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SHORT PAPERS AND NOTES

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PRELIMINARY FINDINGS ON THE OCCURRENCE AND SITE FIDELITY OF PHOTO-IDENTIFIED SPERM WHALES (*PHYSETER MACROCEPHALUS*) IN THE NORTHERN GULF OF MEXICO.—Sperm whales (*Physeter macrocephalus*) are the most common large whale in the northern Gulf of Mexico (Schmidly, 1981; Mullin et al., 1994; Davis and Fargion, 1996; Jefferson, 1996; Davis et al., 1999; Würsig et al., 2000). The regular occurrence of this endangered species in the Gulf is known from whaling records of the mid-1700s to early 1900s (Townsend, 1935) and from aerial and ship-based abundance and distribution surveys (Collum and Fritts, 1985; Mullin et al., 1994; Davis and Fargion, 1996; Jefferson, 1996; Davis et al., 1999). Recent population estimates indicate that a minimum of 300–530 sperm whales populate the northern Gulf of Mexico (Davis and Fargion, 1996; Jefferson, 1996; Waring et al., 1997; Davis et al., 1999).

Sperm whales generally inhabit deep waters near oceanic islands, continental shelves, and submarine canyons (Rice, 1989). A similar pattern appears in the northern Gulf of Mexico, with most sperm whale sightings occurring in water depths between 900 and 1200 m (Collum and Fritts, 1985; Mullin et al., 1994; Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 1998, 1999). In particular, the continental slope off the Mississippi River Delta is an area recognized for high densities of sperm whales and represents a habitat where they can be predictably found (Townsend, 1935; Mullin et al., 1994; Davis and Fargion, 1996; Jefferson, 1996; Davis et al., 1998).

Although general information on the distribution and abundance of sperm whales in the Gulf has become increasingly available (Mullin et al., 1994; Davis and Fargion, 1996; Jefferson, 1996; Davis et al., 1999), data regarding individual movement patterns and site fidelity are limited. For example, it is currently unknown if individuals or groups of sperm whales reside in the Gulf year-round, are transient to the region, or undertake migrations to and from other nearby oceanic basins such as the Atlantic or Caribbean. During a collaborative research effort between Texas A&M University and the National Marine Fisheries Service (GulfCet Program), the first information concerning the occurrence, movement patterns, and site

fidelity of individually identified sperm whales off the Mississippi River Delta was gathered, and results from this study are presented here.

Methods.—Two ship-based surveys, during which significant effort was devoted to behavioral observations and photo-identification of sperm whales, were completed. The first sampling period was 20–28 August 1994 and the second was 20–28 October 1996. The respective study areas for each survey were centered on the continental slope south of the Mississippi River Delta (Fig. 1).

During each survey, ship-based observers located sperm whales with 25 × 150 binoculars. Once whales were sighted, observations of surface behavior and group size were recorded, and when weather permitted, a small 4.2-m inflatable boat with a research crew consisting of a driver, photographer, and videographer was launched from the ship. The small boat was guided to sperm whales by VHF radio communication from ship-based observers. The primary objective of this work was to motor within 3–15 m of whales for purposes of individual identification. Sperm whales, like many cetaceans, can be reliably identified from photographs of individually unique nicks and notches on the trailing edge of their flukes (Arnbom, 1987).

Group locations were determined with a hand-held global positioning system, and photographs were collected with Nikon 35-mm cameras equipped with 100–300-mm zoom telephoto lenses and Kodachrome 200 ISO color slide film. Fluke photographs were also taken opportunistically from the ship when whales passed nearby, and one individual (whale 032) was photographed in study area A (see Fig. 1) on 26 August 1996 from a small Texas A&M research boat conducting sperm whale acoustic studies. All fluke photographs were analyzed and cataloged by the Marine Mammal Research Program at Texas A&M University Galveston. The term “resighting” is used here to refer to cases in which a previously identified individual was sighted and photographed again at a later time, date, or year. Three researchers experienced with photo-identification techniques independently confirmed each resighting of an individual whale.

Photogrammetry methods were used to measure the body lengths of individual whales

Fig. 1. Map of the 1994 (A) and 1996 (B) focal study areas. Dashed lines represent depth contours.

during the present study. Following the techniques developed by Gordon (1990) for ship-based measurement of free-ranging sperm whales, body size estimates were derived by the following calculation: $h^1s/f=h$, where h^1 = image size, s = distance to the object, f = focal length of camera lens, and h = size of the object.

