

# Trends in populations of Red-legged Kittiwake *Rissa brevirostris*, a Bering Sea endemic

G. VERNON BYRD, JEFFREY C. WILLIAMS, YURI B. ARTUKHIN and PETER S. VYATKIN

## Summary

The Red-legged Kittiwake *Rissa brevirostris* is a small gull which is restricted to four breeding locations, all in the Bering Sea (Pribilof Islands, Bogoslof Island, Buldir Island, and the Commander Islands). In the mid-1970s, when the earliest counts were made at most sites, approximately 260,000 birds were present at breeding colonies. Subsequent counts indicated that populations at Bogoslof and Buldir had increased by the early 1990s. Data for the Commander Islands were inadequate to make strong conclusions about trends but there were no indications of substantial change between the 1970s and 1990s. In contrast, Red-legged Kittiwakes have declined in the Pribilof Islands by approximately 50% since the mid-1970s, a matter of concern because this island group once contained more than 80% of the world's population. Research is needed to determine causes for declines in Red-legged Kittiwakes and population monitoring should continue to provide a basis for conservation measures.

## Introduction

The Red-legged Kittiwake *Rissa brevirostris* is a rare endemic seabird confined to only four nesting locations, all in the Bering Sea (Byrd 1978, Byrd and Williams 1993). This small gull possesses some of the characteristics which predispose animals to extinction (e.g. occupant of top trophic ring, endemic to a small number of oceanic islands, colonial nester; Terborgh 1974). It is therefore of special interest to resource management agencies. In 1993 the U.S. Fish and Wildlife Service designated the Red-legged Kittiwake a candidate for listing as "threatened" or "endangered" under the U.S. Endangered Species Act but additional information was needed before a determination could be made. Furthermore, the species is included in the Red Book of Russia.

Historic information about Red-legged Kittiwakes, although largely descriptive and anecdotal (e.g. Coues 1875, Stejneger 1885, Turner 1886, Preble and McAtee 1923, Kenyon and Phillips 1965), suggests that the species once may have been more widespread in the Bering Sea (Byrd and Williams 1993, Hatch *et al.* 1993). Nevertheless, adequate quantitative information to assess trends has only recently become available.

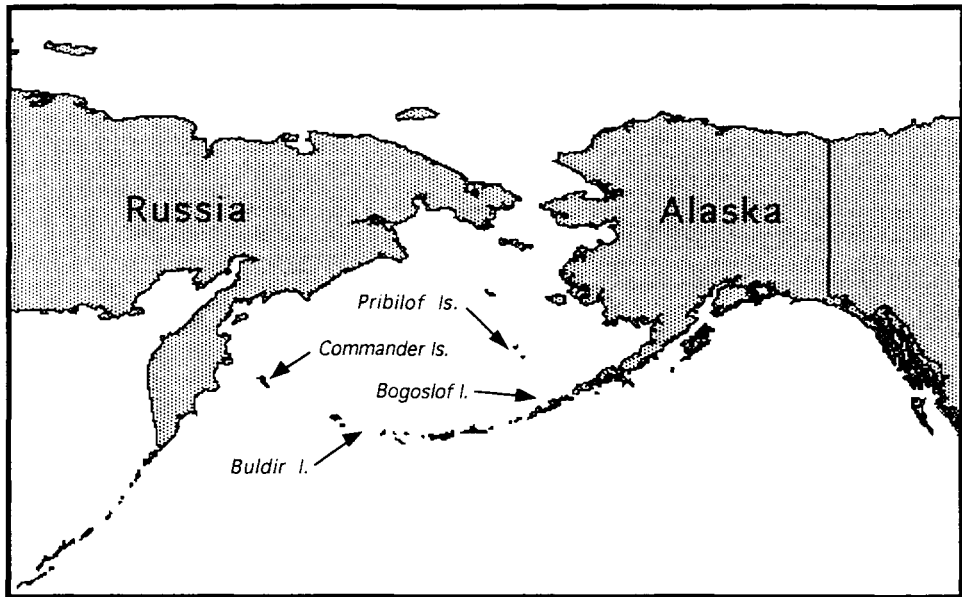


Figure 1. Map of the Bering Sea showing the four locations (indicated by arrows) where Red-legged Kittiwakes breed.

The purpose of this report is to summarize information for each breeding island on nesting distribution, population levels, and trends of Red-legged Kittiwakes to provide insight into whether the species is in danger of extinction throughout all or a significant portion of its range or is likely to become so in the foreseeable future.

