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REPORT TITLE

Satellite-tagging of spotted seals (Phoca largha) at Kasegaluk Lagoon, Alaska, 1992-1993

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EXECUTIVE SUMMARY

In August 1992 and 1993 satellite-linked platform transmitter terminals (PTTs) were attached to eight spotted seals captured in the northeastern Chukchi Sea at Kasegaluk Lagoon. The seals tagged were five males and three females.

After they were attached to seals, PTTs sent signals for 32-298 days. Four of the PTTs continued transmitting into April, May, or June of the following year. In total, 8,089 location records were received from Service Argos (Table 3). When those records were screened to delete unrealistic speeds of movement, the remaining data set included 3,527 class 0 locations and 2,515 locations of classes 1, 2, or 3. When all location qualities are included in the database, seals were located 41%-97% of the days they carried operational transmitters, with an average of 1.3-7.8 location fixes per day.

Two of the PTTs that functioned for relatively short periods show only movements in the Chukchi Sea. Six of the PTTs functioned long enough to show movements of seals southward into the Bering Sea. During August-October, spotted seals spent most of their time in the eastern half of the Chukchi Sea, with most activity concentrated in the regions off Icy Cape, Point Hope, and the Hope Basin. Two seals moved into the Beaufort Sea and two others went to the northern coast of Chukotka. After October all locations were in the Hope Basin and regions to the south. During November-January many locations were in the area between Bering Strait and Nunivak Island, and between St. Matthew Island and the Gulf of Anadyr. During February-May, seals spent most of their time in the region north and east of the Pribilof Islands, and in the area between St. Matthew Island and Cape Navarin.

Results of this study confirm the applicability of satellite telemetry to studies of spotted seal biology.

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INTRODUCTION

Spotted seals (Phoca largha) are medium-sized pinnipeds of the family Phocidae that occur principally in the Okhotsk, Bering, and Chukchi seas. Unlike the relatively well studied harbor seal, the biology of spotted seals has not been well described (Quakenbush 1988). Much of the information available has come from studies conducted in the Bering Sea ice front in spring (e.g., Burns 1970, Fedoseev 1976, Braham et al. 1984). Pupping, breeding, and molting all occur in association with sea ice from March through May. As the sea ice cover diminishes and coastal areas become ice-free, spotted seals move to nearshore areas of Alaska and Russia, some of them migrating northward into the Chukchi Sea. During the open water season, they are commonly seen hauled out on coastal barrier islands, sandbars, rocks, and reefs.

Frost et al. (1983) compiled information on the major summer haulout areas used by spotted seals along the coast of the eastern Chukchi Sea. The most important area identified was Kasegaluk Lagoon (named after the Inupiat word for spotted seal), where 1,000 or more seals were commonly seen hauled out inside the barrier islands. This led to a detailed study conducted during 1989-1991 to document spotted seal distribution, abundance, and habitat use in this region (Frost et al. 1993).

In August 1991 a study was conducted at Kasegaluk Lagoon to assess the feasibility of capturing and attaching satellite tags to spotted seals (Lowry et al. 1994). This report describes the results from additional satellite tags attached to seals at Kasegaluk Lagoon in 1992 and 1993.

METHODS AND MATERIALS

Field Work

Field studies were conducted in Kasegaluk Lagoon, principally at Utukok Pass, Akoliakatat Pass, and Avak Inlet (Figure 1). In 1992, personnel and equipment were transported by boat from Point Lay to Utukok Pass, and a field camp was set up and occupied during 31 July-4 August and 25-30 August. In 1993, boats brought equipment and personnel to Utukok Pass from both Barrow and Point Lay, and a field camp was set up during 2-11 August.

Seals were caught using nets drifted in the lagoon. The net used in 1992 was constructed with large-diameter dark green multifilament nylon twine with a stretched mesh size of 20 cm, and it was 3.7 m deep and 88 m long. The top of the net was supported by foam floats and the bottom weighted with a lead line. The net used in 1993 was similar, except that the stretched mesh size was 30 cm, it used foam core float rope instead of foam floats, and the color was a mixture of blues and greens. Seals that became entangled were immediately taken into a boat, removed from the net,

and put into hoop nets constructed of soft nylon netting with a mesh size of about 2 cm. They were then taken to shore.

Once on shore, seals were physically restrained and sedated with a mixture of ketamine and diazepam administered intramuscularly at standard doses of approximately 2-4 mg/kg ketamine and 0.05-0.10 mg/kg diazepam (Geraci et al. 1981). Each seal was weighed, measured (curvilinear or standard length), and tagged on the hindflippers with individually numbered plastic tags. Approximately 50 cc of blood was drawn from the extradural intervertebral vein (Geraci and Smith 1975).

A satellite-linked platform transmitter terminal (PTT) was glued to the fur of the mid-dorsal surface of each seal using a fast-setting epoxy (Fedak et al. 1984; Stewart et al. 1989). With this type of attachment, it was assumed that the PTT would stay attached until the seal molted in May-June. After tagging was complete, animals were placed above the tide line near the capture site and left undisturbed until they chose to return to the sea.

Equipment

The PTTs used were manufactured by Wildlife Computers (Woodinville, Washington) and they measured 14.8 cm x 10.0 cm x 3.8 cm and weighed about 750 g. They were powered by four lithium C cells, and produced 0.5 watts of signal output through whip antennas. The PTTs transmitted on 401.65 MHz to receivers onboard NOAA polar orbiting satellites. PTTs were equipped with conductivity switches so that they transmitted only when they were out of the water. The transmission rate was once every 45 seconds when the animals were at sea, and switched to a rate of once every 90 seconds when animals were hauled out. Data transmitted included PTT identification code, battery status, and information on the number, duration, and depth of dives.

Data Analysis

Data were obtained through the Argos system. Argos is a joint program of the French Space Agency, the U.S. National Aeronautics and Space Administration, and the U.S. National Oceanic and Atmospheric Administration (NOAA). Argos packages are flown on NOAA Tiros spacecraft, and data processing is done by Service Argos Inc., a subsidiary of the French Space Agency.

The Argos system recorded date and time of each signal received by the satellite (termed an "uplink") and calculated a location for the PTT based on Doppler shift whenever sufficient signals were received during a satellite pass. The accuracy of location calculations varies based in part on the number of uplinks that occur during a satellite pass. Service Argos assigns a quality ranking to location information. This rank is based on predicted accuracy which suggests that for the best data (assigned quality number 3), predicted locations are expected to be within 150 m of actual locations 68% of the time. Locations that are

based on few uplinks or have other potential problems are assigned quality 0. When only one uplink occurred during a satellite pass, sensor data were recorded but no location was calculated. Stewart et al. (1989) and Mate et al. (1992) provide additional description and analysis of the Argos system and its application to marine mammal tracking.

For analysis and presentation of data, dates and times reported by Service Argos were converted to true local time from Greenwich mean time by subtracting 11 hours.

The distance and speed between each sequential pair of fixes were calculated for all location records, and the results were used to screen out inaccurate locations. A computer program was written that would flag records that indicated apparent movement speeds greater than selected values for certain periods of time. A three-stage screening process was used, first looking for speeds of greater than 10 km/hr for periods greater than 5 minutes, then greater than 100 km/hr for more than 1 minute, then greater than 500 km/hr for any length of time. When the suspect records were flagged and the data inspected it was evident that these high speeds were due to one or more location fixes that clearly did not fit with the rest of the data. These records were deleted from the database and distances and speeds were recalculated.

RESULTS

Capture and Tagging of Seals

One spotted seal was captured in 1992 and eight in 1993 (Table 1). In 1992 the weather was quite good during field work. As a result the water in the lagoon was unusually clear, and seals swimming toward the net appeared to see it and avoid it. In 1993, weather conditions were variable and seal catching was most successful on days when the water was murky. None of the seals appeared to be injured or unduly stressed by the capture operations.

One seal captured in 1993 weighed only 40 kg and was judged to be too small to carry a PTT. All other animals were large enough to tag, ranging in weight from 45 to 109 kg. The seals tagged were five males and three females. Individual seals will be referred to in this paper by their PTT identification number (see Table 1).

