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BEHAVIOR AND ECOLOGY OF THE ATLANTIC WHITE-SIDED DOLPHIN (*LAGENORHYNCHUS ACUTUS*) IN COASTAL NEW ENGLAND WATERS

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ABSTRACT

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) are among the most abundant, and least studied, cetaceans in coastal New England. Between April and October 1984 through 1997 we sighted 1,231 groups of Atlantic white-sided dolphins, primarily on Stellwagen Bank and Jeffreys Ledge (two shallow glacial deposits along the coasts of Massachusetts, New Hampshire, and Maine). Mean group size was 52 (±90.9), and was significantly larger from August through October (71.9 ± 111.4) than April through June (35.0 ± 45.4). Calf sightings were uncommon until June and July, after which they were present in over 50% of groups. Combined with observations of apparent newborn calves, this confirms that early summer is an important calving period. The presence of calves did not, however, solely account for the increase in group size. Boat interaction (bow- and stern-wake riding) was the most commonly recorded behavior (47.4% of sightings), followed by traveling (31.4%), interactions with other cetacean species (27.6%), social interaction (15.5%), and feeding (9.5%). While feeding was uncommon, one observation of apparently coordinated "ball" feeding was seen with sand lance (*Ammodytes* spp.) as the visible prey. Aerial behavior showed a positive correlation with group size, although it was often impossible to tell whether the same dolphins were leaping repeatedly. Eighty-eight dolphins were photo-identified using either unusual body pigment or a distinctive dorsal fin. While several individuals were reidentified between years and between areas, no reidentifications were made within a year in the same area. Unusually pigmented individuals were much more likely to be reidentified than those with distinctive dorsal fins, most likely due to higher visibility. We suggest that Atlantic white-sided dolphins are generally using the study area as transients in what appears to be a large home range.

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Key words: Atlantic white-sided dolphin, *Lagenorhynchus acutus,* dolphins, dolphin behavior, New England, dolphin natural history.

The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) is a cold-water dolphin endemic to the North Atlantic Ocean. It ranges from New England to West Greenland in the western North Atlantic, and is found near the British Isles, Norway, Iceland, and East Greenland in the eastern North Atlantic (Gaskin 1992). Like most delphinids, there is a slight sexual size dimorphism. In a mass stranding of 65 animals in New England, males reached lengths up to 267 cm and 234 kg while females were recorded only to 243 cm and 182 kg (Sergeant *et al.* 1980). The species is characterized by a prominent white and yellow flank stripe ranging from behind the eye to the constriction of the caudal peduncle shortly before the start of the tail fluke.

Like most other members of the *Lagenorhynchus* genus, little is known about the life history of this species. Most current knowledge comes from the work of Sergeant *et al.* (1980), who reported on the members of two stranded groups from the New England region and a few animals taken or found in other areas of the Northwest Atlantic. Based on necropsy data, they concluded that the pods examined contained more females than males, and a relatively small number of juveniles. They suggested this to be evidence that juveniles of both sexes are excluded from natal herds following weaning, and some males remained separate from herds for much or all of their lives. They also reported calving to be highly seasonal, with births taking place from May to August with strong peaks in June and July. The presence of females who were both lactating and pregnant indicated that annual reproduction is possible in this species. Stomach contents included common squid (*Illex illecebrosus*) and smelt (*Osmerus mordax*) as the primary prey. Schevill (1956) and Katona *et al.* (1978) also reported herring (*Clupea harengus*) as a common prey in New England waters. Numerous other species including mackerel (*Scomber scombrus*) and mesopelagic fishes have also been found in stomachs of individuals incidentally caught in fishing gear operating in the Eastern North Atlantic, off Ireland (Couperus 1998). Based on the distribution of Atlantic white-sided dolphins (further referred to as white-sided dolphins) and what is known from baleen whale species, CETAP (1982) and Gaskin (1992) hypothesized that American sand lance (*Ammodytes* spp.) were also an important prey in New England waters, especially the southern Gulf of Maine in the spring. Stomach content data have not confirmed this contention.

Information from sightings of live animals at sea is extremely sparse. Schevill (1956) reported that sighting frequency was low off New England. Further studies have mentioned an increase in white-sided dolphin abundance since that time. Sergeant *et al.* (1980) stated that observation frequency had increased during the 1970s, although no data were offered to substantiate this statement; Katona *et al.* (1978) reported that groups of white-sided dolphins were unusually common in 1976, which they felt could have been related to warm water temperature or an increased level of silver hake (*Merluccius bili-*

nearis); and CETAP (1982) reported them to be the fourth most commonly sighted "small whale" in the study area from Virginia to Maine from 1979 to 1981, and the most numerous in total number of individuals sighted. Whether these reports indicate a true increase in abundance, a distribution shift within their range, or insufficient sighting effort prior to the 1970s remains unknown. Katona *et al.* (1978) and Gaskin (1992) also noted that on several occasions dolphins were associated with feeding fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*). CETAP (1982) reported that dolphins were "often" observed bow riding ahead of whales during multispecies sightings.

