Assessing Potential Sublethal and Chronic Health Impacts from the Mississippi Canyon 252 Oil Spill on Coastal and Estuarine Bottlenose Dolphins: Dolphin Tracking – Final Report

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Introduction

The Chicago Zoological Society's Sarasota Dolphin Research Program was contracted to track 25 bottlenose dolphins tagged with satellite-linked transmitters during capture-release health assessments in Barataria Bay, LA during 3-17 August 2011. This research was done to: 1) gain a better understanding of movements and ranges of dolphins in Barataria Bay, an area which has been impacted by oil from the MC 252 oil spill, and 2) evaluate the conditions of the tagged dolphins and the tags and attachments after the first 3 months of deployment. The specific objectives of the research included:

1. Develop and test (through computer modeling) a tag design that will optimize satellite-linked tag performance in terms of longevity of tag attachment and reduction to potential impacts on the animals, prior to tag purchase and deployment;
2. Monitor the 25 satellite-linked tags through the duration of the period during which tags continue to transmit. Based on battery features and the programmed numbers of transmissions per day, transmissions from the satellite-linked tags may continue for up to 240 days;
3. Provide weekly summaries to the trustees and BP, depicting movements of tagged dolphins as determined from satellite-linked transmitters, including summary maps and brief narrative descriptions;
4. Provide a summary report to the trustees and BP following cessation of transmissions from all satellite-linked tags, including ranging maps for each tagged dolphin for the duration of the tracking and a narrative description of their patterns;
5. Deploy an experienced team of Chicago Zoological Society staff members to Grand Isle in late October/early November to attempt to photographically document the conditions of as many of the tagged dolphins as possible, including the condition of the tags and attachments, to facilitate interpretation of tag data.

With the submission of this final report, (Objective #4), all five of the objectives were completed successfully. This report compiles the complete location records for each of the tagged dolphins, previously presented as weekly updates (Objective # 3). Computational flow dynamics modeling (Objective #1) led to the tag and attachment design used on Barataria Bay dolphins. The resulting design exceeded our expectations for duration of deployment, with signals received over a period spanning 261 days (Objective #2). The following information summarizes the movements and ranges of the tagged dolphins in Barataria Bay over the period of remote tracking. Teams continued to monitor the conditions of the tags and dorsal fin attachments through a series of photographic identification surveys beyond November 2011 (Objective #5), through related but separate work plans. A summary of tag and dorsal fin conditions will be presented in a separate final report once final photographic data from August 2012 are available from NOAA, and analyzed.

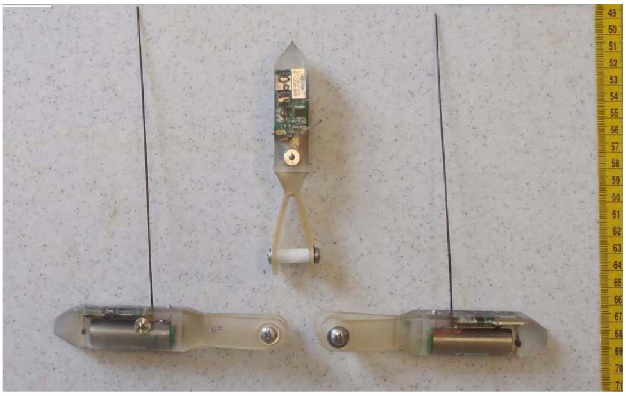
Materials and Methods

Hydrodynamic Modeling, Tag and Attachment Development

The tags and attachment were selected to optimize data collection while minimizing risk to the animals. The designs were the result of more than 40 years of dolphin tag and attachment design, development, testing and evolution by the Sarasota Dolphin Research Program and others (*e.g.*, Evans 1971; Evans et al. 1972; Irvine and Wells 1972; Irvine et al. 1982; Read and Gaskin 1985; Scott et al. 1990; Mate et al. 1995; Read et al. 1996, 1997; Westgate and Read 1998; Westgate et al. 1999; Wells et al. 1999; Scott et al. 2001; Wells 2005; Wells and Gannon 2005; Balmer et al. 2008; Wells et al. 2008a,b, 2009; Scott and Chivers 2009; Balmer et al. 2010, 2011). Design efforts over the years have taken advantage of improved technology leading to smaller electronic components and smaller tags, and increasing numbers of observations of tags post-deployment. Observations of dorsal fin damage from large tags attached by multiple pins drove recent efforts to reduce the number of attachments to a single pin (Irvine et al. 1982; Scott et al. 1990; Wells 2005; Balmer et al. 2010, 2011). Design improvements are continuing at a rapid pace, but the current state-of-the-art approach involves using the smallest tags available, attached by a single pin to the trailing edge of the dorsal fin.

We used SPOT-100 satellite-linked tags (Single-point Finmount, 281A, 2-Lay, Wildlife Computers, Redmond, WA) to obtain location data for the dolphins (Figure 1). This tag was 8.5 cm long, 2 cm wide, weighed 54 g, and had a flexible 18 cm-long antenna. Plastic wings, 4.5 cm-long x 1.5 cm-tall, extending forward from the tag body were positioned on each side of the trailing edge of the dorsal fin, with a matching 5/16" diameter hole in each for attaching the tag 3.5 cm from the fin's trailing edge. The basic shape of the tag built on recent design developments where single pin attachments were used and follow-up observations were possible (Balmer et al. 2011; Wells unpubl.) Computational flow dynamics (CFD) tests performed by Laurens Howle (Duke University) prior to production of tags for the Barataria Bay project resulted in shape and configuration refinements leading to significant reduction in drag as compared to previous designs.

Figure 1. Satellite-linked SPOT-100 tags deployed on bottlenose dolphins in Barataria Bay, LA, in August 2011. Views are of right side, left side, and top of tag. Attachment screws, washers, and Delrin pins are shown. Ruler indicates cm.



Based on the results of Howle's CFD tests and recommendations from Wildlife Computers, the attachment design was modified slightly from our previous design, in order to reduce drag, and consequently risk of injury to the dolphin. In most recent deployments (*e.g.*, Balmer et al. 2008; 2011) we used delrin pins, threaded on the ends, and secured with lock nuts. For the Barataria Bay project, we used a delrin pin system suggested and provided by Wildlife Computers (Redmond, WA). The attachment pin is a 5/16" delrin pin, machine-bored to accept a zinc-plated steel flathead screw in each end. The screws were 3/8 thread-forming screws for plastic, with 10-14 threads. A stainless steel washer was inserted between the screw head and the tag attachment wings. CFD tests found a significant reduction in drag for the lower profile of the screw heads as compared to lock nuts. Therefore, the bored-delrin and screw attachment was adopted to further reduce the possibility of tag migration through the fin as a result of drag forces (Figure 1).

Tag Attachment in the Field
The tag attachment process required less than five minutes. The tag was positioned on the fin and the center of the hole in the attachment wing was marked with a permanent marker. Wearing surgical gloves, the person attaching the tag cleaned the site with a dermachlor scrub followed by methanol. Using a dental injector gun, lidocaine with epinephrine was injected directly into the center of the hole, with 1-2 injections below the edge of the hole as well. A sterilized stainless steel 5/16" coring tool was centered over the mark, and pushed by hand through the fin into a rubber sanding block held against the fin on the other side. The core was saved for genetics in a vial of DMSO. From a selection of pins of different lengths soaking in dermachlor, a pin of appropriate length (about 20 mm) was selected and inserted through the hole in the dorsal fin. The wings of the tag were placed over the holes in the pins, and the screws and washers were attached by hand-tightening with screw drivers, to the point where playing-card-thick space remained between each wing and the fin. The tags were tested for function, photos were taken of the attachments and fin, and the animal was ready for release. By design, the screws/washers in the ends of the delrin attachment pins corrode, allowing the tags to fall off the fins after the end of tag's battery life.

Remote Tracking of Satellite-linked Tags
The tags were programmed to optimize battery life and access to satellites. They were set to transmit during two four-hour windows of time each day (02:00-05:59 and 08:00-11:59 local), based on ARGOS satellite pass prediction values, looking for satellites with >20^{o} elevation for at least 3 minutes. The tags were programmed to transmit up to 250 times each day, yielding a maximum of up to 240 tracking days based solely on battery life (however, in most previous deployments, corroding attachments have released the tag from the dolphin within 2-3 months). Preliminary tracking data (locations plotted on charts) for each dolphin were available from the satellite data processing provider, CLS-America/Argos, within hours of each transmission, via the internet. Final data were provided by CLS-America/Argos on cd-roms each month following completion of their data processing. Summary data were distributed weekly. Original data cd-roms were stored in a secure, locked vault at the Sarasota Dolphin Research Program's base of operations, in Sarasota, Florida. NRDA chain-of-custody procedures were observed at all times for data designated to contribute to the MC 252 NRDA.

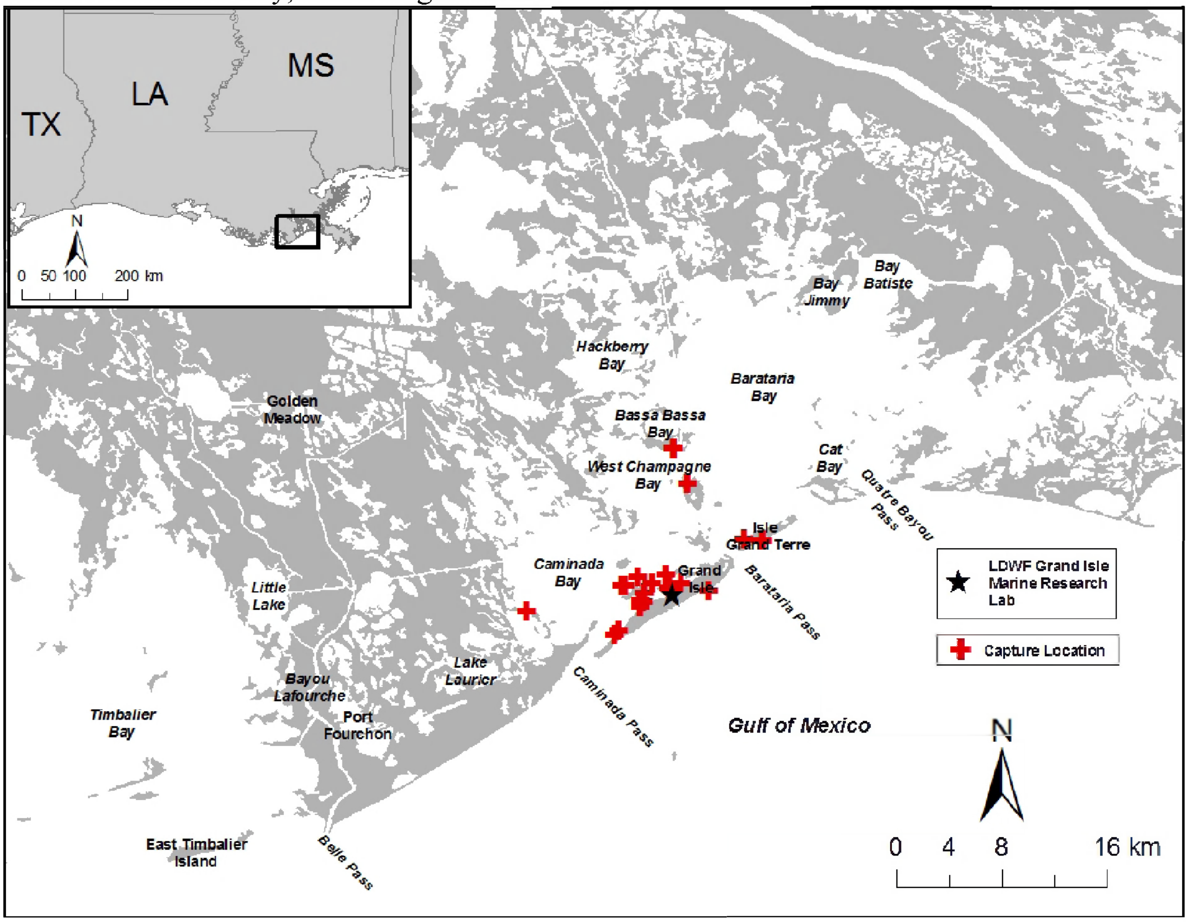
Location Data and Home Range Analyses
Data selection for mapping and home range analyses involved filtering for location plausibility. ARGOS classifies location quality relative to an estimated error radius. The best quality data,

LC3, has an estimated error of <150m. LC2 has an estimated error of <350m. LC1 locations are estimated to be accurate to within 1,000m. For the purposes of this project, we selected the higher quality locations, LC3 and LC2 for plotting and measuring ranges. Location maps were plotted using ArcMap 9.2 (ESRI, Redlands, California, USA). Home ranges were identified through 95% and 50% fixed kernel home range analyses calculated using the Animal Movement Analysis Extension (Hooge et al. 1999) in ArcMap.

Results

In total, 25 dolphins received satellite-linked tags in and around the waters of Barataria Bay, LA (Figure 2).

Figure 2. Capture locations for all 25 dolphins fitted with satellite-linked tags in and around the waters of Barataria Bay, LA in August 2012.



Satellite-linked Tag Performance

Satellite-linked transmitter data were received from all 25 dolphins post-deployment (Table 1). Three types of data were received from the satellite-linked tags: locations, transmissions, and status updates. Location data were described above. Some transmissions merely indicated that the tag was still active, but the transmission was of insufficient quality to provide data on tag condition or location. These transmissions were generally interpreted as meaning that the animal was still alive and the tag was still on the fin, unless other information indicated to the contrary. Status updates provided information on the parameters such as battery voltage remaining, and cumulative number of transmissions, allowing assessment of tag condition and potential longevity.

The number of days from date tagged to final transmission ranged from 48 (Y09) to 260 (Y17) and the total number of transmissions ranged from 12,416 (Y11) to 60,544 (Y01). Battery voltage, cumulative transmission counts, and follow-up photographic identification surveys of tagged individuals provided insight into possible reasons for cessation of transmissions. If battery voltage dropped below about 3.00V and/or the cumulative number of transmissions exceeded about 40,000, it was hypothesized that transmissions ceased due to battery exhaustion. Follow-up photographic identification surveys resighted 24 of the 25 satellite-tagged dolphins. These surveys permitted observations of the condition of the satellite-linked tag and its position on the dorsal fin. If battery voltage was greater than 3.00V during the final transmissions, tag failure was considered to be due to premature cessation, and examination of photos provided additional insight into the cause of cessation, such as bio-fouling or the tag was no longer attached to the dolphin. For 15 of the satellite-linked tags, the suggested reason for tag failure was battery exhaustion. Ten other tags were considered to have ceased transmitting prematurely. Of these, 8 were documented to have lost their tags between the time of the last transmission and the next observation of the animal.

Location and Home Range Analysis
The number of filtered locations for tagged dolphins ranged from 222 (Y12) to 1,067 (Y01) (Table 2). Up to 312 locations of LC3 and LC2 accuracy (Y18) were obtained for a given individual over the course of the project. These locations provided the basis for the following maps, measures, and descriptions (Figure 3). Fixed kernel home range size (95%) ranged from 17.4 km^2 (Y09) to 272.4 km^2 (Y10). Fixed kernel home range size (50%) ranged from 4.4 km^2 (Y09) to 17.4 km^2 (Y10). The maximum straight line measures across the longest dimension for a dolphin range varied, from 9.2 km (Y09) to 36.6 km (Y20). Overall, the tagged dolphins in this region did not exhibit long-range movements over the course of this project. Individual dolphin sighting histories and fixed kernel home range contours (95%, 50%), based upon LC3 and LC2 locations, were plotted to illustrate movements in and around Barataria Bay (Figures 4 - 28). A brief narrative of each tagged individual's movement pattern is provided below their respective figure.

