Factors Influencing Behavior in a Boating Speed Zone

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The greatest source of human-related mortality for endangered Florida manatees is collisions with watercraft. Regulation of boat speeds is the principal management tool to minimize this threat. Demands on law enforcement limit their ability to monitor boater behavior and managers seek alternative strategies to increase compliance. The purposes of this study were to: (1) explore the effectiveness of an on-site sign to enhance boater compliance in a boating speed zone, and (2) examine the environmental and boating characteristics that influence the probability of compliance. Signs designed to increase compliance were posted halfway through the 18-week study period. The signs were not related to compliance level. Logistic regression models showed that only time of day and boat type were significantly related to compliance. Results suggest that passive methods of persuasion may not be an effective means of influencing boater behavior.

Keywords boating, compliance, fear appeal, manatee, Trichechus manatus

Introduction

The Florida manatee (Trichechus manatus latirostris) was listed as endangered in 1967 (Udall, 1967) and subsequently protected under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.). Protection efforts have focused on reducing threats from anthropogenic sources, primarily morbidity and mortality from collisions with watercraft. Since 1976, an annual average of 24% (range = 11% to 33%) of recovered manatee carcasses were determined to be killed by collisions with watercraft (USFWS, 2001). The primary management strategy to reduce this threat has been to limit boat speeds in areas where manatees are most likely to occur. Since 1979, almost 300,000 acres of Florida’s coastal waters have been regulated by the state for manatee protection (Florida Fish and Wildlife
Concern that boaters have not been adhering to manatee speed zone regulations led to a number of boating studies investigating compliance, and compliance studies are currently included as an objective in the current revision of the manatee recovery plan (USFWS, 2001). As defined by Ridgeway (2000), compliance is a change in behavior toward a group standard to avoid punishment or receive a reward. Because an individual can conform to a standard without personally believing in it, compliance does not necessarily denote an enduring behavioral change. From these boating studies, we can conclude that a myriad of variables both within and between study sites are related to compliance. However, there are two general trends: personal watercraft (e.g., jet skis) tend to be the least compliant vessels (Gorzelany, 1996, 1998, 2000; Gorzelany, 2001; Shapiro, 2001; Tyson & Combs, 1999), and compliance tends to be positively correlated with vessel length (Gorzelany, 1998, 2001; Shapiro, 2001; Tyson & Coombs, 1999; but see Tyson, 2001). Other identified relationships between compliance and observed variables (e.g., direction of travel) tend to vary among sites (Shapiro, 2001).

Previous research on boating behavior in manatee speed zones indicates that the presence of law enforcement mediates compliance (Gorzelany, 1996, 1998, 2001; Shapiro, 2001; Tyson & Coombs, 1999). This was further supported by a survey of Florida boaters in the Tampa Bay region that asked respondents about variables influencing compliance (Aipanjiguly et al., 2003). However, demands on wildlife officers at the local, state, and federal levels as well as the widely dispersed locations of manatee zones around the state, preclude the officers’ ability to maintain a persistent presence in manatee zones. Thus, wildlife managers seek strategies to increase compliance without increasing the burden on law enforcement agencies.

The purpose of this study was twofold: to investigate the effect of an alternative method of increasing compliance and to examine covariates that may help law enforcement understand and predict noncompliance. First, we examined the effectiveness of a supplemental on-site sign with messages providing two possible consequences of noncompliance (i.e., being sanctioned and colliding with a manatee) as well as the proper coping mechanism to avoid these outcomes (i.e., slow down). Current regulatory signs serve simply to inform boaters about the rule in place. Research on persuasion shows that people are more likely to comply with rules when they are aware of the possible consequences of noncompliance (e.g., Gramann & Vander Stoep, 1987). We tested the following hypothesis:

\[ H_0: \] The presence of on-site signs is not related to compliance level in the boating speed zone.

\[ H_1: \] The presence of on-site signs is positively related to compliance level in the boating speed zone.

The focus was on increasing compliance above and beyond current levels achieved by the current management structure (i.e., the combination of regulatory signs and the status quo enforcement effort). We made the assumption that the effect of the persuasive messages could be observed behaviorally. Because of this assumption, we did not attempt to demonstrate causality; rather, we simply looked for an association between the on-site signs and behavior. Finally, the term on-site sign is used throughout the paper to indicate that the supplemental signs were posted for boaters at the entrance to and throughout the speed zone. This differs from other efforts to influence boater behavior that provide messages at kiosks or during interventions at public access areas (e.g., Flamm, 2003).
Second, we were interested in understanding whether external variables such as boat type or weather, for example, could aid law enforcement agencies in predicting noncompliance. This second purpose was largely exploratory and used a model-building rather than a hypothesis-testing approach.