### Study area

All breeding locations of Red-legged Kittiwakes are in the southern Bering Sea (Figure 1). Three of the breeding locations are in Alaska (Pribilof Islands, Bogoslof Island and Buldir Island), all within the Alaska Maritime National Wildlife Refuge managed by the U.S. Fish and Wildlife Service. The fourth breeding location is the Russian Commander Islands. All four nesting locations are adjacent to a pelagic marine ecosystem with deep water (> 1,000 m), where Red-legged Kittiwakes prey on small fish that they capture near the ocean surface (Byrd and Williams 1993).

The southern Bering Sea has cool, foggy summers and relatively mild winters (Armstrong 1977). High winds, particularly in winter, are a dominant weather feature. The nesting islands are treeless, and the vegetation has been termed "maritime tundra" (Amundson 1977). Red-legged Kittiwakes nest on small ledges on vertical sea cliffs (Squibb and Hunt 1983, Byrd and Williams 1993). At all nesting locations, they are sympatric with their larger congener, Black-legged Kittiwake *Rissa tridactyla* and with other species of ledge-nesting seabirds such as cormorants, *Phalacrocorax* spp. and murrens *Uria* spp. Predators of Red-legged Kittiwakes vary among locations: large gulls *Larus* spp., at the Commander

Islands, Buldir and Bogoslof, Arctic fox *Alopex lagopus* in the Commander and Pribilof islands and Bald Eagles *Haliaeetus leucocephalus* at Buldir. Native people live in the Pribilof and Commander islands but Buldir and Bogoslof are not inhabited by humans. A few kittiwakes are taken by subsistence hunters in the Pribilofs.

## Methods

Census methods varied among sites. Most approaches involved counting birds or nests on all cliffs from land or a small boat once during the incubation or early chick-rearing phase of the reproductive cycle when the attendance of Red-legged Kittiwakes is relatively regular at nest sites (Byrd 1989). At most sites, cliffs were photographed and subdivided into identifiable subareas for data recording. In all cases, other ledge-nesting species also were counted during the kittiwake surveys (e.g. Byrd and Williams 1994a). Details of methods at each site follow:

### *Pribilof Islands*

*St George Island* At large colonies such as St George complete censuses were extremely difficult. Hickey and Craighead (1977) photographed ledge-nesting seabirds on all cliffs twice during July and early August 1976 (within the normal census period; Byrd 1989). They used a stratified random-sampling technique, based on cliff heights, to select sections of cliff on which to count birds from the photographs. Hickey and Craighead were able to separate images on photographs only into species groups (e.g. kittiwakes). To estimate the number of Red-legged Kittiwakes, they established 63 "reference ledges" (Hickey and Craighead 1977, p. 15), sections of cliff visible from land, on which all birds were counted to estimate species proportions. These reference ledges were photographed and observation points were marked to facilitate future comparisons. Population trends since 1976 are based on counts of birds on the original reference ledges. Since 1985, 3–5 replicate counts of birds have been made each year surveys occurred.

*St Paul Island* Hickey and Craighead (1977, p. 63) provided an "order-of-magnitude" estimate for St Paul by multiplying densities estimated for St George times cliff areas in each height stratum at St. Paul. They set up 35 "reference ledges" on St Paul in 1976 to estimate species proportions there. Also in 1976 a count of Red-legged Kittiwake nests, but not birds, on the entire island was made in July (Hunt *et al.* 1981). As at St George, population trends since 1976 are based on counts at original reference ledges; replicate counts occurring since 1985.

*Otter Island* A. L. Sowls and A. Golovkin (unpubl. data) censused nests around the entire island on 5 July 1993 from an inflatable boat. They were unable to differentiate the two species of kittiwakes reliably as seen from the water, so they went ashore and estimated species proportions by counting nests in 10 plots (321 nests).

*Bogoslof Islands*

*Bogoslof and Fire islands* Nests were censused around the entire islands between 28 June and 1 July 1973 from inflatable boats and land-based observation points (Byrd *et al.* 1980). Observers were able to approach closely enough to identify Red-legged Kittiwakes on nests. Subsequent surveys in 1994 (22 July and 5 August) employed similar methods.

*Buldir Islands*

*Buldir Island* Nests, but not birds, were censused around the entire island from an inflatable boat operated close enough to colonies to identify Red-legged Kittiwakes on nests. The south and north sides of the island was surveyed on 12 July and 14 August 1976, respectively. The entire island, except a stretch of cliff used as an index area, was surveyed on 13–22 July 1992. The average of replicate counts made from 3–21 July on the index area was added to counts of other areas to obtain the island total in 1992. In addition to comparing censuses of the entire island, numbers of Red-legged Kittiwake nests were compared between the mid-1970s and 1990s by using counts on index areas surveyed during the incubation and early chick-rearing period annually 1974–1976, 1988–1992 and in 1994.

*Outer Rock* Outer Rock was surveyed on 19 July 1976 and again on 26 July 1992.