Table 1. Satellite-linked transmitter performance data collected in and around the waters of Barataria Bay, LA from August 2011 to April 2012.

FB	PTT	Date Tagged	Date Final Location Received	Deployment to Final Location (# of Days)	Date Final Status Update Received	Deployment to Final Status Update (# of Days)	Date Final Transmission Received	Deployment to Final Transmission (# of Days)	Final Battery Strength (V)	# of Transmissions	Evidence of Biofouling	Final Date Sighted With Tag	Initial Date Sighted Without Tag	Suggested Reason for Tag Failure
Y00	109138	4-Aug-11	22-Nov-11	110	22-Nov-11	110	22-Nov-11	110	3.216	28,032	Slight	19-Nov-11	20-Apr-12	Premature cessation
Y01	109141	3-Aug-11	30-Mar-12	240	30-Mar-12	240	30-Mar-12	240	2.832	60,544	Slight	29-Mar-12	20-Apr-12	Battery exhausted
Y02	109148	4-Aug-11	9-Nov-11	97	9-Nov-11	97	9-Nov-11	97	3.152	24,704	Unknown	4-Aug-11	19-Nov-11	Premature cessation
Y03	109143	3-Aug-11	11-Dec-11	130	12-Dec-11	131	12-Dec-11	131	2.944	19,328	Heavy	13-Nov-11	25-Feb-12	Battery exhausted
Y04	109146	7-Aug-11	11-Oct-11	65	2-Jan-12	148	2-Jan-12	148	3.216	15,744	Heavy	19-Nov-11	7-Feb-12	Premature cessation
Y07	109134	5-Aug-11	1-Feb-12	180	1-Feb-12	180	1-Feb-12	180	2.768	38,016	Heavy	10-Feb-12	18-May-12	Battery exhausted
Y08	109152	9-Aug-11	12-Oct-11	64	13-Oct-11	65	13-Oct-11	65	3.152	16,256	No	22-Sep-11	27-Oct-11	Premature cessation
Y09	109135	5-Aug-11	22-Sep-11	48	22-Sep-11	48	22-Sep-11	48	3.200	12,672	No	9-Sep-11	No resight	Premature cessation
Y10	109145	9-Aug-11	22-Mar-12	226	22-Mar-12	226	26-Mar-12	230	2.800	56,960	Slight	11-Sep-11	24-Apr-12	Battery exhausted
Y11	109144	5-Aug-11	26-Sep-11	52	27-Sep-11	53	28-Sep-11	54	3.280	12,416	No	10-Sep-11	14-Nov-11	Premature cessation
Y12	109155	10-Aug-11	1-Feb-12	175	1-Feb-12	175	1-Feb-12	175	2.848	14,464	Slight	31-Jan-12	No resight	Premature cessation
Y13	109149	7-Aug-11	25-Jan-12	171	25-Jan-12	171	25-Jan-12	171	3.056	43,392	No	20-Sep-11	19-Apr-12	Battery exhausted
Y14	109136	11-Aug-11	9-Mar-12	211	9-Mar-12	211	16-Mar-12	218	2.896	53,376	Slight	10-Feb-12	19-Apr-12	Battery exhausted
Y15	109161	7-Aug-11	1-Jan-12	147	1-Jan-12	147	22-Jan-12	168	2.960	15,488	Heavy	16-Feb-12	30-Mar-12	Battery exhausted
Y16	109137	12-Aug-11	5-Jan-12	146	9-Jan-12	150	9-Jan-12	150	2.832	38,016	Moderate	14-Nov-11	13-Feb-12	Battery exhausted
Y17	109160	8-Aug-11	11-Apr-12	247	11-Apr-12	247	24-Apr-12	260	3.024	40,576	Heavy	18-May-12	No resight	Battery exhausted
Y18	109157	15-Aug-11	27-Feb-12	196	27-Feb-12	196	27-Feb-12	196	2.784	49,536	Slight	26-Feb-12	17-May-12	Battery exhausted
Y19	109139	9-Aug-11	18-Jan-12	162	7-Feb-12	182	7-Feb-12	182	3.136	18,560	Slight	20-Sep-11	27-Mar-12	Premature cessation
Y20	109150	15-Aug-11	10-Dec-11	117	10-Dec-11	117	10-Dec-11	117	3.168	29,568	No	20-Sep-11	7-Feb-12	Premature cessation
Y22	109162	16-Aug-11	22-Feb-12	190	24-Feb-12	192	24-Feb-12	192	2.800	48,256	Heavy	26-Feb-12	19-Apr-12	Battery exhausted
Y25	109158	11-Aug-11	21-Jan-12	163	21-Jan-12	163	21-Jan-12	163	2.912	41,088	Unknown	11-Aug-11	14-Feb-12	Battery exhausted
Y27	109147	11-Aug-11	19-Mar-12	221	19-Mar-12	221	19-Mar-12	221	2.880	55,680	Unknown	11-Aug-11	No resight	Battery exhausted
Y33	109133	12-Aug-11	17-Jan-12	158	17-Jan-12	158	17-Jan-12	158	2.992	36,992	Slight	21-Sep-11	20-Apr-12	Battery exhausted
Y37	109154	16-Aug-11	28-Jan-12	165	29-Jan-12	166	29-Jan-12	166	3.040	41,856	Unknown	16-Aug-11	14-Feb-12	Battery exhausted
Y39	109142	16-Aug-11	31-Dec-11	137	31-Dec-11	137	31-Dec-11	137	3.136	34,944	Moderate	19-Nov-11	11-Feb-12	Premature cessation

Table 2. Location and home range analysis for satellite-linked transmitter data collected in and around the waters of Barataria Bay, LA from August 2011 to April 2012.

FB	Date Tagged	Date Final Location Received	Deployment to Final Location (# of Days)	# of Filtered Locations	Location Class 3 (~150 m)	Location Class 2 (~350 m)	Location Class 1 (~1 km)	Location Class 0 (>1 km)	95% Fixed Kernel Home Range Area (km^2)	50% Fixed Kernel Home Range Area (km^2)	Maximum Distance Between Locations (km)	Distance from Capture and Farthest Location (km)
Y00	4-Aug-11	22-Nov-11	110	544	25	106	174	91	79.7	17.0	22.4	18.5
Y01	3-Aug-11	30-Mar-12	240	1067	85	204	205	88	129.4	11.7	19.0	17.4
Y02	4-Aug-11	9-Nov-11	97	425	14	71	163	72	151.0	17.3	20.5	11.6
Y03	3-Aug-11	11-Dec-11	130	323	22	48	78	44	85.2	13.8	15.9	8.8
Y04	7-Aug-11	11-Oct-11	65	381	32	70	111	57	120.8	7.2	16.5	9.9
Y07	5-Aug-11	1-Feb-12	180	843	48	148	252	94	109.1	17.7	32.4	28.5
Y08	9-Aug-11	12-Oct-11	64	332	28	39	79	45	91.4	9.0	27.5	14.5
Y09	5-Aug-11	22-Sep-11	48	272	22	45	45	22	17.4	4.4	9.2	7.9
Y10	9-Aug-11	22-Mar-12	226	737	50	105	138	67	272.4	17.4	27.0	19.6
Y11	5-Aug-11	26-Sep-11	52	342	17	45	80	40	54.4	6.8	15.5	8.5
Y12	10-Aug-11	1-Feb-12	175	222	19	38	64	29	98.7	21.0	13.9	8.6
Y13	7-Aug-11	25-Jan-12	171	825	86	193	267	93	149.9	29.4	23.7	23.7
Y14	11-Aug-11	9-Mar-12	211	941	54	212	330	111	169.8	14.4	27.6	20.8
Y15	7-Aug-11	1-Jan-12	147	265	8	11	60	38	177.1	38.7	14.9	11.1
Y16	12-Aug-11	5-Jan-12	146	284	24	52	87	29	50.5	8.0	12.1	7.5
Y17	8-Aug-11	11-Apr-12	247	945	52	170	290	154	24.9	2.7	11.0	8.1
Y18	15-Aug-11	27-Feb-12	196	956	89	223	226	81	271.6	41.3	30.0	25.7
Y19	9-Aug-11	18-Jan-12	162	260	7	17	48	43	37.8	5.5	9.4	9.4
Y20	15-Aug-11	10-Dec-11	117	639	60	128	176	88	270.7	12.2	36.6	26.2
Y22	16-Aug-11	22-Feb-12	190	845	44	118	252	141	111.5	6.1	20.8	14.1
Y25	11-Aug-11	21-Jan-12	163	789	40	161	262	112	134.5	17.2	19.8	19.6
Y27	11-Aug-11	19-Mar-12	221	960	71	196	282	138	209.9	52.3	36.0	27.4
Y33	12-Aug-11	17-Jan-12	158	593	45	119	148	64	86.9	10.8	21.8	18.4
Y37	16-Aug-11	28-Jan-12	165	790	70	231	233	81	203.3	21.4	21.8	21.0
Y39	16-Aug-11	31-Dec-11	137	722	46	97	172	108	62.1	6.4	17.5	9.9

Figure 3. (a) Satellite-linked locations (LC3 and LC2), and (b) 95% and (c) 50% fixed-kernel home range contours for all dolphins tagged in Barataria Bay, LA from August 2011 to April 2012.

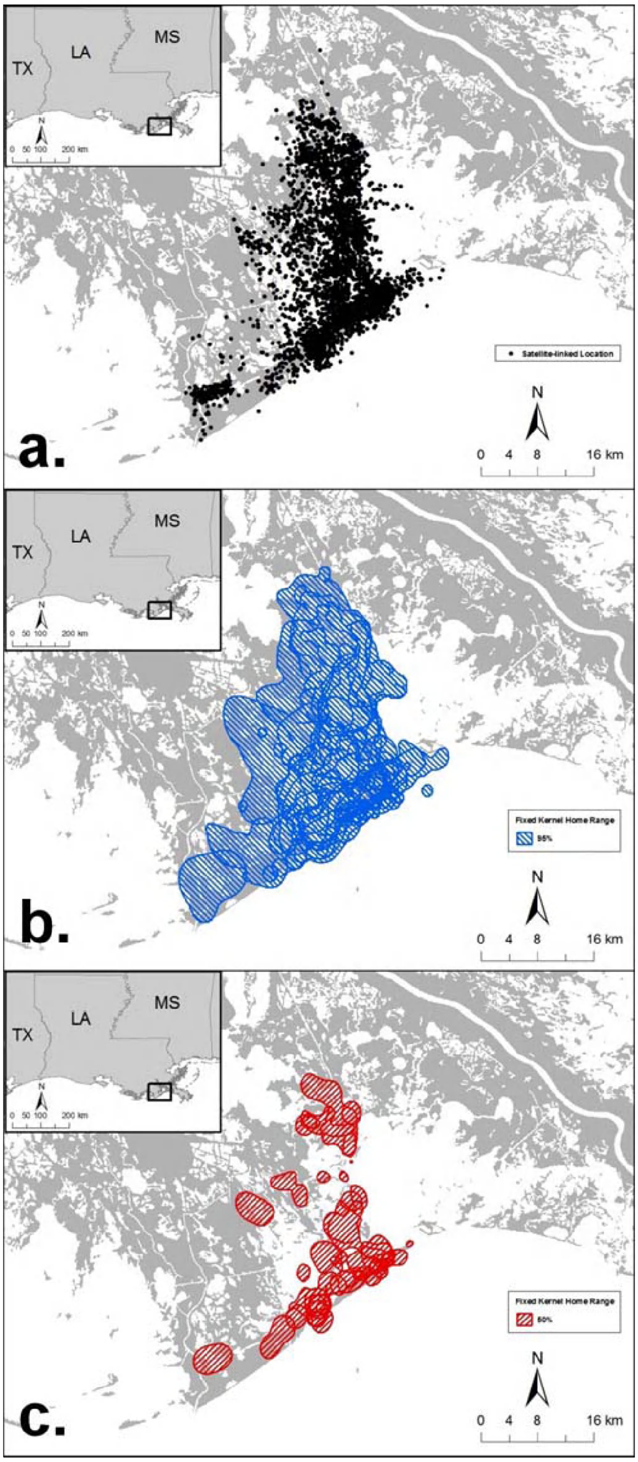
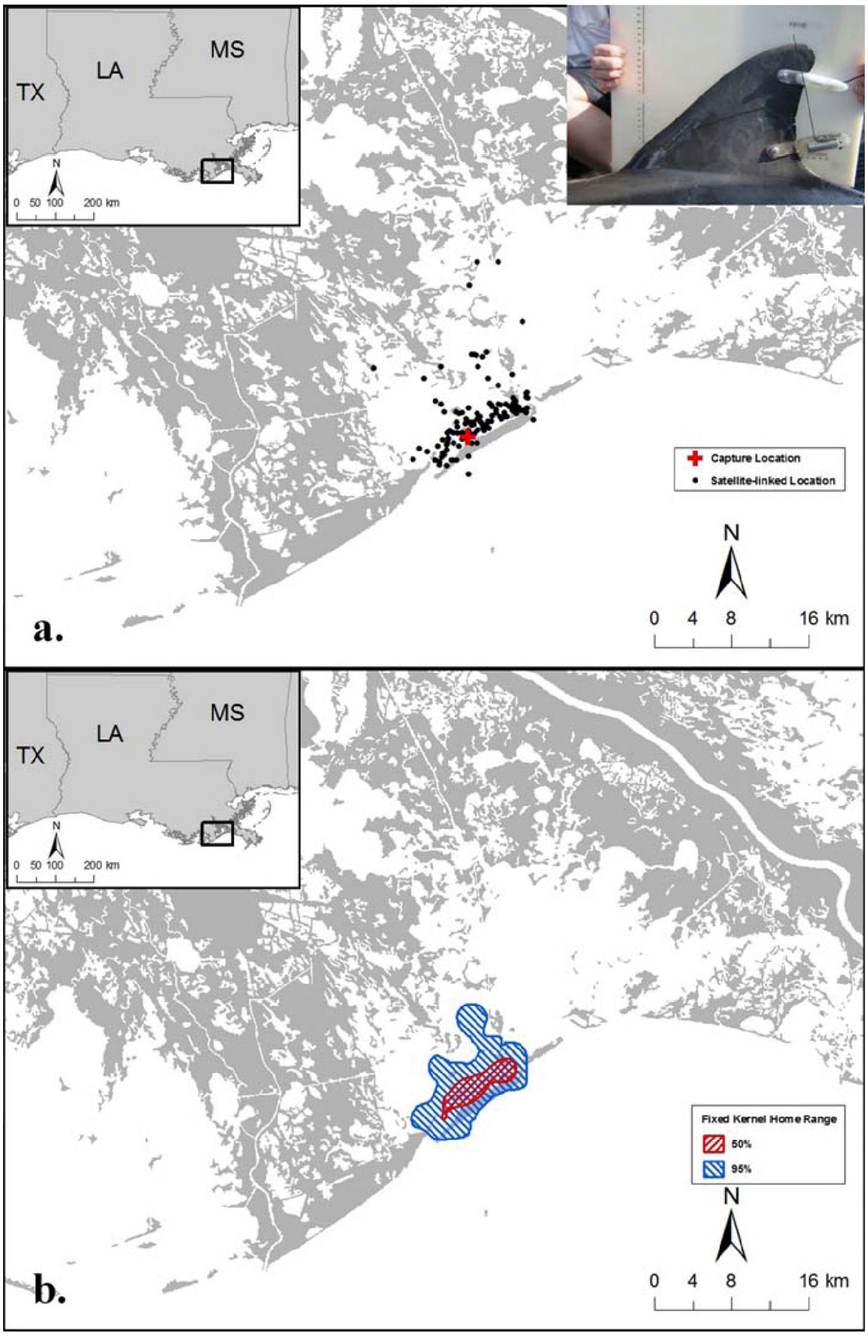
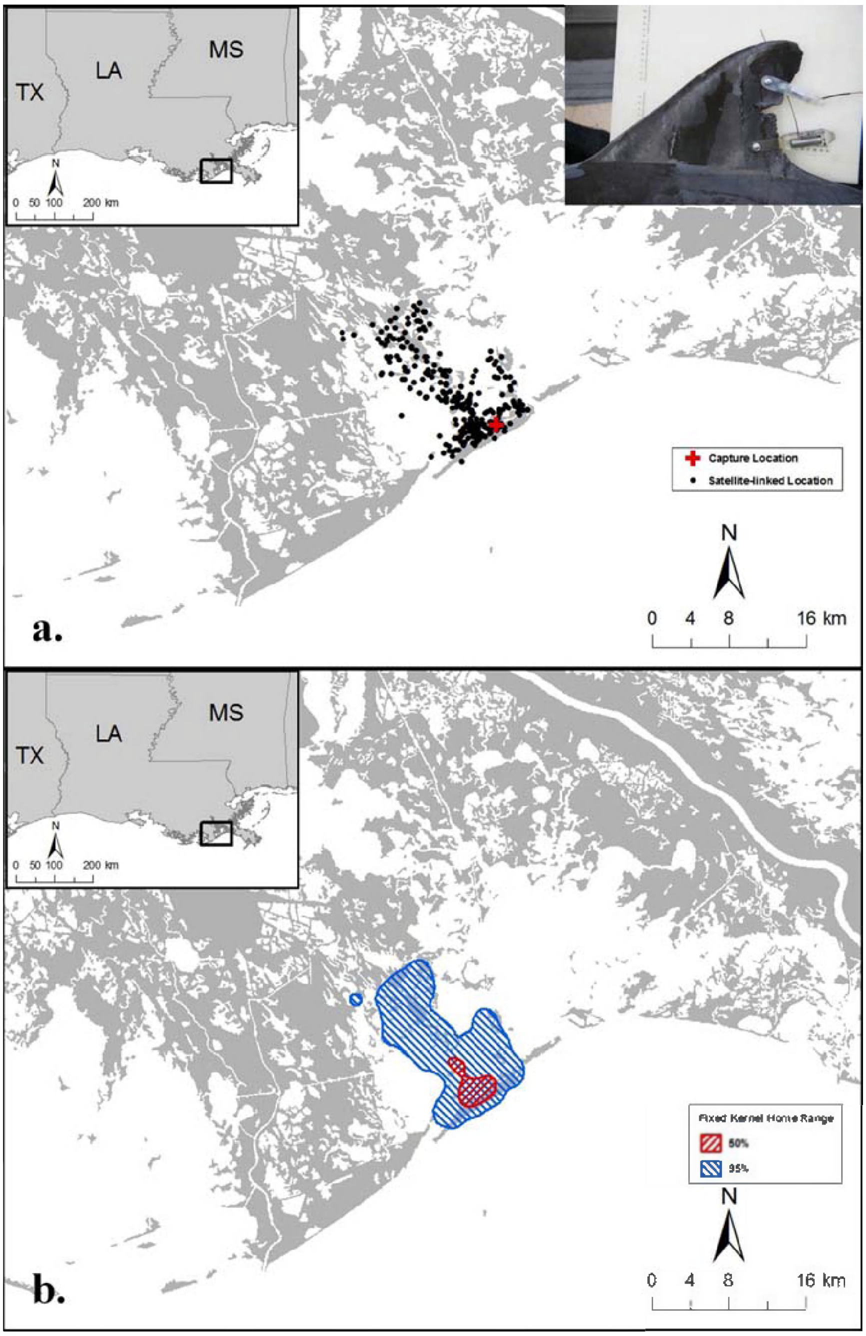