**Background**

To examine the effect of the supplemental on-site sign we first identify the process by which we assume boaters interpret the information. This is important in that it influences the content and presentation of persuasive messages. Then, we discuss two elements included in the sign that should influence boater behavior above and beyond a regulatory sign which simply enumerates a rule.

Our approach was based on the elaboration likelihood model’s peripheral route to persuasion in which the recipient does not make an effort to weigh arguments but instead relies on simple cues to influence attitudes and behavior (Petty et al., 1992). Attitudes formed using this route tend to be less accessible, less persistent over time, and less resistant to change; however, they can be quite effective in influencing behavior in the short term. We chose this framework because the speed zones at either end of the manatee slow-speed zone assessed in this study permitted boats to travel at speeds up to 25 mph. Consequently, boaters were not likely to stop or cogitate about the messages presented to them at the zone’s entrance. Moreover, enduring behavioral change was not the objective of this study.

We incorporated a fear appeal into the research by communicating the potential for a large speeding fine. A fear appeal is a persuasive message that is designed to arouse anxiety or fear in an individual by depicting a significant, personally relevant threat (Witte, 1992; 1994). It has three components: fear, threat, and efficacy (Witte, 1992; 1994). Fear is a negative emotion associated with a high level of arousal and is elicited by a threat. A threat is an existing danger or harm in one’s environment. Perceived threat, the thoughts about the threat, has been identified as a key variable in persuasion attempts using fear appeals. Two underlying constructs comprise perceived threat: perceived severity is a person’s beliefs about the seriousness or noxiousness of the threat, and perceived susceptibility is a person’s beliefs about the probability of experiencing that threat. The third component of a fear appeal is efficacy. Response efficacy involves an individual’s belief that the recommended coping behavior effectively averts a threat. Self-efficacy is an individual’s belief that they can perform the recommended behavior to avert the threat. Strong fear appeals with high-efficacy messages result in the greatest amount of behavior change (Witte & Allen, 2000). Additionally, when efficacy is high, perceived threat mediates the relationship between fear and behavior (Witte, 1994).

Fear appeal research in the natural resource setting has focused mostly on depreciative behavior and has demonstrated effectiveness. Schwartzkopf (1984) found that a fear-appeal sign was four times as effective as no sign in reducing squirrel feeding. Martin (1992) found that pumice removal from Mount St. Helens National Monument decreased by 97% when a fear appeal indicating the sanction was posted. Johnson and Swearingen (1992) found that sanction signs reduced off-trail hiking by 75%. In a laboratory setting, Gramann, Bonifeld, and Kim (1995) showed that fear appeals were more effective than other messages in influencing participants’ rule-obedience intentions.

Finally, we utilized prosocial behavior theory to create the on-site sign, which is grounded in two propositions that people are more willing to “help” if they are aware of
the consequences of their behavior and/or when people feel responsible and qualified to “help” (Schwartz, 1977). Messages targeting the former proposition are called “awareness of consequences” (AC) messages. Those targeting the latter are called “ascription of responsibility” (AR) messages. Thus, the on-site sign was a combination fear-appeal and awareness-of-consequences that was designed to supplement the current regulatory waterway signs and persuade boaters to comply with the slow-speed designation.

Again, natural resource-related research in this area demonstrates that this approach can be effective. Schwartzkopf (1984) found that AC/AR messages were twice as effective at reducing squirrel feeding behavior than no sign. Johnson and Swearingen (1992) found that signs with an AC message reduced off-trail hiking by 52%. Martin (1992) found that AC/AR messages reduced pumice removal by visitors from Mount St. Helens National Monument by two-thirds. Moreover, this finding occurred in a context in which compliance was already high. Finally, in a laboratory experiment, Gramann, Bonifeld, and Kim (1995) found that AC/AR messages promoted rule obedience intentions; but they were more effective on high social-responsibility subjects.

Although fear appeals are often reported to be at least as effective as AC/AR messages, most authors recommend using the two approaches concomitantly. This is because people disregard rules for a number of reasons (Gramann & Vander Stoep 1987). Unintentional violations occur when an individual is unaware of rules prohibiting certain behavior. Releasor-cue violations occur when environmental cues reduce social inhibitions against an action. For example, a boat operator may speed if he/she notices other vessels are doing so. Uninformed violations are committed when an individual is not aware of the negative consequences of the noncompliant behavior. In other words, the actor may know that a rule exists but may not know the negative consequences that may occur to themselves, others, or the environment. Responsibility-denial violations occur when an individual feels that obeying the rule in a particular circumstance may seem unreasonable or impossible even if they support the norm in principle. Boaters speeding through manatee zones to avoid severe weather is an example of this. Status-confirming violations occur when an individual feels social pressure from an important referent group to violate a norm. Finally, willful violations occur when individuals are pursuing goals that are in fundamental conflict with resource protection. These violators are fully aware that their actions are wrong. This may occur in manatee zones when vessel operators believe that minimizing travel time is a priority. We expected to see a relationship between the on-site signs and compliance because the fear appeal and awareness of consequences message was expected to influence, at minimum, unintentional, releaser-cue, and uninformed violators.

