

An assessment of the behaviors of overwintering manatees as influenced by interactions with tourists at two sites in central Florida

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Abstract

We used a combination of focal animal and scan samples over the course of two winter seasons to assess behavioral patterns of manatees as a function of the presence and activities of recreational swimmers and boats in and around Crystal River National Wildlife Refuge, Florida. The nature and outcome of human–manatee interactions and the frequency of harassment of manatees by swimmers (as defined by the US Fish and Wildlife Service) were also recorded. The use of protected (no-entry) sanctuaries by manatees was significantly greater when both the numbers of swimmers and boats increased, and when water temperatures were lower in surrounding areas. The time manatees spent bottom-resting and nursing decreased while the time spent milling and swimming increased when swimmers were present compared with when they were absent. Over half of the direct interactions recorded between swimmers and manatees constituted some form of harassment as defined by Refuge guidelines, and manatees were far more likely to terminate these interactions than were swimmers. We conclude that the existence of no-entry sanctuaries is very important for the conservation of manatees in the area and thought must be given to expanding the sanctuary network. Furthermore, additional efforts at enforcement and public education are needed. We address, qualitatively, several potential management options to better-secure manatees at this critical time of the year.

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1. Introduction

As one of the most endangered marine mammals in North America, the Florida subspecies of the West Indian manatee (*Trichechus manatus latirostris*) has been under special state protection since 1893; the species is also federally protected by both the Marine Mammal Protection Act and the Endangered Species Act [US Fish and Wildlife Service (USFWS) 2001]. Historically, hunting was the major cause of decline, but new threats to the species emerged because Florida's residential and tourist populations have both increased greatly since the 1950s. In 1978, the Florida Manatee Sanctuary Act was passed to expand protection for the species; this designated the entire state as a manatee refuge and allowed for strict enforcement of speedboat regulations.

The intent of these various laws is to assure that manatees are protected from human-associated impacts (i.e. disturbance and direct mortality) and that important habitat is identified and protected. Formal protection has reached a critical juncture, however, in that recreational users and conservationists disagree over current protective measures (Koelsch, 2002). Human-related mortality has steadily increased since the studies first conducted in the 1970s (O'Shea et al., 1985; Ackerman et al., 1995; Langtimm et al., 1998); mortality from watercraft alone increased from 21% (late 1970s) to 29% (late 1990s) of all known manatee deaths. However, a 2001 aerial census estimated manatee numbers statewide at 3276 animals, the highest total count since these surveys began in 1977 (Garrott et al., 1994; Ackerman, 2001). This census sparked an initiative by boating and other recreational interests to relax protective measures and to down list the species from endangered to threatened (Koelsch, 2002). Many conservatists, however, believe that aerial surveys are not reliable for census purposes for several reasons

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(e.g. Ackerman, 1995; Lefebvre et al., 1995); two such surveys conducted 11 days apart, for example, resulted in state-wide counts of 1629 and 2222 animals (a 36% difference). Better population models are needed to assess trends more accurately (Eberhardt and O'Shea, 1995).

Marmontel et al. (1997) concluded that the potential long-term survival of the species appears good provided that efforts to reduce mortality continue. These include the protection of warm-water refugia and the improvement and maintenance of habitat quality. The species is very popular with the public as a result of frequently tame behavior and the ability to exist in densely populated areas (O'Shea et al., 1995). Two sites located in the Crystal and Homosassa Rivers in Citrus County along the west coast of central Florida (Fig. 1), where manatees congregate in large numbers in the winter due to the presence of warm springs, offer opportunities for recreational swimmers to interact with wild manatees through various commercial operators and private boat rentals. Tourist numbers have increased over the years such that on some weekend days during the peak season (December and January), swimmers may outnumber manatees by 30:1 (S. Shapiro, Florida Marine Research Institute, personal communication, 2000). A 1989 study found that between 40,000 and 60,000 tourists visited Crystal River annually, mostly to view manatees (Buckingham, 1989). The number has increased to over 90,000 people per year recently (Anonymous, 1999, S. Gillette, USFWS, personal communication). An estimated

15–20% of the US manatee population overwinters in this area (J. Klein, USFWS, personal communication). Since 1980 no-entry sanctuaries have been established during the winter in select portions of the Crystal River National Wildlife Sanctuary (CRNWR) by setting up floating lines or buoys in the vicinity of warm springs and across which boats and swimmers are not permitted.

