An Aerial Survey Method for Estimation of Boater Use in Biscayne National Park During 2003-2004

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Executive Summary

Over the past several decades, the combination of rapidly growing human populations, overfishing, and habitat alterations have placed significant stress on marine resources in the Florida Keys ecosystem, including Biscayne National Park. In response to concerns about resource sustainability, the Park is currently formulating management plans to balance Park visitor use and impacts on fishery and habitat resources. A key information need in this planning effort is the extent of boater use in Park waters. This study was undertaken to establish a cost-effective method for estimating boater use of Biscayne National Park. The study plan was to conduct an aerial census of vessels in Park waters, conduct a concurrent census of boat trailers at major public boat ramps in and around the Park, and use the vessel and trailer data to develop a statistical model for predicting total boater use. The complexity of the study environment required development of a mobile GIS recording system to collect real-time in-flight data on vessel usage including position (latitude and longitude), time of sighting, vessel number and characterization, and disposition. Direct counts of vessels within Park waters were obtained using a small fixed-wing Cessna 182 aircraft. A census of boat trailers was carried out on the same days and time frames (1200-1500h) as the flight surveys at five public marinas. A total of 52 vessel-trailer surveys were conducted from March 2003 to February 2004. Sampling effort was allocated by season (spring, summer, fall, and winter) and day of the week category (midweek and weekend/holiday) to conduct the vessel-trailer surveys on days that reflected the full gradient of boater use of Park waters, from lowest-use to highest-use days. Our results showed that the number of trailers at public marinas was a generally good predictor of the number of boats in Park waters. Our recommendations for precise estimation of boater use in Biscayne National Park are:

- Implement an automated system for obtaining daily trailer counts at the following 5 marinas: Homestead/Bayfront Park, Black Point, Matheson Hammock, Dinner Key, and Crandon Park.
- Calibrate and verify automated trailer counts with occasional direct trailer counts by creel census personnel.
- Use the combined season boat-trailer regression model,

  $$\text{Boats} = 44.279 + 0.9577 * \text{Trailers} \qquad (r^2 = 0.943)$$

  for estimation.
- Conduct aerial surveys to obtain vessel counts on special high-use days (e.g., Columbus Day Regatta weekend, lobster mini-season, etc.), since model predictions may be unreliable.

The aerial survey GIS database developed in this project will also be instrumental for a number of ongoing and future studies evaluating biological and socioeconomic aspects of Park visitor use, including estimation of spatial fishing effort.

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1.0 Introduction

Situated at the northeastern end of the Florida Keys coral reef ecosystem (**Figure 1**), Biscayne National Park (BISC) is a unique tropical marine environment, renown for its productive coral reef ecosystem, diverse natural resources, broad fishing and boating opportunities, and spectacular scenic beauty (Ault et al. 2001). This ecosystem provides the foundation for multibillion dollar fishing and tourism industries in south Florida (Johns et al. 2001). Over the past several decades, however, the combination of rapidly growing human populations, overfishing, habitat alterations, and changes in regional water quality have placed significant stress on the marine resources in the Florida Keys ecosystem, including BISC (Ault et al. 1998, 2001, 2002). To address these important ecosystem and fishery management issues, BISC is developing a comprehensive General Management Plan as well as a comprehensive Fisheries Management Plan. The planning process is the precursor to implementation of policies that balance current Park visitor use and impacts on marine resources.

One of the central issues in visitor use of BISC is development of a better understanding of the extent of boater use in Park waters. In the 1970s, an innovative methodology for estimating total boater use of Park waters was developed. The method entailed establishing a statistical relationship between counts of boat trailers at the major public boat ramps in close proximity to the Park with direct counts of boats in Park waters conducted from an airplane (Jim Tilmant, National Park Service, Fort Collins, CO, personal communication). Once this relationship is established, total boater use can be predicted rather inexpensively from trailer counts conducted on a daily, weekly, monthly, etc., basis. While trailer counts have been included in the BISC creel survey of recreational fishing for the past two decades, it has been over 15 years since the last aerial survey of boater use was conducted. During this time, substantial changes in the conditions underlying the relationship between trailer counts and boater use have occurred, including the expansion of Park boundaries, the addition of a major public marina (Black Point), human population increases in south Florida, and concomitant increases in registered vessels (**Figure 2**). To estimate boater use in BISC at the present time, a study was initiated to re-establish the statistical relationship between boat trailers at marinas and total boats in Park waters.

Figure 1: Map of Biscayne National Park showing the location of principal public boat ramps surrounding Biscayne Bay, and the general flight track for the aerial vessel census.

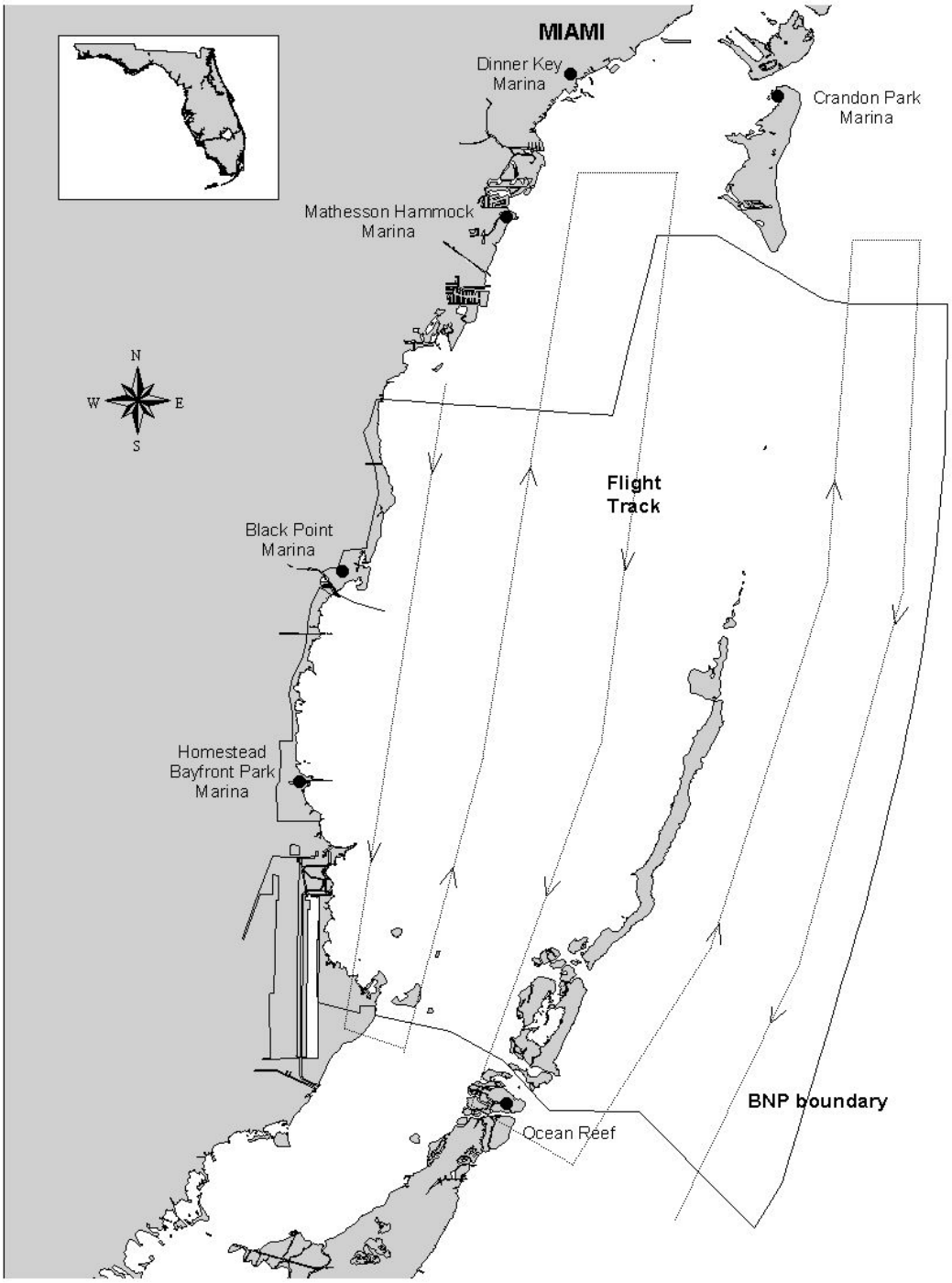
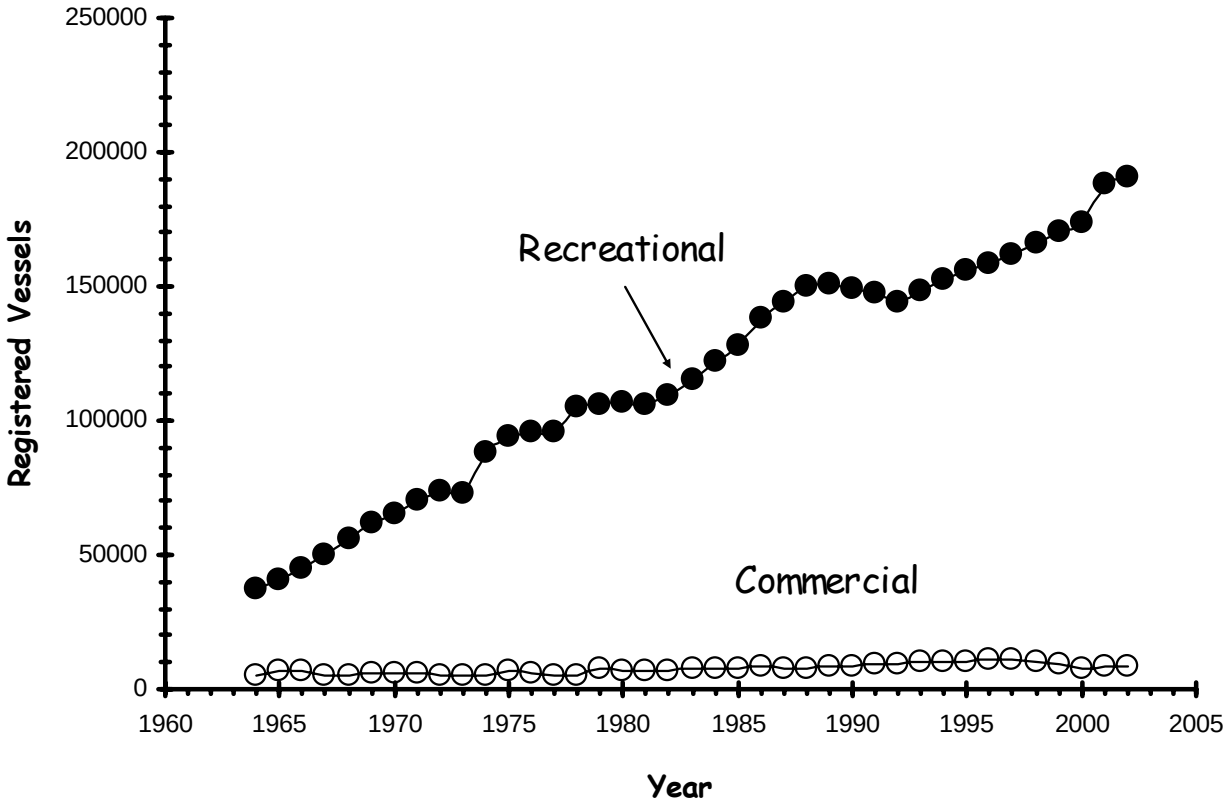


Figure 2: The number of recreational and commercial registered vessels in south Florida (5 counties: Broward, Collier, Miami-Dade, Monroe, Palm Beach) from 1964 to 2002.



This study's goal is to establish a cost-effective method for estimating boater use of BISC on a seasonal and annual basis. There are three study objectives: (1) to conduct an aerial census of vessels in Park waters; (2) to conduct a concurrent census of boat trailers at major public boat ramps in the vicinity of BISC; and (3) to develop a statistical model for predicting total boater use from the data of (1) and (2). This report documents our findings based on four seasonal surveys.

2.0 Methods

2.1 Mobile GIS Recording System

A mobile GIS recording system, with all components mounted on a lap desk, was developed to collect real-time in-flight data on vessel usage including position (latitude and

longitude), time of sighting, vessel number and characterization, and disposition. The main components of the system are a IBM-compatible laptop computer interfaced with a global positioning unit (Garmin GPS 176), and ESRI Arcview 3.3 and Tracking Analyst software (McClellan et al. 2003). By using two battery packs, power requirements for the laptop were extended to allow up to four hours of continuous recording. During a flight, the GIS system displays the real-time position of the aircraft on a digital nautical chart. The primary scientific observer records the actual position of vessels encountered during the flight on this visual display via a mouse click. A dialog box is activated at each mouse click, enabling the observer to quickly record the type of vessel (i.e., motorboat<30 ft, motorboat>30 ft, sailboat, commercial fishing vessel, or other such as kayaks, barges, casino boats, etc.) and its disposition (e.g., fishing, diving, cruising, anchored/moored, etc.). The dialog box also enables the observer to record the number of vessels at a given location for situations in which multiple vessels of similar type and disposition are in close proximity to one another. Data records are automatically written to a digital file as they are entered during a flight. Example database records are shown in **Appendix A1**. A datafile for each survey flight track is downloaded from the GPS unit at the conclusion of each flight.

2.2 Aerial Census of Vessels

Direct counts of vessels within BISC waters were conducted using a small fixed-wing Cessna 182 aircraft. The general survey track for a single overflight of Park waters is shown in **Figure 1**. The aircraft was flown at 90-100 nautical miles per hour at altitudes ranging from 500 to 1000 ft. A single survey sample consisted of one complete circuit of the flight route, which required approximately 2 hours. Flights were conducted exclusively between the hours of 1200 and 1500 during which boater use and trailer occupancy at marinas are at daily peak levels (Jim Tilmant, personal communication). The angle of the sun during this midday period was also conducive for visual observation of vessels from an airplane. Survey personnel for each flight included the aircraft pilot and 1 to 2 observers. Observers recorded vessel data using the mobile GIS system described above.

2.3 Boat Trailer Census

A census of boat trailers was conducted on the same days and time frames (1200-1500h) as the flight surveys at five primary public marinas in the vicinity of BISC (**Figure 1**): Homestead/Bayfront Park Marina (at Park headquarters), Black Point Marina, Matheson Hammock Marina, Dinner Key Marina, and Crandon Park Marina. The trailer census was a collaborative effort between University of Miami and BISC scientific personnel. For a given survey sample, the date, time, and total number of boat trailers were recorded at each marina. Counts were also obtained for the following trailer categories: 1-axle, 2-axle, 3-axle, and personal watercraft (e.g., jet ski) trailers. An example datasheet for the marina trailer survey is provided in **Appendix A2**. A digital database was compiled using Excel.

2.4 Allocation of Sampling Effort

Sampling effort was allocated by season (spring, summer, fall, and winter) and day of the week category (midweek and weekend/holiday) in an attempt to conduct the vessel-trailer surveys on days that reflected the full gradient of boater use of Park waters, from lowest-use to highest-use days. Within each season, surveys were evenly allocated between midweek and weekend/holiday categories. Specific survey dates were randomly selected within each day of the week category, with the constraint of a maximum of one survey per consecutive 2- or 3-day weekend/holiday period and one survey per consecutive 4- or 5-day midweek period.

2.5 Statistical Procedures

Paired observations of daily vessel counts and trailer counts were used to develop a statistical model of the form

$$\text{Vessels}_i = f(\text{Trailers}_i) + \varepsilon_i \quad , \qquad (1)$$

in which the number of vessels at day-time i is predicted as a function of the number of boat trailers at day-time i, and ε is the model error term. The relationship was developed according to standard regression model-building protocols (Neter et al. 1996). Seasonal differences in the vessel-trailer relationship (eq. 1) were evaluated using analysis of covariance (ANCOVA), with the number of trailers treated as the model covariate. All statistical computations were carried out using SAS statistical software.

3.0 Results

A total of 52 vessel-trailer surveys were conducted from March 2003 to February 2004. Sample sizes by season were as follows: spring 2003 (March-April), *n*=12 surveys; summer 2003 (Memorial Day weekend to Labor Day weekend), *n*=18; fall 2003 (October-November), *n*=12; and winter 2004 (January-February), *n*=10 (**Table 1**).

3.1 Aerial Census of Vessels

Example aerial vessel census maps are shown in **Figure 3**, illustrating differences in boater use of Park waters among a typical low-use day (**Figure 3a**), a typical high-use day (**Figure 3b**), and an extreme high-use day (**Figure 3c**). The complete set of daily fight maps are given in **Appendices B1** to **B4** for the respective spring 2003, summer 2003, fall 2003, and winter 2004 seasons.

Small motorboats (less than 30 ft in length) accounted for the majority (50-80%) of vessels in Park waters irrespective of day of the week or season (**Figure 4**). Vessel disposition data were compiled into 7 categories (**Table 2**). Over 30% of surveyed vessels were in transit (e.g., cruising, sailing, etc.) irrespective of day of week or season (**Figure 5**). The two other predominant use categories were 'anchored' and 'fishing'. As described in **Table 2**, persons on anchored vessels were generally engaged in picnicking, sunbathing, swimming, and the like, and notable concentrations of these vessels were observed inside Biscayne Bay near Elliot Key on most weekends and holidays during spring, summer, and fall (e.g., **Figures 3b**, **3c**, **6**). The proportion of anchored vessels during spring through fall was generally low on weekdays (5-10%) and substantially higher on weekends and holidays (30-40%). Concomitantly during spring through fall, the proportion of vessels engaged in fishing was generally high on weekdays (30-45%) and somewhat lower on weekends and holidays (15-25%). During winter, the proportion of anchored vessels was low (10%) and the proportion of fishing vessels was high (35%) irrespective of day of week. The proportion of vessels with persons engaged in diving activities (e.g., scuba, snorkel) was highest in summer compared to other seasons, while the proportion of docked vessels was highest in winter compared to other seasons.

Table 1: Trailer and vessel counts by survey date and day of week for the following seasons: (a) spring, (b) summer, (c) fall, and (d) winter. Day of week category is denoted in parentheses: MW=midweek; WH=weekend/holiday.

(a) Spring

Date	Day of Week	No. of Trailers		No. of Vessels
3/16/2003	Sunday (WH)	768		692
3/17/2003	Monday (MW)	61		97
3/23/2003	Sunday (WH)	563		575
3/25/2003	Tuesday (MW)	68		123
3/29/2003	Saturday (WH)	779		807
4/2/2003	Wednesday (MW)	55		74
4/3/2003	Thursday (MW)	89		167
4/6/2003	Sunday (WH)	605		689
4/12/2003	Saturday (WH)	358		505
4/13/2003	Sunday (WH)	786		954
4/15/2003	Tuesday (MW)	73		115
4/17/2003	Thursday (MW)	141		204
n=12		mean = 362.2		mean = 416.8

(b) Summer

Date	Day of Week	No. of Trailers		No. of Vessels
5/26/2003	[1]Monday (WH)	828		928
5/28/2003	Wednesday (MW)	27		46
5/31/2003	Saturday (WH)	762		622
6/9/2003	Monday (MW)	95		95
6/15/2003	Sunday (WH)	493		459
6/19/2003	Thursday (MW)	107		101
6/26/2003	Thursday (MW)	161		141
7/1/2003	Tuesday (MW)	110		102
7/5/2003	Saturday (WH)	466		476
7/10/2003	Thursday (MW)	104		94
7/12/2003	Saturday (WH)	710		562
7/17/2003	Thursday (MW)	106		93
7/30/2003	[2]Wednesday (WH)	690		751
8/2/2003	Saturday (WH)	626		504
8/5/2003	Tuesday (MW)	75		92
8/15/2003	Friday (MW)	134		150
8/17/2003	Sunday (WH)	846		873
8/30/2003	Saturday (WH)	283		425
n=18		mean = 367.9		mean = 361.9

[1]Memorial Day
[2]Opening Day, Lobster Mini-Season

Table 1: (cont.)

(c) Fall

Date	Day of Week	No. of Trailers		No. of Vessels
10/2/2003	Thursday (MW)	60		94
10/11/2003	[3]Saturday (WH)	1294		2318
10/19/2003	Sunday (WH)	426		423
10/21/2003	Tuesday (MW)	89		110
10/26/2003	Sunday (WH)	212		222
10/28/2003	Tuesday (MW)	74		103
11/2/2003	Sunday (WH)	86		77
11/8/2003	Saturday (WH)	290		347
11/18/2003	Tuesday (MW)	44		81
11/19/2003	Wednesday (MW)	35		88
11/22/2003	Saturday (WH)	284		311
11/25/2003	Tuesday (MW)	149		216
n=12		mean = 253.6		mean = 365.8

[3]Columbus Day Regatta weekend

(d) Winter

Date	Day of Week	No. of Trailers		No. of Vessels
1/8/2004	Thursday (MW)	38		75
1/11/2004	Sunday (WH)	52		93
1/17/2004	Saturday (WH)	529		638
1/25/2004	Sunday (WH)	511		613
1/29/2004	Thursday (MW)	37		167
2/8/2004	Sunday (WH)	115		136
2/10/2004	Tuesday (MW)	81		157
2/11/2004	Wednesday (MW)	146		216
2/15/2004	Sunday (WH)	89		186
2/17/2004	Tuesday (MW)	51		149
n=10		mean = 164.9		mean = 243.0

Figure 3: Example aerial vessel census maps illustrating **(a)** a typical low-use day (Wednesday, May 28, 2003), **(b)** a typical high-use day (Memorial Day, May 26, 2003), and **(c)** an extreme high-use day (Columbus Day Regatta weekend, Saturday, October 11, 2003). The flight path is denoted by the blue dotted line; the number of vessels at a given location is denoted by the red dots.

(a)

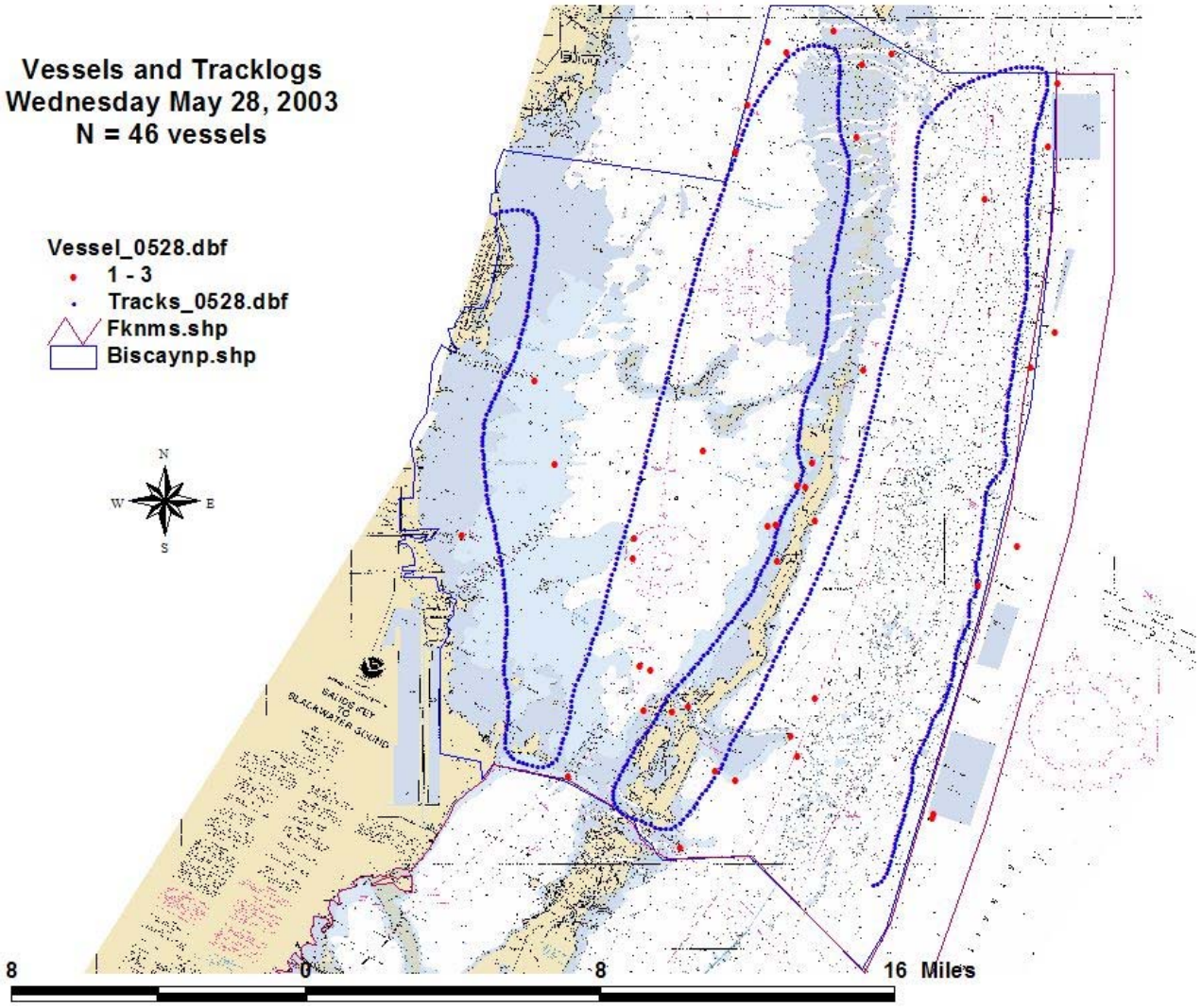


Figure 3: (cont.)

(b)

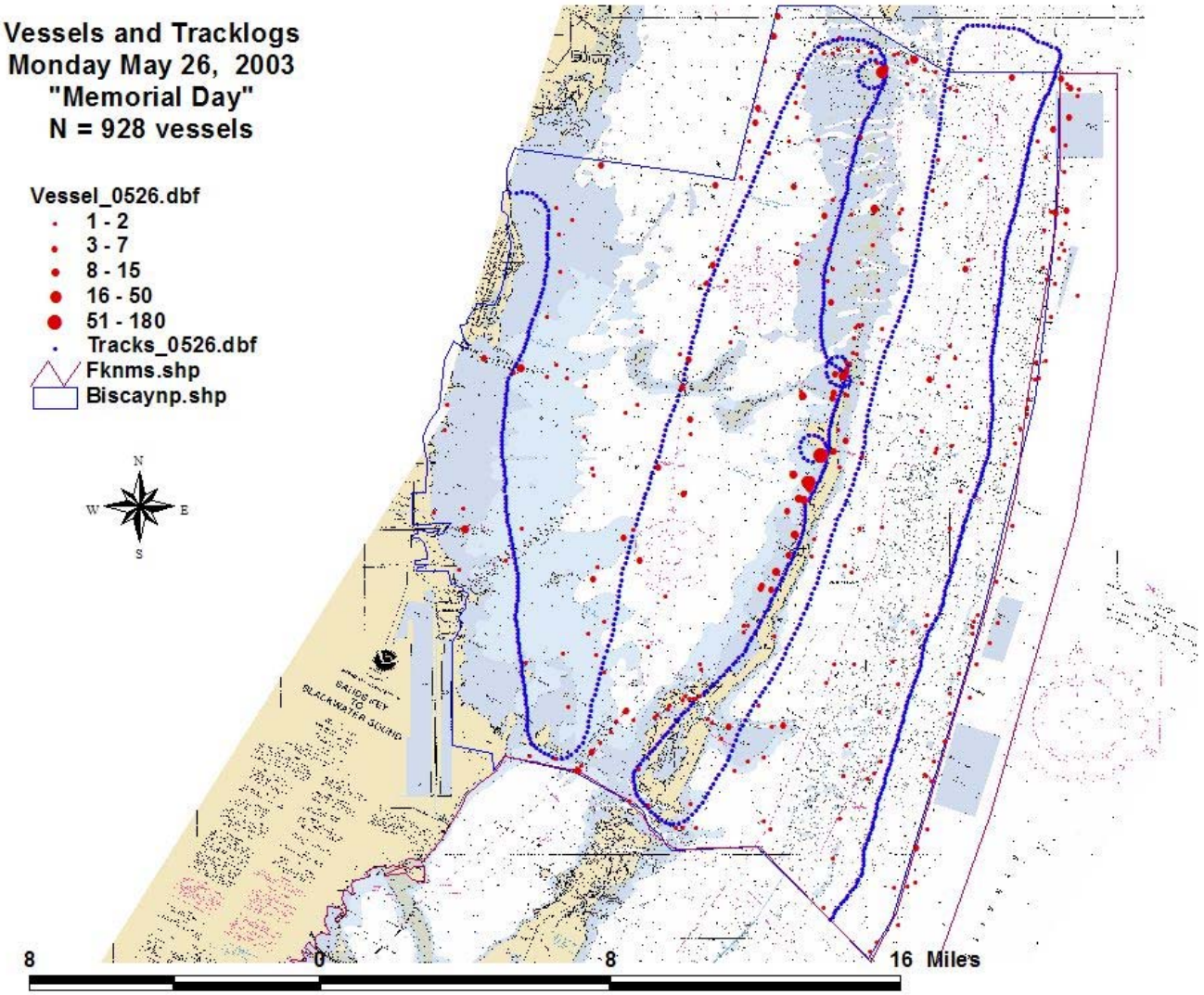


Figure 3: (cont.)

(c)

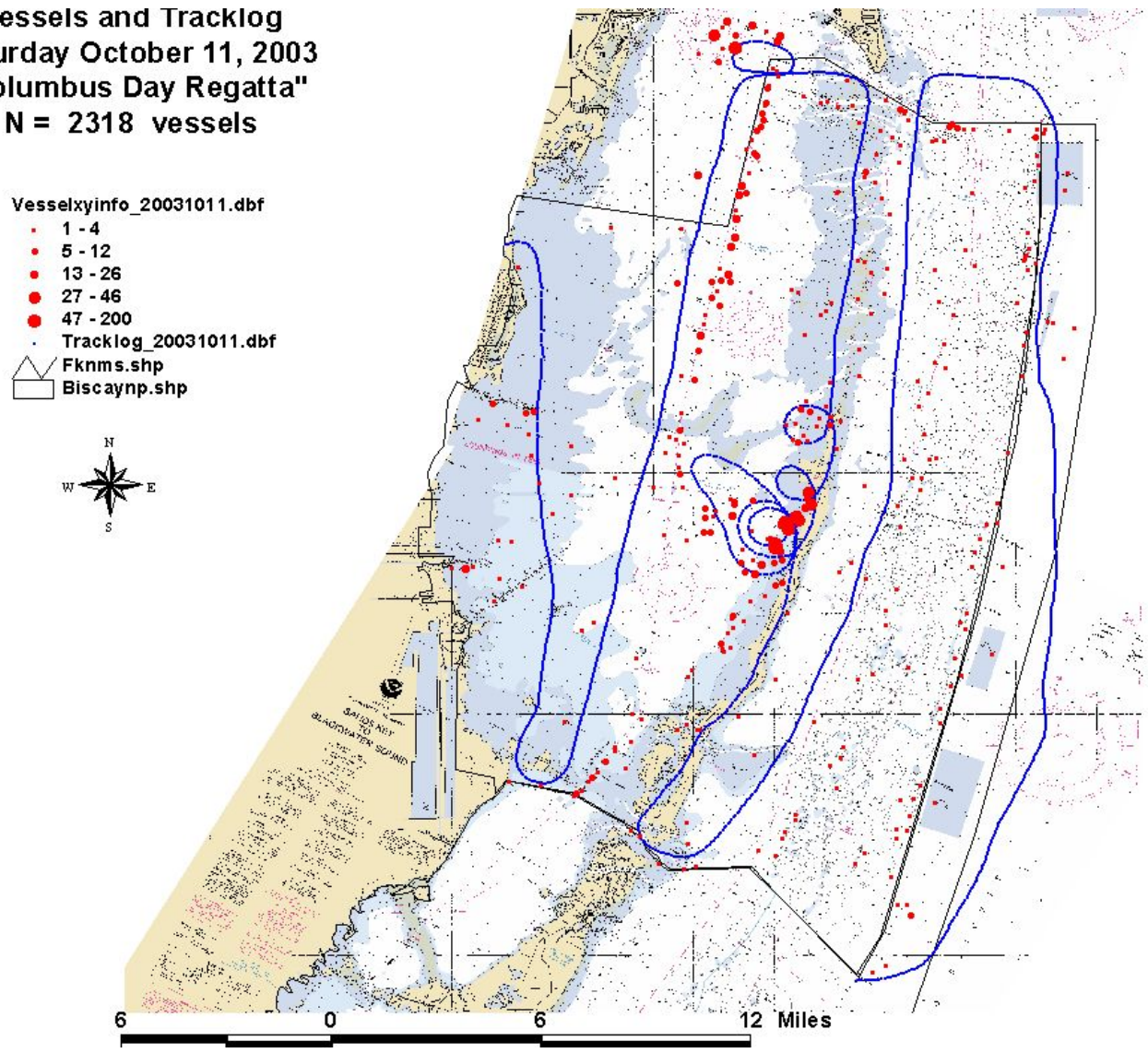


Figure 4: Relative composition of vessel types in Biscayne National Park waters by day of the week for 2003-2004 aerial surveys in (a) spring, (b) summer, (c) fall, and (d) winter.

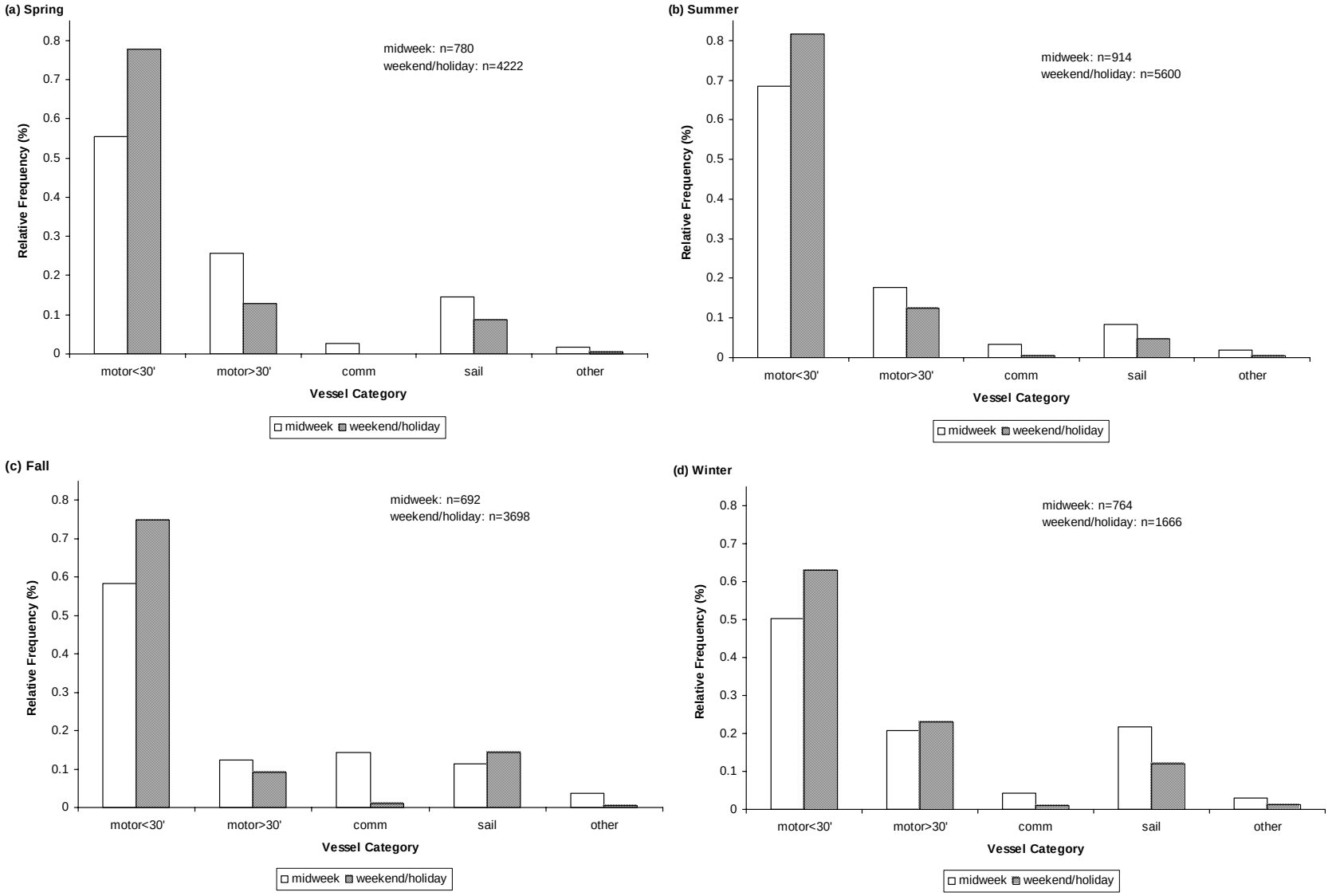


Table 2: Description of vessel disposition categories.

Vessel Disposition Category	Description
Cruising	Motorboats, sailboats, etc., in transit.
Anchored	Vessels anchored or moored but not engaged in fishing or diving; most often, persons are picnicking, sunbathing, swimming, etc.; see Figure 6 for example photos.
Fishing	Vessels with persons engaged in: recreational or commercial hook-and-line fishing; commercial baitfishing with various nets; commercial crabbing or lobstering with traps.
Diving	Vessels with persons engaged in scuba diving or snorkeling.
Dive/Fish	Vessels likely engaged in diving or fishing, but flight observers were not able to discern between the two activities.
Docked	Vessels secured to a boat dock or similar structure.
Other	Vessels engaged in patrolling (e.g., Coast Guard, Park rangers), casino operations, barge operations, scientific research; derelict vessels, grounded vessels, vessels under tow.