PTT Performance

After they were attached to seals, PTTs sent signals for 32-298 days (Table 2). The PTT attached in August 1992 continued to transmit into April 1993. Of the seven PTTs attached in August 1993, two transmitted into May 1994 and one into June 1994.

In total, 8,089 location records for all PTTs combined were received from Service Argos (Table 3). When those records were

screened as described in the Methods section, 2,047 records were deleted. Of the deleted records, 1,889 were location quality 0, 115 were quality 1, 43 were quality 2, and 0 were quality 3. The remaining data set included 3,527 class 0 locations and 2,515 locations of classes 1, 2, or 3.

When only quality 1-3 locations are considered, the total number of fixes obtained for a single seal ranged from 18 to 526 (Table 3). Most were of location quality 1 (44%-69%) or quality 2 (30%-55%); relatively few were quality 3 (0%-3%). On average, each PTT gave 0.6 to 4.6 fixes of quality 1-3 per operational day (Table 2). One or more fixes of quality 1-3 were obtained on 16%-76% of the days that each PTT was operational. When quality 0 locations are included in the database, the percent of days on which seals were located increased to 41%-97%, and the average number of locations per day increased to 1.3-7.8.

Movements of Seals

All locations received for each individual tagged seal are shown in Figures 2-9. Two of the PTTs that functioned for relatively short periods show only movements in the Chukchi Sea. Seal 2286 remained near the Kasegaluk lagoon tagging location (Figure 8), while seal 15991 ranged westward into the Chukchi Sea and was at the north coast of Chukotka when the last transmission was received (Figure 5).

Six of the PTTs functioned long enough to show movements of seals southward into the Bering Sea. Seals 2284 and 11044 showed very similar patterns (Figures 2 and 3), spending time in or near Kotzebue Sound, passing southward across the mouth of Norton Sound to the vicinity of Nunivak Island, then to the area between the Pribilofs and St. Matthew Island. Seal 11041 followed a somewhat similar pattern (Figure 4), but it spent more time in the area between Norton Sound and St. Lawrence Island, then moved to the region between St. Matthew Island and Cape Navarin. After being tagged, seals 15992 and 15993 moved eastward into the western Beaufort Sea (Figures 6 and 7). Seal 15992 moved southward offshore until it reached the Yukon-Kuskokwim Delta, while 15993 spent time near the Seward Peninsula, St. Lawrence Island, and St. Matthew Island, then moved south to the area east of the Pribilof Islands. After leaving the Kasegaluk Lagoon area seal 2281 spent time along the southern coast of Chukokta and off the Gulf of Anadyr then moved the area south of St. Matthew Island (Figure 9).

DISCUSSION

Satellite-linked PTTs attached in 1992 and 1993 allowed the tracking of individual spotted seals as they moved through the Beaufort, Chukchi, and Bering seas. Two of the eight PTTs failed prematurely and provided relatively little information. The other six functioned well, providing data over periods ranging from 150-291 days. In general, the PTTs used in 1992-1993 provided more

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Table 1. Spotted seals captured at Kasegaluk Lagoon, Alaska, August 1992 and 1993.

Tag Date	Location	PTT no.	Sex	Length (cm)[a]	Weight (kg)
27 Aug. 1992	Utukok Pass	2284	male	162 cl	105
4 Aug. 1993	Utukok Pass	11044	female	130 sl	70
6 Aug. 1993	Akokiakatat Pass	11041	male	125 sl	51
6 Aug. 1993	Akokiakatat Pass	15991	male	120 sl	50
6 Aug. 1993	Akokiakatat Pass	15992	female	137 sl	84
6 Aug. 1993	Akokiakatat Pass	15993	female	116 sl	45
6 Aug. 1993	Akoliakatat Pass	---	male	116 sl	40
7 Aug. 1993	Avak Inlet	2286	male	148 sl	97
8 Aug. 1993	Utukok Pass	2281	male	143 sl	109

[a] cl= curvilinear length; sl=standard length

Table 2. Summary of location data obtained for spotted seals satellite tagged at Kasegaluk Lagoon, August 1992 and 1993.

Tag No.	Date of last transmission	Total days operational	Days located		Locations/day	
			LQ>0	all LQs	LQ>0	all LQs
2284	19 Apr. 1993	236	155	210	2.2	4.9
11044	20 May 1994	289	141	243	1.3	4.0
11041	20 Feb. 1994	198	137	193	2.5	7.8
15991	3 Oct. 1993	58	44	50	4.6	7.6
15992	3 Jan. 1994	152	51	107	0.9	2.7
15993	4 May 1994	270	128	172	1.8	3.4
2286	8 Sep. 1993	32	5	13	0.6	1.5
2281	2 June 1994	298	88	153	0.7	1.3

Table 3. Number and quality of location fixes obtained from spotted seals satellite tagged at Kasegaluk Lagoon, August 1992 and 1993. Figures shown are the number of records left after screening/the number of records discarded by screening.

PTT No.	No. of fixes by location quality				
	0	1	2	3	Total
2284	619/374	326/14	192/6	8/0	1145/394
11044	758/368	239/13	137/4	10/0	1144/385
11041	1057/538	301/28	187/8	2/0	1547/574
15991	179/70	115/11	146/8	3/0	443/89
15992	271/154	96/4	42/1	1/0	410/159
15993	423/201	260/13	221/14	3/0	907/228
2286	30/22	12/2	6/0	0/0	48/24
2281	190/162	135/30	71/2	2/0	398/194
TOTAL	3527/1889	1484/115	1002/43	29/0	6042/2047

