Short-term Movements of Radio-tagged Harbor Seals in New England

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Abstract - We captured and radio-tagged 29 harbor seals in spring 2001 in Chatham, MA, and off Rockland, ME. Male and female seals of all ages were captured in Chatham, compared to mostly juveniles in Maine. Seventy-five percent (9/12) of the Chatham seals moved to the Maine coast in spring and summer during the pupping, breeding, and moult seasons. Similarly, seventy-one percent (12/17) of seals tagged in western Penobscot Bay remained in the mid-Maine coastal region during these seasons. These short-term movement patterns suggest that Penobscot Bay may be the source for some of the seals overwintering in southern New England.

Introduction

Phoca vitulina concolor (Dekay) (harbor seal) is the most abundant and widely distributed phocid seal in New England coastal waters (Baraff and Loughlin 2000, Gilbert et al. 2005). Although the stock structure is unknown, Temte et al. (1991) proposed that harbor seals found along the eastern US and Canadian coasts represent one stock.

Harbor seals are year-round inhabitants in the coastal waters of Maine and eastern Canada (Baird 2001, Katona et al. 1993), and occur seasonally along the southern New England to New Jersey coasts between September and May (Barlas 1999; deHart 2002; Schneider and Payne 1983; C. Slocum, Stockton College, pers. comm.). A general southward movement in the fall from the Bay of Fundy to southern New England (SNE) and mid-Atlantic waters (MAD) has been suggested from a decline in numbers in the Bay of Fundy with a corresponding increase in numbers in southern New England (Barlas 1999, Rosenfeld et al. 1988, Whitman and Payne 1990). A northward movement from mid-Atlantic and southern New England to Maine and eastern Canada occurs prior to the pupping and breeding season. Births occur from May through early June along the Maine coast, and progressively later in eastern Canada (Bowen et al. 2003, Dubé et al. 2003, Gilbert and Stein 1981, Kenney 1994, Richardson 1976, Temte et al. 1991, Whitman and Payne 1990, Wilson 1978).

Since passage of the Marine Mammal Protection Act (MMPA) in 1972, the observed count of seals during the pupping season along the New England coast has increased nearly nine-fold. Five coast-wide surveys

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(1981, 1986, 1993, 1997 and 2001) have been conducted along the Maine coast in May/June during pupping (Gilbert and Guldager 1998, Gilbert et al. 2005, Kenney and Gilbert 1994). Prior to 2001, none of the estimates were corrected for the fraction of seals in the water (e.g., not hauled-out) during the survey flights. The 1997 (31,000) count was nearly 3 and 2.4 times greater, respectively, than 1981 (10,500) and 1986 (12,900) counts (Guldager 2001). The 2001 observed and corrected counts, respectively, were 38,000 and 99,300 harbor seals (Gilbert et al. 2005). Harbor seals were counted in a March 1986 aerial survey (J.R. Gilbert, unpubl. data) that coincided with a similar survey in southern New England (Payne and Selzer 1989). In Maine, 5799 harbor seals were counted compared to 4736 animals counted between the Maine–New Hampshire border and western Rhode Island coast by Payne and Selzer (1989). Barlas (1999) reported maximum counts of ≈ 6500 seals in spring 1999 from aerial surveys conducted between Isles of Shoals and eastern Long Island. It is not known whether the seals observed in southern New England in the winter may have included some harbor seals from eastern Canada, as suggested by Rosenfeld et al. (1988) and Temte et al. (1991).