Figure 4. (a) Y00's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



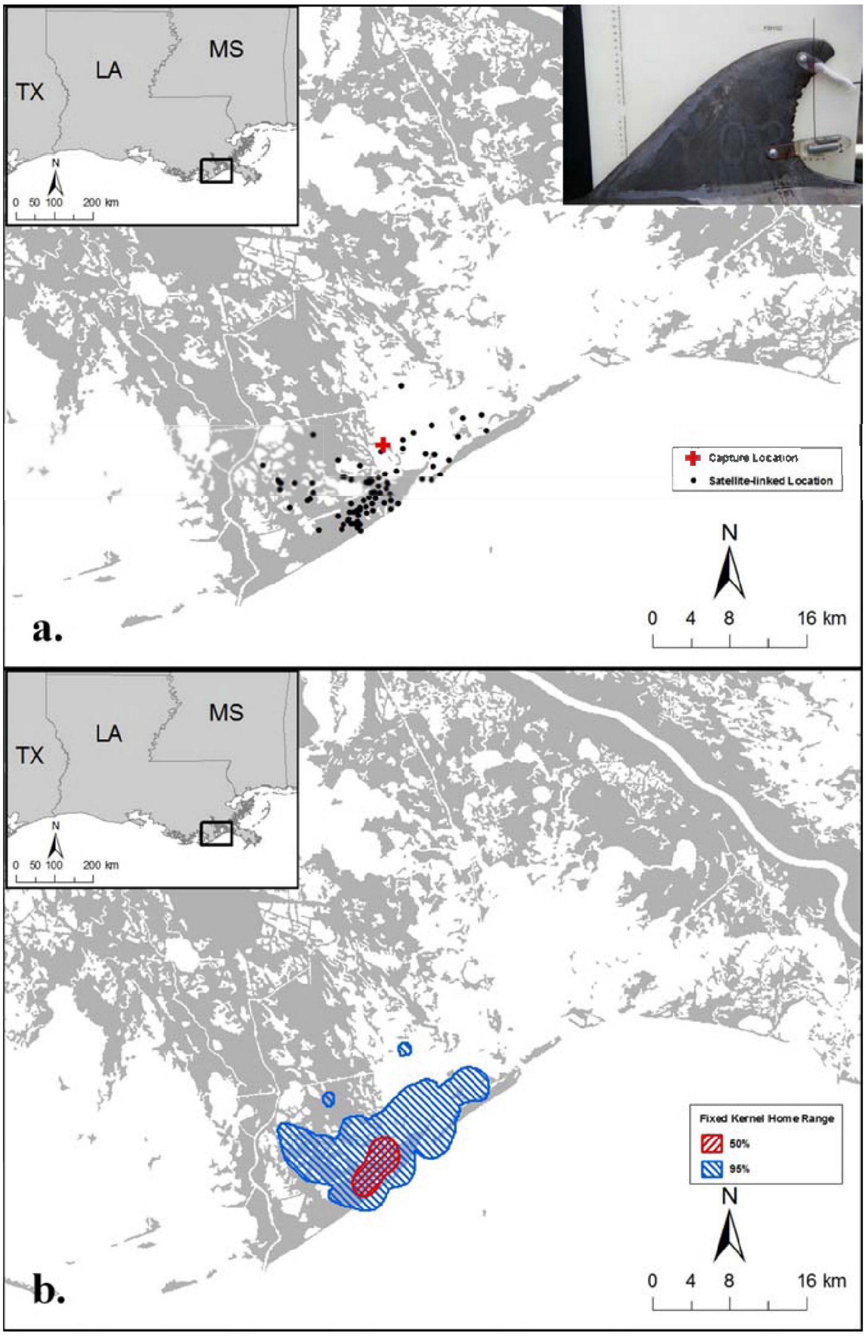
Y00's 50% fixed kernel home range was concentrated along the estuarine waters of Grand Isle, with the 95% fixed kernel home range extending into West Champagne Bay, Caminada Bay, and Caminada Pass, the coastal waters of Grand Isle, and Barataria Pass.

Figure 5. (a) Y01's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



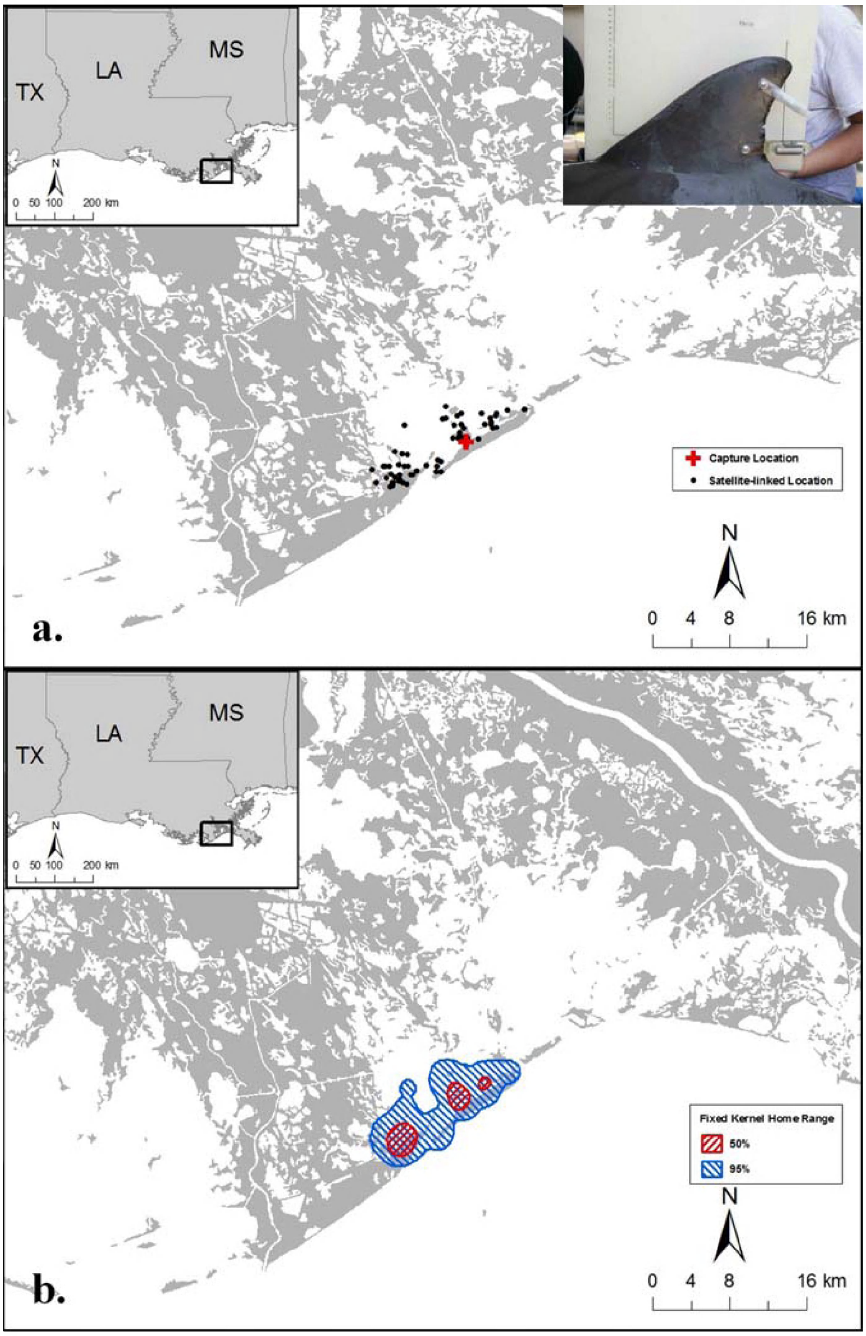
Y01's 50% fixed kernel home range was concentrated along the estuarine waters of Grand Isle, with the 95% fixed kernel home range extending into Caminada Bay, West Champagne Bay, Barataria Pass, the southwest corner of Isle Grand Terre, and the coastal waters of Grand Isle.

Figure 6. (a) Y02's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



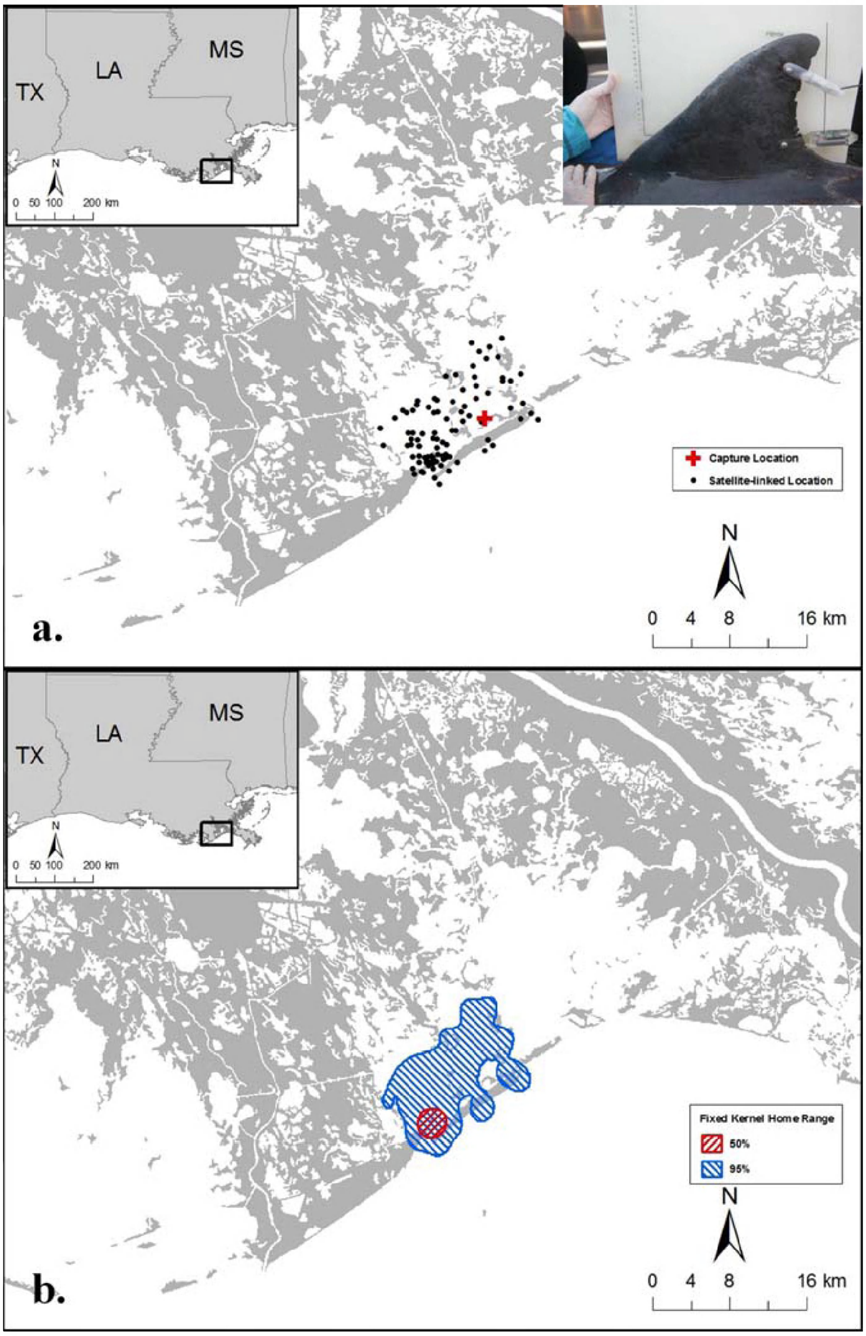
Y02's 50% fixed kernel home range was concentrated in and around the estuarine waters of Lake Laurier, with the 95% fixed kernel home range extending into the estuarine waters northeast of Port Fourchon, Caminada Bay, Caminada Pass, and the estuarine waters of Grand Isle.