Methods

Site Description

The Indian River North/Packwood Place, Oak Hill Area manatee slow-speed zone (Rule 68 C-22.012 (3)(a) 23, Florida Administrative Code) is 8.9 km long and located in the Atlantic Intracoastal Waterway between Edgewater and Oak Hill in Volusia County, Florida (Figure 1). A private fishing pier located approximately 0.75 km south of the northern end of the speed zone (28 56' 00'' N, 80 51' 59'' W) served as the observation site. The Intracoastal Waterway was relatively narrow, approximately 0.18 km wide, which facilitated observation. The main boating activity near the observation point was cruising but vessels occasionally stopped to fish.
To minimize variables and increase the validity of this research, the site met criteria relating to these areas: zone designation, traffic flow, ease of data collection, adequacy of regulatory waterway signs, and saliency to experts. First, the site was a year-round slow speed zone without a quantitative speed limit and the zone’s designation was not scheduled to change during the study period. Second, the channel was narrow enough so that traffic flowed predominantly in two directions, thereby minimizing the probability of boaters entering the zone without passing regulatory waterway signs. Also, the on-site signs were posted adjacent to the regulatory signs so that boaters passed within reading distance of at least one on-site sign. Third, the distance from the shoreline to the boat-use area was close enough to allow observers to view boat registration numbers with binoculars. Fourth, the regulatory waterway signs were adequately posted and relatively easy for boaters to
see as they entered the speed zone. Fifth, the site was identified as an area of concern for watercraft-related manatee mortality (C. Shaw and J. Valade, U.S. Fish and Wildlife Service pers. comm.), and was in an area considered by Florida Fish and Wildlife Conservation Commission law enforcement to have relatively poor levels of compliance (Audrey Zahn, Florida Fish and Wildlife Conservation Commission Officer, pers. comm.).

**On-Site Sign Design**

The on-site signs used in this study read “WATCH YOUR SPEED” across the top and “MAX FINE $500” across the bottom (Figure 2). The middle contained an image of a manatee in front of light blue streaks used to indicate that the animal is near the surface of the water. Sign messages were created based on a literature review as well as regulations and guidance provided by the U.S. Fish and Wildlife Service, the U.S. Coast Guard, and the Florida Fish and Wildlife Conservation Commission’s Office of Boating and Waterways.

Fines for speeding in manatee zones range from approximately $60 in county jurisdictions to a maximum of $25,000 and jail time in federal zones. Therefore, we chose to use the possible federal fine of $500 as a sufficiently “noxious” yet realistic threat in the fear appeal message (see Witte, 1992). “WATCH YOUR SPEED” was used as the recommended coping behavior instead of “SLOW DOWN” because the latter language is reserved solely for regulatory waterway signs (Tara Alford, Florida Fish and Wildlife Conservation Commission Office of Boating and Waterways, pers. communication). The image of the manatee served as an implied “awareness of consequences” message, providing the vessel operator with a visual illustration of the reason for the regulation: manatees are

![Figure 2. The fear-appeal sign tested in this study.](image-url)
injured or killed by collisions with fast-moving watercraft. In addition, it increased the on-site sign’s attractiveness and thus the probability of its being read.

We followed regulations governing regulatory waterway signs to create the sign (Florida Administrative Code 68D-23.108 and 68 D-23.109). Sign shape was restricted to a square or rectangle and could not be smaller than 3 feet by 3 feet (we used a 3-foot by 4-foot sign). Although we were able to use light blue to indicate water and gray for the manatee, the sign had to have a predominantly white background with an “international orange” border not less than 2 inches wide. The color of the sign text was limited to black. We engaged the services of a graphic designer to create a professional sign that incorporated our theoretical constructs, considered graphic-design principles, and remained within the bounds of regulatory constraints. The on-site signs were posted below regulatory waterway signs.

**Data Collection**

Sampling took place over 18 weeks between September 28, 2002 and February 9, 2003. Halfway through the study, December 8, 2002, six on-site signs were posted adjacent to regulatory waterway signs throughout the manatee speed zone so that all boats traveling past the observation point had an opportunity to see at least one sign. Previous research demonstrates that most recreational boating occurs on weekends (Gorzelany, 1998) so vessel passes were recorded on Saturday and Sunday every week for six hours each day, from 0815 h to 1115 h and 1215 h to 1515 h.

Compliance was measured qualitatively by comparing the speed of vessels passing through the slow speed zone to the qualitative definitions of speed defined by Gorzelany (2004). A vessel was considered compliant if it was operating at slow speed, fully settled in the water with minimum wake; technically noncompliant if the vessel was plowing (i.e., the vessel’s bow was elevated with significant wake from bow and stern); and blatantly noncompliant if the vessel was on plane (i.e., traveling fast enough to raise the boat out of the water). For watercraft with a nonplaning hull, blatant noncompliance was assigned to fast-moving vessels with considerable wake.