Many types of interactions between humans and manatees in these areas have long been a concern because they may influence manatee behaviors in ways detrimental to the species (e.g. Hartman, 1971, 1979; Powell and Rathbun, 1984; Packard et al., 1989; Wooding, 1997; Buckingham et al., 1999), and they are illegal under federal guidelines (USFWS, 2001). It is feared that harassment, particularly in the vicinity of some warm springs winter refugia, can drive manatees away to less favorable areas, thereby increasing the risk of cold-related illnesses (Irvine, 1983; Packard et al., 1989). Although there are instances in which manatees will actively seek out human contact, many dispute whether this should be encouraged for the long-term health and safety of the species (e.g. Seideman, 1997). In spite of the importance of the area for overwintering manatees and the rapid growth of manatee-viewing tourism, there have been few studies addressing the nature and types of interactions between people and manatees (e.g. Abernathy, 1995; Wooding, 1997), and none that looked specifically at implications of direct-contact interactions on manatee behavior. The purposes of this study are to: (1) explore the implications of recreational swimmers and boaters on the behavior of manatees, (2) assess relative risks of different types of human activities on manatees, (3) record, specifically, outcomes of human encounters with manatees, and (4) examine manatee use of protected sanctuaries.

2. Methods

This study was conducted over two winter seasons (early January to early March of 2001 and 2002), at two sites: Three Sisters Spring of the Crystal River and Blue Waters of the Homosassa River (Fig. 1). Due to unpredictability of cold fronts and tidal fluctuations—and their effects on manatee distribution and behavior—data were collected opportunistically (i.e. when manatees were present at either site).

We used scan sampling (Lehner, 1996) to assess manatee use of the protected sanctuary at Three Sisters Spring both with and without boaters and swimmers present in the area. Observation periods were divided into 5–6 h intervals, alternating between 07:00–12:00 or 12:00–18:00 depending on the presence of manatees. Weather conditions were recorded at the start of each interval and tide levels were recorded throughout. Water temperatures were monitored through the use of

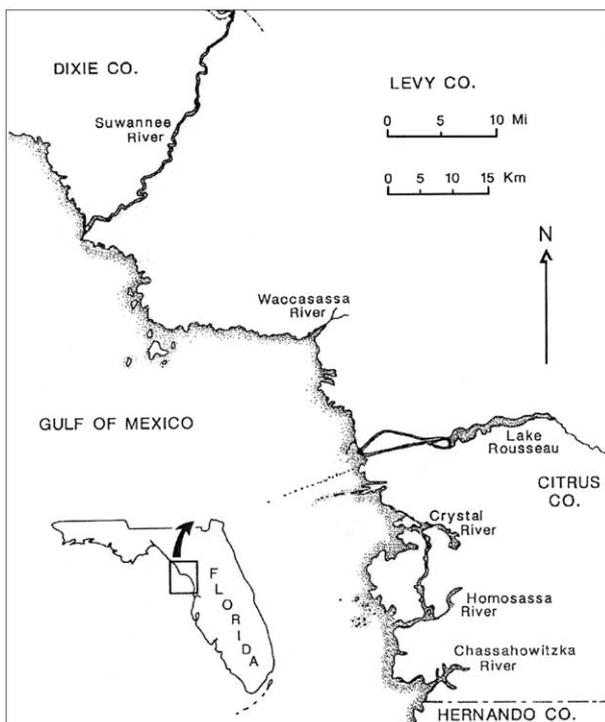


Fig. 1. A map of Florida with an enlargement of Central Florida showing the location of the Crystal and Homosassa Rivers and surrounding features (courtesy of Florida Marine Research Institute).

Stowaway tid-bit temperature units strategically placed throughout study sites. Scan samples were done every 15 min. The numbers of manatees both inside and outside the sanctuary and the numbers of swimmers and boats outside the sanctuary were recorded. Areas designated as outside the sanctuary only included those areas up to five linear meters from the sanctuary lines, as estimated visually. Observations were made from scaffolding erected on the bank facing the sanctuary. Visibility from the site was usually excellent and polarized sunglasses and binoculars were used as needed.