Figure 5: Relative frequency of vessel use categories (see Table 2 for description) in Biscayne National Park waters by day of the week for 2003-2004 aerial surveys in (a) spring, (b) summer, (c) fall, and (d) winter.

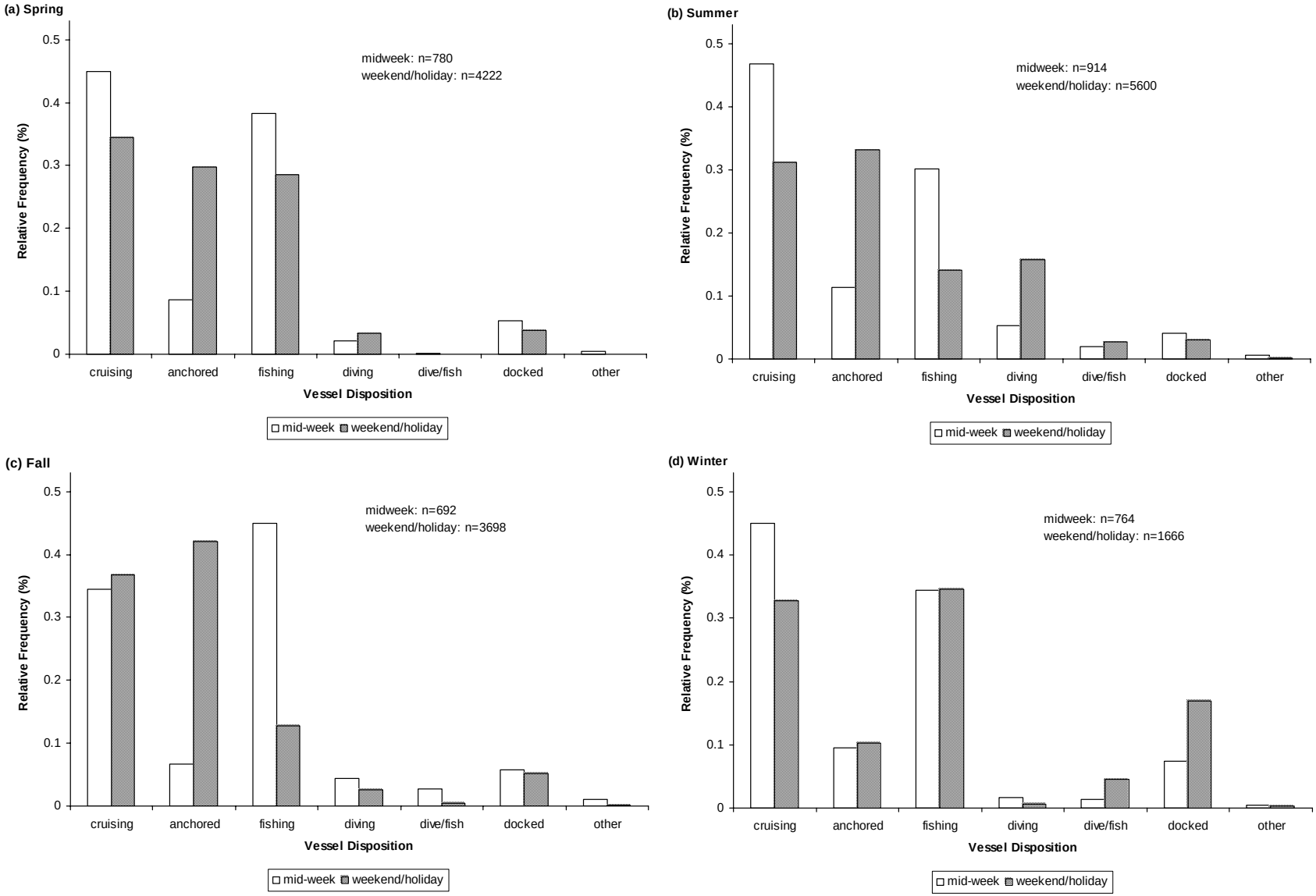


Figure 6: Aerial photos taken during Columbus Day Regatta weekend: (a) view looking eastward at concentration of anchored vessels near Elliot Key; (b) closer view of concentration of vessels near Elliot Key.

(a)

(b)

3.2 Boat Trailer Census

Trailer counts by date and location (i.e., marina) are given in **Table 3** for spring 2003 through winter 2004 marina surveys. These totals do not include trailers for personal watercraft since this vessel type is not allowed in BISC waters. Boat trailers were predominately of the 1-axle or 2-axle type (**Figure 7**). The vast majority of boat trailer types (1-, 2-, and 3-axle) observed at public marinas were designed for transporting motorboats smaller than 30 ft in length. Dinner Key Marina accounted for 10% or less of boat trailers in the survey, with each of the other four marinas accounting for approximately equal proportions of trailers by day of the week and season (**Figure 8**).

3.3 Estimation of Vessels from Trailers

A scatterplot of boat and trailer counts for all 52 surveys denoting season is shown in **Figure 9**. These data are also provided in **Table 1**. A strong linear relationship between the number of boats and number of trailers was apparent. High-use days, with high counts of boats and trailers, mostly occurred during spring and summer. An exception was the survey for the Columbus Day Regatta weekend in fall 2003. For this extreme high-use day, the observed number of boats was 2-3 times higher than any other high-use day surveyed. For reasons discussed below, the Columbus Day survey was treated as an outlier and was excluded from regression analyses of the boat-trailer relationship.

A strong linear relationship between boats and trailers was also apparent during each season (**Figures 10a-10d**). Highest-use days occurred on weekends and holidays in each season. No statistical differences were detected among slopes of seasonal regression models (ANCOVA, $p > 0.75$; **Figure 10e**). However, differences were detected among intercepts ($p<0.01$), indicating that seasonal regression relationships were parallel but not exactly coincident.

The regression model for all seasons combined is shown in **Figure 11**. Vessels in BISC waters and trailers at boat ramps were highly correlated as the model r^2 was 0.943. Error residuals were normally distributed (Shapiro-Wilk test, $p>0.1$). There was a slight indication of heterogeneity of variance of error residuals, with an increase in variance of vessel numbers at higher number of trailers, but the problem was not severe enough to warrant application of transformation or re-weighting procedures.

The combined season boat-trailer regression function (**Figure 11**) was used to investigate

the impacts on model performance of excluding trailer counts from Dinner Key Marina and Crandon Park Marina, the two public marinas farthest from Park headquarters (adjacent to Homestead/Bayfront Park; **Figure 1**). Four cases were evaluated (**Table 4**): (1) including data from all marinas (**Figure 11**); (2) excluding trailer data from Dinner Key Marina; (3) excluding data from Crandon Park Marina; and (4) excluding data from both marinas (**Figure 12**). While changes occurred in regression parameter estimates among the four cases, most notably changes in model slopes, there was virtually no change in model r^2 values.

Table 3: Trailer counts by date and location for marina surveys during (a) spring, (b) summer, (c) fall, and (d) winter. Start times for each count are given in 24 h units.

(a) Spring

		Homestead/ Bayfront Park		Black Point		Matheson Hammock		Dinner Key		Crandon Park	
Date	**Day**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**
3/16/03	Sun	1330	148	1245	215	1205	178	1230	45	1241	181
3/17/03	Mon	1240	13	1220	19	1200	10	1210	7	1230	12
3/23/03	Sun	1344	80	1321	152	1232	156	1230	39	1246	135
3/25/03	Tue	1354	18	1310	18	1212	10	1230	3	1205	19
3/29/03	Sat	1325	204	1248	204	1220	207	1320	37	1305	126
4/2/03	Wed	1232	18	1217	10	1149	16	1235	2	1250	9
4/3/03	Thu	1514	22	1500	28	1212	20	1225	6	1235	13
4/6/03	Sun	1355	96	1232	179	1200	156	1255	44	1315	131
4/12/03	Sat	1438	72	1410	96	1335	112	1231	19	1250	59
4/13/03	Sun	1314	208	1218	197	1154	187	1200	42	1225	152
4/15/03	Tue	1516	26	1452	13	1421	16	1235	2	1249	16
4/17/03	Thu	1350	55	1320	26	1245	17	1320	12	1255	31

Table 3: (cont.)

(b) Summer

		Homestead/ Bayfront Park		Black Point		Matheson Hammock		Dinner Key		Crandon Park	
Date	**Day**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**	**Time**	**Trailers**
5/26/03	[1]Mon	1300	169	1223	215	1148	205	1235	45	1300	194
5/28/03	Wed	1536	9	1520	4	1443	6	1230	0	1240	8
5/31/03	Sat	1325	151	1305	194	1230	192	1325	44	1240	181
6/9/03	Mon	1120	23	1140	27	1205	25	1211	7	1228	13
6/15/03	Sun	1230	123	1230	106	1300	131	1215	30	1235	103
6/19/03	Thu	1340	27	1145	30	1230	23	1246	10	1225	17
6/26/03	Thu	1300	47	1328	38	1353	36	1306	10	1247	30
7/1/03	Tue	1355	23	1340	19	1300	26	1230	14	1215	28
7/5/03	Sat	1345	102	1210	114	1235	103	1200	23	1215	124
7/10/03	Thu	1400	25	1300	30	1200	21	1230	8	1215	20
7/12/03	Sat	1400	151	1330	176	1245	187	1320	40	1245	156
7/17/03	Thu	1315	25	1330	31	1400	25	1245	10	1300	15
7/30/03	[2]Wed	1235	162	1245	180	1315	139	1245	49	1205	160
8/2/03	Sat	1430	132	1315	143	1340	167	1305	38	1245	146
8/5/03	Tue	1345	19	1410	21	1450	19	1250	1	1240	15
8/15/03	Fri	1430	25	1330	42	1400	34	1305	6	1245	27
8/17/03	Sun	1345	190	1313	245	1200	173	1300	37	1245	201
8/30/03	Sat	1335	60	1145	66	1115	43	1340	26	1320	88

[1]Memorial Day
[2]Opening Day, Lobster Mini-Season

Table 3: (cont.)

(c) Fall

Date	Day	Homestead/ Bayfront Park		Black Point		Matheson Hammock		Dinner Key		Crandon Park	
		Time	Trailers	Time	Trailers	Time	Trailers	Time	Trailers	Time	Trailers
10/2/03	Thu	1340	14	1325	16	1255	15	1258	4	1245	11
10/11/03	[3]Sat	1200	267	1310	427	1240	314	1310	53	1220	233
10/19/03	Sun	1330	69	1305	122	1230	140	1222	24	1205	71
10/21/03	Tue	1225	21	1250	22	1330	21	1340	7	1326	18
10/26/03	Sun	1326	35	1244	49	1215	55	1239	24	1210	49
10/28/03	Tue	1345	18	1326	17	1258	14	1202	19	1222	6
11/2/03	Sun	1255	10	1235	18	1210	17	1359	19	1342	22
11/8/03	Sat	1304	41	1235	69	1155	60	1332	22	1345	98
11/18/03	Tue	1304	14	1245	10	1220	10	1223	3	1205	7
11/19/03	Wed	1337	9	1301	7	1242	6	1316	3	1215	10
11/22/03	Sat	1349	52	1329	69	1300	83	1247	24	1312	56
11/25/03	Tue	1252	40	1238	34	1212	28	1317	12	1333	35

[3]Columbus Day Regatta weekend

Table 3: (cont.)

(d) Winter

Date	Day	Homestead/ Bayfront Park		Black Point		Matheson Hammock		Dinner Key		Crandon Park	
		Time	Trailers	Time	Trailers	Time	Trailers	Time	Trailers	Time	Trailers
1/8/04	Thu	1415	10	1400	7	1330	5	1326	13	1310	3
1/11/04	Sun	1243	3	1131	18	1200	11	1304	7	1326	13
1/17/04	Sat	1344	119	1250	121	1215	142	1210	49	1223	98
1/25/04	Sun	1340	95	1320	106	1243	183	1346	47	1323	80
1/29/04	Thu	1429	5	1245	11	1307	9	1304	4	1318	8
2/8/04	Sun	1313	20	1253	21	1222	22	1259	10	1243	42
2/10/04	Tue	1252	20	1357	21	1333	18	1255	6	1235	16
2/11/04	Wed	1220	30	1339	43	1258	29	1228	12	1242	32
2/15/04	Sun	1238	16	1258	25	1322	24	1245	0	1220	24
2/17/04	Tue	1202	10	1218	15	1310	10	1348	4	1400	12

Figure 7: Relative composition of boat trailer types by day of the week for 2003-2004 marina surveys in (a) spring, (b) summer, (c) fall, and (d) winter.

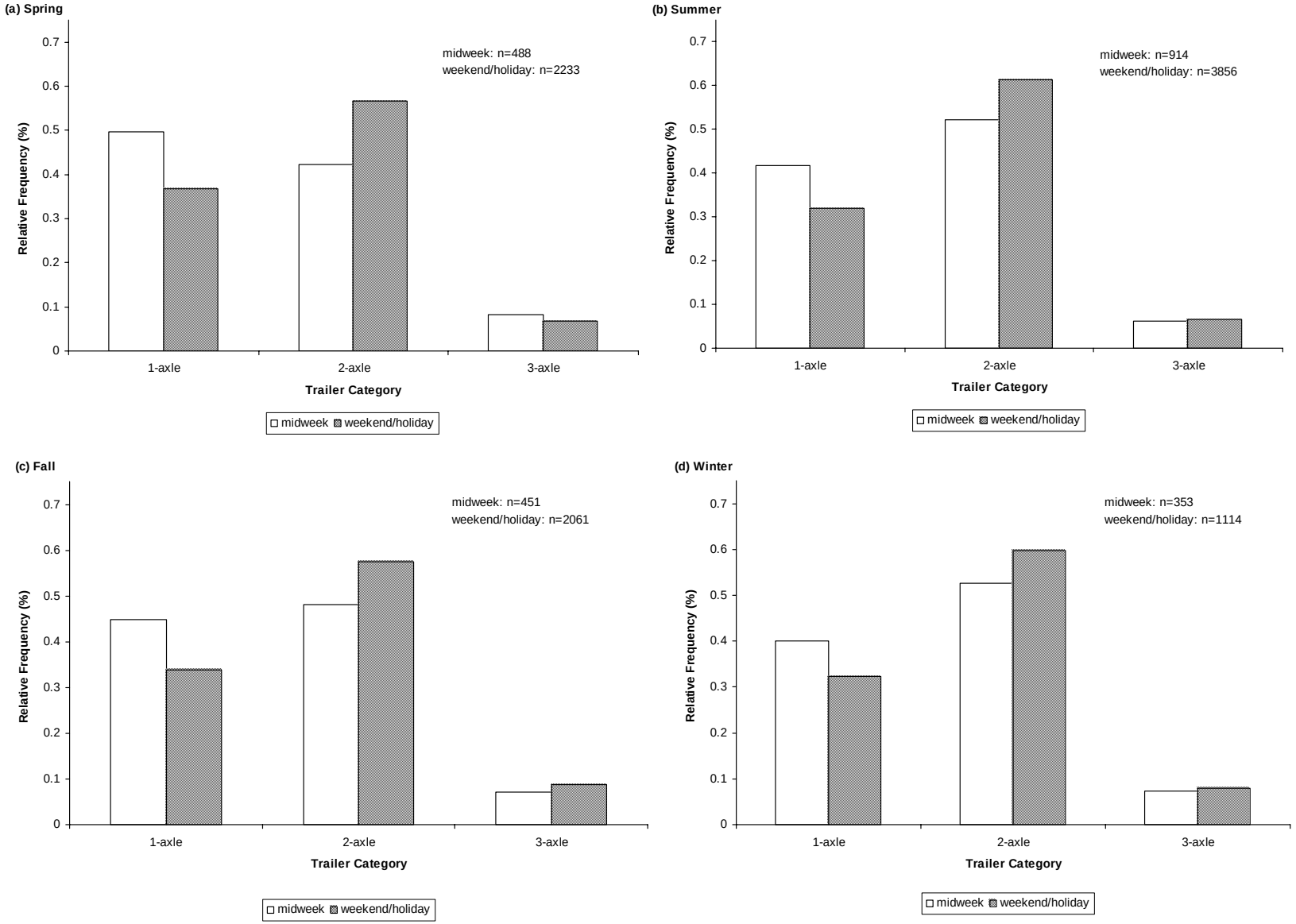


Figure 8: Relative frequency of boat trailers in the 5 designated marinas by day of the week for 2003-2004 marina surveys in (a) spring, (b) summer, (c) fall, and (d) winter (HB=Homestead Bayfront, BP=Black Point, MH=Matheson Hammock, DK=Dinner Key, CP=Crandon Park).

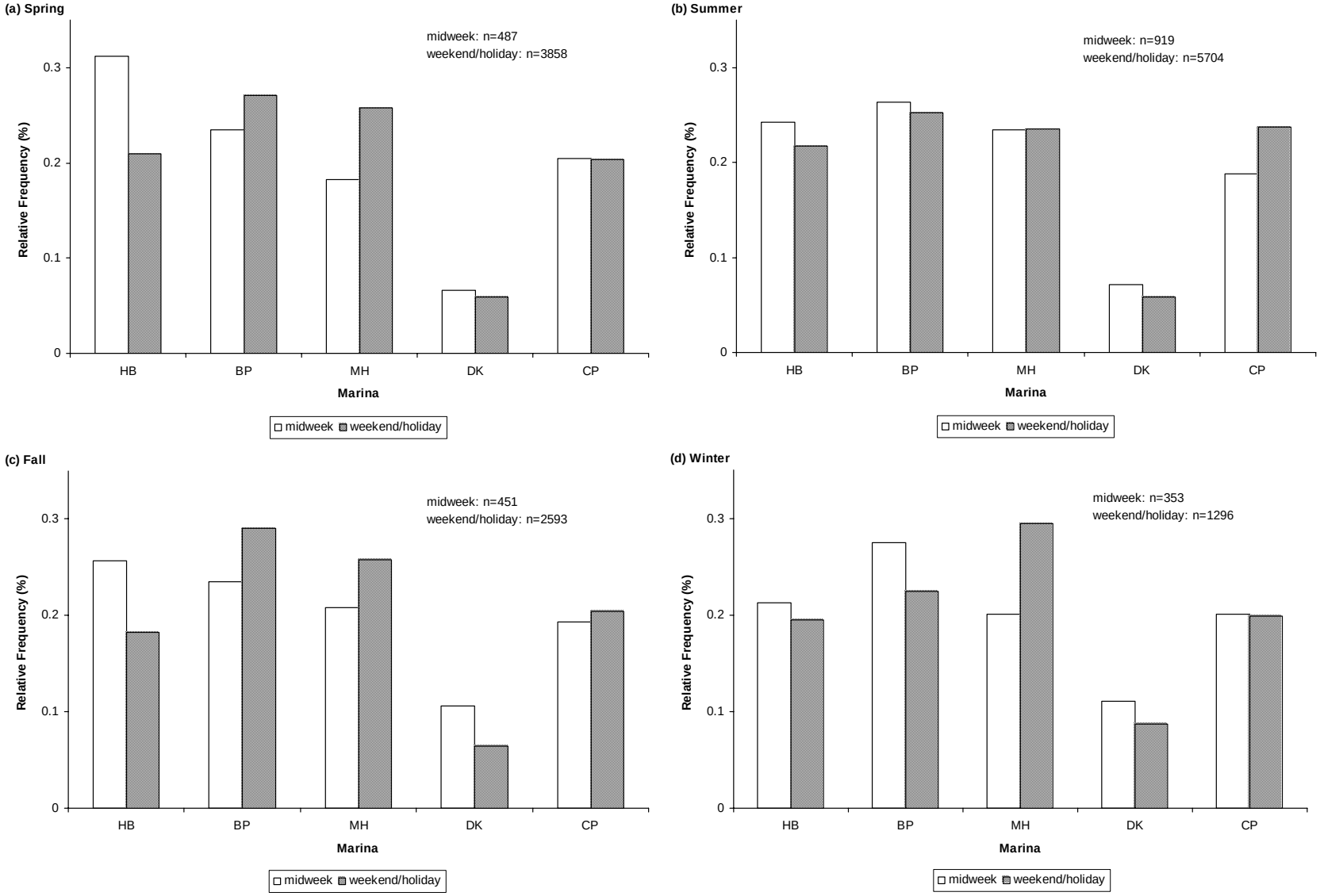


Figure 9: Scatterplot of boat counts and trailer counts. Points are denoted by season.

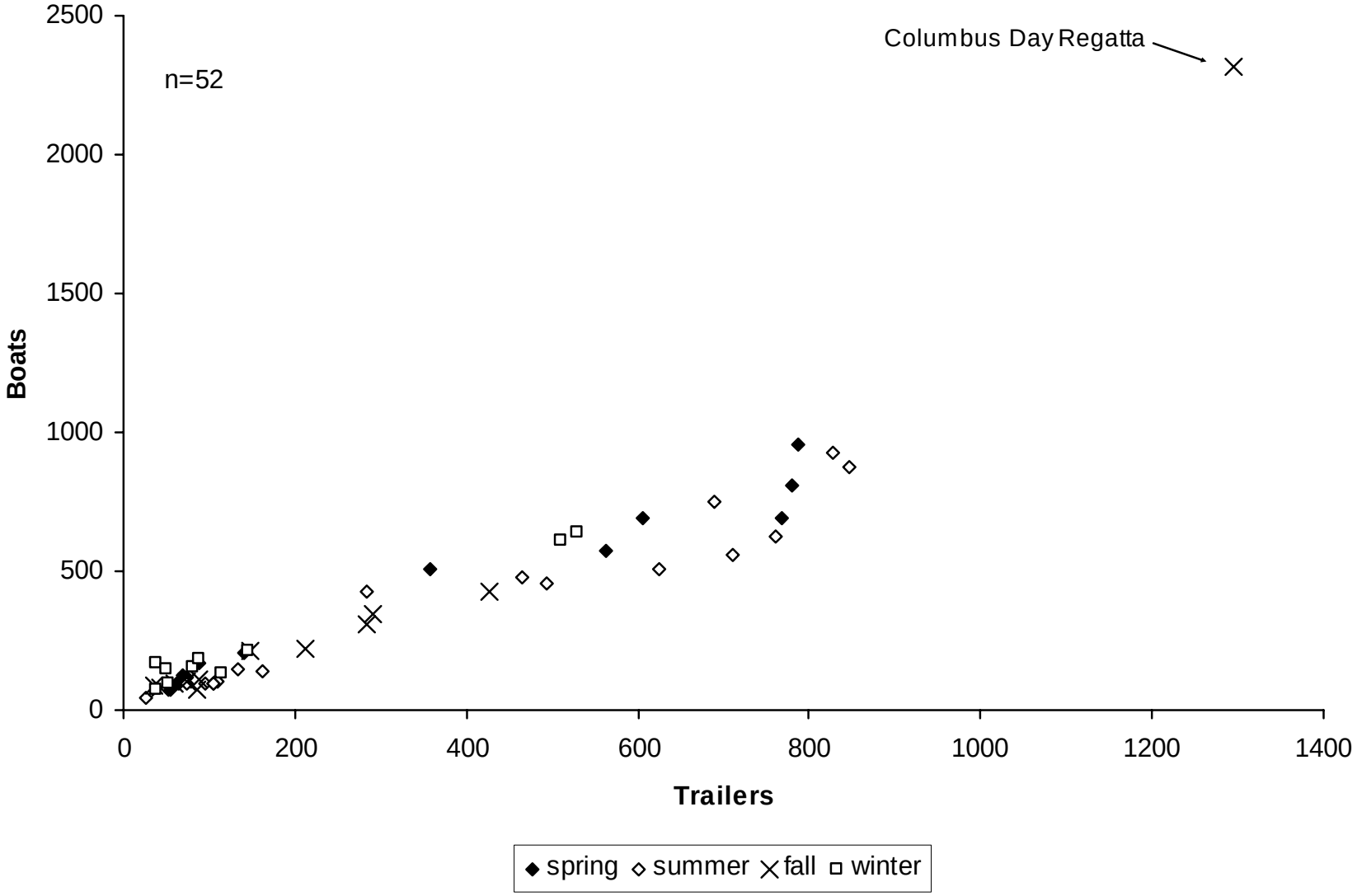


Figure 10: Scatterplots of boat counts and trailer counts, with fitted regression models predicting the number of boats as a function of the number of trailers, by season: (a) spring, (b) summer, (c) fall, and (d) winter; points are denoted by day of week (mw=midweek, wh=weekend/holiday). (e) Fitted regression lines for all four seasons and ANCOVA results.

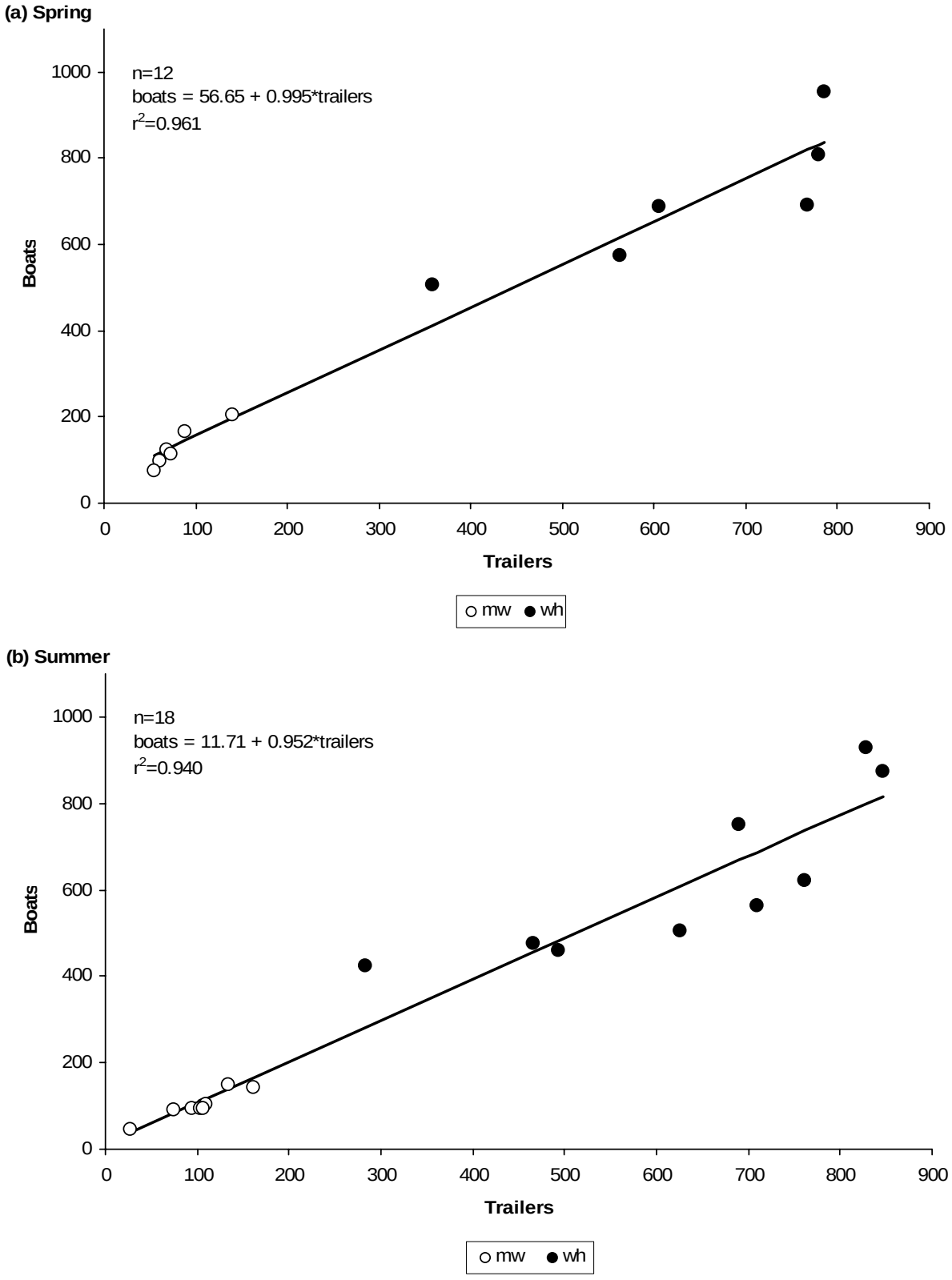
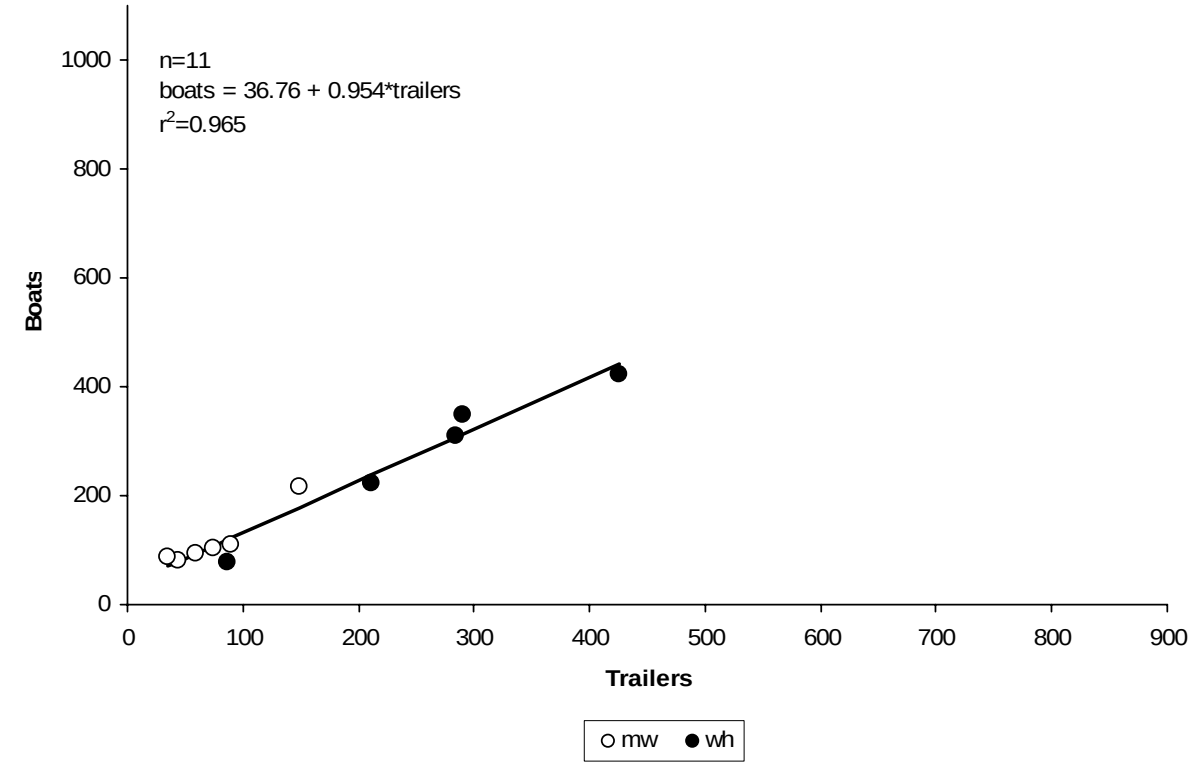


Figure 10: (cont.)

(c) Fall



(d) Winter

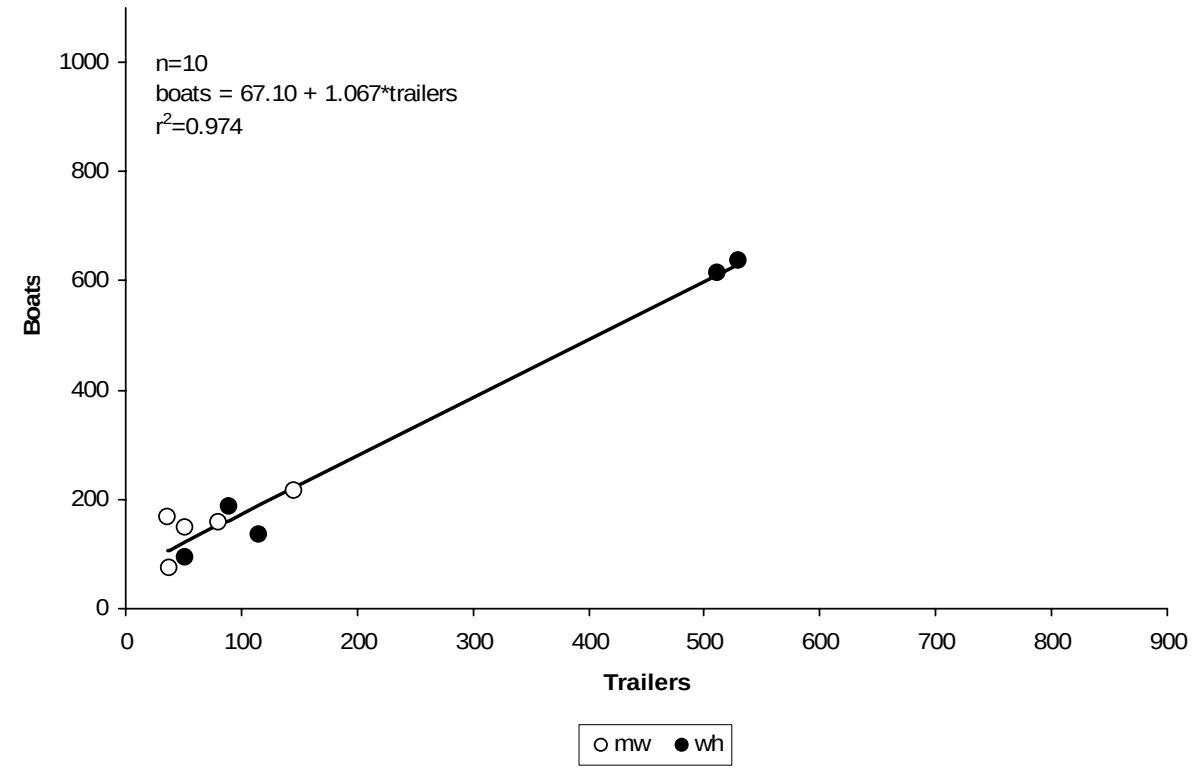


Figure 10: (cont.)

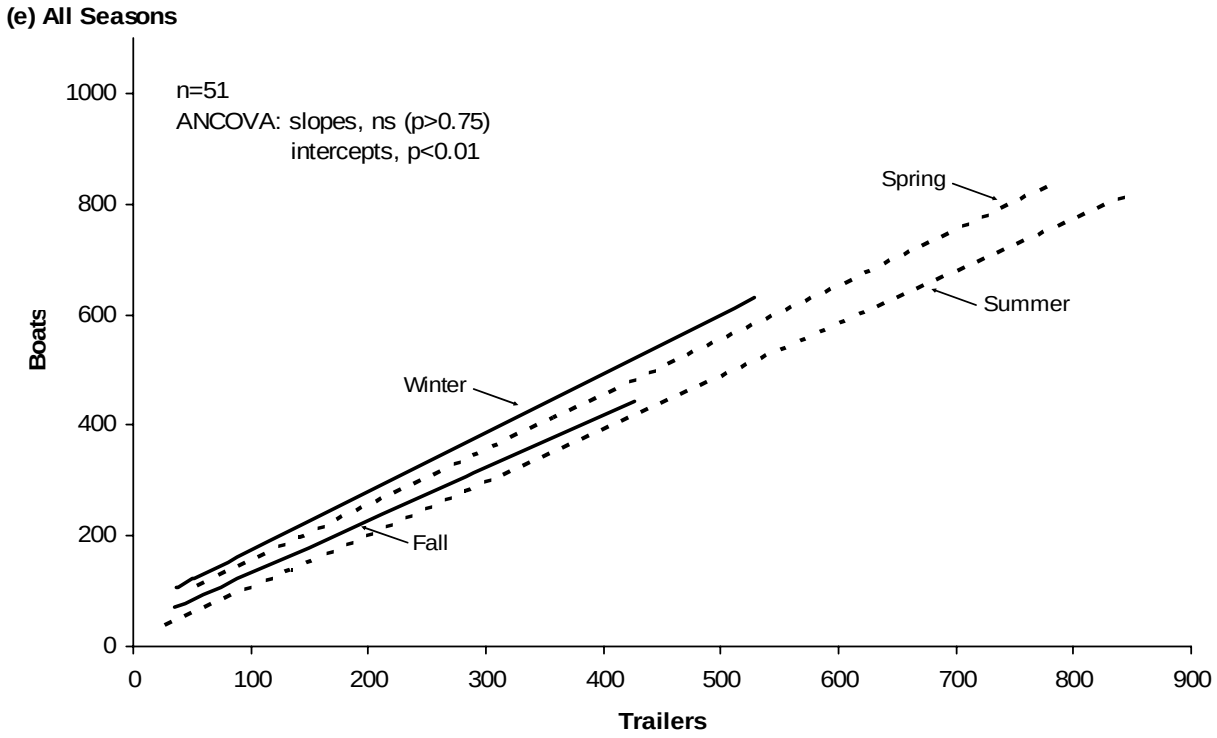


Figure 11: Scatterplot of boat counts and trailer counts for all seasons combined, with the fitted regression model (solid line) and associated 95% confidence interval (dotted lines); points are denoted by day of week (mw=midweek, wh=weekend/holiday).