Prior to 1999, few harbor seals were captured and tagged in New England. In 1981, two sub-adult male harbor seals were captured at night in Holmes

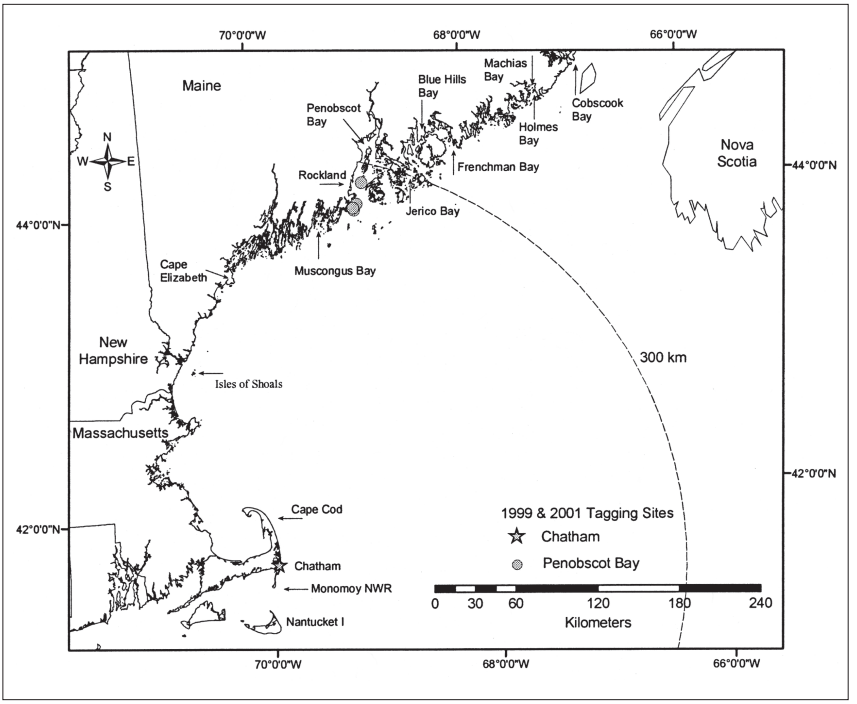

Figure 1. Map of New England coast from Cape Cod to Maine. The dashed line represents a 300-km buffer from the Chatham tagging location.

Bay (Gilbert and Stein 1981, see Fig. 1). One animal was radio-tagged and tracked in Holmes Bay until the tag was shed 22 days later. Between 1982 and 1984, seventy-nine weaned harbor seal pups were tagged, primarily in Blue Hill and East Penobscot Bays, ME (Gilbert and Wynne 1983, 1984, 1985). Most were tagged with flipper tags and streamers only; but five also had VHF radios attached. Most of the 25 resightings during the next three years were in the same year and area where they were tagged. However, two were seen in Nova Scotia, one the same summer and the other the next summer. Four were seen in the Cape Cod–Nantucket area the winter and spring following tagging. Radio-tagged individuals were not found after June 24.

Here we report the short-term movements of harbor seals that were radio-tagged in spring 1999 and 2001.

Methods

We captured and tagged four seals in Western Penobscot Bay (Fig. 1) from 3–7 May 1999 (Table 1) and 39 seals in Chatham, MA, and Western Penobscot Bay (Fig. 1) between 14 March and 20 April 2001 (Tables 2 and 3).

Capture operations were similar in both years and at all sites, following techniques described by Jeffries et al. (1993) and Withrow and Loughlin (1997). The capture net was made of four different colored (dark green, light green, dark blue, and light blue) panels, each 25 m long and 7.4 m deep. The netting was #30 nylon with 30-cm stretch mesh, florescent pink floatline, and leadline (Research Nets Inc., Redmond, WA; reference to products or trade names does not imply endorsement by NOAA Fisheries Service).

Captured seals were externally examined, and sex, age class, standard length, girth, mass, ultrasound, and injuries, scars, and wounds were recorded (Withrow and Loughlin 1997).

In 1999, we attached a VHF transmitter (Telonics mode 7PN) mounted on a Temple tag to each hind flipper. In 2001, two VHF transmitters were attached to each animal; one (Lotek model MBFT-5) was mounted on a flipper tag (Alflex) and a second (Telonics MOD-073) was glued to the

Table 1. Capture date, location, transmitter frequency, sex, standard length, weight, age class, and seal identification (ID) number for harbor seals captured in Western Penobscot Bay in 1999.