Nearby landmarks served as boundaries for a 0.40-km-long extent of the manatee slow-speed zone that served as the observation area for boater behavior. Environmental data were collected at the beginning of the morning and afternoon observation sessions and as weather conditions changed. Boat-related data were collected once a vessel entered the observation area. The following variables were recorded for all vessels entering the observation area: time of observation, vessel type (see Table 1), vessel length, direction of travel, vessel speed, and presence or absence of law enforcement. Additionally, recording vessel registration numbers and/or name and hailing ports allowed us to keep track of unique vessels. For vessels that traveled at multiple speeds during a single pass through the observation area, the fastest speed was recorded. Because the boat-speed definitions were qualitative, when clear distinctions between boat speeds were not clear, the slower (i.e., more compliant) speed was selected.

**Data Reduction**

First, outliers were removed based on expert opinion. Second, two-way chi-square tests were conducted to determine dependencies between observed environmental factors and compliance. Because this technique did not address the lack of independence within the nontreatment and treatment data, we conducted chi-square tests ($\alpha = 0.05$) for pretreatment and treatment observations separately. Additionally, to avoid bias, we used only the
Table 1  
Description of boat types observed in this study (initially defined by Gorzelany (1992)).

<table>
<thead>
<tr>
<th>Boat Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabin cruiser ($n = 70$)$^a$</td>
<td>Vessels less than 26 feet in length and identified by a small window in the bow, indicating a cuddy cabin.</td>
</tr>
<tr>
<td>Jon boat ($n = 64$)$^a$</td>
<td>These boats include the majority of the small, open skiffs and aluminum boats that are operated from the rear via a tiller. They usually have small engines (35 hp or less).</td>
</tr>
<tr>
<td>Open fisherman ($n = 347$)$^a$</td>
<td>One of the most common vessels that are encountered. “Open” refers to the very small amount of enclosed space on board and extensive walk-around space around a center console. People frequently operate these boats from a standing position in the center of the vessel. The overall style and function are of a multipurpose/fishing boat.</td>
</tr>
<tr>
<td>Pontoon boat ($n = 127$)$^a$</td>
<td>This has a deck sitting atop a pair of aluminum pontoons, with an outboard engine in the rear.</td>
</tr>
<tr>
<td>Runabout ($n = 119$)$^a$</td>
<td>Similar to the open fisherman and cabin cruiser, the orientation of the driving position is similar to that of an automobile. They generally have a front windshield and a driver’s seat at the forward end. They do not have as much open, walk-around deck space as an open fisherman does and are designed more for pleasure, water sports, or recreational boating.</td>
</tr>
<tr>
<td>Sailboat ($n = 256$)$^a$</td>
<td>This category includes vessels that are propelled partly or wholly by a sail.</td>
</tr>
<tr>
<td>Yacht ($n = 413$)$^a$</td>
<td>Vessels 26 feet or longer, characterized by their enclosed space for sleeping, eating, and longer travels. Deck and/or open space are usually reduced in favor of the enclosed area.</td>
</tr>
</tbody>
</table>

$^a$Sample size based on the first observation of uniquely identified vessels. Similar recreational boat types were grouped into a “runabout” category to enhance data analysis. The “Yacht/Cabin cruiser” category was divided into two separate categories to capture possible behavioral differences between small and large vessels.

first observation of each unique vessel. If a vessel was observed multiple times in the pretreatment and treatment, the first observation in each treatment period was used. A multiple correspondence analysis was used to reduce the dataset further.

Data Analysis

To understand how well boat characteristics and weather variables could predict compliance rates we chose a logistic formulation

\[ P_i = \frac{1}{1 + e^{-\beta x_i}} \]
Table 2

Contingency table comparing pretreatment and treatment compliance frequencies.

<table>
<thead>
<tr>
<th></th>
<th>Pretreatment</th>
<th>Treatment</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliant</td>
<td>548</td>
<td>273</td>
<td>821</td>
</tr>
<tr>
<td>Technically noncompliant</td>
<td>313</td>
<td>129</td>
<td>442</td>
</tr>
<tr>
<td>Blatantly noncompliant</td>
<td>83</td>
<td>50</td>
<td>133</td>
</tr>
<tr>
<td>Totals</td>
<td>944</td>
<td>452</td>
<td>1396</td>
</tr>
</tbody>
</table>

$X^2 = 3.9967$, d.f. = 2, $p = 0.1356$.

Where for each individual $i$, $P_i$ is the probability that this individual is compliant or blatantly noncompliant, $x_i$ is the vector of explanatory variables that define the individual, and $\beta$ is the regression parameter to be estimated.