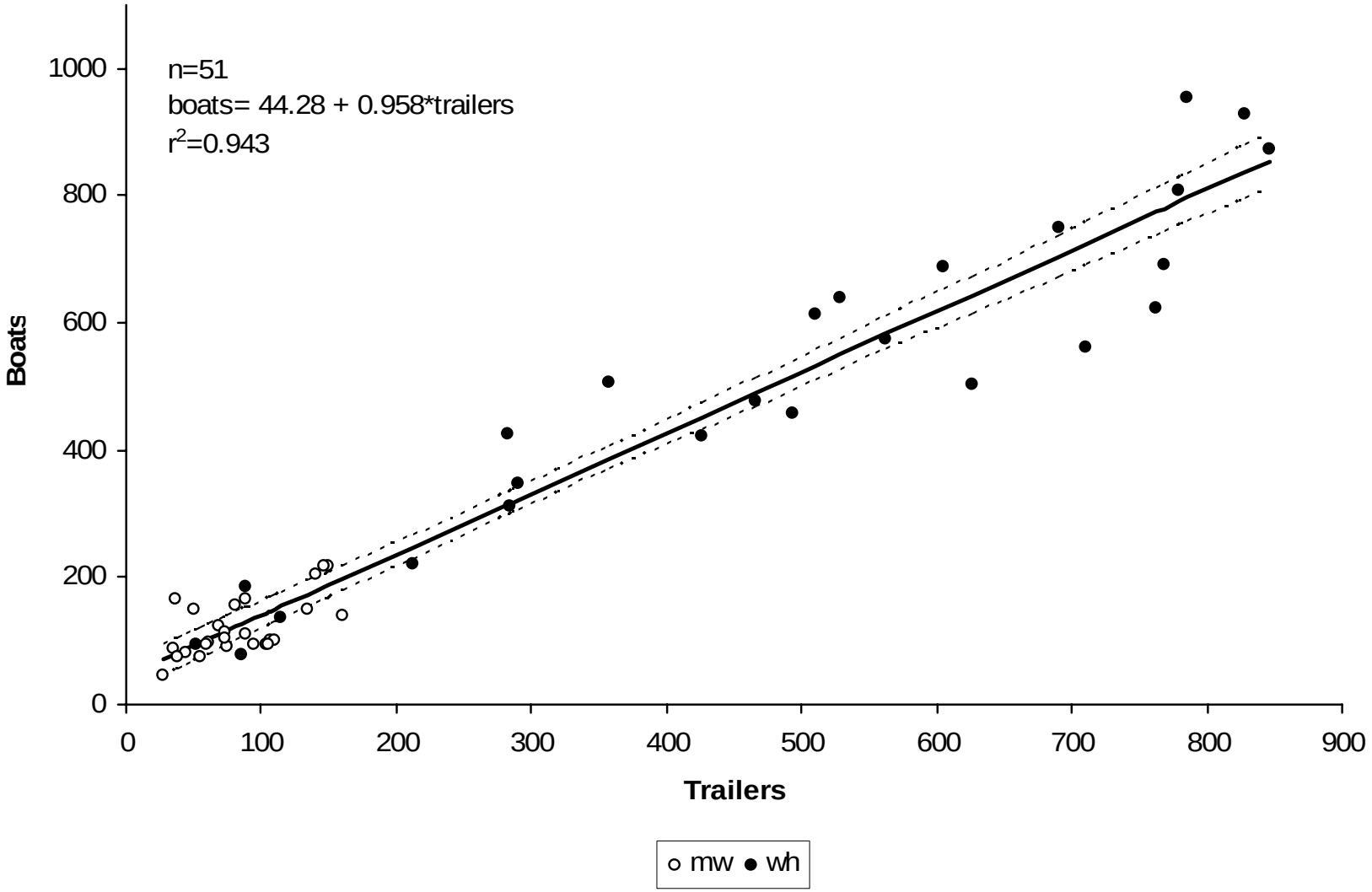


Figure 12: Boat-trailer scatterplot and regression model for case where trailer count data from Dinner Key Marina and Crandon Park Marina were excluded. Points are denoted by day of week (mw=midweek, wh=weekend/holiday).

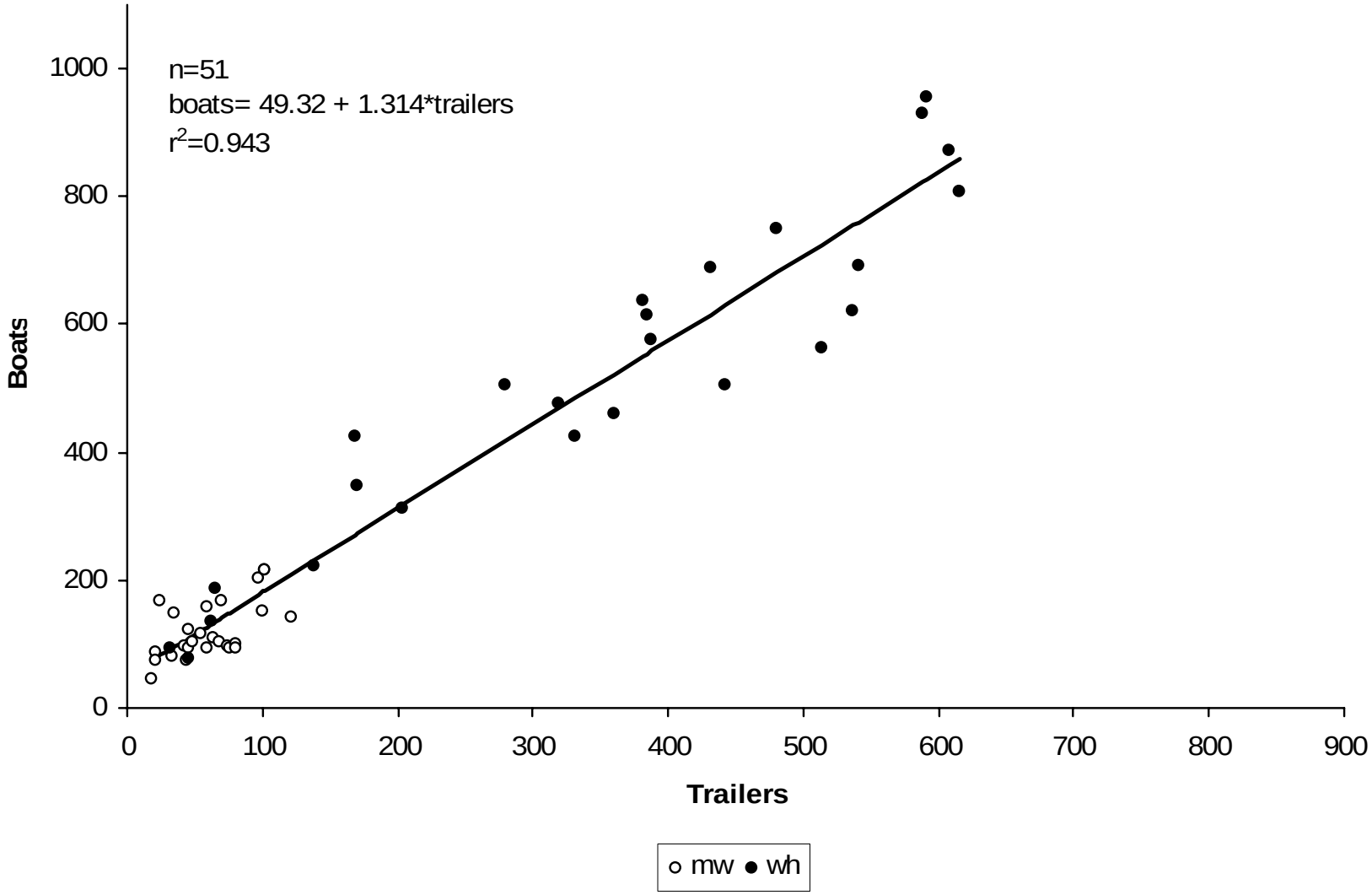


Table 4: Parameter estimates (with corresponding standard errors SE) and r^2 values for combined season (*n*=51) boat-trailer regression models for cases where trailer count data were included for all marinas or excluded from selected marinas.

Regression Case	Intercept (SE)	Slope (SE)	r^2
All marinas included	44.279 (13.035)	0.9577 (0.0335)	0.943
Dinner Key excluded	48.217 (13.104)	1.0122 (0.0359)	0.942
Crandon Park excluded	44.093 (12.846)	1.2246 (0.0422)	0.945
Dinner Key and Crandon Park excluded	49.319 (12.963)	1.3141 (0.0462)	0.943

4.0 Discussion

Our results showed that the number of trailers at public marinas was a generally good predictor of the number of boats in Biscayne National Park waters. This finding corroborates the results of previous aerial surveys conducted in the late 1970s (Jim Tilmant, personal communication) and early 1990s (McClellan 1996). One of the likely reasons for the strong linear relationship between boats and trailers was that the most common vessel type observed in Park waters, motorboats <30 ft in length, is the principal vessel type transported to and from public boat ramps using 1- and 2-axle trailers. In addition, the relative composition of vessel types in Park waters and trailer types at public marinas were similar irrespective of season and day of the week.

Issues to consider for practical application of boat-trailer regression models for estimating boater use in Park waters include: (1) model choice between season-specific or combined season functions; (2) sampling procedures for obtaining trailer count data from public marinas; (3) estimation procedures for special high-use days.

Season-specific vs. combined season models:- The goal of allocating surveys among four different seasons was to conduct vessel-trailer counts on days that reflected the full gradient of boater use of Park waters, from lowest-use to highest-use days, with a limited sampling budget. While ANCOVA analysis indicated slight differences in boat-trailer relationships among seasons, some points to note are: sample sizes were fairly low in any particular season; the range of boat and trailer counts was lower in winter and fall compared to spring and summer; and, within a particular season there were notable gaps in boat and trailer counts between low- and high-use days. Pooling data among seasons eliminated most of these problems; moreover, the goal of sampling along a continuum of low- to high-use days seems to have been accomplished. The combined season regression model exhibits a well-defined linear form, has a very high r^2, and satisfies the error residual assumptions of normality and constant variance. Conducting additional surveys to develop robust, season-specific boat-trailer relationships does not appear to be warranted by our results.

Sampling procedures for trailer counts:- There are two questions to consider regarding public marina surveys of boat trailers: (i) how often should marinas be sampled? and (ii) which marinas should be included in the survey? Ideally, trailer counts should be obtained on a daily basis. This will enable boater use of Park waters to be estimated from the regression model for each

calendar day, and these estimates can then be summed to estimate boater use for weekly, monthly, seasonal, annual, etc., time periods. While the boat-trailer regression model was developed from data obtained for a specific time period (1200-1500h) during a day, the model properties described above indicate that reliable estimates of total daily boater use should be obtained from input values of total daily trailer counts. We recommend development of some automated procedure for obtaining daily trailer counts, such as installing video cameras or vehicle counting devices at marina entrances, or making arrangements to obtain daily gate receipts from the marina operators. Occasional trailer counts by Park personnel as part of the creel census program could be used to calibrate and verify the automated daily counts.

Our findings suggest that obtaining trailer count data from the 3 marinas closest to BISC headquarters—Homestead/Bayfront Park, Black Point, and Matheson Hammock—would provide estimates of total boater use comparable to estimates based on trailer counts from all 5 marinas sampled in the present study. However, total boater use is only one of several important management issues that can be addressed using the aerial survey database. Although the modeling focus of this study emphasized total vessel use in BISC waters, the aerial survey GIS database contains information on the composition and disposition of the Park visitor fleet (sailboat, motorboat, fishing, diving, etc.) as well as its spatial distribution. These data will be instrumental for a number of ongoing and future studies evaluating biological and socioeconomic aspects of BISC visitor use. For example, calibration of fleet composition and disposition information between the aerial survey and the BISC creel census will yield fairly accurate data on the spatial distribution of fishing effort in the Park. These data are fundamental inputs for the new class of spatially-explicit stock assessment models that analyze biological and economic effects of proposed or implemented spatial zone management policies (Bohnsack and Ault 1996; Ault et al. 1999a, 1999b, 2003a; Meester et al. 2001, 2004). A previous study (Ault et al. 2003b) found that the different public marinas surrounding BISC waters draw boaters from different spatial areas of Miami-Dade County and southern Florida, and also that boaters departing from the different marinas use different spatial areas of the Park. Using the aerial survey data to model spatial aspects of boater use will likely require creel data from all 5 public marinas rather than those closest to Park headquarters. We thus recommend that all 5 marinas be included in both the creel census program and trailer count survey.

Special high-use days:-The case of the Columbus Day Regatta survey illustrates that the boat-

trailer regression model may not be appropriate for all situations. For this particular day, the model would have predicted a much lower number of boats based on the trailer count than were observed during the flight survey. Factors contributing to the undercount of trailers with respect to vessels in Park waters include: (i) Marina sampling personnel noted that the parking lots were at full capacity for the Columbus Day Regatta survey. Trailers that were parked in the vicinity of the marinas but outside the parking lots were included in the count; however, trailers parked far away from the marina lots were likely not included in the count. (ii) Flight personnel noted steady streams of vessels entering the Park from northern Biscayne Bay and from offshore waters both north and south of the Park. Thus, for the Regatta it seems that a much higher proportion of vessels entered the Park from outside the domain of the five sampled public marinas compared to other days. Fleet composition and disposition may also be non-representative on special high-use days. For example, the proportion of anchored vessels was substantially higher for the Columbus Day regatta compared to other weekend/holiday days during fall, and the proportion of vessels engaged in diving activities was substantially higher for the lobster mini-season survey compared to other weekend/holiday days during summer. For these reasons, we recommend that vessels be sampled and counted from aerial surveys on special high-use days rather than predicted from the boat-trailer regression model.

Our recommendations for estimating total boater use in BISC waters are summarized as follows:

1. Implement an automated system for obtaining daily trailer counts at the following marinas: Homestead/Bayfront Park Marina, Black Point Marina, Matheson Hammock Marina, Dinner Key Marina, and Crandon Park Marina.
2. Calibrate and verify automated trailer counts with occasional direct trailer counts by creel census personnel.
3. Use the combined season boat-trailer regression model for estimation except for special high-use days.
4. Conduct aerial surveys to obtain vessel counts on special high-use days.

Acknowledgments

We thank the participating scientists and flight personnel from Biscayne National Park, Everglades National Park, University of Miami Rosenstiel School of Marine and Atmospheric Science, and NOAA Southeast Fisheries Science Center for their assistance with this project. This study was funded by the National Park Service through the Cooperative Ecosystems Study Unit, Contract No. H500000B494-J5250020400.

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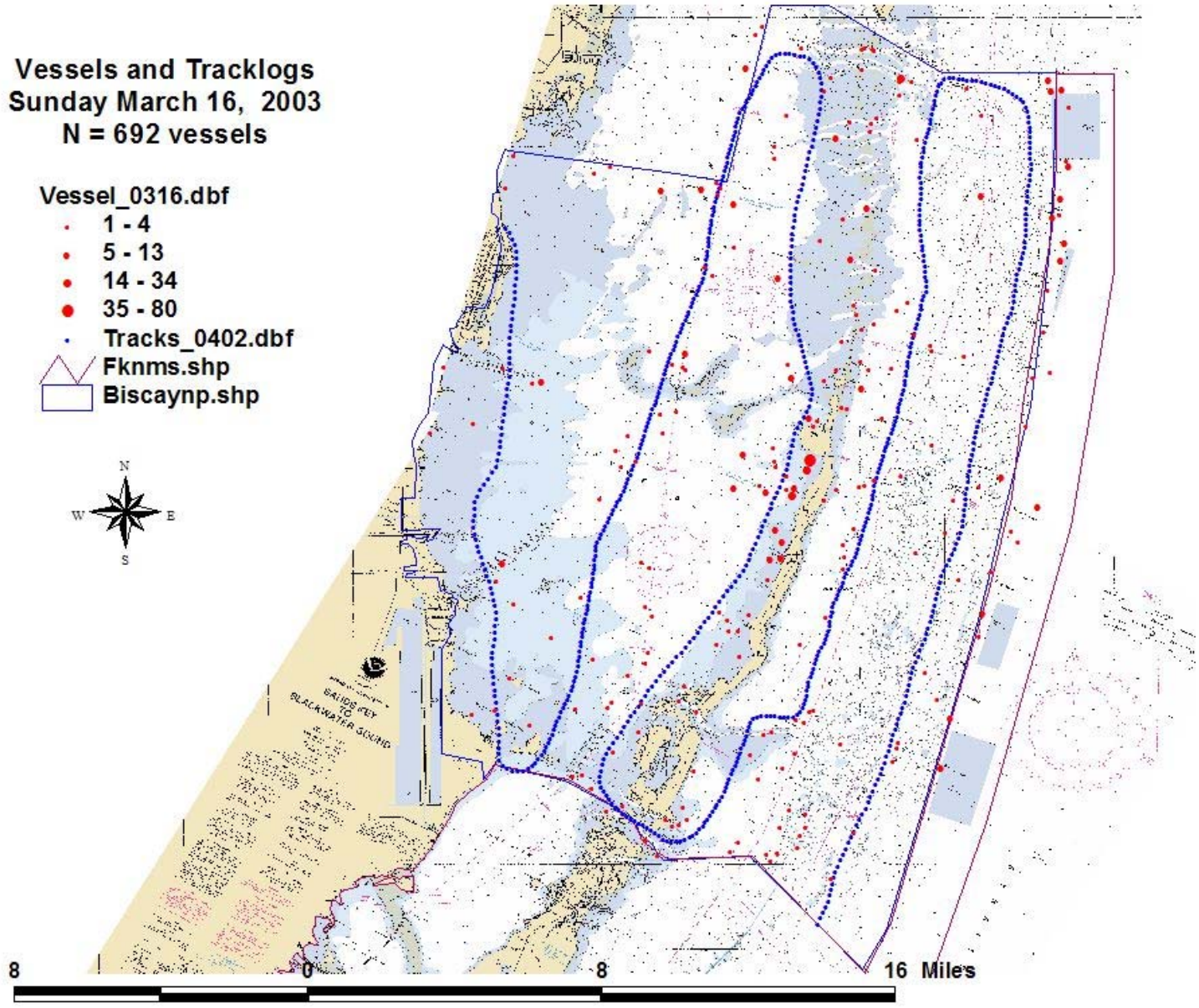
Appendix A1: Example database records for the aerial vessel census. The records are produced by the onboard GIS during each flight. ID=record identification number; SAMP#=sample identification number (survey date); XCOORD=longitude (decimal degrees); YCOORD=latitude; VESSEL=vessel category; NUMBER=number of vessels; COMMENTS=vessel disposition.

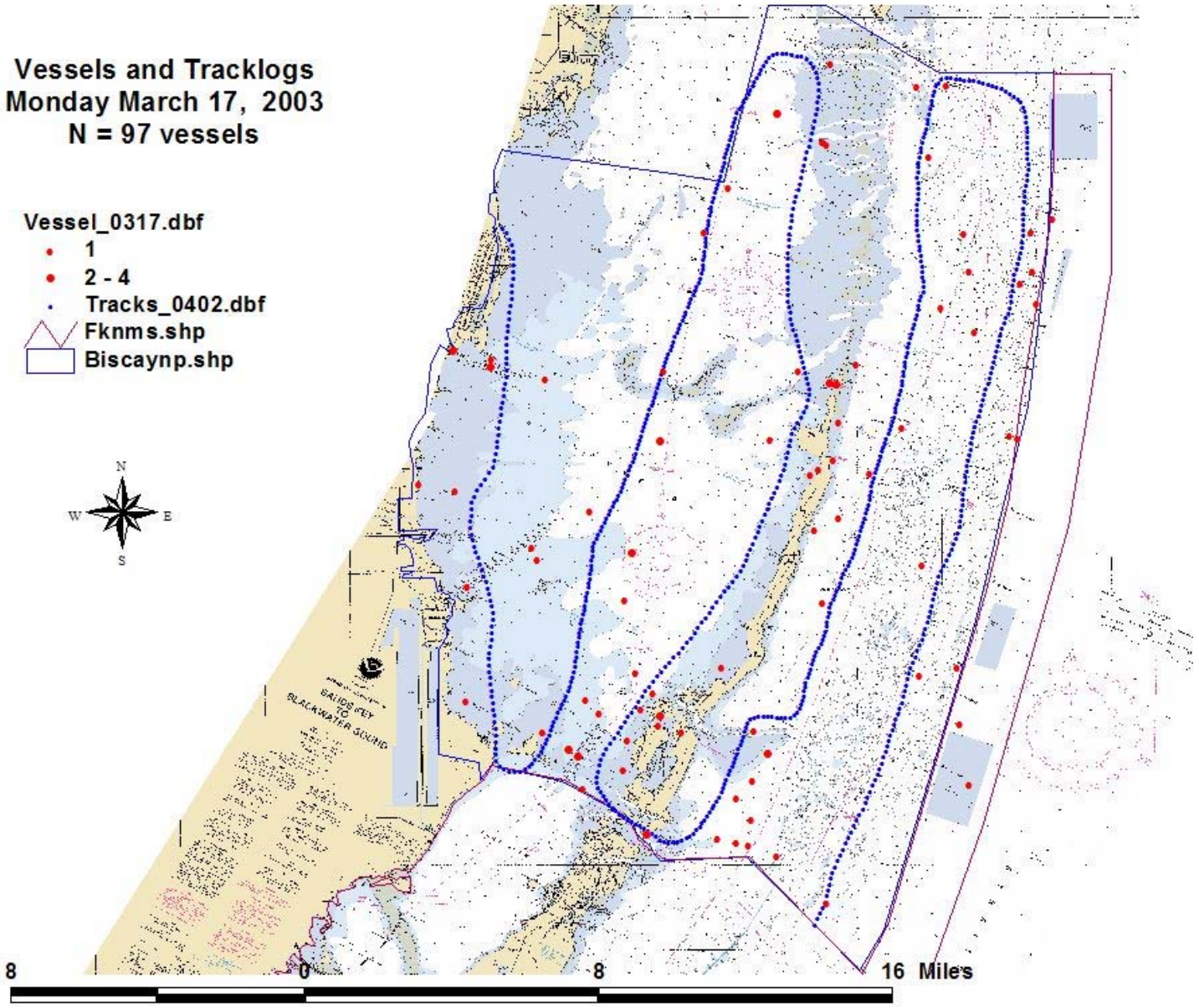
ID	SAMP#	YEAR	MONTH	DAY	TIME	XCOORD	YCOORD	VESSEL	NUMBER	COMMENTS
1792	20030413	2003	4	13	13:46:53	-80.15913	25.47513	FishChart	2	cruise
1793	20030413	2003	4	13	13:47:01	-80.15792	25.46899	FishRec	3	cruise
1794	20030413	2003	4	13	13:47:19	-80.15637	25.48344	DiveRec	2	dive/snor
1795	20030413	2003	4	13	13:47:36	-80.16035	25.48897	FishRec	1	fishing
1796	20030413	2003	4	13	13:47:43	-80.17540	25.49365	FishRec	5	cruise
1797	20030413	2003	4	13	13:47:58	-80.14780	25.48750	DiveRec	1	dive/snor
1798	20030413	2003	4	13	13:48:15	-80.14866	25.49693	FishChart	1	cruise
1799	20030413	2003	4	13	13:48:35	-80.15777	25.51444	FishRec	1	cruise
1800	20030413	2003	4	13	13:48:45	-80.13982	25.52721	FishRec	1	fishing
1801	20030413	2003	4	13	13:48:54	-80.13062	25.54970	FishRec	7	cruise
1802	20030413	2003	4	13	13:49:09	-80.16664	25.52580	FishRec	1	fishing
1803	20030413	2003	4	13	13:49:32	-80.13236	25.54992	Sailboat	1	cruise
1804	20030413	2003	4	13	13:49:38	-80.15626	25.53607	FishRec	1	cruise
1805	20030413	2003	4	13	13:49:43	-80.16588	25.54148	FishRec	1	fishing
1806	20030413	2003	4	13	13:49:55	-80.13106	25.55370	FishChart	1	cruise
1807	20030413	2003	4	13	13:50:11	-80.15723	25.55684	FishRec	1	cruise
1808	20030413	2003	4	13	13:50:39	-80.12716	25.56528	Sailboat	1	cruise
1809	20030413	2003	4	13	13:51:02	-80.12770	25.55457	FishRec	1	fishing
1810	20030413	2003	4	13	13:51:08	-80.15377	25.58474	FishRec	2	fishing
1811	20030413	2003	4	13	13:51:26	-80.12446	25.59394	FishRec	1	cruise
1812	20030413	2003	4	13	13:51:56	-80.10845	25.59556	FishRec	1	cruise
1813	20030413	2003	4	13	13:52:02	-80.11981	25.60735	FishChart	1	cruise
1814	20030413	2003	4	13	13:52:33	-80.15215	25.59978	FishRec	1	cruise
1815	20030413	2003	4	13	13:52:44	-80.15312	25.65580	FishRec	10	cruise
1816	20030413	2003	4	13	13:52:58	-80.13192	25.63958	FishRec	5	fishing
1817	20030413	2003	4	13	13:53:05	-80.13365	25.64196	FishChart	1	fishing
1818	20030413	2003	4	13	13:53:41	-80.13214	25.64412	Sailboat	2	cruise
1819	20030413	2003	4	13	13:54:00	-80.08012	25.63503	OtherVes	1	casino

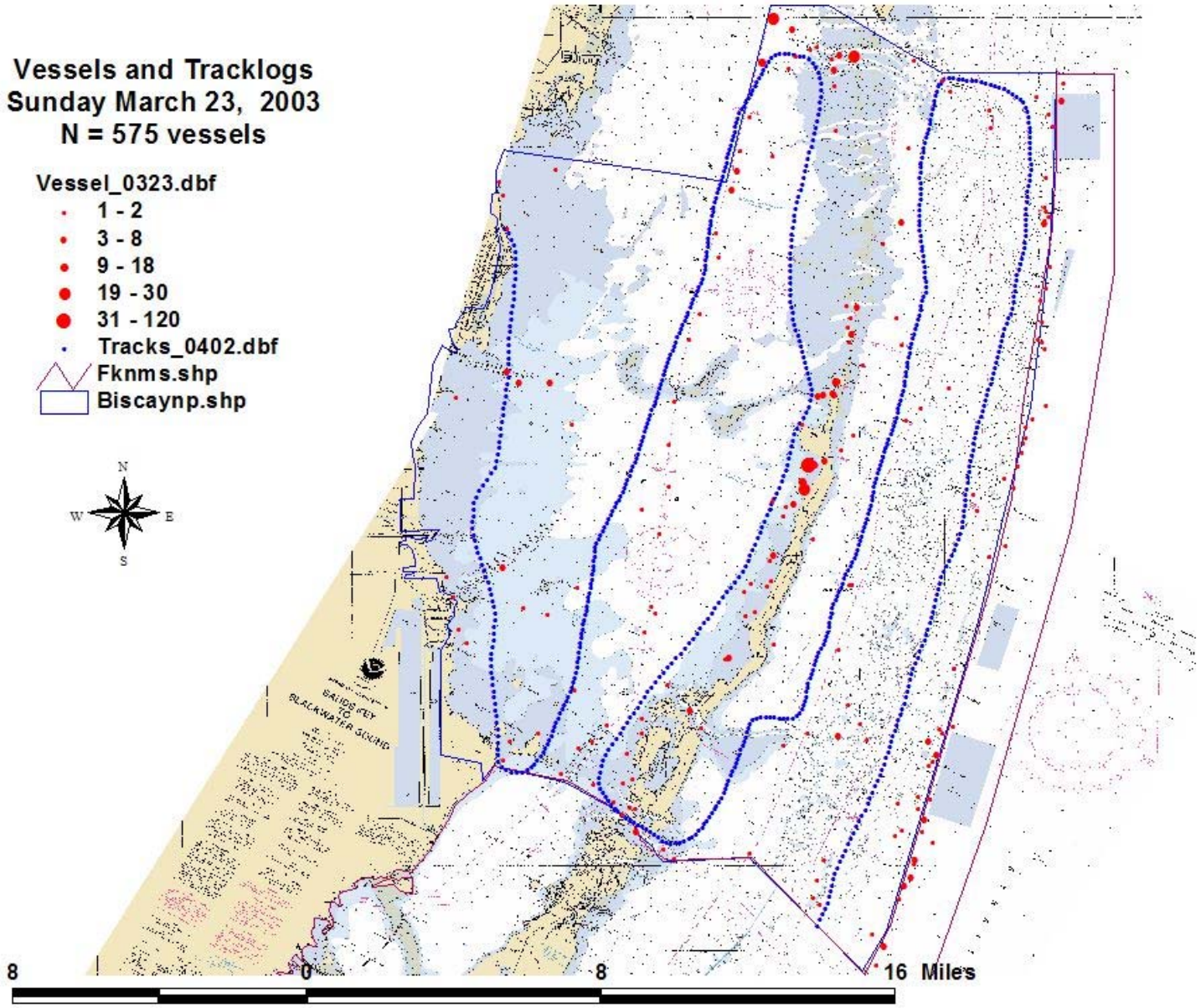
Appendix A2: Datasheet for boat trailer census. Name=name of observer; Location=marina; Time=start time for trailer count; PWC=personal watercraft (e.g., jet skis).

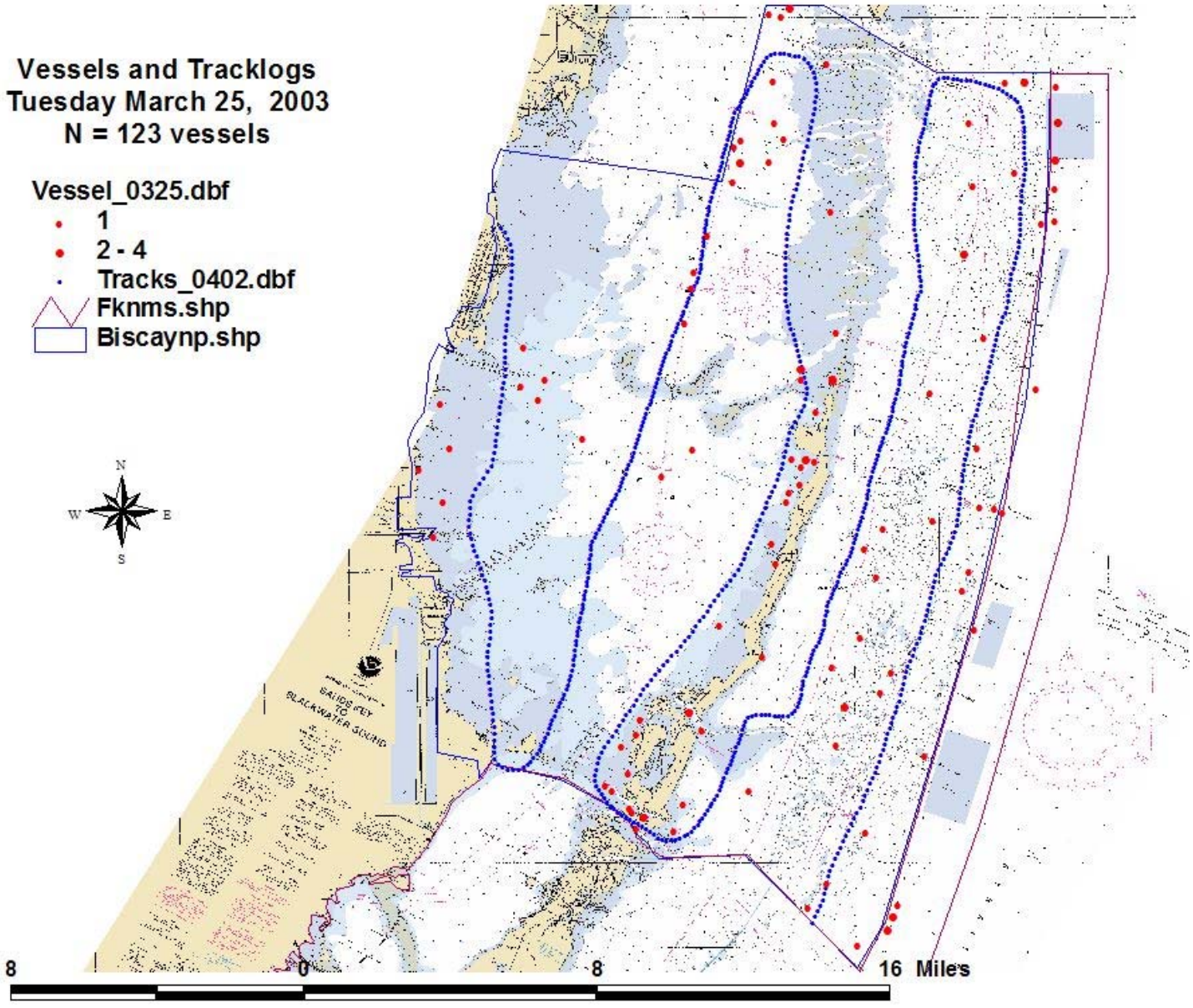
Name	Location	Date	Time start/ Time end	Total # of Trailers	# 1-Axle Trailers	# 2-Axle Trailers	# 3-Axle Trailers	PWC

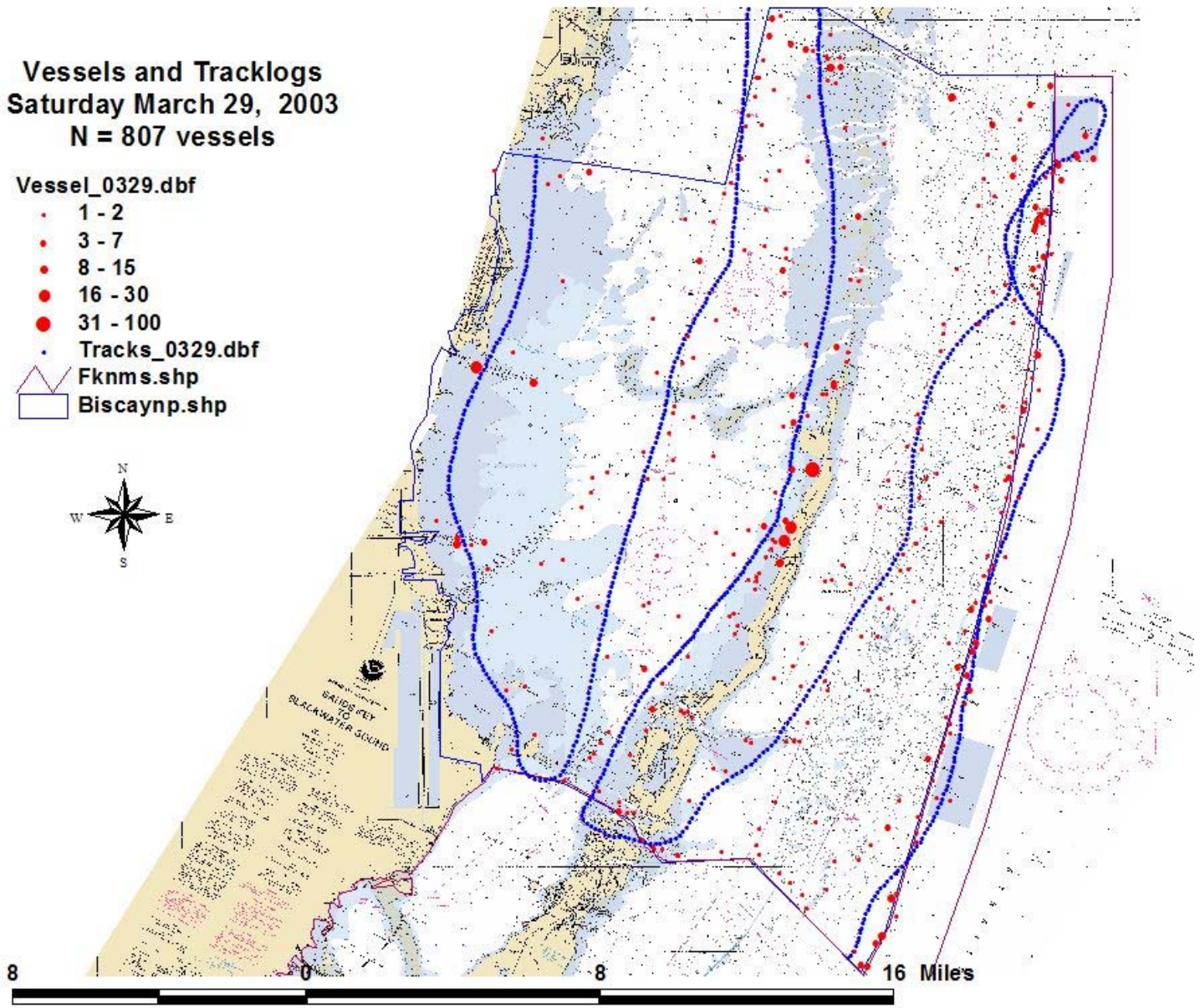
Appendix B1: Daily flight maps for spring 2003 aerial surveys.

