

Final Report : FKNMS-2005-004
Title: Evaluation of Potential Spillover of lobsters from the Dry Tortugas National Park to the Tortugas Ecological Reserve (North)

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Logistical summary:

In mid-May, a total of 36 VR2 sonic receivers were placed into Dry Tortugas (DTRO), Tortugas Ecological Reserve North (TERN), and Florida Keys National Marine Sanctuary (FKNMS) waters. Locations were marked with sub-surface buoys and GPS coordinates. Sixteen receivers were placed in TERN waters and all were recovered in early and late August. Eight receivers were placed in FKNMS waters south of TERN and west of DTRO. Seven receivers were recovered in early and late August. Twelve VR2 sonic receivers around Loggerhead Key within DTRO waters on soft bottom areas. All 12 receivers were recovered during early-August 2005. No samples of any kind were collected during this project. We listed Wes Pratt of Mote Marine Laboratory as a possible collaborator regarding his concurrent nurse shark tagging efforts within DTRO. We are pleased to note that we did detect some of his tagged sharks with our sonic receivers and have shared that information with him.

Technical summary:

Between May and August 2005, we conducted a project to determine if spiny lobster spillover was possible from Dry Tortugas National Park (DTRO) to the newly created (2001) Tortugas Ecological Reserve (North) (TERN) located to the west of the Park. Thirty-six sonic receivers were strategically positioned near the primary tagging sites (near Loggerhead Key) and between DTRO and TERN (Figure 1). The goal was to detect if any of the forty-seven sonic tagged lobsters at Loggerhead Key walked into TERN ("spillover"). In spite of stretching distances between sonic receivers to detection limits of the sonic tags and enduring a category two hurricane (Dennis) in early July, all but three sonic receivers operated throughout the project

(three receivers had flooded battery chambers but recorded data until the time of flooding) and all sonic receivers were located during the retrieval phase in August. One receiver, however, was lost due to a problem during recovery and a subsequent effort to find it failed. This receiver (SN 5119; see Table 1 for coordinates) is located outside both DTRO and TERN.

None of the tagged lobsters was released within immediate detection range of sonic receivers with the exception of five lobsters released at two sites within TERN. Of the fifty-two lobsters released, twenty-six lobsters moved within range of at least one sonic receiver.

At least three of the thirty-three lobsters tagged in the “Little Africa” (west side of Loggerhead Key) walked through the “west gate” outside DTRO satisfying the definition of spillover for this project. None of the “Little Africa” lobsters were detected by receivers on the east side of Loggerhead Key.

Of the fourteen lobsters tagged on the east side of Loggerhead Key (White Shoals and Jewfish Rock), eight were detected by receivers on the east side of Loggerhead Key. Two of the tags were also picked up by the Bat Cave receiver over twelve kilometers from White Shoals.

Although nothing about the timing of the contacts disproves that these contacts were made by sonic tagged lobsters, we do not claim these two events as proven spillover events. None of the tagged east side lobsters was detected by west side Loggerhead Key receivers.

Introduction:

The Tortugas Ecological Reserve is the largest (451 km²) and newest (established in 2001) reserve in south Florida where an adult population of spiny lobster is protected from fishing. The Tortugas Ecological Reserve contains in its northern half, TERN (Tortugas Ecological Reserve North), (230 km²), a large area of habitat with characteristics consistent with sustaining adult lobster populations; however, we found few lobsters during baseline lobster surveys conducted prior to the formation of the reserve.

During the spring of 2000, we conducted a series of exploratory lobster surveys to access the lobster population in DNTP and TERN. In TERN we found large rocky outcrops with many crevices suitable for use as lobster shelters and a rich diversity of sessile benthic fauna such as macroalgae, octocorals and sponges. We also found rubble zones which lobsters typically use as foraging areas. We estimated an abundance of lobsters at only 18 lobsters per hectare in the region that has become TERN and 72 lobsters per hectare in the Dry Tortugas National Park (DTNP), a 30 year old lobster sanctuary.

Because of the proximity of the Tortugas Ecological Reserve to a large adult population in Dry Tortugas National Park, we hypothesized that the future performance of the new reserve as an adult breeding lobster sanctuary in five to ten years may depend on adult spillover from the Dry Tortugas National Park to the Tortugas Ecological Reserve. We base this hypothesis in part on an examination of the size distributions of spiny lobsters found in both areas during our baseline study (e.g.; both small (<70mm carapace length) and large (>100 mm carapace length) lobsters are rare in the TERN but common in the DTNP).

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Materials and Methods:

The primary means to examine the possibility of spillover from DTRO and TERN is sonic tags on lobsters and sonic receivers placed in strategic positions. Sonic receivers were placed at depths from 25 to 30 m of water in two lines to form a “Gate” (Figure 1, Table 1). Each line of receivers contained 10 sonic receivers spaced 800 m apart. The rationale for two lines is to determine direction of travel (e.g.; a tagged lobster leaving DTRO could come within range of a single line of receivers and then turn back toward the Park, but the second line of receivers we allow us to differentiate between a “back and forth” movement versus a committed movement into TERN). In addition, twelve receivers were placed around Loggerhead Key in an attempt to determine the departure direction of any lobsters that might leave the Loggerhead area. The four last receivers were placed at hard bottom sites within TERN.

Sonic tags were placed on 52 lobsters, primarily near Loggerhead Key in DTRO (Figure 1 and Table 2). Twenty tagged lobsters were female, the remainder male. Sizes of the lobsters ranged from 65 mm CL (carapace length) to 168 mm CL. The primary tagging area was a region known as “Little Africa” located on the west side of Loggerhead Key. We tagged 33 lobsters in this region.

Receivers were deployed on May 17, 2005 and lobsters were tagged from May 18 to May 20, 2005. In the second week of July, the eye of a category two hurricane (“Dennis”) swept within 50 km of the study site. Because of this storm and the high level of activity in the tropics this season, we elected to try and retrieve the receivers at the earliest opportunity. With the help

of the NOAA vessel "Nancy Foster", the first opportunity came in early August. All but three receivers were recovered during the first week of August. Two more receivers were recovered in late August leaving one receiver (SN 5119) missing (Table 1).