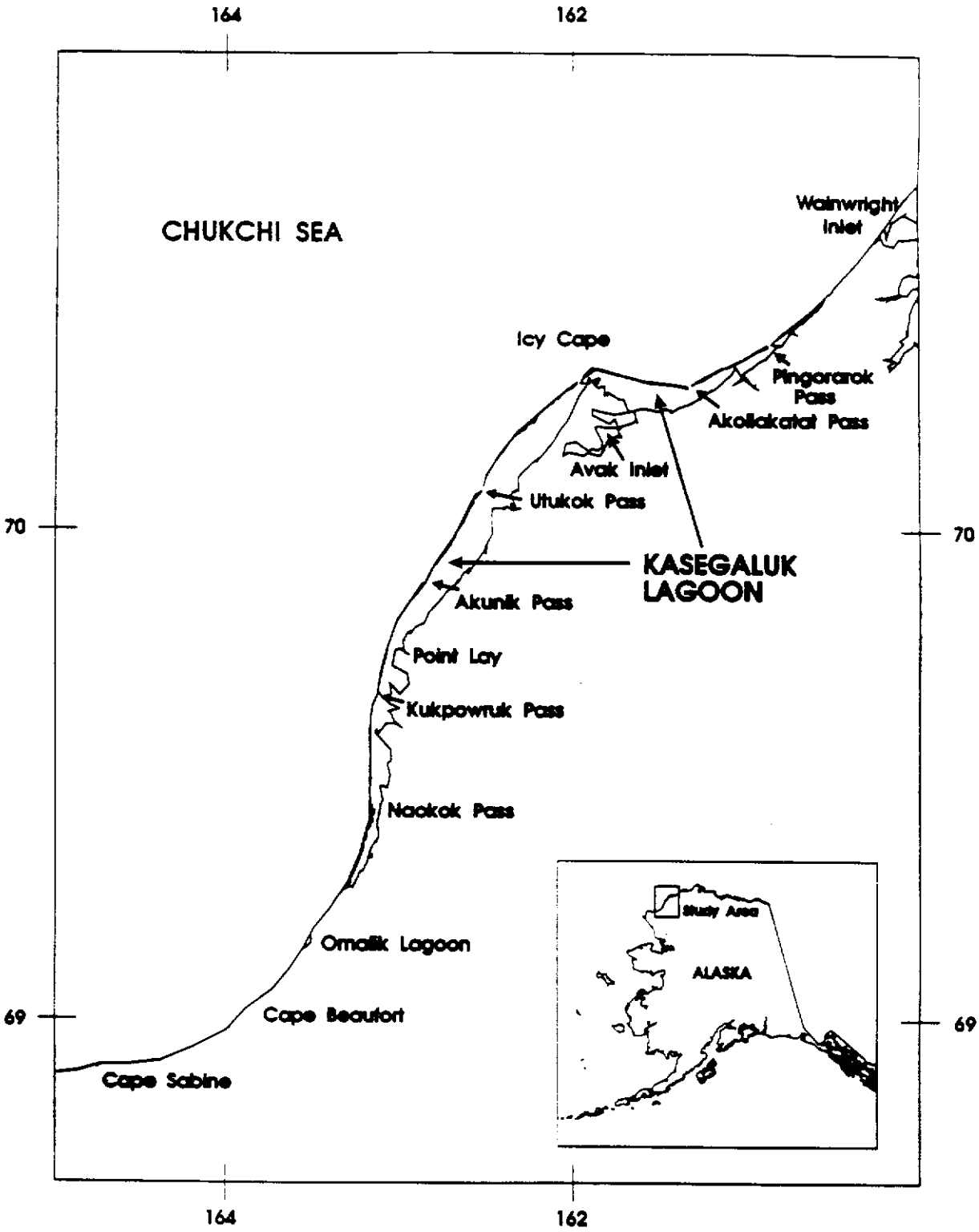

Figure 1. Map of the northeastern Chukchi Sea showing Kasegaluk Lagoon.

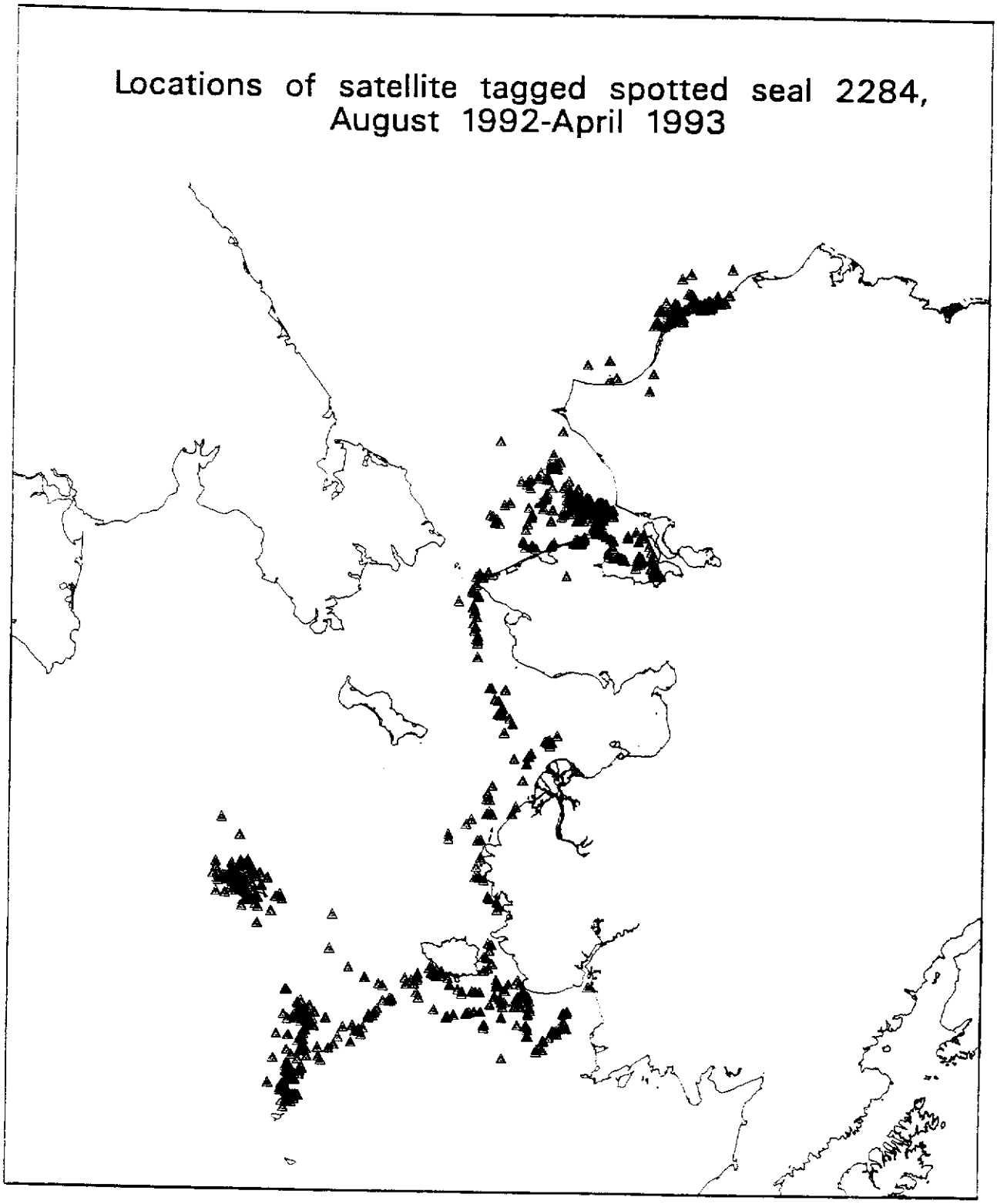

Figure 2. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 2284, obtained during August 1992-April 1993.

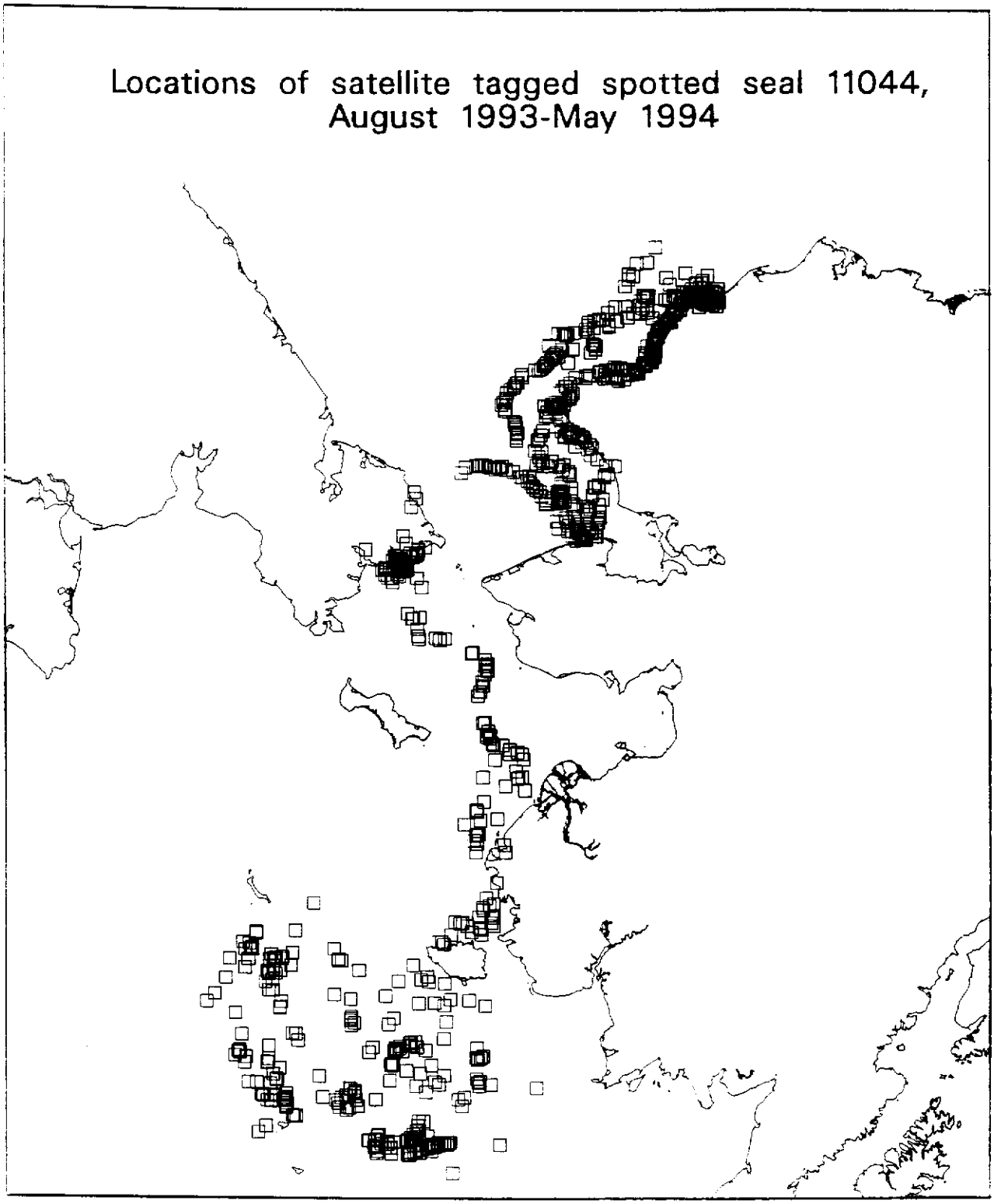

Figure 3. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 11044, obtained during August 1993-May 1994.

