

PRELIMINARY EVIDENCE THAT BOAT SPEED RESTRICTIONS REDUCE DEATHS OF FLORIDA MANATEES

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Impacts with the hulls and propellers of watercraft are the largest source of human-related injury and death for Florida manatees (*Trichechus manatus latirostris*). Since the late 1970s, when dedicated manatee salvage and necropsy efforts began, such deaths have ranged from a low of 15 in 1983 to a high of 95 in 2002 and accounted for about one-fifth to one-third of all natural and human-related Florida manatee deaths annually (Ackerman *et al.* 1995, Marine Mammal Commission 2004). Because vessel operators are unable to detect and avoid manatees reliably, resource managers have tried to reduce collisions by establishing boat speed zones in areas where manatees and watercraft-related manatee deaths are most common. Although slower speeds may reduce injuries by reducing the force of collision impacts, the principal objective of speed restrictions has been to allow manatees more time to detect and avoid oncoming boats.

Efforts to establish speed zones began in earnest in 1989 when the Florida Governor and Cabinet directed state and county agencies to develop such zones throughout 13 key counties. By the early 2000s, speed zone networks had been adopted for each of those counties. Those networks include several types of speed zones—including channel-exempt (*i.e.*, zones where slow speed requirements apply only outside of marked channels), channel-inclusive (*i.e.*, zones where slow speed applies both within and outside marked channels), and shoreline speed zones (*i.e.*, zones where reduced speed applies within specified distances from shore)—that can impose various speed limits (*e.g.*, idle and slow in the most restricted areas, up to 25–30 mph [40–48 kmh] in some marked channels). The selection of zone types and speeds has depended on site-specific assessments of manatee habitat, vessel traffic patterns, geographic conditions, and public comment.

Despite these measures, little has been done to date to assess their biological effectiveness, and there has been no clear evidence of a decline in watercraft-related manatee deaths. The annual total number of water craft-related deaths has increased substantially since the late 1980s, although the proportion of such deaths

compared to deaths from all causes has remained relatively steady. For example, in the first five years after efforts began to develop county-wide speed zones (1990–1994), watercraft-related deaths averaged 45/yr and 25% of total mortality (226 of 897 deaths) compared to 81/yr and 25% of total mortality (403 of 1,595 deaths) over the most recent 5-yr period (2000–2004). The absence of a clear decline could be due to at least four causes: (1) the assumption that manatees are able to avoid slow-moving boats is false and boat speed restrictions offer little protection; (2) compliance rates with established zones have been too low to reduce collision risks; (3) the type or extent of speed zones have been too weak to protect manatees (*e.g.*, slow or idle speed restrictions are not covering the right areas or enough area); and (4) the new zones have been partially effective, but increasing numbers of boats and manatees have increased the number of collisions at a pace faster than new speed zones have reduced them.

Trends in watercraft-related deaths along waterways in Sykes Creek and the Barge Canal at Merritt Island, Florida, are beginning to provide information that suggests boat speed zones can be effective and that the absence of decline in such deaths is more likely due to low boater compliance, inadequately designed speed provisions, and increasing numbers of boats and manatees. Sykes Creek and the Barge Canal are part of an estuarine system along Florida's east coast near Cape Canaveral (Fig. 1). They are used extensively by manatees and boats to cross Merritt Island, the southern 49 km of which separates the Indian and Banana rivers. The Barge Canal is a dredged waterway 46 m wide running east-west about 6.5 km. Sykes Creek is a natural waterway that runs north-south connecting the center of the Barge Canal with Newfound Harbor, about 5.6 km to the south. The southern end of Newfound Harbor opens to the Banana River about 6.4 km farther south. Tides in this area are very low, generally well under a foot in height. The shorelines of Sykes Creek are heavily developed with adjoining canals and marinas.

Manatees use both the Barge Canal and Sykes Creek as a travel corridor between important habitats in the Indian and Banana rivers. The Indian River is part of the principal north-south migratory corridor for manatees along Florida's east coast. Two warm-water refuges formed by power plant outfalls 13 and 18 km north of the Canal's western end occur along its shoreline. The northern Banana River, extending 21 km north of the eastern end of the Barge Canal, provides an important feeding and resting area. Winter counts of over 500 animals have been made at the two power plants (Laist and Reynolds 2004) and similar counts have been made during the spring in the northern Banana River (U.S. Fish and Wildlife Service 2001). At both power plants and in the northern Banana River, manatees are protected by no-entry areas that prohibit access by public vessels.