We used focal animal sampling (Martin and Bateson, 1998) to assess effects of the presence of swimmers and boats on the behavior of individual manatees. An ethogram of common behaviors (Table 1) was developed from a combination of observations made during the first few weeks of field work (December 2000) and research conducted under the auspices of the Sirenia Project (R. Bonde, personal communication). Focal animal samples were done either with the observer underwater using snorkeling gear (i.e. for most of the samples at Blue Waters, due to low visibility) or from scaffolding on land (at Three Sisters). We recorded the sex of focal individuals when possible, and age class using Hartman (1971) and Odell (1977). Specifically, calves were less than 1.8 m long and were always observed with a larger animal, sometimes directly nursing from a female. Adults were those individuals greater than 2.6 m long, and juveniles were between 1.8 and 2.6 m (estimated visually). Swimmer present samples were defined as those in which at least one human swimmer was recorded less than 3 m away from the focal manatee for at least 75% of the observation period. When in water (i.e. at Blue Waters), the observer stayed at least 3 m away from focal manatees, a distance at which observable behaviors did not change. Focal subjects were photographed when possible and were sketched into an

underwater notebook; all data from focal samples were recorded therein as well.

We also recorded various aspects of direct interactions between humans and manatees while conducting focal animal samples in which swimmers were present. Information regarding who initiated the interaction (human or manatee), the type of interaction, and who terminated the interaction, were noted. Reactions by manatees to initiations by swimmer were also recorded. These were classified into three categories: habituation, attraction and avoidance (sensu Knight and Cole, 1991; Whittaker and Knight, 1998). Habituation was defined as the manatee ignoring the swimmer, i.e. by continuing any activity in which the animal was engaged before the interaction began. Attraction was defined as the manatee changing its previous behavior and orienting toward and interacting with the swimmer. Any attempt by the manatee to escape (either by fast or slow swimming) from the human swimmer was recorded as avoidance. The final behavior—defined as the behavior in which the animal was engaged 30 s after the interaction was terminated—was also recorded. Instances of harassment as defined by USFWS guidelines disseminated to the public at CRNWR (Table 2) were recorded as they occurred to evaluate their frequency at both sites.

Data were analyzed with SPSS Version 10. Independent two-sample *t*-tests were used to compare mean times spent engaging in different behaviors both with and without swimmers present. Manatee counts both inside and outside of sanctuaries as a function of swimmer and boater activities were analyzed with simple correlations (Pearson's). Correlations were also used for comparing manatee counts against environmental variables at the Three Sisters site (e.g. water temperature, air temperature and tide levels). Human/manatee interactions, and manatee responses to them, are reported as frequencies to avoid difficulties associated with the uncertainty of generating theoretical chance expectations

Table 1

Ethogram of common manatee behaviors recorded during focal animal sampling at Three Sisters Spring and Blue Waters study sites. In addition to those described below, other behaviors were opportunistically noted as they occurred

Manatee behavior and code	Description of the behavior
1. Surface Rest (SR)	Resting/sleeping at the surface with back exposed and tail and flippers vertical in the water column. Breathing generally occurs every 4 + min.
2. Bottom Rest (BR)	Resting/sleeping at the bottom or in the water column. Breathing generally occurs every 4 + min.
3. Mill (M)	Slow, non-directional travel in the same general area. This is also known as pacing or idling behavior.
4. Nurse (N)	Calf located below the surface with its head under the cow's axilla and touching the cow's body.
5. Bottom Feed (BF)	Feeding on the bottom of the water column, causing water to muddy. Usually, vegetation in the mouth is observable when the animal surfaces to breath.
6. Surface Feed (SF)	Feeding on floating vegetation at or very close to the water surface.
7. Slow Swim (SS)	Steady movement in one direction at a slow to moderate pace.
8. Fast Swim (FS)	Steady movement in one direction at a fast pace.
9. Cavort/play (CP)	Intense socialization with one or more manatees. This may include rolling, splashing, embracing, chasing and sexual activity.