We ran separate binary models for the pretreatment and treatment data. In the first model, technically noncompliant was merged with blatantly noncompliant. This model was analogous to estimating probabilities for compliance. The second model combined compliant with technically noncompliant, which was analogous to estimating probabilities for blatant noncompliance.

Results

Effect of Signs on Boater Behavior

During the pretreatment, 1170 vessel passes were recorded and 636 vessel passes were observed during the treatment. The overall compliance rate decreased from 61% to 58% after the signs were posted. Technical noncompliance decreased from 30% to 28%, while blatant noncompliance increased from 8% to 14%. Law enforcement was present during 2.9% of the overall observation time. A chi-square test compared boater behavior between the pretreatment and treatment periods (Table 2). To meet the assumptions of the chi-square test, only the first observation of uniquely-identified vessels were used ($N_{\text{pretreatment}} = 944$, $N_{\text{treatment}} = 452$). We did not reject the null hypothesis and concluded no relationship between the on-site signs and compliance levels between the pretreatment and treatment ($X^2 = 4.00$, $df = 2$, $p = 0.14$).

Factors Affecting Boater Behavior

Given that the on-site signs were not related to compliance, we examined the data in detail to identify more subtle dependencies between boating, environmental characteristics, and boater compliance using methods similar to Gorzelany (2004). Table 3 shows the results of the chi-square tests comparing observed independent variables to compliance; and, wind speed and direction were removed from further analysis. Based on the multiple correspondence analysis, sea state was dropped (Figures 3 and 4). Boat length and boat type were highly correlated, so we removed boat length from the model, leaving boat type. The other remaining variable was sample window: morning (AM) or afternoon (PM).
Table 3
Chi-square statistics testing for dependencies between explanatory variables and compliance levels for pretreatment and treatment observations. Only the first observation of vessels were used for those boats observed more than once

<table>
<thead>
<tr>
<th>Contingency table</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>X²</td>
</tr>
<tr>
<td>Boat type vs. compliance</td>
<td>12</td>
<td>104.3072</td>
</tr>
<tr>
<td>Boat length vs. compliance</td>
<td>6</td>
<td>34.6382</td>
</tr>
<tr>
<td>Window vs. compliance</td>
<td>2</td>
<td>5.7124</td>
</tr>
<tr>
<td>Wind speed vs. compliance</td>
<td>4</td>
<td>7.4680</td>
</tr>
<tr>
<td>Sea state vs. compliance</td>
<td>2</td>
<td>11.4410</td>
</tr>
<tr>
<td>Wind direction vs. compliance</td>
<td>14</td>
<td>45.0630</td>
</tr>
</tbody>
</table>

Pretreatment Model: Compliant
In the pretreatment compliant model, technically and blatantly noncompliant boats were combined and compared to compliant boats. The convergence criterion was satisfied and we rejected the null hypothesis and concluded that the boat-type coefficient was not zero and that there was a dependency between boat type and compliance. However, the predictive ability of the model was poor (pseudo $R^2 = 0.0430$). Maximum likelihood estimates showed evidence that jon boats were least compliant, and runabouts and sailboats were most compliant. Open fishermen were weakly associated with being compliant. Cabin cruisers, pontoon boats, and yachts were not significantly associated with compliance.

Figure 3. Multiple correspondence analysis of boat type, boat length, time window, and sea state variables before on-site signs were posted. Boat type abbreviations: CC = Cabin cruiser, RU = Runabout, PT = Pontoon boat, OF = Open fisherman, SA = Sailboat, YT = Yacht, JN = Jon boat. Boat length abbreviations: 12 = less than 16 feet; 16 = 16 to 25 feet; 26 = 26 to 39 feet, 40 = greater than 40 feet. Time window abbreviations: AM = Morning, PM = Afternoon. Sea state abbreviations: 0 = less than 1 foot, 1 = 1 to 2 feet.
Fig. 4. Multiple correspondence analysis of boat type, boat length, time window, and sea state variables after on-site signs were posted. Boat type abbreviations: CC = Cabin cruiser, RU = Runabout, PT = Pontoon boat, OF = Open fisherman, SA = Sailboat, YT = Yacht, JN = Jon boat. Boat length abbreviations: 12 = less than 16 feet; 16 = 16 to 25 feet; 26 = 26 to 39 feet; 40 = greater than 40 feet. Time window abbreviations: AM = Morning, PM = Afternoon. Sea state abbreviations: 0 = less than 1 foot, 1 = 1 to 2 feet.

Rerunning the model without the cabin cruiser, pontoon, and yacht categories of boat type improved the fit (AIC intercept and covariates decreased from 1256.636 to 686.530, and SC intercept and covariates decreased from 1290.587 to 703.652) but changed the predictive power only slightly (pseudo $R^2 = 0.0450$). The probabilities of compliance for each boat type are shown in Table 4a.