*Middle Rock* Red-legged Kittiwake nests were counted on 9 August 1974, 4 June 1995, 19 July 1976, 17 June 1984, and 26 July 1992.

*Commander Islands*

*Arij Kamen Island* It is not clear exactly which date Red-legged Kittiwake nests were censused on in 1960 but in 1971 surveys were conducted in June and in August. Later surveys were as follows: 1989 (26–27 June from land), 1990 (18–23 July from land), and 1993 (28 July from land and from a boat) (cf. Vyatkin and Artukhin 1994).

*Toporkov Island* Vyatkin and Artukhin (1994) counted all seabirds including Red-legged Kittiwake nests on 25–26 July 1993 from land.

*Bering Island* All seabirds, including nests of Red-legged Kittiwake, were counted from a small boat and from land between 18 July and 17 August 1993 (Vyatkin and Artukhin 1994). In 1989 and 1990 counts were conducted from land; 6–18 July 1989 and 5–17 August 1990.

*Mednyi Island* Red-legged Kittiwake nests were counted from a small boat and from land during the following periods: 29 June–29 July 1986; 25–28 July 1988, and 1 June–19 July 1994.

## Results

### *Population levels and breeding distribution*

The following annotated list provides, for each nesting location, a description of the distribution of Red-legged Kittiwakes and the earliest ("baseline") population estimates predicated upon either censuses or sampling with specified accuracy.

*Pribilof Islands* The Pribilof Islands group is composed of four islands (Figure 2). St George Island contained more ledge-nesting habitat than the other islands, about 48 km of cliffs ranging from less than 10 m to over 300 m tall (Hickey and Craighead 1977). In 1976, this island supported an estimated 220,000 Red-legged Kittiwakes, over 80% of the world's breeding population (Table 1). Ledge-nesting seabirds, including Red-legged Kittiwakes, occupied cliffs around most of the island's coastline (Figure 2). The highest densities of Red-legged Kittiwakes were in the High Bluffs area, where the species nested both in pure colonies and mixed with other ledge-nesting species. Hickey and Craighead (1977) estimated that Red-legged Kittiwakes comprised nearly 11% of the ledge-nesters at St George and were four times more numerous than Black-legged Kittiwakes (Table 2).

At St Paul Island, which contained about 11 km of cliffs ranging from less than 10 m to 100 m high, Hickey and Craighead (1977) estimated 2,200 Red-legged Kittiwakes in 1976 based on cliff area and mean densities at St George (Table 1). Also in 1976, Hunt (1977) counted 850 nests suggesting at least 1,700 breeders were present. Ledge-nesting seabirds nested mostly on the southern and western portions of St Paul, but few Red-legged Kittiwakes were found except in the West Cliffs area (Figure 2). At St Paul, Red-legged Kittiwakes comprised only about 1% of the ledge-nesting seabirds and were outnumbered by Black-legged Kittiwakes by 14 to 1 (Hickey and Craighead 1977).

Otter Island, with 1.6 km of sea cliffs ranging from 10 m to 90 m high, has not been so well studied as St George and St Paul islands but available data suggested Otter contained about 2,000 Red-legged Kittiwakes in 1993 (Table 1). They comprised about 4% of the ledge nesters at Otter and were outnumbered by Black-legged Kittiwake by about 2.5 to 1. Ledge-nesters, including Red-legged Kittiwakes, were distributed primarily along the south and west sides. Walrus Island had only about 200 m of cliffs, all under 10 m tall, and no Red-legged Kittiwakes were found there during a census in 1987 (G.V.B. unpubl. data).

*Bogoslof Islands* The group includes two islands, Bogoslof and Fire (Figure 2). In 1973 when Red-legged Kittiwakes were first discovered at Bogoslof (Byrd 1978), the island had about 2 km of cliff habitat, most less than 15 m high. The exception was Castle Rock which rose to 110 m. A new unnamed dome, over 100 m tall, rose from the sea at the north end of Bogoslof during a volcanic eruption in 1992 adding additional habitat for nesting seabirds. In 1973 about 81 Red-legged Kittiwake nests were counted on Castle Rock and Kenyon Dome (Figure 2), the only two locations where this species was found (Table 1).