The ability of white-sided dolphins to move through a wide-ranging area was recently documented by Mate *et al.* (1994), who satellite-tracked an Atlantic white-sided dolphin for a >300-km straight-line distance in 64.3 h. Since this animal was a rehabilitated individual rereleased to the wild, however, its behavior may not have been similar to that of a non-affected individual.

While group sizes for this species have not been generally reported, CETAP (1982) reported a mean of 54.3 individuals per sighting. Virtually no other details of live animal behavior have been published. In this paper we present the results of a 12-yr study on Atlantic white-sided dolphin sightings in the southern Gulf of Maine.

Methods

Data on white-sided dolphins were collected from commercial whale-watching vessels and dedicated platforms from 1984 to 1997 on Stellwagen Bank (1,644 effort days) and from 1986 to 1997 on Jeffreys Ledge (494 effort days), both in the southern Gulf of Maine (Fig. 1). A small number of identification photographs and ad hoc behavioral notes were also used from 1982–1983. Both Jeffreys Ledge and Stellwagen Bank are high-relief glacial deposits. Stellwagen Bank has a uniformly sandy bottom with depths ranging from 18 to 37 m, while Jeffreys Ledge has a mixture of sand, gravel, and rocks along the sea floor and depths ranging from 45 to 61 m. Predominant marine mammal prey has generally been sand lance on Stellwagen Bank (Overholtz and Nicolas 1979; Hain *et al.* 1982, 1995; Weinrich *et al.* 1997), although some herring, mackerel, and squid are also present. On Jeffreys Ledge, primary marine mammal prey is herring, but squid and mackerel are also present (Weinrich *et al.* 1997). Both areas are high concentration areas for Atlantic white-sided dolphins (CETAP 1982, Selzer and Payne 1988).

Commercial whale watches operated out of Gloucester and Boston, Massachusetts (Fig. 1), on a daily basis (weather permitting) from mid-April to late October of each year. Daily coverage usually included four or more whale-watching excursions, each of which typically spent 90–120 min in areas where whales were likely to be present, and another 60–90 min each way in transit to or from these areas. Commercial whale-watch boats were typically 20–30 m long, and powered by one to four diesel engines. The destination of each

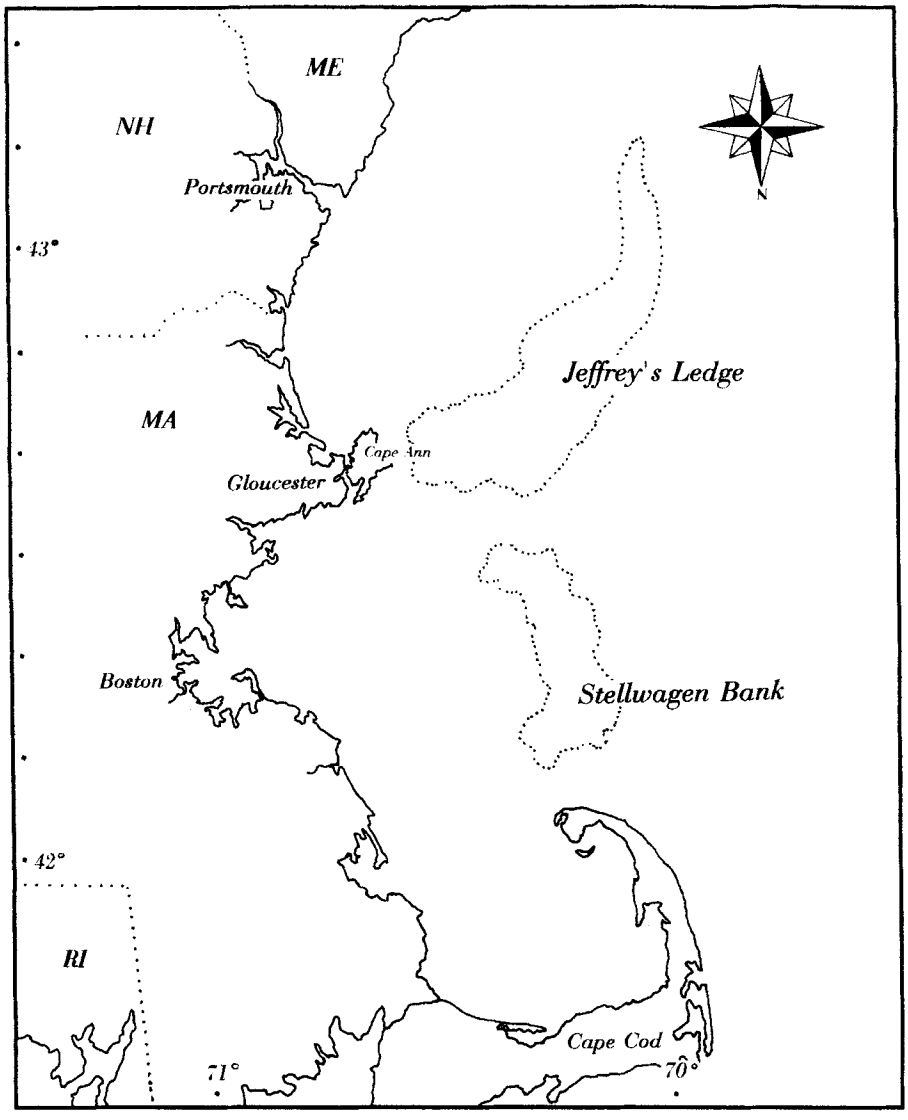

Figure 1. Primary study areas. Jeffreys Ledge contour line is 55-m isobath; for Stellwagen Bank, contour line is 33-m isobath.

cruise (Stellwagen Bank or Jeffreys Ledge) was determined by the suspected or known location of whale concentrations. Stellwagen Bank was heavily emphasized from 1988 to 1992 and in 1997, with coverage of the two areas approximately equal in 1986–1987 and 1993–1996.