Figure 7. (a) Y03's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



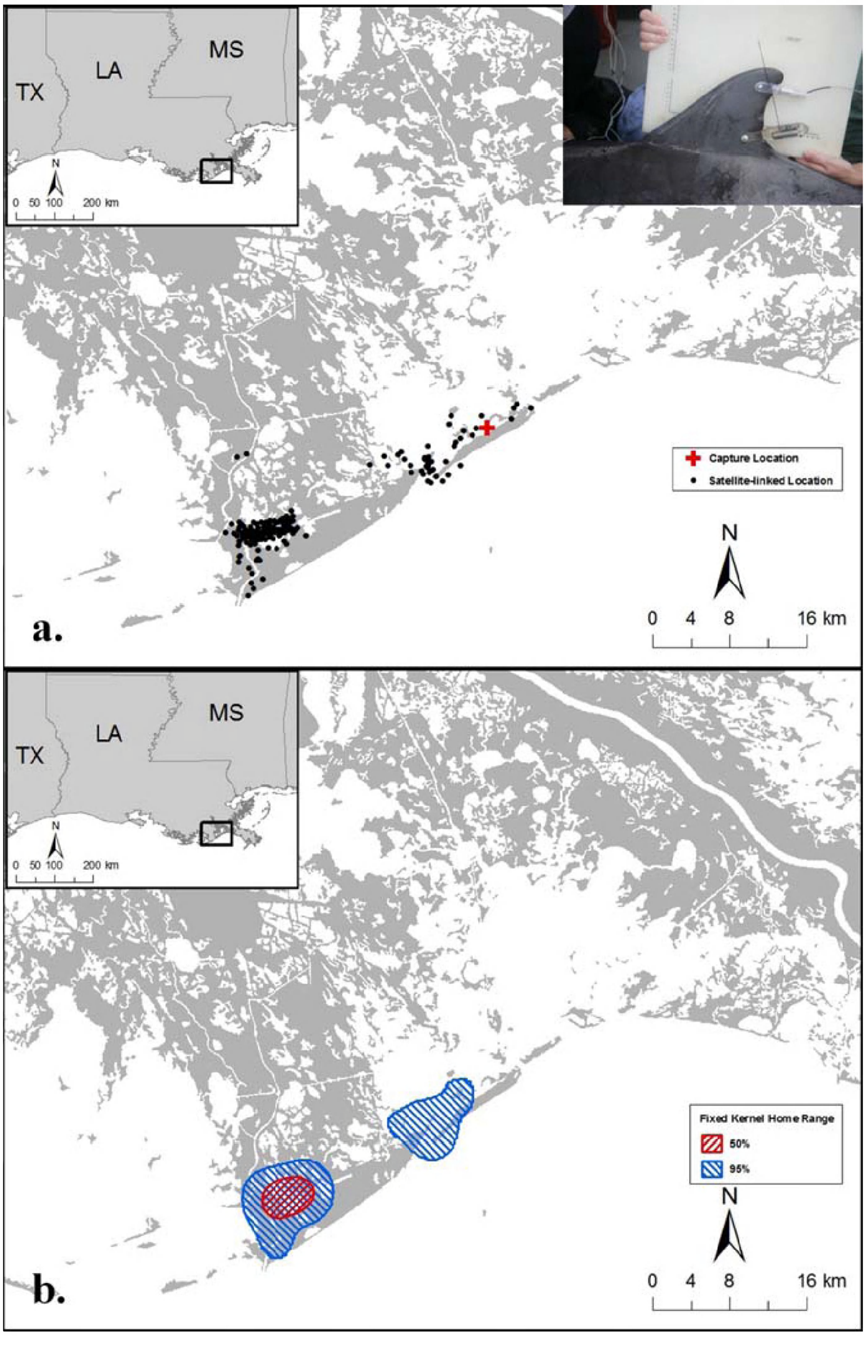
Y03's 50% fixed kernel home range was concentrated around the southwest corner of Caminada Bay and the estuarine waters of Grand Isle, with the 95% fixed kernel home range extending into Caminada Bay, Caminada Pass, Barataria Pass, and the coastal waters of Grand Isle.

Figure 8. (a) Y04's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



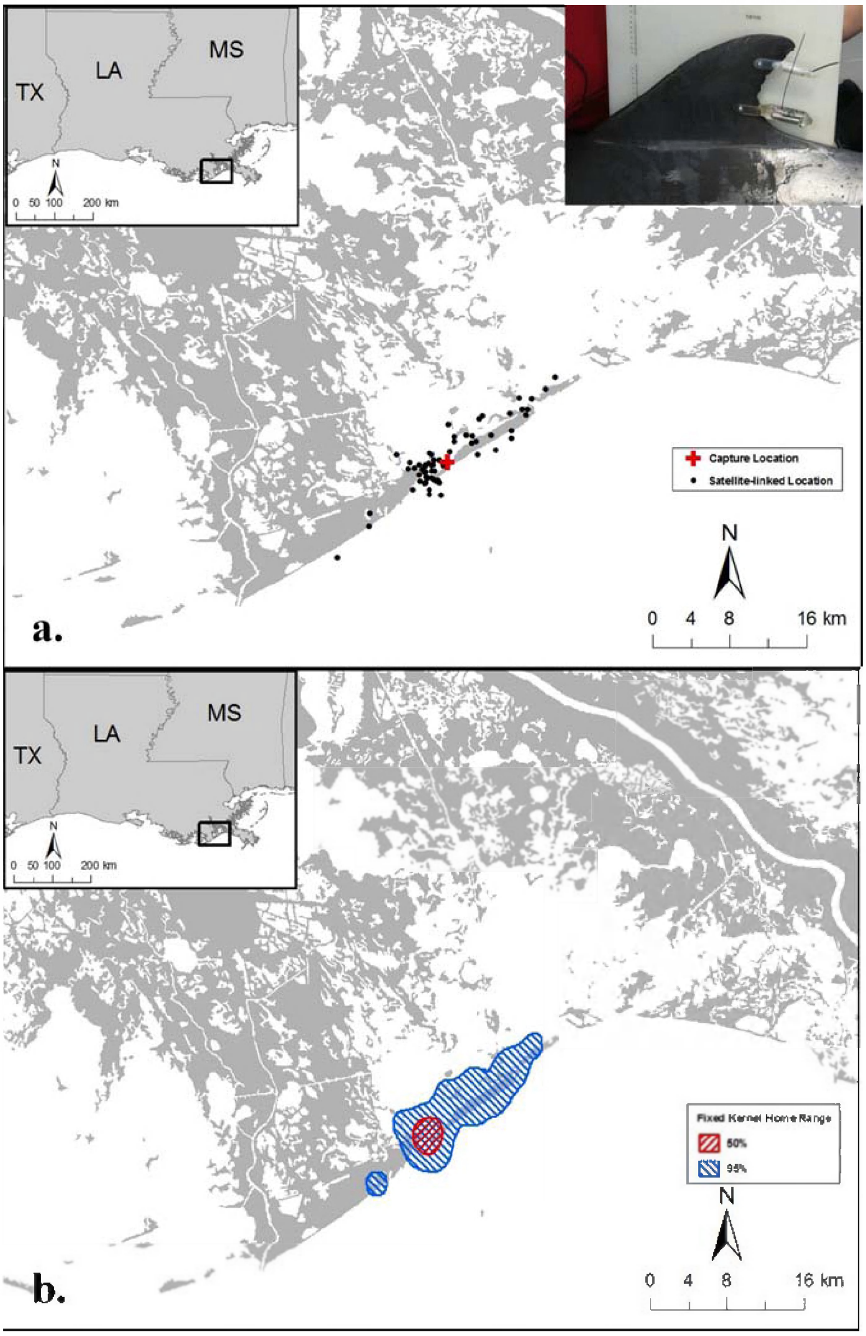
Y04's 50% fixed kernel home range was concentrated around Caminada Pass, with the 95% fixed kernel home range extending into Caminada Bay, the estuarine and coastal waters of Grand Isle, West Champagne Bay, and Barataria Pass.

Figure 9. (a) Y07's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



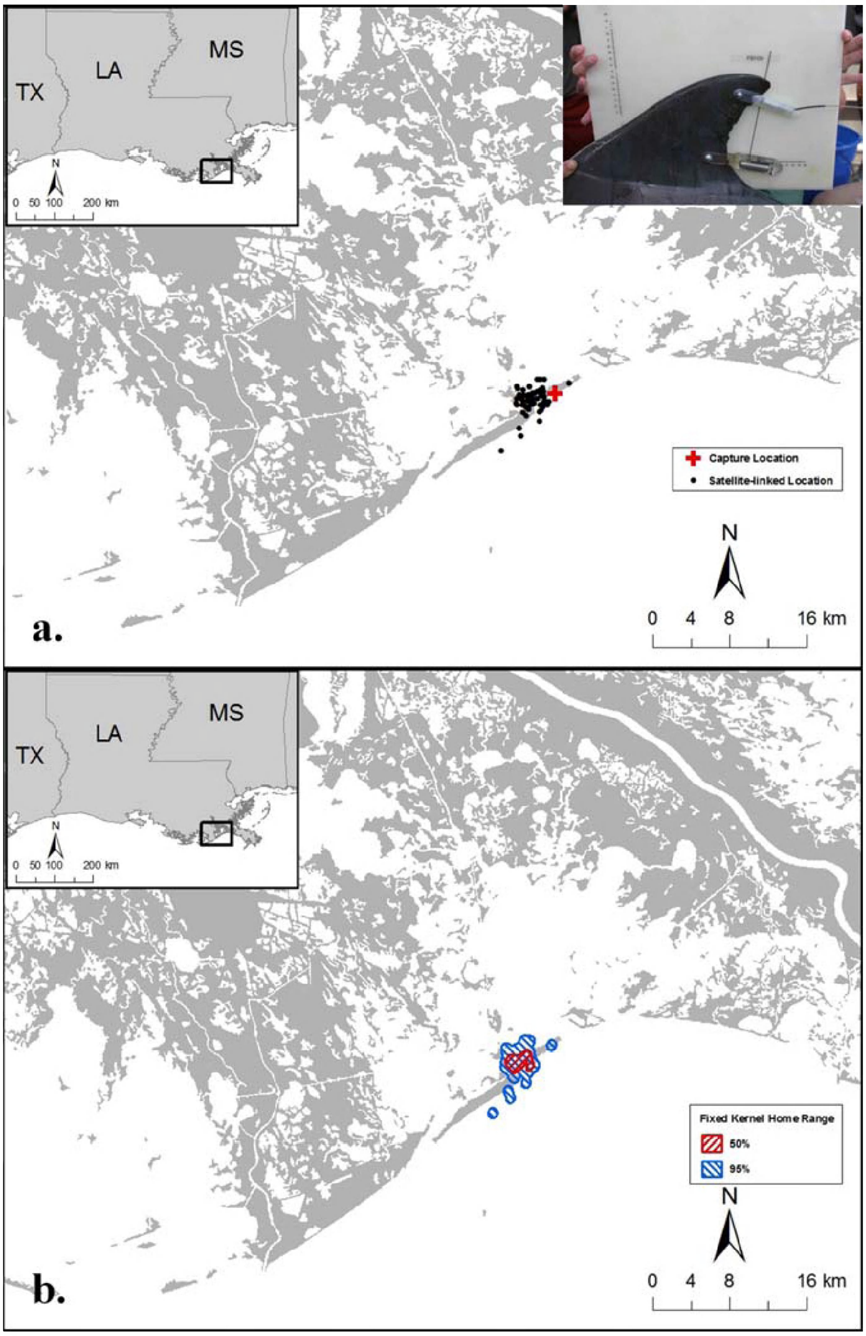
Y07's 50% fixed kernel home range was concentrated around the estuarine waters of Port Fourchon, with the 95% fixed kernel home range including Bayou Fourchon, Belle Pass, Caminada Bay, and Caminada Pass.

Figure 10. (a) Y08's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



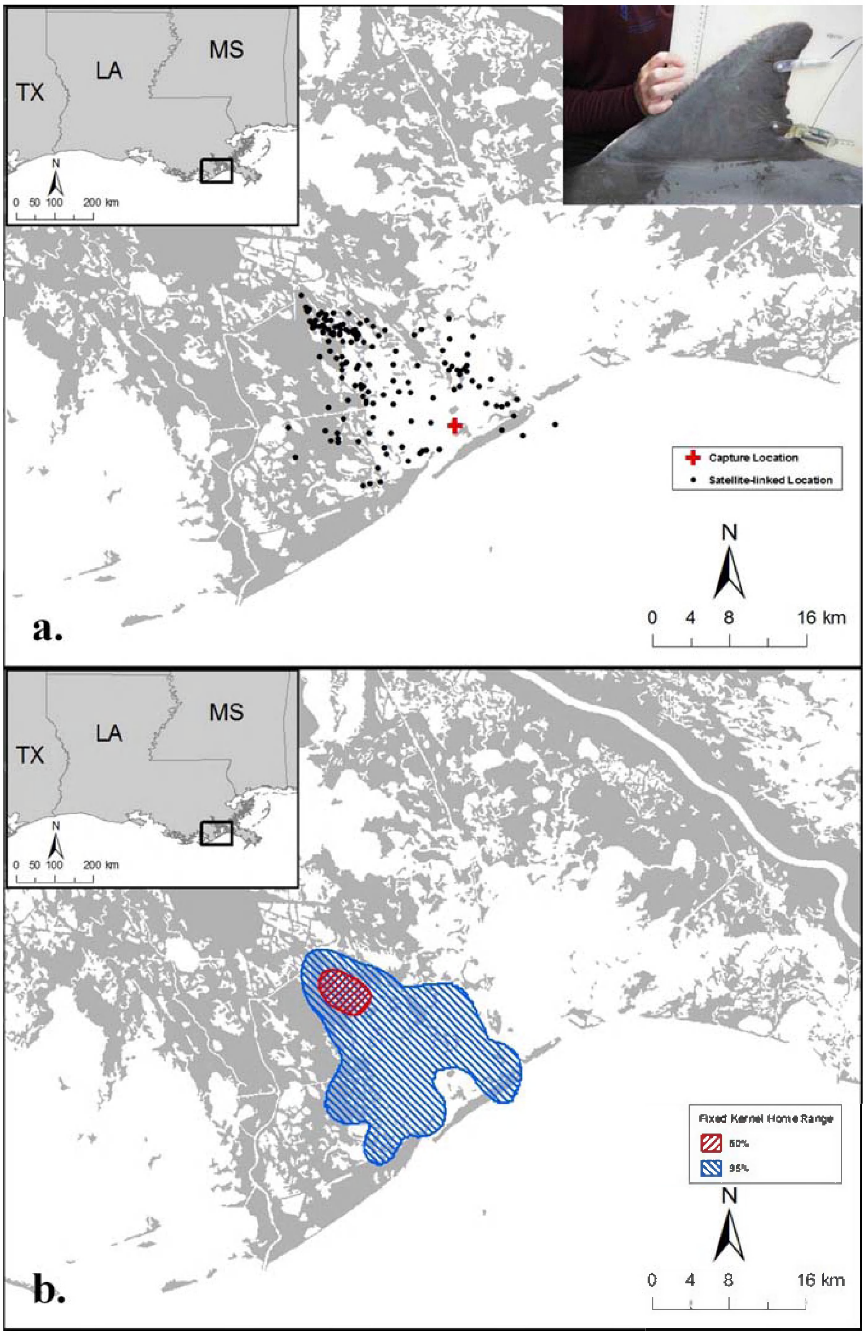
Y08's 50% fixed kernel home range was concentrated around Caminada Pass, with the 95% fixed kernel home range including the southern corner of Caminada Bay, and the estuarine and coastal waters of Grand Isle.