Data were downloaded from each receiver and assembled in the laboratory into a single file for use in GIS software (Arc View). Arc View with Tracker Analysis, was used to determine whether spillover occurred with any tagged lobster.

Results and discussion:

Of the 52 lobsters fitted with sonic tags, 26 lobsters moved within range of a sonic receiver. Of the 35 recovered VR2 receivers, 21 receivers recorded sonic tag data. Over 20 thousand “pings” were recorded (Table 4) from the sonic tags, however, 86% (17,219 pings) of those pings were recorded from just three lobsters tagged at the “Gary’s Grotto” site in TERN by a single receiver placed near “Gary’s Grotto”. Another 2,099 pings were recorded by two lobsters tagged at the other TERN site known as the “Bat Cave”.

Little Africa Lobsters

A total of 33 lobsters were tagged in two adjacent locations west of Loggerhead Key in about 3 m of water. Only lobsters tagged in the “Little Africa” (west of Loggerhead Key) were detected by receivers placed west of Loggerhead Key and by the gate placed between DTRO and TERN (Table 4). Thirteen of the 33 “Little Africa” lobsters moved offshore away from Loggerhead Key during some portion of this study. Four (44%) were females and nine (38%) were males. Of the four females reaching the west Loggerhead Key line of receivers, two continued on into deeper water to be detected by both the east and west gate receivers and presumably became “spillover” lobsters. One of the nine males that moved within range of the west of Loggerhead receivers continued through both the east and west gate receivers and presumably into TERN. There was a non-significant tendency for larger female and male lobsters to be detected by the west Loggerhead Key receivers (Table 5). The mean size of female lobsters detected west of Loggerhead Key was 17 mm CL larger than female lobsters that were not detected by the west Loggerhead Key receivers. A possible reason may be that

female lobsters smaller than 80 mm CL are rarely found with eggs. The larger egg bearing females were probably moving to deeper water to spawn. Only one of four female lobsters tagged above 90 mm CL was not detected by the west Loggerhead Key receivers.

TERN Lobsters

None of the five lobsters tagged in TERN (Bat Cave and Gary's Grotto) left their respective tagging areas to be detected elsewhere. Four of the five lobsters tagged were female. All four were reproductively active with brown eggs and ripe ovaries at the time of tagging. The three females at Gary's Grotto were detected daily by the sonic receiver placed near the release site. We believe it unlikely that any lost their tag which hypothetically would constantly ping the receiver because the number of pings always decreased during the day when the lobsters would seek shelter and increase at night when the lobsters would forage for food more or less in the open. The female at Bat Cave likewise remained within range of a receiver though the number of pings recorded was much lower. There were a few days when the receiver did not receive a ping from this lobster but typically for only one or two days. Conversely, the large male tagged at the Bat Cave, did not make contact with the receiver at Bat Cave for 17 days starting one week after he was tagged. Then after July 10th (one day after the passage of Hurricane Dennis) this tag was not heard from again.

White Shoals and Jewfish Rock Lobsters

Fourteen lobsters (seven male and female) were tagged on the east side of Loggerhead Key. Eight lobsters (four male and female) tags were picked up by three of the east Loggerhead sonic receivers closest to the tagging sites. The most commonly detected lobster from east of

Loggerhead Key was a small (74 mm CL) male that was detected daily by a nearby receiver till June 10th, then infrequently until June 22nd when contact was lost. All of the other lobsters ended contact with any east Loggerhead receiver between mid-May and mid-June. One unlikely possibility is that Tropical Storm Arlene which past approximately 160 km (100 miles) to the west of DTRO on June 10th, tipped the sonic receivers over thus reducing their range (most of the shallow water receivers were recovered in a tipped over state). This is unlikely because these receivers have been tested several times in shallow water to tropical storm force and none have tipped over. The cause of the tipping receivers is more likely due to Hurricane Dennis which swept through the area as a category 1 strengthening to category 2 on July 9th. The area east of Loggerhead Key contains far more pinnacles and hard bottom than west of Loggerhead Key. It is more likely that tagged lobsters simply moved to places out of range of the receivers by late June.

Two tags from Jewfish Rock have intriguing but unexplainable histories. Tag 939 was placed on a 102 mm CL male at Jewfish Rock on May 18th. Three days later (May 21st), the tag was recorded once by the sonic receiver approximately 500 m to the north of Jewfish Rock. Five days later (May 26th) a single ping was recorded by the receiver at Bat Cave inside TERN. The straight line distance from the tagging site to Bat Cave is 12.3 km and the shortest path around Loggerhead Key and greater than 500 meters from any sonic receiver is 13.5 km. The next receiver to record this tag was the same receiver 500 m north of Jewfish Rock on June 9th (14 days after the Bat Cave detection and the same day as the passage of Hurricane Dennis). The north Jewfish Rock receiver would record two more pings from this tag, once on June 11th and

once on June 15th. Tag 940 was placed on a small 73 mm CL female on May 18th. This tag was recorded by a sonic receiver placed 550 m south of Jewfish Rock on June 11th. Four days later (June 15th), the Bat Cave sonic receiver recorded one ping from this tag. It is impossible to rule out that the lobsters we tagged could have traveled from Jewfish Rock to Bat Cave in the time given. Another lobster in this project traveled more than 3 km one night and more than 4 km on another night. It is also impossible to prove that these tagged lobsters made separate trips from Jewfish Rock to Bat Cave (with one tag returning). At this time, these records will have to remain untested and unproved but notable.

Lobster 1026

Lobster tag number 1026 made contact with more sonic receivers than any other lobster we tagged during this project. Because of this, we are reporting these movements in detail herein. The movements of this female lobster suggest much about female lobster behavior during the reproductive season. Lobster 1026 was tagged on May 18th at the Little Africa Site just west of Loggerhead Key in about 10ft of water. This was a large female (124 mm CL). She had orange eggs, a fresh spermatophore, and ripe ovaries. This reproductive condition suggested she would soon move to deeper water to spawn, return to Little Africa and then in June, spawn again. If she moved to deeper water in mid-May to spawn, we did not detect it. Our first detection of this lobster was June 6th by a middle western Loggerhead receiver (Figure 2). By June 11th, she was relocated to the north end of the west Loggerhead Key receivers (Figure 3). The timing of this manoeuver is consistent with a second spawning since the initial tagging. The next contact occurs on July 4th by a sonic receiver to the southwest of Loggerhead Key then by a

deep water receiver on the south end of the “gate” on July 5th (Figure 4A and B). This is consistent with a third clutch of eggs and this time deep water receivers outside DTRO detected her movement. For the next three days, July 6 to 9th, she stays within detection of the same three receivers (Figure 5). On July 9th, Hurricane Dennis passes just 50 km to the west with closest approach during the morning hours. By nightfall of June 9th, and just twelve hours after the passage of the center of the hurricane, she leaves this area and makes contact with the northern end on the morning of June 10th. The minimum distance traveled over these twelve hours is four kilometers. She continues to move along the northern most end of the “gate” during the day on July 10th, then turns south by nightfall (Figure 6). On the following night of July 11-12, lobster 1026 turns north again, moving northward.