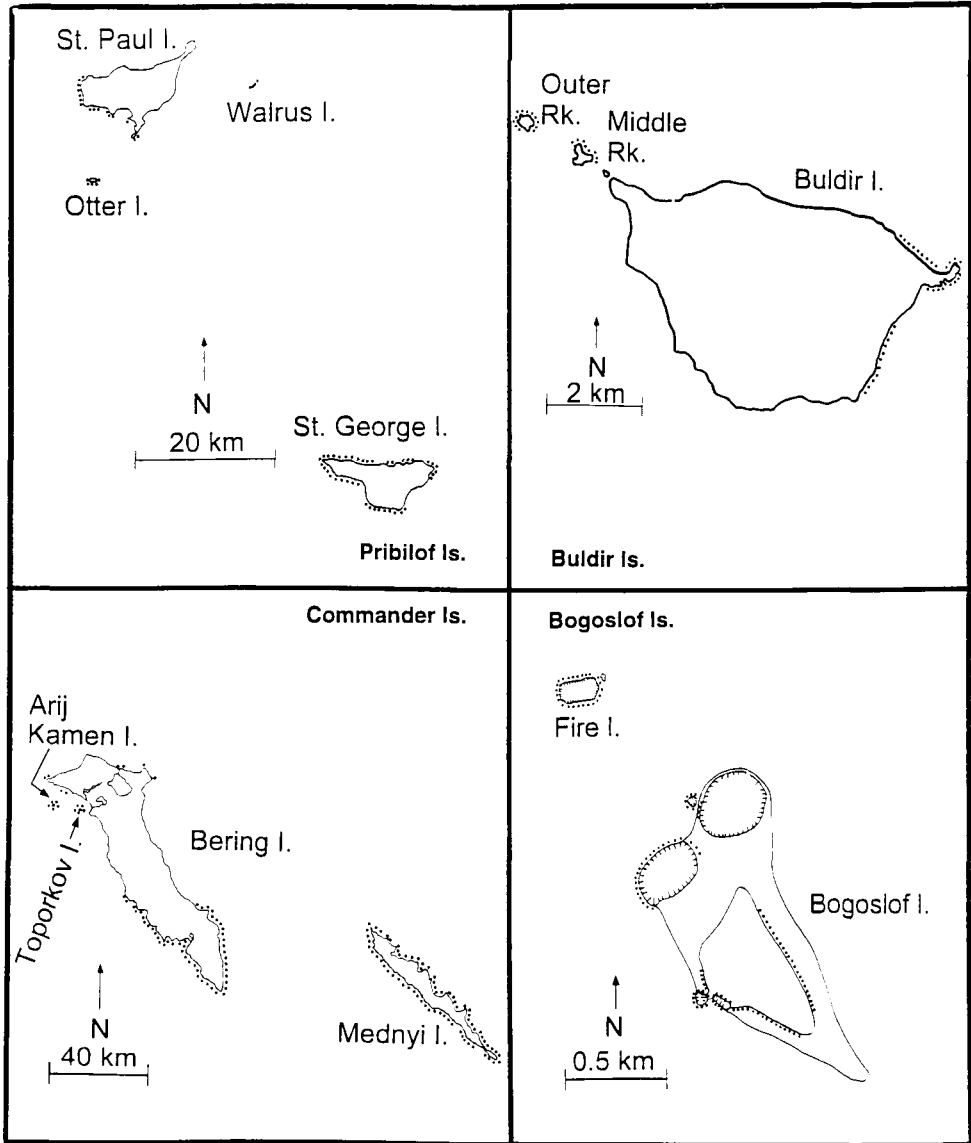


Figure 2. Map of the four locations where Red-legged Kittiwakes breed showing the distributions of ledge-nesting seabirds (indicated by dots).

Red-legged Kittiwakes comprised less than 1% of the more than 44,000 ledge-nesters present at Bogoslof in 1973 and they were outnumbered by Black-legged Kittiwake by nearly 10 to 1 (Byrd et al. 1980).

Fire Island, a 70 m tall, 0.5 ha rock, had 20 Red-legged Kittiwake nests in 1973 (Table 1). Over 40,000 ledge-nesting seabirds occupied the island, so Red-legged Kittiwakes comprised far less than 1%. They were outnumbered 50 to 1 by Black-legged Kittiwakes at Fire Island (Byrd et al. 1980).

Table 1. Population estimates of Red-legged Kittiwakes at various breeding colonies