Figure 11. (a) Y09's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



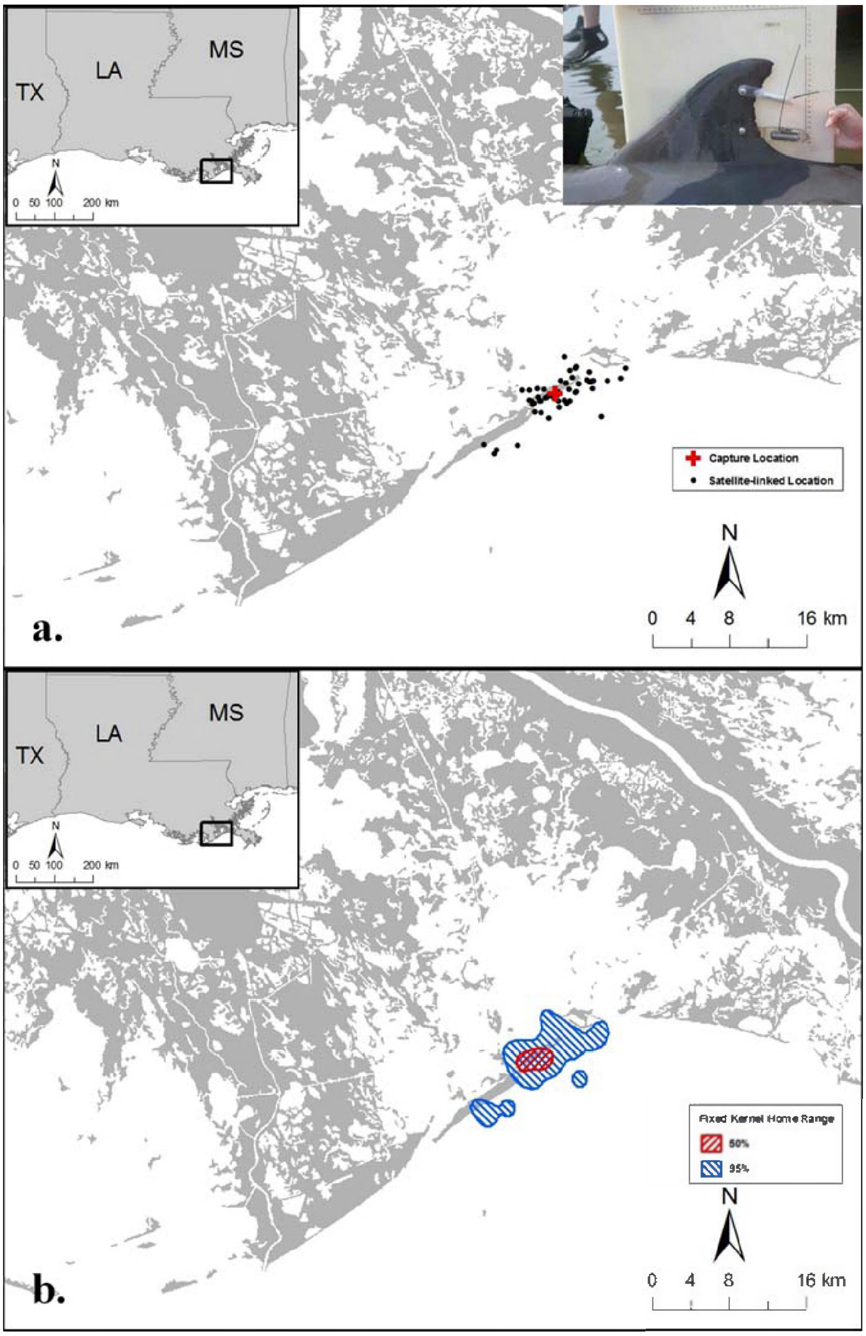
Y09's 50% fixed kernel home range was concentrated around the northwest corner of Grand Isle, with the 95% fixed kernel home range including the coastal waters of Grand Isle.

Figure 12. (a) Y10's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



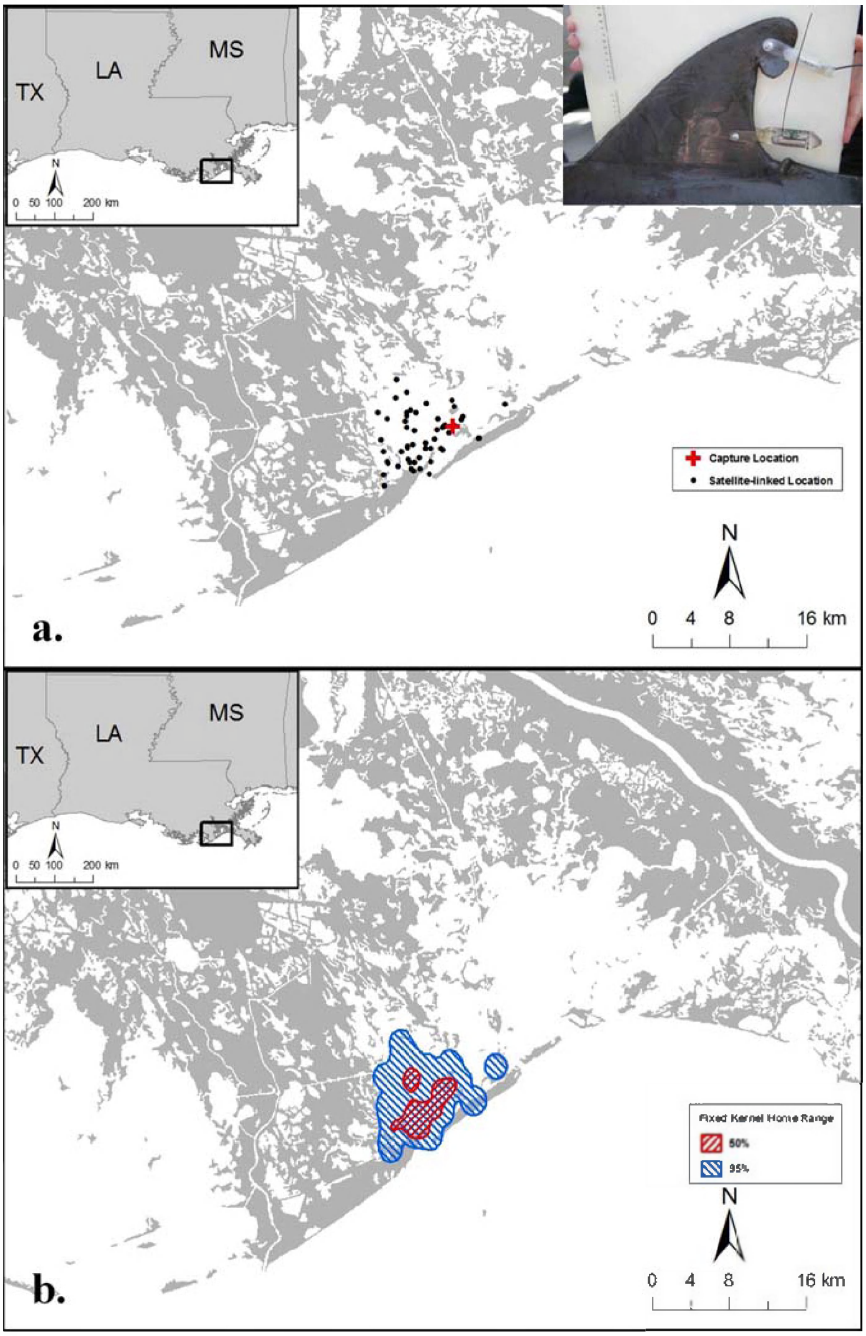
Y10's 50% fixed kernel home range was concentrated around the northwest corner of Caminada Bay, with the 95% fixed kernel home range including all of Caminada Bay, Caminada Pass, the northwest corner of Grand Isle, and Barataria Pass.

Figure 13. (a) Y11's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



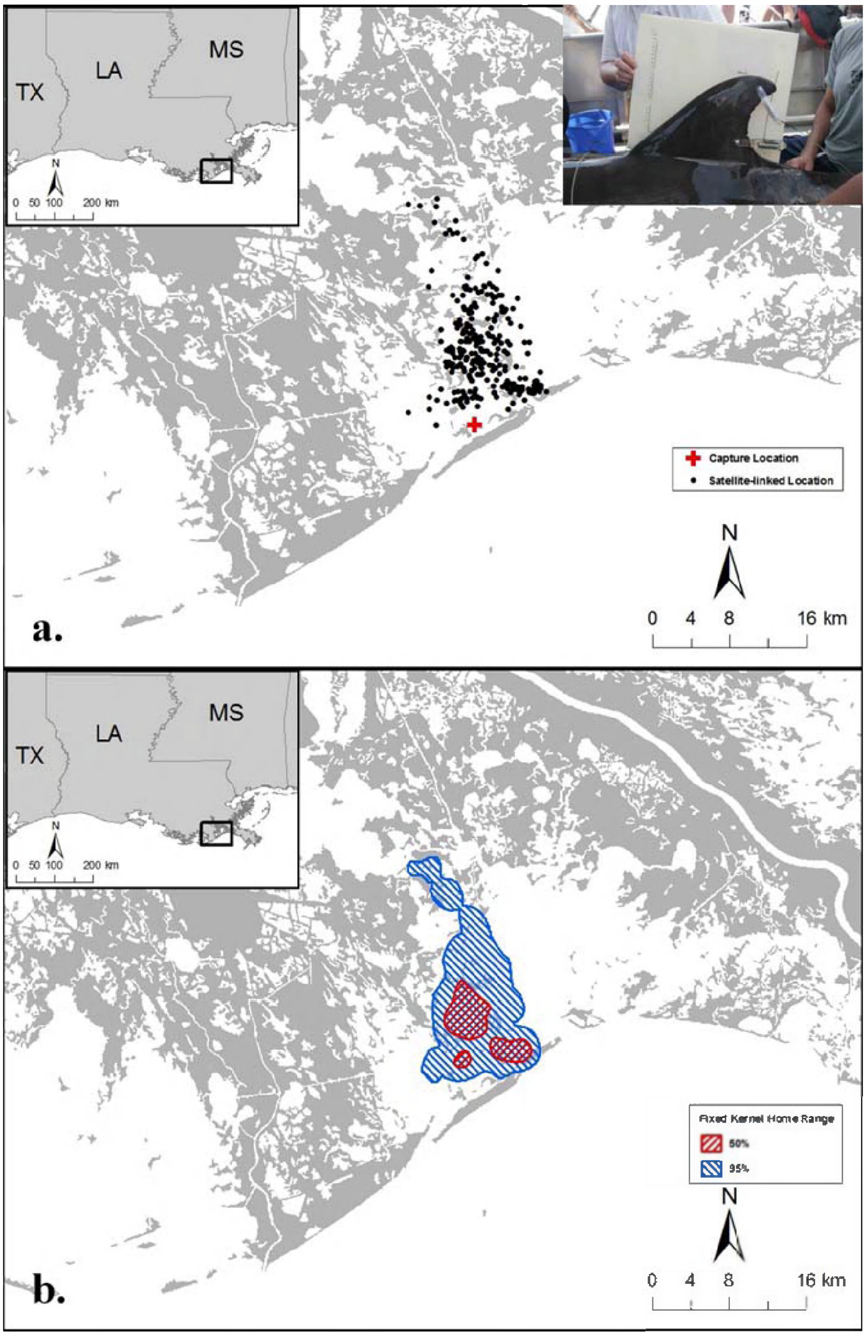
Y11's 50% fixed kernel home range was concentrated around Barataria Pass, with the 95% fixed kernel home range including the coastal waters of Grand Isle, southwest corner of Barataria Bay, and the coastal waters of Grand Terre.

Figure 14. (a) Y12's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



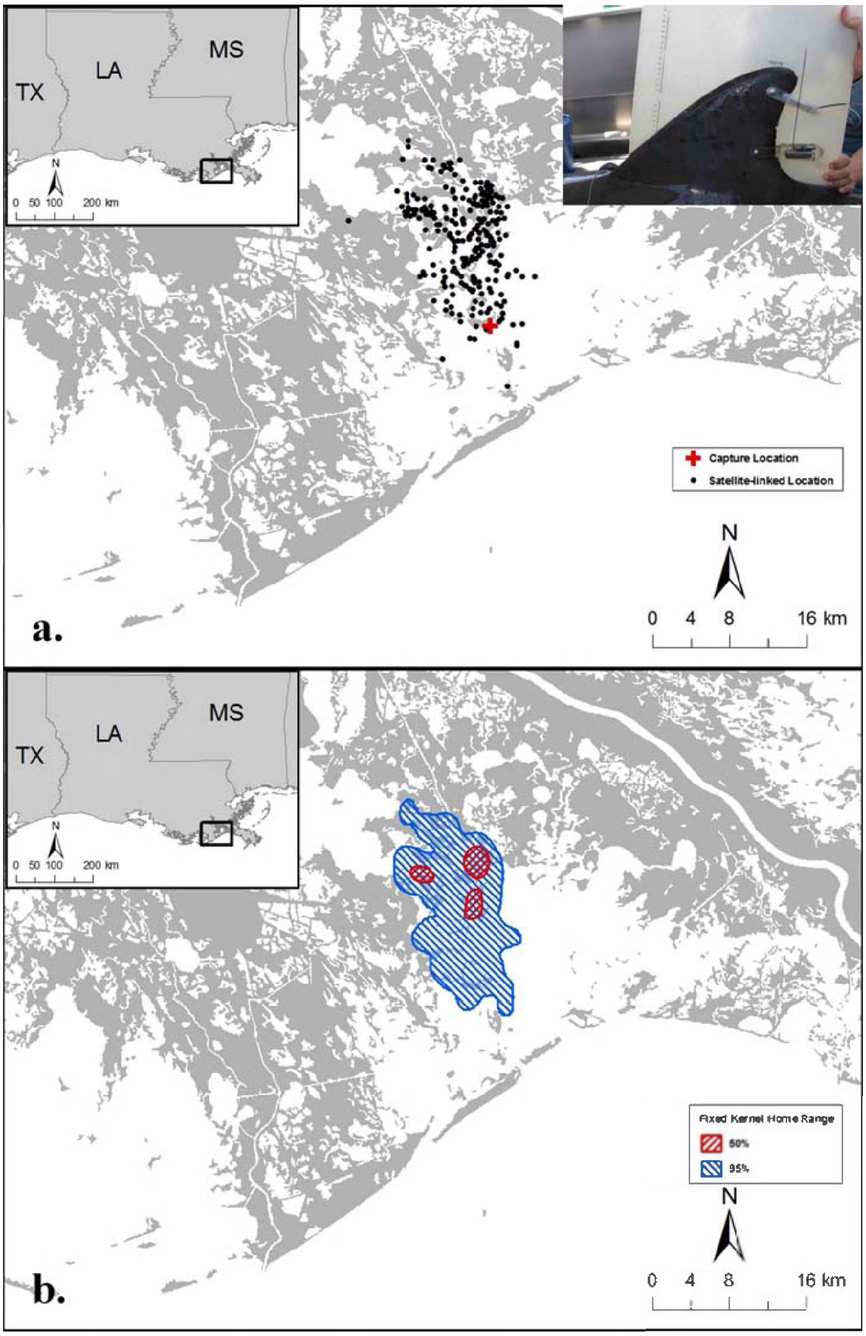
Y12's 50% fixed kernel home range was concentrated in Caminada Bay, with the 95% fixed kernel home range including Caminada Pass and the northwest corner of Grand Isle.