Conclusions:

- (1) Spillover (the migration of adult lobsters) from DTRO to TERN is now factually established. Approximately 40% of both male and female lobsters tagged within the “Little Africa” region of the west side of Loggerhead Key, move sufficiently westward (about one kilometer) to be detected by the west Loggerhead sonic detectors. Approximately 10% of the “Little Africa” lobsters walked into TERN over the course of the project (2.5 months). Two of the fourteen lobster tags placed to the east of Loggerhead Key were detected by a single ping each at the Bat Cave Site within TERN and nearly 13 km from the tagging site. Because only a single ping was recorded for each tag at Bat Cave, we cannot conclude the lobsters we tagged made this journey but nothing about the timing of the pings in these data eliminates the possibility.
- (2) Lobster 1026, a large female lobster, provided evidence that female lobsters of this size can produce at least three clutches per breeding season. From an earlier study, we have evidence that female lobsters of this size begin producing egg masses in mid to late April (Bertelsen and Hunt, 1996; Bertelsen and Matthews, 2001) in the Dry Tortugas region. If this was the case for lobster 1026, then we may have tagged her while carrying her second egg mass thus giving her four clutches for the season.
- (3) Davis, G.E. (1974) hypothesized that breeding female lobsters moved to deeper water during the summer. This project supports that hypothesis in that four of seven west Loggerhead females larger than 80 mm CL, were detected by sonic receivers placed further offshore of Loggerhead Key whereas eight of twenty-one male large lobsters were detected.
- (4) TERN and DTRO may have value together toward the adult lobster population in the region.

Evidence in this study coupled with observations by Gary Davis in the 1970's and by FWC in the 1990's, suggest that DTRO may provide a valuable breeding area for large female lobsters with DTRO's resident large male lobster population and TERN may provide valuable spawning ground for the release of eggs by those same large female lobsters.

References:

Bertelsen R.D. and J.H. Hunt (1996) Spiny lobster spawning potential and population assessment: A Monitoring Program for the South Florida Fishing Region. Final Report MARFIN Grant 0518. 23 pp.

Bertelsen R.D. and T.R. Matthews (2001) Fecundity dynamics of female spiny lobster (*Panulirus argus*) in a south Florida fishery and Dry Tortugas National Park lobster sanctuary. Mar. Freshwater Res. 52:1559-1565.

Davis, G.E. 1974. Notes on the status of spiny lobsters *Panulirus argus* at Dry Tortugas, Florida. US National Park Service report. 9 pp.

Table 1. Location, position, and depth of VR2 sonic receivers. The three locations are “Gate” (the double north-south line just outside the western boundary of Dry Tortugas National Park; “Loggerhead Key” (separate north-south lines of receivers on the east and west sides of Loggerhead Key; and “Tortugas Banks” (four additional receivers placed next to hard bottom regions within Tortugas Banks).

Location	VR2 number	Latitude	Longitude	Depth (ft)
Gate	2311	24.6774	-82.9402	93
Gate	2316	24.6192	-82.9669	49
Gate	2322	24.6306	-82.9730	103
Gate	2325	24.6793	-82.9476	102
Gate	2330	24.6228	-82.9730	69
Gate	2331	24.6738	-82.9532	102
Gate	4207	24.6683	-82.9582	103
Gate	4208	24.6717	-82.9457	97
Gate	4209	24.6554	-82.9617	103
Gate	4210	24.6420	-82.9667	83
Gate	5115	24.6631	-82.9639	105
Gate	5116	24.6608	-82.9564	102
Gate	5117	24.6460	-82.9732	116
Gate	5118	24.6344	-82.9667	83
Gate	5119	24.6268	-82.9668	72
Gate	5120	24.6665	-82.9508	99
Gate	5121	24.6383	-82.9729	105
Gate	5122	24.6575	-82.9688	108
Gate	5123	24.6499	-82.9669	105
Gate	5124	24.6534	-82.9756	107
Loggerhead Key	2313	24.6272	-82.9420	25
Loggerhead Key	2314	24.6586	-82.9075	31
Loggerhead Key	2318	24.6499	-82.9039	63
Loggerhead Key	2319	24.6546	-82.9194	20
Loggerhead Key	2321	24.6415	-82.9057	64
Loggerhead Key	2323	24.6349	-82.9107	65
Loggerhead Key	2324	24.6264	-82.9156	64
Loggerhead Key	2326	24.6461	-82.9232	20
Loggerhead Key	2327	24.6144	-82.9345	50
Loggerhead Key	2328	24.6205	-82.9257	50
Loggerhead Key	2329	24.6326	-82.9356	24
Loggerhead Key	2332	24.6387	-82.9282	24
Tortugas Banks	2312	24.6597	-83.0047	95
Tortugas Banks	2315	24.6992	-82.9993	85
Tortugas Banks	2317	24.6548	-83.0317	59
Tortugas Banks	2320	24.6781	-83.0159	73

Table 2 (cont.)

Table 2. Basic size, sex, reproductive status and location of each sonic tagged lobsters released during this study.