Results.—A total of 37 individual whales were photographically identified during 1994 and 1996. Sighting locations were predominantly in water depths between 700 and 1,100 m. The distances between sightings for whales seen two or more times were calculated for within-day periods ($n = 10$), between-day periods ($n = 4$), and between years ($n = 4$). Four of the 37 whales identified (10.8%) were resighted on multiple days intra-annually, and four individuals were resighted interannually. The ranges of distances between resightings were 2.4–9.9 km on the same day, 17.3–24.3 km between days, and 36.6–46.2 km between years (Table 1). The time between sightings of identified whales on the same day ranged from 47.0 to 91.0 min, and minimum travel speeds between these sightings ranged from 2.6 to 12.7 $\text{km}\cdot\text{hr}^{-1}$ (mean $\pm$ SD = $5.2 \pm 3.14 \text{ km}\cdot\text{hr}^{-1}$) (Table 2).

The mean ($\pm$ SD) group size observed for

1994 and 1996 combined was 2.2 whales (± 1.61 , $n = 239$), and mean ($\pm$ SD) group sizes in 1994 and 1996 separately were 2.2 (± 1.65 , $n = 223$) and 1.9 (± 1.00 , $n = 16$), respectively. Of the 239 groups observed, 48.5% ($n = 116$) consisted of single whales, and 72.0% ($n = 172$) of all groups contained two animals or less. Although the age/sex composition of sperm whale groups encountered during the study was undetermined, several groups contained calves, and body size estimates for five whales measured photographically (mean $\pm$ SD = $9.0 \pm 1.58 \text{ m}$, range = 6.6–10.4 m) fell within the range typical of females and immature individuals (Best, 1979).

Discussion.—The occurrence, movement patterns, and site fidelity of individually identified sperm whales reported here indicate that at least some whales maintained a level of intra- and interannual site fidelity to waters offshore of the Mississippi River Delta in the northern Gulf of Mexico. These findings, in combination with the high densities of sperm whales observed in the same region by whalers (Townsend, 1935) and during ship and aerial surveys (Davis et al., 1999), suggest that the continental slope south of the Mississippi River Delta, and perhaps more specifically the Mississippi Canyon, plays an important role in the ecology

TABLE 1. Sighting locations, sighting dates, and distances between sightings for photo-identified individuals. Distances represent minimum estimates between sequential sightings.

Whale ID	Sighting date	Latitude (°N)	Longitude (°W)	Distance (km)	Whale ID	Sighting date	Latitude (°N)	Longitude (°W)	Distance (km)
001	08/23/94	28.7388	88.7525		016	08/28/94	28.5687	88.9020	
001	08/23/94	28.7122	88.6553	9.92	016	10/20/96	28.9150	88.9250	38.55
001	08/25/94	28.7308	88.8680	20.83	017	08/25/94	28.6568	88.8427	
002	08/22/94	28.7080	88.8550		018	08/22/94	28.7048	88.8367	
003	08/23/94	28.7120	88.7157		019	08/28/94	28.5610	88.9078	
003	08/23/94	28.7125	88.6557	5.85	020	08/23/94	28.7277	88.7568	
004	08/23/94	28.7120	88.7157		021	10/20/96	28.9540	88.9150	
004	08/23/94	28.7125	88.6557	5.85	022	10/28/96	28.0112	89.1528	
005	08/24/94	28.7405	88.8012		023	10/28/96	28.0291	89.1286	
005	08/28/94	28.5388	88.8977	24.31	024	10/28/96	28.0462	89.1244	
005	10/20/96	28.9540	88.9150	46.16	025	10/20/96	28.6610	89.0040	
006	08/23/94	28.7163	88.7382		026	10/20/96	28.6420	88.9910	
006	08/28/94	28.5743	88.9032	22.54	026	10/20/96	28.6250	89.0060	2.39
006	08/28/94	28.5447	88.8980	3.33	027	10/20/96	28.6250	89.0060	
007	08/23/94	28.6973	88.6348		028	10/20/96	28.6420	88.9910	
008	08/28/94	28.5673	88.9023		028	10/20/96	28.6250	89.0060	2.39
009	08/28/94	28.5447	88.8980		029	08/23/94	28.7363	88.6610	
009	10/20/96	28.9370	88.9190	43.64	029	10/20/96	28.6070	89.0060	36.58
010	08/23/94	28.7130	88.6917		030	10/20/96	28.8640	88.9770	
010	08/25/94	28.7308	88.8680	17.30	031	10/20/96	28.8910	88.9430	
011	08/28/94	28.5743	88.9032		032	08/26/96	28.7853	88.7542	
012	08/25/94	28.7100	88.8605		033	10/20/96	28.9150	88.9250	
013	08/24/94	28.6828	88.8615		034	10/28/96	28.0746	89.1713	
014	08/23/94	28.7015	88.8058		035	10/28/96	28.0462	89.1244	
014	08/23/94	28.7087	88.7808	2.56	036	08/23/94	28.7358	88.6575	
015 ^a	08/23/94	28.7015	88.8058		037	10/20/96	28.6610	89.0040	
015	08/23/94	28.7087	88.7808	2.56					
015	08/23/94	28.7163	88.7382	4.24					