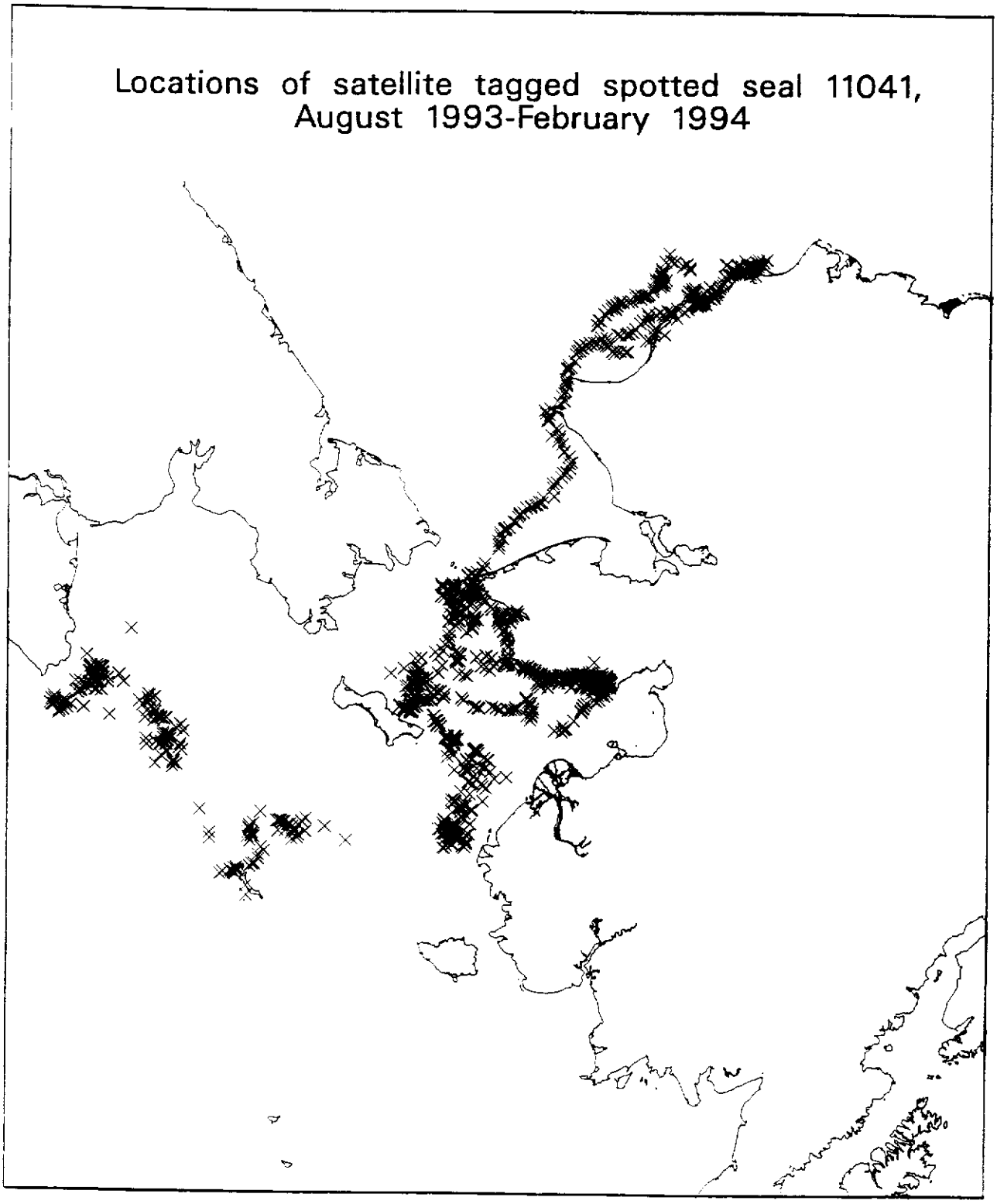

Figure 4. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 11041, obtained during August 1993-February 1994.

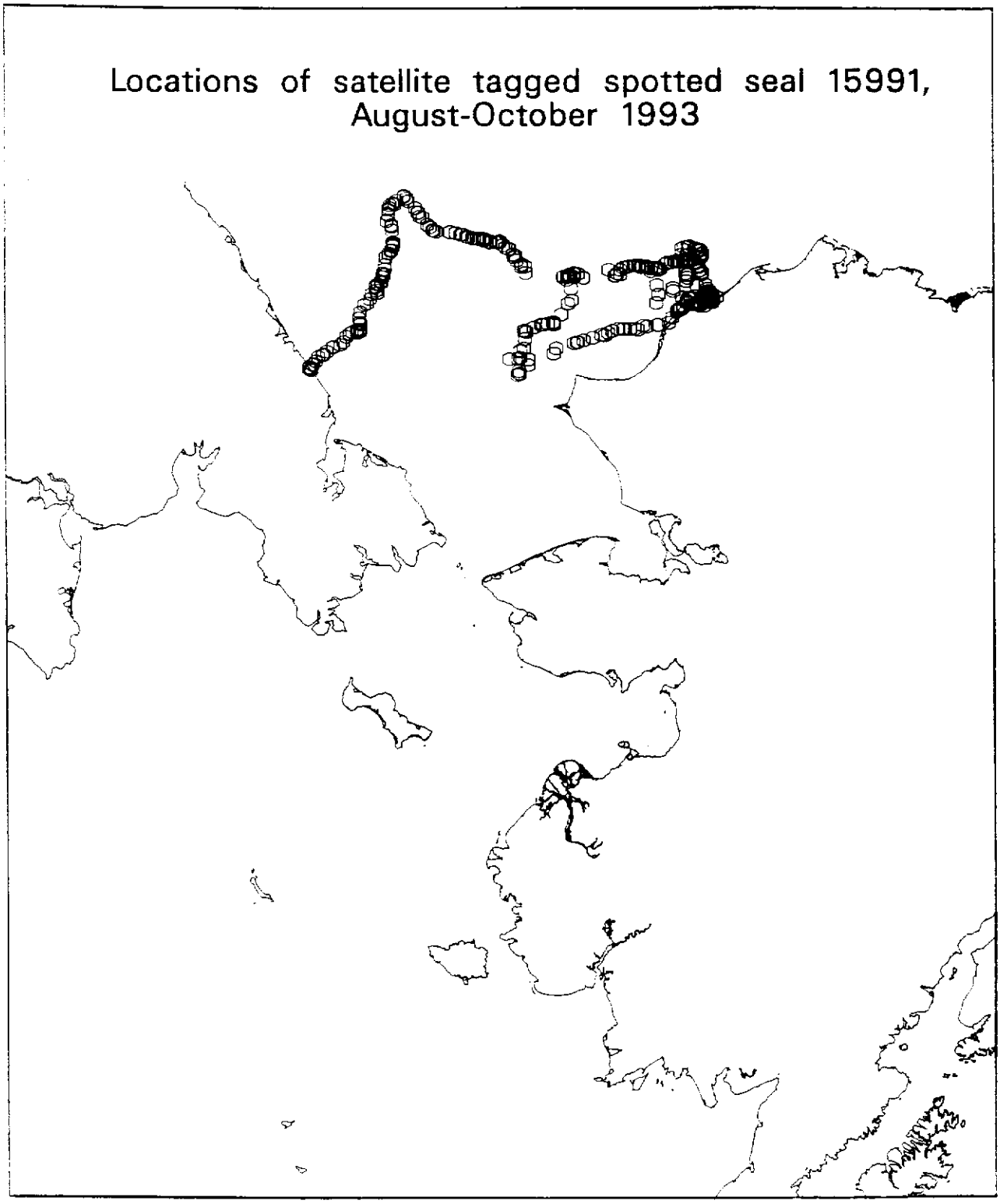

Figure 5. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 15991, obtained during August-October 1993.