Table 2

Types of benign interaction and harassment observed during the course of this study and their definitions adapted from US Fish and Wildlife Service (2001 and brochures) and from preliminary observations taken at CRNWR

<i>Types of benign interaction</i>	Definition
1. Passive observation by swimmer	Swimmers and manatees passively observe each other. Manatees swim near and around swimmers. No direct contact.
2. Touch/Rub initiated	Swimmer touches/rubs manatee gently by a manatee after manatee first approaches swimmer.
<i>Types of Harassment</i>	
1. Approach/Dive Down	Swimmer approaches or dives down on/toward and touches a manatee.
2. Pursue/Chase	Swimmer actively swims after a manatee that is swimming away.
3. Poke/Prod	Swimmer uses hands, feet or other objects to touch the animal in an aggressive manner.
4. Separate (cow and calf)	Swimmer engages in any activity that causes a cow to become separated from her calf. This is frequently the result of pursue/chase.
5. Grab/Ride	Swimmer attempts to hold onto or mount a manatee.
6. Feed	Swimmer actively attempts to feed a manatee.
7. Step/Stand	Swimmer actively attempts to/succeeds in stepping or standing on a manatee.
8. Drive Over	Boat drives over a manatee that is underwater.
9. Sanctuary Entry	Swimmer enters a designated and delineated no-entry sanctuary.

(e.g. Fienberg, 1980). Chi-square tests of homogeneity were used to compare differences in frequencies of the types of interactions across sites. A decision level of 0.05 was chosen for all statistical tests.

3. Results

Scan sample observations were made for 58 days over the course of the two seasons at Three Sisters Spring. Manatees were present for 43 of those days. Manatee use of the protected sanctuary was positively correlated with both swimmer and boat numbers outside the sanctuary ($P < 0.005$ in both cases). The highest overall counts of manatees observed at Three Sisters were during the first scan sample of mornings in which tides were high and air temperatures fell below 12.5 °C.

Significant correlations at this site were found between manatee counts and weather conditions, tide levels and two measurements of water temperature. Total manatee counts at the Three Sisters site were negatively correlated with water temperature in the Gulf of Mexico and in the sanctuary ($P < 0.005$ in both cases). Total manatee counts were positively correlated with high tide levels and weather conditions (incoming cold fronts with heavy thunderstorms; $P < 0.01$).

Focal animal samples were primarily collected during the morning hours between 7:00 AM and noon at both Three Sisters Spring and Blue Waters because human swimmers tended to be present in the mornings. At Blue Waters, focal samples were collected through underwater observations in 90% of all cases, and the remaining 10% were made from an observation platform. All focal samples recorded from Three Sisters Spring were done from scaffolding on land. Those samples in which

manatees could be clearly seen for the entire 15-min observation period were used for the analyses. The main behaviors observed during focal samples with both swimmers present and absent were: bottom resting, slow swimming, milling, fast swimming, cavorting/playing and nursing. Other less common behaviors were noted (e.g. bottom and surface feeding, chewing rope or other objects) but did not occur in sufficient frequencies for results to be statistically analyzed.

At Three Sisters Spring, 102 focal animal samples were recorded with swimmers present and 110 were recorded with swimmers absent. The comparable numbers at Blue Waters were 105 and 111, respectively. Most (73.1%) of the manatees chosen for focal samples were adults. Sex could not be determined for the majority of focal manatees at both sites because genitalia were not visible and no calves or juveniles were present. Of behaviors recorded during focal samples, bottom resting, surface resting and nursing were primarily observed when swimmers were absent, and milling, slow and fast swimming and cavorting/playing were primarily observed when swimmers were present (Table 3). At Three Sisters Spring, the times spent bottom resting and nursing were significantly less with swimmers present and the times spent slow swimming, milling and cavorting/playing were significantly more with swimmers present.

Over the course of two winter seasons, 240 direct interactions between swimmers and manatees were recorded at Three Sisters Spring and 251 were recorded at Blue Waters. These interactions included any instance in which contact was made between swimmer and manatee, as well as any type of harassment as defined previously (i.e. chasing or surrounding manatees without touching them, etc.; Table 2). At Three Sisters

Table 3

Mean times that manatees spent engaged in various behaviors with swimmers both present and absent, recorded during 15 min focal animal samples. Results for Three Sisters Spring and Blue Waters are combined

Behavior	People present	Mean time spent (min)	P-value
Bottom Rest	Yes(207samples)	5.0	<0.005
	No(221 samples)	13.05	
Slow Swim	Yes	2.95	<0.005
	No	0.75	
Mill	Yes	4.8	<0.005
	No	0.5	
Surface Rest	Yes	0.1	NS
	No	0.1	
Cavort/Play	Yes	0.55	<0.005
	No	0.0	
Nurse	Yes	0.1	<0.005
	No	0.2	
Number of Breaths	Yes	6.0	NS
	No	4.2	