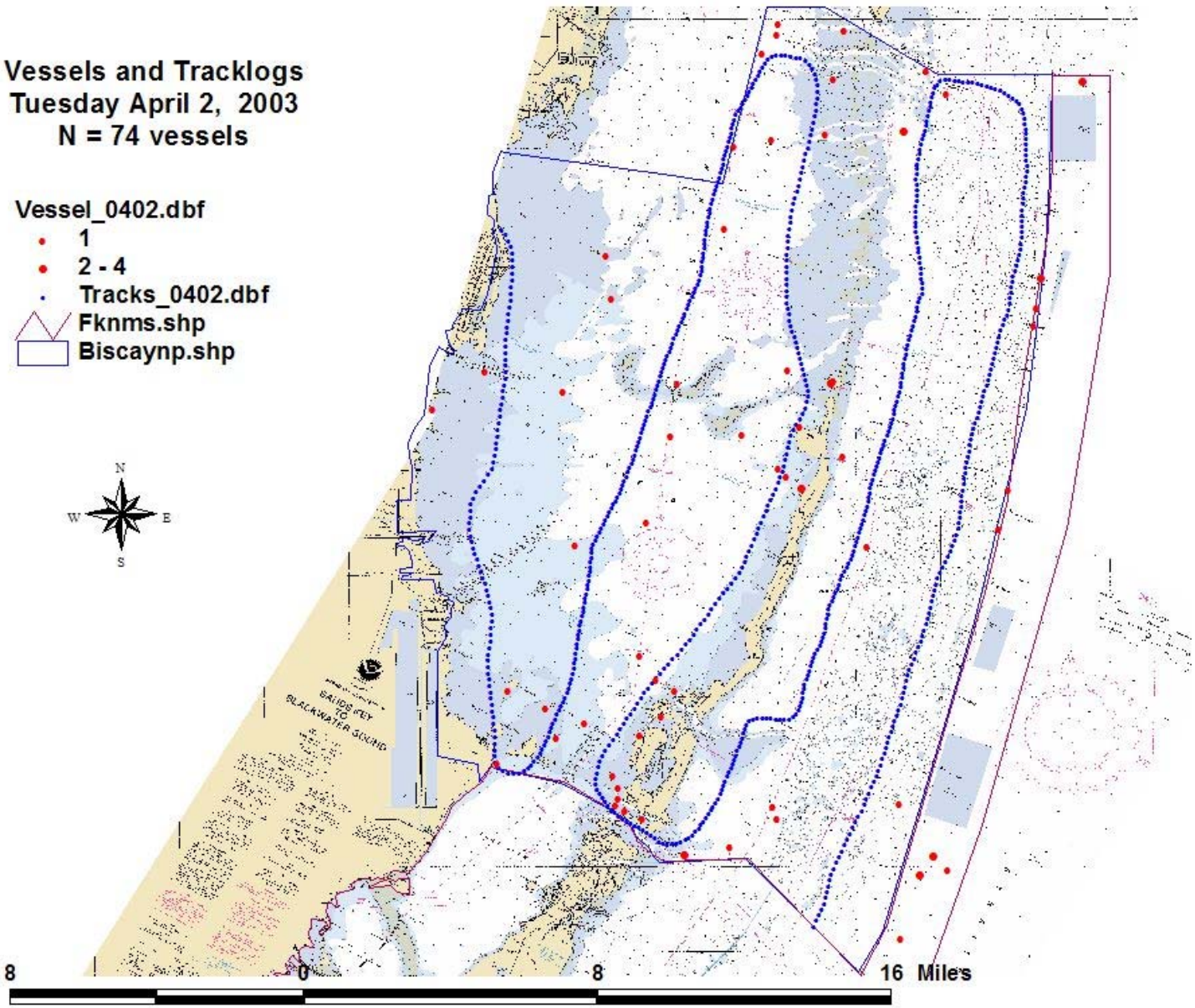

Vessels and Tracklogs
Sunday March 16, 2003
N = 692 vessels
Vessel_0316.dbf
1 - 4
5 - 13
14 - 34
35 - 80
Tracks_0402.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

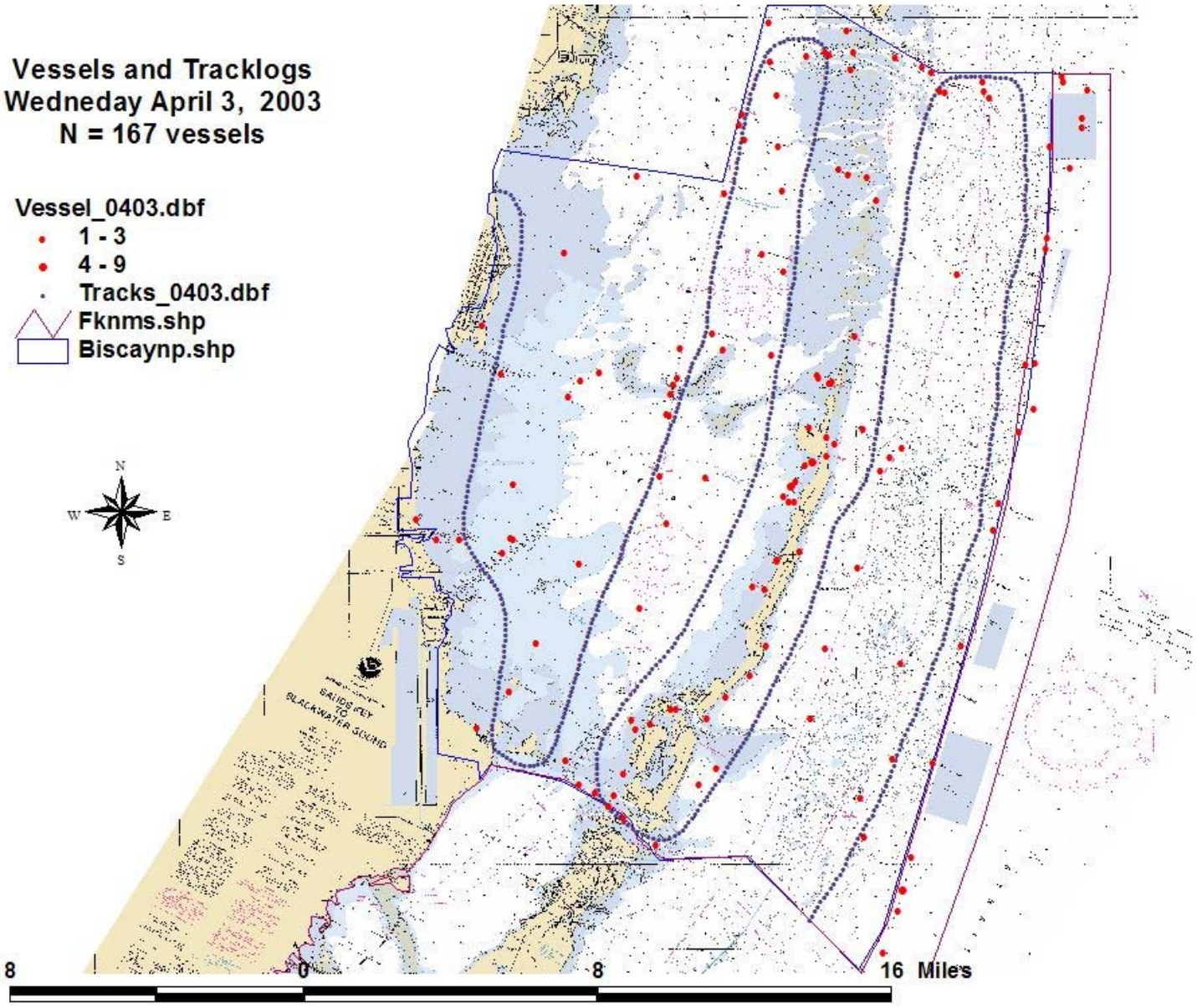

Vessels and Tracklogs
Monday March 17, 2003
N = 97 vessels
Vessel_0317.dbf
1
2 - 4
Tracks_0402.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BALDS KEY TO BLACKWATER SOUND
8
0
8
16 Miles

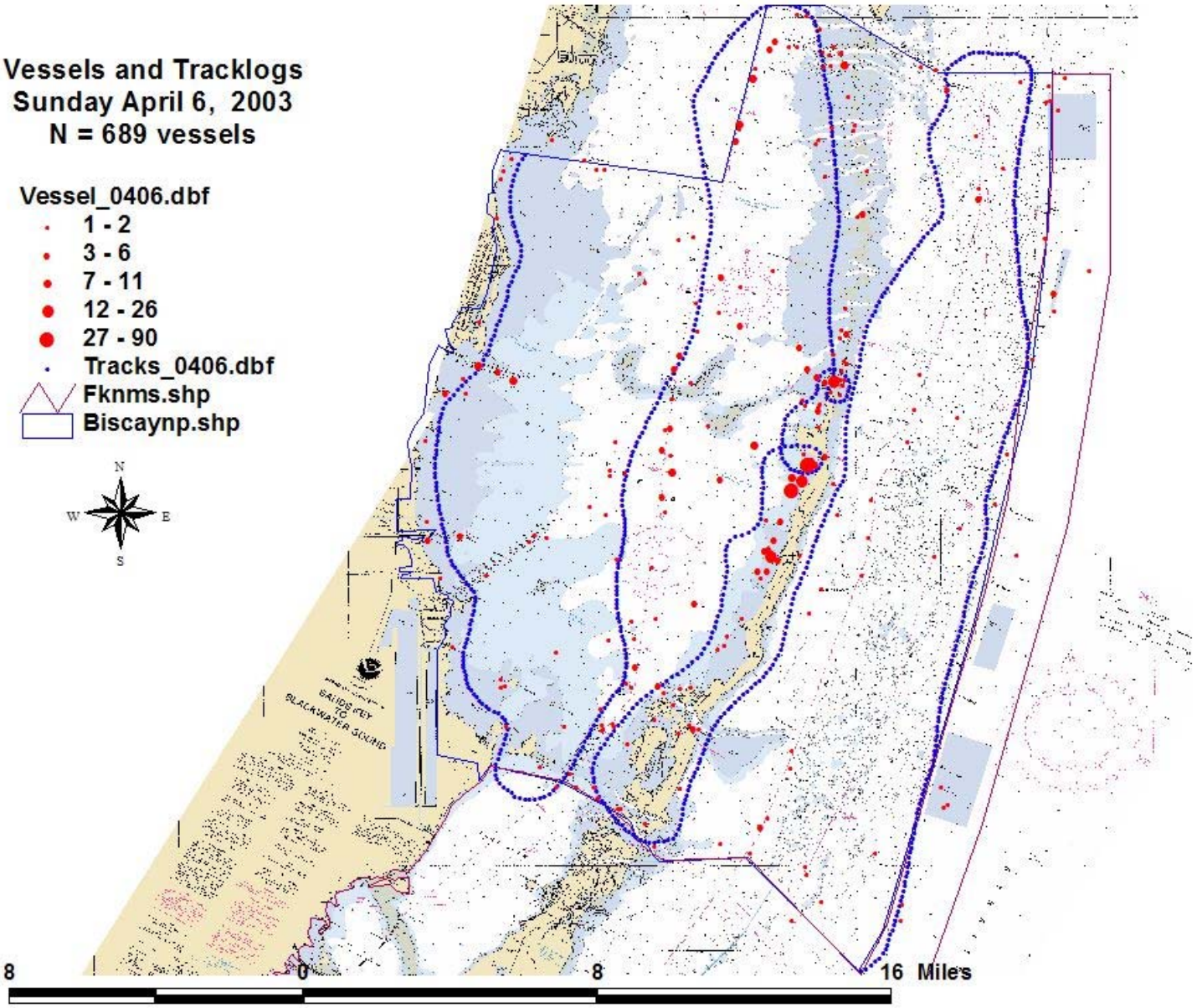

Vessels and Tracklogs
Sunday March 23, 2003
N = 575 vessels
Vessel_0323.dbf
1 - 2
3 - 8
9 - 18
19 - 30
31 - 120
Tracks_0402.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

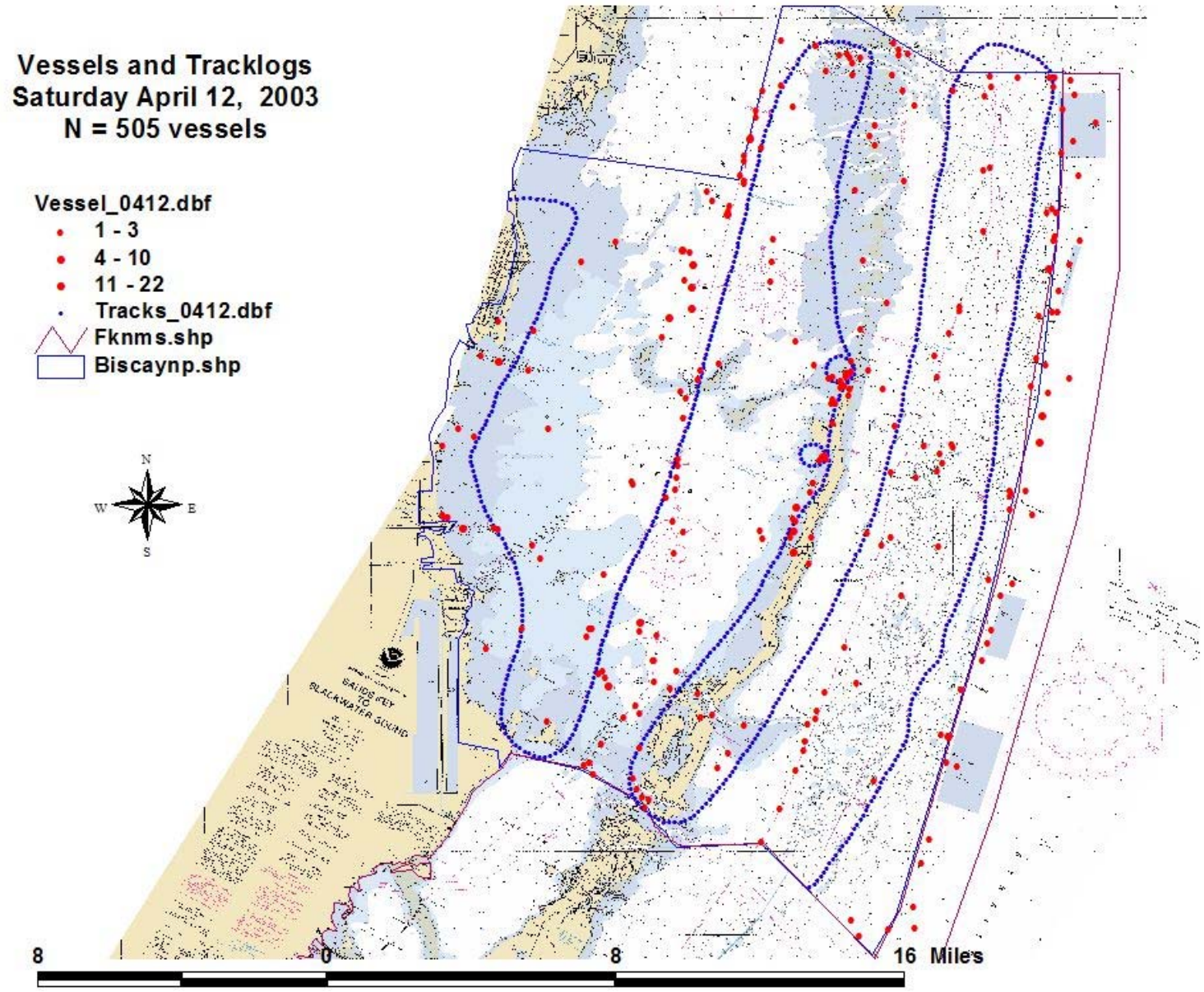

Vessels and Tracklogs
Tuesday March 25, 2003
N = 123 vessels
Vessel_0325.dbf
1
2 - 4
Tracks_0402.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BAILEY KEY TO BLACKWATER SOUND
8
0
8
16 Miles

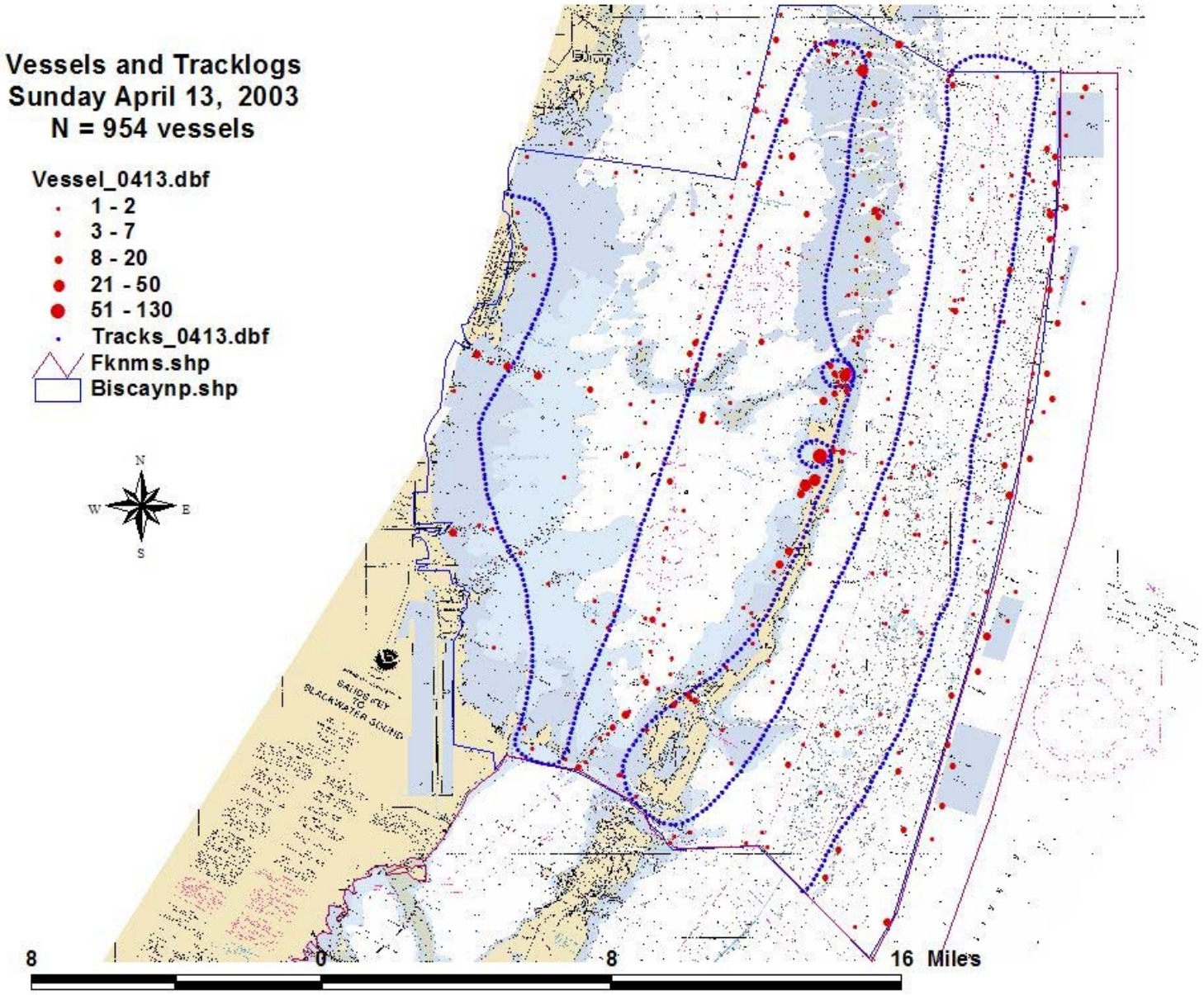

Vessels and Tracklogs
Saturday March 29, 2003
N = 807 vessels
Vessel_0329.dbf
1 - 2
3 - 7
8 - 15
16 - 30
31 - 100
Tracks_0329.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

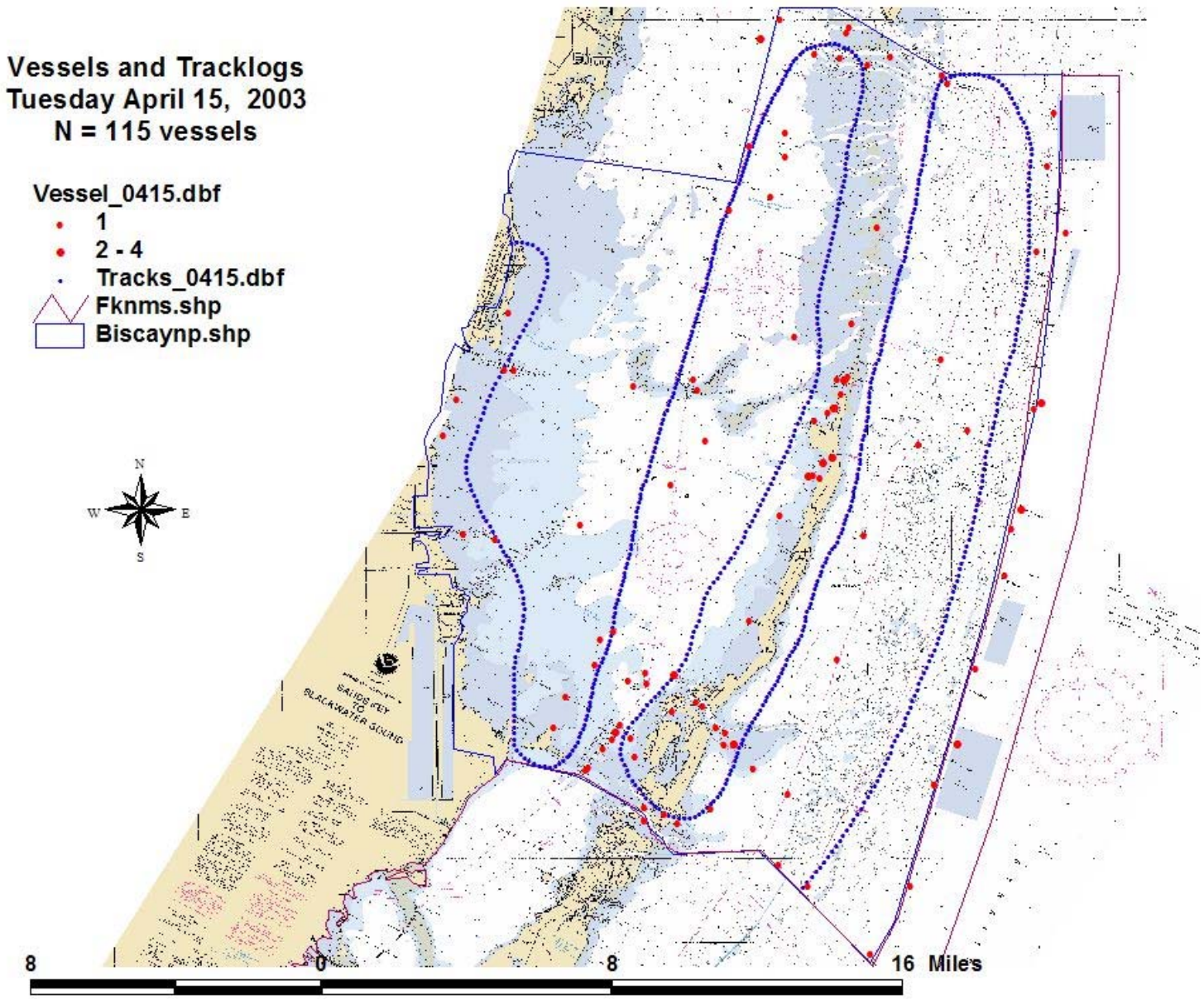

Vessels and Tracklogs
Tuesday April 2, 2003
N = 74 vessels
Vessel_0402.dbf
1
2 - 4
Tracks_0402.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

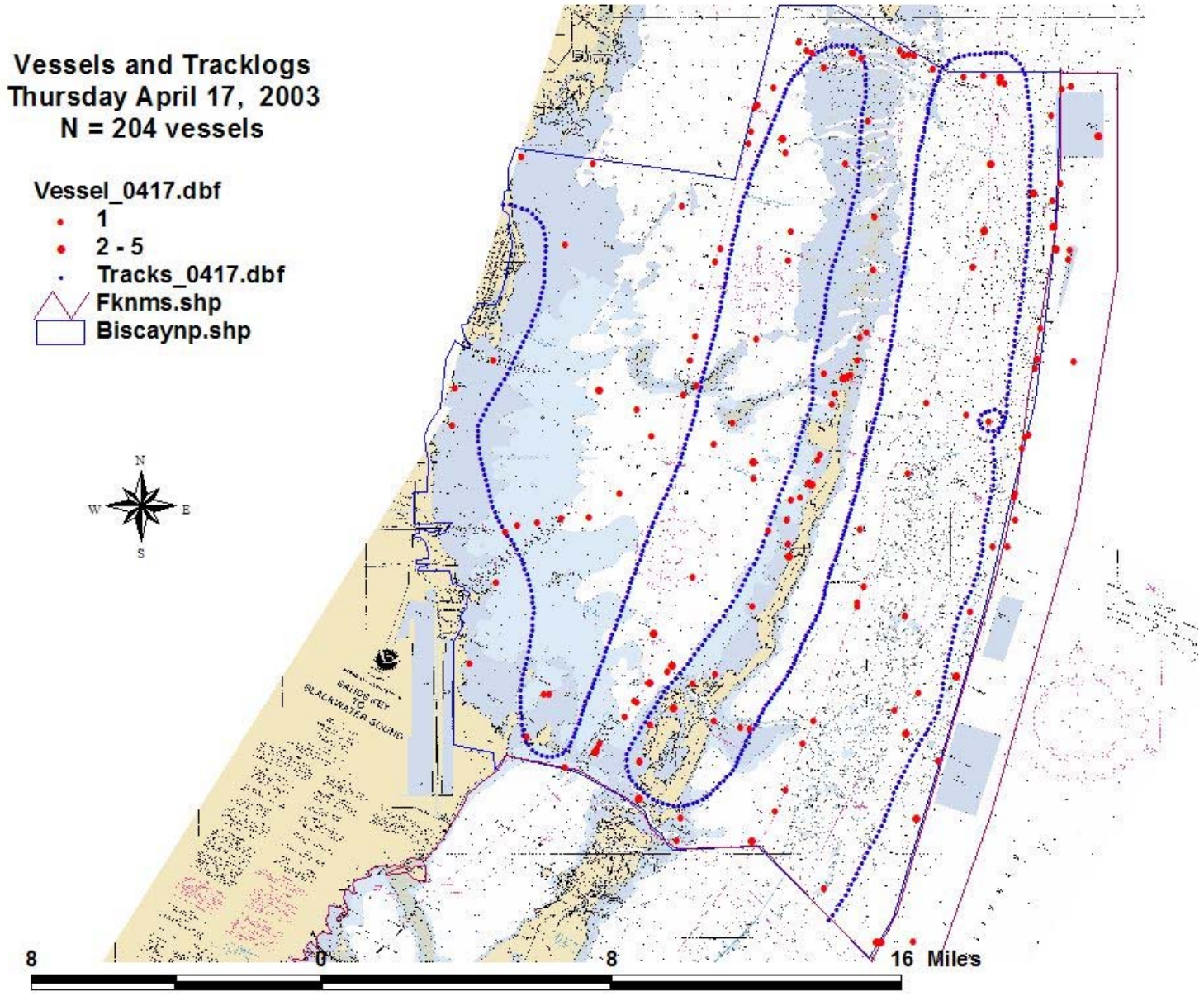

Vessels and Tracklogs
Wedneday April 3, 2003
N = 167 vessels
Vessel_0403.dbf
1 - 3
4 - 9
Tracks_0403.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BALDS KEY
TO
BLACKWATER SOUND
8
0
8
16 Miles


Vessels and Tracklogs
Sunday April 6, 2003
N = 689 vessels
Vessel_0406.dbf
1 - 2
3 - 6
7 - 11
12 - 26
27 - 90
Tracks_0406.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

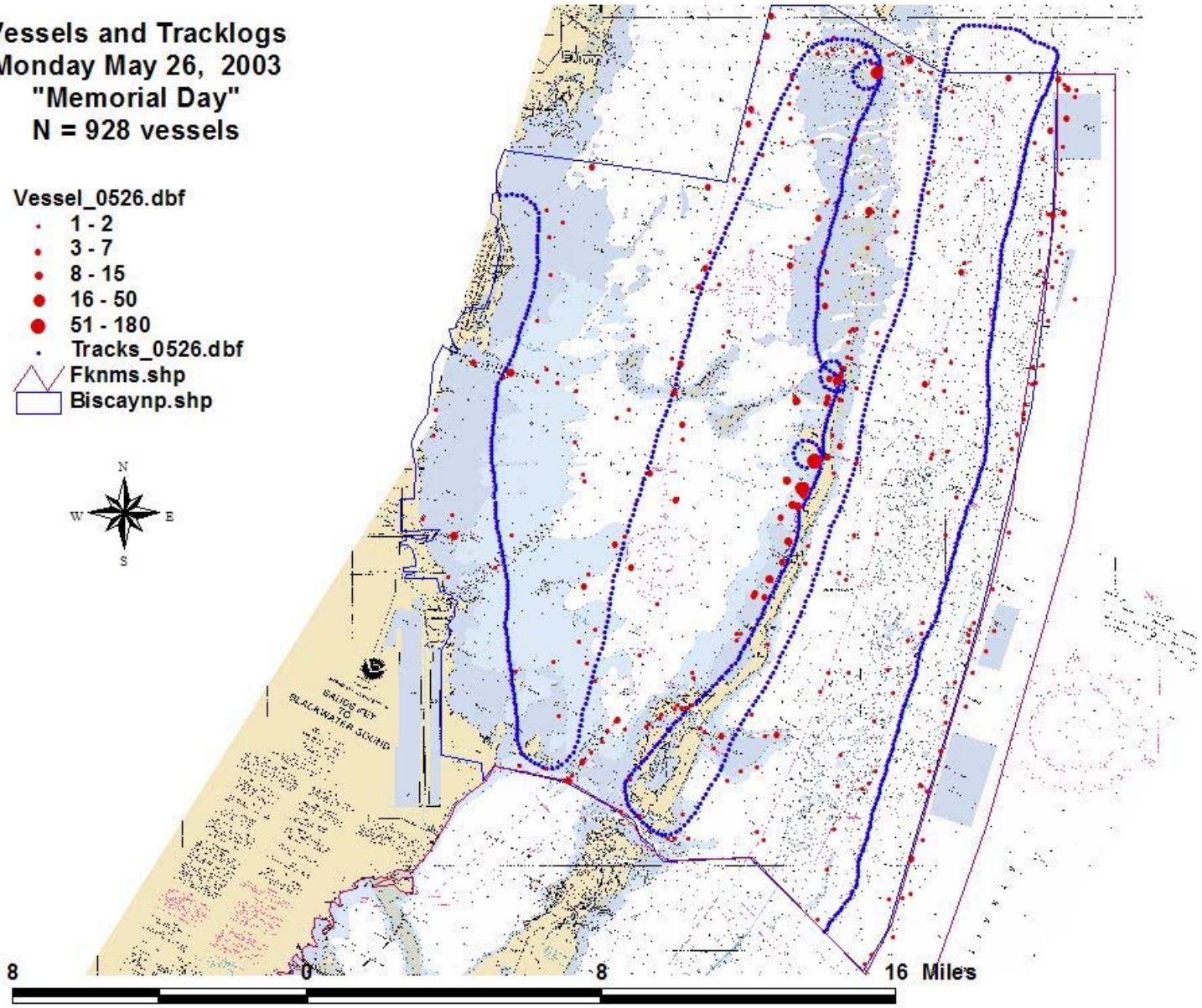

Vessels and Tracklogs
Saturday April 12, 2003
N = 505 vessels
Vessel_0412.dbf
1 - 3
4 - 10
11 - 22
Tracks_0412.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BAIDS KEY TO BLACKWATER SOUND
8
0
8
16 Miles

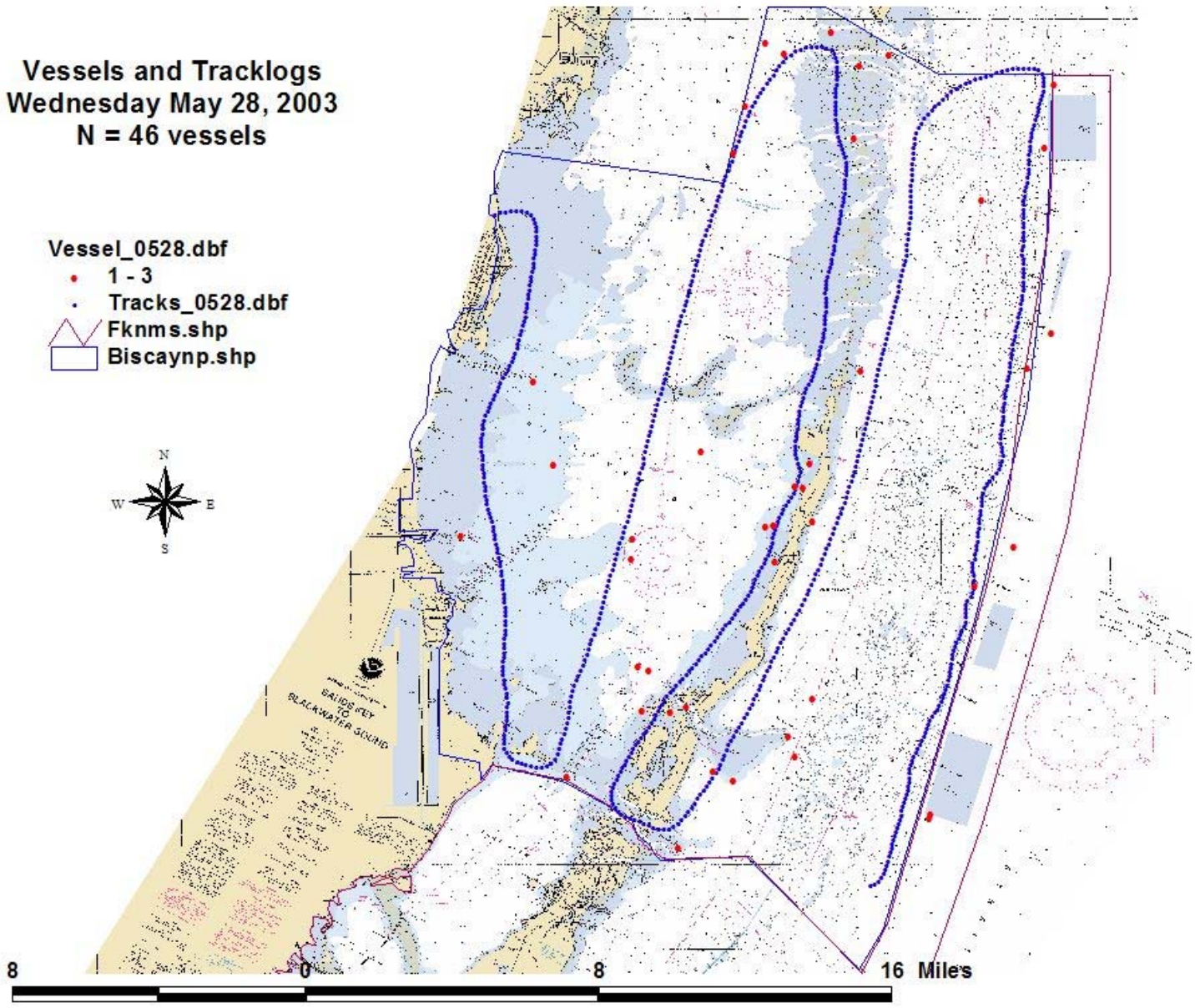

Vessels and Tracklogs
Sunday April 13, 2003
N = 954 vessels
Vessel_0413.dbf
1 - 2
3 - 7
8 - 20
21 - 50
51 - 130
Tracks_0413.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