Location	No. of Red-legged Kittiwakes		Method	Reference
	Mid-1970s	1990s		
<i>Pribilof Is.</i>				
St George I	220,000	123,000	Estimate <sup>a</sup>	Hickey and Craighead 1977, Dragoo and Sundseth 1993
St Paul I	2,200	1,000	Estimate <sup>b</sup>	Hickey and Craighead 1977, Climo 1993
Otter I	No data	2,000	Nest census <sup>c</sup>	A. Sowls unpubl. data, 1993
<i>Sub-total</i>	>222,200 <sup>d</sup>	126,000		
<i>Bogoslof Is.</i>				
Bogoslof I.	160	412	Nest census	Byrd <i>et al.</i> 1980, Byrd and Williams 1994b
Fire I.	40	242	Nest census	Byrd <i>et al.</i> 1980, Byrd and Williams 1994b
<i>Sub-total</i>	200	654		
<i>Buldir Is.</i>				
Outer/Middle Rks	200	562	Nest census	Byrd and Day 1986, J.C.W. unpubl. data, 1993
Buldir I.	4,180	8,788	Nest census	Byrd and Day 1986, J.C.W. unpubl. data, 1993
<i>Sub-total</i>	4,400	9,350		
<i>Commander Is.</i>				
Arij Kamen I.	No data	880	Nest census	Vyatkin and Artukhin 1994
Toporkov I.	No data	58	Nest census	Vyatkin and Artukhin 1994
Bering I.	No data	30,606	Nest census	Vyatkin and Artukhin 1994
Mednyi I.	No data	800	Nest census	Y.B.A. unpubl. data, 1994
<i>Sub-total</i>		32,344		
<i>Total</i>	>259,344 <sup>e</sup>	168,348		

<sup>a</sup> Hickey and Craighead (1977) counted "white" birds on randomly selected clusters from photographs of cliffs, then used proportions of various species on reference ledges that could be counted directly to determine species composition. Counts in 1992 (Dragoo and Sundseth 1993) were 44% lower than 1976 counts on the same plots used as reference ledges by Hickey and Craighead (1977) in 1976. Thus, the 1990s estimate was based on a reduction of 44% from the 1976 estimate.

<sup>b</sup> Hickey and Craighead (1977) used data from St George on density obtained from counts from photographs there, and extrapolated for cliff area at St Paul. St Paul reference ledges were used to determine species composition. Counts in 1992 (Climo 1993) were 54% lower than counts on the same plots used as reference ledges by Hickey and Craighead (1977) in 1976. Thus, the 1990s estimate was based on a 54% reduction from the 1976 count.

<sup>c</sup> Censuses of nests were doubled in all cases, here and below, for estimates of individuals.

<sup>d</sup> The "greater than" sign is used to indicate that totals do not include data for all sites.

<sup>e</sup> Total includes the mid-1990s data for the Commander Islands.

*Buldir Islands* In 1976, an estimated 4,400 Red-legged Kittiwakes nested at Buldir (Table 1). Most of the 4 km of cliff nesting habitat occurred along the eastern end of the island. Cliff tops ranged from 20 to 80 m tall. Kittiwakes and other ledge-nesters also occurred on Middle and Outer Rocks (Figure 2). Red-legged Kittiwakes comprised about 13% of the ledge-nesters at Buldir in 1993 but accounted for only 8% of the ledge-nesters at Outer Rock and occurred

Table 2. Proportion of Red-legged Kittiwakes in assemblages of ledge-nesting seabirds at various sites

Location	Total ledge-nesters <sup>a</sup>	Proportion of ledge-nesters (%)	Ratio of RLKI:BLKI <sup>b</sup>	Reference
<i>Pribilofs</i>				
St George	2,057,000	10.7	4:1	Hickey and Craighead 1977
St Paul	207,900	1.1	1:14	Hickey and Craighead 1977
Otter	47,700	4.2	1:3	A. SOWLS unpubl. data, 1993
<i>Bogoslof</i>				
Fire	41,640	<0.1	1:50	Byrd <i>et al.</i> 1980
Bogoslof	44,131	0.4	1:10	Byrd <i>et al.</i> 1980
<i>Buldir</i>				
Outer Rock	5,589	7.7	1:10	J.C.W. unpubl. data, 1992
Middle Rock	1,882	<0.1	1:100	J.C.W. unpubl. data, 1992
Buldir	33,408	13.0	1:5	J.C.W. unpubl. data, 1992
<i>Commanders</i>				
Arij Kamen	15,714	5.6	1:4	Vyatkin and Artukhin 1994
Toporkov	708	8.2	1:5	Vyatkin and Artukhin 1994
Bering	267,260	11.5	1:2	Vyatkin and Artukhin 1994
Mednyi	309,660	0.3	1:17	Y.B.A. unpubl. data, 1994

<sup>a</sup> Includes fulmars, cormorants, kittiwakes and murres.

<sup>b</sup> BLKI, Black-legged Kittiwake; RLKI, Red-legged Kittiwake.

in very low numbers at Middle Rock (Table 2). Black-legged Kittiwakes outnumbered Red-legged Kittiwakes by 5 to 1 on Buldir and the former species was even more prevalent at Outer and Middle rocks.

*Commander Islands* This group of islands includes two large islands, Bering and Mednyi, and two small islands near Bering (Arij Kamen and Toporkov) (Figure 2). Red-legged Kittiwake population estimates by Marakov (1976) and Firsova (1978) were based on incomplete coverage (Y.B.A. unpubl. data) and no baseline numbers were available for some of the islands in this area until after 1985 (Artukhin 1990, 1991) (Table 1).

