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Final Contract Report #CF 13-05 Proposal to Determine Male Cownose Ray Movement After Mating in Chesapeake Bay: a Potential Fishery Management Concern

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Final Contract Report

#CF 13-05

Proposal to Determine Male Cownose Ray Movement After Mating in Chesapeake Bay: a Potential Fishery Management Concern

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WILLIAM & MARY VIMS
VIRGINIA INSTITUTE OF MARINE SCIENCE
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VIRGINIA MARINE RESOURCES COMMISSION

FINAL REPORT for #CF 13-05 -- Proposal to Determine Male Cownose Ray Movement After Mating in Chesapeake Bay: a Potential Fishery Management Concern

BACKGROUND

Cownose rays appear each year in Virginia waters in early May. Mixing of the sexes is observed within the migrating cownose ray population as they reach Chesapeake Bay with this mixing extending through mating (early to mid-August), at which point sexual segregation occurs. From May through early July, rays are easily accessible, and therefore more frequently observed, within near shore commercial haul seine and pound net fisheries. Timing of parturition in cownose ray is an important consideration for fishery management. If fished when rays first become accessible to fishery in May and through mid-June (note that juveniles are not present in large quantities), for every mature female harvested, two rays will be removed from the population: mom and near-term embryo. If fished after parturition is completed (mid-July), offspring may be allowed to enter recruitment effort. However, mating in cownose rays occurs as soon as parturition is complete, resulting in pregnancies of 11.5-12 month gestation (within many sampling efforts during this period half the mature females are observed still with at-term pups while other half which recently gave birth have already been mated with). Upon mating, sexual segregation occurs. Females are observed to remain in shallow water habitats throughout the summer and early fall, while it remains uncertain where male cownose ray inhabit when segregated due to lack of fishery-independent sampling of deep water habitats throughout the Bay and insufficient sampling of habitats along the eastern shore of Bay. Landings of cownose ray as by-catch in these traditional fisheries (subsidy paid by state to fishermen for landing cownose ray) contained mixed sexes from May through July, but nearly 100% female from August through October.

Given the importance of understanding life history parameters of an unregulated elasmobranch species in which a targeted commercial fishery is being promoted, more definitive information is needed. With possible commercial harvesting of cownose ray restricted due to reproductive biology constraints, together with the aggregate foraging behavior within near-shore habitats, overexploitation of female rays can quickly occur

with reliance on traditional fisheries. If a male-only fishery evolves for periods during the summer, understanding movement of males post-mating is critical, especially if alternative fishing methods need to be explored for harvest. Research funded by NOAA 2006-2010 focused on cownose ray life history, trophic ecology and shellfish predation and provided valuable information on this elasmobranch species in preparation for the initiation of a targeted commercial fishery (Fisher 2010). Key components of the ray life history are becoming better understood as a result of this work and subsequent work tracking rays migratory behavior. Satellite tags employed to track and identify ray movement have provided critical information to our understanding of where this species over-winters when they leave the bay in September for their southern migration to wintering grounds. These tags log temperature, depth and light intensity which can be used to calculate latitude and longitude by geolocations based on a state-space model and estimates by the Kalman filter. After a predetermined amount of time, the tag releases from the fish, floats to the surface and uploads its data to the ARGOS satellite system. The use of satellite tags placed on mature males prior to mating may provide currently unknown movement and habitat information post-mating. A proposal was submitted to VMRC in September 2012 for funding to support an ongoing ray tagging study using satellite tags to help understand male ray habitat use post-mating and better underhand ray migration patterns. Funds for five satellite tags was requested from VMRC to compliment the 6 satellite tags already obtained and set to deploy in May 2013. With the 5 requested tags, a total of 11 satellite tags would be available to increase our likelihood to obtain data on ray movement and habitat use. These tags will also serve in support of a graduate student thesis. An incoming fisheries graduate student at VIMS has funding support for her studies, but little funding for equipment. A segment of her thesis will focus on cownose ray tagging and migratory behavior. The requested tags will serve dual purpose; continuation of identifying missing life history information for this highly sensitive species, as well as providing a research objective in support of a graduate student program. Funding through VMRC's Virginia Commercial Marine Fishing Improvement Funds for 5 satellite tags was finalized March 2013.

SCOPE OF WORK

Progress through June 1, 2013

The award was finalized March 4, 2013 and tagging of rays needed to be accomplished prior to ray mating period (June 24-July 6) after which time no male rays would be available to tag. Initial effort was placed on working with Wildlife Computers to produce the MiniPAT Pop-up Archival Transmitting Tags (8-10 week process), and the satellite service provider (CLS America) to be able to perform the proposed work in 2013. The tags were received May 2, 2013 and initial work was performed to prepare tags for deployment. Deployment preparation included programming each tag for environmental data recording (depth, temperature, light-level), frequency of data sampling, and deployment duration (when to pop-off). An Institutional Animal Care and Use Committee (IACUC) protocol for tagging rays was developed and approved with graduate student assistance.