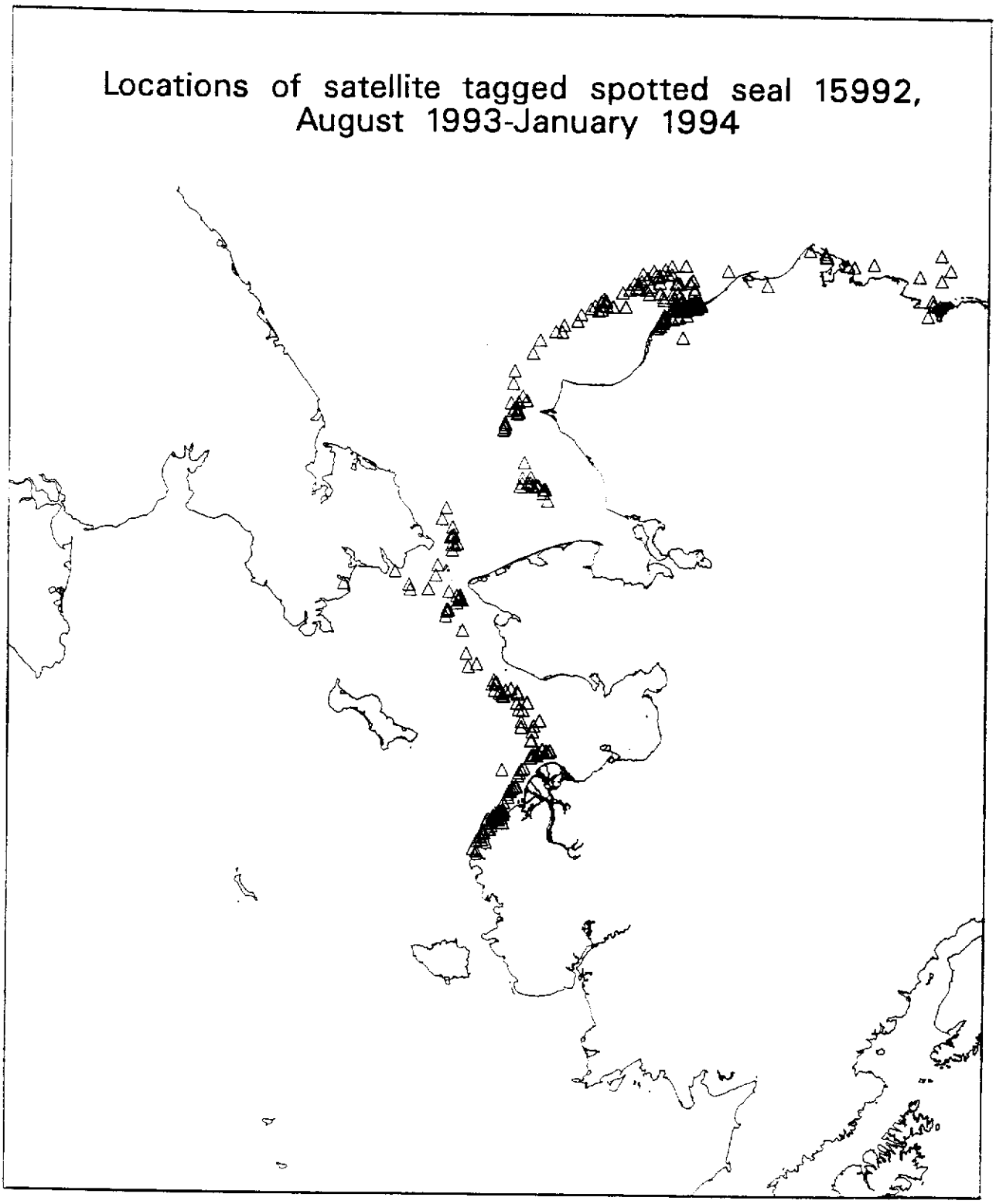

Figure 6. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 15992, obtained during August 1993-January 1994.

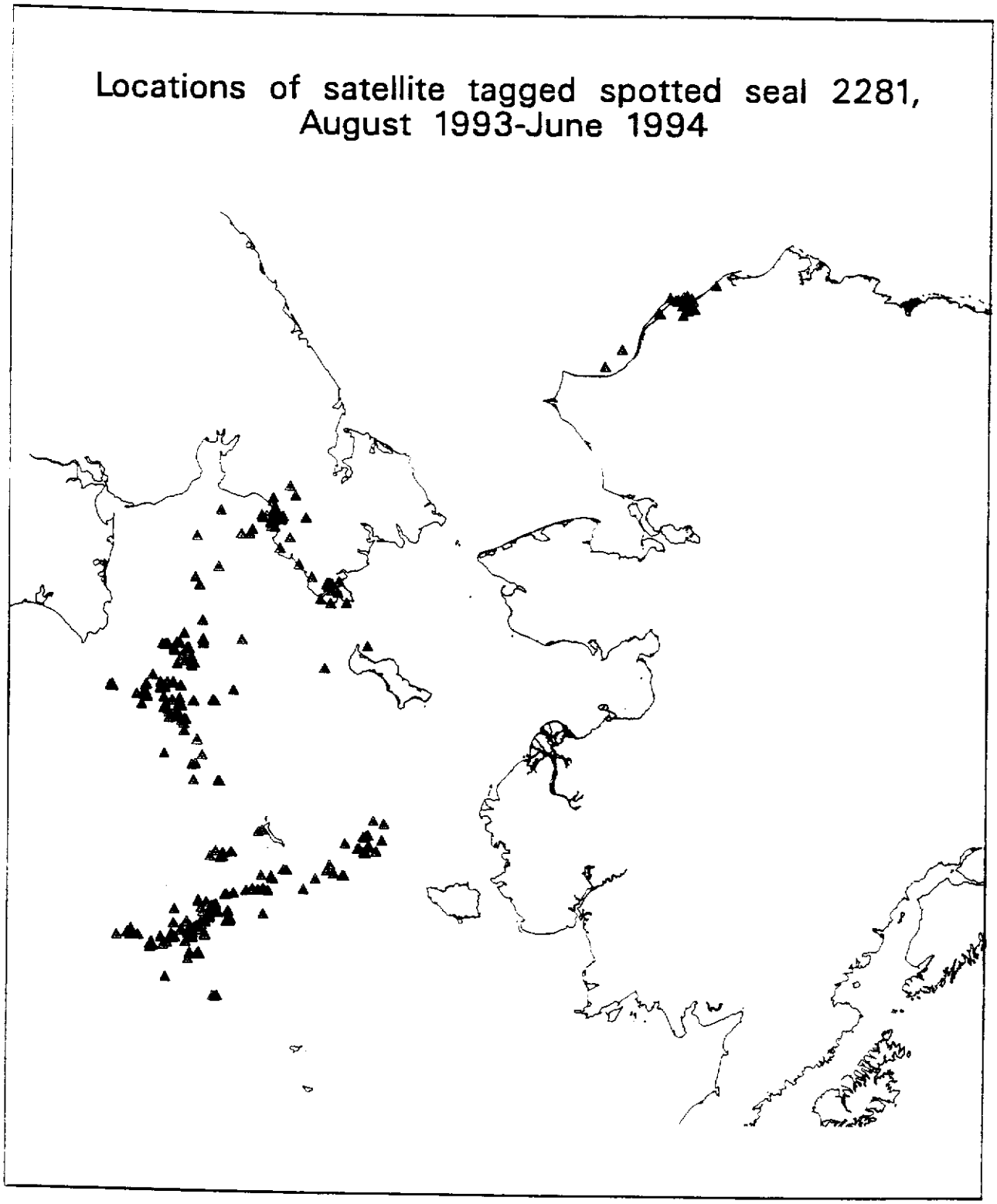

Figure 7. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 15993, obtained during August 1993-May 1994.