Figure 15. (a) Y13's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



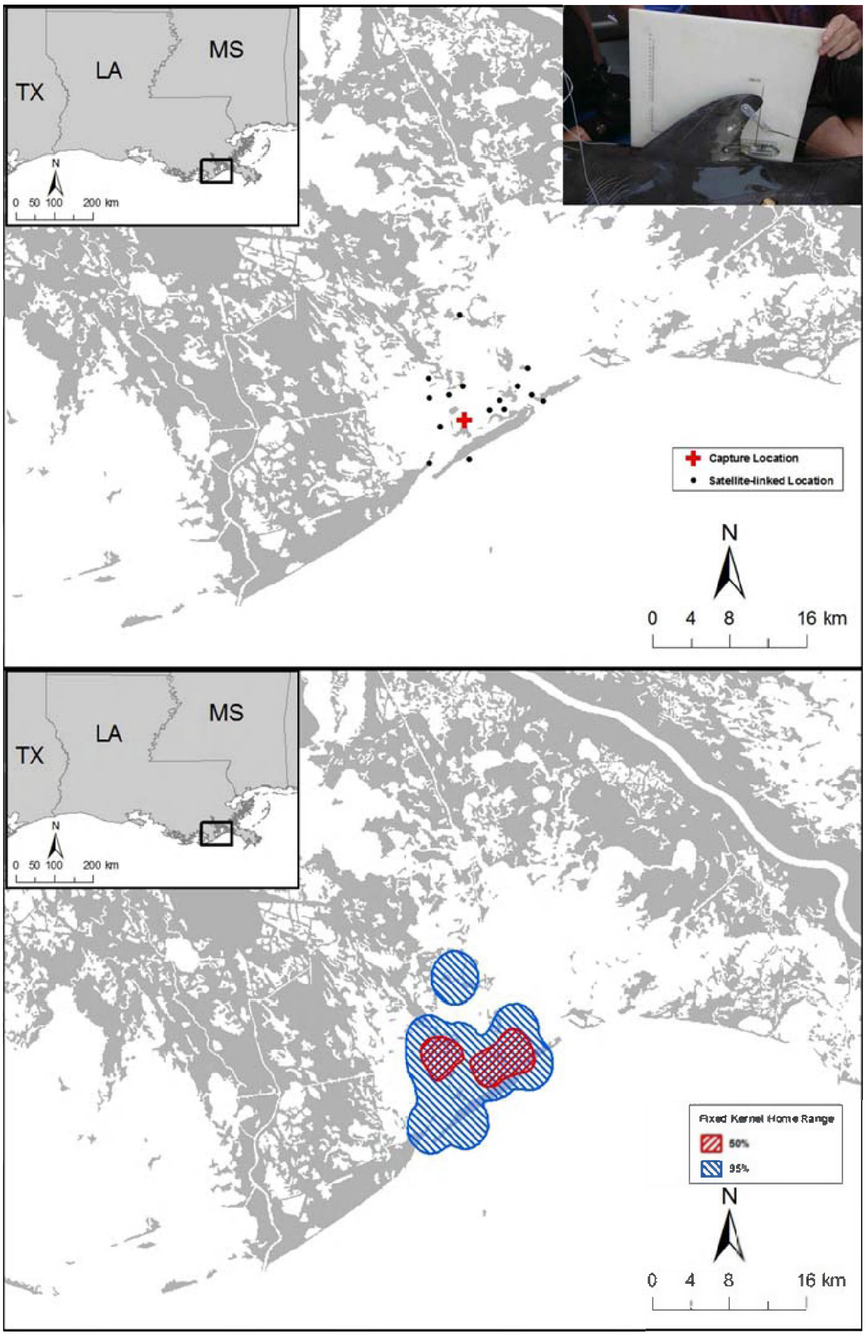
Y13's 50% fixed kernel home range was concentrated in Barataria Pass and West Champagne Bay, with the 95% fixed kernel home range including Caminada Bay, Bassa Bassa Bay, and Hackberry Bay.

Figure 16. (a) Y14's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



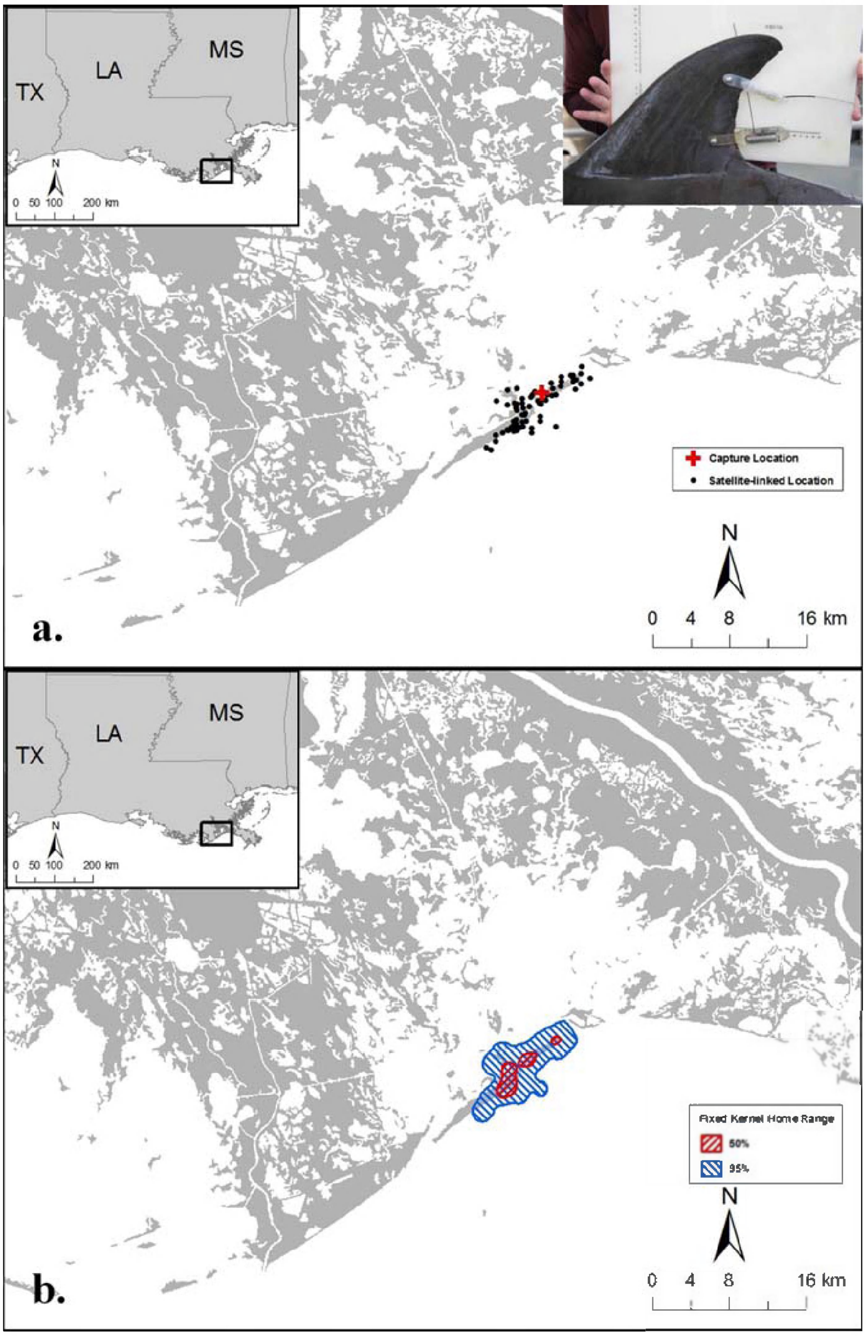
Y14's 50% fixed kernel home range was concentrated in Mud Lake, the waters south of Mud Lake, and Grand Bayou, with the 95% fixed kernel home range including Hackberry Bay, West Champagne Bay, Bassa Bassa Bay, and Barataria Bay.

Figure 17. (a) Y15's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



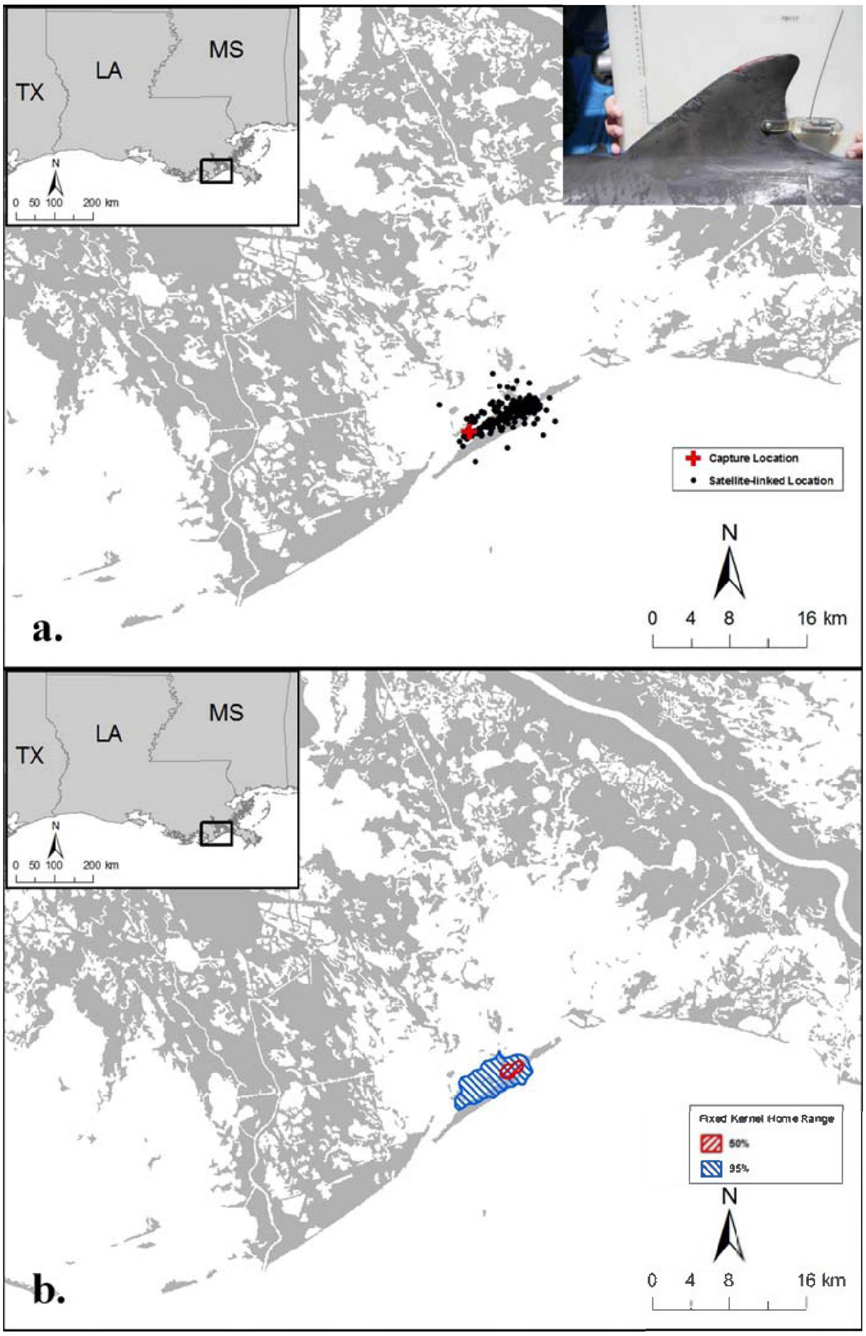
Y15's 50% fixed kernel home range was concentrated in Caminada Bay, northwest corner of Grand Isle, and Barataria Pass, with the 95% fixed kernel home range including Caminada Pass, West Champagne Bay, Bassa Bassa Bay, and Barataria Bay.

Figure 18. (a) Y16's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



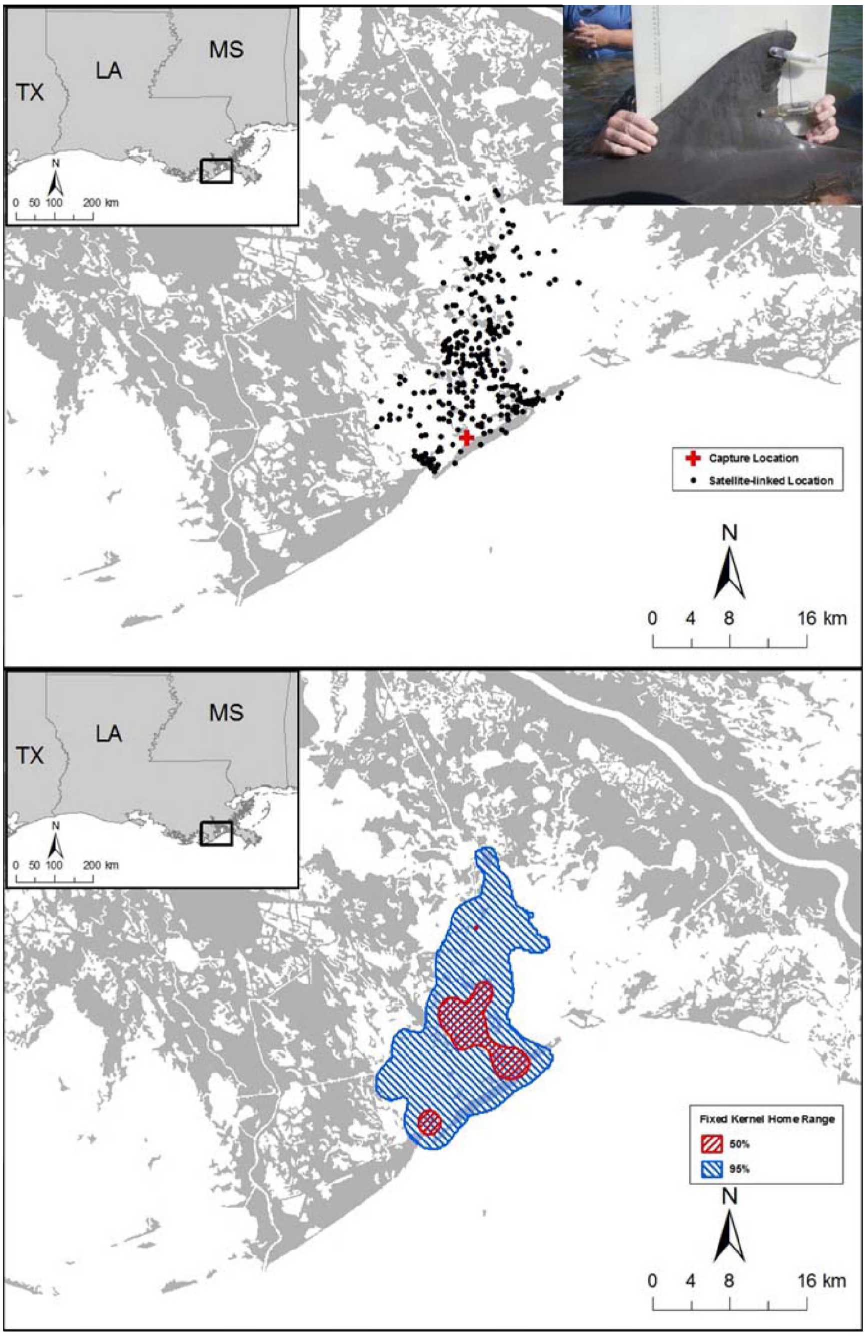
Y16's 50% fixed kernel home range was concentrated along the estuarine and coastal waters of Grand Isle, with the 95% fixed kernel home range including Barataria Pass.