^a The distance between the first and third sightings of whale 015 on 08/23/94 was 6.80 km.

of this odontocete species. The nutrient-rich discharge of the Mississippi River into offshore Gulf waters may result in a particularly productive, albeit presently poorly understood, habitat for sperm whale prey items such as

squid. Finer scale movements of sperm whales in the general area may also be affected by the presence of cyclonic and anticyclonic ocean current gyres that bud off the Yucatan Current (Davis et al., 1999).

The mean group size of 2.2 observed during the present study falls well within the range of 1.4–3.5 previously reported for sperm whales in the northern Gulf of Mexico (Collum and Fritts, 1985; Mullin et al., 1994; Davis and Fargion, 1996; Davis et al., 1999). As proposed by Mullin and colleagues (Mullin et al., 1994), the relatively small group size characteristic of sperm whales in the Gulf appears to correspond to the “clusters” formed by sperm whales off the Galapagos Islands (Whitehead and Arnborn, 1987). Whitehead and Arnborn (1987) defined a whale cluster as whales swimming in a coordinated manner within 100 m of each other. Female-based groups in the Galapagos form one to four clusters while at the surface, with an average size of 1.7 animals and a mean intercluster distance of 213 m (White-

TABLE 2. Minimum travel speeds for whales identified two or more times on the same day.

Time between sightings (min)	Distance between sightings (km)	Minimum travel speed (km/hr)
47.0	9.92	12.7
51.0	5.85	6.9
49.0	5.85	7.2
77.0	3.33	2.6
42.0	2.56	3.7
42.0	2.56	3.7
49.0	4.24	5.2
91.0	6.80	4.5
55.0	2.39	2.6
55.0	2.39	2.6

head, 1989). Although not quantitatively substantiated by the work reported here, it was our impression that once a group of sperm whales was detected, it was common to then begin sighting additional groups in the same general vicinity.

The social structure and movement patterns of sperm whales in the Gulf of Mexico are poorly known. Long-term studies off the Galapagos have described the primary sperm whale social unit as relatively stable groups composed of females, calves, and juveniles that remain in tropical and subtropical waters year-round (Whitehead and Arnborn, 1987; Whitehead et al., 1991; Richard et al., 1996; Christal et al., 1998). Sexually immature males disperse from their natal groups at approximately 6 yr of age (Richard et al., 1996) and form "bachelor" schools with other like-aged males (Best, 1979). In contrast, sexually mature males are often solitary, spending considerable time in high-latitude waters (Rice, 1989). During their late 20s, however, mature males return to tropical and subtropical waters to breed (Rice, 1989; Christal et al., 1998).

Strong sexual dimorphism occurs in sperm whales, with males and females growing to approximately 18 m and 12 m, respectively (Rice, 1989). Body size estimates reported here fall within the known ranges for female and immature sperm whales (Best, 1979). No observations of exceptionally large whales (relative to nearby conspecifics) were recorded during the study, which may indicate that large adult males are either infrequent visitors or simply do not inhabit the northern Gulf of Mexico. Although the above findings are based on a limited set of observations, when combined with descriptions of sperm whale social organization in other areas, it is reasonable to assume that sperm whales in the northern Gulf also maintain a social system characterized by female-based groups. Until additional data at both the spatial and temporal level are collected, two possible movement patterns may be hypothesized for sperm whales in the Gulf of Mexico: 1) female-based groups remain in the Gulf year-round and males move into the area on an occasional basis, or 2) female-based groups immigrate to and emigrate from the Gulf to mix with mature males in other oceanic regions such as the Atlantic or Caribbean.

Questions regarding population size, stock structure, and long-distance movement patterns can be addressed in the future by additional photo-identification studies in combination with other techniques such as genetic sampling and satellite tracking. In light of the

current expansion of oil and gas development activities into the offshore regions of the Gulf of Mexico, it is critical that increased information be collected regarding the basic behavioral ecology and potential industry-related disturbance of deep-water cetaceans such as the sperm whale.

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