The largest of the Commander Islands, Bering Island, has about 70 km of cliff habitat which ranges from less than 10 m to over 300 m high. The highest and most extensive cliffs are in the southern portion of the island. Vyatkin and Artukhin counted over 267,000 ledge-nesting seabirds at Bering Island in 1993. This total included 30,606 Red-legged Kittiwakes (based on a count of 15,303 nests, Table 1), about 12% of the total ledge-nesting seabirds at Bering Island (Table 2). Black-legged Kittiwakes outnumbered Red-legged Kittiwakes by 1.5 to 1.

The other large island in the Commanders, Mednyi Island, has about 100 km of cliffs and over 309,000 nesting ledge-nesting seabirds were found there in 1994 (Y.B.A. unpubl. data). About 1,000 Red-legged Kittiwakes were counted on Mednyi Island in 1986 and about 800 were present in 1994 (Table 1). Red-legged Kittiwakes comprised less than 1% of all ledge-nesters on Mednyi. They were outnumbered by Black-legged Kittiwakes by about 17 to 1.



Arij Kamen, one of the small islands near the north end of Bering Island, has about 400 m of cliff up to 50 m tall. About 15,700 ledge-nesting seabirds were present in 1993 including 880 Red-legged Kittiwakes (Table 1). Red-legged Kittiwakes comprised about 6% of all ledge-nesters at Arij Kamen, but they were outnumbered by Black-legged Kittiwakes by nearly 4 to 1.

Toporkov Island, the other small island near the north end of Bering Island, has only 700 m of cliffs, mostly less than 10 m high, and only about 700 ledge-nesting seabirds were found there in 1993. This total included only 58 Red-legged Kittiwakes (8% of the total ledge-nesting seabirds at Toporkov) which were outnumbered 5 to 1 by Black-legged Kittiwakes (Table 2).

### Population Trends

*Pribilof Islands* Numbers of Red-legged Kittiwakes at study plots on St George and St Paul have declined since 1976 (Figure 3). At St George the numbers counted on index plots declined from approximately 4,000 birds in 1976 to around 2,000 birds by 1992. This highly significant decline ( $H_0$ : Slope = 0,  $P < 0.001$ ) averaged about  $-3.2\%$  per year. The rate of change was even higher ( $-3.9\%$  per year) between 1976 and 1989 but the 1992 count ameliorated the trend, at least temporarily.

At St Paul a similar decline occurred on index plots; from 114 birds in 1976 to 53 birds in 1992 (Figure 3). Although the overall trend at St Paul was significant ( $H_0$ : Slope = 0,  $P < 0.01$ ), the pattern of change was different from St George. At St Paul numbers declined linearly at  $5\%$  per year between 1976 and 1987, but counts increased temporarily in 1988 and 1989. Data for Otter and Walrus islands were inadequate to evaluate trends.

*Bogoslof Islands* Complete island counts were made in 1973 and 1994. The number of nests counted in 1994 at Bogoslof (206) was more than double the total for 1973 (81). An even larger increase was noted at Fire Island; 121 nests in 1994 (Byrd and Williams 1994b) compared with 20 nests in 1973.

*Buldir Island* Two avenues of comparison are available for Buldir Island. Total island counts of nests increased from 4,000 in 1976 to 9,350 in 1992. Furthermore, counts of nests on study plots were significantly higher ( $P < 0.01$ ) during 1988–1994 than in the mid-1970s) (Figure 4).

*Commander Islands* As indicated above, complete counts of Red-legged Kittiwakes in the Commander Islands were not made until the 1990s. Nevertheless, counts at Arij Kamen and at several sites on Bering and Mednyi provide a basis for evaluating trends (Tables 3 and 4). Estimates of both species of kittiwakes lumped together at Arij Kamen Island made by Firsova in the early 1970s were much higher than earlier counts by Kartashov (1961), and subsequently Y.B.A. has found fewer Red-legged Kittiwakes there than did Firsova. If a temporary increase really occurred, populations have now returned to 1960 levels. Recent counts at three colonies on Bering Island suggested slight declines in the number of nests from 1989 to 1993 (Table 3), and Artukhin found