From January 1986 through May 2002, 31 manatees killed by watercraft were found in the Barge Canal and Sykes Creek and immediately adjacent waters (*i.e.*, within 1 km of either end of the canal and in the northern end of Newfound Harbor (Fig. 1, Table 1). During this period an average of 1.9 boat kills per year was recorded in this area. Seven other carcasses attributed to boat strikes were found directly across the Banana River from the Barge Canal near the west side of Canaveral Locks. Most of these carcasses (*i.e.*, 23 of 38) were found in the spring between 1 March and

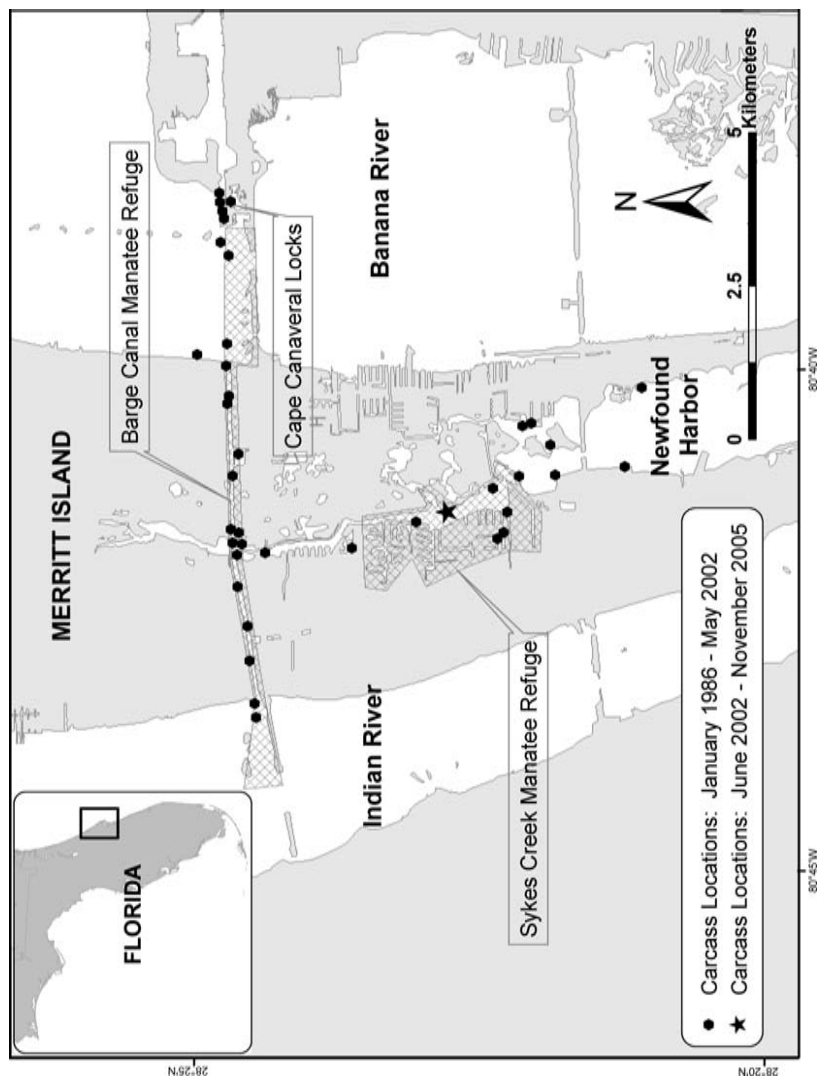


Figure 1. Study area and location of manatee carcasses killed by watercraft and recovered in Sykes Creek and the Barge Canal in Brevard County, Florida from 1 January 1986 through 1 December 2005 (Unpublished data, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL).

Table 1. Watercraft-related mortality of Florida manatees in Sykes Creek and the Barge Canal: 1 January 1986–1 December 2005 (Unpublished data, Florida Fish and Wildlife Commission, Fish and Wildlife Research Institute, St. Petersburg, FL).

Year	Number of deaths			Subtotal	Average annual mortality (Canal/Creek/Harbor)	Number of deaths		Average annual mortality (All areas)
	Barge Canal	Sykes Creek	Newfound Harbor			Cape Canaveral	Total all areas	
No regulations								
1986	0	3	0	3		0	3	
1987	0	0	0	0		0	0	
1988	1	0	0	1		0	1	
1989	1	2	0	3		0	3	
<26 June 1990	1	0	0	1		2	3	
Subtotal	3	5	0	8	1.78	2	10	2.23
Channel-exempt slow-speed zone in Sykes Creek, no regulations in the Barge Canal								
>26 June 1990	0	0	0	0		0	0	
1991	1	0	1	2		1	3	
1992	1	1	0	2		0	2	
1993	2	0	0	2		0	2	
<12 October 1994	2	1	0	3		1	4	
Subtotal	6	2	1	9	2.09	2	11	2.56
Channel-exempt slow speed zone in lower Sykes Creek; slow speed/shoreline only slow speed zones in the Barge Canal								
>12 October 1994	0	0	0	0		0	0	
1995	1	0	0	1		0	1	
1996	1	0	0	1		0	1	
1997	0	0	0	0		2	2	
1998	0	1	0	1		1	2	
1999	2	0	1	3		0	3	
2000	0	3	0	3		0	3	
2001	2	1	0	3		0	3	
<1 June 2002	2	0	0	2		0	2	
Subtotal	8	5	1	14	1.83	3	17	2.22
Slow speed throughout the Barge Canal, Sykes Creek, and west of Canaveral Locks								
>1 June 2002	0	0	0	0		0	0	
2003	0	1	0	1		0	0	
2004	0	0	0	0		0	0	
1 December 2005	0	0	0	0		0	0	
Subtotal	0	1	0	1	0.29	0	0	0.29