Progress June-September 1, 2013

The programming of tags and construction of tethering harnesses were prepared prior to ray tagging. Tags were programmed to release either 100 days (6 tags), or 150 days (5 tags) after deployment. The rays were collected by traditional commercial haul seine net. Rays were placed into large insulated totes filled with seawater immediately after hauled onboard and transported to VIMS lab. Seawater was kept oxygenated by circulating in fresh seawater and with an air stone during transportation (0.5 – 1.0 hour). The movement of the rays from the fishing gear and to and from holding tanks was performed by hand to minimize any possible injury to rays. Rays were housed in the ray/turtle outdoor holding tank at VIMS boat basin (10ft x 14ft x 4 ft deep), which is equipped with a flow-through seawater system, to minimize stress due to high density. The rays were allowed to acclimate 72 hours in tank before subjecting to tagging. Overall ray health was assessed by observing ray swimming behavior, lethargy (period of inactivity and reactivity), and rhythmic nature of ray breathing through spiracle and gill movement as well as physical appearance (coloration, wound repair). Pre-tagging evaluation protocol ensured only healthy, non-compromised rays will be subjected to tagging, thus giving us

a baseline to evaluate post-tagging ray health. The MiniPAT Pop-up Archival Transmitting Tags (MiniPAT; 115mm x 40mm w/o antenna, 53g weight in air) were tethered with 200 # monofilament nylon fishing line through and around the base of the tail just forward of the small second dorsal fin, finishing the loop on the dorsal side of the tail: starting from dorsal side of ray, monofilament running down through muscle on the right side of the vertebrae exiting the ventral side of tail, then continuing back through muscle on left side of vertebrae and exiting the dorsal side of tail where one end of resulting loop is ran through burn pin of tag and then crimped to other end of loop allowing for the tag to free floating. This method provides a more centralized positioning of tag to minimize drag and, therefore stress on the ray. Rays were tagged on June 12, 2013 and July 5, 2013, held 24 hours to evaluate ray health post-tagging, then released at into the York River at Gloucester Point beach (lat/long; 37.247/-76.505).

RESULTS/DISCUSSION

All 11 miniPAT archival tags were deployed on male cownose rays with graduate student involvement (Table 1). Three tags (tags 2, 5, 10) were never heard from, providing no data. A total of 6 tags experienced pre-mature release with four (tags 1, 4, 6, 11) recovered within 21 days after deployment, and two (tags 7, 8) never recovered. Pre-mature releases may have resulted from mortality due to predation or other factors. Two tags (tags 3, 9) popped-off near programmed dates.

All but one pre-maturely released tags were located south of deployment site (VIMS, York River), with tag 11P0477 popping-off farther north in the bay in Insley Cove just inside Asquith Island, MD (Figure 1). Data recovered from that tag was corrupted or missing (Figure 2) but does show indications of normal ray daily movement from water surface to dives to depths of 6-12 meters.

Abrupt changes in ray swimming/diving behavior combined with correlated temperature changes can provide possible indication of ray death by predation. In figure 3, ray behavior shows that the ray stayed on the surface the first day of deployment followed by multiple deep dives extending to 24 meters, normal activity for benthic foraging

predators. Within multiple dives between 6-8 meters the second day of deployment, ray movement at those depths stopped abruptly, and remained at constant depth (~6 meters) and temperature for 3-4 days until, at which time (6/21) the pin corroded allowing the tag to float to surface and exposed to daily temperature changes.

The large portion of mating activity in the lower Chesapeake Bay in summer 2013 was observed to extend from mid-June through the first week in July. Data recovered from pre-released tags covers pre- and post-mating periods, with male cownose ray habitat use prior to and during mating, when sexes of reproducing age rays are mixed, is observed in shallow, warmer near-shore areas. This is depicted in tag 11P0431 data in which male ray dives were frequent, but limited to 3-7 meters (Figure 4). Only an occasional deep dive (20 meters) was observed. This tag was found beached on the eastern side of the bay (Kiptopeke State Park), meaning the ray traversed the bay, which may explain the infrequent deep dives made during the movement.

Post mating, tag data depicts male cownose rays occupying areas in which deeper dives occur than that observed before mating, suggesting that males move to deeper and cooler water habitats (Figure 5). Male ray positioning within the water column seems to follow a cyclic nature, making diurnal dives in relation to tidal (Figure 6) or daylight (Figure 7) influences.

Three rays were outside Chesapeake Bay when tags popped-off. Tag 11P0461 pop-off 7-15-13 (32 days at liberty) above Washington Canyon, ~65 miles off Burton Bay on VA Eastern Shore (Figure 8) but only fragmented temp depth data, and no usable data was transferred from tag. Tag 11P0486 popped-off 10-11-2013 (119 days at liberty) near shore (36.45 N -75.723 W) close to the VA-NC boarder (Figure 9) and provided good depth and temperature data. Viewing the depth/temperature data from mid-Sept to tag release, it is likely that this ray was preyed upon prior to tag release. Upon surfacing and downloading data, the tag experienced a great deal of drift along the NC coast then out sea prior to battery depletion. The date and location where the tag released from the male ray coincides with the fall mass cownose ray southern migratory route observed from

previous tagging of female cownose rays from Chesapeake Bay. In reviewing tag data from this ray (Figure 10), a shift to deeper and cooler water coincided with the end of observed mating period (early July) and was maintained through September at which time more extreme dive depths (>30 meters) were observed. Tag 11P0827 popped-off near programmed date. This was one of 5 that were programmed for 150 days with the hope to capture male ray movement during residency in Chesapeake Bay as well as southern migratory route and terminal destination. Only the terminal position of the ray was obtained for this tag, with satellite detection putting it very close to, or on the beach at Harbour Beach, Florida (Figure 11). There was only 1 day of signaling with no usable data recovered. The location after release are very close to shore, possibly even on shore. This tag was either washed up on the beach or lying in a position that was not good for getting transmissions to the satellites. As with other tags that were found, hope remains of recovering this tag for direct downloading of the full archival data set. The beach area is a very populated shoreline in Florida so there is a chance that someone had found the tag and taken it inside or to an area where it is not able to get the transmissions out to the satellites.