SEX	MOLT	SIZE (mmCL)	EGGS	SPERMAT- OPHORE	OVARY	CODE	LOCATION	DEPLOYED	LAT	LONG
male	intermolt	102				939	Jewish Rock	18-May-05	24.6305	-82.9122
female	intermolt	87		fresh		1045	Jewish Rock	18-May-05	24.6305	-82.9122
female	intermolt	78				1042	Jewish Rock	18-May-05	24.6305	-82.9122
female	intermolt	74				959	Jewish Rock	18-May-05	24.6305	-82.9122
female	intermolt	73				940	Jewish Rock	18-May-05	24.6305	-82.9122
male	intermolt	72				1041	Jewish Rock	18-May-05	24.6305	-82.9122
male	intermolt	69				1043	Jewish Rock	18-May-05	24.6305	-82.9122
male	intermolt	149				963	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	130				941	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	130				943	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	127		fresh	ripe	947	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	124	orange	fresh	ripe	1026	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	123		fresh		942	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	122		fresh	ripe	1027	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	114				1025	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	114				952	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	113				949	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	110				944	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	110				958	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	104				960	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	96				914	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	91				953	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	91		fresh	ripe	951	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	89		fresh	ripe	946	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	83				948	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	82				950	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	81				956	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	80				945	Little Africa	18-May-05	24.6353	-82.9208
female	intermolt	76				962	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	76				961	Little Africa	18-May-05	24.6353	-82.9208
male	intermolt	168				925	Bat Cave	19-May-05	24.6538	-83.0327
female	intermolt	110	brown	fresh	ripe	924	Bat Cave	19-May-05	24.6538	-83.0327
female	intermolt	104	brown	fresh	ripe?	916	Gary's grotto	19-May-05	24.6782	-83.0178
female	intermolt	104	brown	fresh	ripe?	919	Gary's grotto	19-May-05	24.6782	-83.0178
female	intermolt	102	brown	fresh	ripe?	915	Gary's grotto	19-May-05	24.6782	-83.0178
male	intermolt	134				954	Little Africa South	19-May-05	24.6336	-82.9231
male	post molt	123				926	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	107				936	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	96				955	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	94				932	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	93				928	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	90				935	Little Africa South	19-May-05	24.6336	-82.9231
female	intermolt	84	orange	eroded	ripe	922	Little Africa South	19-May-05	24.6336	-82.9231

Table 2 (cont.)

male	intermolt	77	964	Little Africa South	19-May-05	24.6336	-82.9231
male	intermolt	143	920	White Shoals	20-May-05	24.6332	-82.9073
male	intermolt	108	927	White Shoals	20-May-05	24.6332	-82.9073
female	intermolt	89	913	White Shoals	20-May-05	24.6332	-82.9073
male	intermolt	80	921	White Shoals	20-May-05	24.6332	-82.9073
male	intermolt	74	933	White Shoals	20-May-05	24.6332	-82.9073
male	intermolt	74	907	White Shoals	20-May-05	24.6332	-82.9073
female	intermolt	65	957	White Shoals	20-May-05	24.6332	-82.9073

Table 3. Summary information of sonic tagged lobsters by gender, size, and location.

Location (Date)	Female			Male			Totals		
	Maximum size (mm)	Minimum size (mm)	Number tagged	Maximum size (mm)	Minimum size (mm)	Number tagged	Maximum size (mm)	Minimum size (mm)	Number tagged
Bat Cave (5/19/05)	110	110	1	168	168	1	168	110	2
Gary's Grotto (5/19/05)	104	102	3				104	102	3
Jewfish Rock (5/18/05)	87	72	5	102	69	2	102	69	7
Little Africa (5/18/05)	127	76	8	149	76	16	149	76	24
Little Africa South (5/19/05)	84	84	1	134	77	8	134	77	9
White Shoals (5/20/05)	89	65	2	143	74	5	143	65	7
Group Total	127	65	20	168	69	32	168	65	52

Table 4. Number of "pings" recorded for each lobster tagging location by sonic receiver location.

Tag location	Receiver location								Group Total	
	East		West		East Gate		West Gate			TERN
	Loggerhead	Sum	Loggerhead	Sum	Sum	Sum	Sum	Sum		
Bat Cave	.	.	.	.	.	.	.	.	2099	2099
Gary's grotto	.	.	.	.	.	.	.	.	17219	17219
Jewfish Rock	29	.	.	.	.	.	.	.	2	31
Little Africa	.	.	180	169	155	.	.	.	.	504
Little Africa South	.	.	18	.	.	.	.	.	.	18
White Shoals	266	.	.	.	.	.	.	.	.	266
Group Total	295	198	198	169	155	19320	155	19320	20137	

Table 5. Fate of sonic tagged lobsters from "Little Africa" by size and sex. "(S)" indicates that the lobster not only reached the west of Loggerhead line of sonic receivers but continued westward and was detected passing through the gate outside DTRO and into TERN (i.e.; a confirmed spillover). None of the lobsters tagged on the east side of Loggerhead were detected by either the west of Loggerhead receivers or the gate receivers; however, two east Loggerhead tags were detected once each by the Bat Cave receiver within TERN (see text).

Fate of Little Africa tagged lobsters

Size (mm CL)	Female		Male	
	Not detected	West of Loggerhead	Not detected	West of Loggerhead
76	1		1	
77			1	
80	1			
81				1
82			1	
83	1			
84		1		
89	1			
90			1	
91		(S) 1		1
93			1	
94			1	
96			1	1
104			1	
107				1
110			1	(S) 1
113				1
114			3	
122	1			
123			2	
124		(S) 1		
127		1		
130			1	1
134				1
149				1
Mean size	90	107	103	112

Figure 1. Location of tagging sites ("+" symbols) and VR2 sonic receivers (push pins).