Date	Exact location	Transmitter frequency	Sex	Length (cm)	Weight (kg)	Age	Seal ID
05/03/99	Hewett Rocks	***	M	***	37.2	Juvenile	99PV001[1]
05/04/99	Robinson Rock	L:164.180 R:164.210	F	112	37.1	Juvenile	99PV002
05/06/99	Crescent Island	L:164.142 R:164.191	M	161	110.4	Adult	99PV003
05/07/99	Robison Rock	L:164.202 R:164.161	F	112	32.2	Juvenile	99PV004

[1]Seal died in capture net.

lower back using 5-min epoxy (Fedak et al. 1983). These attachment locations allowed signal transmission when the seasl were hauled-out (Gilbert et al. 2005). A second numbered flipper tag (Alflex) was attached to the other hind flipper.

We made surveys for seals between 4 and 22 June 1999 from Muscongus Bay to Frenchman Bay and the outer islands (Fig. 1).

Surveys made between 1 and 14 May 2001, prior to population surveys, and 16 May to 4 June covered the area between Cobscook Bay on the US–Canadian Border and the Isle of Shoals on the Maine–New Hampshire border (Fig. 1). From 21–26 May, the time of low tide was too late in the evening or too early in the morning for effective searching. A final flight was conducted on 18 July, at the start of the molt period, and only covered Penobscot Bay.

The tracking surveys were conducted at 2 h around low tide, and the aircraft flew at an altitude of 600 m. For safety reasons it could not descend to obtain precise locations of resighted seals; therefore, general area locations (e.g., around Vinalhaven, near Mount Desert Island) were adopted.

Table 2. Capture date, transmitter frequency, sex, standard length, weight, age class, and seal identification (ID) number for harbor seals captured in Chatham Harbor, Chatham, MA in 2001.

Date	Transmitter frequency	Sex	Length (cm)	Weight (kg)	Age	Seal ID
03/14/01	T:164.000	M	124	51.0	Subadult	UM01
03/14/01	T:164.720[A]	M	[B]	108.0	Adult	UM02
03/14/01	No Radio[C]	M	152	89.2	Adult	UM03
03/14/01	No Radio[C]	M	153	98.6	Adult	UM04
03/14/01	No Radio[C]	M	140	[B]	Adult	UM05
03/14/01	No Radio[C]	M	[B]	[B]	[B]	UM06
03/14/01	No Radio[C]	M	[B]	[B]	[B]	UM07
03/14/01	No Radio[C]	M	[B]	[B]	[B]	UM08
03/14/01	No Radio[C]	M	[B]	[B]	[B]	UM09
03/15/01	T:164.660, L:165.890	M	141	86.8	Adult	UM10
03/15/01	T:164.540, L:165.930	F	105	30.2	Juvenile	UM11
03/15/01	T:164.140, L:165.950	F	151	96.8	Adult	UM12[D]
03/15/01	L:165.790	M	132	66.2	Adult	UM13[E]
03/15/01	T:165.300, L:165.870	M	153	98.0	Adult	UM14
03/15/01	T:165.040, L:165.970	M	140	88.4	Adult	UM15
03/15/01	T:164.080, L:165.830	M	143	90.6	Adult	UM16
03/16/01	T:164.760, L:165.910	M	90	26.6	Juvenile	UM17
03/19/01	T:165.200, L:165.990	M	138	101.2	Adult	UM18
03/20/01	T:164.820, L:165.310	M	137	120.2	Adult	UM19
03/20/01	T:165.020, L:165.690	M	135	84.8	Adult	UM20
03/20/01	T:164.780, L:165.650	M	140	77.4	Adult	UM21

[A]Tag fell off animal after release.
[B]No data.
[C]Tide change flooded the sand bar and animals were minimally processed, and were tagged in the right hindflipper with an Allflex tag.
[D]Deemed to be pregnant.
[E]Flipper tag only.

Results

In 1999, we caught four seals in Western Penobscot Bay (Fig. 1, Table 1). The first seal died before it could be recovered when the capture net became snagged on the bottom (Table 1).