Figure 19. (a) Y17's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



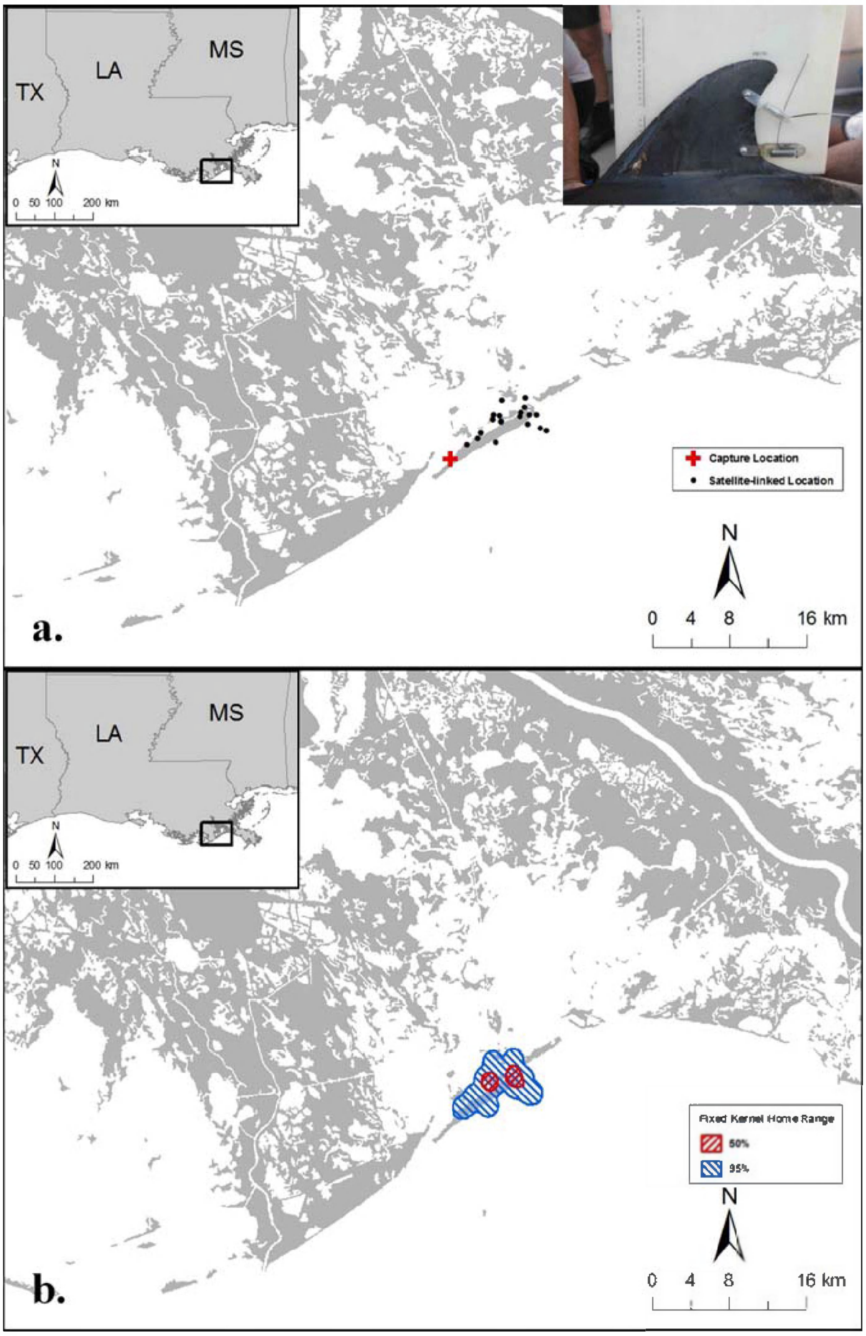
Y17's 50% fixed kernel home range was concentrated in Barataria Pass, with the 95% fixed kernel home range including the estuarine waters of Grand Isle.

Figure 20. (a) Y18's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



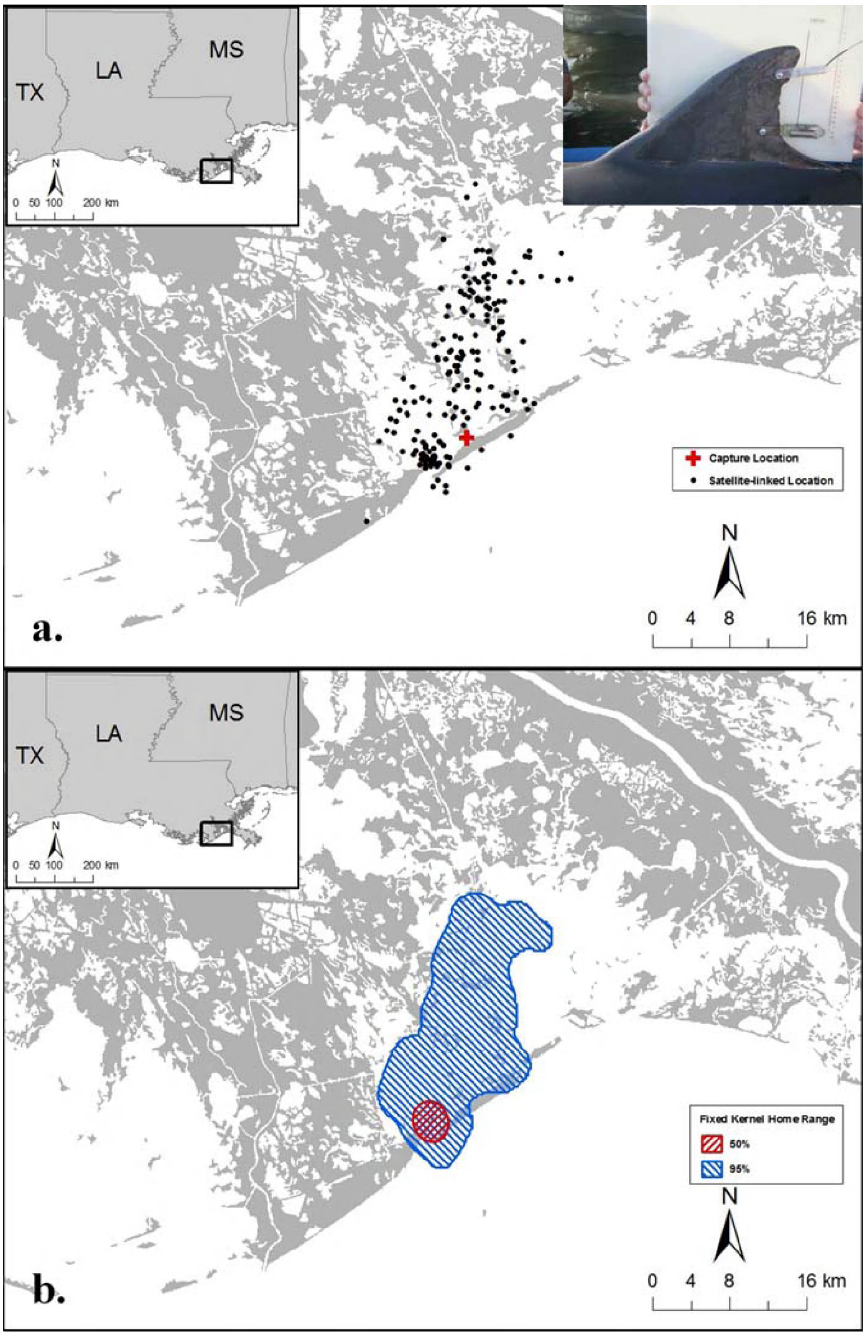
Y18's 50% fixed kernel home range was concentrated in Caminada Pass, Barataria Pass, and West Champagne Bay, with the 95% fixed kernel home range including the estuarine and coastal waters of Grand Isle, Caminada Bay, West Champagne Bay, Bassa Bassa Bay, Hackberry Bay, and Barataria Bay.

Figure 21. (a) Y19's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



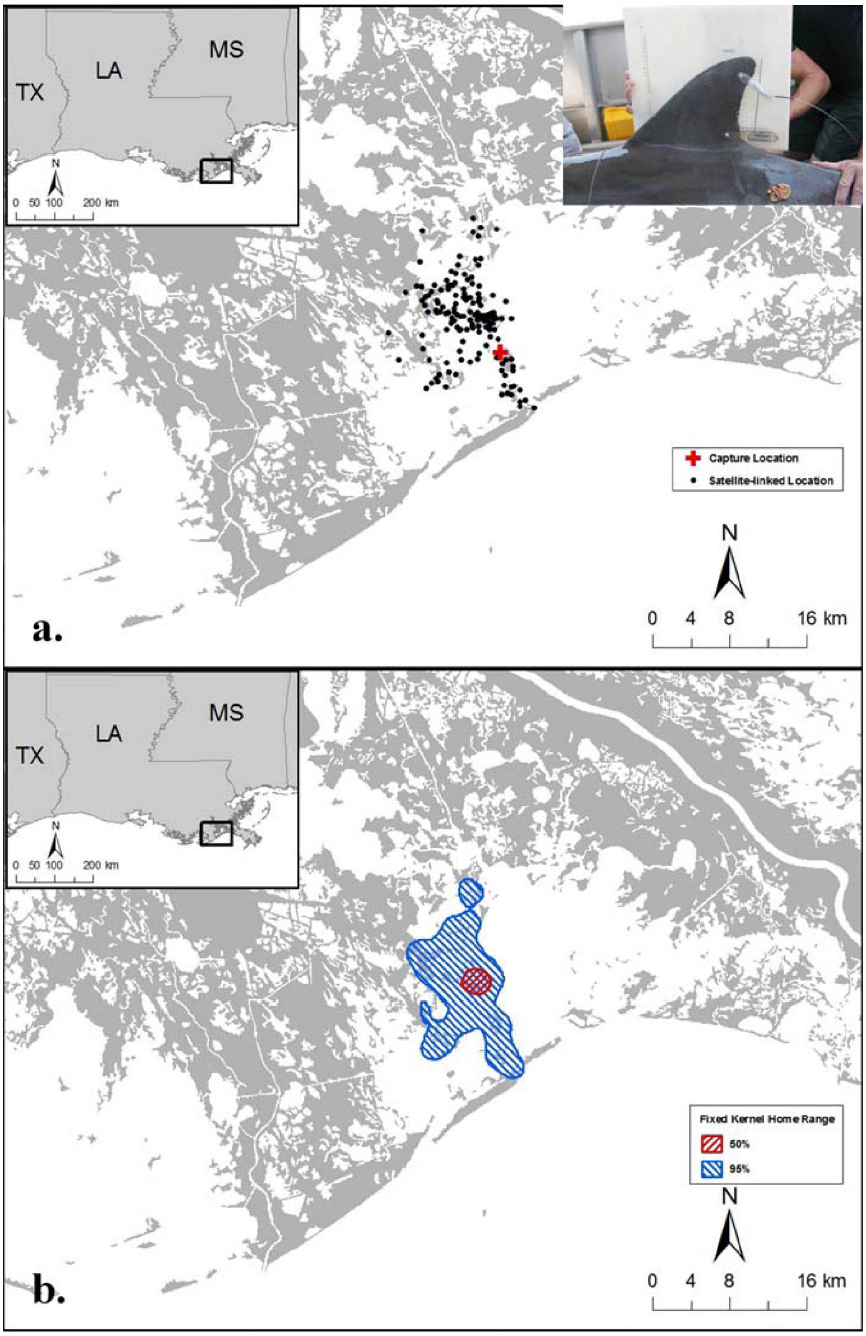
Y19's 50% fixed kernel home range was concentrated in Barataria Pass and the northwest corner of Grand Isle, with the 95% fixed kernel home range including the estuarine and coastal waters of Grand Isle.

Figure 22. (a) Y20's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



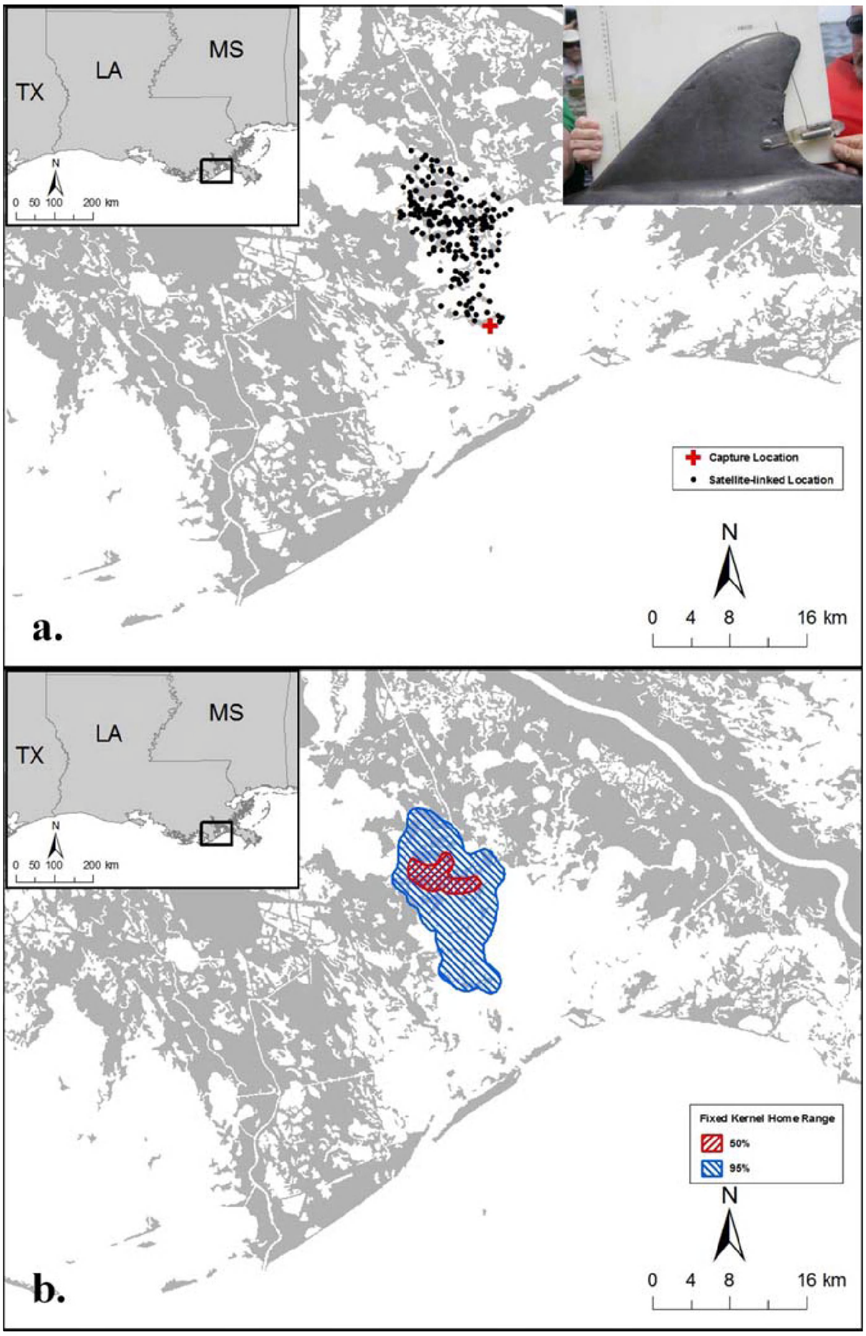
Y20's 50% fixed kernel home range was concentrated in Caminada Pass, with the 95% fixed kernel home range including Caminada Bay, the estuarine and coastal waters of Grand Isle, Barataria Pass, West Champagne Bay, Bassa Bassa Bay, Hackberry Bay, and Barataria Bay.