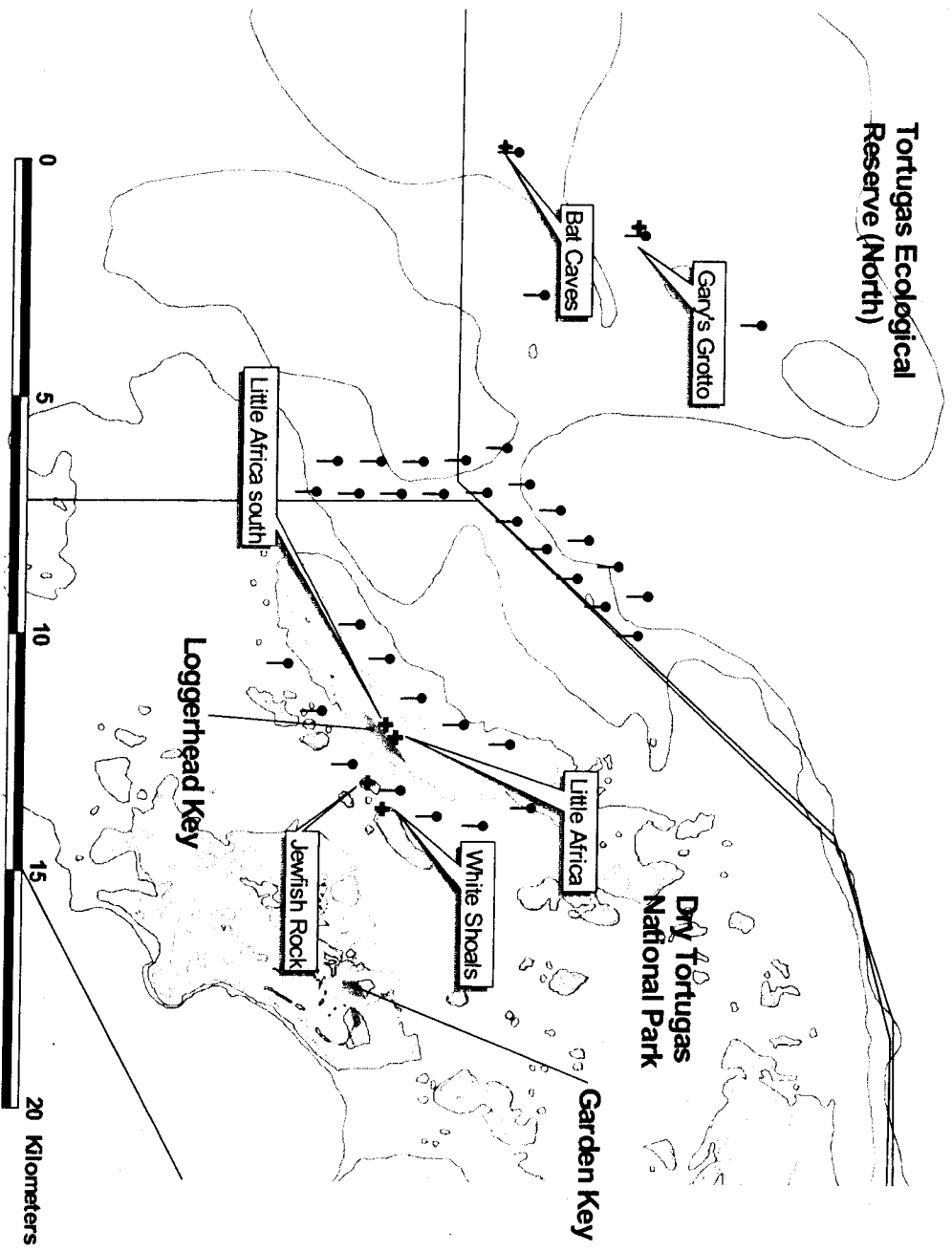


Figure 2. The Initial detection of the female lobster 1026 on June 6th. This lobster was a 124 mm CL female with orange eggs, fresh spermatophore, and ripe ovaries at the time of tagging.

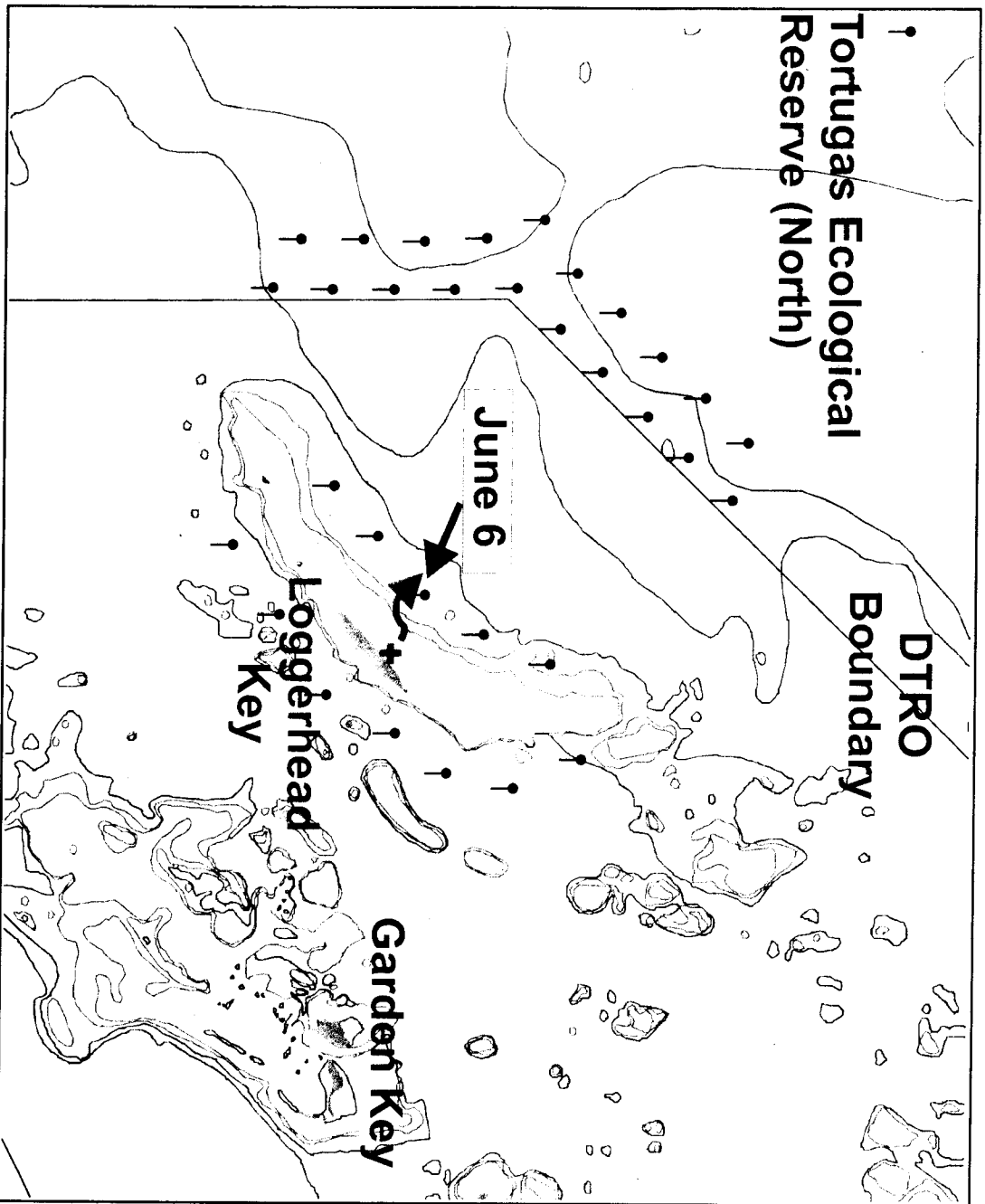


Figure 3. The second position of lobster 1026 on the northern end of the west Loggerhead Key sonic receivers on June 11th is consistent with a release of a second clutch of eggs since the tagging on May 18th.