**Pretreatment Model: Blatantly Noncompliant**

In the pretreatment blatantly noncompliant model, compliant and technically noncompliant vessels were combined and compared to blatantly noncompliant vessels. The convergence criterion was satisfied, and we rejected the null hypothesis and concluded that the boat-type coefficient was not zero ($p < 0.0001$). The fit of this version of the model was much better than the pretreatment compliant model; however, the model’s predictability was still poor (pseudo $R^2 = 0.0653$; Table 4b). Maximum likelihood estimates showed that sailboats were more compliant than the other vessels. Jon boats were the most noncompliant. Open fisherman and pontoon boats tended to be less compliant whereas runabouts tended to be slightly more compliant. Cabin cruisers and yachts were not significantly associated with compliance. Rerunning the model without the cabin cruiser and yacht categories of boat type improved the fit (AIC intercept and covariates decreased from 512.330 to 245.631 and SC intercept and covariates decreased from 546.281 to 263.911) but changed the predictive power only slightly (pseudo $R^2 = 0.0673$). The probabilities of compliance for each boat type are shown in Table 4.

**Treatment Model: Compliant**

In the treatment model for compliant vessels, the convergence criterion was satisfied, and we rejected the null hypothesis and concluded that the window coefficient was not zero ($p < 0.0011$). The hypothesis of a nonzero coefficient for boat type was statistically marginal.
Table 4
Analysis of maximum likelihood estimates derived from the binary logistic models of boat type versus compliance level

<table>
<thead>
<tr>
<th>a. Pretreatment, Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat type</td>
</tr>
<tr>
<td>Interception</td>
</tr>
<tr>
<td>Cabin cruiser</td>
</tr>
<tr>
<td>Jon boat</td>
</tr>
<tr>
<td>Open fisherman</td>
</tr>
<tr>
<td>Pontoon</td>
</tr>
<tr>
<td>Runabout</td>
</tr>
<tr>
<td>Sailboat</td>
</tr>
<tr>
<td>Yacht</td>
</tr>
</tbody>
</table>

AIC intercept and covariates = 1256.636.
SC intercept and covariates = 1290.587.
R² = 0.0430.

b. Pretreatment, Blatantly Noncompliant

| Boat type | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chi-square |
| Interception | 1 | 2.5605 | 0.1975 | 168.0186 | <.0001 |
| Cabin cruiser | 1 | −0.2092 | 0.4844 | 0.1865 | 0.6659 |
| Jon boat | 1 | −2.0265 | 0.3251 | 38.8622 | <.0001 |
| Open fisherman | 1 | −0.6146 | 0.2592 | 5.6240 | 0.0177 |
| Pontoon | 1 | −0.7435 | 0.3208 | 5.3718 | 0.0205 |
| Runabout | 1 | 0.8841 | 0.5336 | 2.7456 | 0.0975 |
| Sailboat | 1 | 2.5014 | 0.8703 | 8.2615 | 0.0040 |
| Yacht | 1 | 0.0434 | 36.6347 | 0.0000 | 0.9991 |

AIC intercept and covariates = 512.330.
SC intercept and covariates = 546.281.
R² = 0.0653.

c. Treatment, Compliant

| Boat type | DF | Estimate | Standard Error | Wald Chi-square | Pr > Chi-square |
| Interception | 1 | 0.3086 | 0.1338 | 5.3243 | 0.0210 |
| Cabin cruiser | 1 | 0.0420 | 0.3847 | 0.0119 | 0.9131 |
| Jon boat | 1 | −0.4987 | 0.4254 | 1.3740 | 0.2411 |
| Open fisherman | 1 | −0.1140 | 0.2086 | 0.2988 | 0.5846 |
| Pontoon | 1 | −0.5505 | 0.3230 | 2.9039 | 0.0884 |
| Runabout | 1 | 0.2822 | 0.4135 | 0.4658 | 0.4949 |
| Sailboat | 1 | 0.6233 | 0.2386 | 6.8225 | 0.0090 |
| Yacht | 1 | 0.2157 | 0.2030 | 1.1294 | 0.2879 |
| Afternoon | 1 | 0.3377 | 0.1039 | 10.5698 | 0.0011 |

AIC intercept and covariates = 603.948.
SC intercept and covariates = 636.858.
R² = 0.0411.
Boater Behavior in Speed Zones 369

