	Port O'Connor, TX	54.8	28.326	-96.380	SPOT5	10/14/12	26.522	-97.209	YES	23	216.9	9.43
245	T-251	09/21/12	Port O'Connor, TX	64.2	28.326	-96.380	SPOT5	09/28/12	28.377	-96.522	NO	7	15	2.14
246	T-252	09/07/12	Port O'Connor, TX	51.1	28.326	-96.380	SPOT5	09/30/12	28.402	-96.419	YES	23	9.3	0.40
247	T-253	09/21/12	Port O'Connor, TX	52.7	28.326	-96.380	SPOT5	09/24/12	28.361	-96.375	YES	3	3.9	1.30
248	T-254	09/07/12	Port O'Connor, TX	44.0	28.340	-96.381	SPOT5	09/14/12	28.299	-96.411	YES	7	5.4	0.77
249	T-255	06/26/13	Tampa, FL	59.1	27.578	-82.643	SPOT5	08/28/13	27.834	-82.472	NO	63	33.1	0.53
250	T-256	06/26/13	Tampa, FL	59.1	27.566	-82.683	SPOT5	10/22/13	28.964	-89.404	NO	118	677	5.74
251	T-257	09/17/14	Port O'Connor, TX	45.3	28.339	-96.365	SPOT5	09/22/14	28.444	-96.290	NO	5	13.8	2.76