In addition to whale-watch vessels, observations were supplemented by dedicated cruises aboard a 6.1-m outboard-powered or an 8.3-m diesel-powered vessel. Excursions lasted for 4–12 h. While these cruises were also focused on

Jeffreys Ledge or Stellwagen Bank, they allowed a much more thorough survey of the entire area than the whale watches.

A small number of sightings of white-sided dolphins took place in areas outside of either Jeffreys Ledge or Stellwagen Bank. These were focused in the 50-fathom (96-m) contour just north of the Great South Channel off Nantucket, MA, and the waters between Stellwagen Bank and Jeffreys Ledge. These sightings were included in our general database for population descriptions. In cases where data are segregated by habitat, however, these sightings are discarded due to their small sample size.

When Atlantic white-sided dolphins were sighted, a decision was made whether or not to approach them. If the group was not approached, their location was noted, but no additional data were recorded unless the group was less than 100 m away. In these cases an estimate of the number of dolphins present was made.

If a decision was made to approach the dolphins, two observers recorded information about the group, including: the LORAN position at five-minute intervals; estimated number in the group; travel direction; spatial structure (a uniformly spread single group or pockets of small subgroups with obvious spatial separation of at least 200 m between closest individuals); relative size class (small, medium, or large) of the dolphins present, visually estimated, and which size was most prominent (categorized as calf, ~1 m; small, 1–1.5 m; medium, 1.5–2 m; and large, >2 m); presence or absence of calves, and their estimated number. The presence or absence, and number of displays of the following behaviors were also noted: bow- or stern-wake riding (for these we also recorded the size of animals engaging in the activity), tail slapping, chin slapping, simple leaps, and acrobatic leaps (those involving twists and turns in the air); whether potential prey was present and, if so, of what species; the most prominent overall behavioral categories of the group (see below); whether the dolphins were associated with other cetacean species (*e.g.*, bow-riding the other species, or staying in their immediate vicinity) and, if so, the species and behavior of the associated animals. Most dolphin approaches lasted between five and ten minutes, although some observations of up to thirty minutes were included in the data set.

Behavior was broken into the following simple categories:

Traveling—Swimming at consistent speed without spending notable time at any single location.

Boat interaction—Riding or surfing on the bow- and/or stern-wake of the vessel.

Presumed feeding—Dolphin group showing little, if any, lateral displacement for five minutes or more, with individual dolphins circling around and remaining in an area less than 300 m diameter (direct feeding was actually observed only once).

Dolphin–other species interaction—A group of dolphins both in the immediate vicinity of, and coordinating their behavior with, individuals of another species (*e.g.*, surfacing and diving in synchrony, moving in the same direction, *etc.*).

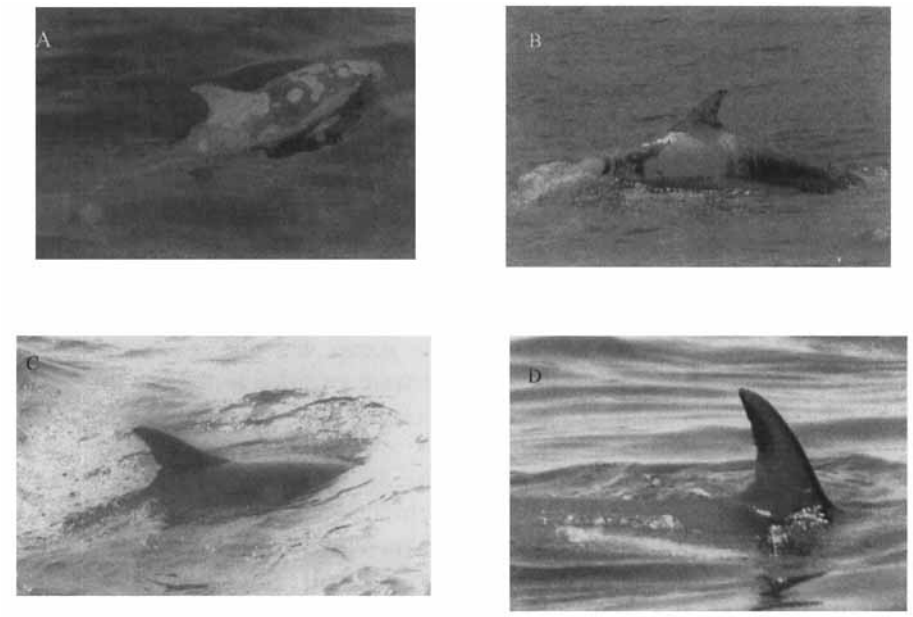

Figure 2. Examples of distinctively marked Atlantic white-sided dolphins, including both distinctively pigmented individuals and those with distinctive dorsal fin nicks and notches.