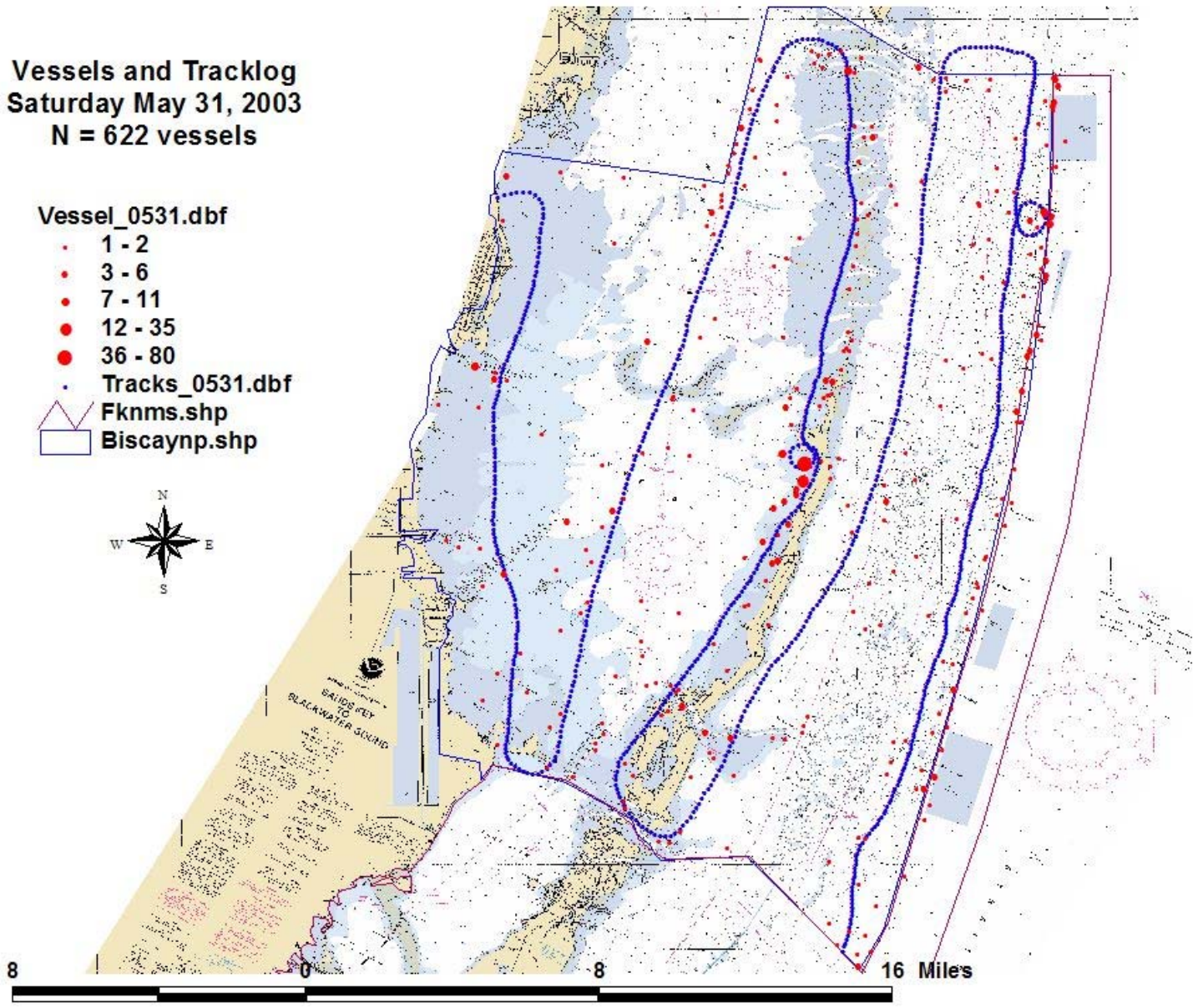

Vessels and Tracklogs
Tuesday April 15, 2003
N = 115 vessels
Vessel_0415.dbf
1
2 - 4
Tracks_0415.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

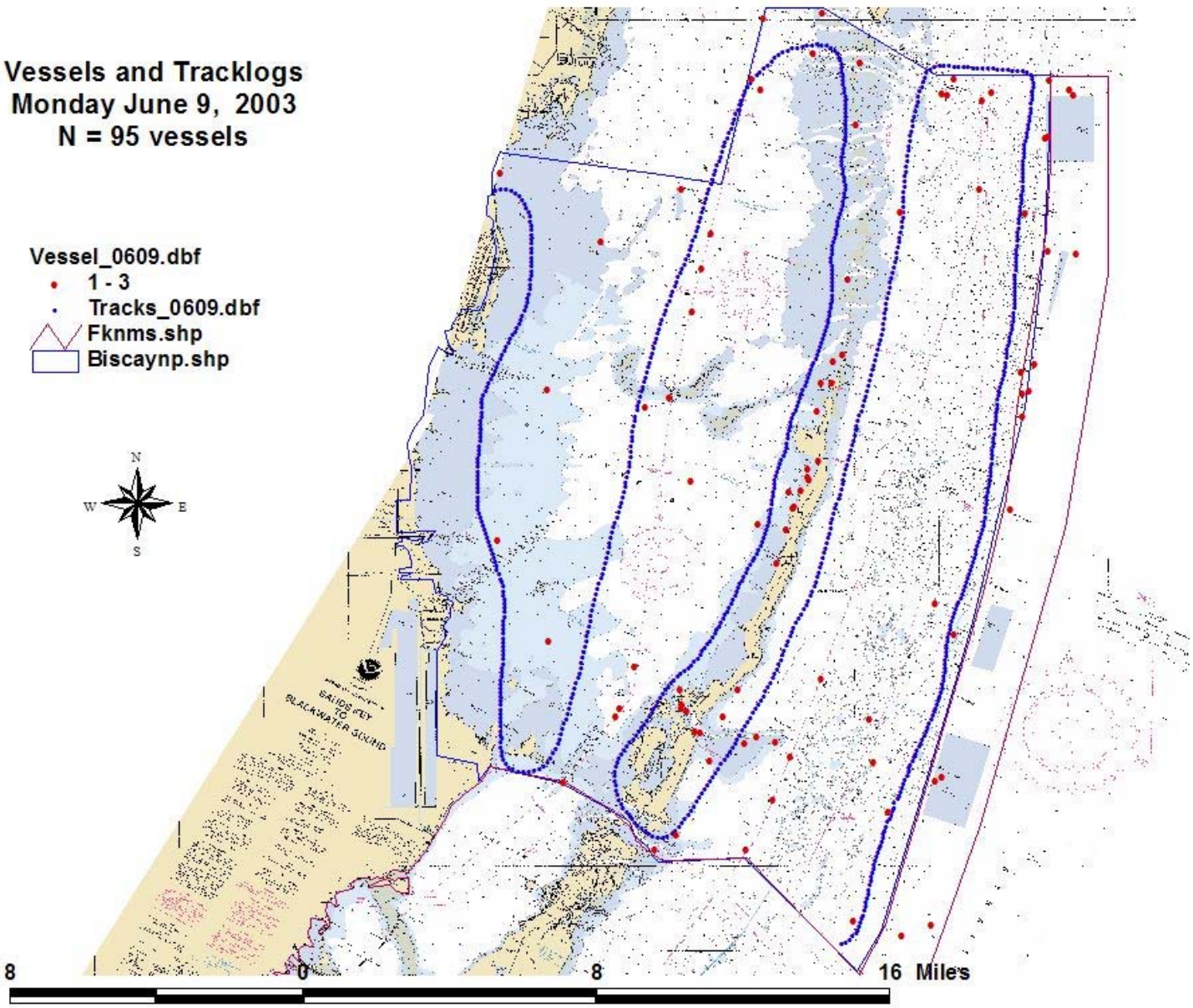

Vessels and Tracklogs
Thursday April 17, 2003
N = 204 vessels
Vessel_0417.dbf
1
2 - 5
Tracks_0417.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

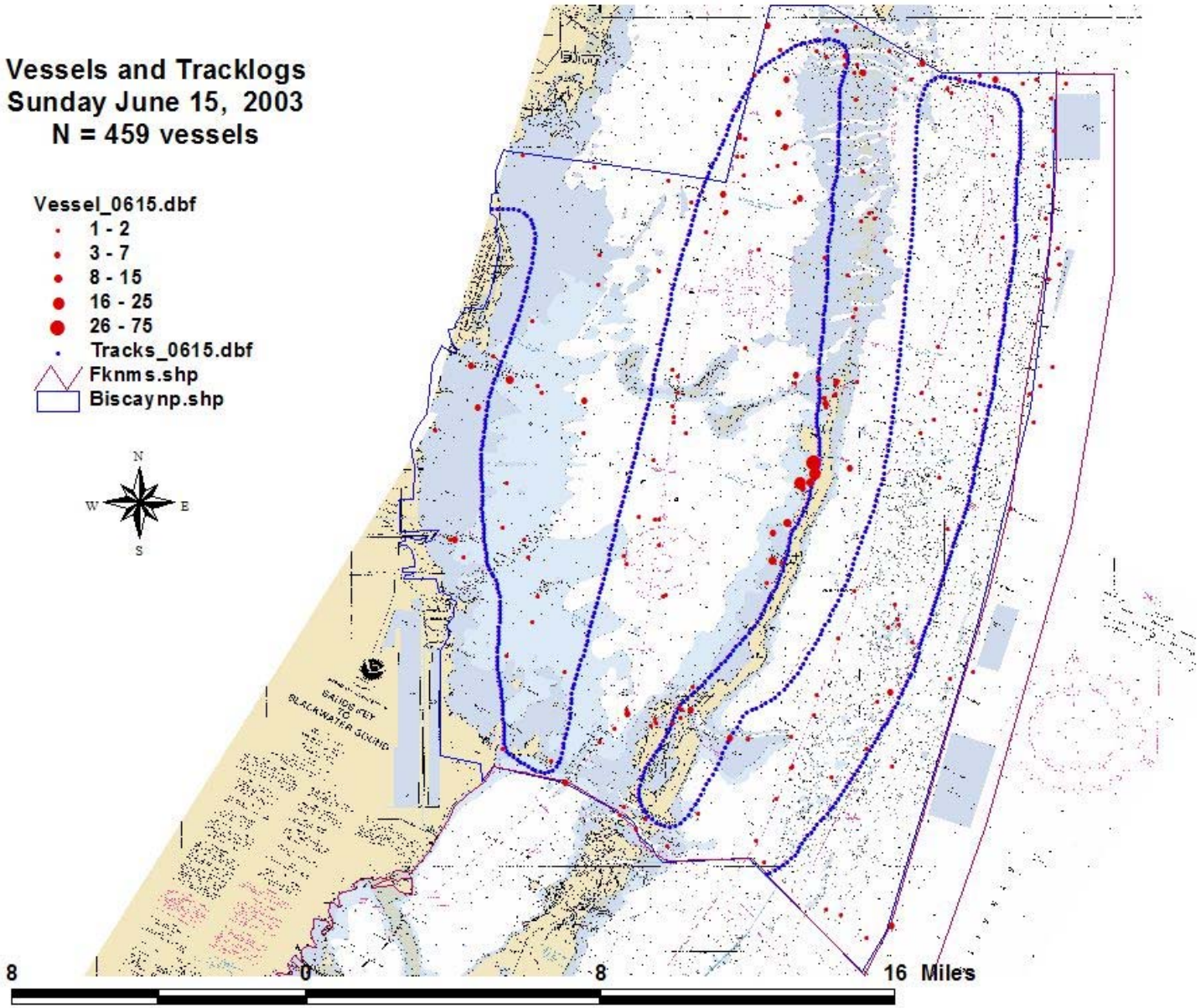
Appendix B2: Daily flight maps for summer 2003 aerial surveys.

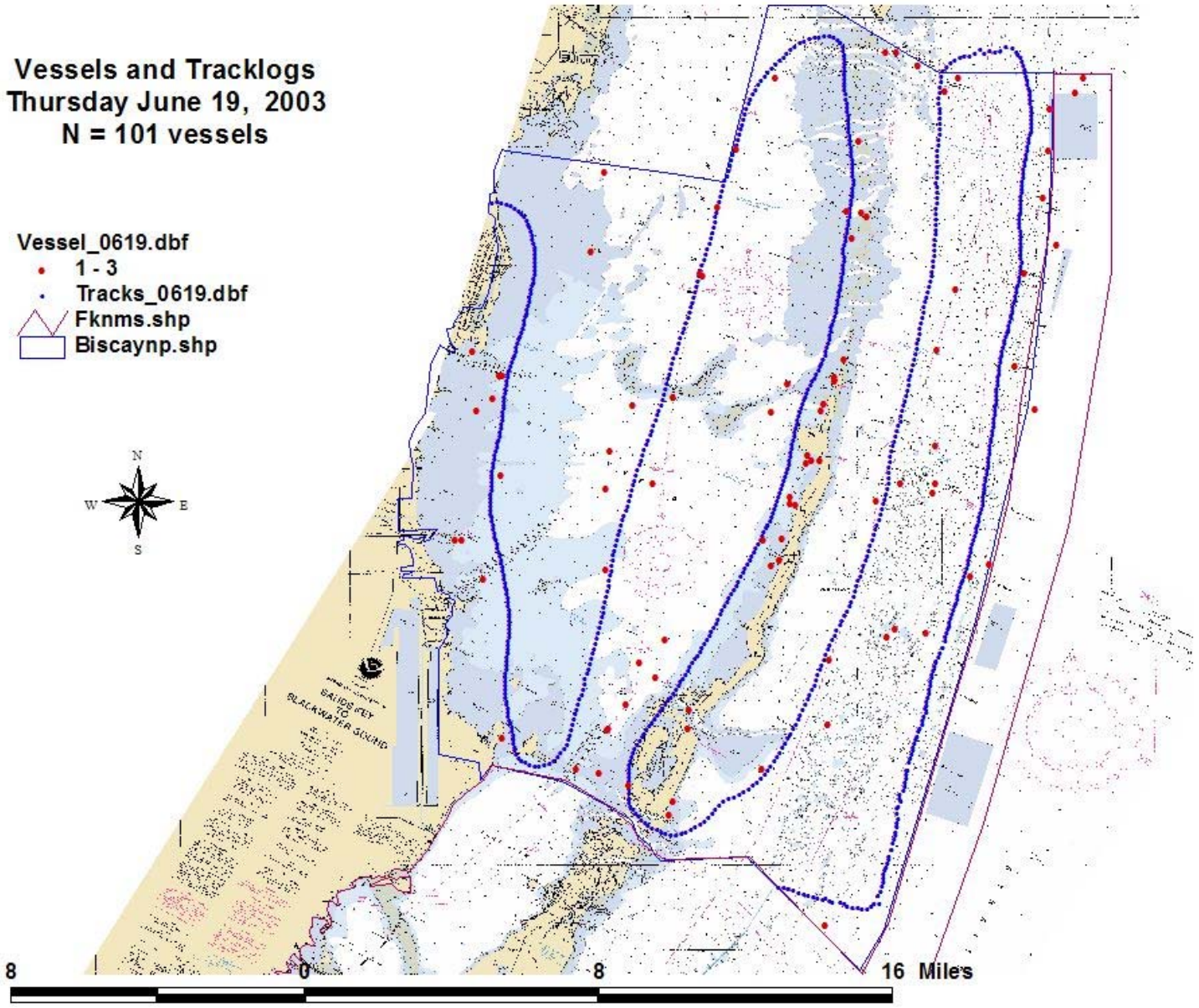

Vessels and Tracklogs
Monday May 26, 2003
"Memorial Day"
N = 928 vessels
Vessel_0526.dbf
1 - 2
3 - 7
8 - 15
16 - 50
51 - 180
Tracks_0526.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

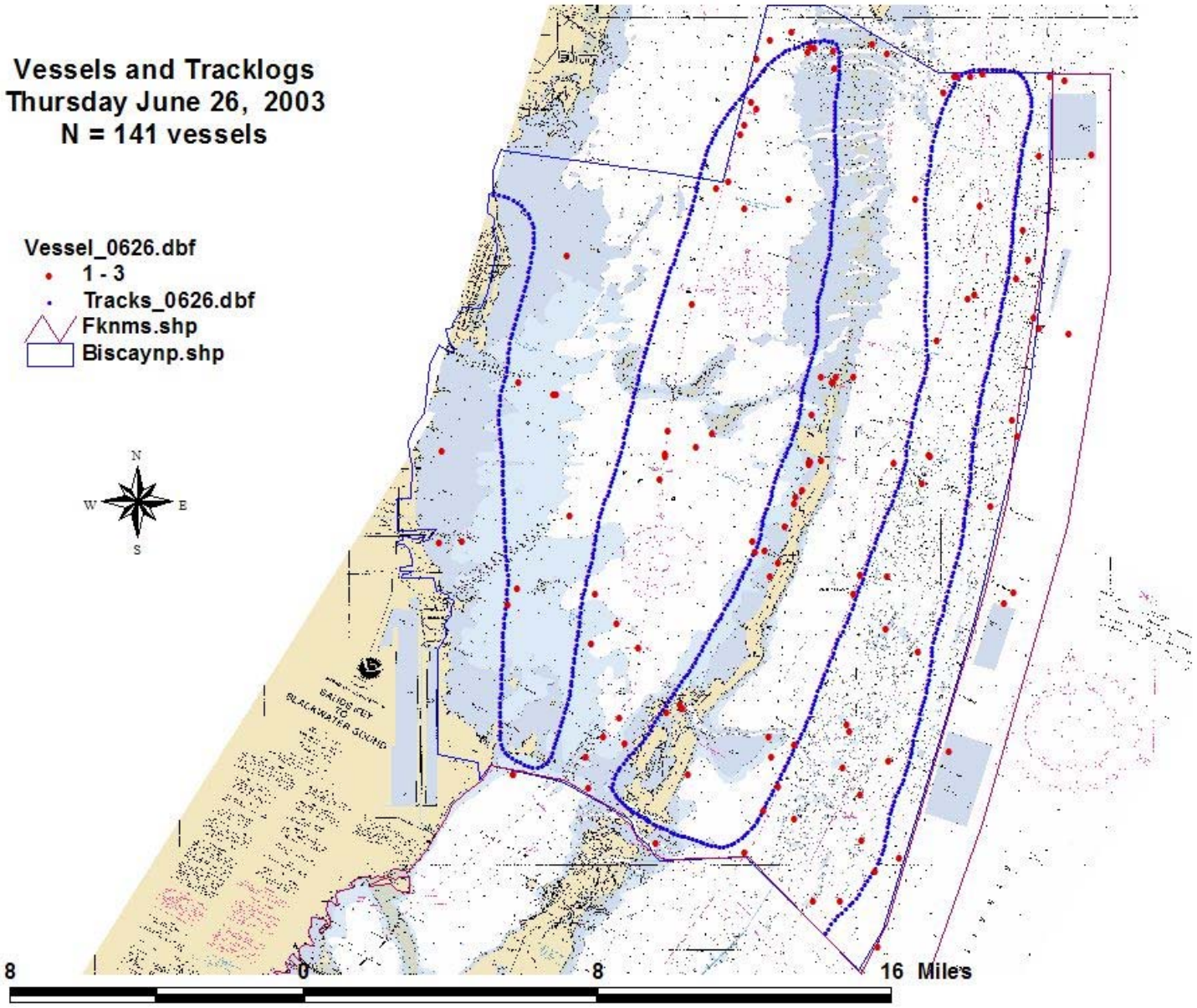

Vessels and Tracklogs
Wednesday May 28, 2003
N = 46 vessels
Vessel_0528.dbf
1 - 3
Tracks_0528.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

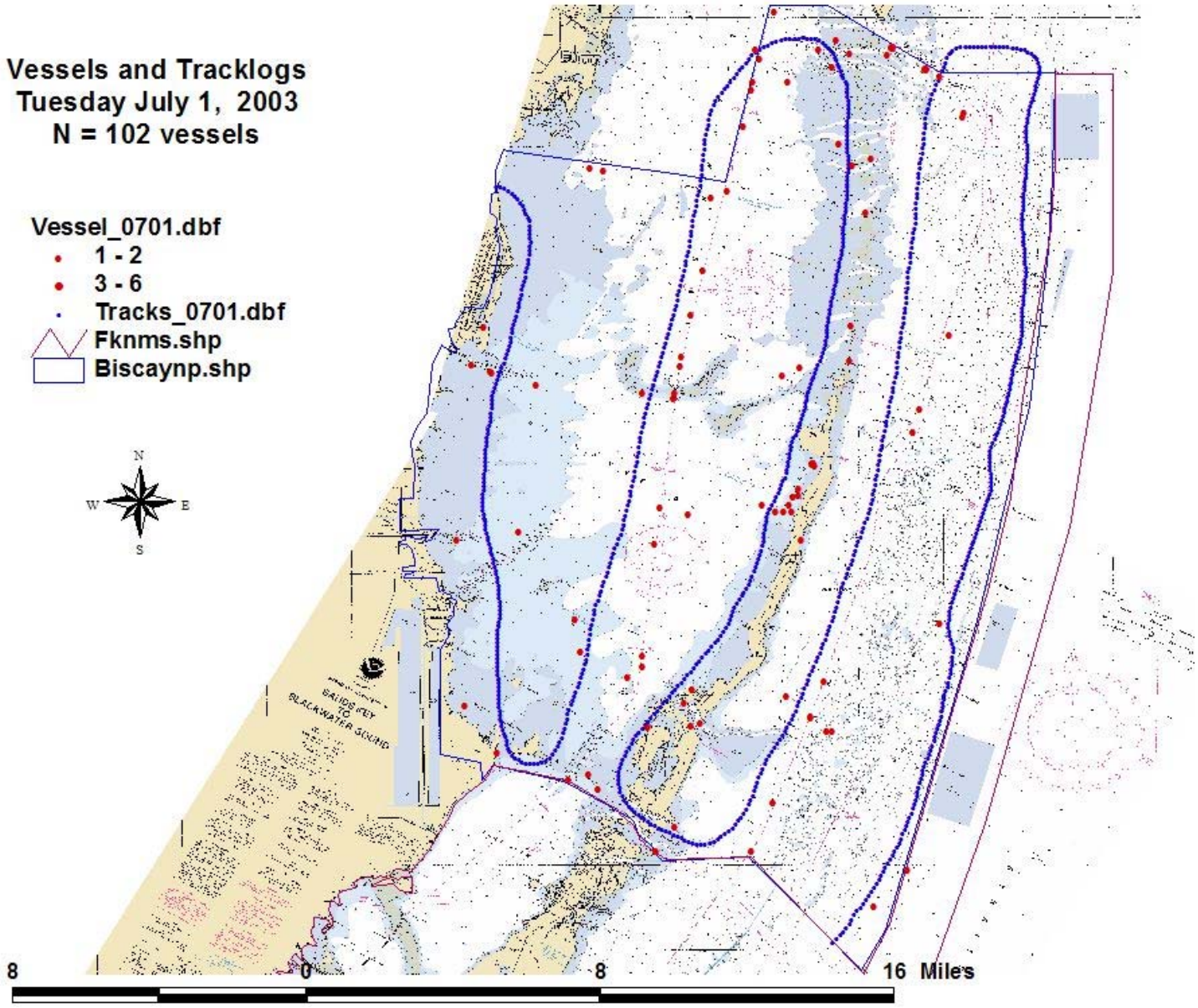

Vessels and Tracklog
Saturday May 31, 2003
N = 622 vessels
Vessel_0531.dbf
1 - 2
3 - 6
7 - 11
12 - 35
36 - 80
Tracks_0531.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

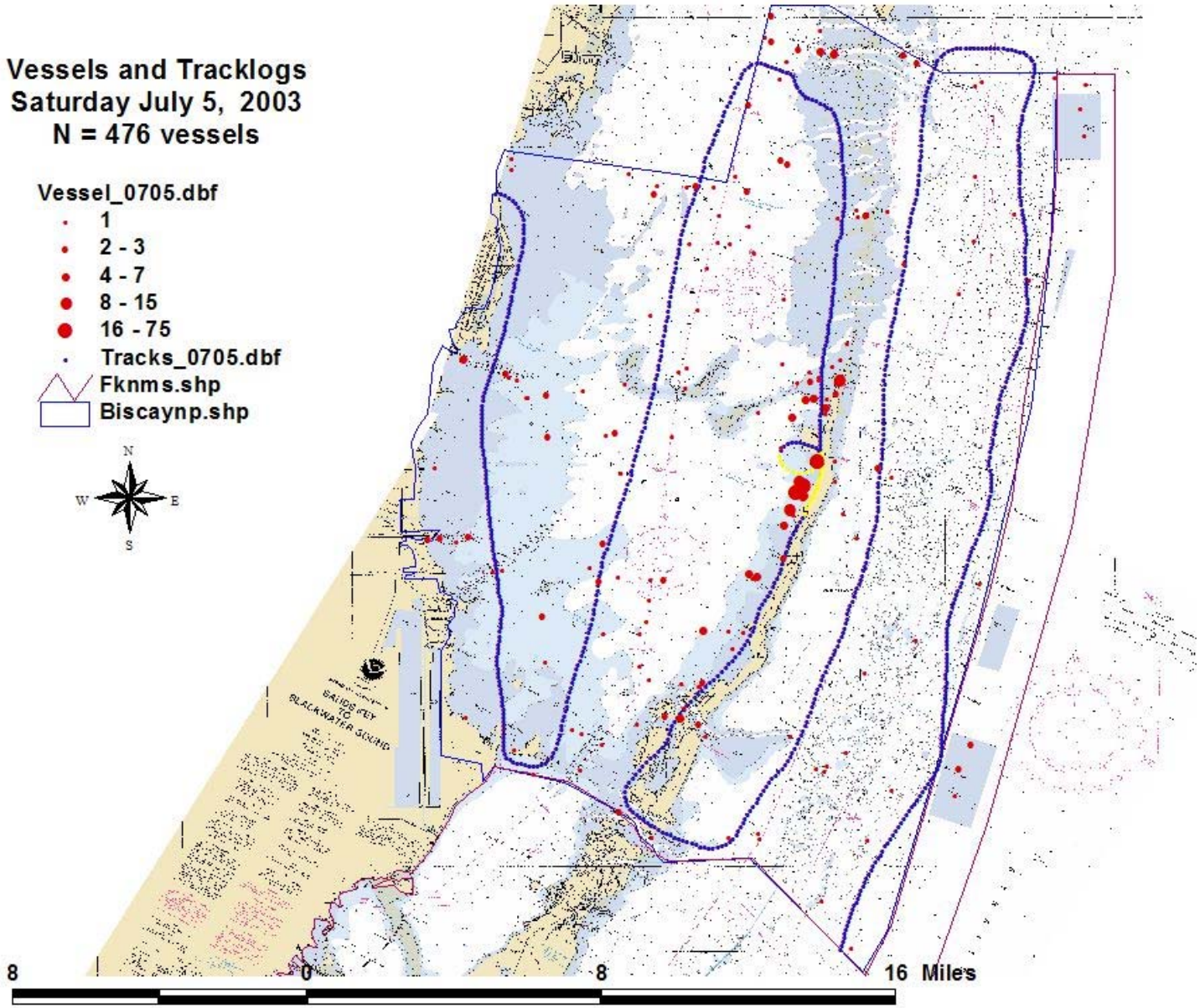

Vessels and Tracklogs
Monday June 9, 2003
N = 95 vessels
Vessel_0609.dbf
1 - 3
Tracks_0609.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

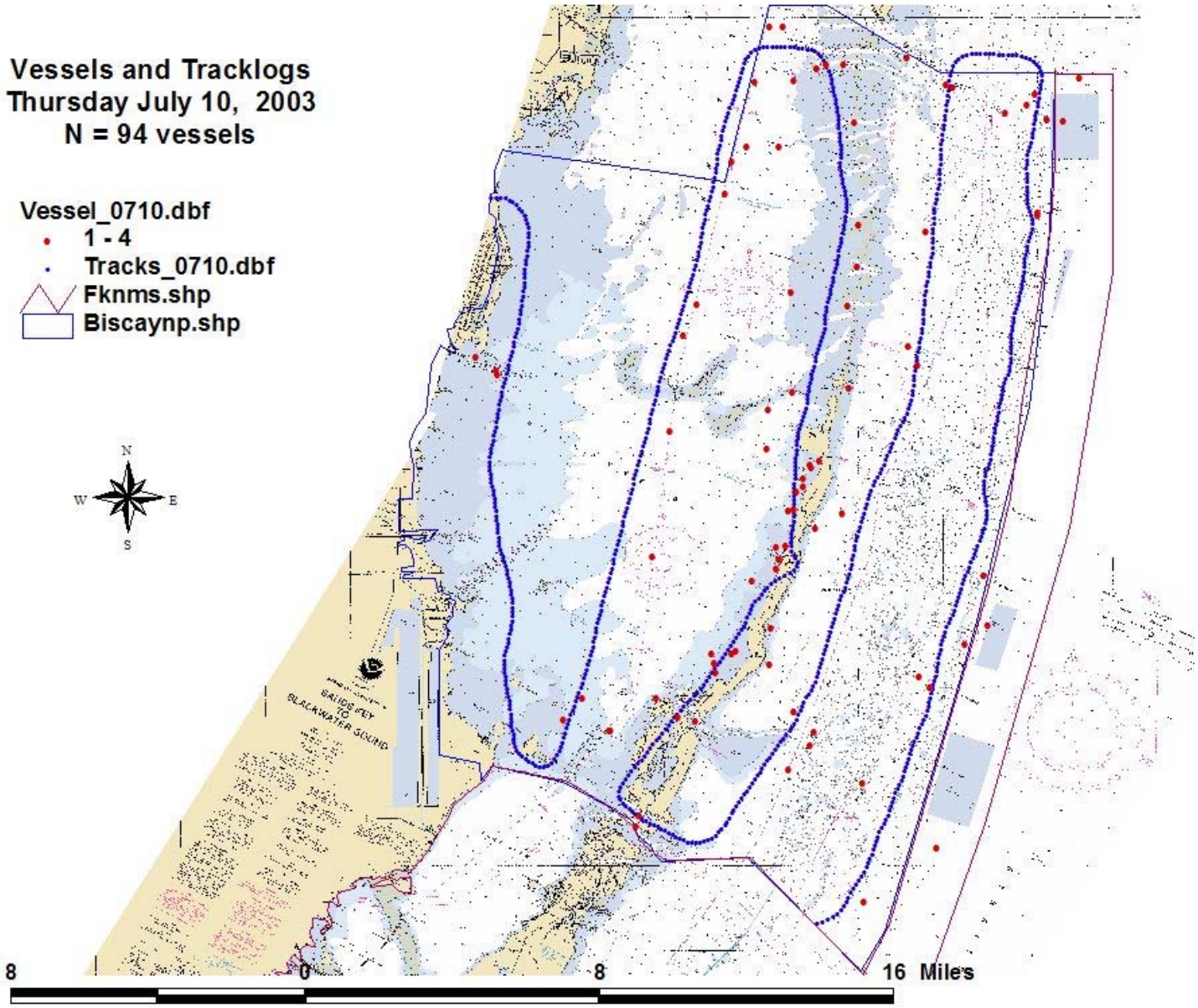

Vessels and Tracklogs
Sunday June 15, 2003
N = 459 vessels
Vessel_0615.dbf
1 - 2
3 - 7
8 - 15
16 - 25
26 - 75
Tracks_0615.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

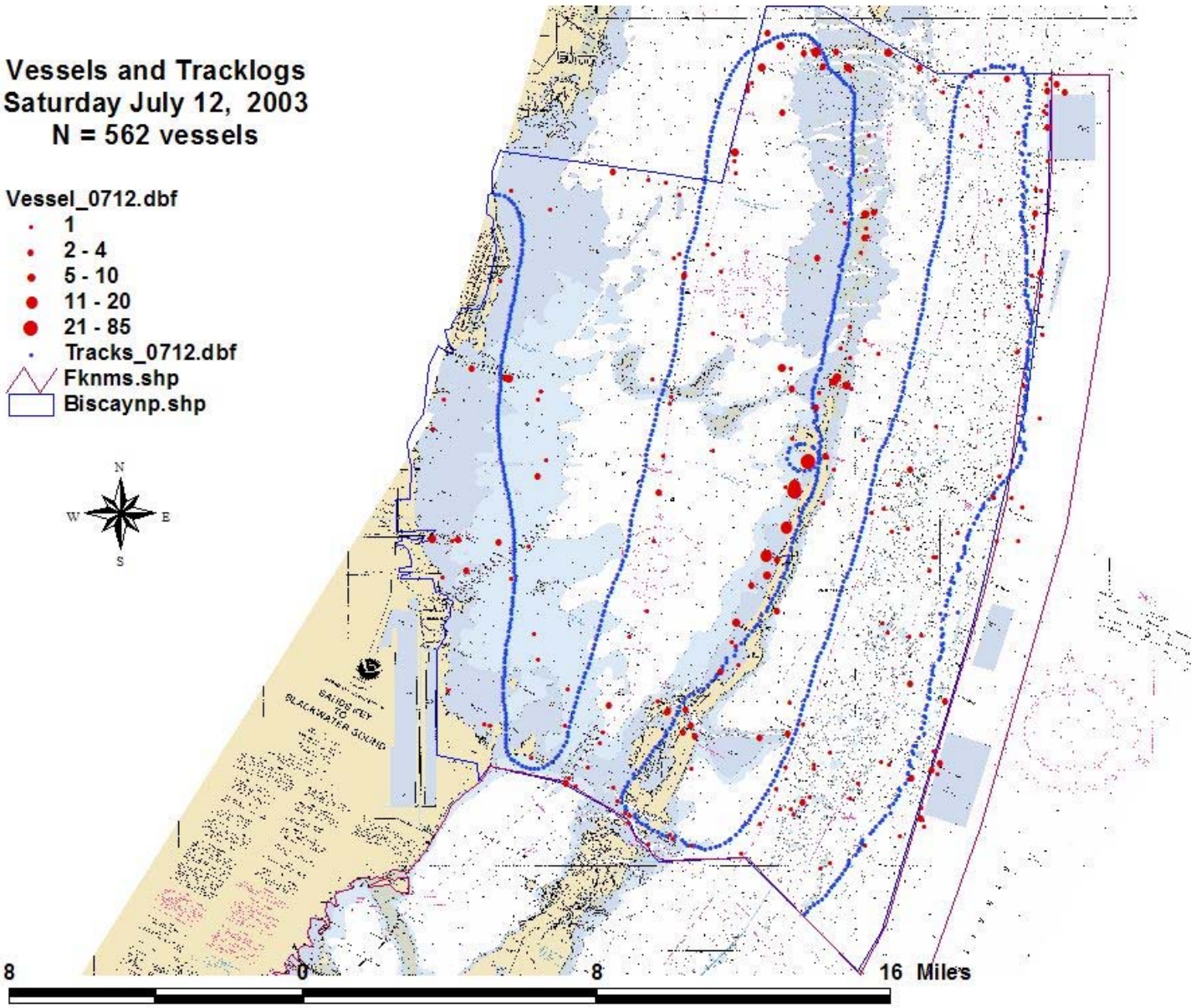

Vessels and Tracklogs
Thursday June 19, 2003
N = 101 vessels
Vessel_0619.dbf
1 - 3
Tracks_0619.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

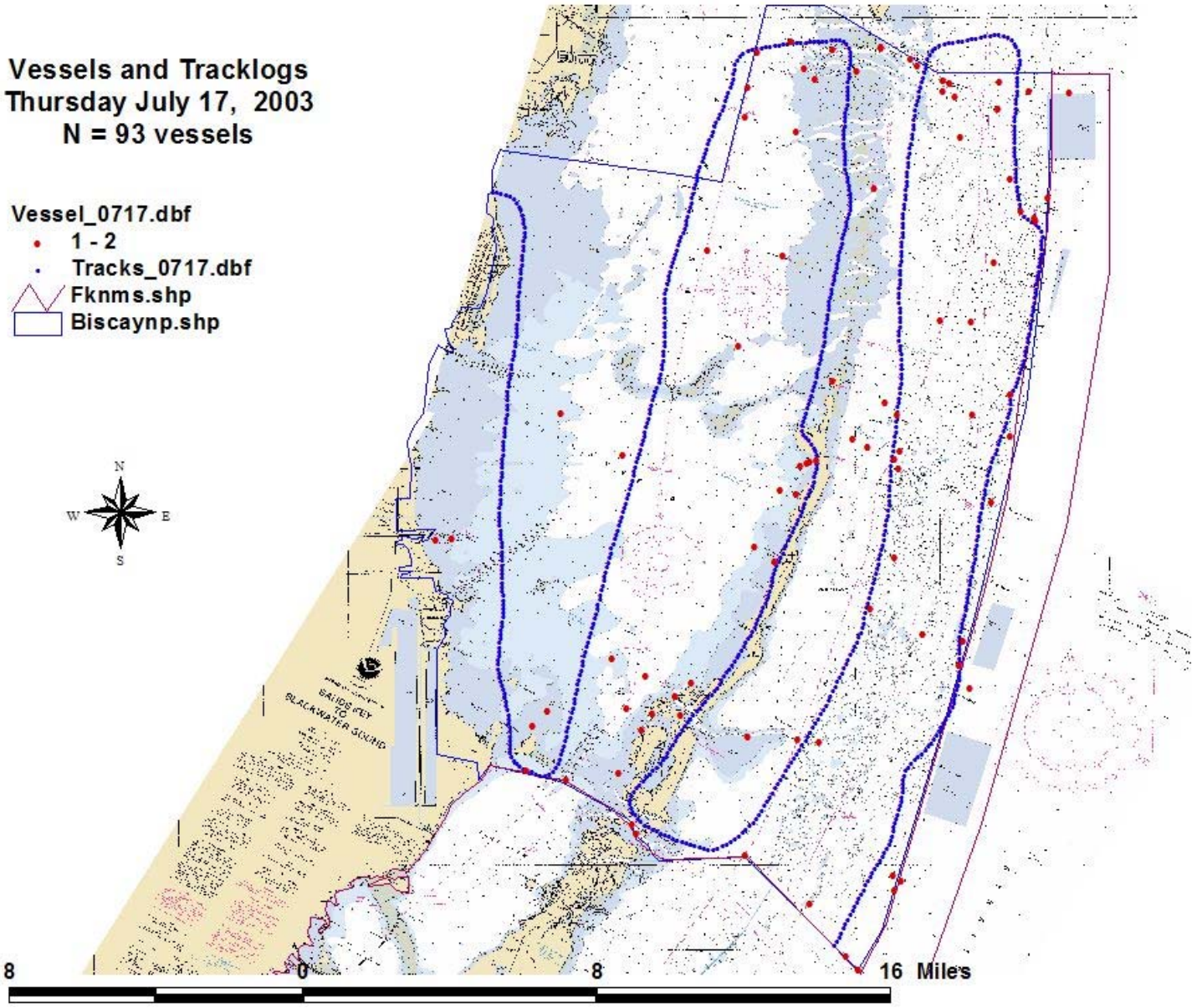

Vessels and Tracklogs
Thursday June 26, 2003
N = 141 vessels
Vessel_0626.dbf
1 - 3
Tracks_0626.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