From this study, though less tag data than expected was obtained, it suggests male cownose rays segregate from females post-mating into deeper water habitats, with identification of these habitats unclear. Data from tag 11P0486 clearly reflects movement of the male ray into deeper habitats post-mating, but without correct geolocation, it is difficult to determine where those deeper water habitats are, in the bay or outside the bay. With tag 11P0461 popping off in deep water off-shore VA eastern shore shortly following mating period, suggests that male rays may exit the bay and reside off-shore until fall migration, at which time sexes re-mix.

The graduate student commenced her pre-qualifications meeting with her committee with thesis projects involving ray tagging reviewed.

FURTHER DISCUSSION

Pop-up Satellite Archival Tag (PSATs) can be a very useful tool to explore habitat use, movement patterns and mortality events. The tags were originally designed for pelagic species so satellites can pick up the signals from any tag with minimal disruption. We chose to use PSATs on a coastal species, cownose rays, to gain valuable information regarding their migration patterns and differences habitat usage for males versus females after mating. However, using PSATs on coastal species is difficult; there are more factors in the coastal environment to disrupt satellite signal. Not only do the satellites need to be range for the tags to transmit data, the antenna needs to have a clear path to send the signals. For example shadows from the land, thick vegetation (sea grass or phytoplankton blooms) and man-made structures, such as docks and boats, can also weaken the signal. Our tags have a light sensor, which is used to predict the geolocation. However, the light sensor is again sensitive to the same factors that cause disruption to the signal transmission. Because most geolocation programs use a light-based system, this causes the calculated migration track of this coastal species to be highly variable and inaccurate, as depicted in Figure 12 for tag 11P0588 in which the ray had never left the Chesapeake Bay. The two programs we tried using takes raw geolocations based on a state-space model and estimates by the Kalman filter, however were unsuccessful at creating a plausible track. We unfortunately cannot utilize the geolocation method that uses a hidden Markov model by matching tidal patterns with depth measurements because our study species is not primarily benthic.

Currently, the PSATs have not been an effective tool to determine small scale spatial distribution patterns for the cownose rays. Nonetheless, there is some valuable data that the tags were able to provide. We are able to see movement patterns in the water column, which suggest they make frequent trips to the benthos, but do not stay down for long periods. Pop-up locations are also fairly accurate because the antennas are above sea level and can constantly send signals to any Argos satellites that pass overhead.

LITERATURE CITED

Fisher, R.A. 2010. Life history, trophic ecology, and prey handling by cownose ray, *Rhinoptera bonasus* from Chesapeake Bay. Report NA07NMF4570324 to National Oceanic and Atmospheric Administration. VIMS Marine Resource Report No. 2010-10. http://www.vims.edu/GreyLit/VIMS/mrr10-10.pdf

APPENDIX

TABLE & FIGURES

Table 1.

Summary Information for mini-PAT (Pop-up Archival Transmitting) Tags released at VIMS. (Lat/Long: 37.247/-76.505)

Tag #	Deployment (pop-off) days programmed	Tag_ID	Date_Release	Date_corrosion	Days_ at_liberty	Lat_end	Long_end
1	100	11P0431	6/13/2013	6/25/2013	13	31.5	-78.661
2	100	11P0473	6/13/2013	NA	NA	NA	NA
3	100	11P0486	6/13/2013	10/11/2013	119	36.45	-75.723
4	100	11P0678	7/6/2013	7/25/2013	20	37	-76.118
5	100	11P0634	6/14/2013	NA	NA	NA	NA
6	100	11P0463	6/14/2013	6/18/2013	5	34.5	-77.157
7	150	11P0477	6/14/2013	7/9/2013	26	38.288	-76.107
8	150	11P0461	6/14/2013	7/15/2013	32	37.5	-74.578
9	150	11P0827	7/6/2013	11/30/2013	145	28.151	-80.584
10	150	11P0472	7/6/2013	NA	NA	NA	NA
11	150	11P0558	7/5/2013	7/11/2013	7	32.5	-78.515

Figure 1.