We made five radio-survey searching flights in June during daytime low tides (Table 4). We detected only one radio transmitter on each of the tagged seals. Evidently, three of the transmitters did not function or were shed. The

Table 3. Capture date, location, transmitter frequency, sex, standard length, weight, age class, and seal identification (ID) number for harbor seals captured in Western Penobscot Bay in 2001.

Date	Exact location	Transmitter frequency	Sex	Length (cm)	Weight (kg)	Age	Seal ID
04/15/01	Hewett Island Rocks	T:164.440 L:165.630	M	116	32.8	Juvenile	UM22
04/15/01	Hewett Island Rocks	T:165.080 L:165.710	F	102	25.6	Juvenile	UM23
04/15/01	Hewett Island Rocks	T:165.240 L:165.750	M	112	42.0	Juvenile	UM24
04/16/01	Robinson Rock	T:165.060 L:165.590	F	138	88.2	Adult[A]	UM25
04/16/01	Robinson Rock	T:164.458 L:165.570	M	99	[B]	Juvenile	UM26
04/17/01	Hewett Island Rocks	T:165.230 L:165.150	F	115	31.5	Juvenile	UM27
04/17/01	Hewett Island Rocks	T:165.120 L:165.730	F	103	30.2	Juvenile	UM28
04/17/01	Hewett Island Rocks	T:164.940 L:165.550	F	104	24.3	Juvenile	UM29
04/17/01	Hewett Island Rocks	T:164.970[C] L:165.190	F	121	38.4	Juvenile	UM30
04/17/01	Hewett Island Rocks	TL164.520 L:165.230	F	95	25.8	Juvenile	UM31
04/17/01	Hewett Island Rocks	T:164.680 L:165.170	M	143	92.8	Adult	UM32
04/17/01	Hewett Island Rocks	[D]	M	96	34.2	Juvenile	UM33
04/19/01	Hewett Island Rocks	T:165.100 L:165.530	M	107	33.7	Juvenile	UM34
04/20/01	Hewett Island Rocks	T:164.400 L:165.210	M	106	30.1	Juvenile	UM35
04/20/01	Nettle Island	T:165.140 L:165.130	M	104	24.6	Juvenile	UM36
04/20/01	Nettle Island	T:165.180 L:165.470	M	99	24.0	Juvenile	UM37
04/21/01	Nettle Island	T:165.280 L:165.490	M	94	27.6	Juvenile	UM38
04/21/01	NettleIsland	T:164.640 L:165.430	M	100	31.2	Juvenile	UM39

[A]Deemed to be pregnant.
[B]No data.
[C]Head tag.
[D]Seal died in capture net.

transmitters were detected at a range of 8–13 km. Most detections were made within Penobscot Bay, and seal 004 was always found around its capture site, Robinson Rock (Table 5). Seal 002 was twice located around Seal Ledge, western side of Vinalhaven (10 km) and once at Robison Rock, whereas, 003 was only detected once at Wooden Ball Island, 25 km south of the tagging site (Fig. 2).

We caught 30 seals on tidally exposed sandbars in Chatham Harbor between 14 and 20 March 2001. We disentangled nine of these and released them without tagging. Seven others were handled only briefly and released due to rising tide (Table 2). Ninety percent (19/21) of the seals were males, principally adults (12/15; 80.0%). An adult female (UM12) was deemed to be pregnant (axillary girth = 124 cm).

We caught 18 seals on tidal ledges in Western Penobscot Bay (WPB) between 15 and 20 April 2001. Most (56%) were juvenile males. One seal died in the capture net (Table 3). One adult male and a pregnant female were also captured.

Aerial tracking was not conducted in the period between the Chatham and WPB capture and tagging work. Monitoring of seals in Chatham Harbor was conducted on three occasions, (29 March, 02 April, and 10 April) during daytime low tides. Nine different seals were detected with three animals detected twice (Table 6). Although most of the seals were completely out of the water, few flipper mounted transmitters were detected.