2281?

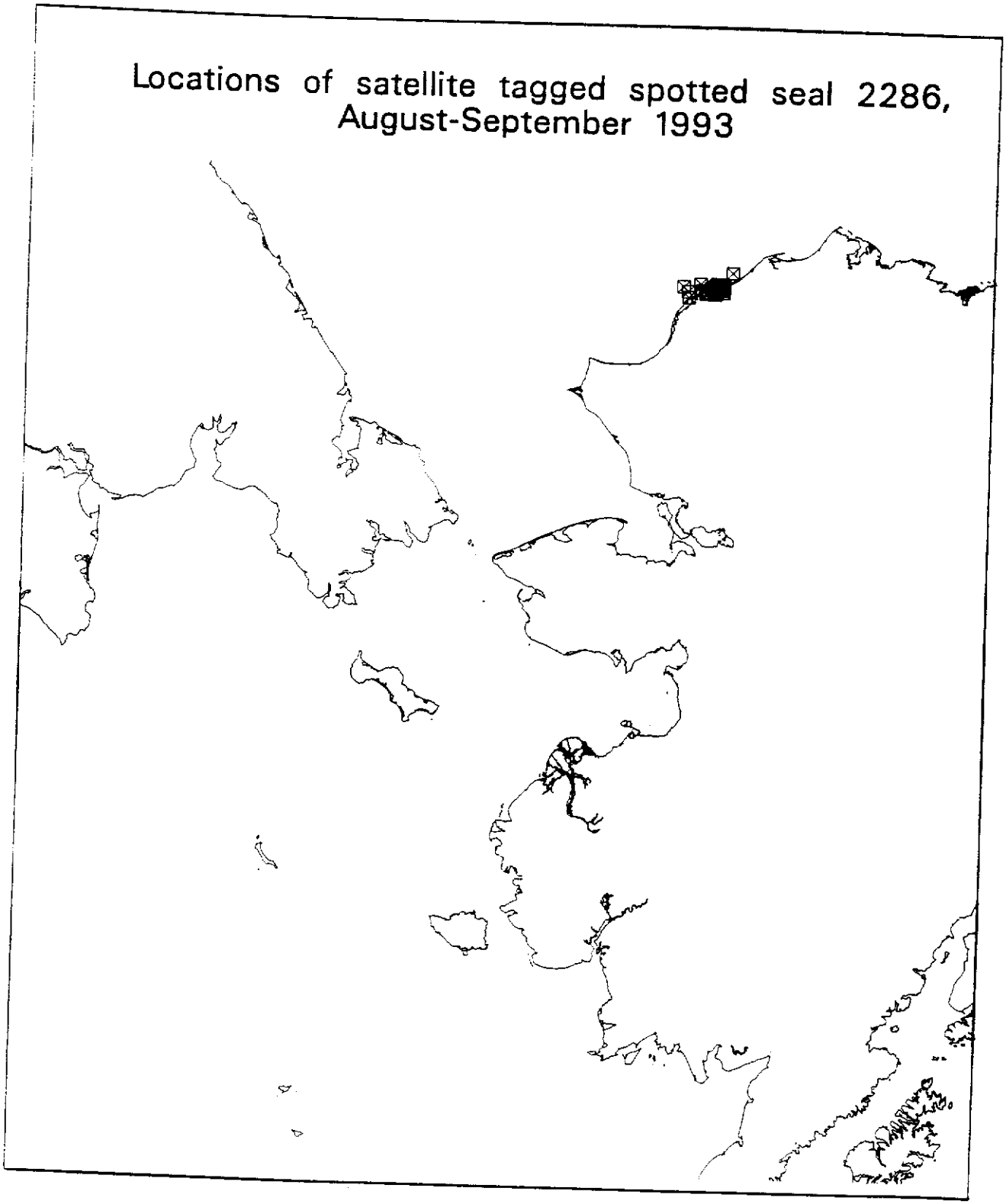

Figure 8. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 2286, obtained during August-September 1993.

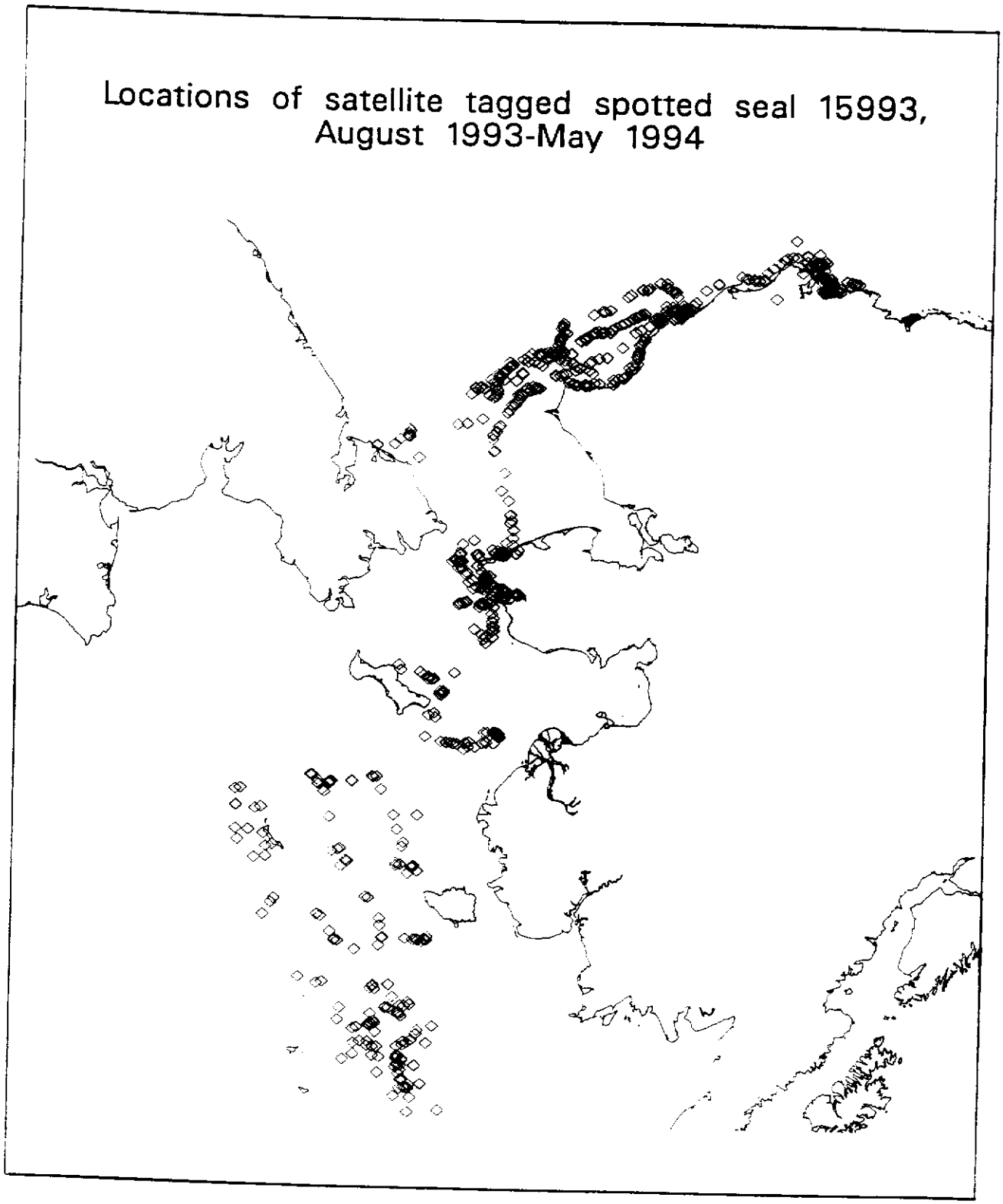

Figure 9. Map of the Chukchi and Bering seas showing locations of satellite tagged spotted seal number 15993, obtained during August 1993-June 1994.