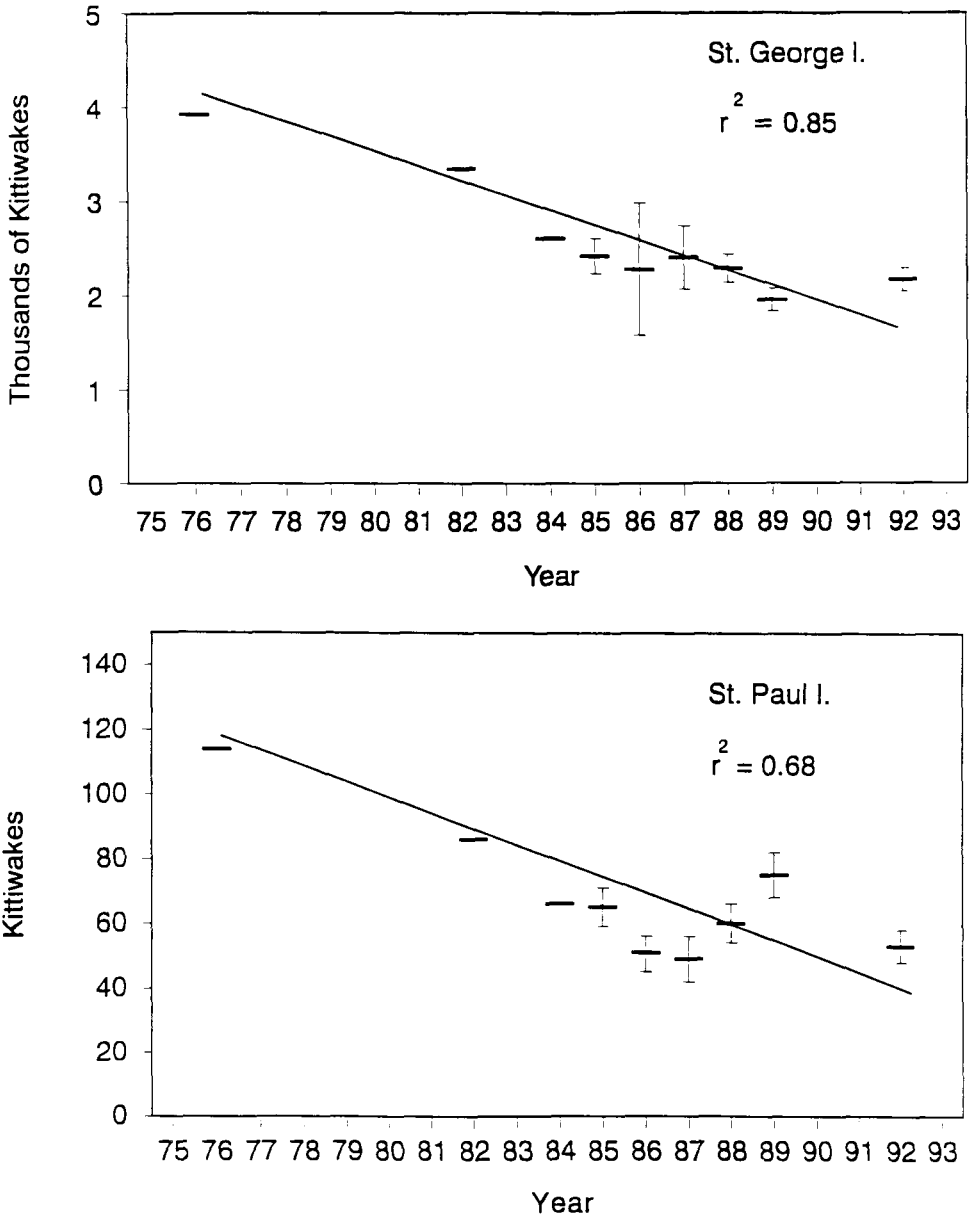


Figure 3. Trends in counts of Red-legged Kittiwakes at St George and St Paul islands, Pribilof Islands, Alaska. Means with 90% confidence intervals are indicated for years with multiple counts. Simple linear regression lines are shown.

slightly fewer nests in 1994 than in 1986 at comparable colonies on Mednyi Island (Table 4).

**Discussion**

More than 80% of approximately 260,000 Red-legged Kittiwakes at breeding colonies in the Bering Sea in the 1970s was found at a single site, St George