Table 4
Analysis of maximum likelihood estimates derived from the binary logistic models of boat type versus compliance level (Continued)

d. Treatment, Blatantly Noncompliant

<table>
<thead>
<tr>
<th>Boat type</th>
<th>DF</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Wald Chi-square</th>
<th>Pr &gt; Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>2.0458</td>
<td>0.2095</td>
<td>95.3910</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cabin cruiser</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Jon boat</td>
<td>1</td>
<td>−1.3527</td>
<td>0.4588</td>
<td>8.6903</td>
<td>0.0032</td>
</tr>
<tr>
<td>Open fisherman</td>
<td>1</td>
<td>−0.8643</td>
<td>0.2759</td>
<td>9.8108</td>
<td>0.0017</td>
</tr>
<tr>
<td>Pontoon</td>
<td>1</td>
<td>−0.6959</td>
<td>0.4047</td>
<td>2.9562</td>
<td>0.0855</td>
</tr>
<tr>
<td>Runabout</td>
<td>1</td>
<td>0.2568</td>
<td>0.6407</td>
<td>1.606</td>
<td>0.6886</td>
</tr>
<tr>
<td>Sailboat</td>
<td>1</td>
<td>0.8665</td>
<td>0.4295</td>
<td>4.0709</td>
<td>0.0436</td>
</tr>
<tr>
<td>Yacht</td>
<td>1</td>
<td>1.7895</td>
<td>0.5204</td>
<td>11.8266</td>
<td>0.0006</td>
</tr>
</tbody>
</table>

AIC intercept and covariates = 276.711
SC intercept and covariates = 301.066
R² = 0.0995

(p = 0.0701) but was not deleted from subsequent analysis. The fit of the model was better than in the pretreatment mode; however, the predictive ability of the model was still poor (pseudo R² = 0.0411; Table 4c). Maximum likelihood estimates showed that there was evidence that sailboats were more compliant than the other vessels, and pontoon boats were weakly associated with greater noncompliance. The remaining vessel types had no significant association. The afternoon sampling window had a strong association with compliance, whereas the morning sampling window was associated more toward noncompliance. Rerunning the model with sailboats, runabouts, and sampling window improved the fit (AIC intercept and covariates decreased from 603.948 to 151.076, and SC intercept and covariates decreased from 636.858 to 159.413) but reduced the predictive power slightly (pseudo R² = 0.0203). The probabilities of compliance for each boat type are shown in Table 5.

Treatment Model: Blatantly Noncompliant

In the treatment model for blatant noncompliance, the convergence criterion was not satisfied. No blatantly noncompliant cabin cruisers were observed and this resulted in a null set in the blatant noncompliant category and consequently a model that did not converge. We reran the model without cabin cruisers and the convergence criterion was satisfied. However, we could not reject the null hypothesis that the window coefficient was not zero (p < 0.3306). Therefore, we reran the model with boat type only. The model converged and the hypothesis for a zero coefficient for boat type was rejected (p = 0.0001). The fit of the model was better than the analogous pretreatment model; however, the predictive ability of the model remained poor (pseudo R² = 0.0995; Table 4d). Maximum likelihood estimates showed that there was evidence that sailboats and yachts were more compliant than the other vessels. Pontoon boats were weakly associated toward more noncompliance. Jon boats and open fisherman vessels tended to be noncompliant. Runabouts had no significant
Table 5

Probabilities of compliance by boat type for pretreatment and treatment observations

<table>
<thead>
<tr>
<th>Boat types</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compliant</td>
<td></td>
<td>Blatantly Non-compliant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AM</td>
<td>PM</td>
<td>AM</td>
<td>PM</td>
</tr>
<tr>
<td>Cabin cruiser</td>
<td>0.58696</td>
<td>0.66559</td>
<td>0.08696</td>
<td></td>
</tr>
<tr>
<td>Jonboat</td>
<td>0.30436</td>
<td>0.53684</td>
<td>0.36957</td>
<td>0.33333</td>
</tr>
<tr>
<td>Open fisherman</td>
<td>0.62931</td>
<td>0.63002</td>
<td>0.12500</td>
<td>0.23478</td>
</tr>
<tr>
<td>Pontoon</td>
<td>0.58065</td>
<td>0.52394</td>
<td>0.13978</td>
<td>0.20588</td>
</tr>
<tr>
<td>Runabout</td>
<td>0.67009</td>
<td>0.71678</td>
<td>0.03093</td>
<td>0.09091</td>
</tr>
<tr>
<td>Sailboat</td>
<td>0.70435</td>
<td>0.78067</td>
<td>0.00629</td>
<td>0.05155</td>
</tr>
<tr>
<td>Yacht</td>
<td>0.47971</td>
<td>0.70308</td>
<td>0.05904</td>
<td>0.02114</td>
</tr>
</tbody>
</table>

*No vessels were observed in this category.