Social interaction—Dolphins repeatedly jumping or tail slapping, rolling with each other, or clearly focusing on interactions between each other.

Other—Any other behavioral category.

Data were analyzed using SPSS/PC version 4.1. Parametric statistical tests were used throughout, with a significance level of $P = 0.05$. Pair-wise mean comparisons were made using independent t-tests except where noted. All sightings where group size was recorded were included in the overall database. Because data forms had varying degrees of completeness, sample sizes for each analysis varied considerably, and are given throughout the paper.

If observers noted any distinctive dolphins, an attempt was made to photo-identify them. Two classes of distinctive individuals were noted (Fig. 2). Some animals were immediately recognizable through highly prominent marks, including partly missing dorsal fins or large amounts of white pigment on the dorsal fin or flanks. This white coloration has been noted in several other odontocete species (Hain and Leatherwood 1982), although it is unknown whether it is a permanent, genetically determined pattern [similar markings were attributed to partial albinism in dusky dolphins (*Lagenorhynchus obscurus*) by Van Waerebeek (1993)], or whether it has an environmentally determined origin (and is therefore possibly variable over time). We also attempted, where possible, to photograph animals with distinctive dorsal fin nicks or notches. This technique has been used in many species of coastal dolphins with great

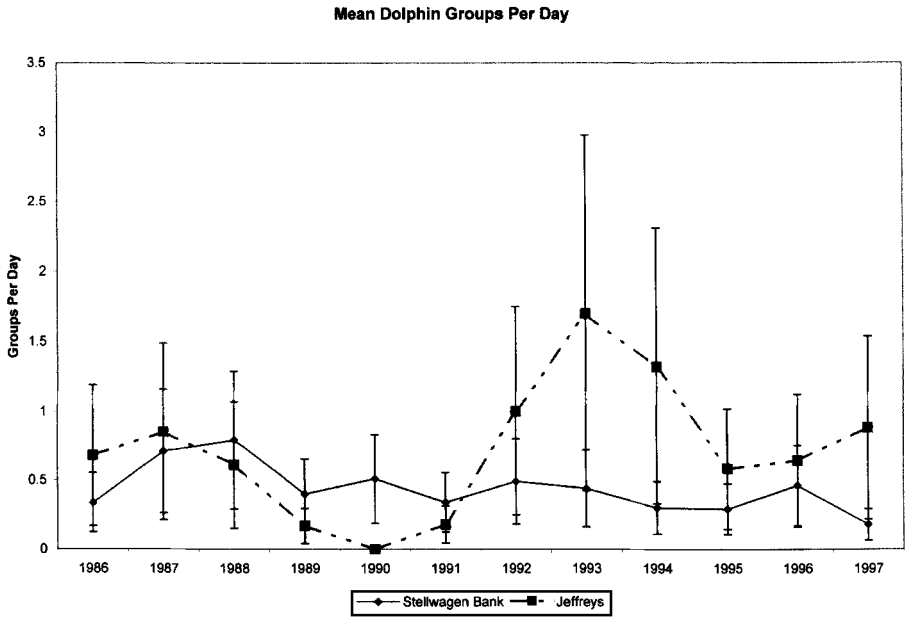

Figure 3. Mean number of Atlantic white-sided dolphin groups seen per day on Stellwagen Bank and Jeffreys Ledge by year, 1986–1997.

success (Wells *et al.* 1987; Würsig and Würsig 1977, 1980; Würsig and Jefferson 1990).

Results

Sighting Frequency

Atlantic white-sided dolphins were seen a total of 1,231 times between 1986 and 1997. Of these sightings, 729 (59.2%) were on Stellwagen Bank (or 0.4 groups/day throughout the study), 425 (34.5%) were on Jeffreys Ledge (or 0.9 groups/day throughout the study), and 77 (6.3%) were in other areas. No significant trend in annual sighting frequency (based on mean number of groups seen per day) was detected either for the entire study area ($r^2 = -0.12$, $P = 0.99$), or Jeffreys Ledge ($r^2 = 0.09$, $P = 0.33$), while Stellwagen Bank showed a significant decrease ($r^2 = -0.34$, $P = 0.05$; Fig. 3).

Group Size

The mean group size of all sightings of Atlantic white-sided dolphins was 52.4 (SD = 90.90, $n = 985$, range 2–2,500). When broken down by month, however, mean group sizes showed a significant increase through the year (ANOVA test, $F = 10.32$, df = 6, 1,096, $P < 0.001$), from a low of 25.7 (SD = 30.54, $n = 136$) in June to a high of 89.5 (SD = 164.35, $n = 151$)