252	T-258	02/03/14	North Miami Beach, FL	49.5	25.897	-80.113	SPOT5	02/06/14	26.252	-80.083	YES	3	39.6	13.20

253	T-259	03/28/13	Belize River, Belize	36.4	17.514	-88.121	SPOT5	07/17/13	17.424	-88.262	NO	111	18	0.16
254	T-260	06/18/14	Apalachicola, FL	54.2	29.871	-84.503	SPOT5	07/18/14	29.206	-89.515	NO	30	491	16.37
255	T-261	05/25/14	Apalachicola, FL	54.5	29.871	-84.503	SPOT5	08/07/14	29.071	-88.948	NO	74	439.9	5.94
256	T-262	08/21/15	Long Cay, Belize	49.6	17.630	-88.056	12/15/15	not heard	no loc		NO		0	
257	T-263	04/24/13	Apalachicola, FL	62.5	29.890	-84.411	SPOT5	05/09/13	30.446	-86.153	YES	15	178.7	11.91
258	T-264	05/23/13	Apalachicola, FL	77.3	29.871	-84.503	SPOT5	07/23/13	29.807	-85.408	NO	61	87.7	1.44
259	T-265	05/19/14	Apalachicola, FL	59.0	29.871	-84.503	SPOT5	06/23/14	26.929	-82.942	NO	35	361.4	10.33
260	T-266	04/07/13	Tarpon Bay, FL	36.9	25.421	-80.972	SPOT5	06/04/13	25.366	-80.995	NO	58	6.5	0.11
261	T-267	03/11/13	Shark River, FL	49.1	25.351	-81.087	SPOT5	07/01/13	26.504	-82.041	YES	112	160	1.43
262	T-268	06/18/15	Apalachicola, FL	52.6	29.871	-84.503	SPOT5	06/26/15	29.686	-85.372	YES	8	86.5	10.81
263	T-269	05/01/15	Apalachicola, FL	45.4	29.871	-84.503	SPOT5	07/24/15	29.002	-89.552	NO	84	498.9	5.94
264	T-270	04/10/13	Mud Bay, FL	49.1	25.282	-81.081	SPOT5	04/11/13	25.281	-81.086	YES	1	0.5	0.50
265	T-271	04/09/13	Ponce de Leon Bay, FL	43.9	25.270	-81.172	SPOT5	04/09/13	25.270	-81.172	YES	0	0	
266	T-272	04/07/13	Tarpon Bay, FL	62.8	25.423	-80.977	SPOT5	04/30/13	25.413	-81.023	NO	23	4.8	0.21