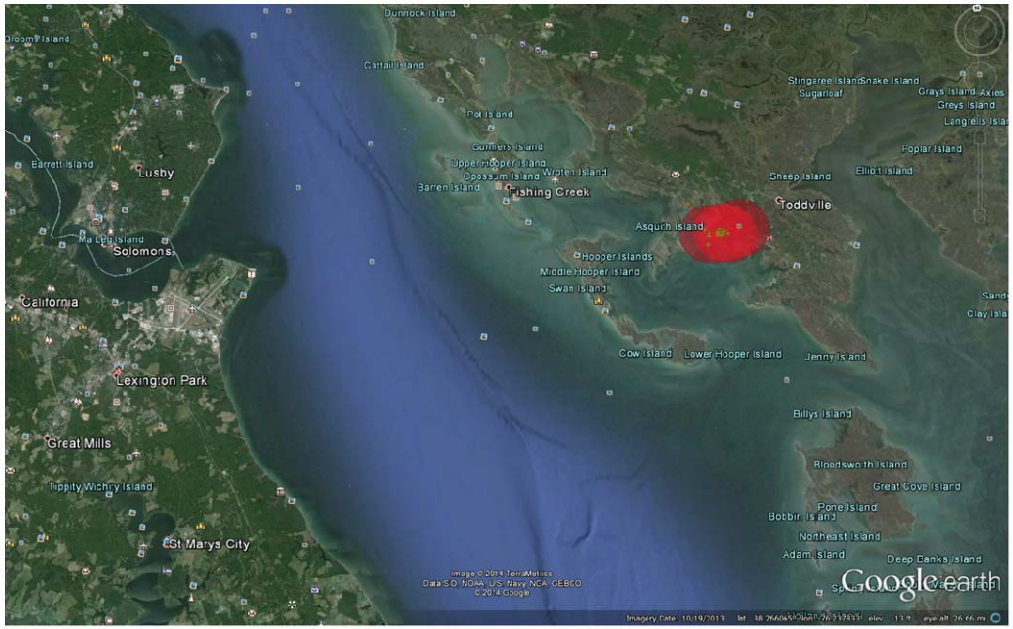

Figure 1. Pre-mature pop-off location of tag 11P0477 in Insley Cove, Asquith Island, MD.

Figure 2.

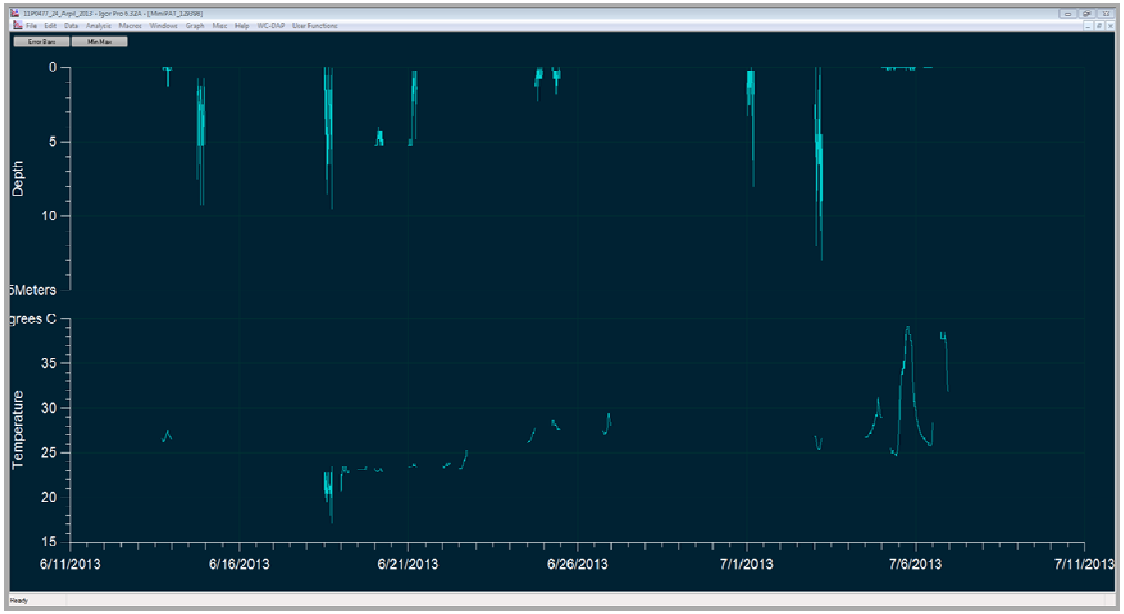

Figure 2. Partial depth and temperature data recovered from tag 11P0477 during deployment.

Figure 3.

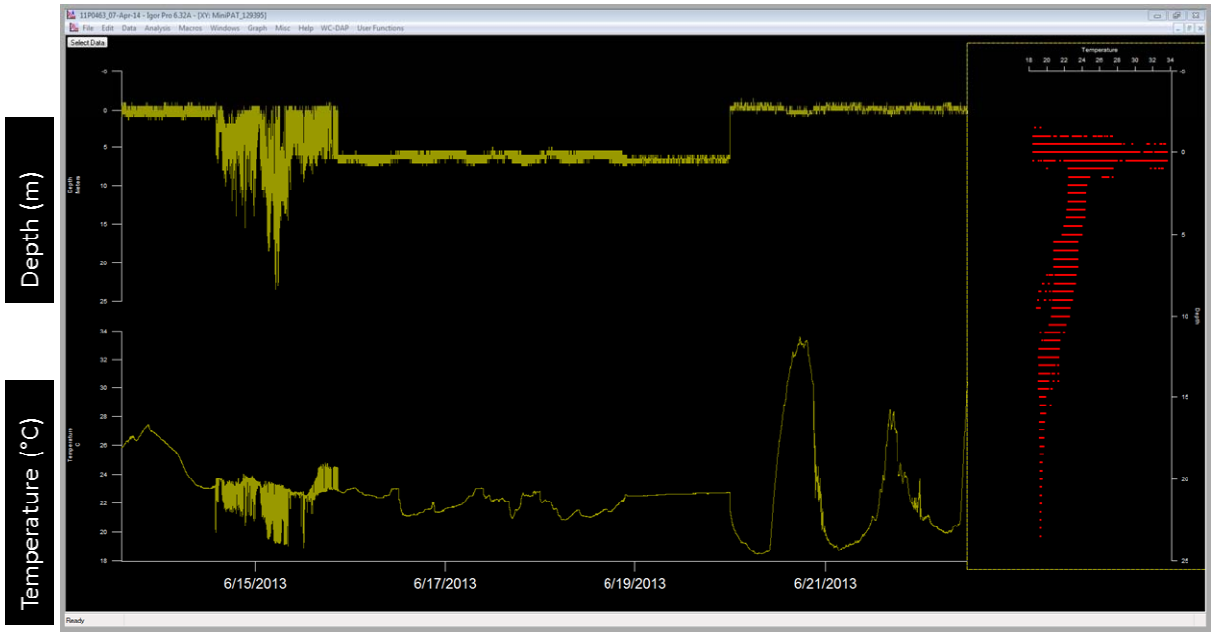

Figure 3. Depth and temperature profile for ray (tag 11P0463) during 5 day deployment period. Tag was found beached at Ft. Monroe 6/23/2013 with pin burned.