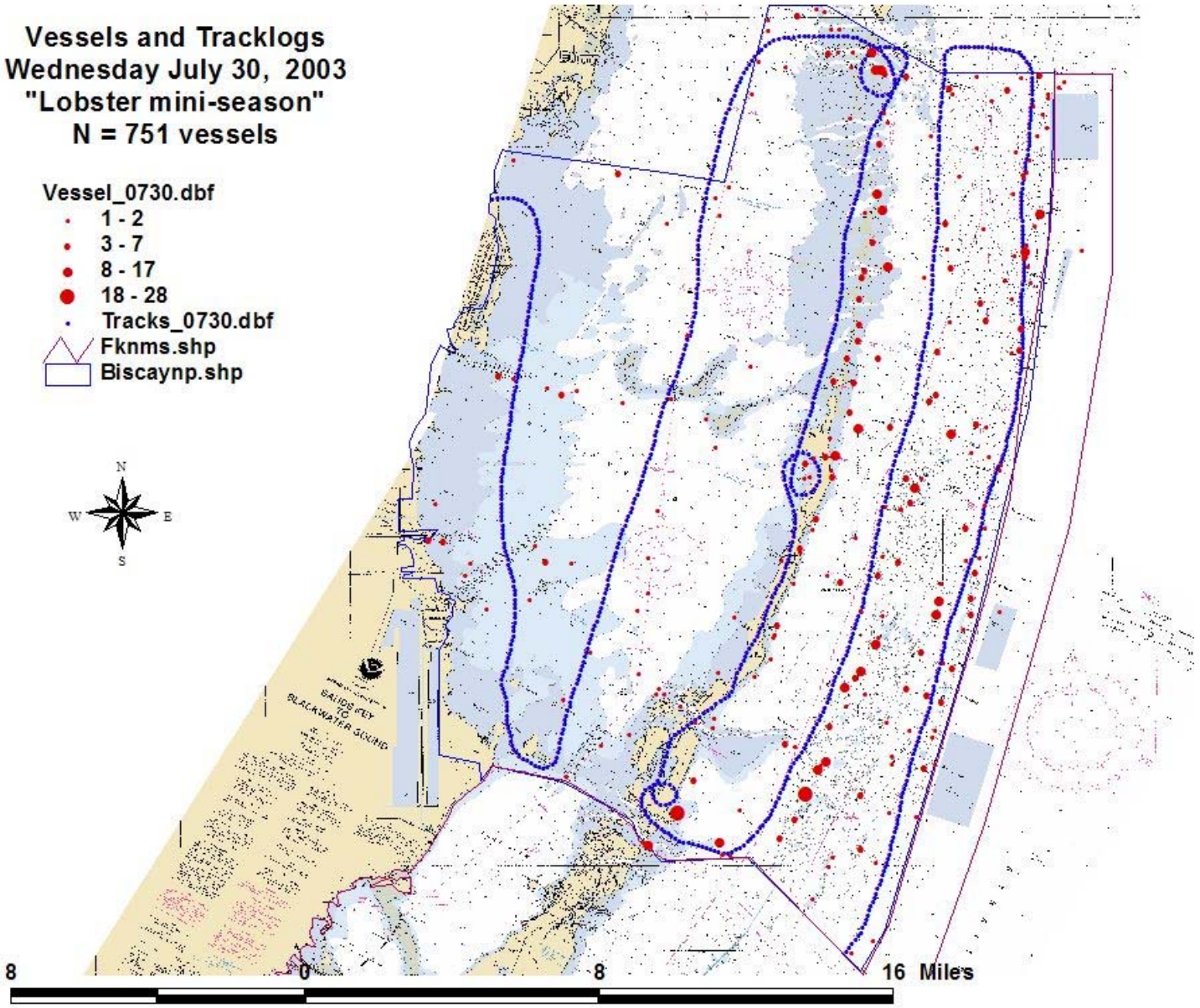

Vessels and Tracklogs
Tuesday July 1, 2003
N = 102 vessels
Vessel_0701.dbf
1 - 2
3 - 6
Tracks_0701.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
SAILING KEY
TO KEY
BLACKWATER SOUND
8
0
8
16 Miles

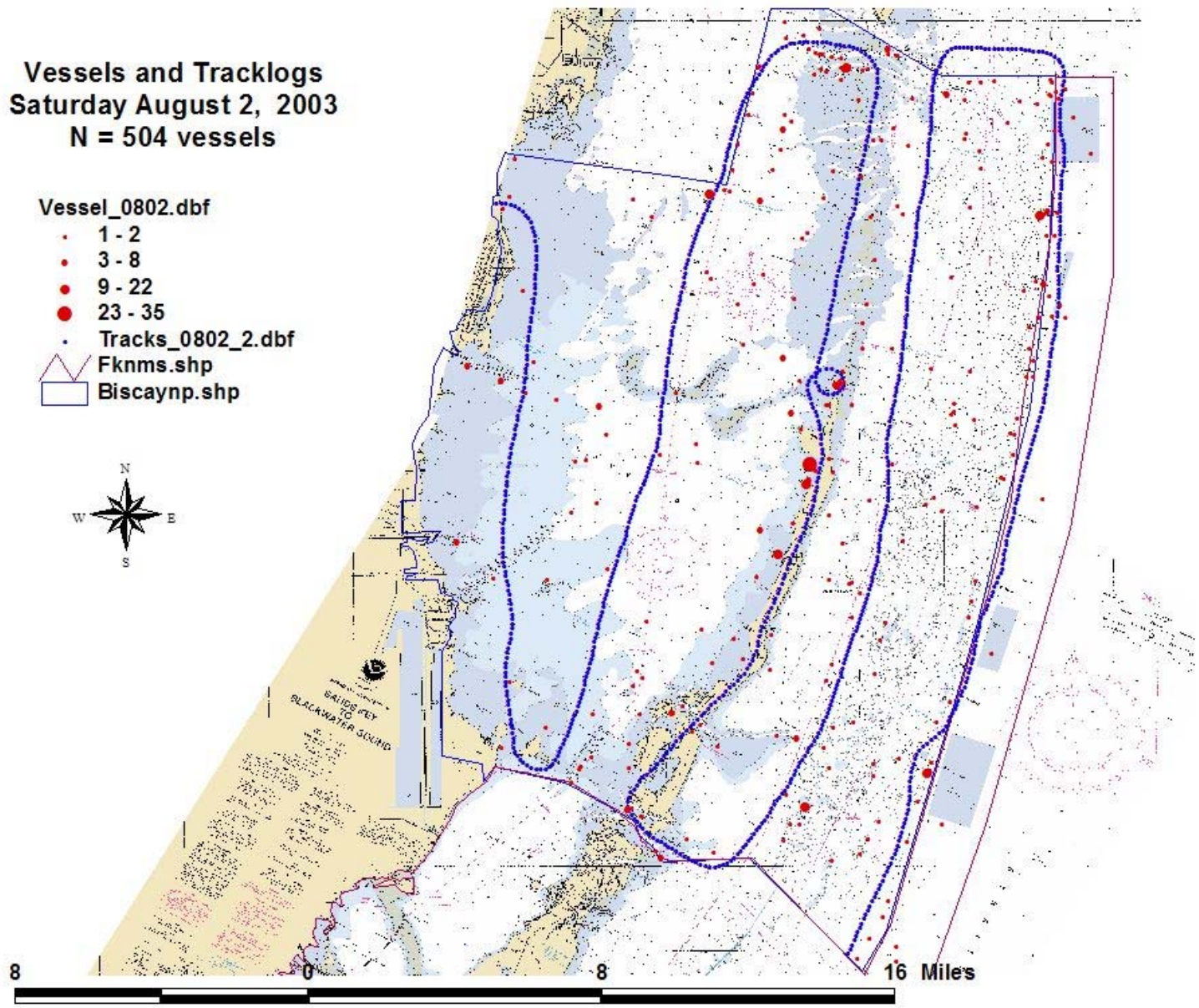

Vessels and Tracklogs
Saturday July 5, 2003
N = 476 vessels
Vessel_0705.dbf
1
2 - 3
4 - 7
8 - 15
16 - 75
Tracks_0705.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

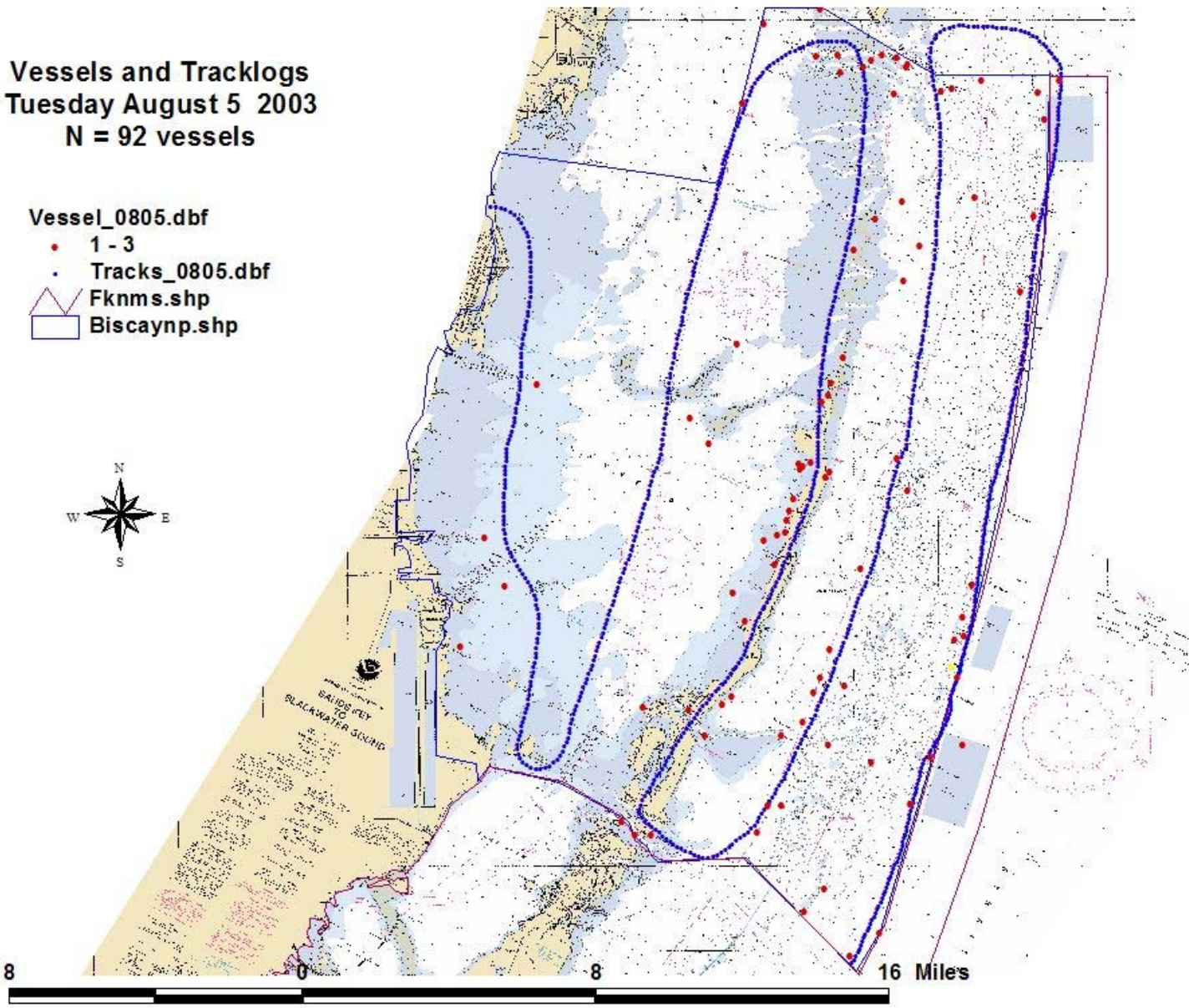

Vessels and Tracklogs
Thursday July 10, 2003
N = 94 vessels
Vessel_0710.dbf
1 - 4
Tracks_0710.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BAILEY TO BLACKWATER SOUND
8
0
8
16 Miles

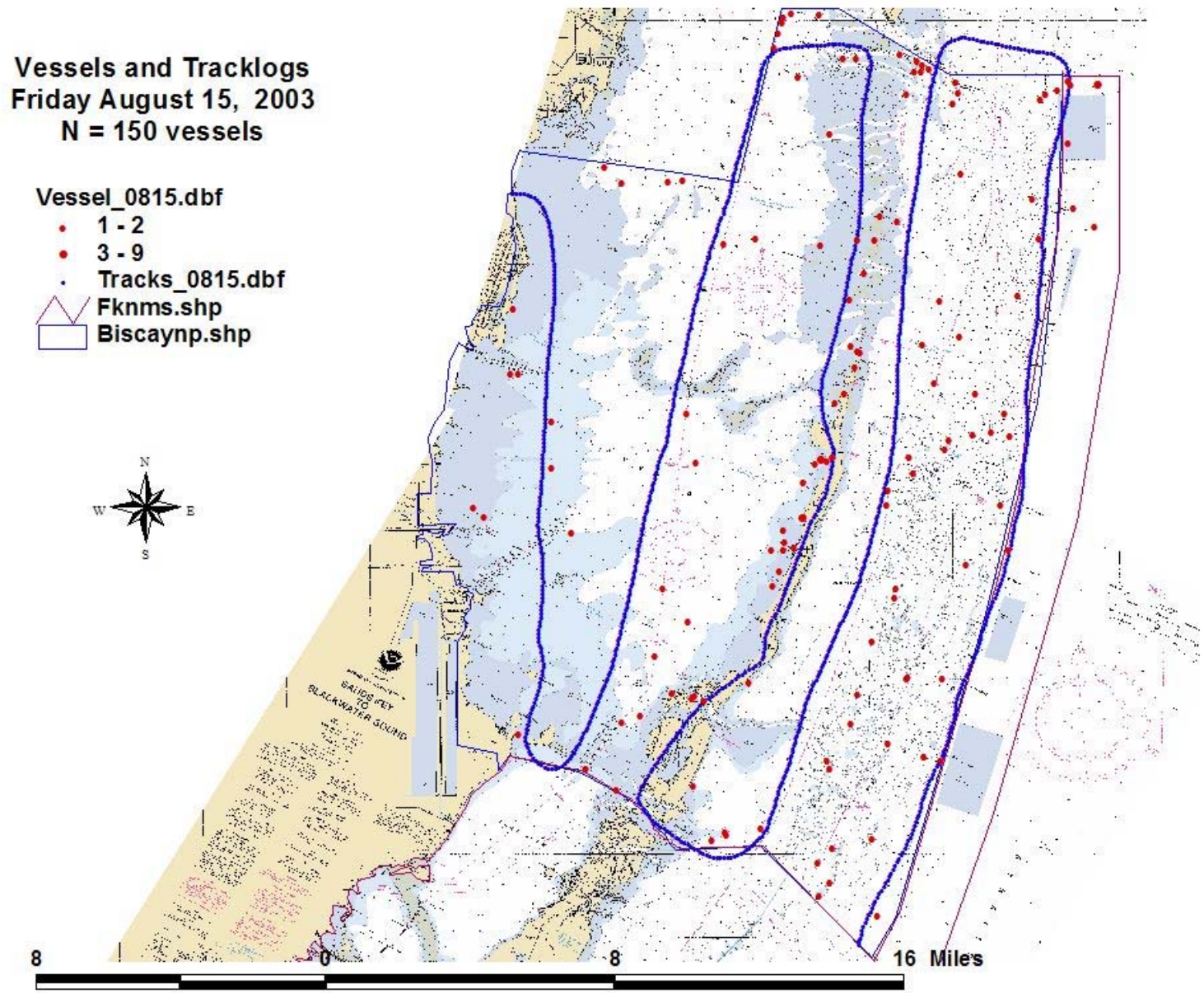

Vessels and Tracklogs
Saturday July 12, 2003
N = 562 vessels
Vessel_0712.dbf
1
2 - 4
5 - 10
11 - 20
21 - 85
Tracks_0712.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

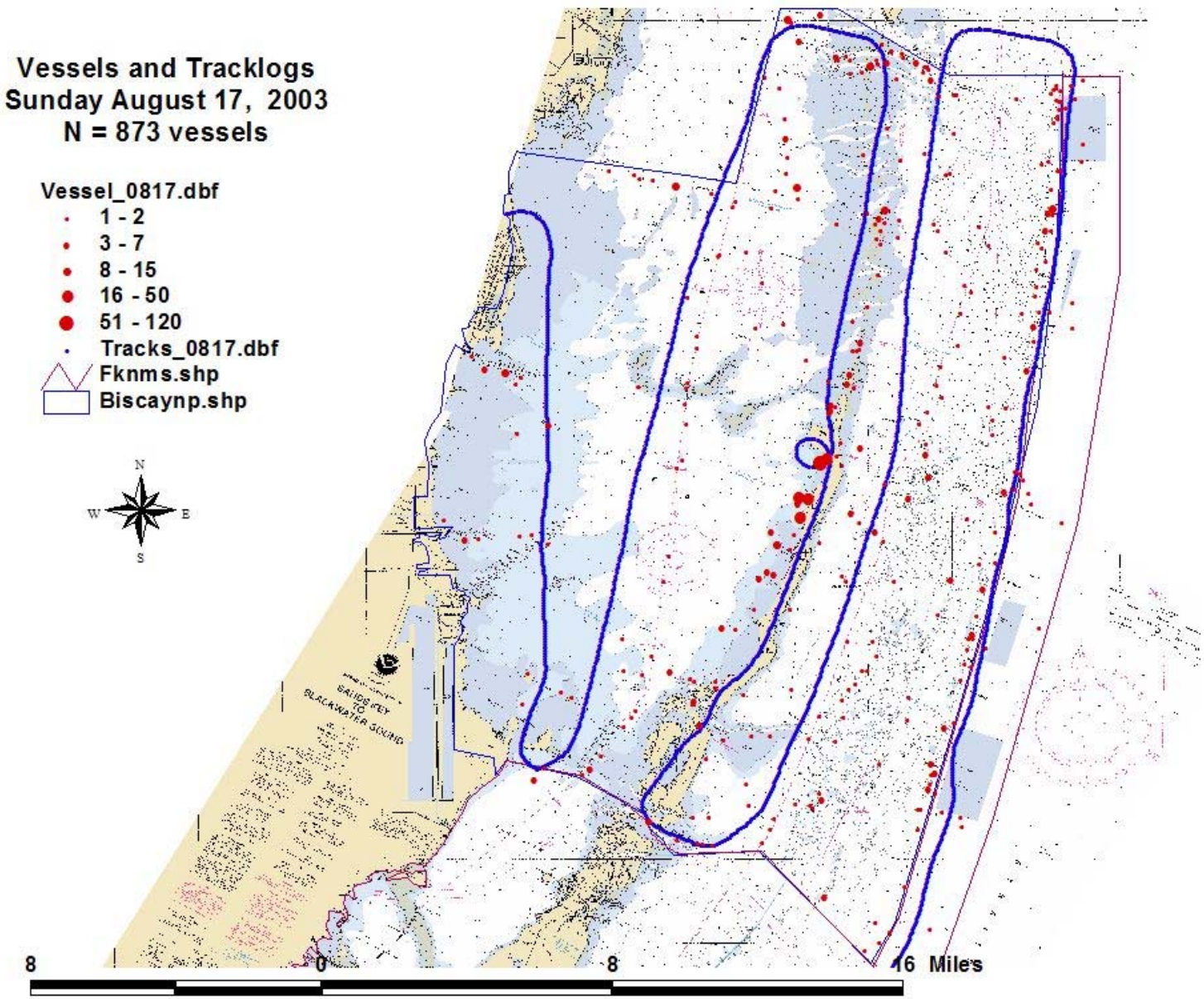

Vessels and Tracklogs
Thursday July 17, 2003
N = 93 vessels
Vessel_0717.dbf
1 - 2
Tracks_0717.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

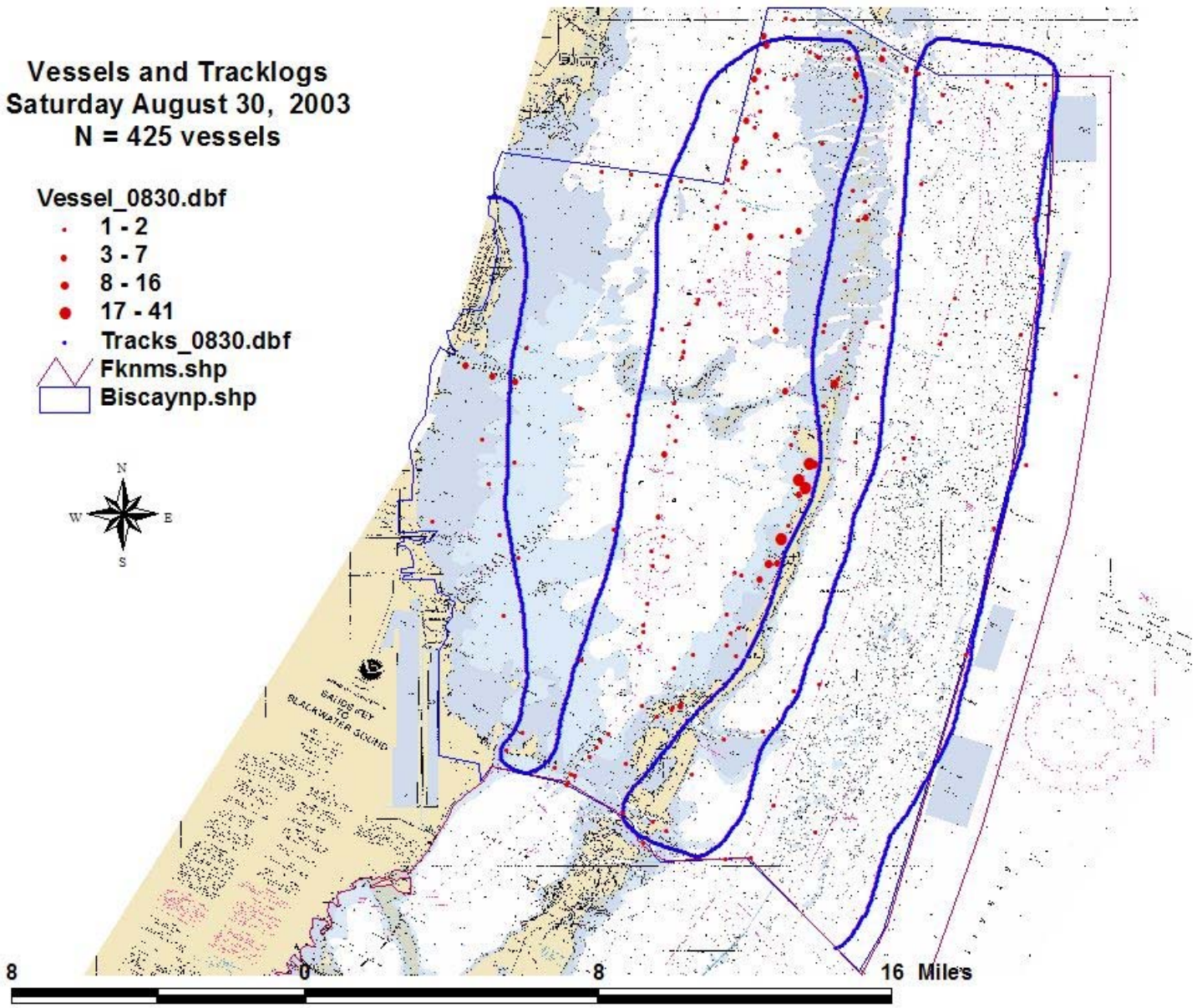

Vessels and Tracklogs
Wednesday July 30, 2003
"Lobster mini-season"
N = 751 vessels
Vessel_0730.dbf
1 - 2
3 - 7
8 - 17
18 - 28
Tracks_0730.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
BAILEY KEY
TO
BLACKWATER SOUND
8
0
8
16 Miles


Vessels and Tracklogs
Saturday August 2, 2003
N = 504 vessels
Vessel_0802.dbf
1 - 2
3 - 8
9 - 22
23 - 35
Tracks_0802_2.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

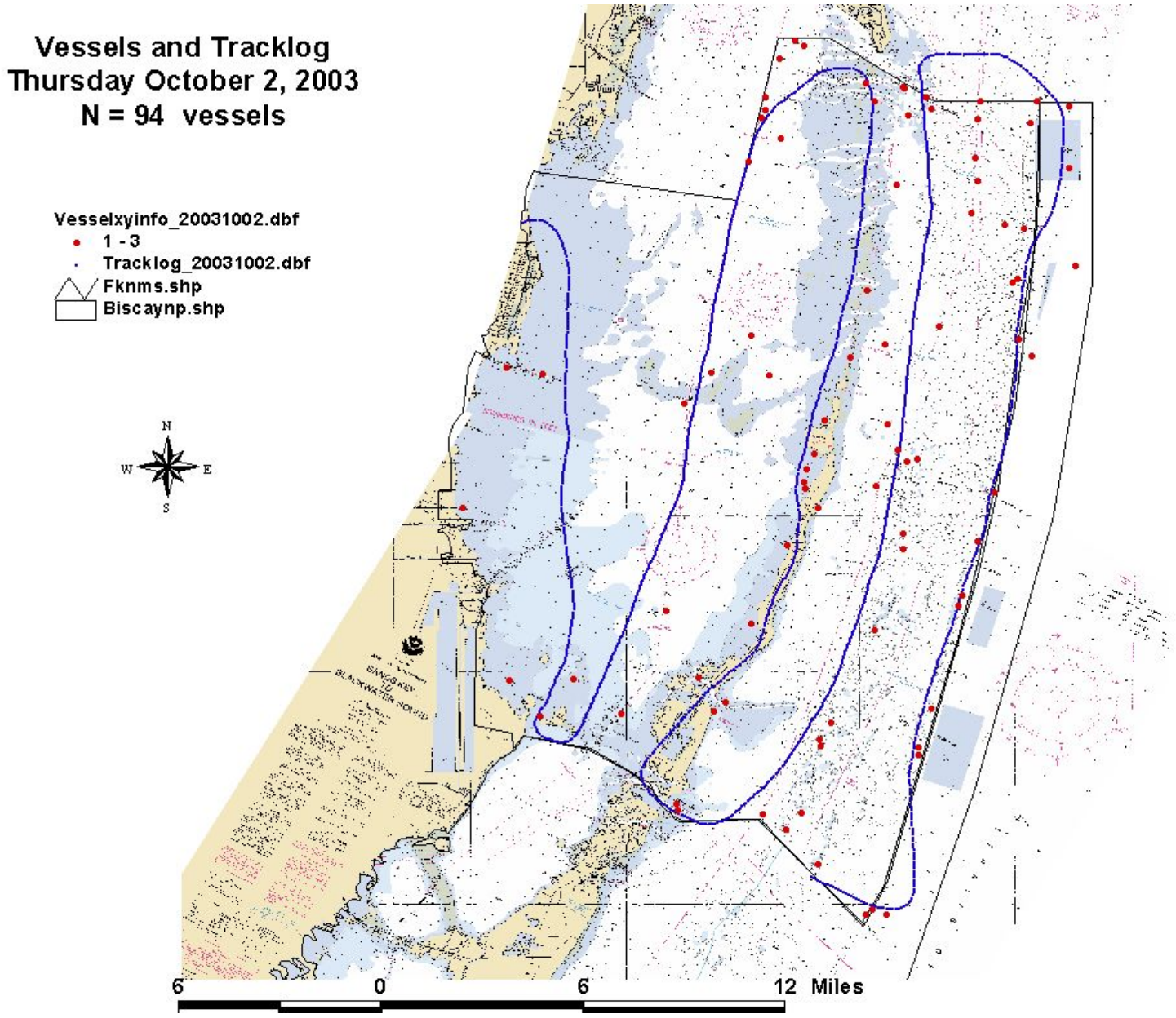

Vessels and Tracklogs
Tuesday August 5 2003
N = 92 vessels
Vessel_0805.dbf
1 - 3
Tracks_0805.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

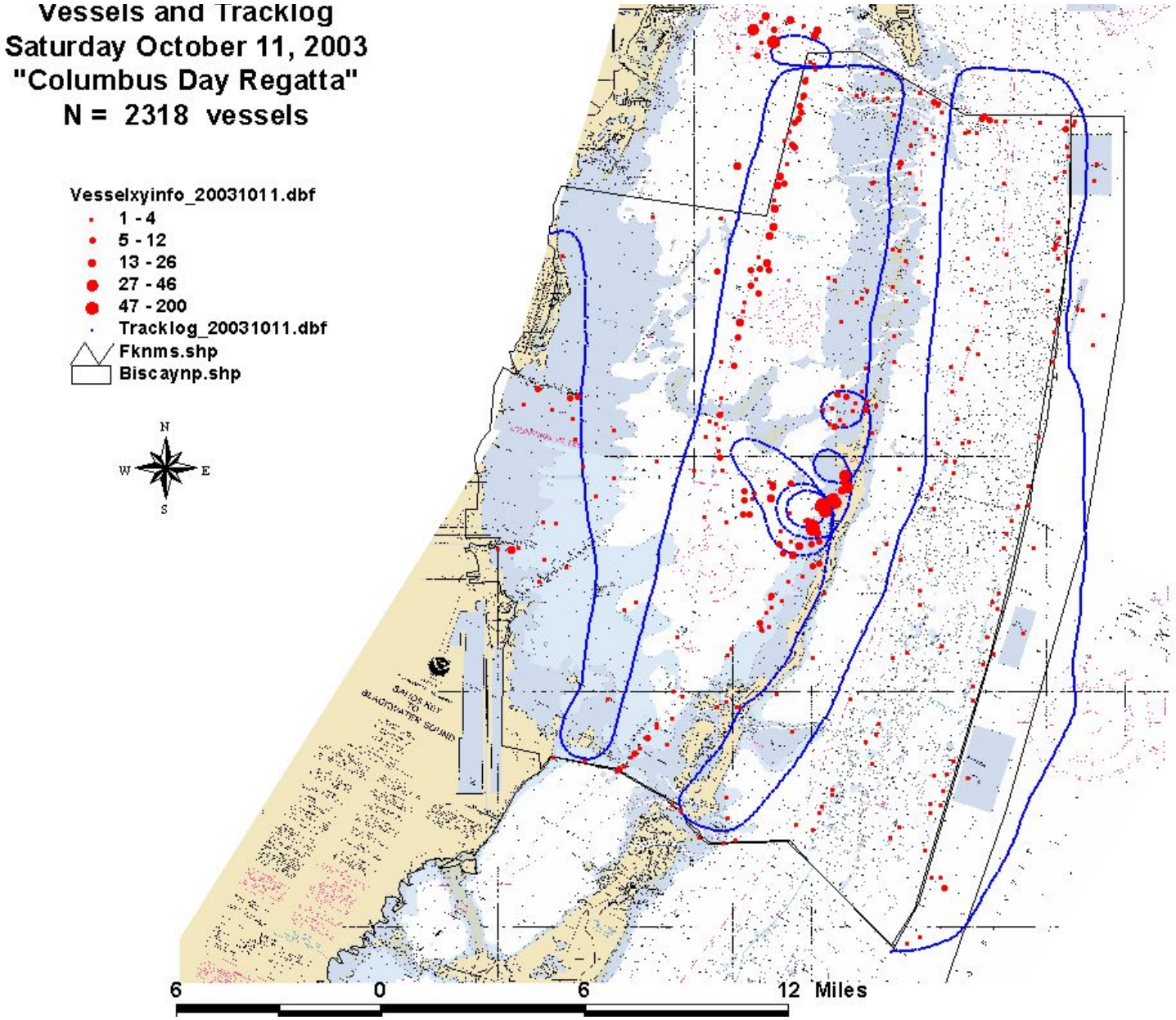

Vessels and Tracklogs
Friday August 15, 2003
N = 150 vessels
Vessel_0815.dbf
1 - 2
3 - 9
Tracks_0815.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

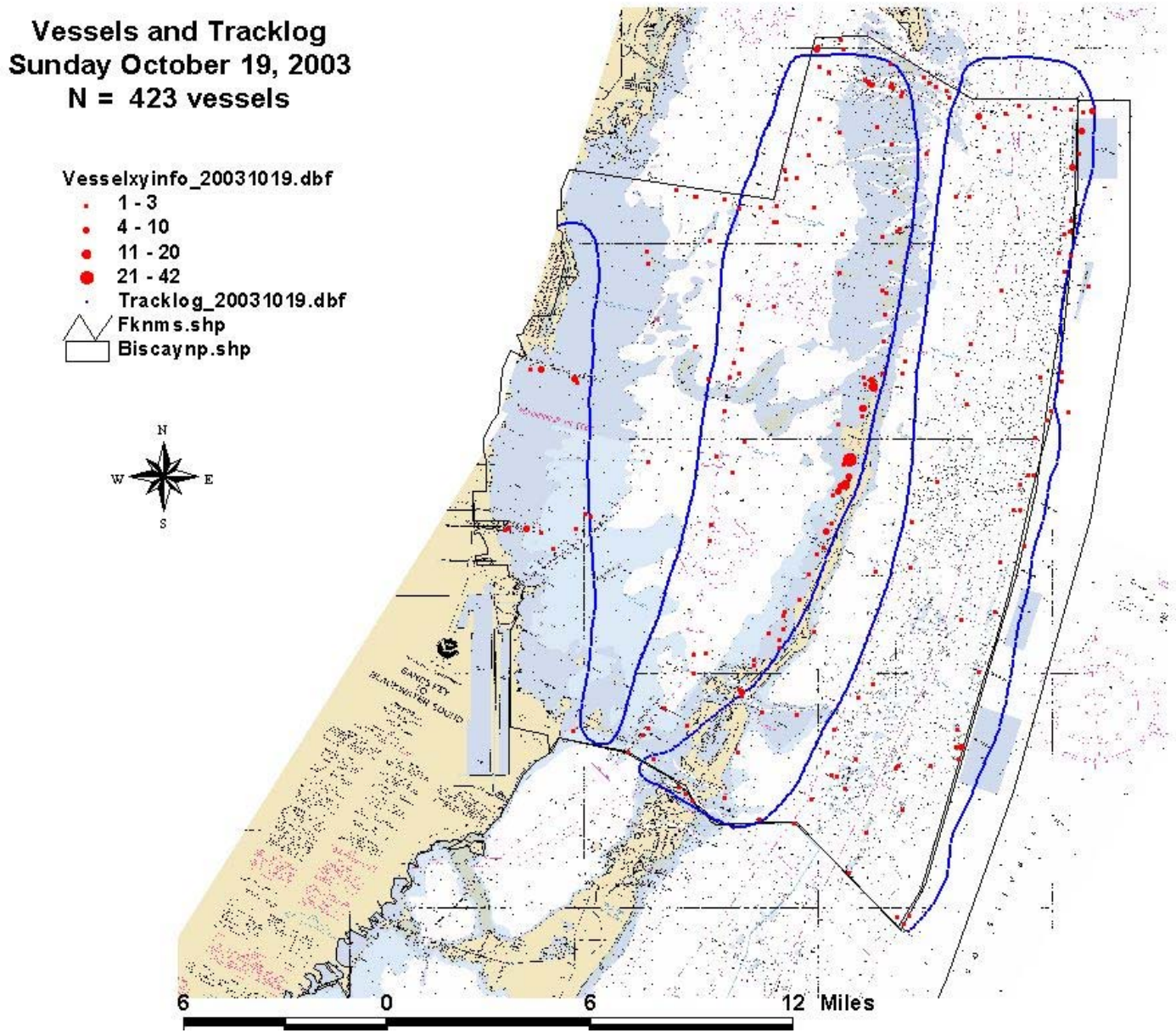

Vessels and Tracklogs
Sunday August 17, 2003
N = 873 vessels
Vessel_0817.dbf
1 - 2
3 - 7
8 - 15
16 - 50
51 - 120
Tracks_0817.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