267	T-273	04/27/14	Florida Bay, FL	64.2	24.852	-80.755	SPOT5	06/06/14	27.321	-80.339	YES	40	278	6.95
268	T-274	04/10/13	Tarpon Bay, FL	24.1	25.415	-80.994	SPOT5	04/30/13	25.296	-81.223	YES	20	26.6	1.33
269	T-275	05/09/15	Apalachicola, FL	59.0	29.871	-84.503	SPOT5	06/04/15	29.680	-88.871	NO	26	422.6	16.25
270	T-276	08/18/15	Long Cay, Belize	36.3	17.630	-88.056	SPOT5	10/15/15	17.443	-88.075	NO	58	20.9	0.36
271	T-277	05/24/13	Apalachicola, FL	59.1	29.871	-84.503	SPOT5	09/05/13	29.492	-89.152	NO	104	451.6	4.34
272	T-278	08/22/14	Port O'Connor, TX	59.1	28.339	-96.365	SPOT5	09/17/14	28.212	-96.636	NO	26	30.1	1.16
273	T-279	06/17/16	Apalachicola, FL	57.3	29.871	-84.503	12/01/16	12/01/16	28.170	-88.711	NO	167	451.2	2.70
274	T-281	04/25/16	Florida Bay, FL	45.7	24.916	-80.739	09/01/16	05/24/16	26.887	-80.052	YES	29	229.9	7.93
275	T-282	10/12/14	Port O'Connor, TX	80.1	28.339	-96.365	03/01/15	03/02/15	18.738	-92.829	NO	141	1127.9	8.00
276	T-284	09/20/14	Port O'Connor, TX	52.6	28.339	-96.365	03/01/15	01/09/15	18.780	-95.678	NO	111	1066.4	9.61
277	T-286	09/20/14	Port O'Connor, TX	59.1	28.339	-96.365	SPOT5	11/27/14	20.047	-96.521	NO	68	923.2	13.58
278	T-287	07/18/14	Apalachicola, FL	64.2	29.871	-84.503	SPOT5	09/13/14	29.878	-84.342	NO	57	15.6	0.27
279	T-288	09/17/14	Port O'Connor, TX	77.2	28.339	-96.365	SPOT5	09/26/14	27.989	-96.818	NO	9	59.1	6.57
280	T-289	10/15/13	Port O'Connor, TX	49.9	28.339	-96.365	SPOT5	10/16/13	28.379	-96.237	NO	1	13.3	13.30