Figure 4.

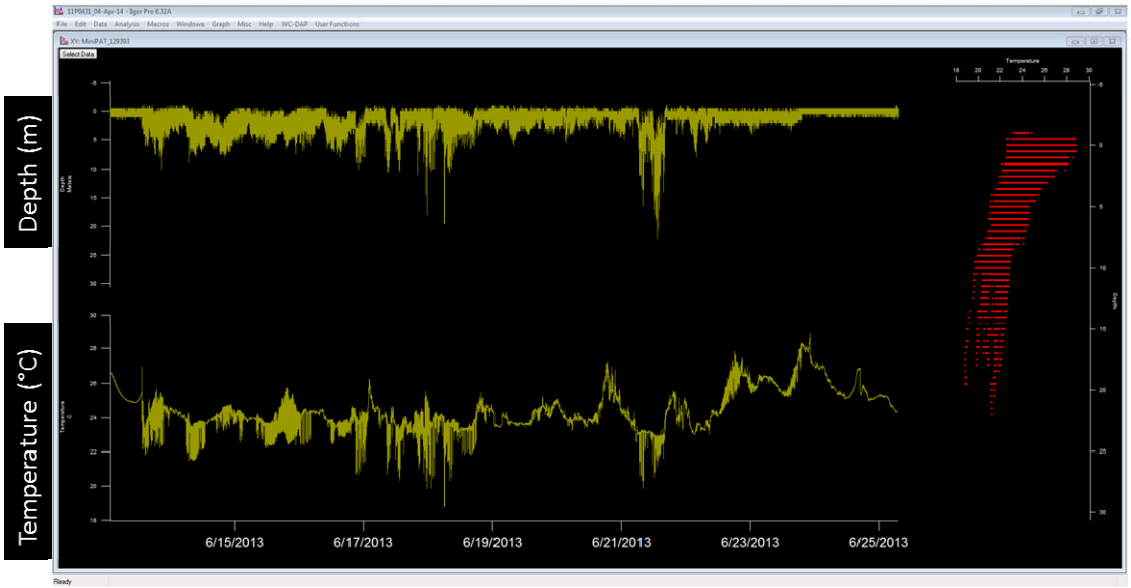

Figure 4. Depth and temperature data for a male cownose ray (tag 11P0431) mid- to late-June, during period mating is observed to begin.

Figure 5.

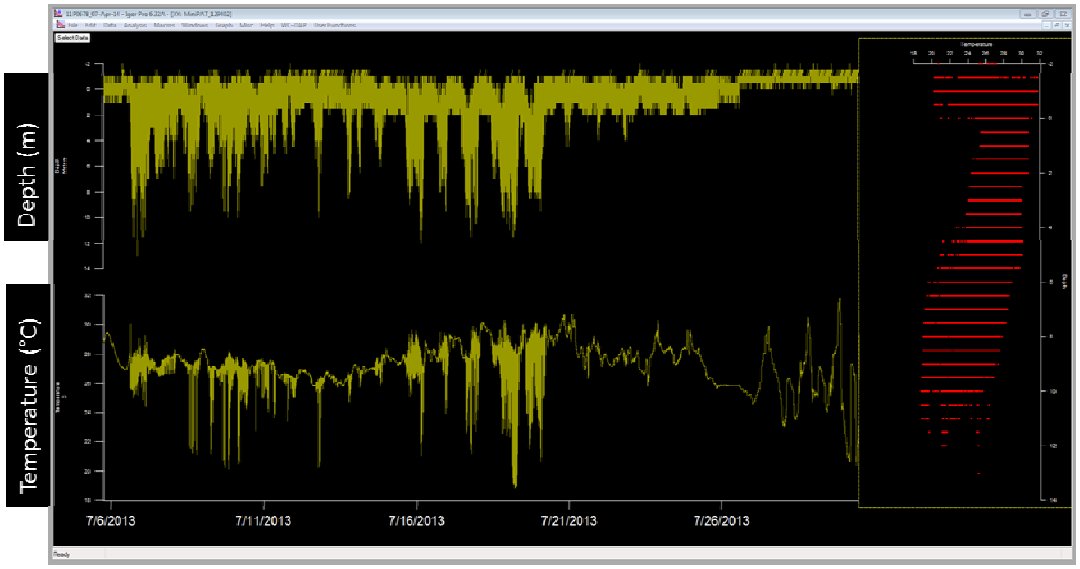

Figure 5. Depth and temperature data from pre-maturely released tag 11P0678 showing male cownose rays frequent dives to depths of 10-13 meters.

Figure 6.