30 June. Occasional signs of partially healed vessel collision wounds suggests that some animals hit by boats survive long enough to move away from collision locations before dying, though it is unclear to what extent they may do so. Thus, some dead animals hit by boats and found in the canal or creek may have been struck elsewhere, while others hit in the canal or creek may die and be found in other waterways. It also is possible that animals killed quickly by collisions may drift into or out of the canal and creek by tides and wind before discovery. Nevertheless, watercraft-related manatee death in Sykes Creek and the Barge Canal represents one of the largest concentrations of such deaths anywhere in Florida.

Because of this concentration of deaths, efforts have been made to establish boat speed zones in these waterways. The first such measure was adopted by the State of Florida on 26 June 1990 for the southern half of Sykes Creek. It established a year-round channel-exempt speed zone that allowed speeds up to 25 mph (40 kmh) along the marked channel in the center of the creek, but required slow speed (*i.e.*, the speed of a vessel when it is fully off plane and completely settled in the water so as not to create excessive wake; generally about 5–7 mph [8–11 kmh]) in all areas outside the channel. On 12 October 1994 protection was expanded to include portions of the Barge Canal. Those rules established three 0.9-km long bank-to-bank slow-speed zones in the canal separated by four 0.9–1.4 km long shoreline slow-speed zones (*i.e.*, speeds of 25 mph [40 kmh] were permitted down the center of the canal, but slow speed was required within 7.6 m [25 ft] of either shoreline). During the summer of 1997 the Fish and Wildlife Service supported a study of boater compliance with the speed restrictions (Tyson and Combs 1999). The study revealed that 9.2% of all vessel traffic was blatantly noncompliant and an additional 22.6% was in technical noncompliance.¹

Because of continuing vessel-related manatee deaths despite these rules, the U.S. Fish and Wildlife Service designated the Barge Canal and a 4.5-km segment of Sykes Creek, including many of its adjoining canals, as two Manatee Refuges on 7 January 2002 (Fig. 1). The accompanying regulations, which took effect upon posting, require year-round slow-speed travel throughout all areas of both refuges, including the channels. Steps to post the new zone and advise local boaters of the new restrictions took several months and, on the last weekend in May 2002, enforcement actions were begun to assure compliance with the new measures. In 2003 Service officers spent 450 h enforcing refuge rules and issued 240 warnings or citations. In 2004 they also devoted 450 h to enforcement and issued 146 warnings or citations. Although systematic efforts to document boater compliance rates have not been conducted since the two refuges were designated, enforcement officers claim levels

¹ Boater compliance studies classify vessel speed into five categories: idle speed (about 1–3 mph), slow speed (about 5–7 mph), plowing speed (when the bow of a vessel with a planning hull design rides higher than the stern, about 10–15 mph), cruising speed (when the bow of a vessel with a non-planning hull creates a noticeable displacement; about 10–15 mph), and planning speed (when a vessel with a planning hull rises partially out of the water, typically above 15 mph). Technical non-compliance is one speed category above the posted speed and blatant non-compliance is two speed categories above the posted speed.

of boater awareness and compliance with the new rules has improved greatly, as indicated by the reduced number of warnings or citations in 2004.

Since enforcement of the new rules began, watercraft-related manatee deaths in the two refuges have decreased sharply. In the first 42 mo after the new rules went into effect (*i.e.*, from 1 June 2002 to 1 December 2005), only one watercraft-related manatee death was reported in Sykes Creek and the Barge Canal (0.29 deaths per year) compared to eight deaths (2.34 deaths per year) in the 42 mo before the rules went into effect. Also, no new deaths have been reported in the Banana River near Canaveral Locks or in the northern end of Newfound Harbor. A number of possible factors may have contributed to this decline. For example, the decline could reflect a statistical aberration due to a relatively short period of implementation. The slower speeds also may have reduced vessel traffic by discouraging some boaters from using the canal and creek as a travel corridor between the Banana and Indian rivers. Boat traffic also may have been reduced to some unknown extent by other factors such as the economic downturn following the 11 September 2001 terrorist attack, by the series of three hurricanes in Florida in the late summer and fall of 2004, and by the closure of the Canaveral Lock for maintenance between late October 2004 and early March 2005 (Canaveral Lock connects the Banana River and the Atlantic Ocean east of the two refuges).