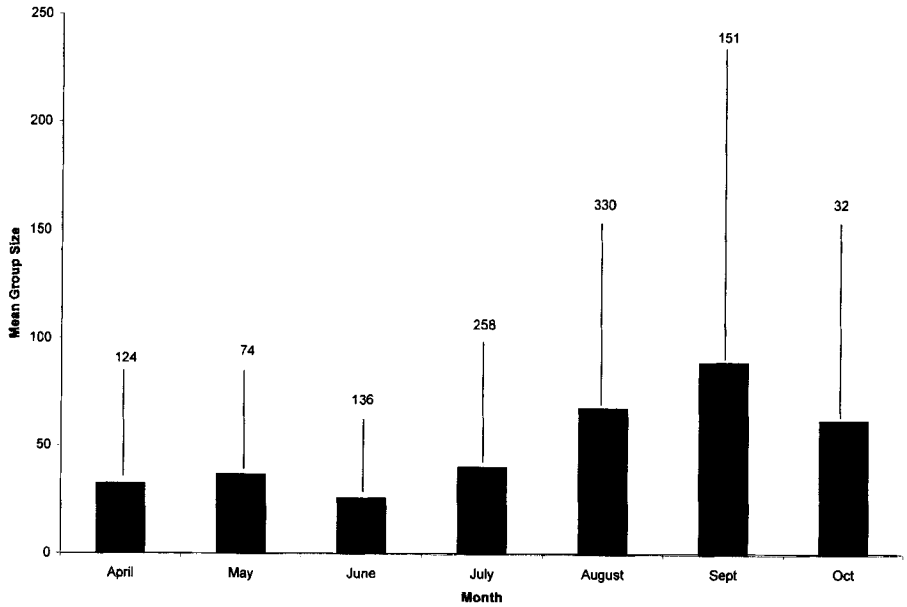

Figure 4. Mean group size of Atlantic white-sided dolphins by month, 1984–1995. Error bars represent one standard deviation, and total sample size of each month given on top of bar.

in September (Fig. 4). Group sizes showed no significant difference from April to June (ANOVA test, $F = 1.94$, df = 2, 331, $P = 0.145$) or from August to October (ANOVA test, $F = 1.91$, df = 2, 508, $P = 0.149$), indicating that there was a sudden, rather than gradual, increase in group size during the second half of the field season. There was also a significant difference in group size based on habitat through the season: on Jeffreys Ledge mean group size was 74.0 (SD = 131.85), while on Stellwagen Bank the mean group size was only 40.1 (SD = 53.03, $t = 6.18$, $P < 0.001$).

Group size also varied based on the presence or absence of calves in a group. When calves were present, mean group size was 76.0 (SD = 121.19, $n = 460$) animals, whereas without calves it was 36.0 (SD = 55.71, $n = 643$) ($t = 4.74$, $P < 0.001$; Table 1). Since the presence of calves also has a seasonal effect (see below), we tested group size by month both with and without calves. In both cases, a significant increase in group size was seen through the season (with calves: ANOVA test, $F = 4.71$, df = 6, 454, $P < 0.001$; without calves: ANOVA test, $F = 4.49$, df = 6, 635, $P < 0.001$), indicating that seasonality alone did not account for the difference in calf and non-calf groups.

Dolphin groups were also found to vary in size depending on behavior ($n = 470$). Dolphin groups were significantly larger during travel, dolphin-boat interactions, and social interaction, than during feeding and dolphin-other species interactions (1-way ANOVA, $F = 2.74$, df = 6, 463, $P = 0.01$).

Table 1. Mean group size by month for groups with and without one or more young-of-the-year calves. Stellwagen Bank and Jeffreys Ledge.

Month	Mean (SD, *n*) dolphin group size	
	Calf present	Calf absent
April	29.11 (18.85, 9)	32.49 (47.90, 115)
May	42.08 (49.90, 12)	35.56 (43.05, 62)
June	38.48 (39.28, 52)	17.74 (19.77, 84)
July	48.18 (60.03, 133)	31.78 (42.17, 125)
August	94.35 (118.51, 163)	41.93 (61.91, 167)
September	116.23 (205.31, 79)	60.25 (93.60, 72)
October	104.58 (113.49, 12)	27.89 (30.95, 18)
Total	75.98 (121.19, 460)	35.95 (55.71, 643)

Calf Presence

Calves were recorded in 460 of 1,112 observed groups (41.4%). Calves were uncommon in April (7.2% of all groups had at least one calf present) or May (19.3% of groups), but were more common during June (38.2% of groups) and July (51.5% of groups). From July through September, calves were present in close to or slightly above 50% of all groups sighted, with a slight drop-off during October (Fig. 5).

Our observations support the contention that some calving takes place during the early summer period. On 12 July 1994 we observed a very small dolphin, estimated at approximately 1 m in length, at close range for several minutes. The dolphin had a slightly bent dorsal fin and numerous dark rings around its body, which we assumed to be fetal folds. It surfaced to breathe

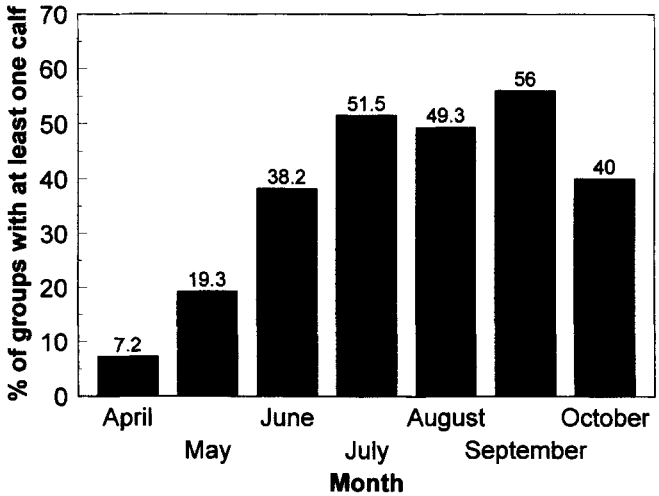

Figure 5. Percentage of observed Atlantic white-sided dolphin groups containing at least one calf by month, 1984–1995.