Table 4. Detection locations for harbor seals radio tagged in Penobscot Bay in 1999.

Flight date	Seals detected	Search / detection region[A]
4 June	None	Penobscot, Frenchman, Blue Hill, and Muscongus Bays searched
7 June	002	Seal Ledge near Vinalhaven—western side
7 June	003	Wooden Ball Island
7 June	004	Robinson Rock
10 June	002, 004	Robinson Rock–Penobscot and Blue Hill Bays and outer islands were searched
17 June	004	Robinson Rock
22 June	002	Seal Ledge near Vinalhaven—western side
22 June	004	Robinson Rock

[A]See Figure 2.

Table 5. Detection of radio tagged harbor seals in Chatham Harbor in 2001.

Date	Time of low tide	Seals detected[A]
29 March	1125	UM12 (T-164.140, L-165.950) & UM15 (T-165.040)
2 April	1512	UM01 (T-164.000), UM10 (L-165.890), UM12 (T-164.140, L-165.300), UM13 (L-165.790) & UM14 (T-165.300)
10 April	1007	UM01 (T-164.000), UM18 (T-165.200), UM19 (T-164.820), and UM21 (T-164.780)

[A]T = Telonics tag, L = Lotek tag.

Table 6. Detection of tagged seals along the Maine coast in spring 2001, by flight date.

Seal ID	Tag freq.	Size group	Sex	Tag location	May															June		July	
					1	2	3	4	10	11	12	14	17	18	20	27	29	30	31	1	4	18	Total
UM12	164.140	A	F	Chatham		X			X			X	X	X		X	X	X	X	X			10
UM25	165.060	A	F	Maine			X					X	X	X	X				X	X			7
UM11	164.540	J	F	Chatham																			0
UM23	165.080	J	F	Maine			X													X			2
UM27	165.230	J	F	Maine																			0
UM28	165.120	J	F	Maine																		X	1
UM29	164.940	J	F	Maine					X										X		X		3
UM30	164.970	J	F	Maine	X	X	X	X			X	X	X	X		X			X	X			11
UM31	164.520	J	F	Maine		X	X	X							X							X	5
UM01	164.000	A	M	Chatham							X	X	X	X	X	X							6
UM10	164.660	A	M	Chatham								X					X	X	X	X			5
UM13	—	A	M	Chatham																			0
UM14	165.300	A	M	Chatham									X					X	X	X		X	5
UM15	165.040	A	M	Chatham																			0
UM16	164.080	A	M	Chatham															X			X	2
UM18	165.200	A	M	Chatham	X	X	X	X					X									X	6
UM19	164.820	A	M	Chatham	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X		15
UM20	165.020	A	M	Chatham		X								X							X		3
UM21	164.780	A	M	Chatham																			0
UM32	164.680	A	M	Maine	X	X	X	X								X		X					6
UM17	164.760	J	M	Chatham								X										X	2
UM22	164.440	J	M	Maine		X	X	X				X			X					X	X		7
UM24	165.240	J	M	Maine		X	X	X							X					X	X		6
UM26	164.458	J	M	Maine							X		X	X	X					X	X		6
UM34	165.100	J	M	Maine									X						X	X			3
UM35	164.400	J	M	Maine	X	X	X	X				X	X	X			X	X	X	X	X		12
UM36	165.140	J	M	Maine					X	X	X					X	X		X	X			7
UM37	165.180	J	M	Maine																			0
UM38	165.280	J	M	Maine																			0
UM39	164.640	J	M	Maine																			0

We began aerial radio-surveys between 1 and 14 May 2001. Seventy-five percent (9/12) and 76% (13/17), respectively, of the Chatham and WPB T-transmitter-tagged seals were detected at least once (Table 6). During the 16 May–4 June 2001 population survey, 67% (8/12) and 71% (12/17), respectively, were detected (Gilbert et al. 2005). On 18 July, 33% and 12% of each group were located (Table 6).