281	T-290	09/01/14	Apalachicola, FL	49.9	29.871	-84.503	SPOT5	11/15/14	25.427	-81.167	NO	75	594	7.92
282	T-291	07/13/14	Apalachicola, FL	47.7	29.871	-84.503	SPOT5	07/26/14	30.039	-83.930	NO	13	58.3	4.48
283	T-292	09/11/16	Port O'Connor, TX	59.1	28.339	-96.365	SPOT5	09/19/16	28.136	-96.672	NO	8	37.6	4.70
284	T-293	06/02/16	Apalachicola, FL	62.5	29.871	-84.503	SPOT5	06/17/16	28.889	-82.604	YES	15	214.2	14.28
285	T-294	09/12/16	Port O'Connor, TX	66.0	28.339	-96.365	SPOT5	09/16/16	28.178	-96.702	NO	4	37.6	9.40
286	T-296	06/22/16	Apalachicola, FL	54.5	29.871	-84.503	SPOT5	10/04/16	29.947	-85.305	NO	104	77.8	0.75
287	T-297	08/21/15	Long Cay, Belize	41.3	17.630	-88.056	SPOT5	09/14/15	17.598	-88.087	NO	24	4.8	0.20
288	T-298	05/07/15	Apalachicola, FL	66.0	29.871	-84.503	SPOT5	01/20/16	24.820	-80.878	NO	258	666.7	2.58