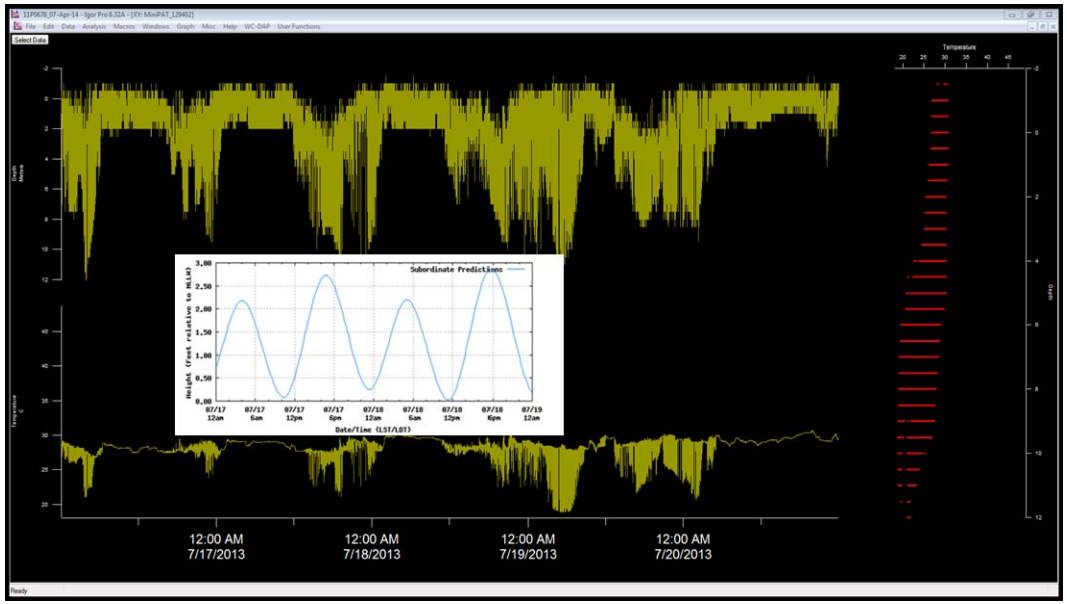

Figure 6. Depth (top histogram) and temperature (bottom histogram) showing male cownose ray daily movement post-mating between water surface and dives to 15 meters. Inset showing tide cycles during period of repeated dives.

Figure 7.

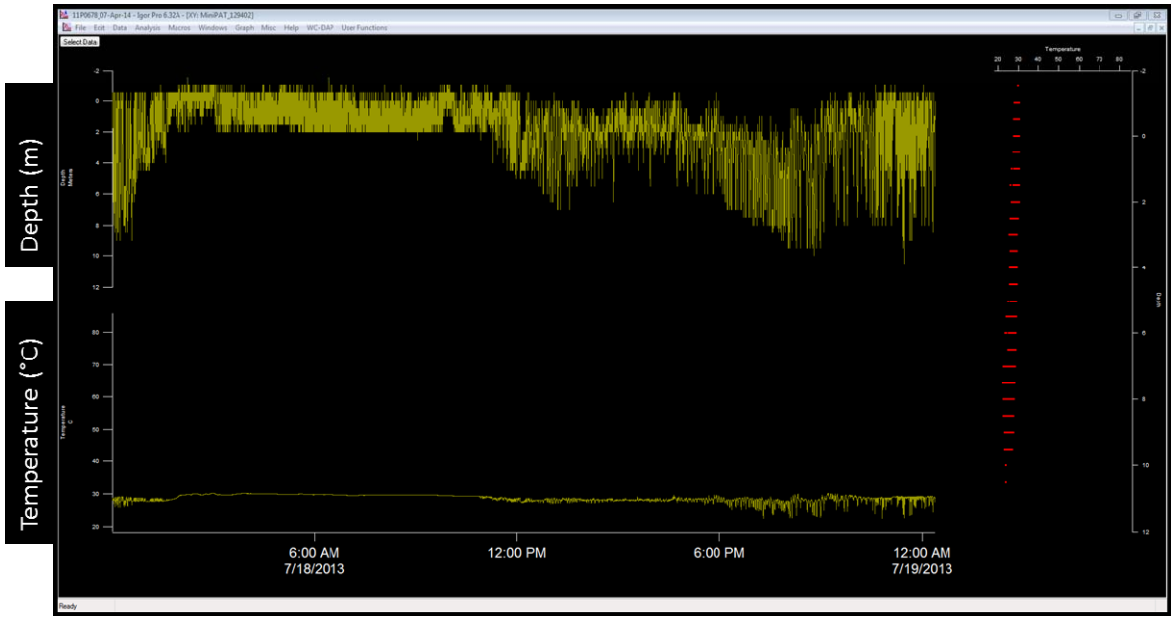

Figure 7. Depth and temperature over course of one day showing male cownose ray diurnal positioning in water post-mating.

Figure 8.