Nine of the twelve Chatham T-tagged seals were later detected in mid-Maine coastal waters (Table 6). The pregnant female and two adult males used haul-outs in the area between Cape Elizabeth (209 km) and Pemaquid Pt (249 km) (Fig. 3, Table7). Three adult, one sub-adult, and one juvenile male seal were mostly in the greater Penobscot Bay system between Vinalhaven (274 km) and Isle au Haut (287 km) (Fig. 3), and one seal was detected at the Isles of Shoals (151 km) on 14 May (Table 7). The latter seal was also detected on 18 July around Vinalhaven.

Most WPB T-tagged seals were detected within the greater Penobscot Bay system, between Port Clyde (20 km) and Isle au Haut (35 km), including outer islands (i.e., Metinic [14 km] and Wooden Ball [25 km]), (Fig 2, Table 8). Most locations were within 50 km of the tagging site, including several seals (i.e., UM24, UM26, UM28) that were only detected in the vicinity (< 5 km) of the tagging site (Fig. 2). The pregnant female (UM25) was detected on seven flights (Table 6) and was always within 10 km of Robinson Rock. One juvenile of each sex was detected at both Metinic Island/Green Island

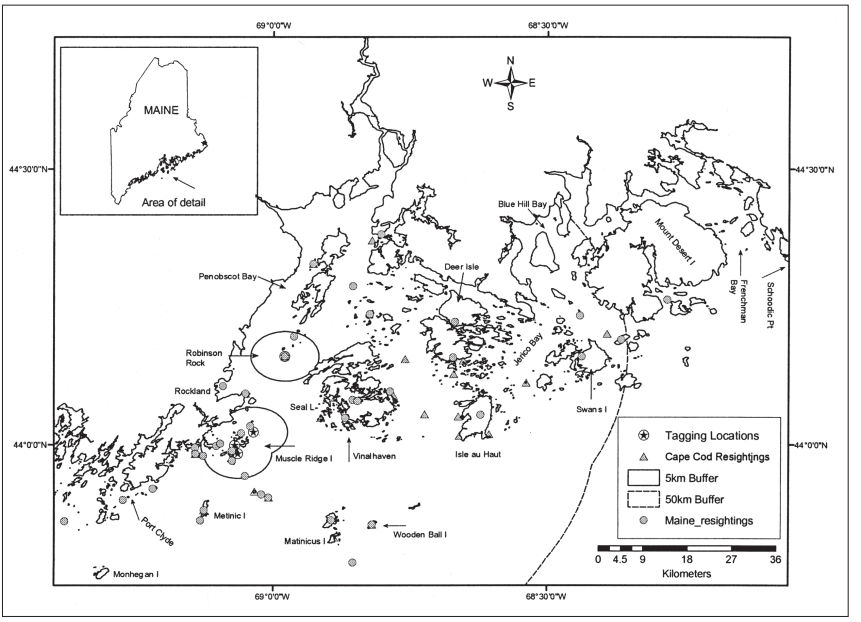

Figure 2. Mid-Maine coast from Monhegan Island to Mount Desert Island. The solid lines are 5-km buffers around the WPB tagging sites. The dashed line is the 50-km buffer around the Muscle Ridge site. The symbols represent the best general location for detected seals on each flight day.

and Western/Eastern Rock (c. 25 km), located north of Monhegan Island (Figs. 2, 3; Table 8). Two juvenile seals (UM23 and UM34) were detected around Swans Island/Gott Island (60 km), which is the longest distance recorded during the study period.