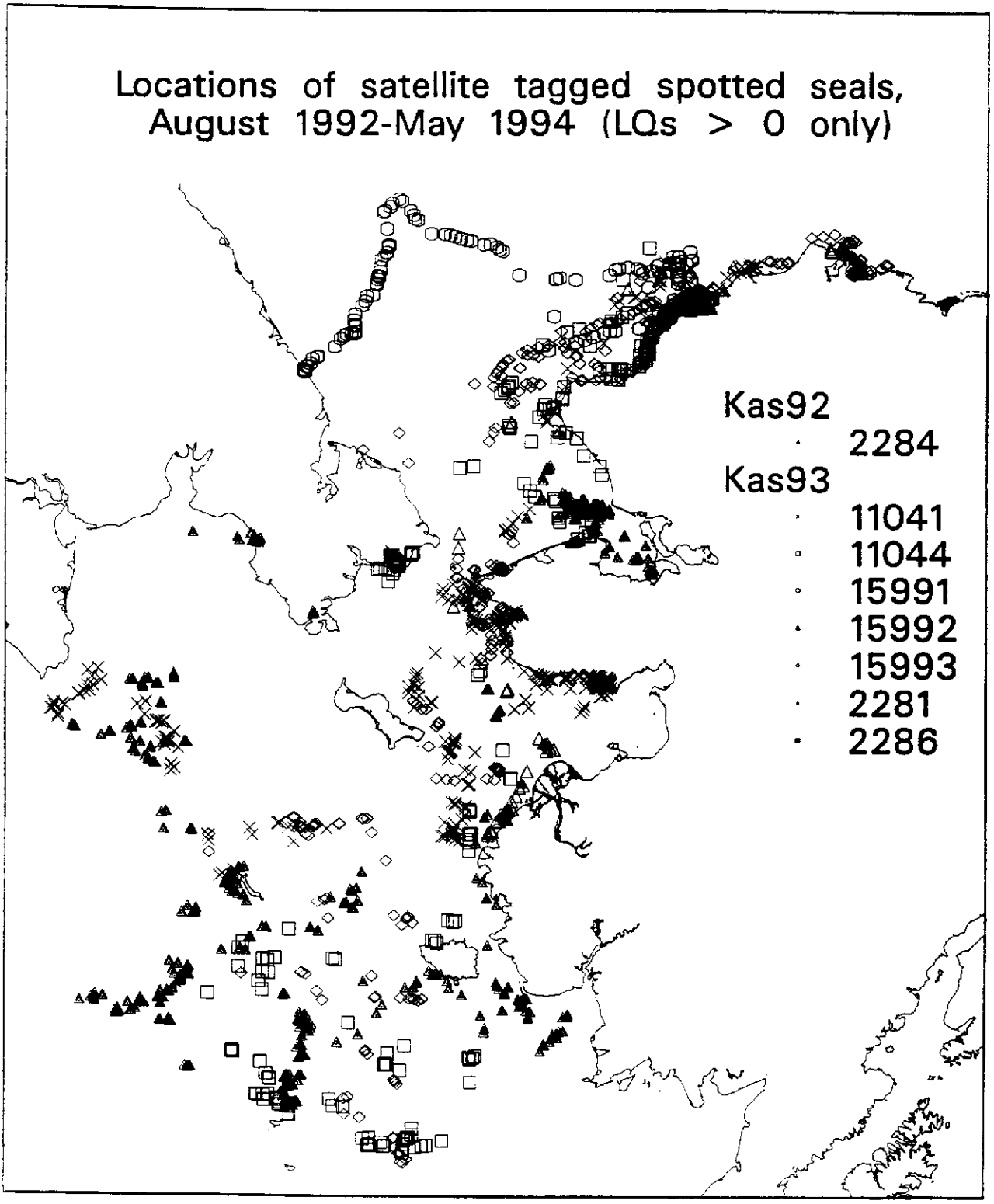

Figure 10. Map of the Chukchi and Bering seas showing only locations of quality 1, 2, or 3 for all satellite tagged spotted seals, August 1992-May 1994.

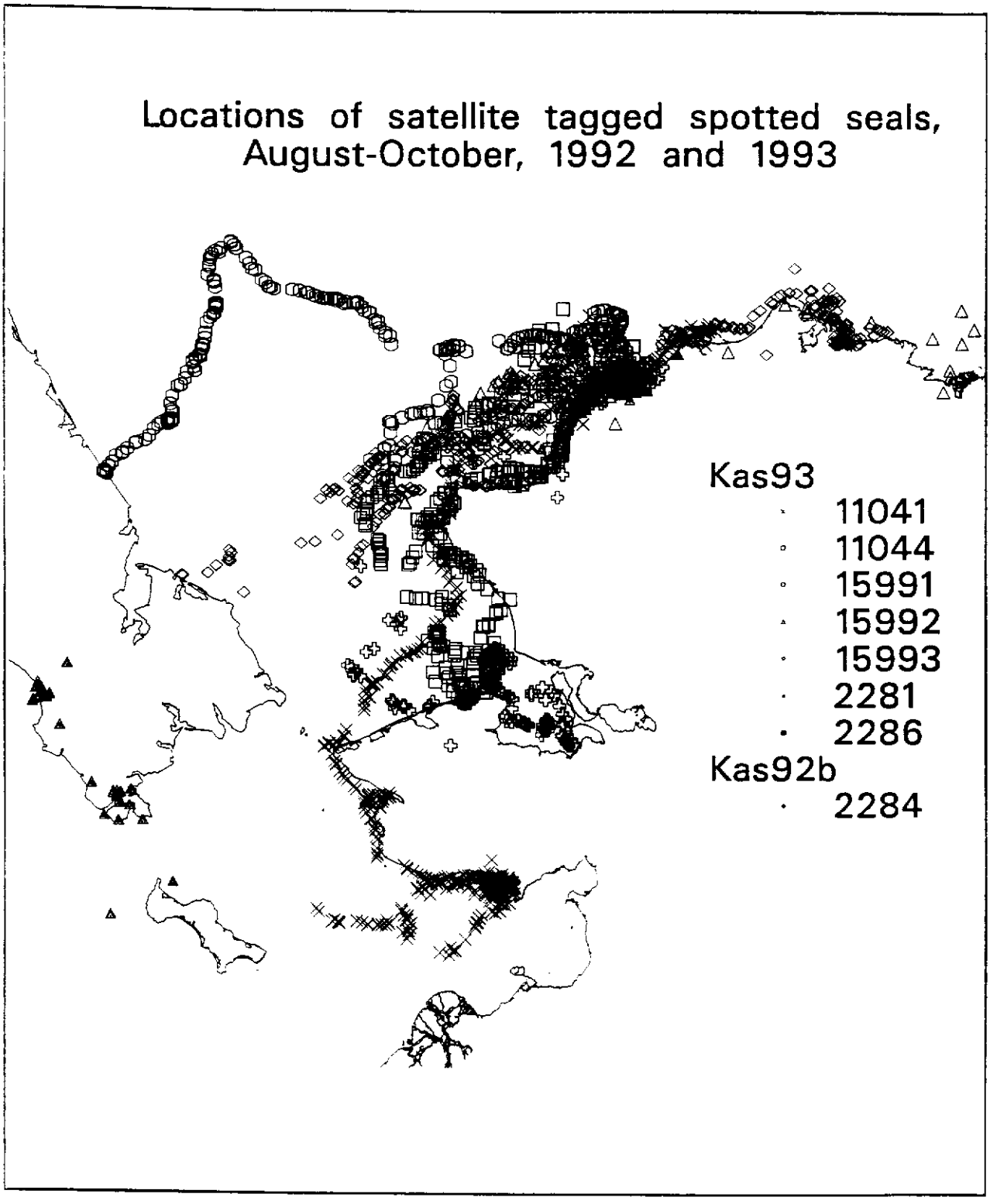

Figure 11. Map of the Chukchi and Bering seas showing all locations obtained during the months of August-October 1992 and 1993 for all satellite tagged spotted seals.