Spring, swimmers initiated 177 or 73.7% of all interactions, while manatees initiated the remainder. Swimmers initiated 152 or 60.5% of the interactions at Blue Waters. Of the interactions observed at Three Sisters Spring, 182 or 75.8% were classified as harassment (Table 4). Non-harassment interactions were recorded in the remainder of cases. At Blue Waters, 149 or 59.2% of interactions were classified as harassment. Interactions that fell into the category of harassment occurred more frequently at Three Sisters than at Blue Waters

Table 4

The types of interactions, both benign and harassing, observed during focal animal samples and the frequencies of occurrence at Three Sisters Spring and Blue Waters

Type of Harassment	Three Sisters Spring		Blue Waters	
	Frequency	Percent	Frequency	Percent
Approach/Dive Down	128	53.3	109	43.4
Pursue/Chase	14	5.8	8	3.2
Poke/Prod	1	0.4	1	0.4
Separate (cow/calf)	6	2.5	2	0.8
Grab/Ride	8	3.3	5	2.0
Surround	15	6.3	12	4.7
Step/Stand	5	2.1	3	1.2
Drive Over	1	0.4	9	3.6
Sanctuary Entry	4	1.7	0	0.0
Subtotals	182	75.8	149	59.3
<i>Other (Benign) Interactions</i>				
Passive Observation	54	22.5	91	36.3
Touch/Rub	4	1.7	11	4.4
Subtotals	58	24.2	102	40.7
Grand Totals	240	100.0	251	100.0

($P < 0.0005$). The frequency of interactions initiated by manatees between sites was also significantly different; manatees initiated proportionally more interactions at Blue Waters ($P < 0.0005$). However, the frequency of different harassment interaction types were the same between sites ($P > 0.100$).

The most common forms of harassment observed were when swimmers approached or dove down on and touched focal manatees (Table 4). For example, this was recorded in 128 or 70.3% of harassment interactions, and 53.3% of total interactions, at Three Sisters Spring. Manatee responses to these interactions were also similar across sites. The data show that swimmers initiated, but that manatees terminated, most interactions (Table 5). Fleeing was the most common response by the animals. Furthermore, most focal manatees were observed either slow or fast swimming away from human swimmers 30 s after the interaction was terminated (Table 5).

4. Discussion

Tourism is now the largest industry worldwide, and nature-based tourism of some form is the fastest-growing subsector of all tourism (McLaren, 1998). While some forms of nature-based tourism strive to have lower impacts on natural systems and phenomena including

Table 5

The frequency and percent of: interactions initiated by swimmers versus manatees, the reactions of manatees to interactions with swimmers, and interactions terminated by swimmers versus manatees^a

Interaction Sequence	Frequency	Percent
Initiation		
Human	305	66.6
Manatee	153	33.4
Total	458	100.0
Reaction by Manatee		
Habituation	46	10.1
Attraction	171	37.3
Avoidance	241	52.6
Total	458	100.0
Termination		
Human	52	11.4
Manatee	406	88.6
Total	458	100.0
Final behavior observed 30 s after termination		
Slow swim into sanctuary	43	9.5
Slow swim away from swimmer	258	56.3
Fast swim away from swimmer	33	7.2
Bottom Rest	118	25.7
Other	6	1.3
Total	458	100.0

^a The behaviors of manatees observed 30 s after interactions were terminated are also provided. Data for both sites are combined.

the behavior of native species (i.e. ecotourism), it is well-known that even low-impact forms of tourism can affect the behavioral patterns of some large vertebrates negatively (e.g. Knight and Cole, 1991). In the case of overwintering manatees in and around CRNWR, the numbers of tourists and boats have increased greatly over the past decade and the area is quite critical to the survival of up to 20% of the US population (S. Gillette, USFWS, personal communication). The overall spatial distribution of manatees in the area is most influenced by the location of warm springs (e.g. Irvine, 1983), and the springs located at Three Sisters are among the most important. Therefore, any human impacts or interactions that negatively affect manatees' ability to use these areas during the winter season must be considered seriously given the endangered status of the Florida population.