289	T-299	09/11/16	Port O'Connor, TX	51.0	28.339	-96.365	SPOT5	09/12/16	28.184	-96.599	NO	1	28.7	28.70
290	T-300	06/12/17	Apalachicola, FL	54.5	29.871	-84.503	SPOT5	07/14/17	29.107	-89.525	NO	32	494	15.44
291	T-302	06/16/18	Apalachicola, FL	52.2	29.871	-84.503	SPOT5	07/20/18	29.714	-84.910	NO	34	43	1.26
292	T-304	05/11/18	Apalachicola, FL	99.0	29.871	-84.503	12/10/18	06/19/18	26.862	-83.943	NO	39	339.4	8.70



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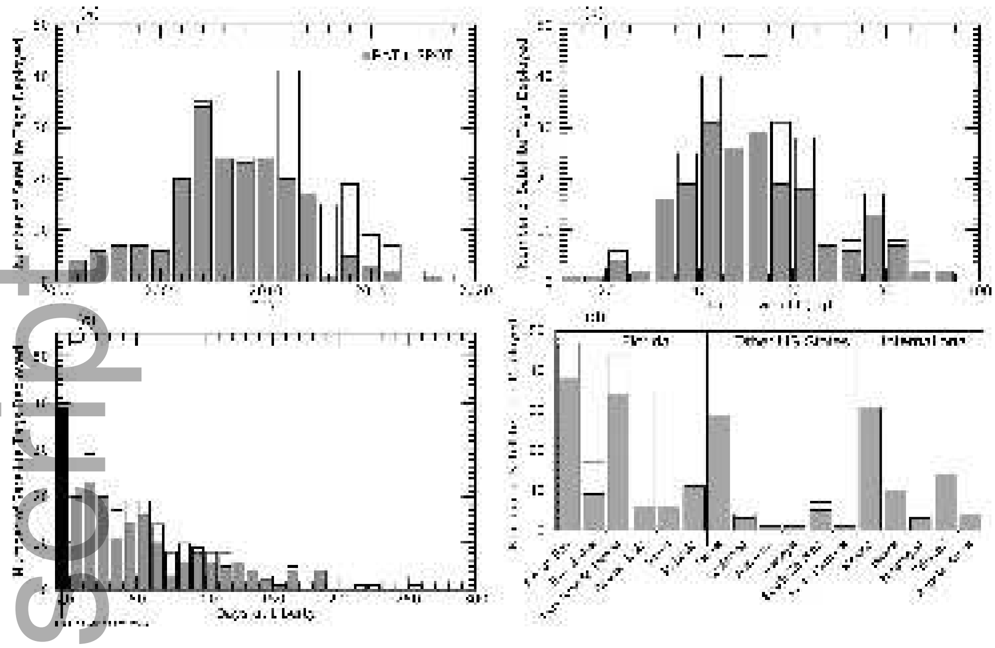

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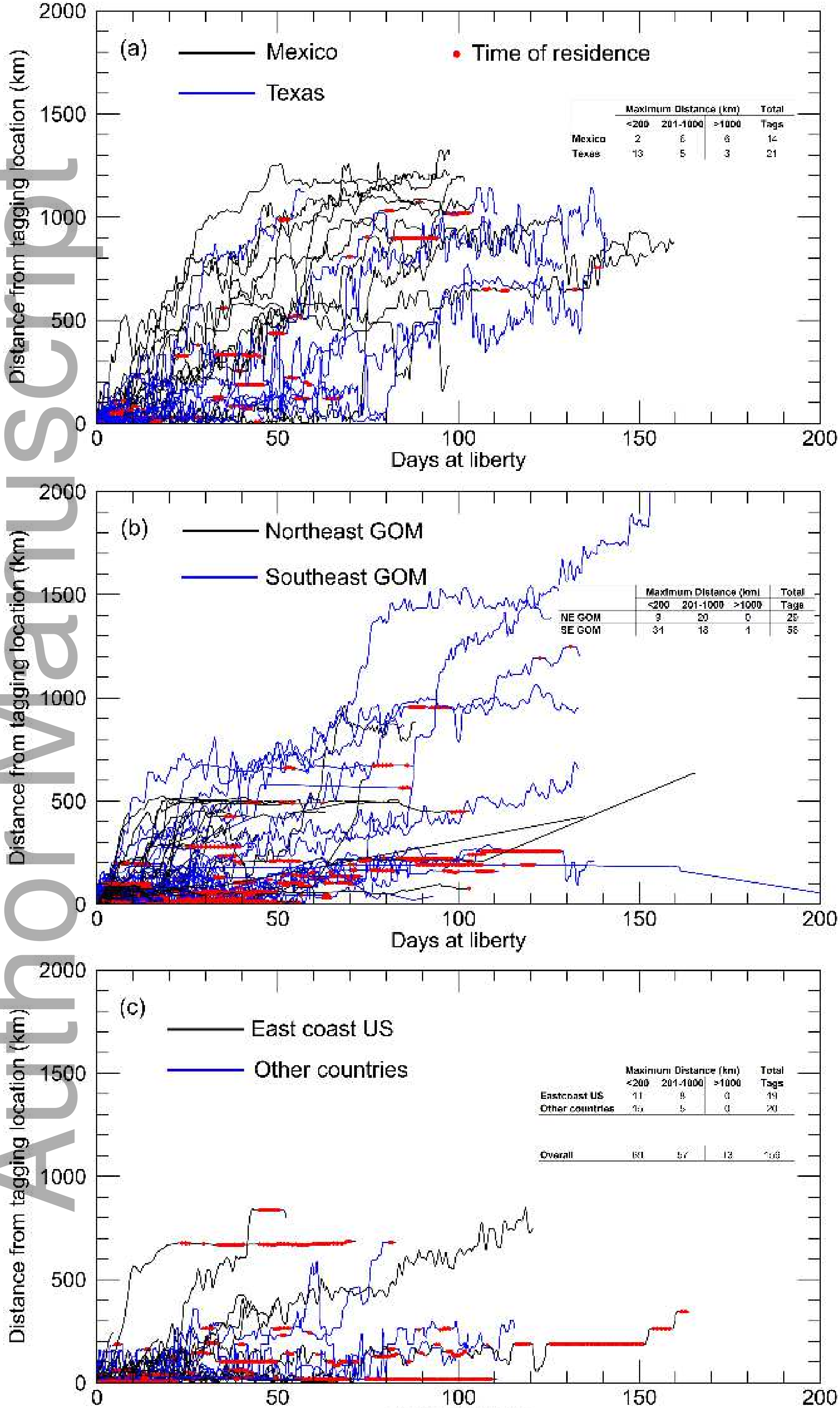

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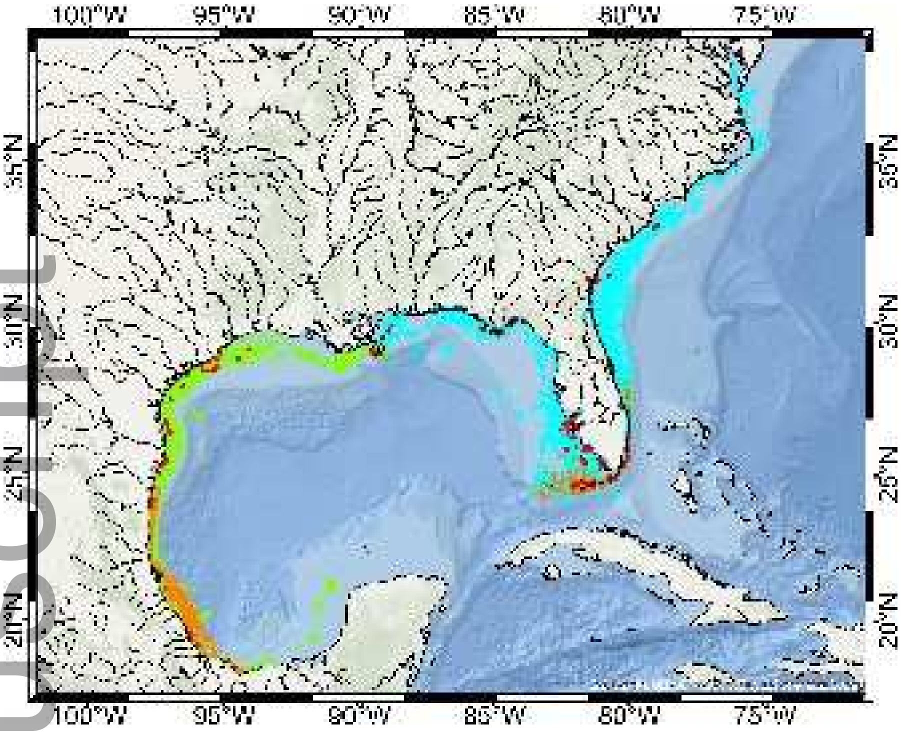

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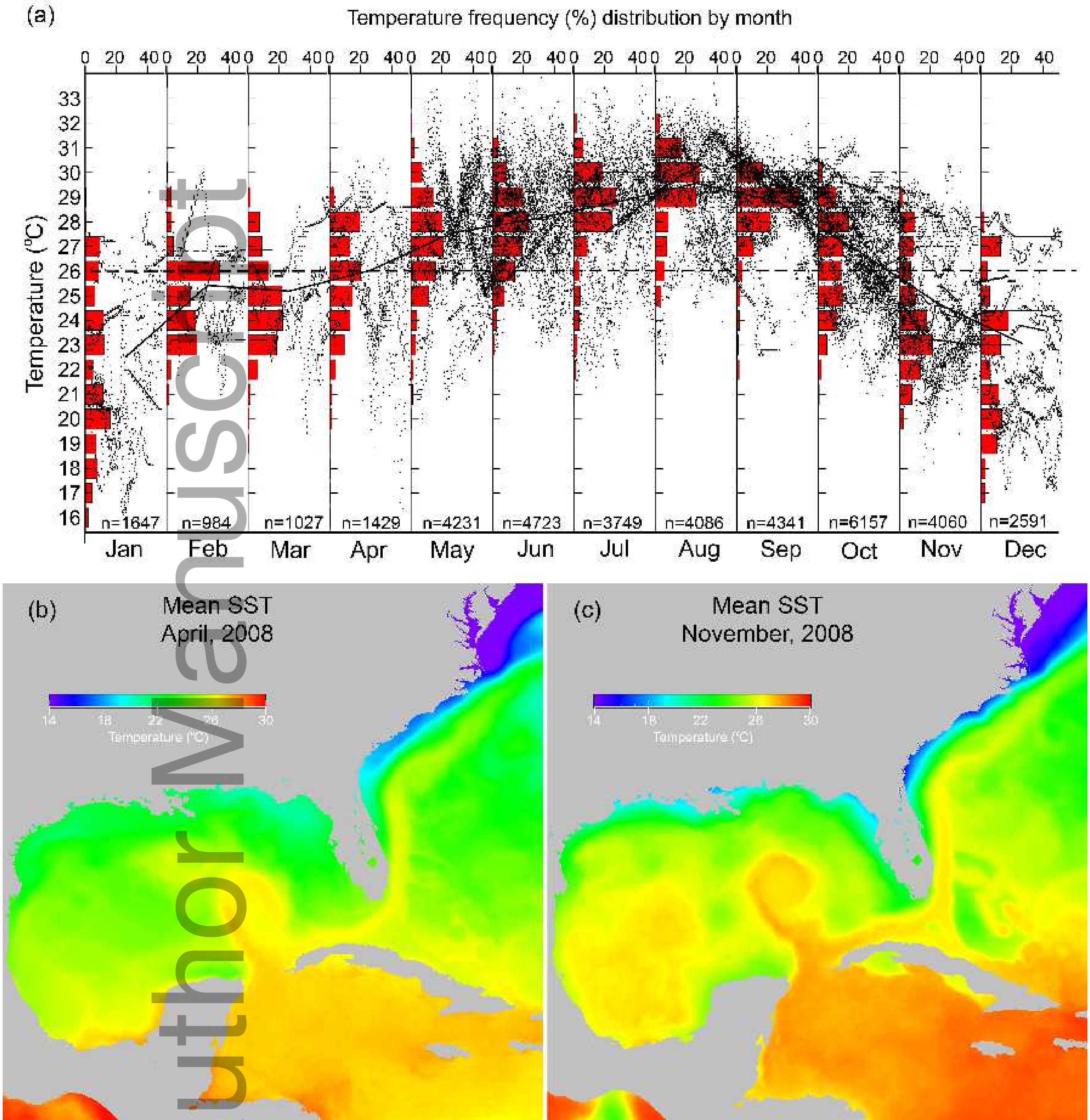