Table 2. Predominant size categories of Atlantic white-sided dolphins by area.

Predominant size-class	Number of groups	
	Stellwagen	Jeffreys
Large	69	28
Medium	126	123
Small	42	36
Even Mix	20	10
Total	257	197

almost vertically, rather than in the more fluid horizontal motion typical of most dolphins, and cleared the water to the dorsal fin repeatedly. Throughout the observation of 20 min, the small dolphin stayed within 2 m of an adult (visually estimated). Its appearance and awkward behavior indicated to us that the calf was probably no more than a few days old, and was most likely accompanying its mother. Similarly, observations of very small dolphins, approximately half the size of the accompanying adult, increased suddenly during July each year.

Size of Individual Dolphins

Predominant dolphin size was recorded in 478 groups, of which 260 (54.4%) groups were dominated by medium-sized animals, 104 (21.8%) were predominantly comprised of large animals, 84 (17.6%) were predominantly small animals, and 30 (6.2%) were an approximately even mixture of individuals of all sizes. There was a significant difference in predominant size-class between Jeffreys Ledge and Stellwagen Bank ($\chi^2 = 12.89$, $P = 0.005$; Table 2), with Jeffreys having a higher proportion of medium-sized animal groups (62.4% of 197) than Stellwagen (49.0% of 257 sightings), and a lower proportion of large animal groups (14.2% on Jeffreys and 26.8% on Stellwagen). Proportion of small animal groups and even mixes were similar between the two habitats.

Behavior

Behavioral categories—Dolphin behavior was recorded in 470 sightings. In 151 sightings more than one behavior was recorded. Boat interaction was the most common behavior (223 cases, or 47.4% of the 470 sighting subsample), followed by traveling (148 cases, 31.4%), and dolphin–other species interactions (130 cases, 27.6%). Less common behavioral categories were social interactions (73 cases, 15.5%), feeding (45 cases, 9.5%), and "other" (2 cases, 0.4%). No significant difference in the frequency of behaviors was found between the two habitats ($\chi^2 = 3.34$, $P = 0.65$; Table 3).

Boat interactions—Bow-wave riding was recorded in 341 of the 403 cases

Table 3. The number of observations of different dolphin behaviors by area.

Behavior	Number of observations		
	Stellwagen	Jeffreys	Total
Travel	82	58	148
Boat interactions	103	97	223
Feeding	27	15	45
Other species interaction	130	69	55
Social interaction	35	32	73
Other	2	0	2
Total	318	257	621

(84.6%) where the presence or absence of bow riding was noted. In 175 cases the predominant size of individuals engaged in bow riding was noted. Of these, 84 (48.0%) were large animals, 71 (40.6%) were medium-sized, and 19 (10.8%) were predominantly small animals. There was a significant difference in the size breakdown of bow-riding dolphins between Jeffreys Ledge and Stellwagen Bank, with proportionately more large animals and fewer small animals bow riding on Jeffreys Ledge ($\chi^2 = 10.13$, $P = 0.004$). Only one instance of a cow/calf pair bow riding was noted. The mean number of animals bow riding was 8.4 (SD = 6.99, $n = 166$).

Stern-wake riding was also prominent, occurring in 269 of 316 cases where presence or absence was recorded (85.1%). Once again, large (41.7%) and medium animals (46.0%) predominated in this activity, although there was no significant difference in predominant size between the two habitats ($\chi^2 = 2.31$, $P = 0.31$). A mean of 6.4 (SD = 10.69, $n = 135$) animals rode the stern wake.

Aerial behavior—Aerial behavior, or jumping, was broken into two categories: simple and complex leaps. Simple leaps were those that did not involve any spinning or twisting, but rather involved the dolphin clearing the water and re-entering it with a smooth arc. Complex leaps were typically higher, and involved twists and turns while in the air. Overall, aerial behaviors were recorded on 319 of 373 (85.5%) sightings.

When leaps were seen, they were often repeated. Mean number of simple leaps was 8.8 (SD = 7.5, $n = 130$), while the mean number of complex leaps was 5.8 (SD = 7.53, $n = 77$). Numbers of leaps in each category showed a significant positive relationship to group size (simple leaps: $r^2 = 0.47$, $P < 0.001$; complex leaps: $r^2 = 0.48$, $P < 0.001$), indicating that numbers of leaps increased as group size increased. While we attempted to determine whether the same animal was leaping more than once, the time between jumps and the rapid movements of individuals made it impossible to assess this factor. Mean group sizes were significantly larger when leaps were present ($\bar{x} = 92.7$, SD = 122.70 individuals in the group when leaps were present; $\bar{x} = 27.7$, SD = 36.48 when leaps were noted to be absent [$n = 373$]).