Discussion

This study showed that an on-site sign incorporating a fear appeal message was not related to compliance during the nine-week treatment period. Blatant noncompliance actually increased four percent after these signs were posted. Although there is no evidence to suggest that this increase in blatant noncompliance was due to the signs, fear appeals sometimes can lead to reactance in individuals. Reactance occurs when a message causes an individual to perceive a decrease in their personal freedom and results in a behavioral response involving an increase in the current noncompliant behavior (Witte, 1992). We believe that reactance could have occurred with some of the boaters, but that it is equally likely that most boaters did not notice the signs nor were they influenced by their message. This idea is supported by the statistically nonsignificant chi-square result in Table 2. Additionally, other variables related to the persuasion context, including source, receiver, channel, message, and situational factors, may have influenced the sign’s effectiveness (see Ajzen, 1992); however, these factors were not measured in this study.

Some of our results were similar to Gorzelany (2004). Jon boats, the smallest of the powered vessels, had a low level of compliance, but they represented only a small percentage of vessel passes in the study. Sailboats were the most compliant vessels. This was expected because sailboat hulls are not designed for motorized performance and therefore do not
move through the water in the same way that powerboats do. Results for yachts, cabin cruisers, open fisherman vessels, and runabouts were mixed.

Although we identified some relationships similar to those reported by Gorzelany (2004), we were able to examine compliance in more detail because we collected registration numbers from the observed vessels. The unique vessel numbers allowed us to distinguish vessels from each other. By using a single observation of each unique vessel we were able to preserve the assumption of independent observations and avoid bias created by having a few vessels represented by many observations (Siegel & Castellan, 1988). Additionally, the logistic approach provides more insight and paints a slightly different picture by not only identifying relationships but by also creating a model to understand how the relationships are related to behavior. As illustrated by the fair to weak-fitting models, variables such as boat type, although significantly related to compliance, do not account for much variation in either model.

Enhancing compliance in speed zones is largely an issue of persuading boaters to slow down. Persuasion relies mostly on an individual receiving a message, processing it, and choosing the appropriate behavior. Although extrinsic factors may be related to an individual’s proclivity for persuasion, compliance is ultimately a decision made by the boat’s operator. Our research reinforces previous studies reporting that compliance cannot be consistently correlated with other observed variables (e.g., Shapiro, 2001). Thus, a behavioral-analysis approach may be useful for looking at on-site compliance rates; but, it is not, by itself, a useful tool for explaining compliance because it focuses on the boat rather than the boater. Future research should consider both the behavioral and social psychological factors associated with compliance. A few studies have asked boaters about travel patterns (e.g., Sidman & Flamm, 2001; Sidman et al., 2004), and others have begun to delineate factors influencing compliance. The method used by Aipanjiguly et al. (2003) and Flamm (2003) incorporates both behavioral analysis and follow-up phone surveys to better understand the link between attitudes, knowledge, and behavior of boaters in Florida. Future studies are also using this approach to understand the influence of education and regulation on boater behavior in manatee speed zones. By shifting the unit of analysis from the boat to the boater, managers will be able to better seek alternative means of influencing boater behavior.

Explaining compliance is not easy, as is evidenced by the related literature on compliance in roadway construction zones, which lack silver-bullet solutions that do not involve the presence of law enforcement (e.g., Garber and Srinivasan, 1998; Ullman et al., 1999; Maze et al., 2000). Additionally, although some research on wildlife-vehicle collisions examines attempts to modify human behavior (Messmer et al., 2000; Gordon et al., 2001; Al-Ghamdi and AlGadhi, 2004), the literature has a much stronger emphasis on spatial separation (e.g., Clevenger and Waltho, 2000; Romin and Bissonette, 1996; Farrell et al., 2002). Aside from no-entry zones for boats, spatial design approaches to minimize collisions between manatees and watercraft are difficult due to the nature of the marine environment. Whereas automobiles are restricted to roadways, watercraft can access any portion of the coastal waters that their vessel’s draft permits. Furthermore, there is a vertical dimension added in the marine environment; manatees commonly use the area just below the “road” surface. This sharing of space leads to increased risk of collisions between boats and manatees. Analogous design problems likely are encountered on roadways, for example, when attempting to reduce avian–vehicle collisions.

Improving compliance on the water will likely require approaches more dynamic than simply the strategic placement of supplemental on-site signs. For example, Maze et al. (2000) reviewed studies examining the effectiveness of different techniques to reduce
speeding in highway construction zones. The most effective fear appeal technique assessed was the speed monitoring display, which posted to motorists’ speeds as they passed. Another type of fear appeal indicates the presence of enforcement when none actually exists. For example, strategically placed, empty police cars create the impression that law enforcement is present. The effectiveness of this technique is enhanced when these “dummy” cars are randomly replaced with actual law enforcement officers. Finally, another approach similar to “dummy” cars is to establish time and space halo effects (Rothengatter, 1982). Halo effects come about when motorists have seen or experienced law enforcement activity along a roadway. A memory persists that there is a risk of law enforcement presence and affected motorists slow down repeatedly when they pass through the area. Adapting these techniques to the marine environment may not be straightforward but provide a basis for designing more effective behavioral interventions.

References

Boater Behavior in Speed Zones