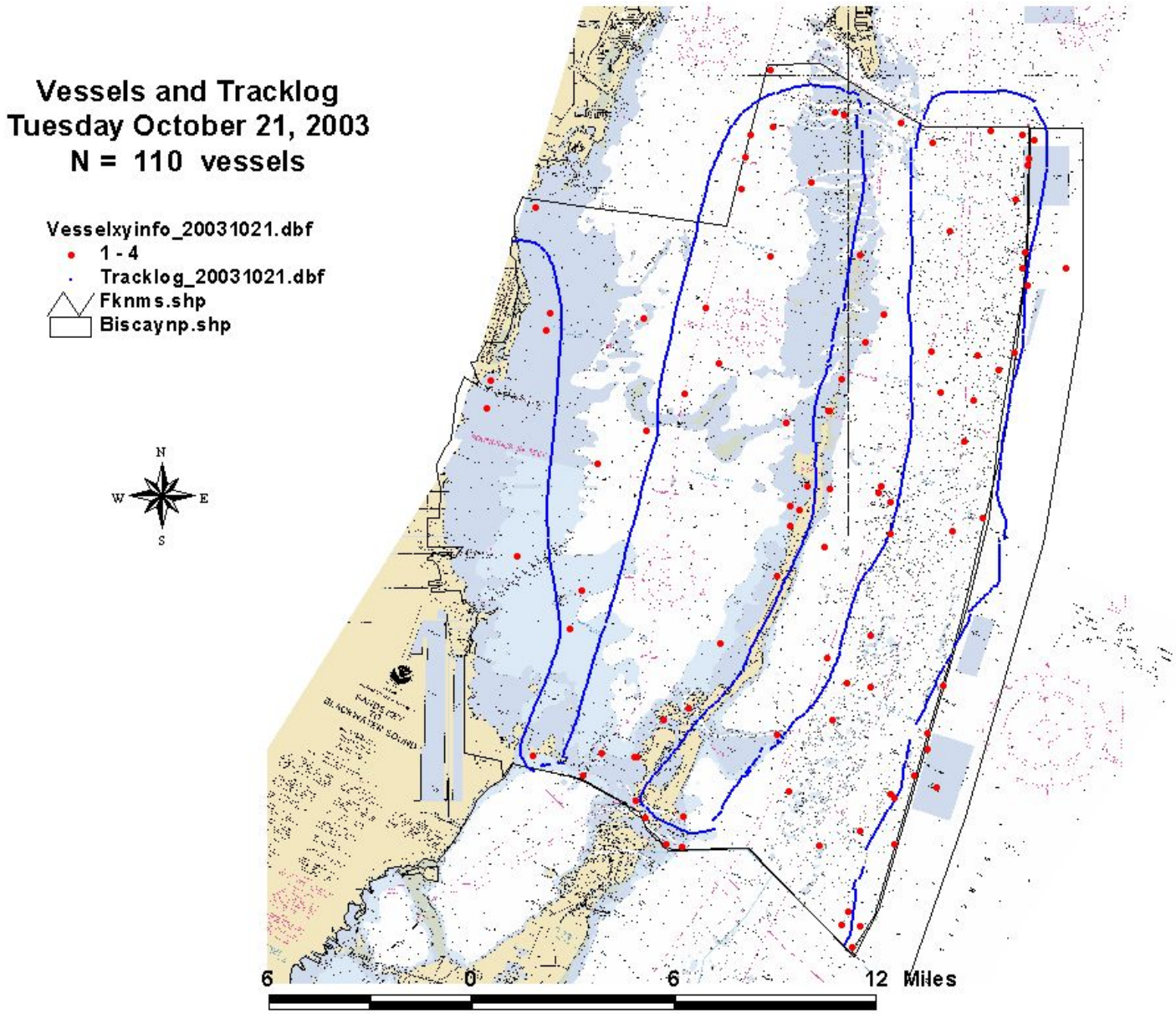

Vessels and Tracklogs
Saturday August 30, 2003
N = 425 vessels
Vessel_0830.dbf
1 - 2
3 - 7
8 - 16
17 - 41
Tracks_0830.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
8
0
8
16 Miles

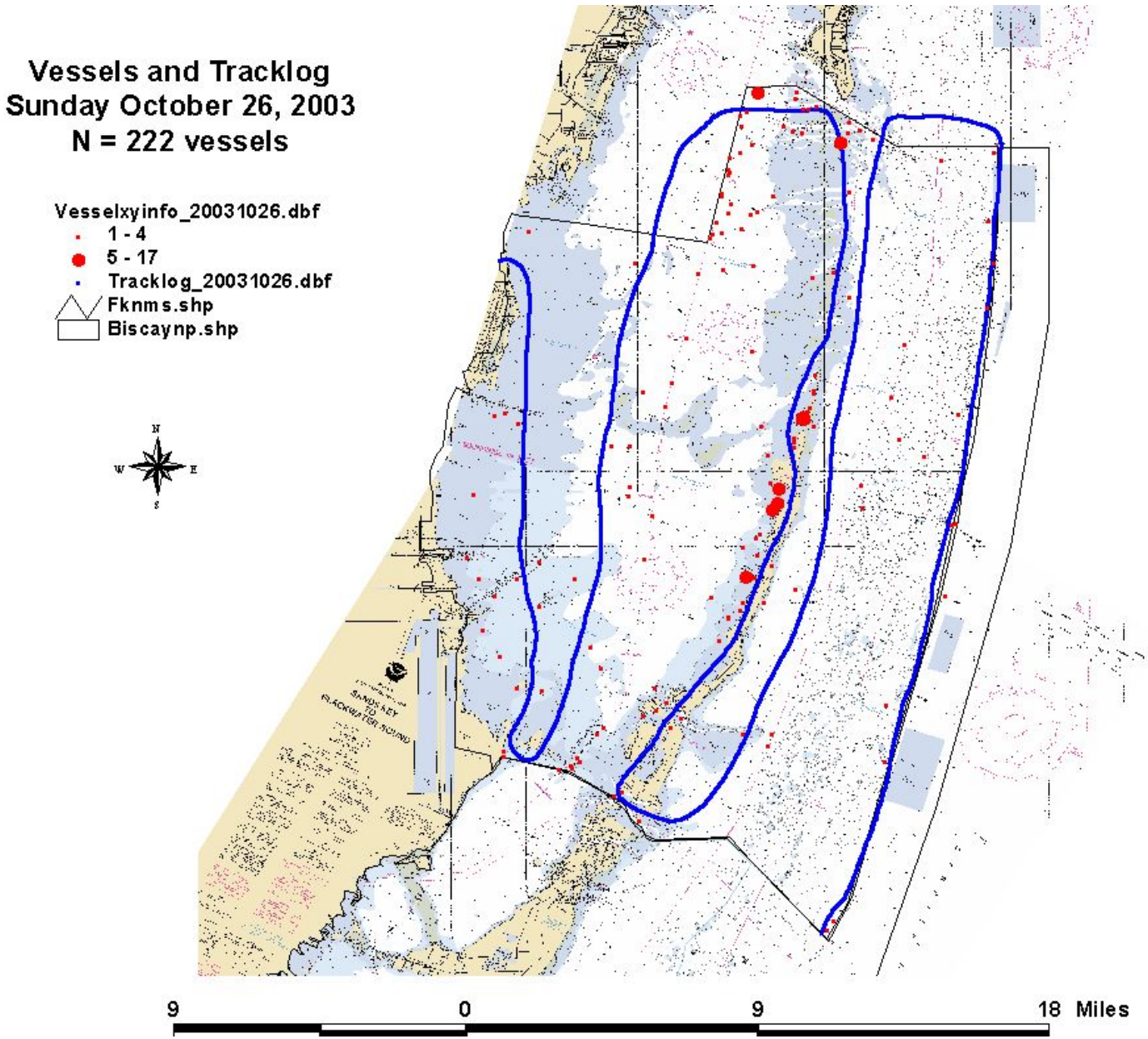
Appendix B3: Daily flight maps for fall 2003 aerial surveys.

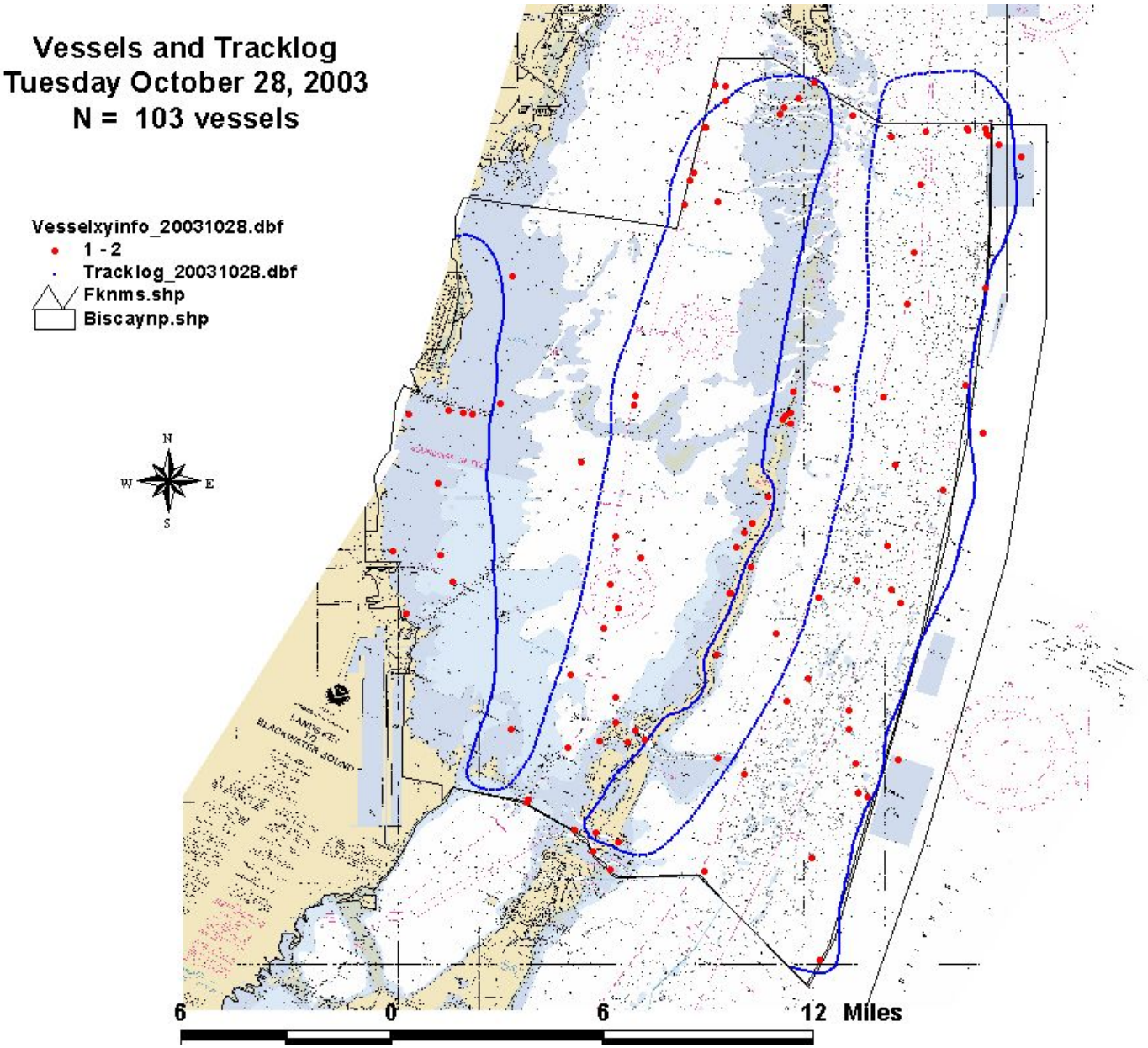

Vessels and Tracklog
Thursday October 2, 2003
N = 94 vessels
Vesselxyinfo_20031002.dbf
1 - 3
Tracklog_20031002.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

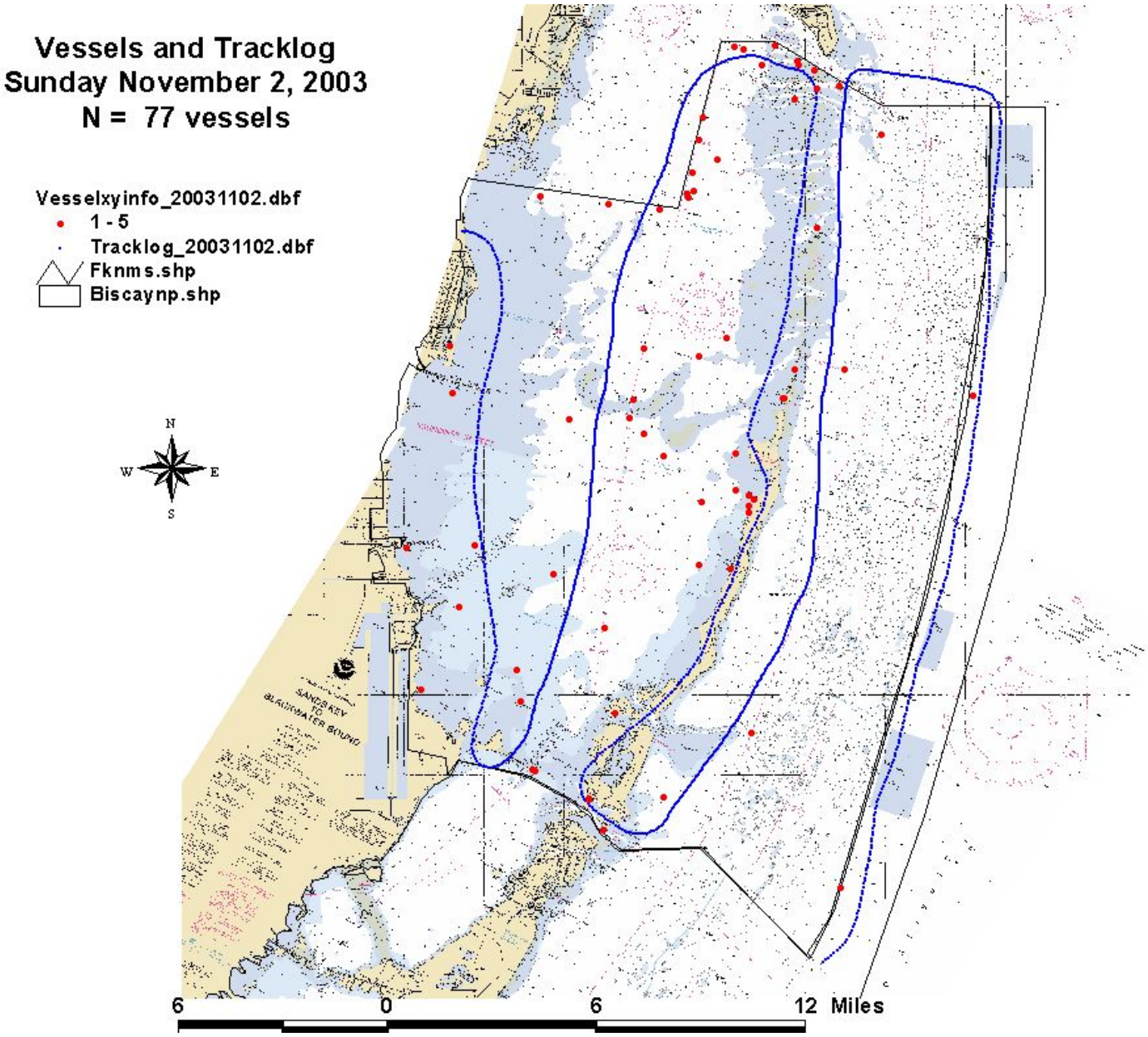

Vessels and Tracklog
Saturday October 11, 2003
"Columbus Day Regatta"
N = 2318 vessels
Vesselxyinfo_20031011.dbf
1 - 4
5 - 12
13 - 26
27 - 46
47 - 200
Tracklog_20031011.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

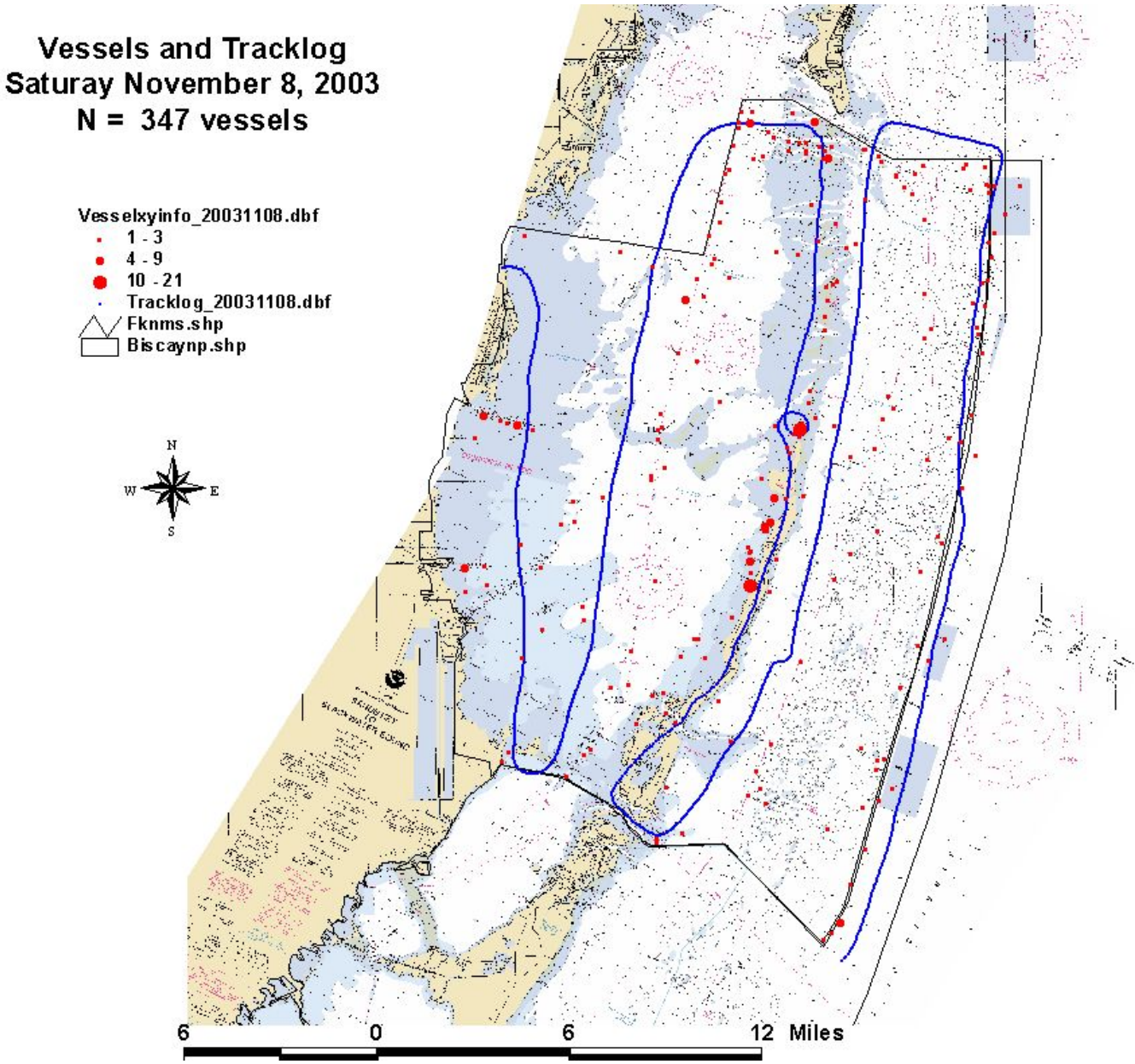

Vessels and Tracklog
Sunday October 19, 2003
N = 423 vessels
Vesselxyinfo_20031019.dbf
1 - 3
4 - 10
11 - 20
21 - 42
Tracklog_20031019.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

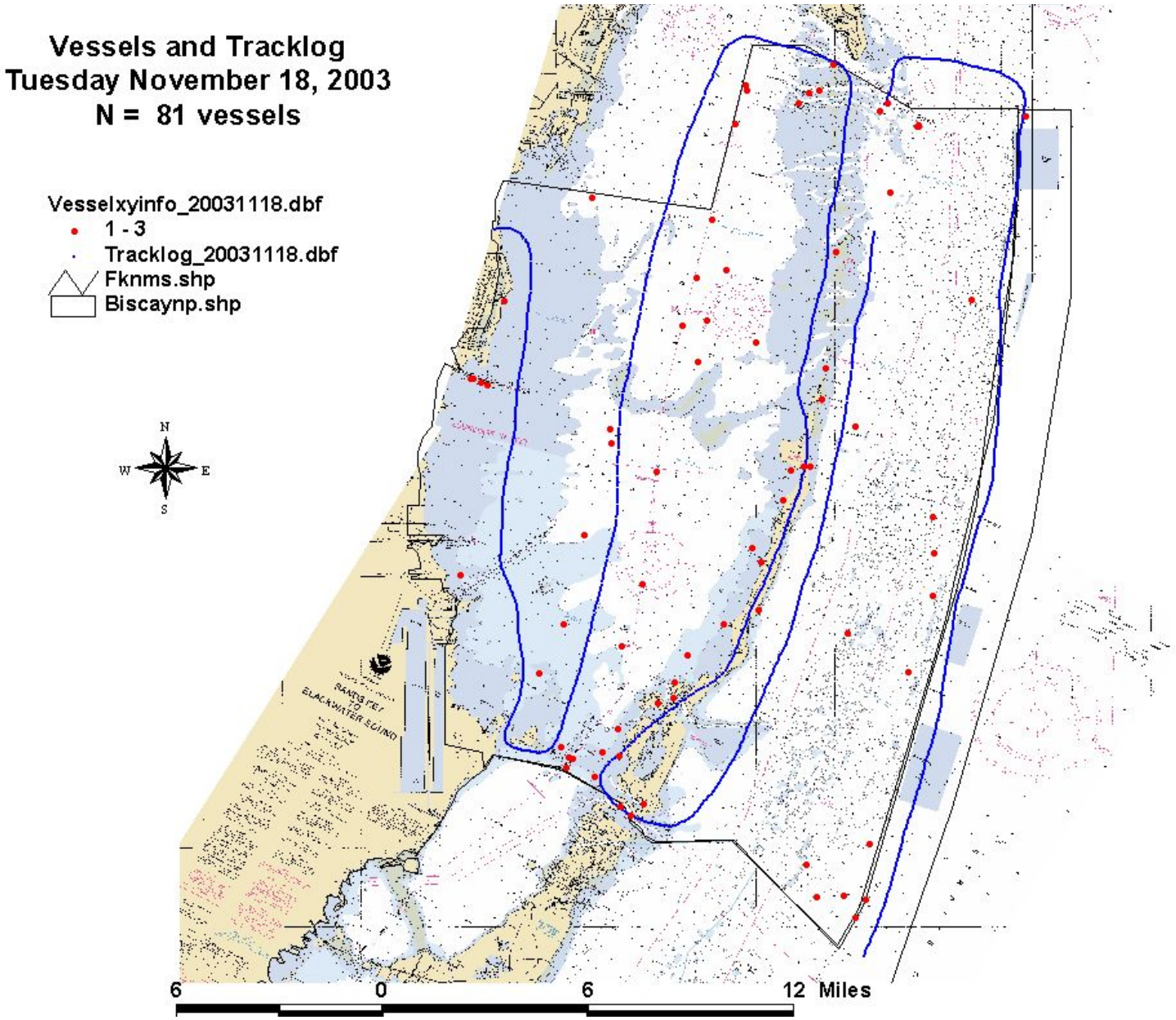

Vessels and Tracklog
Tuesday October 21, 2003
N = 110 vessels
Vesselxyinfo_20031021.dbf
1 - 4
Tracklog_20031021.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

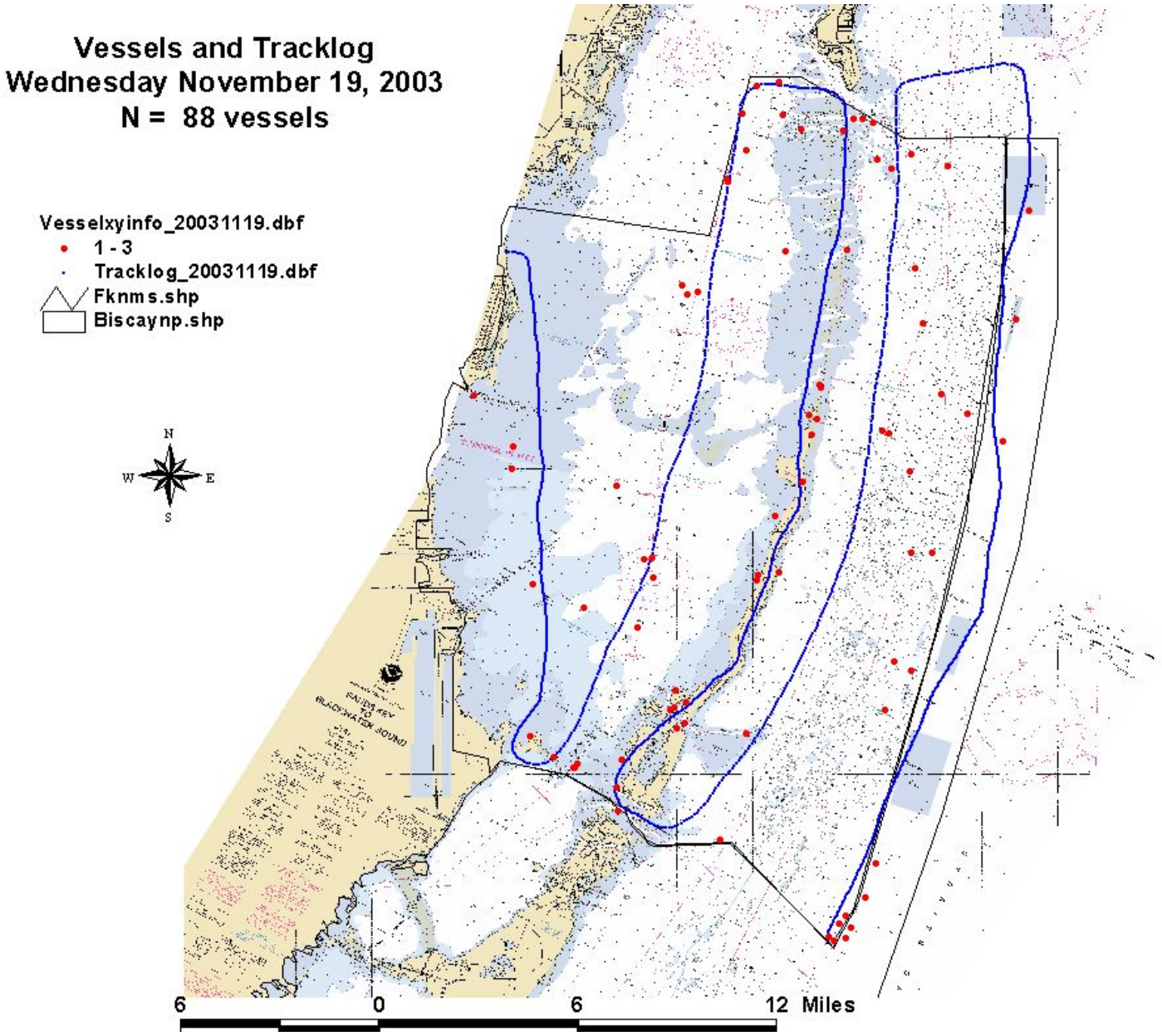

Vessels and Tracklog
Sunday October 26, 2003
N = 222 vessels
Vesselxyinfo_20031026.dbf
1 - 4
5 - 17
Tracklog_20031026.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
SANDY KEY TO BLACKWATER SOUND
9
0
9
18 Miles

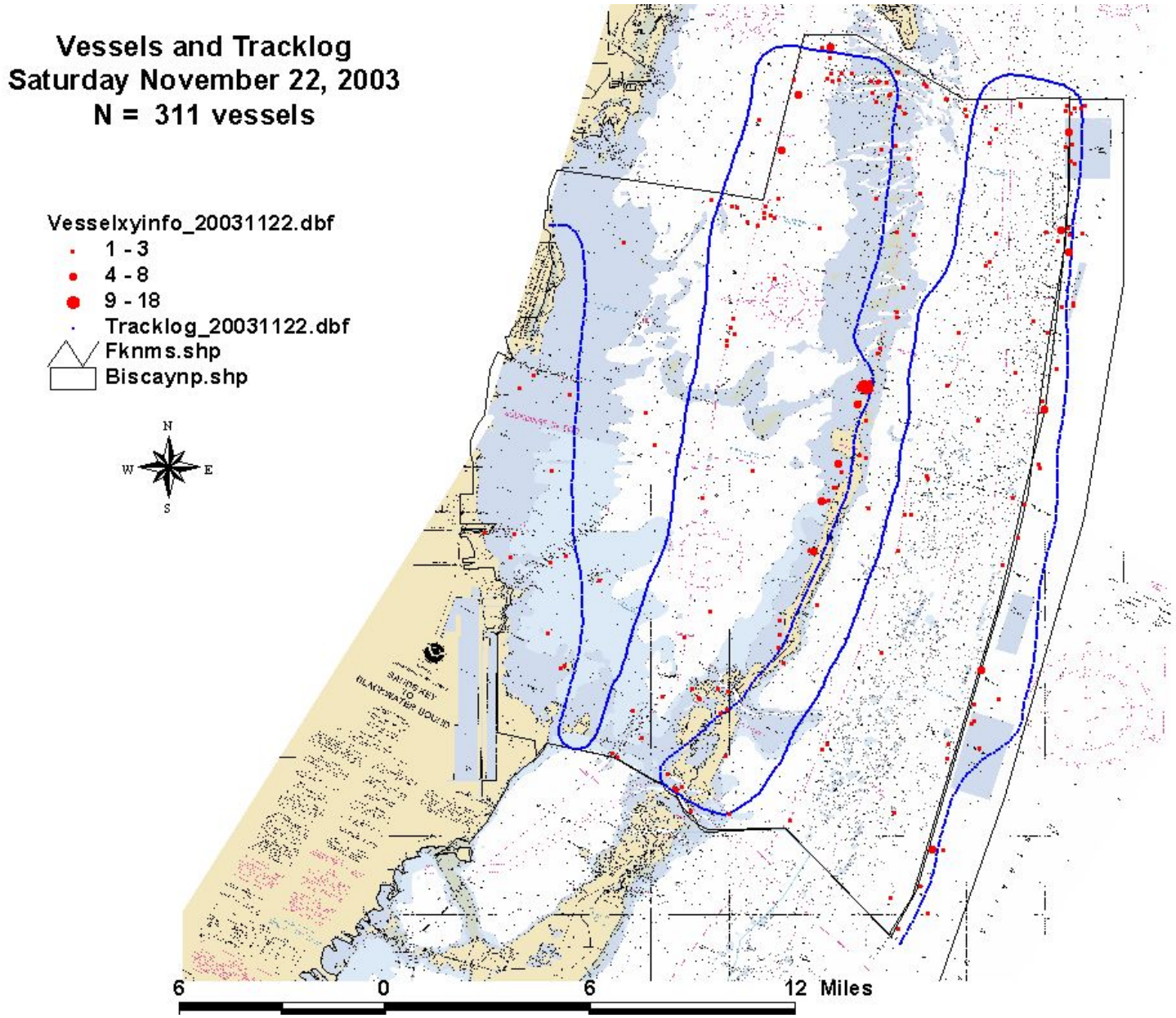

Vessels and Tracklog
Tuesday October 28, 2003
N = 103 vessels
Vesselxyinfo_20031028.dbf
1 - 2
Tracklog_20031028.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

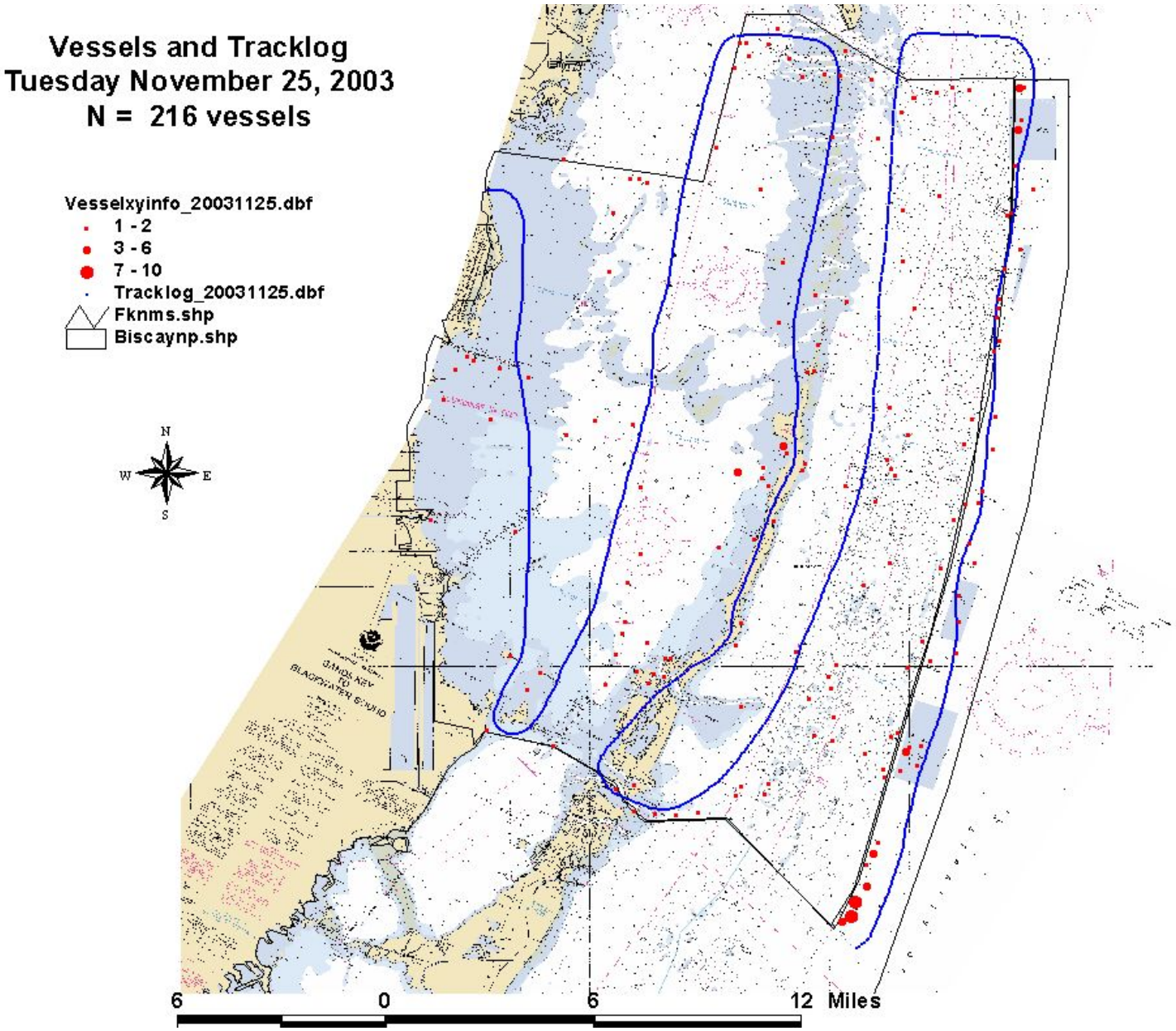

Vessels and Tracklog
Sunday November 2, 2003
N = 77 vessels
Vesselxyinfo_20031102.dbf
1 - 5
Tracklog_20031102.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
SANDRAEV
TO
BLACKWATER SOUND
6
0
6
12 Miles


Vessels and Tracklog
Saturay November 8, 2003
N = 347 vessels
Vesselxyinfo_20031108.dbf
1 - 3
4 - 9
10 - 21
Tracklog_20031108.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

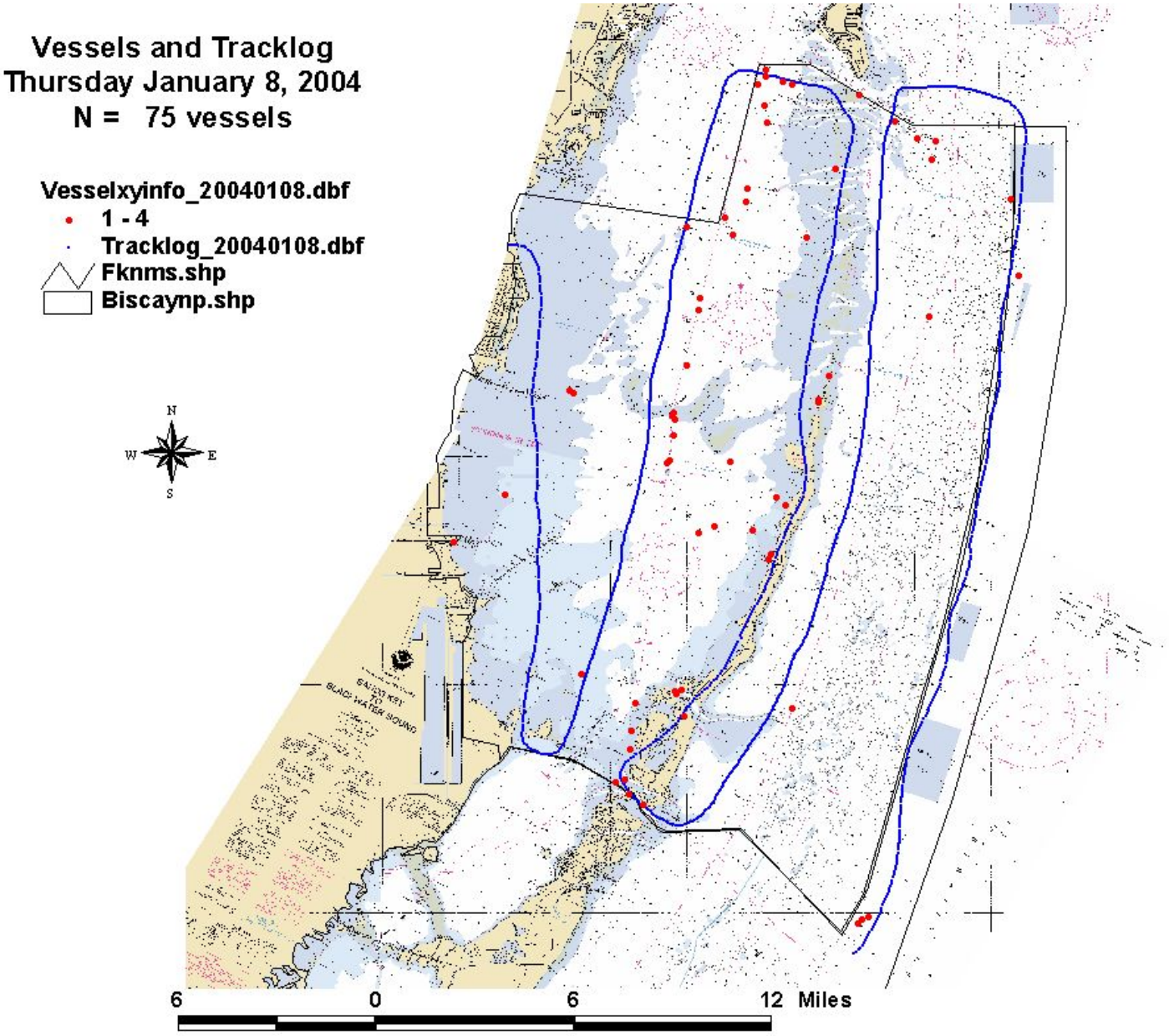

Vessels and Tracklog
Tuesday November 18, 2003
N = 81 vessels
Vesselxyinfo_20031118.dbf
1 - 3
Tracklog_20031118.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
SANIBEL
TO
BLACKWATER SOUND
6
0
6
12 Miles