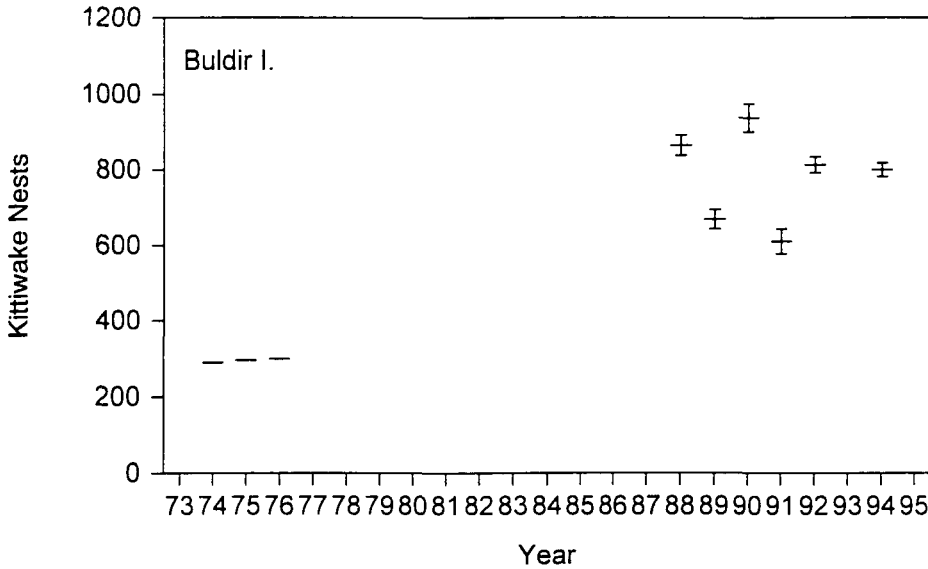


Figure 4. Distribution of counts of Red-legged Kittiwake nests at Buldir Island, Alaska. Means with 90% confidence intervals are indicated for years with multiple counts. There were significantly more nests present during the period 1988–1994 than in the mid-1970s ( $P < 0.01$ ).

Table 3. Comparison of counts of Red-legged Kittiwake nests at Arij Kamen and selected colonies on Bering Island, Commander Islands

Location	Year <sup>1</sup>				
	1960	1971	1989	1990	1993
Arij Kamen	440	800	450	500	440
Bering Island					
Severo-Zapadnyi Cape			45	59	8
Shipitsinskyi Cape			170	142	136
Peregrebnyaya Bay			1270	1315	1202
Total			1485	1516	1346

<sup>1</sup> References for counts are as follows: 1960, Kartashov (1961); 1971, Firsova (1978); 1989–1990, Artukhin (1990); 1993, Vyatkin and Artukhin (1994).

Island. The second largest colony, at Bering Island, contained 12% and no other colony had more than 2% of the population. Red-legged Kittiwakes outnumbered Black-legged Kittiwakes only at St George Island. Between the 1970s and 1990s, populations at St George declined by an estimated 50% but the population appears to have stabilized at the reduced level. A similar decline was recorded on nearby St Paul. In contrast, a small population at Bogoslof and Fire islands, 300 km south-east of the Pribilofs, had increased more than threefold and the population had doubled at Buldir Island, in the western Bering Sea. The only historic information available from the Commander Islands suggested that numbers of nesting Red-legged Kittiwakes at Arij Kamen Island

Table 4. Comparison of counts<sup>a</sup> of Red-legged Kittiwake nests at selected nesting locations on Mednyi Island, Commander Islands

Location	Year <sup>a</sup>		
	1986	1988	1994
Zhirovskoi Cape	100		81
Chernyi Cape	20		7
Drovyanye Stolby Cape	40	33	53
Yuznyi Cape	100	83	42
Govorushchey Cape	5	5	6
Sen'kinskiy Cape	6		16
Bobrovaya Bay	173		173
Total	444		378

<sup>a</sup> Y.B.A. unpubl. data.

in 1993 were similar to 1960 levels. Slightly fewer nests were found at Bering and Mednyi islands in 1993 and 1994, respectively, than in the late 1980s but it is too early to know whether this is a trend or just normal interannual fluctuation.

Causes for the decline of Red-legged Kittiwakes in the Pribilof Islands are not known but the effects apparently do not extend to other colonies. Nevertheless, since such a substantial proportion of the world's population of Red-legged Kittiwakes occurs in the Pribilofs, the decline there is of concern. Of all the breeding stations for Red-legged Kittiwakes, potential threats are probably greatest in the Pribilof Islands. Within the past decade, these islands have been developed to support major commercial fisheries which occur in the waters nearby. Development of the necessary infrastructure (e.g. construction of harbours, land-based processing facilities and support structures) has been accomplished with a minimum of impact on kittiwake ledge-nesting habitat but the potential for disturbance has increased (e.g. oil spills, accidental introduction of rats, harassment of birds). The disruption of marine food webs by fisheries is not well understood, but the removal of a large biomass of fish in the commercial harvest may adversely affect Red-legged Kittiwakes.

Research is needed to determine causes for declines in Red-legged Kittiwakes. Furthermore, population monitoring needs to continue to determine whether declines continue.

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V. BYRD and J. WILLIAMS

U.S. Fish and Wildlife Service, 2355 Kachemak Bay Drive, Suite 101, Homer, AK 99603, U.S.A.

Y. ARTUKHIN and P. VYATKIN

Kamchatka Institute of Ecology and Nature Management, Rybakov pr., 19-a, Petropavlovsk-Kamchatsky, Russia 683024