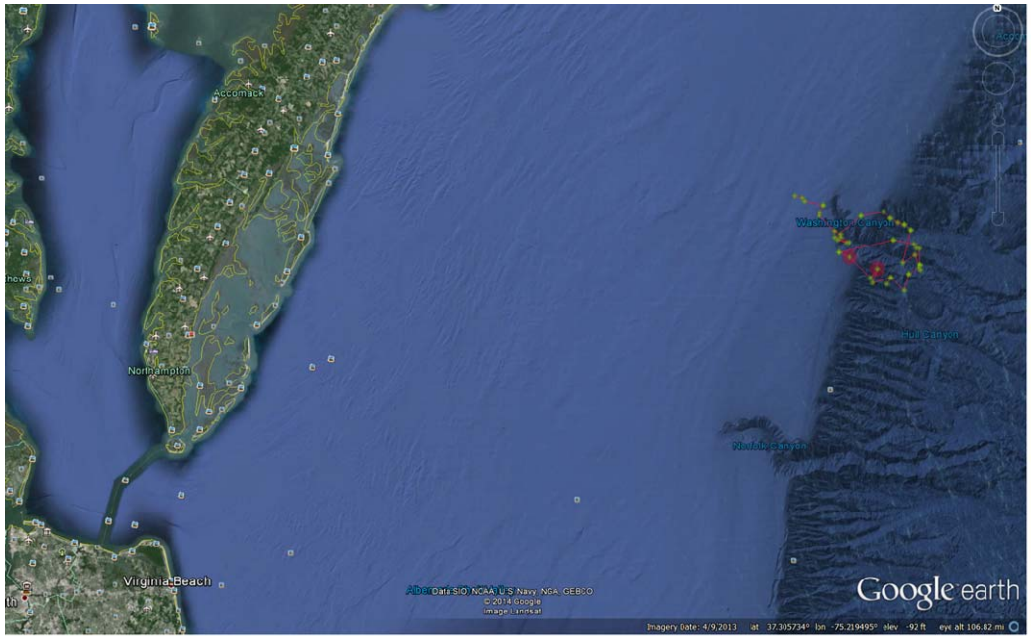

Figure 8. Location of tag 11P0461 when popped-off prematurely ; Washington Canyon, ~65 miles off Burton Bay on VA Eastern Shore.

Figure 9.

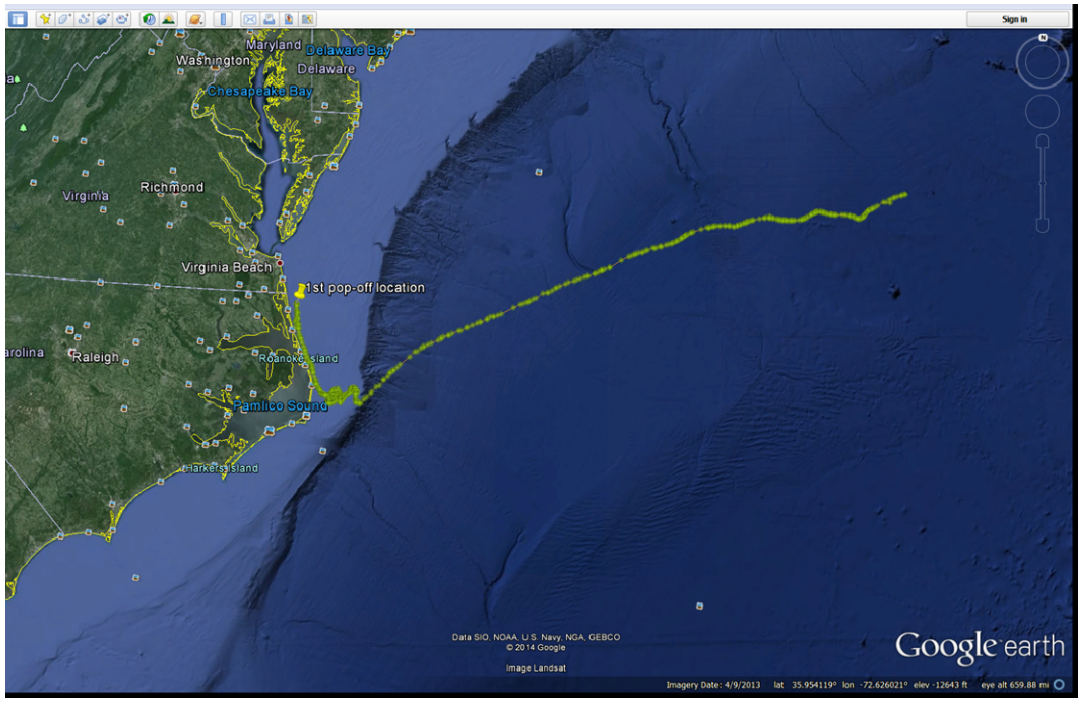

Figure 9. Location tag 11P0486 popped-off (pin) and drift path along NC coast and then out to sea.

Figure 10.