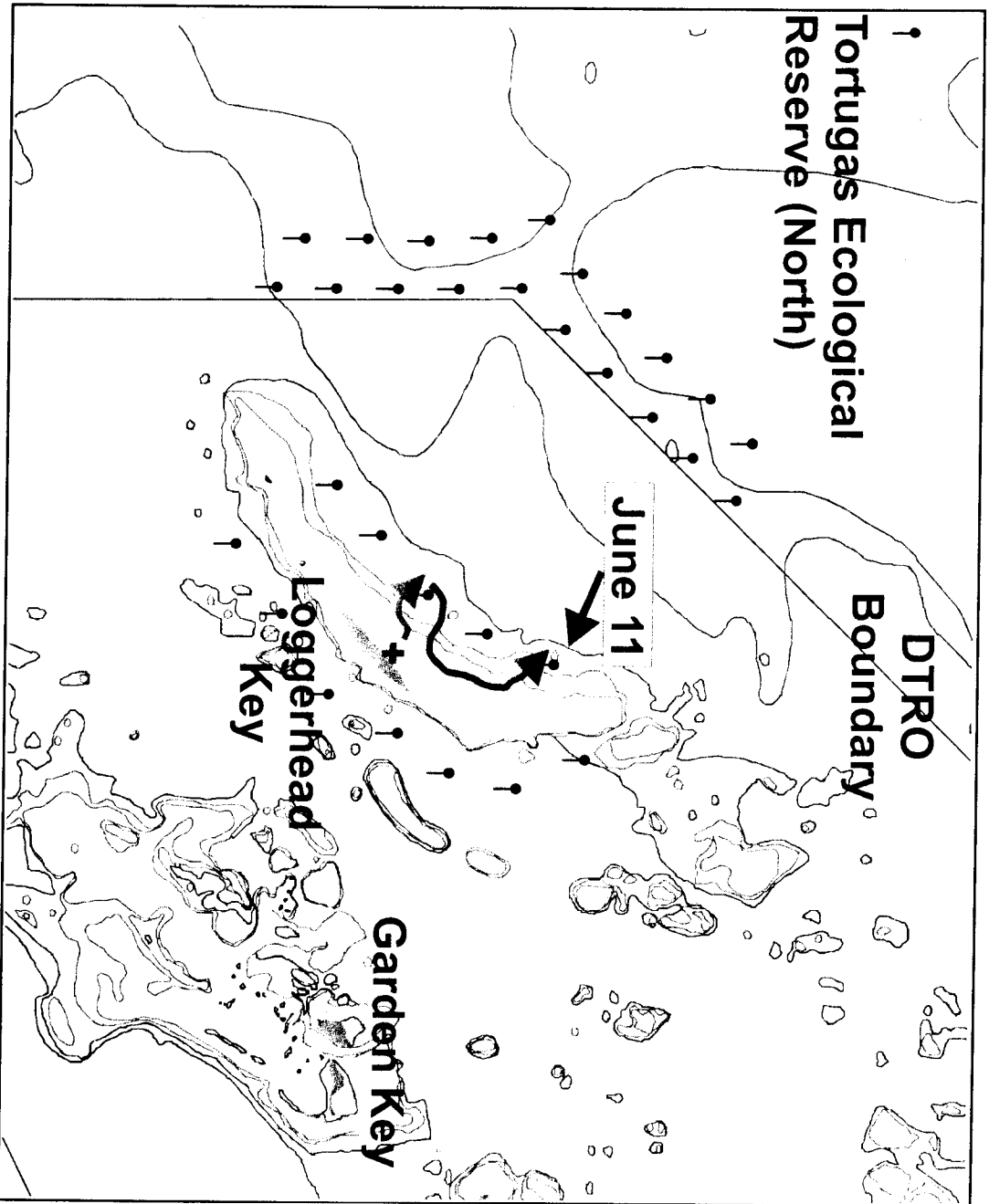


Figure 4 A. Contact with lobster 1026 is made on July 4th to the south of Loggerhead Key, then on the south end of the "gate" on July 5th. The timing of this movement is consistent with a third spawning since tagged on May 18th.