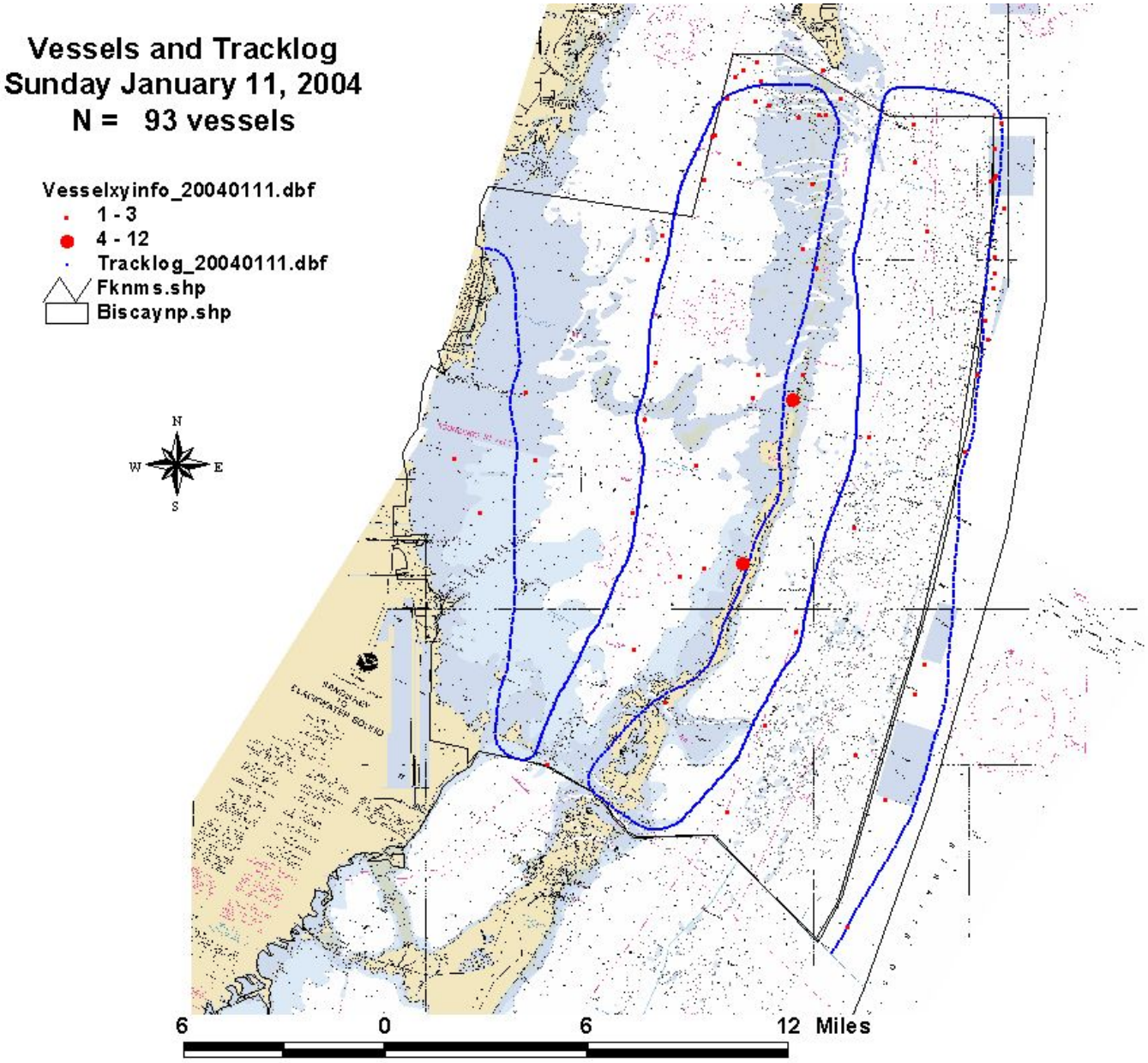

Vessels and Tracklog
Wednesday November 19, 2003
N = 88 vessels
Vesselxyinfo_20031119.dbf
1 - 3
Tracklog_20031119.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

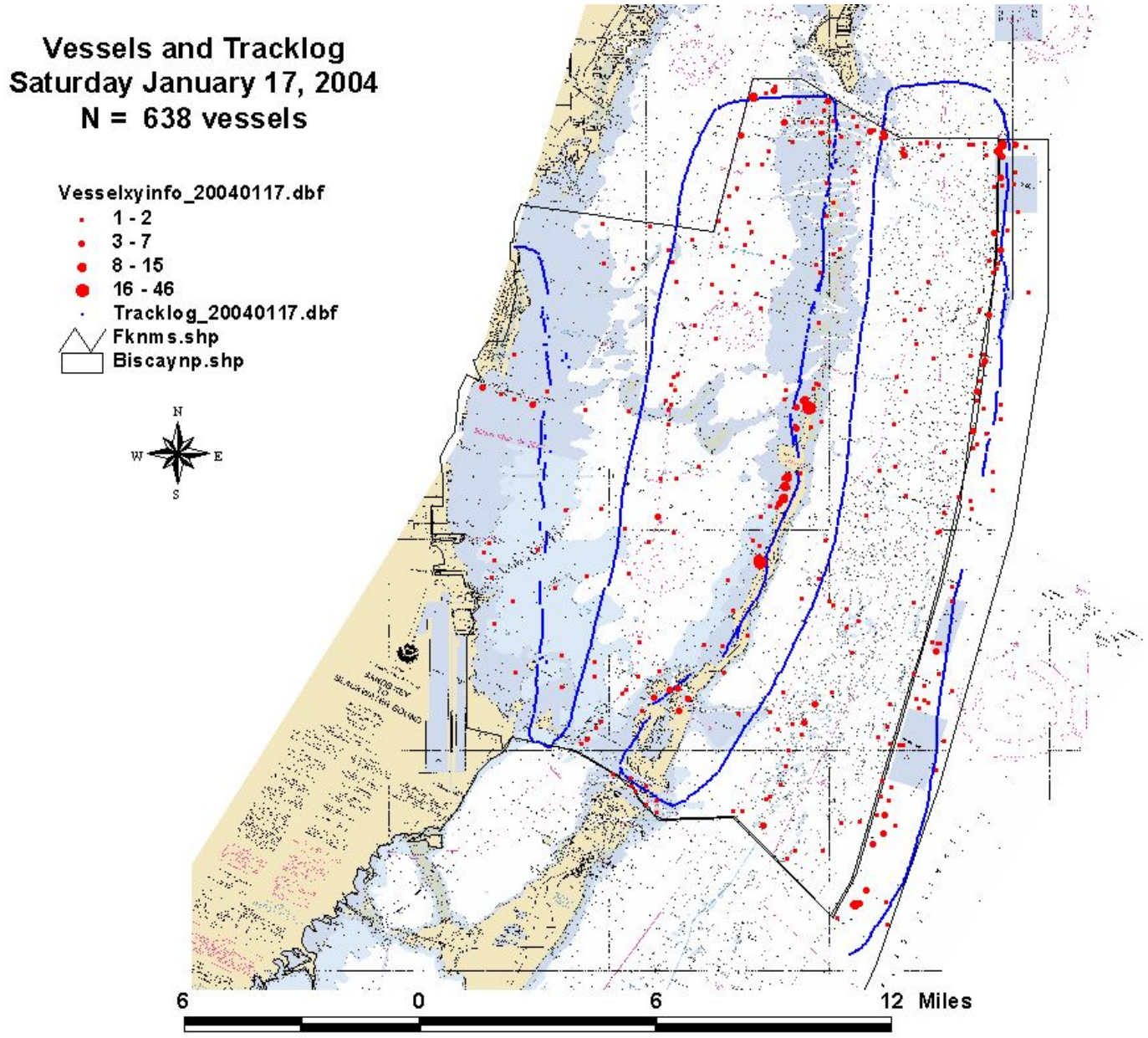

Vessels and Tracklog
Saturday November 22, 2003
N = 311 vessels
Vesselxyinfo_20031122.dbf
1 - 3
4 - 8
9 - 18
Tracklog_20031122.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

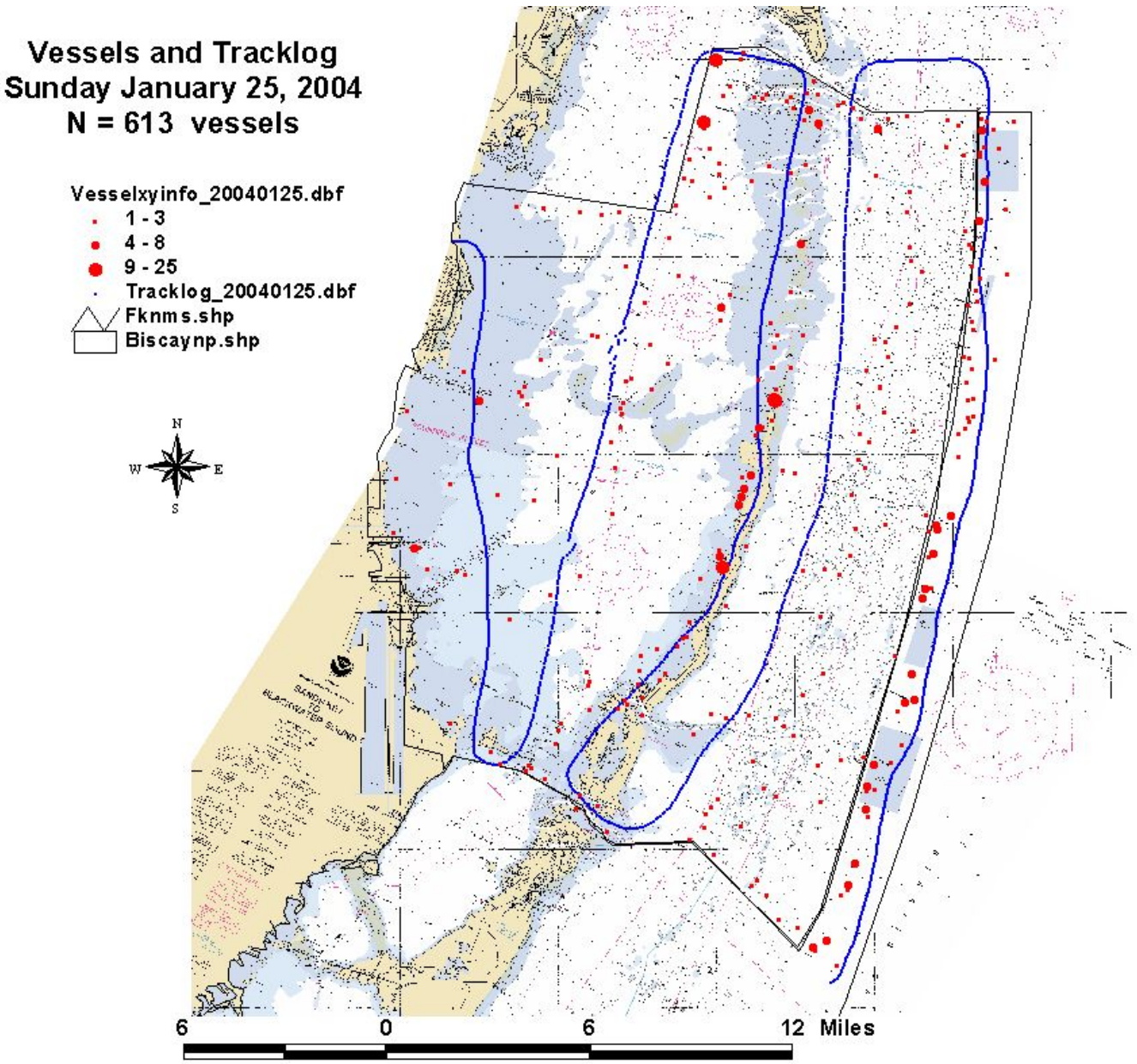

Vessels and Tracklog
Tuesday November 25, 2003
N = 216 vessels
Vesselxyinfo_20031125.dbf
1 - 2
3 - 6
7 - 10
Tracklog_20031125.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

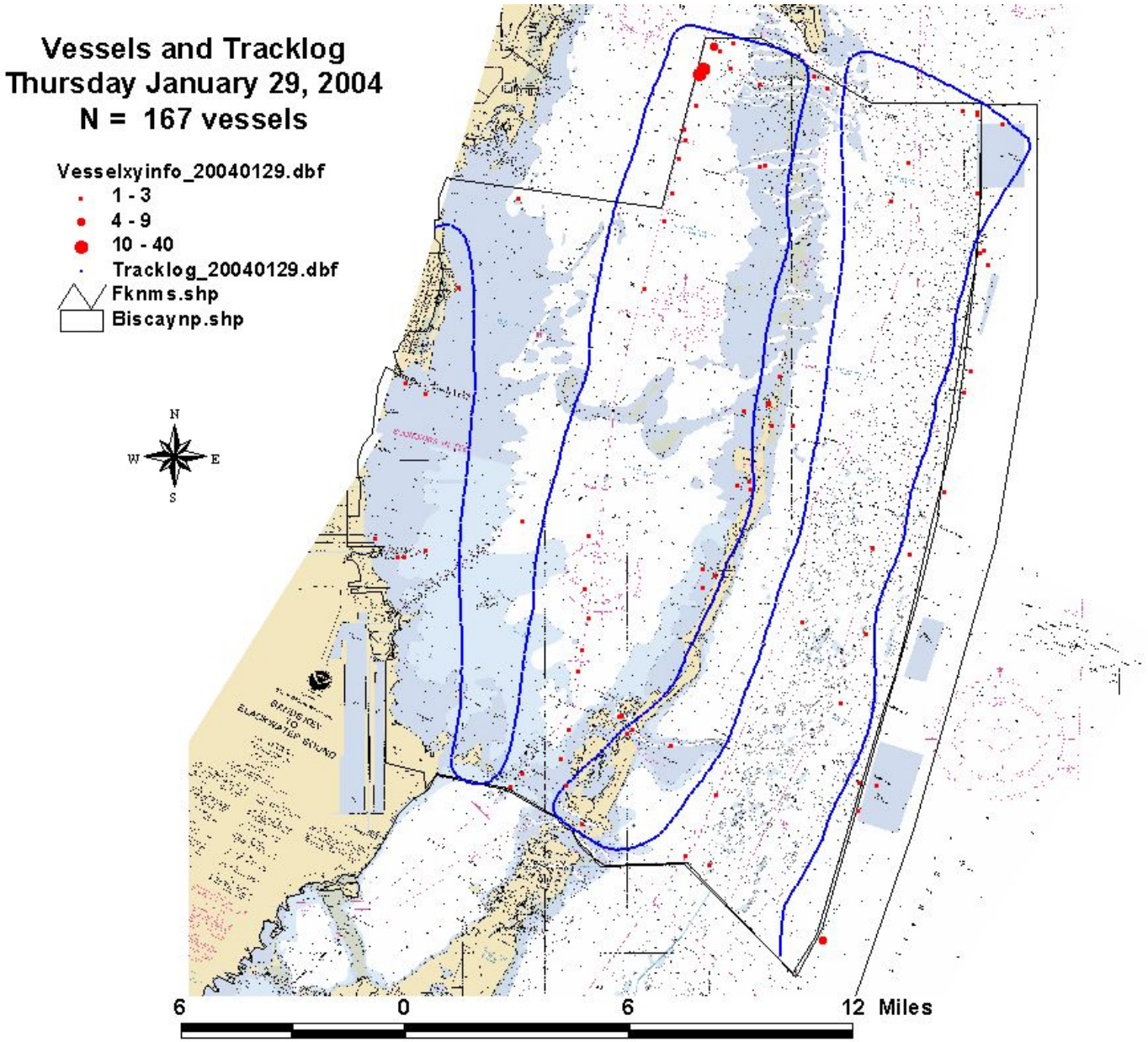
Appendix B4: Daily flight maps for winter 2004 aerial surveys.

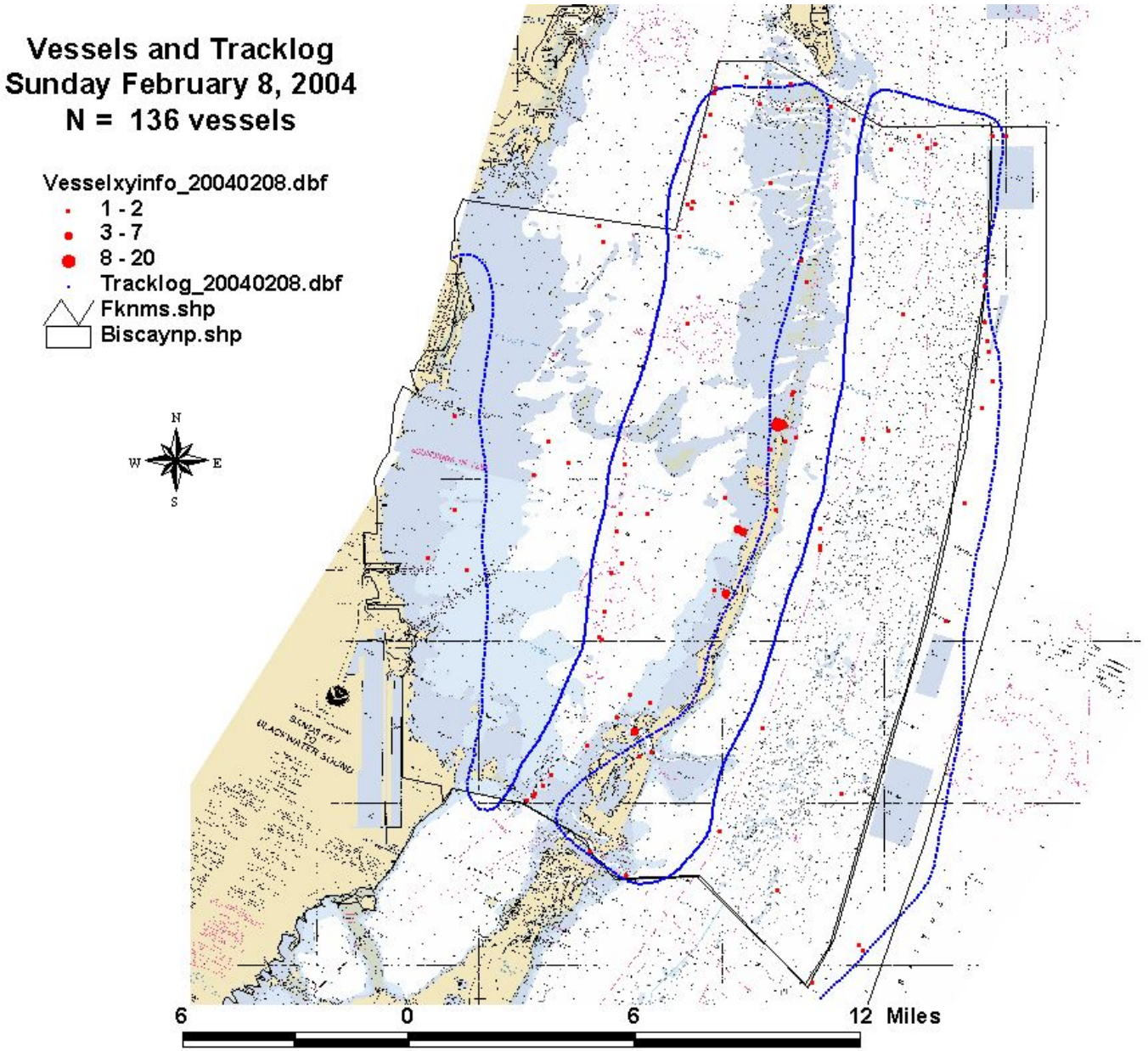

Vessels and Tracklog
Thursday January 8, 2004
N = 75 vessels
Vesselxyinfo_20040108.dbf
1 - 4
Tracklog_20040108.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

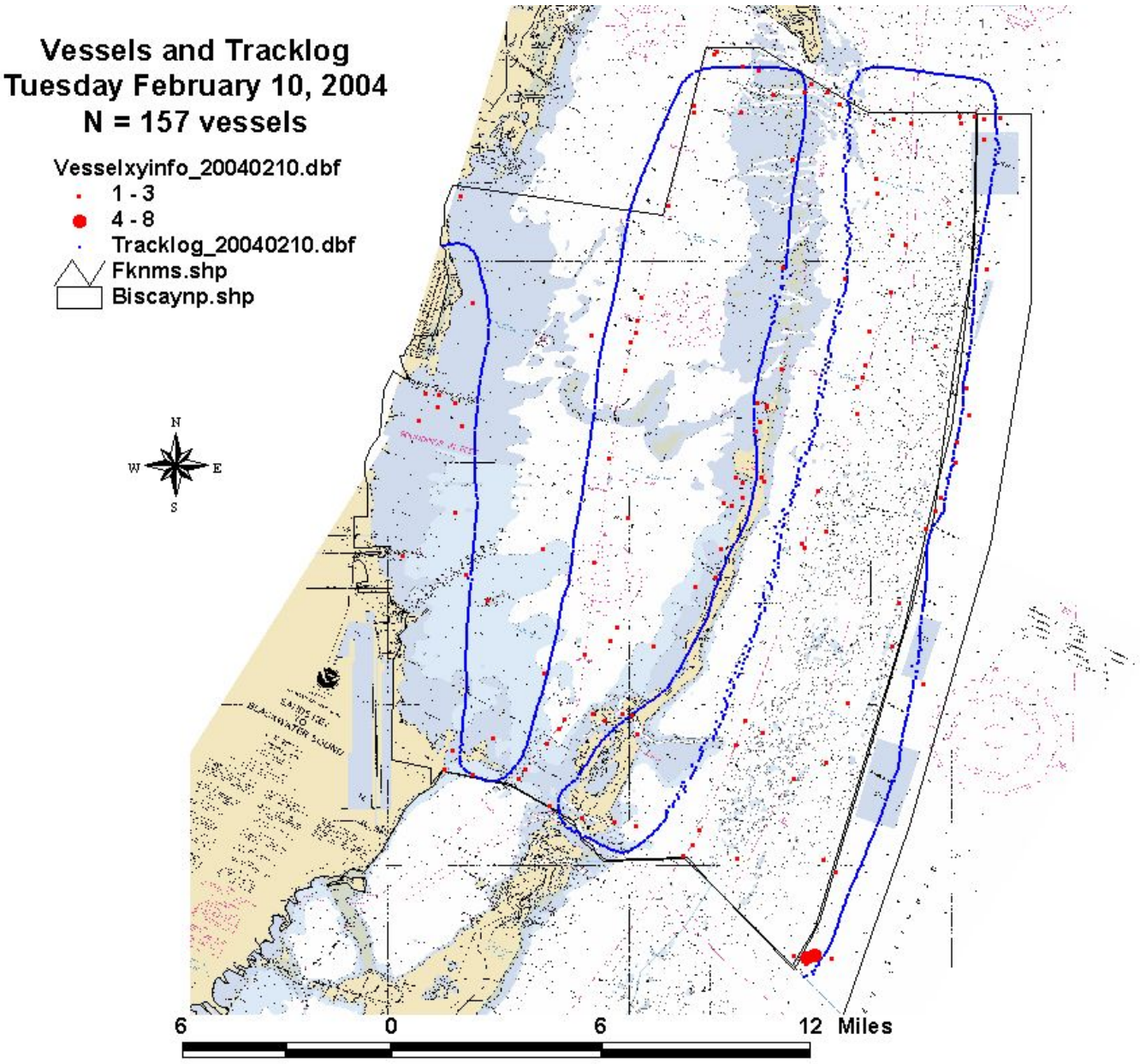

Vessels and Tracklog
Sunday January 11, 2004
N = 93 vessels
Vesselxyinfo_20040111.dbf
1 - 3
4 - 12
Tracklog_20040111.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

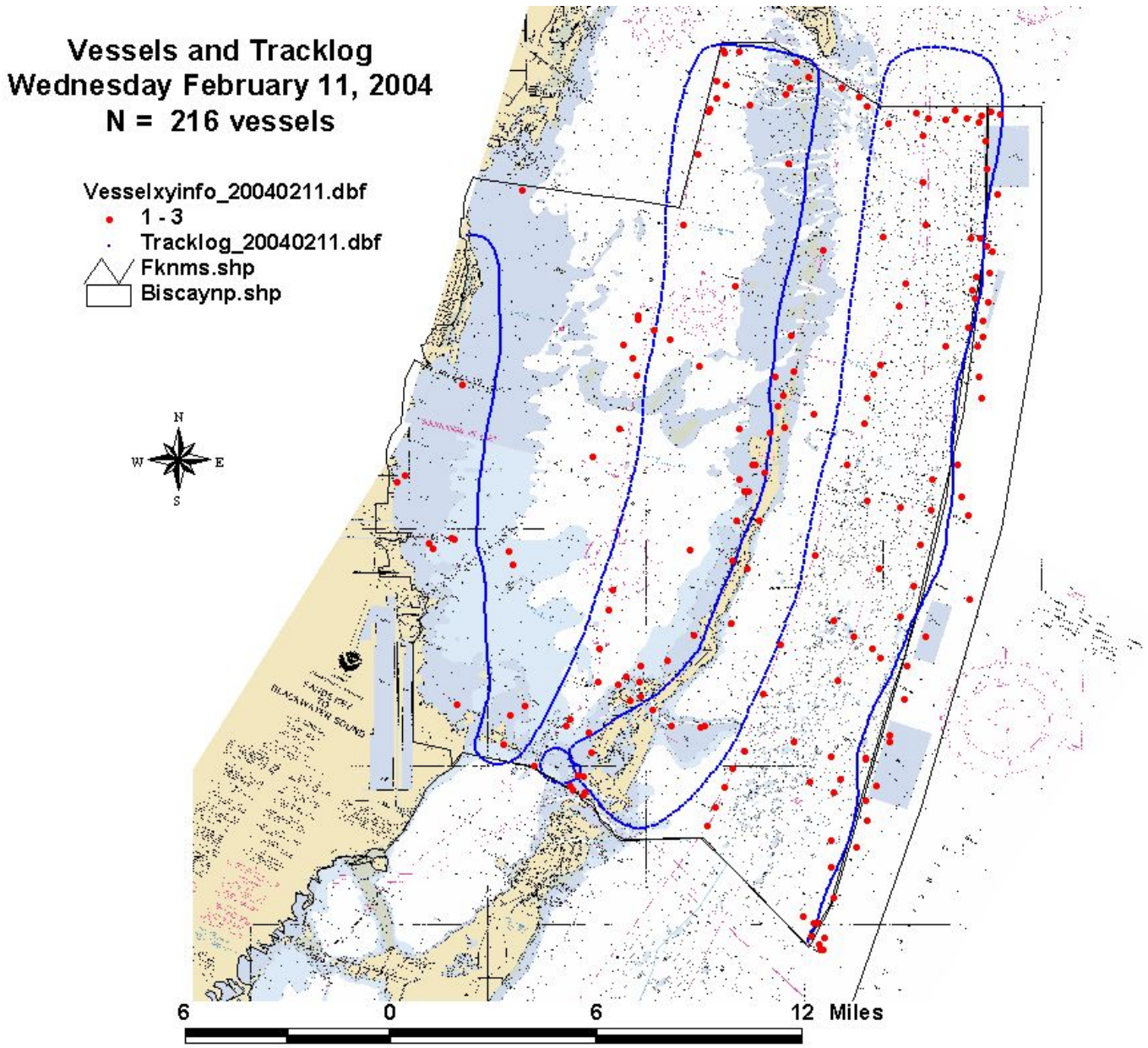

Vessels and Tracklog
Saturday January 17, 2004
N = 638 vessels
Vesselxyinfo_20040117.dbf
1 - 2
3 - 7
8 - 15
16 - 46
Tracklog_20040117.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

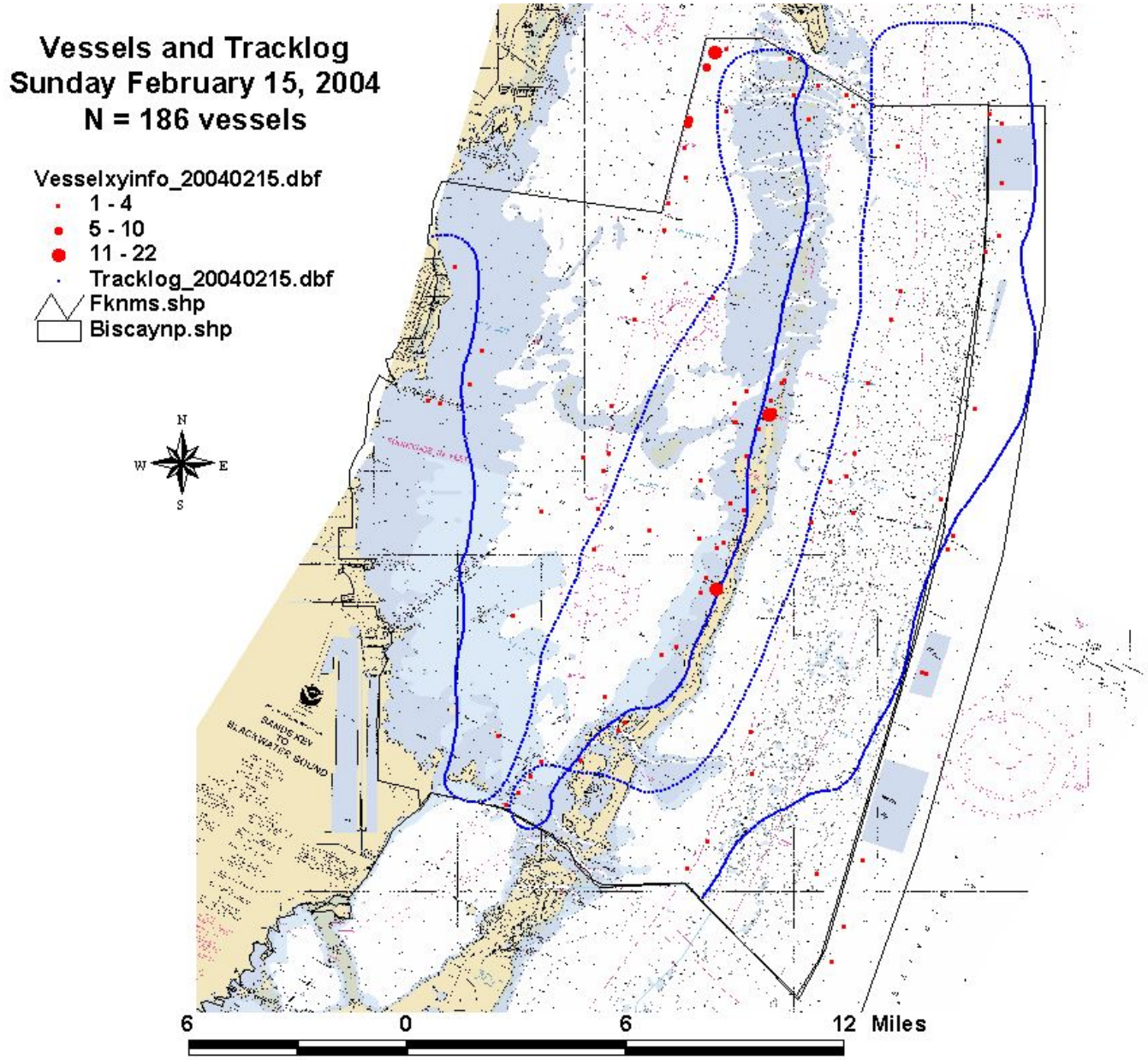

Vessels and Tracklog
Sunday January 25, 2004
N = 613 vessels
Vesselxyinfo_20040125.dbf
1 - 3
4 - 8
9 - 25
Tracklog_20040125.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles

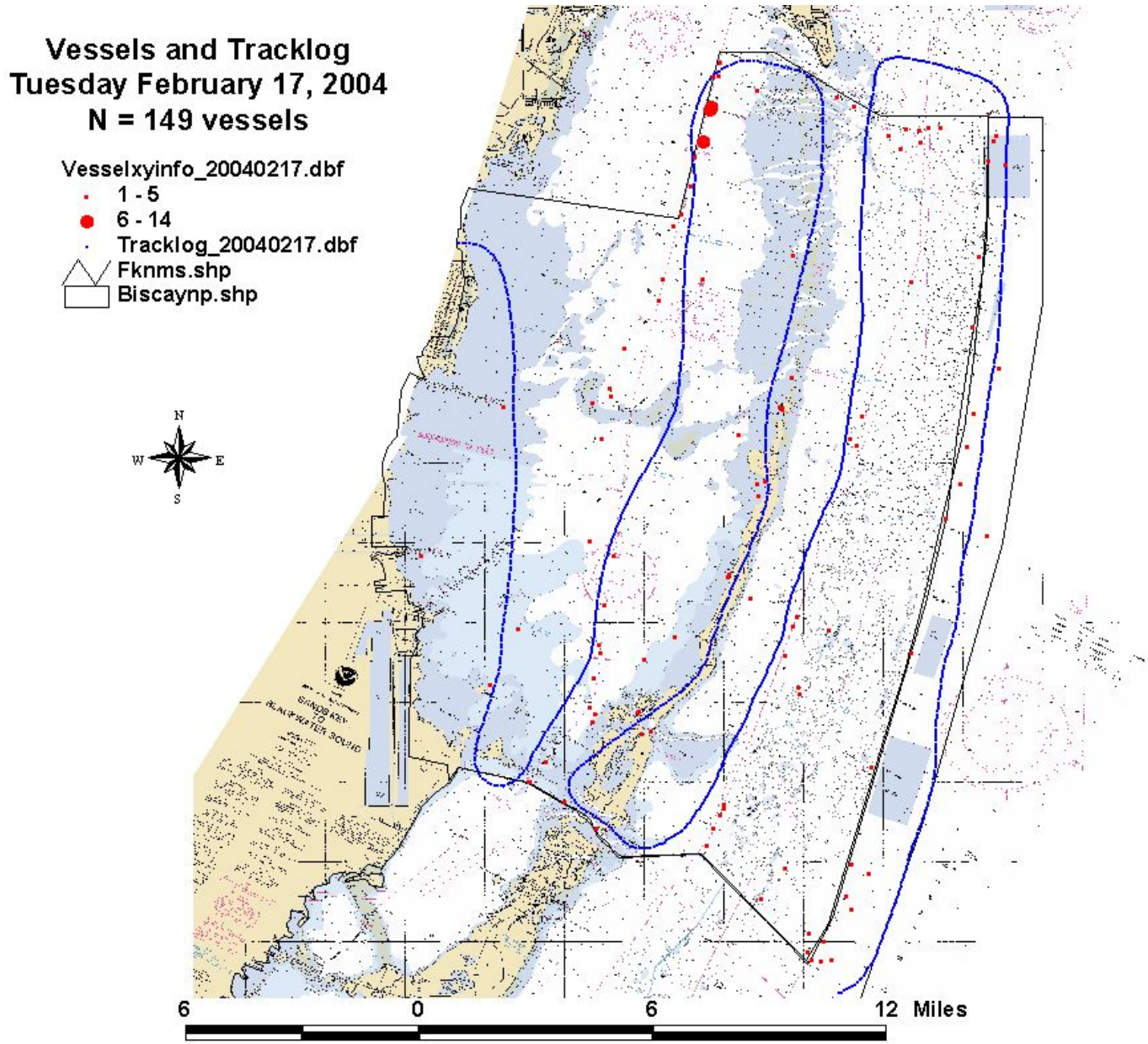

Vessels and Tracklog
Thursday January 29, 2004
N = 167 vessels
Vesselxyinfo_20040129.dbf
1 - 3
4 - 9
10 - 40
Tracklog_20040129.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles


Vessels and Tracklog
Sunday February 8, 2004
N = 136 vessels
Vesselxyinfo_20040208.dbf
1 - 2
3 - 7
8 - 20
Tracklog_20040208.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles


Vessels and Tracklog
Tuesday February 10, 2004
N = 157 vessels
Vesselxyinfo_20040210.dbf
1 - 3
4 - 8
Tracklog_20040210.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12
Miles


Vessels and Tracklog
Wednesday February 11, 2004
N = 216 vessels
Vesselxyinfo_20040211.dbf
1 - 3
Tracklog_20040211.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles


Vessels and Tracklog
Sunday February 15, 2004
N = 186 vessels
Vesselxyinfo_20040215.dbf
1 - 4
5 - 10
11 - 22
Tracklog_20040215.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
SANDS KEY TO BLACKWATER SOUND
6
0
6
12 Miles


Vessels and Tracklog
Tuesday February 17, 2004
N = 149 vessels
Vesselxyinfo_20040217.dbf
1 - 5
6 - 14
Tracklog_20040217.dbf
Fknms.shp
Biscaynp.shp
N
W
E
S
6
0
6
12 Miles