Overall, however, the above factors may have had a minimal effect on reducing collision risks. Historically, only three watercraft-related deaths in the Barge Canal and Sykes Creek occurred between late summer and mid-winter. Thus, hurricanes late in 2004 and the closure of Canaveral Lock in late 2004–early 2005 seem unlikely to have been major factors. Also, while past periods of economic recessions have slowed increases in the number of registered boats, they did not cause a decline in numbers. Instead, we believe that the decline in watercraft-related deaths in the two refuges reflects the improved effectiveness of the new uniform slow speed measures. Such a conclusion would also suggest that channel-exempt slow-speed restrictions, such as those in effect for the area before the refuges were designated, are ineffective or minimally effective as collision reduction measures in waterways with narrow manatee travel areas outside of marked channels. To better assess such possibilities, more time, data, and analysis are needed—particularly on vessel traffic levels, enforcement, and compliance levels—to fully assess the effectiveness of the new speed restrictions.

As a related matter, the decrease also may suggest that most watercraft-related manatee deaths found in the canal and creek before June 2002 were hit and killed in those waterways. For Brevard County as a whole, watercraft-related manatee deaths have not declined in recent years. In waterways east and west of southern Merritt Island near the two refuges (*i.e.*, from points 23 km north of the Barge Canal to 25 km south of the Canal), watercraft deaths since 1986 have averaged 4.77/yr (*i.e.*, 87 deaths ranging from 2 to 8 per year between 1986 and 2004). In the 30 mo before the 1 June effective date for the two new manatee refuges, 15 deaths (4.86/yr) were recorded in those adjacent waters compared to 19 deaths (6.7/yr) in the 30 mo after that time. If manatees struck by boats elsewhere commonly moved or drifted into the canal and creek, one would have expected more than one carcass to have been found in the canal and creek since June 2002. In this regard, the one watercraft-related

death found in the two refuges since June 2002 (*i.e.*, case MEC0303, 21 January 2004) involved an animal with propeller wounds that showed signs of healing and infection. The condition of the wounds as described in the animal's necropsy report suggests that it may have survived a week or more after being hit,² providing the animal an opportunity to have moved some distance from the collision location. Although boat speed restrictions in the Banana River east of Sykes Creek also have been strengthened since 2002—an action that could have reduced the occurrence of carcasses in the two waterways—no major changes were made along the intracoastal waterway west of the two refuges.

The past concentration of watercraft-related manatee deaths and the history of boat speed regulations in Sykes Creek and the Barge Canal make this area one of the best in Florida to assess the effectiveness of boat speed regulations as a manatee protection measure. We believe that recent experience in these waterways suggests that speed restrictions can be effective in reducing collision risks with manatees if they are well designed and enforced. We also believe that the reason for their apparent improved effectiveness is that reduced speed allows time for animals to detect and avoid oncoming boats, and that similar measures may be useful for other marine mammal species vulnerable to collision impacts with vessels (*e.g.*, North Atlantic right whales). We recommend continued efforts to review manatee mortality in, and adjacent to, Sykes Creek and the Barge Canal. We also urge that responsible management agencies make further efforts to document and analyze law enforcement actions, vessel traffic levels, and boater compliance with refuge speed restrictions in both refuges to further evaluate the effectiveness of the new speed restrictions.

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LITERATURE CITED

- ACKERMAN, B. B., S. D. WRIGHT, R. K. BONDE, D. K. O'DELL AND D. J. BANOWETZ. 1995. Trends and patterns in mortality of manatees in Florida, 1974–1992. Pages 223–258 in T. J. O'Shea, B. B. Ackerman and H. F. Percival, eds. Population biology of the Florida manatee. Information and Technology Report No. 1. National Biological Service, Washington, DC. 289 pp.
- LAIST, D. W., AND J. E. REYNOLDS, III. 2004. The influence of power plants and other warm-water refuges on the status of Florida manatees: A speculative analysis. *Marine Mammal Science* 21:739–764.

² Personal communication from Thomas D. Pitchford, Marine Mammal Pathobiology Laboratory, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 3700 54th Avenue South, St. Petersburg, FL 33711, 24 June 2005.

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- MARINE MAMMAL COMMISSION. 2004. Marine Mammal Commission Annual Report to Congress 2003. Bethesda, MD.
- TYSON, S., AND L. COMBS. 1999. Canaveral Barge Canal boater activity and compliance study Brevard County, Florida. U. S. Fish & Wildlife Service. Endangered Species Field Office. Jacksonville, FL.
- U. S. FISH AND WILDLIFE SERVICE. 2003. Florida Manatee Recovery Plan. Southeast Regional Office. Fish and Wildlife Service, U.S. Department of the Interior, Atlanta, GA.

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