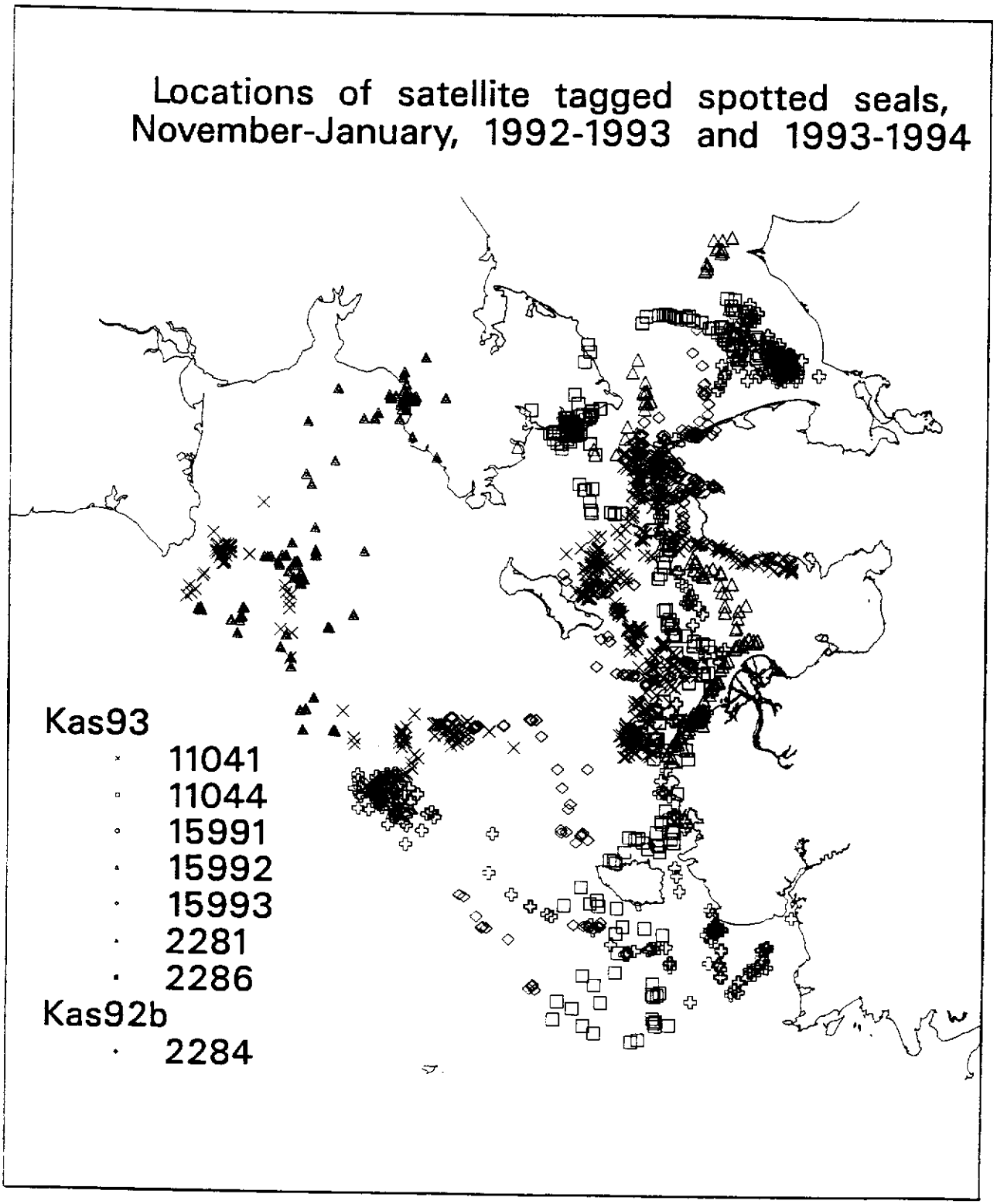

Figure 12. Map of the Chukchi and Bering seas showing all locations obtained during the months of November-January 1992-1993 and 1993-1994 for all satellite tagged spotted seals.

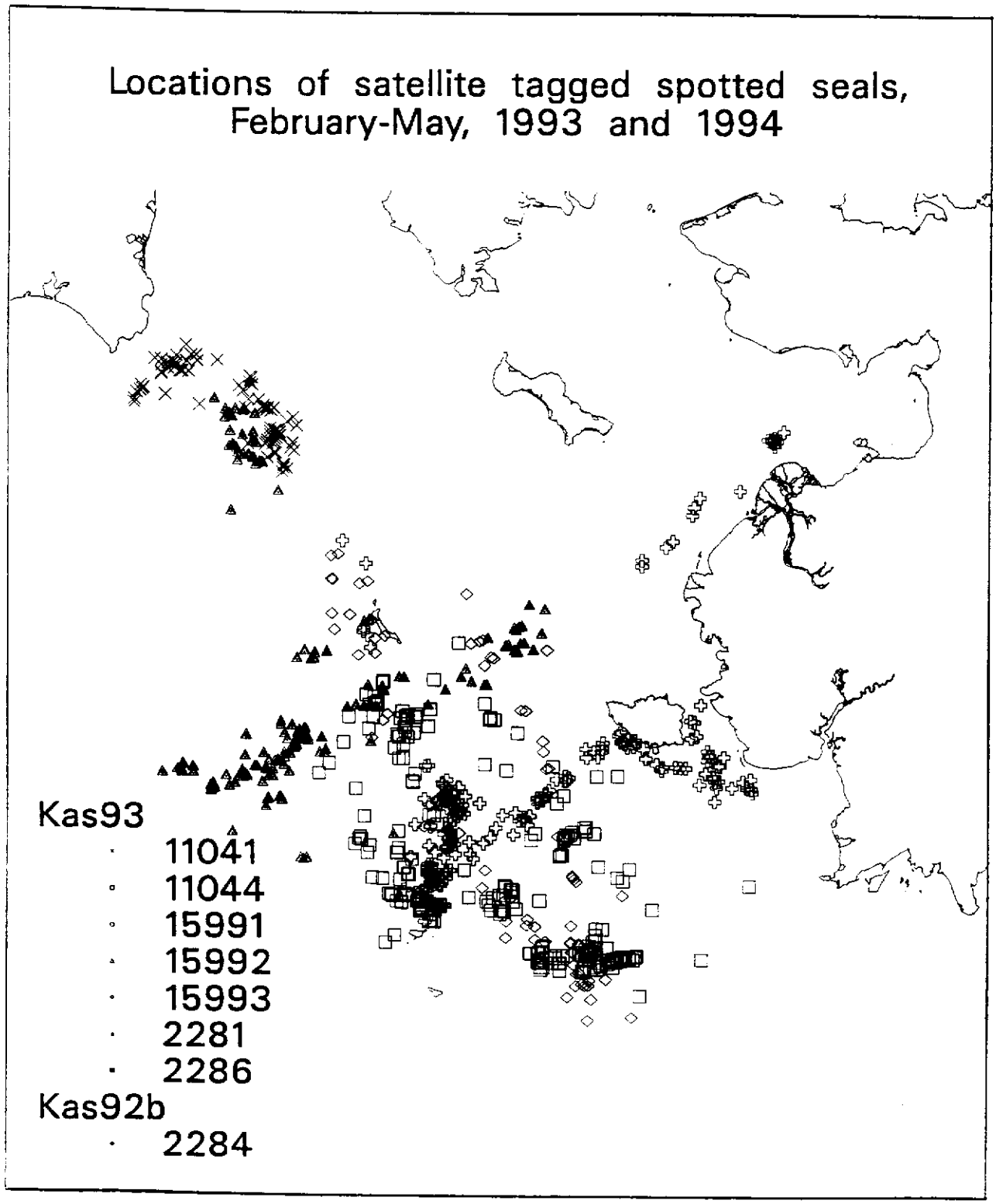

Figure 13. Map of the Chukchi and Bering seas showing all locations obtained during the months of February-May 1993 and 1994 for all satellite tagged spotted seals.