Associated species—Many associations between dolphins and other species consisted of the dolphins apparently "bow riding" the pressure wave of swim-

ming whales. Dolphins were associated with other species on 190 sightings. Of these, 107 (56.4%) were with fin whales, 78 (41.0%) were with humpback whales, and 5 (2.6%) were associated with long-finned pilot whales (*Globicephala melas,* see Baraff and Asmutus-Silvia 1998). The large whale associations typically represent the dolphins traveling immediately ahead of, and most likely "bow riding" the whale. Between the two larger baleen whales, a significant difference was found between our two study areas ($\chi^2 = 6.43$, $P = 0.04$). On Stellwagen Bank fin whales comprised 52.4% of the 101 associated species sightings, while fin whales accounted for 68.9% of the 77 associated species sightings on Jeffreys Ledge.

Humpback whales appear to be disturbed by the presence of white-sided dolphins. High frequencies of trumpet blows, tail slashes, and aerial activity, all associated with agonistic activity in other studies of humpbacks (Watkins 1967, Baker and Herman 1984, Weinrich *et al.* 1992) were recorded in many sightings.

Feeding—Although feeding behavior was inferred on 45 occasions, feeding behavior was seen only once. On 20 December 1997 a group of 35–50 Atlantic white-sided dolphins were observed on Stellwagen Bank. During this observation mainly large (presumably adult) dolphins circled a dark rippling area on the water. Closer inspection revealed a dense aggregation of sand lance (*Ammodytes* spp.) that appeared to be corralled by a subgroup of 10–12 dolphins. Dolphins (including one mother-calf pair) sporadically rushed through the center of the school, presumably feeding on the balled fish.

Photo-identification

Photographs of Atlantic white-sided dolphins were taken in 114 groups, for a total of 163 images. Of these, photographs of sufficient quality to allow reidentification were obtained of 88 individually distinctive dolphins. Of these, 32 had anomalous pigmentation on their bodies, including 10 animals that had substantial amounts of white pigment on their bodies, and six that had primarily or totally white dorsal fins. The other 56 dolphins had notches or other deformities in their dorsal fin. Five dolphins, four of which had unusual pigment, were photographed more than once, and one was photographed three times (Table 4). Whereas there were a number of between-year matches of individuals moving between Stellwagen Bank, Jeffreys Ledge, and the Great South Channel, there are no within-year matches of any dolphin. Two dolphins were matched in consecutive years. The longest interval between matches was five years.

Discussion

Atlantic white-sided dolphins are common visitors to the southern Gulf of Maine. Their sighting frequency has remained high throughout the 12-yr study period, although it dropped sharply on Stellwagen Bank starting in 1994. This corresponds with a similar drop in the number of humpback whales

Table 4. Resightings of photo-identified Atlantic white-sided dolphins.

Distinctive mark	1st Sighting	Area	Resighting	Area
White Pigment[a]	07/07/82	Stellwagen	06/23/85	Stellwagen
White Pigment[a]	07/07/82	Stellwagen	09/02/86	Great South Channel
White Pigment	10/15/88	Stellwagen	07/18/89	Stellwagen
White Pigment	07/01/86	Great South	09/06/87	Great South Channel
White Dorsal Fin	05/05/84	Jeffreys	06/15/88	Great South Channel
Notched Dorsal Fin	09/02/87	Jeffreys	09/19/92	Stellwagen

[a] Same dolphin.

seen on Stellwagen during a similar period (Weinrich *et al.* 1997) that was hypothesized as being related to a decreased abundance of sand lance.

Although dolphin groups were frequently sighted in the two study locations, no individual or group showed any indication of being either a short- or long-term resident during any season. No animal was seen more than once during any year. The lack of residency in our study area would suggest that Atlantic white-sided dolphins, and perhaps other oceanic delphinids, may travel broadly year-round throughout their range.[2] Alternately, despite the frequency of sightings, the study area may merely not be one that is transited between two residential locations.

Dolphin groups were not sighted with equal frequency throughout our field seasons. Sightings were relatively common in April, when we started our effort, but were relatively uncommon during May and June. From July onward, however, sightings were relatively commonplace, with group sizes generally much larger than those seen in the earlier part of the year. Two possibilities could explain the larger group sizes: either smaller groups combine into larger "super-pods" as the season progresses, or two populations each with different social patterns use the area at different times of the year. The relatively few between-year resightings of even very distinctive animals indicate that individual dolphins rarely return to an area annually. Stranding data, however, suggest that winter/spring groups may be made up primarily of adult males, while summer groups are predominantly females and young, with some males present,[3] suggesting that our sightings through the different seasons represent different population components.

As expected for non-resident dolphins, the predominant behavior of many groups was traveling. Often dolphins moved at three to six knots, and traversed a relatively large distance even during a brief observation. They were most often seen traveling in a southerly direction (southeast, south, or southwest). The number of groups in which feeding was the prevalent behavior was small also, as might be expected from transient animals.