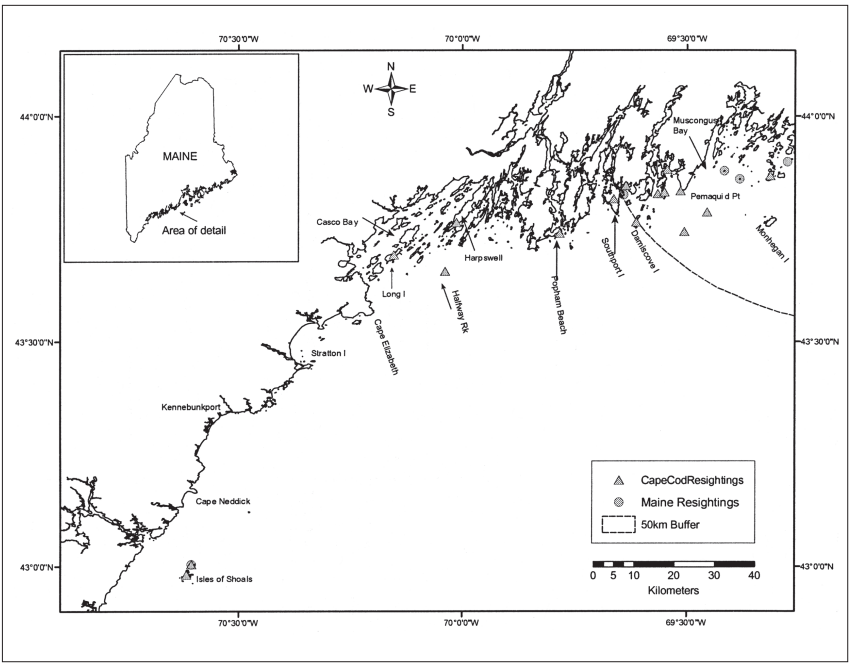

Figure 3. Western Maine from Isles of Shoals to Mohegan Island. The dashed line represents the 50-km buffer from Muscle Ridge tagging locations in WPB. The symbols represent the best general location for detected seals on each flight day.

Table 7. General locations for harbor seals radio tagged in Chatham and detected in Maine coastal waters in 2001.

Seal ID	Size/sex group	General location[A]
UM12	Adult female	Between Popham Beach and Pemaquid Pt.
UM18	Adult male	Popham Beach, Pemaquid Pt., Seal Island, west of Vinalhaven
UM14	Adult male	Southern edge of Vinalhaven, to west side of Isle au Haut and north to Deer Isle
UM10	Adult male	Muscle Ridge (which includes Hewett Island and Nettle Island) and Metinic Island
UM16	Adult male	Metinic/Green Island, west of Vinalhaven
UM20	Adult male	Casco Bay, around Halfway Rock and north towards Bath
UM01	Subadult male	Upper Penobscot Bay northeast of Deer Isle
UM17	Juvenile male	Isles of Shoals and east of Vinalhaven
UM19	Juvenile male	Southern edge of Vinalhaven, to west side of Isle au Haut and north to Deer Isle

[A]UM12, UM18—see Figure 3; UM14, UM19, UM01, UM10, UM16, UM17, and UM20—see Figure 2.

Discussion

Our data on seal movements indicates that at least some of the harbor seals occupying a major SNE winter habitat (Barlas 1999, Payne and Selzer 1989) disperse to mid-Maine coastal waters just before the pupping season. During the peak pupping period, seals tagged in both Chatham and western Penobscot Bay remained in the mid-coastal region. Based on the few seals that we detected in mid-July, we think that those seals remained in this region throughout the molt period. WPB tagged seals did not generally undertake long-range movements, although one juvenile of each sex moved further than 60 km from the tagging site. Limited movement of harbor seals within a seasonal habitat is consistent with findings from other tagging studies (Lesage et al. 2004, Lowry et al. 2001, Thompson 1993, Van Parijs et al. 2000, Yochem et al. 1987). Fine-scale movements along the mid-coastal region, however, were not evaluated because radio detections were assigned to general locations. Movement information, however, suggests that site fidelity may be defined by bay subunits in mid-Maine coastal waters. Harbor seals use both tidally exposed ledges and small-uninhabited islands, and movement between haul-out sites is common (Guldager 2001, Pauli and Terhune 1987).