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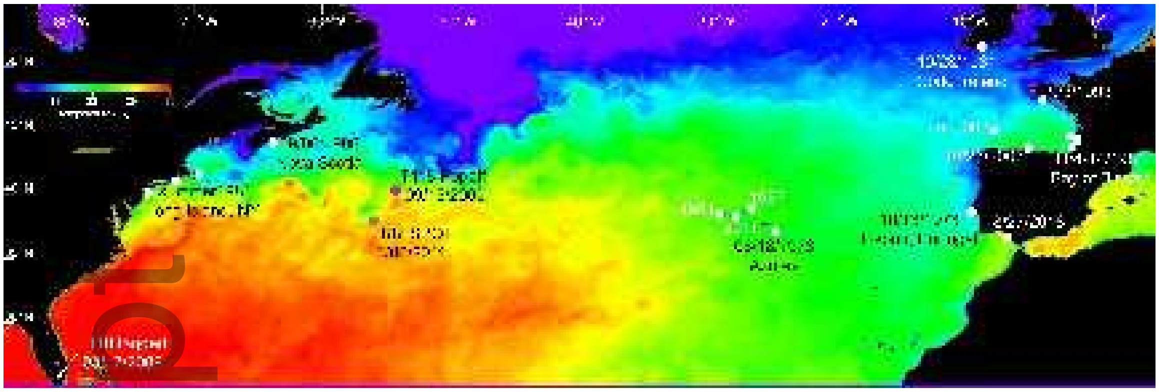

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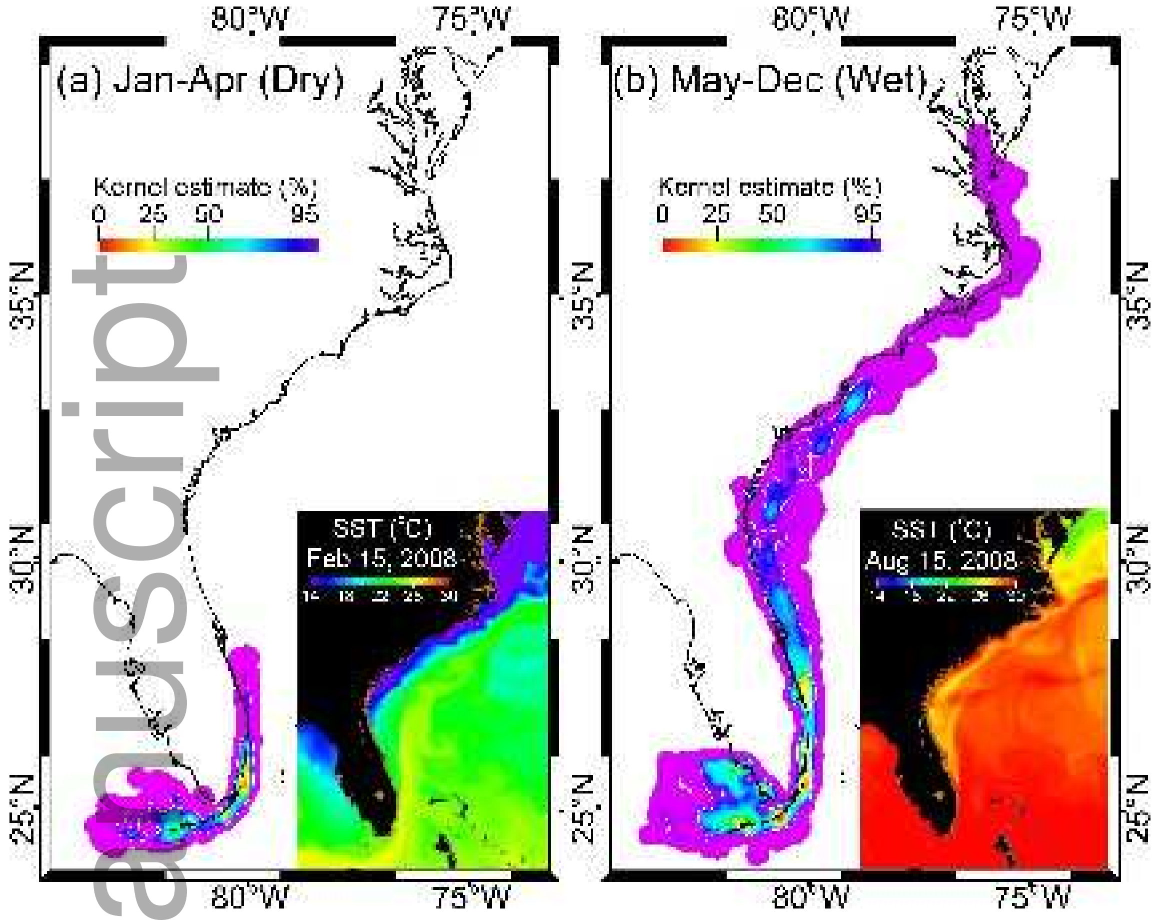

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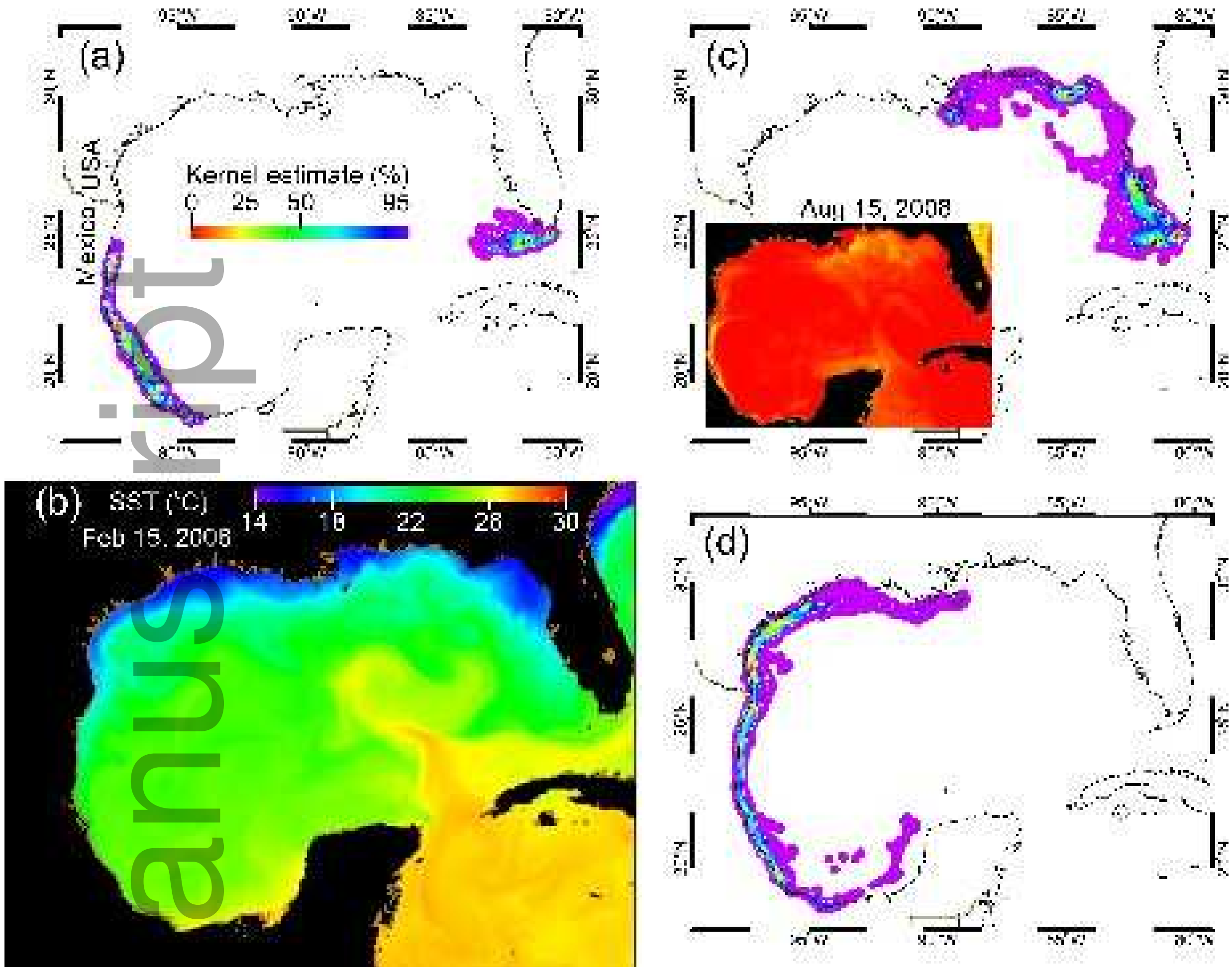

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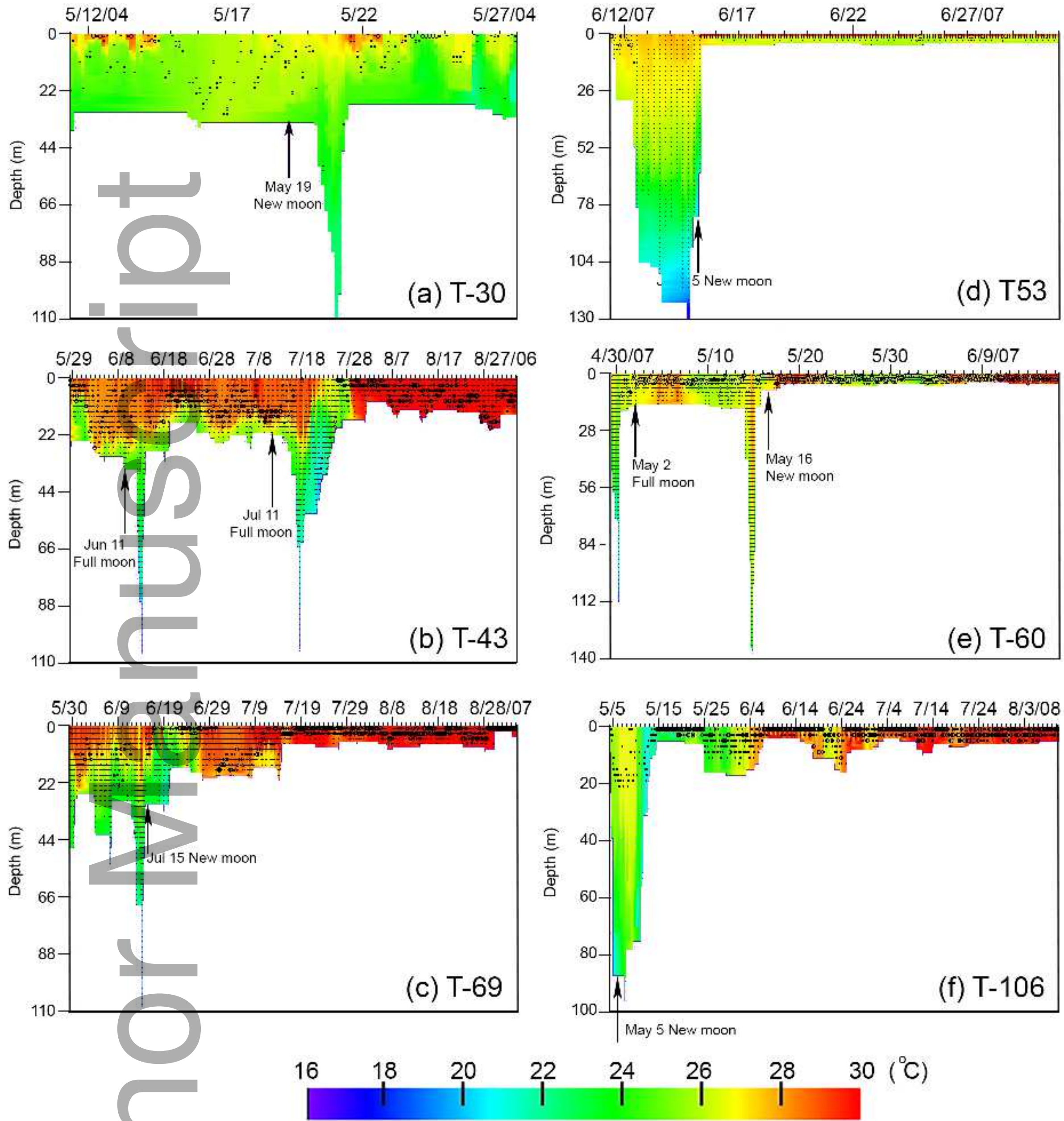

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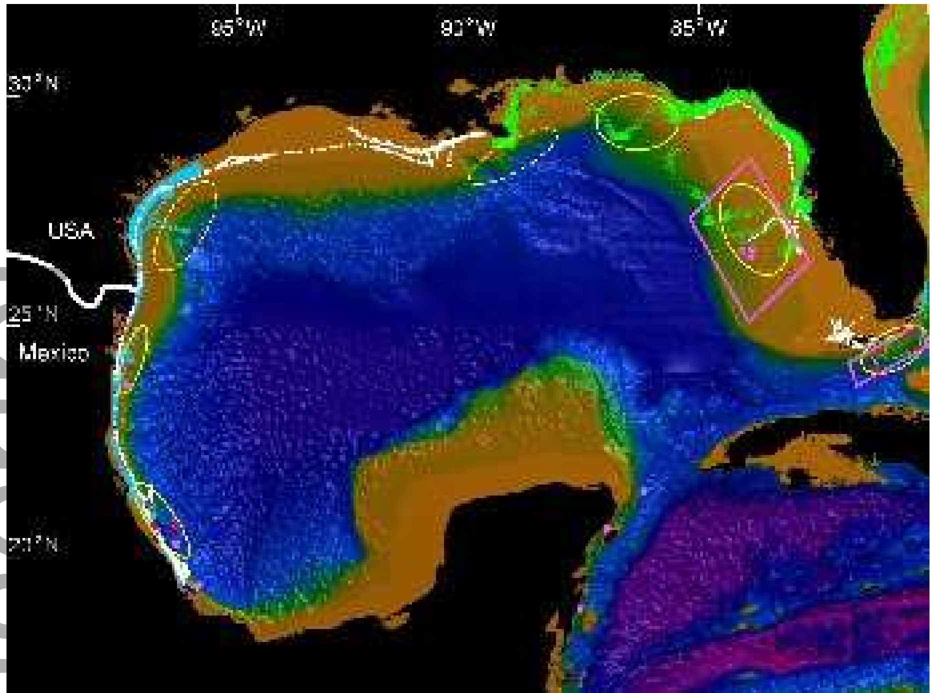

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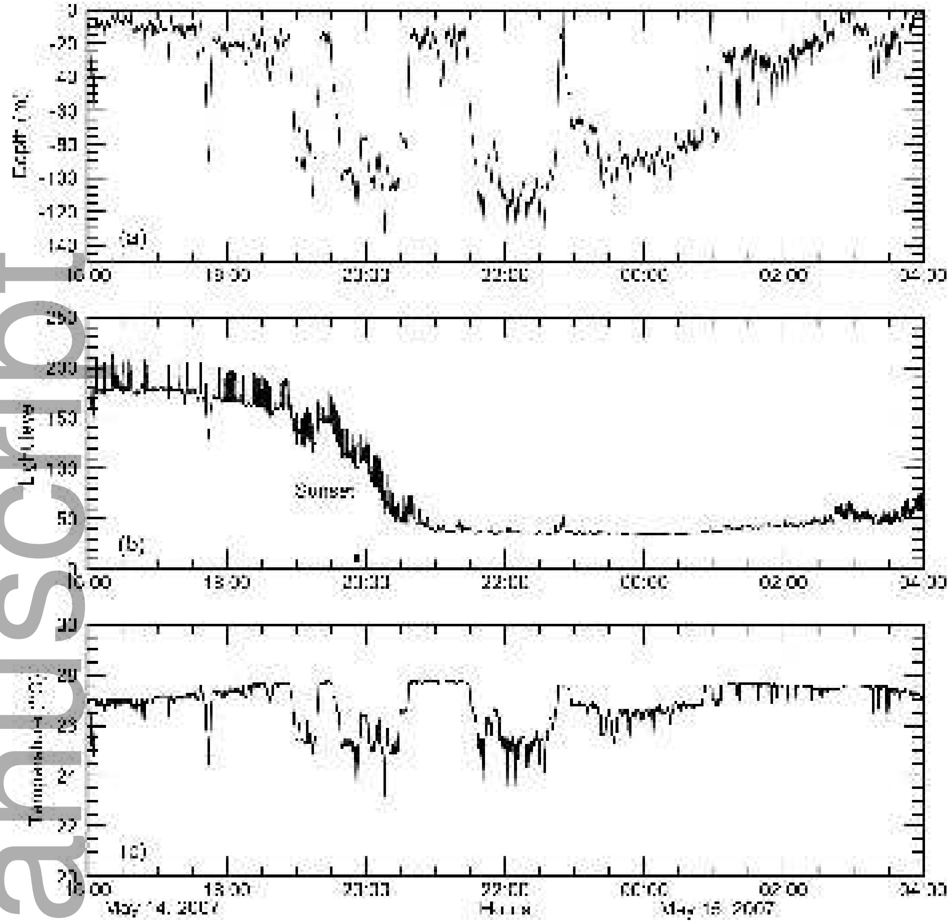

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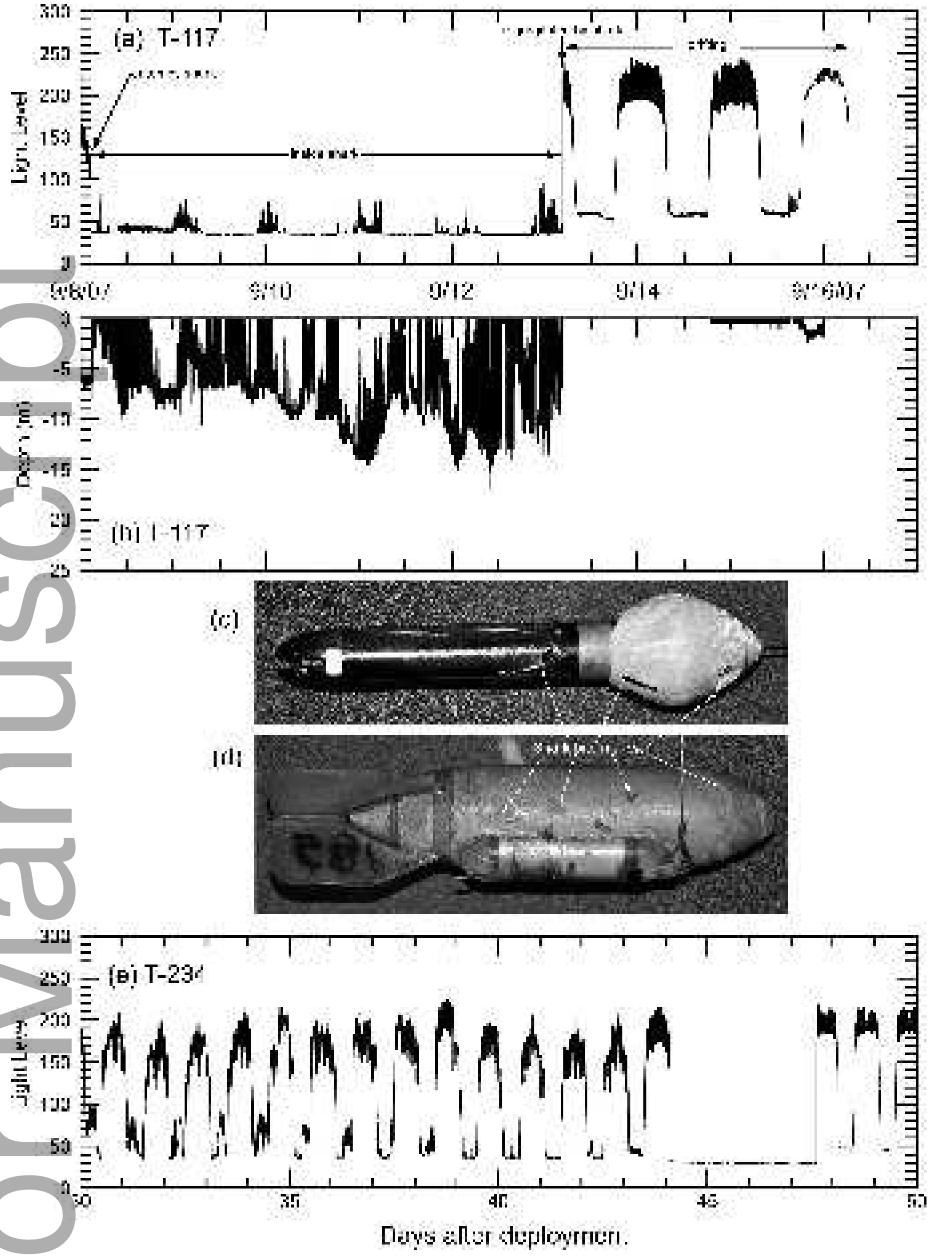

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