On Stellwagen Bank the lack of observations of feeding might also be explained if, contrary to popular assumptions, sand lance are not a major prey item for white-sided dolphins. Sand lance have never been found in the stomachs of Atlantic white-sided dolphins, whether from stranded animals in the northeastern United States,[3] incidentally-caught animals captured in U.S. bottom-set gill net fisheries,[4] or incidentally-caught animals in the northeast Atlantic off of Britain (Couperus 1998). Since sand lance are small, and have a thin bony structure, they may just be digested quickly and therefore be underrepresented in stomach content data. Our lone observation of dolphins feeding on what appeared to be balled sand lance on Stellwagen Bank suggests

[2] Personal communication from Koen Van Waerebeek, Coupre 60, Gent B-9000, Belgium, 19 November 1999.

[3] Personal communication from G. Early, New England Aquarium, Central Wharf, Boston, MA 02110, 10 September 1998.

[4] Personal communication from John Nicholas, Northeast Fisheries Science Center, National Marine Fisheries Service, Woods Hole, MA 02543, 23 April 1998.

this possibility. Our single feeding observation also supports Würsig's (1987) theory of cooperative foraging through encircling prey.

Why dolphins are not seen feeding more often on Jeffreys Ledge is more puzzling. Observations of fishing boats targeting herring in the areas where whales and dolphins are seen suggest that even if herring were not the primary prey of nearby whales, they were present in some numbers. Since surface evidence of feeding was also rarely observed throughout the range of dolphins in the southern Gulf of Maine by CETAP (1982), it does appear that many cases of feeding may be missed, and classified as another behavior (*e.g.*, traveling).

Dolphins were observed to frequently ride the bow and stern wake of vessels when in their company. The actual frequency of bow riding may be slightly overrepresented, as (1) observers might not notice its absence, but will always note its presence; (2) whale-watch boats often tried to solicit this behavior by driving through dolphin groups in their direction of travel; and (3) the behavior, by definition, takes place close to the vessel and is therefore unlikely to be missed. Atlantic white-sided dolphins were often involved in bow riding only when the vessel was traveling in the direction the group had been heading when they were initially sighted. If the vessel steered a course drastically different than the travel direction of the group on approach after dolphins started bow riding, the behavior would usually cease. As soon as the vessel turned back on the course the dolphins had been heading, they resumed the activity. We therefore concur with previous suggestions (Hayes 1953, Fejer and Backus 1960, Lighthill 1970, Newman and Wu 1974) that dolphins may be using this behavior as a way to increase traveling efficiency. Age, experience, and/or rank in the group may have had some effect on which individuals engaged in this behavior; hence, it was rare to see small animals or cow-calf pairs in the pressure waves created by the vessel, while large and medium-sized animals predominated.

Jumps and other aerial activities also seemed to be used in social contexts. Jumps were more frequently seen in larger groups than smaller ones. We did not note any particular social situations during which jumping appeared most common, as Würsig and Würsig (1980) did in dusky dolphins (jumping immediately after feeding). Hence, we cannot comment on the role aerial activity may play in dolphin society, nor whether one or more animals in the group most often did it. In addition to jumping, lob-tailing was also seen, although it was much less common than jumping. The same individual often carried out lob-tails repeatedly in a short period of time.

The results of our photo-identification work indicate widespread movements of Atlantic white-sided dolphins. Despite intensive daily within-area coverage, no dolphin was resighted within a year. If the dolphins were resident over either Stellwagen Bank or Jeffreys Ledge for even a brief period, one would expect at least a few resightings of distinctive animals within a few days of the initial sighting [as with humpback whales (Clapham *et al.* 1993, Weinrich *et al.* 1997) fin whales (Seipt *et al.* 1989), and sei whales (*Balaenoptera borealis*; Schilling *et al.* 1992) in the same area] but that was not the case. Furthermore,

when reidentifications did take place, it was often between two different study areas.

We do, however, believe that there is a great discrepancy in the ability of observers to notice, and photograph, unusually pigmented dolphins *vs.* those with smaller dorsal fin variations. There may be several reasons for this. Unusual white pigment was easily noticed, whereas a more subtle dorsal fin notch or nick might be overlooked. Once spotted however, the white pigment of the distinctively colored dolphin gives the photographer a distinct advantage, as the light color can be followed below the surface as the dolphin travels between respirations. In a normally pigmented animal mixed among many others in the group, it was easy to lose track of a dolphin between surfacings, and it was difficult to prepare a camera for an identifying photograph. We feel this accounts for the comparatively large number of distinctively pigmented dolphin resightings despite the small number of individuals. While we do not know for how long the distinctive coloration lasts, our longest period between matches for this group was four years (in two cases); no change was determined in that period, indicating at least some stability in coloration.

In general, due to the speed and unpredictable nature of the dolphins at the surface, the lack of close approaches for most members of a group due to time constraints (especially true of groups of more than fifty animals), the high number of animals without such distinctive marks, and the difficulty in matching subtle marks from a large population (the Gulf of Maine population was estimated at over 36,000 animals in 1982 (CETAP 1982)), we feel that this technique is of limited use in the study of Atlantic white-sided dolphins.

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