The data presented here show that both human swimmers and boats influence manatee behavior in ways that may negatively affect fitness in the winter season. The scan samples showed that manatee use of sanctuaries off-limits to boats and swimmers increased with the numbers of swimmers and boats in the vicinity. While this is not necessarily negative to manatees, it could become so given that the sanctuary areas have little or no food and the animals must forage elsewhere during the daytime. The focal animal samples showed that resting, nursing and feeding behaviors declined, while swimming, milling and cavorting/playing behaviors increased with human disturbance as measured when swimmers were within 3 m of focal manatees. Of the interactions between humans and manatees witnessed during focal animal samples at both sites combined over the course of this study, the majority (65%) constituted some form of harassment as defined by the USFWS (Anonymous, 1999). Although these types of interactions are illegal, it is evident from this study that efforts at enforcement are insufficient given the current staffing situation and the current (and growing) numbers of tourist who come to view manatees during the winter (see below).

No-entry sanctuaries are effective at reducing some human impacts (e.g. Buckingham et al., 1999). Since its establishment, the sanctuary at Three Sisters Spring has experienced an increase in the numbers of manatees using the site. The highest manatee count obtained during Wooding's (1997) study was 25. Over the course of our study, 20% of the scan animal samples resulted in counts of >30 manatees, indicating the importance of the continued presence of the sanctuary. As the size of Three Sisters sanctuary is heavily influenced by tide—and greater numbers of manatees are aggregating there—alternative sites to locate sanctuaries should be considered. Several potential sites are located nearby but have yet to be designated.

The concept of carrying capacity, as a social construct, must be considered in situations such as this: i.e.

cases in which tourist numbers and/or activities may detract from the natural amenities that tourists come to enjoy. Buckingham et al. (1999) considered the possibility of spatially and temporally limiting the numbers of people into a portion of the Crystal River. This may be important to consider as tourist numbers increase further. The regulation of the numbers of tourists on chartered dive boats would doubtlessly be an improvement over the current situation, but, based on our informal discussions with operators in the area, this may not be politically feasible. Other possibilities would be to alternate days in which swimming is permitted with days in which tourists may observe manatees from boats only. This would have the effect of reducing the numbers of interactions without necessarily reducing the numbers of tourists, and may therefore be more acceptable to local business owners.

While we (and others for that matter) have not shown specifically that interactions with swimmers actually increase mortality or reduce fecundity of manatees, one can assume that effects are negative due to the fact that this species is at the limits of its temperature tolerance in the winter in central Florida, and would not be able to occur there were it not for warm springs in the area. Food is also limited in the vicinity of warm springs, which means that manatees must have access to feeding sites within short distances such that they can come and go daily during cold periods (Rathbun et al., 1990). Interactions that lead to more manatee movements (i.e. many of those shown here) reduce resting time and cause greater energy expenditures. Thus, although we observed no direct manatee mortality due to interactions with swimmers, we conclude that the sum total of these interactions is negative based on a number of lines of evidence. Longitudinal studies, analogous to those done by Reid et al. (1991, 1995), of manatees that are regularly subjected to human interactions are also needed to determine the overall effects of interactions on individual manatees (e.g. long-term health risks, likelihood of mortality, etc.).

The presence of more law enforcement personnel in high use areas, at least during peak times, would be desirable. Given that this is probably not feasible due to agency limitations, expanding the network of enforcement volunteers working in the area may be an option. Further education aimed at the public is also needed and appeared to be inadequate during this study. During the second field season, an updated "manatee manners" video was in production. Making the viewing of this video mandatory for all potential clients of private operators and individuals who lease boats may improve the situation. Although brochures and (now) videos are available, ensuring that all relevant parties have access to the information is difficult due to the fact that there are so many small operators and some tourists come unaccompanied. Our results also suggest that expansion

of sanctuaries during the winter season into Blue Waters is justified based on the importance of sanctuaries for resting manatees and increased human activity in this area. Two small sanctuaries were opened in the area in early 2003. Monitoring at these sites will also be needed.

In conclusion, the population of manatees overwintering in and around CRNWR appears to be stable or increasing, but there are valid causes of concern about growing numbers of tourists who come to view them. While we do not endorse reducing tourist entries by draconian measures, our data suggest that many interactions are likely to be negative to manatees and the presence of tourists affects behavioral patterns during the winter: a critical time of the year. We agree generally with Sorice's (2001) conclusion that protection of manatees, due to their endangered status, should supercede recreational uses. Furthermore, we also suggest that more education, increasing the number of no-entry sanctuaries, and considering options such as view-by-boat-only days, would improve the situation for this species during the winter in the area, without comprising an important economic activity.

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