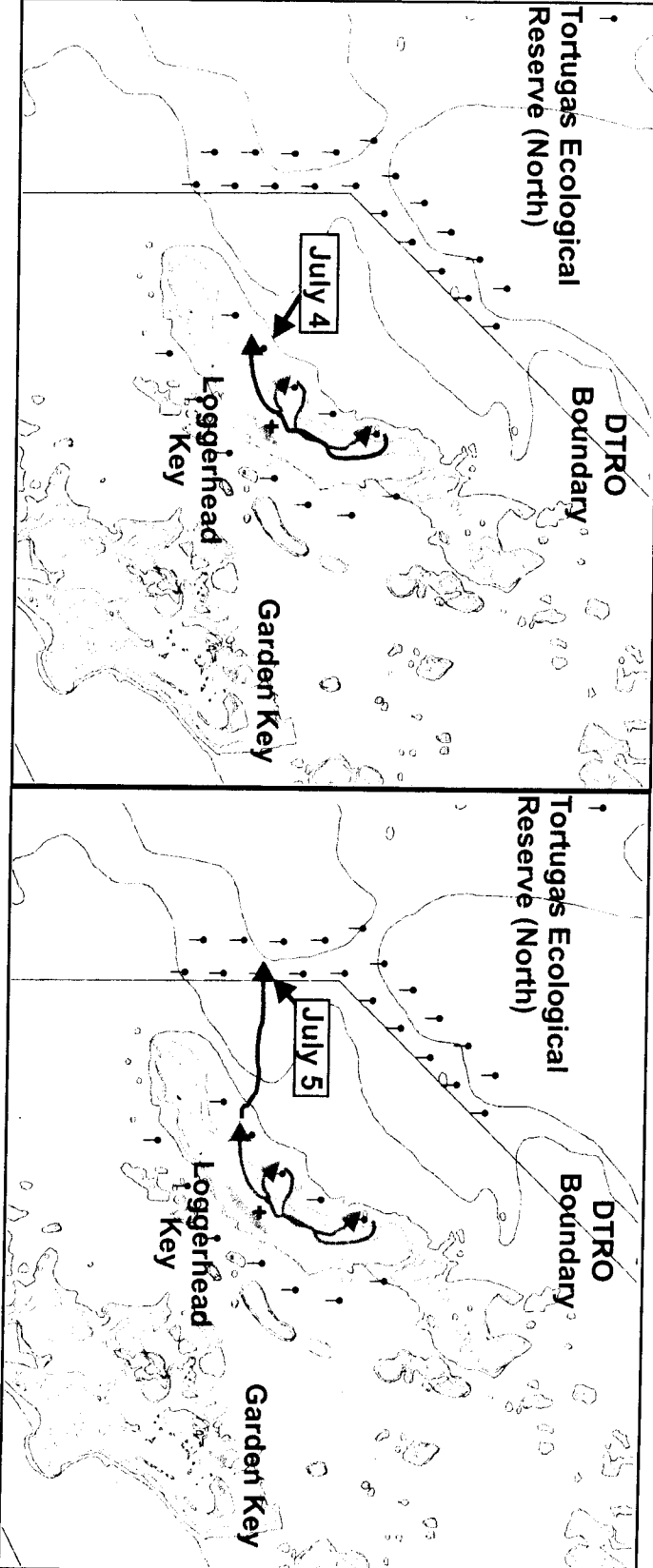


Figure 5. From July 6th to 9th, lobster 1026 remains offshore on the south end of the "gate". On the morning of the 9th, the eye of Hurricane Dennis passes 50 km to the west.

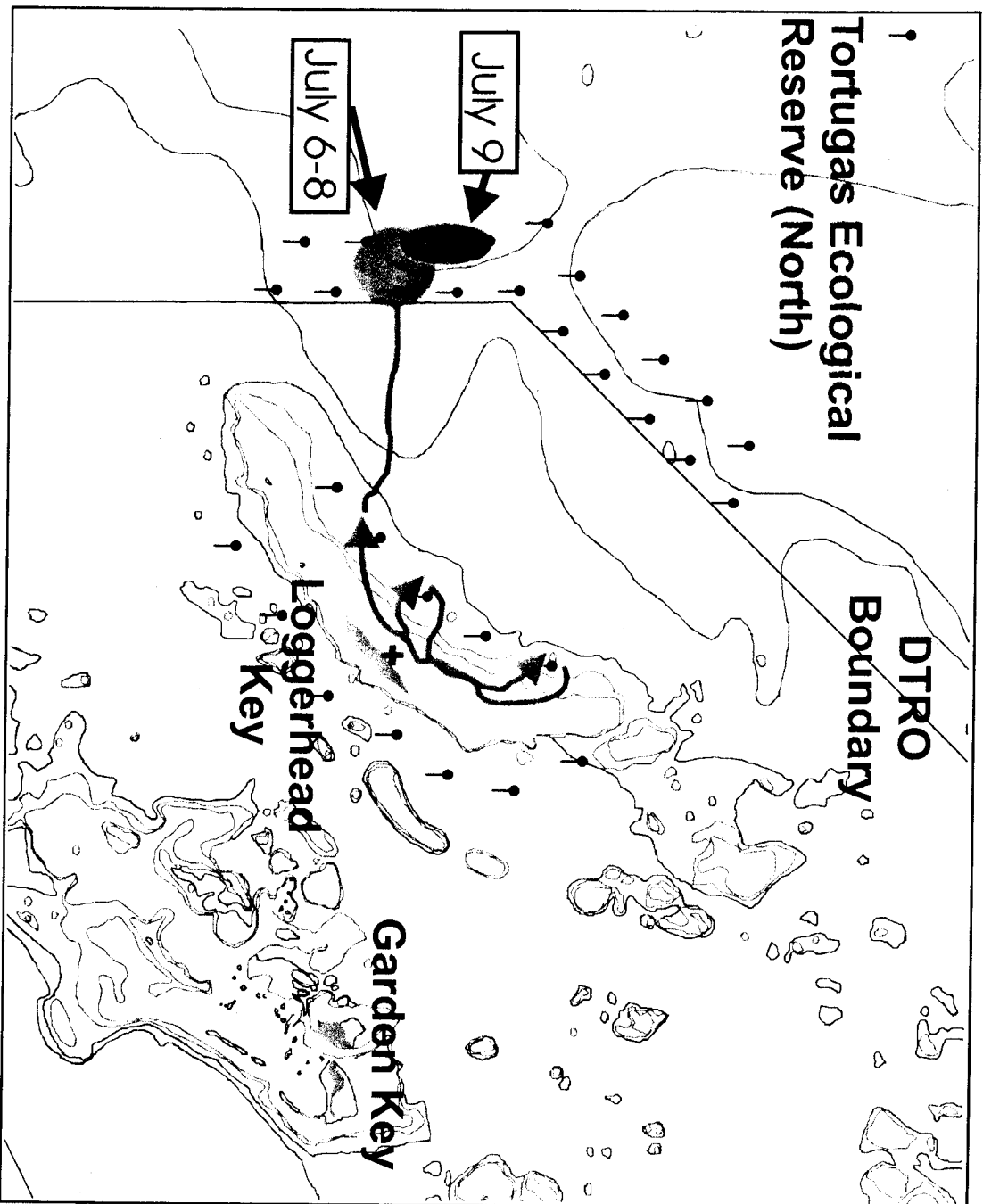


Figure 6. After nightfall and hours after the passage of Hurricane Dennis, lobster 1026 moves to the north end of the "gate" by morning (4 km straight line).