The harbor seals captured in Chatham Harbor were primarily captured at one sand bar and small adjacent bars. We do not know if any of these seals went into Canada, but one clearly moved to downeast Maine. Those seals that were at least loosely associated in Chatham Harbor went to specific parts of the coast, primarily Penobscot Bay. The pregnant female and two adult males, however, were mostly detected between Casco and Muscongus Bays, west of Penobscot Bay. We think that these patterns may indicate

Table 8. General locations of harbor seals radio tagged in Western Penobscot Bay and detected in Maine coastal waters in 2001.

Seal ID	Size/sex group	General location[A]
UM25	Adult female	Robinson Rock, and south around Owls Head and Vinalhaven
UM23	Juvenile female	Swan/Duck Island/Acadia National Park and Isle au Haut
UM28	Juvenile female	Robinson Rock
UM29	Juvenile female	Muscle Ridge, which includes Hewett and Nettle Island; Seal Island west of Vinalhaven
UM30	Juvenile female	Muscle Ridge and outer islands (e.g., Metinic/Green Island and western/eastern Egg Rock)
UM31	Juvenile female	Muscle Ridge and off North Haven
UM32	Adult male	Muscle Ridge and Robinson Rock
UM22	Juvenile male	Muscle Ridge and Metinic Island
UM24	Juvenile male	Muscle Ridge
UM35	Juvenile male	Muscle Ridge and outer islands (e.g., Metinic/Green Island and eastern Egg Rock)
UM36	Juvenile male	Muscle Ridge and Metinic/Green Island
UM26	Juvenile male	Robinson Rock
UM34	Juvenile male	Swans Island and Gott Island

[A]See Figure 2.

some degree of stock structure (i.e., bay units) along the Maine coast. Recent genetic studies in southeastern Alaska have identified fine-scale stock structure (i.e., 12 stocks) in a continuously distributed population (O'Corry-Crowe et al. 2003).

The origin (e.g., Maine or eastern Canada) of seals wintering along the southern New England and mid Atlantic coasts is unknown, but many researchers have assumed or concluded that seals move between US and Canadian waters seasonally (Jacobs and Terhune 2000, Katona et al. 1993, Pauli and Terhune 1987, Rosenfeld et al. 1988, Whitman and Payne 1990)

Data from rehabilitated and released VHF radio- or satellite-tagged seals have provided limited evidence of trans-boundary movements. A satellite-tagged seal released near Cape Elizabeth Maine in January 2001 made one excursion to Cape Cod Bay in mid-February and in early May it was last relocated in Penobscot Bay (WHALENET at http://whale.wheelock.edu). A radio-tagged seal that was released in June 2001 off eastern Long Island, NY, was relocated in Penobscot Bay on the 18 July flight conducted in our study. A satellite-tagged seal released off eastern Long Island in June 2003 moved along the Maine coast and then over to Yarmouth, NS, before the signal was lost (R. DiGiovanni, Riverhead Foundation, pers. comm.). Moreover, none of the rehabilitated and satellite-tagged harbor seals (n = 10) released in New England waters between July 1997 to June 2004 was relocated in Canadian waters (WHALENET at http://whale.wheelock.edu). However, the northeast regional strandings database (NOAA Fisheries, Northeast Regional Office, unpubl. data) contains a few records of seals that were tagged in Canada.

Our study confirms that adult seals occur in SNE waters during winter/spring period. This is contrary to earlier findings (Whitman and Payne 1990), which suggested that juvenile seals were the dominant "age class" of seals in southern New England during the mid-1980s. Since the mid-1980s, however, the harbor seal population (uncorrected count) has nearly quadrupled from 13,000 in 1986 to 38,000 in 2001. Changes in age structure may account for the differences in findings, and sample size may also be important.

Our study provides a small snapshot of seasonal movements of harbor seals in New England waters. However, the findings are insufficient to address numerous scientific and management issues associated with an increasing harbor seal population. Seals are thought to compete with human fishers for prey, but most studies have concluded that there is no evidence for competition (Beverton 1985, DeMaster et al. 2001, Payne and Selzer 1989). Satellite tagging and genetic studies are required to obtain sufficient information on seasonal and fine-scale movements, habitat use, and stock structure to address essential scientific and the management needs.

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