Figure 23. (a) Y22's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



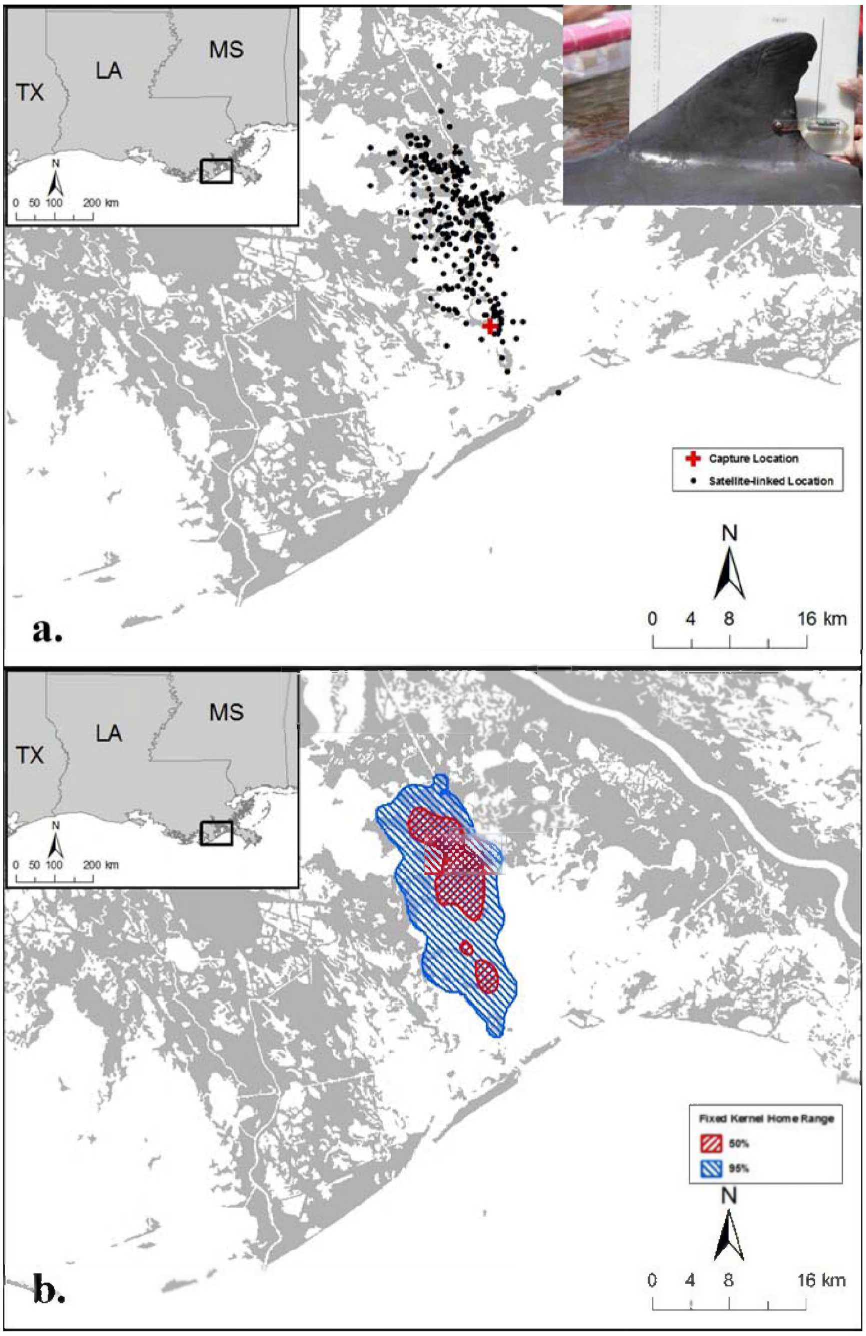
Y22's 50% fixed kernel home range was concentrated in Bassa Bassa Bay, with the 95% fixed kernel home range including Barataria Pass, West Champagne Bay, and Hackberry Bay.

Figure 24. (a) Y25's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



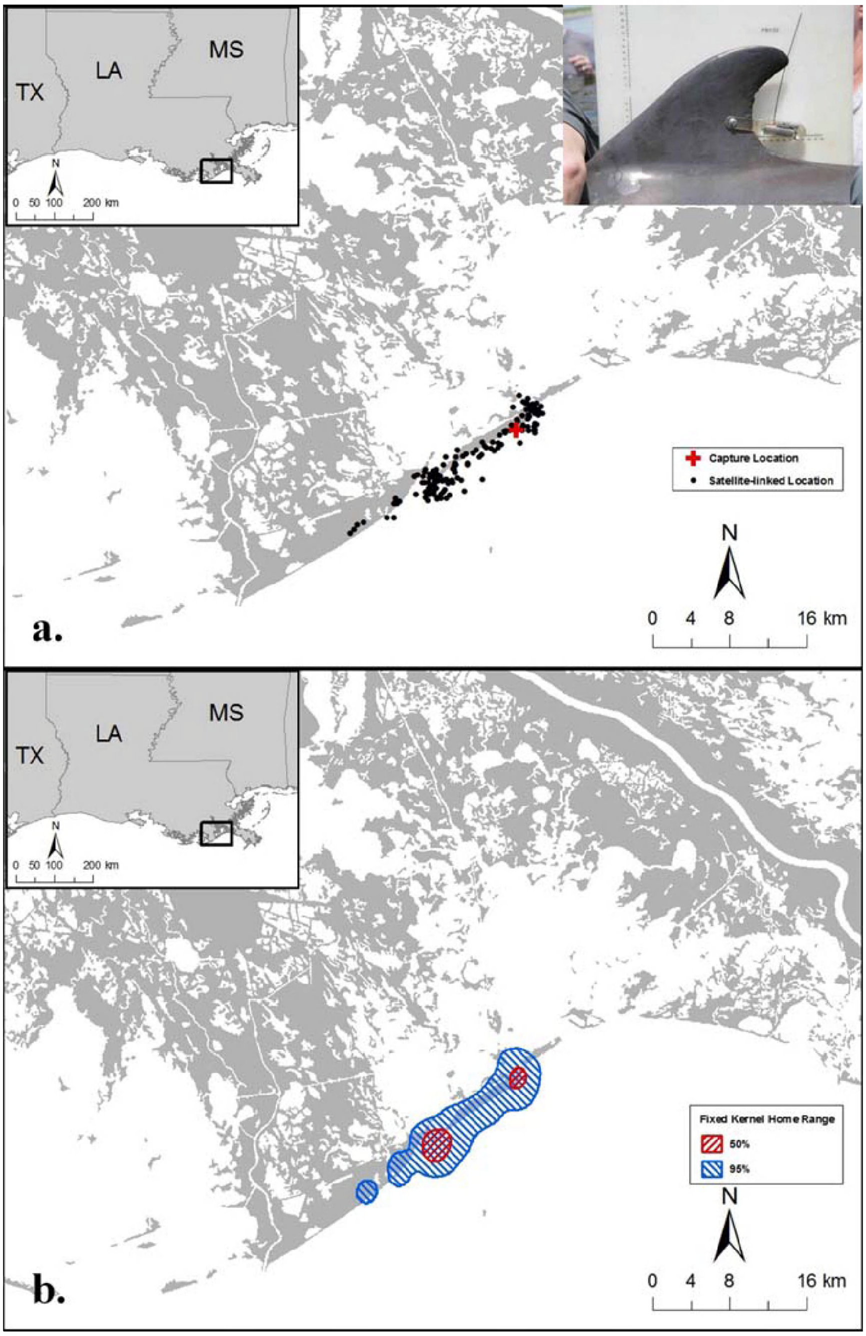
Y25's 50% fixed kernel home range was concentrated in Grand Bayou, with the 95% fixed kernel home range including Mud Lake, Hackberry Bay, West Champagne Bay, and Bassa Bassa Bay.

Figure 25. (a) Y27's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



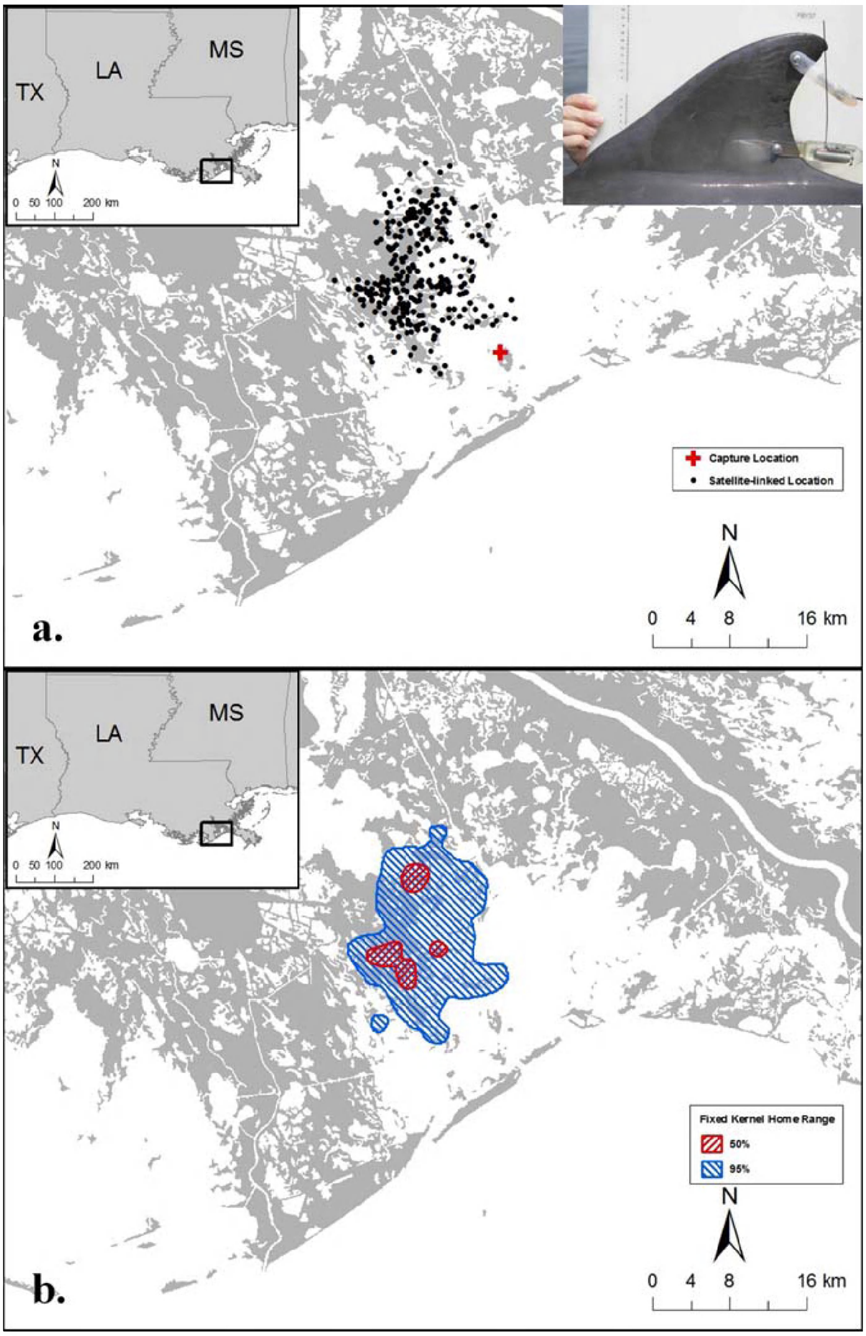
Y27's 50% fixed kernel home range was concentrated in and around the waters of Mud Lake, Hackberry Bay, and Bassa Bassa Bay, with the 95% fixed kernel home range including Grand Bayou, West Champagne Bay, and Barataria Bay.

Figure 26. (a) Y33's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



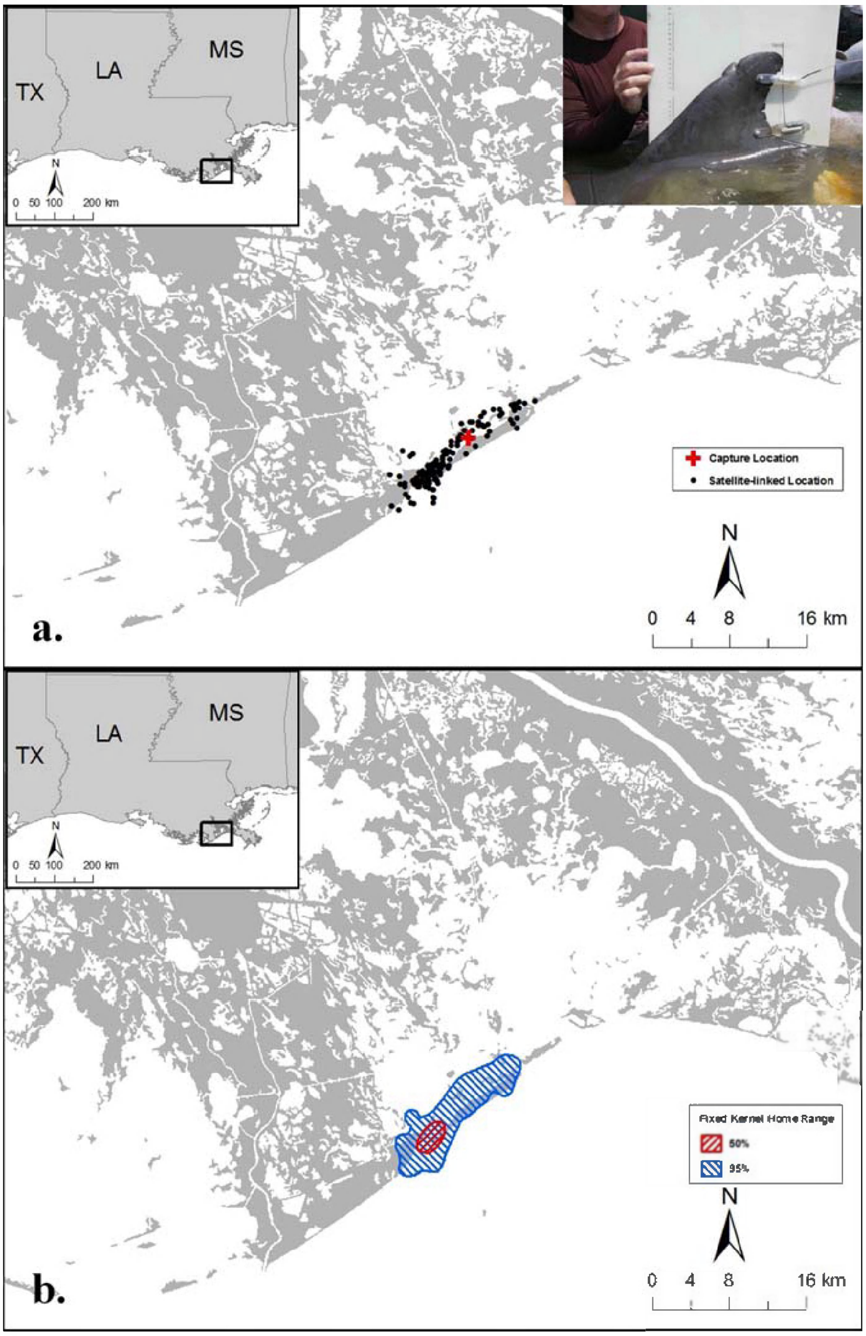
Y33's 50% fixed kernel home range was concentrated around Caminada Pass and Barataria Pass, with the 95% fixed kernel home range the coastal and estuarine waters of Grand Isle.

Figure 27. (a) Y37's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



Y37's 50% fixed kernel home range was concentrated in the waters of West Champagne Bay and Grand Bayou, with the 95% fixed kernel home range including Bassa Bassa Bay and Caminada Bay.

Figure 28. (a) Y39's capture location and satellite-linked locations (LC3 and LC2), and (b) 95% and 50% fixed-kernel home range contours.



Y39's 50% fixed kernel home range was concentrated in Caminada Pass, with the 95% fixed kernel home range including Caminada Bay and the estuarine and coastal waters of Grand Isle.

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