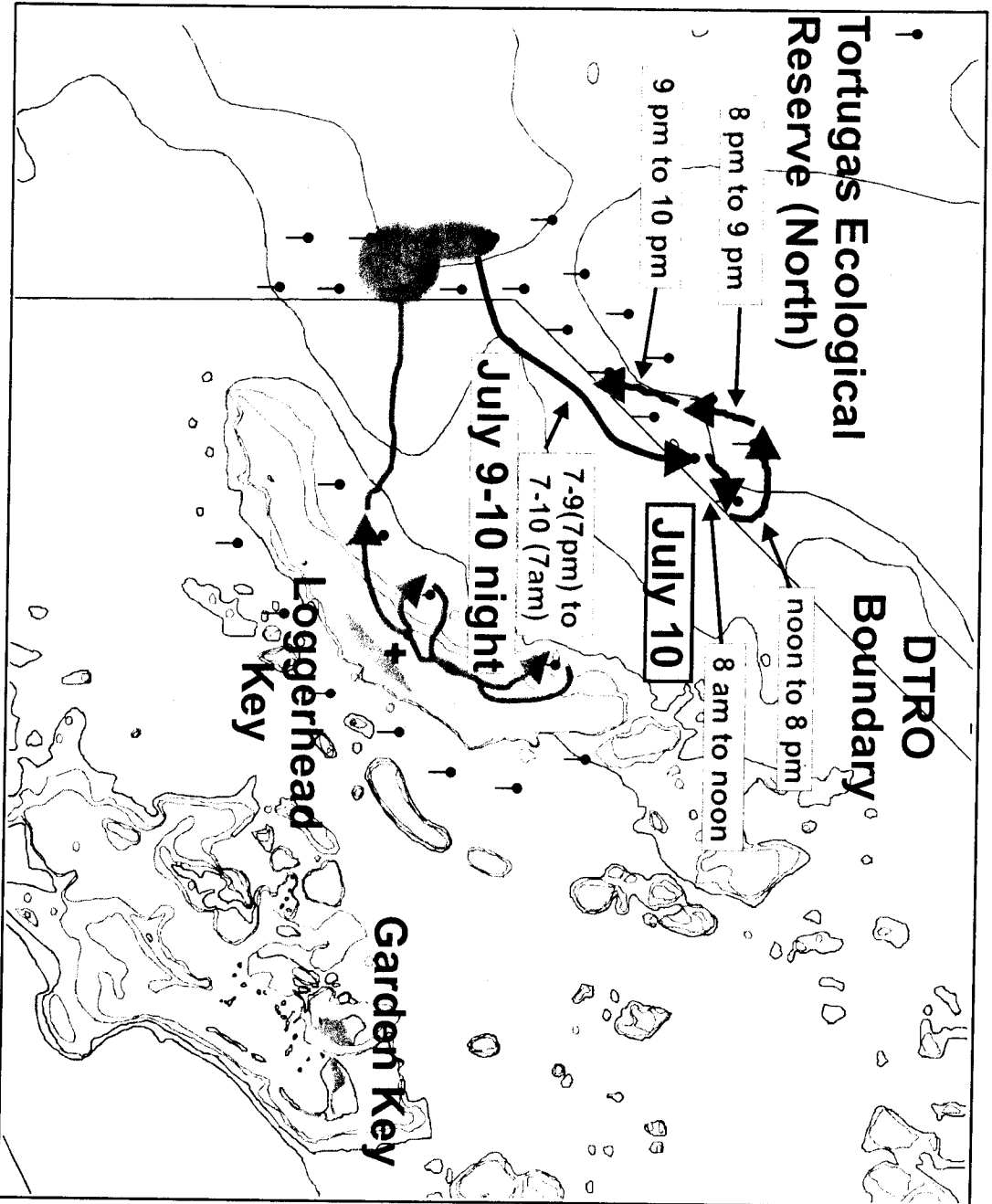
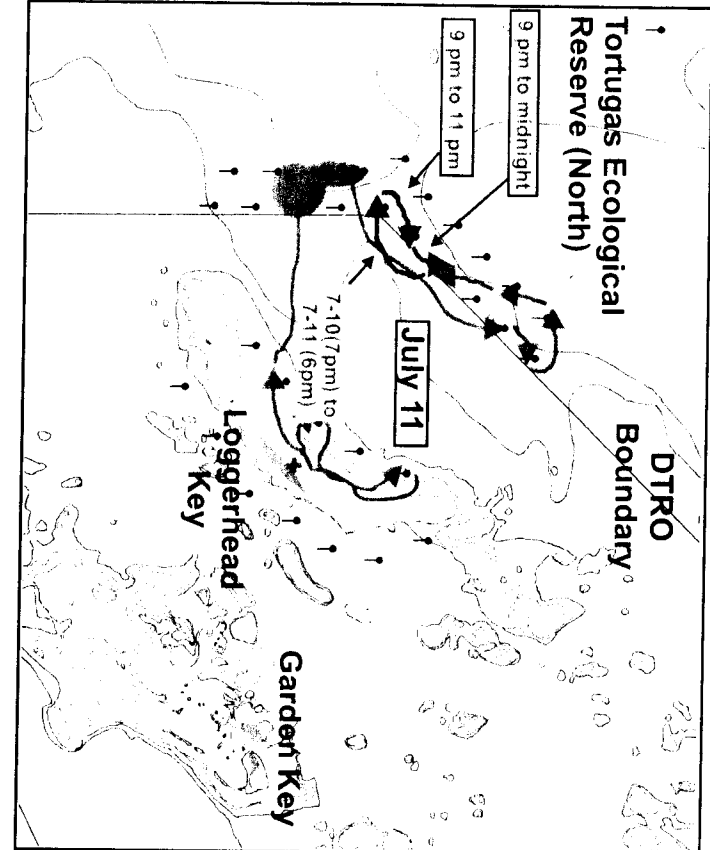


Figure 7. (A) Lobster 1026 finishes moving south on

the morning of July 11th, then turns back north beginning at 9pm. (B) By 1:30am in the morning of July 12th, she leaves the northwest corner of the gate presumably into the TERN heading roughly in the direction of the "Sherwood Forest".

A



B