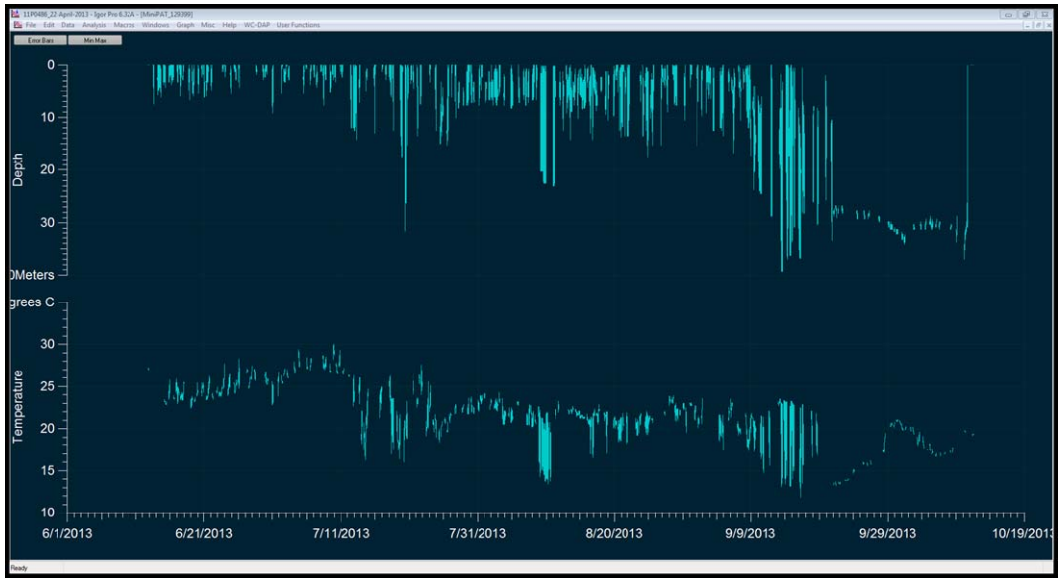

Figure 10. Depth and Temperature data for tag 11P0486 showing 119 days of male cownose ray activity pre (June) and post (early July –September) mating.

Figure 11.

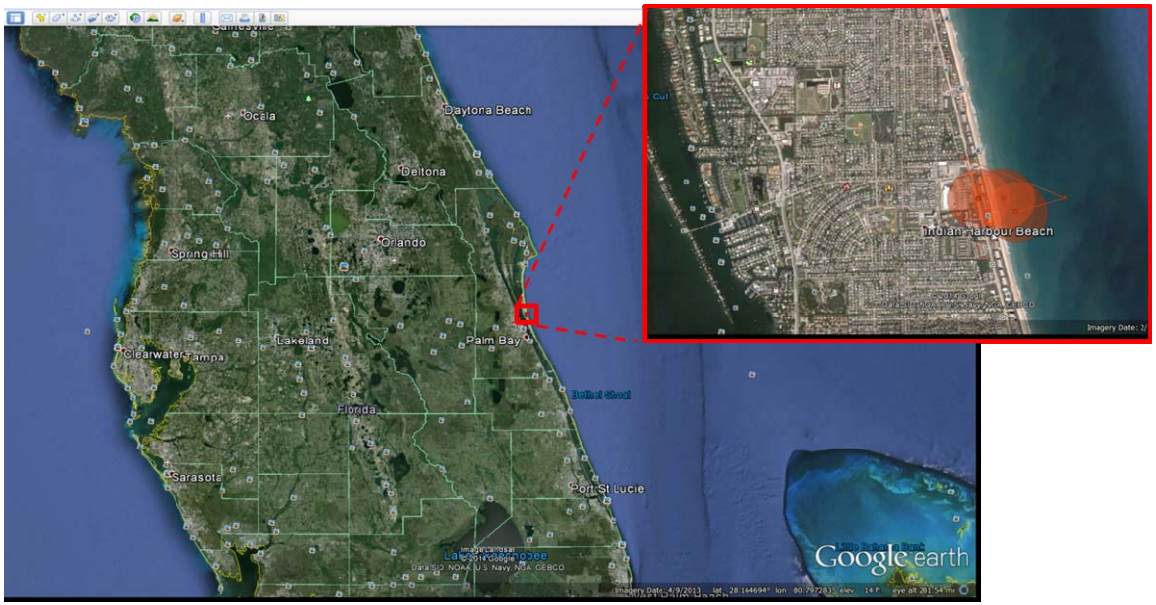

Figure 11. Pop-off location of Tag 11P0827 after 145 days of deployment showing tag located close to shore off Indian Harbour Beach, Florida.

Figure 12.

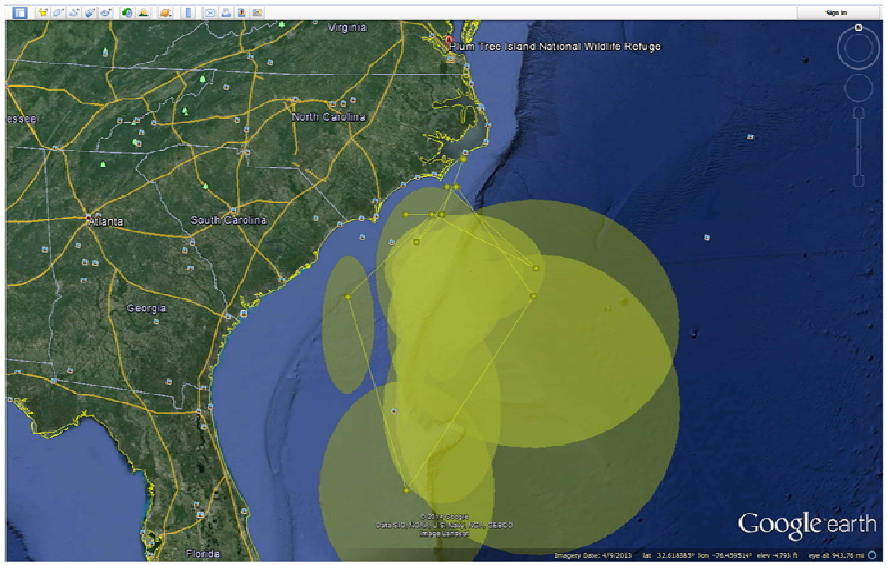

Figure 12. Results of geolocation with Wildlife Computer data analysis program (DAP) processor using Kalman filter for tag 11P0588 recovered data.