

The Avifauna of Buldir Island, Aleutian Islands, Alaska

G. VERNON BYRD¹ and ROBERT H. DAY²

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ABSTRACT. We studied the avifauna of Buldir Island, Aleutian Islands, Alaska, between 1972 and 1984. During the study 126 forms of 125 species were recorded, including first North American records for 6 species and first Aleutian records for 4 others. Due to the absence of mammalian predators and rich food resources nearby, 32 species, 21 of them seabirds, bred at Buldir. Breeding populations totaled approximately 1.8 million pairs of birds, primarily storm-petrels (*Oceanodroma* spp.) and auklets (*Aethia* spp.). Buldir's suite of breeding alcids — 12 species — may be the most diverse of any seabird colony in the world. Our data on migrants suggest that Buldir is near the eastern edge of the Japan-Kuril Islands-Kamchatka flyway. All migrant and breeding species recorded are discussed in an annotated list.

Key words: Buldir Island, Aleutian Islands, Beringia region, zoogeography, breeding birds, migrant birds, Bering Sea, subarctic seabirds

RÉSUMÉ. Nous avons étudié entre 1972 et 1984 l'avifaune de l'île Buldir, dans les îles Aléoutiennes en Alaska. Un total de 126 formes de 125 espèces furent enregistrées, y compris les premières observations en Amérique du Nord de 6 espèces et les premières observations dans les Aléoutiennes de 4 autres espèces. Grâce à l'absence de mammifères prédateurs et à l'accès à de riches ressources alimentaires, 32 espèces, dont 21 espèces d'oiseaux de mer, nichèrent sur Buldir. La population nidificatrice comptait quelque 1.8 million de couples d'oiseaux, en particulier des pétrels de tempête (*Oceanodroma* spp.) et des alques (*Aethia* spp.). Les 12 espèces d'alcides nichant sur Buldir comportent peut-être la suite la plus diversifiée de toutes les colonies d'oiseaux du monde. Nos données portant sur les migrateurs suggèrent que Buldir se situe près de l'extrémité est de l'itinéraire Japon-Îles Buriel-Kamchatka. Toutes les espèces migratrices et nidificatrices enregistrées sont discutées dans une liste annotée.

Mots clés: île Buldir, îles Aléoutiennes, Béringie, zoogéographie, oiseaux nidificateurs, oiseaux migrateurs, mer de Béring, oiseaux de mer subarctiques

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Buldir Island gained ornithological prominence 20 years ago (Jones, 1963) with the discovery there of a remnant breeding population of endangered "Aleutian" Canada Geese (*Branta canadensis leucopareia*). Since Buldir is one of only two relatively large Aleutian Islands where arctic foxes (*Alopex lagopus*) were never introduced, it provides a good example of a relatively undisturbed Aleutian Island ecosystem. The results of our survey of the birds of Buldir provide a basis for speculation about the diversity and magnitude of Aleutian Island bird populations prior to fox introductions (see Murie, 1959; Jones and Byrd, 1979).

Our study was part of an expanded research effort in the Aleutians starting in the late 1960s (Fuller, 1977; Sekora *et al.*, 1979), including surveys mandated by the Wilderness Act of 1964 (U.S. Fish and Wildlife Service, 1973) and the recovery program for Aleutian Canada Geese (Byrd and Springer, 1976; Springer *et al.*, 1978). From 1972 to 1984 teams of biologists visited Buldir, at least briefly, between late April and late September in all but two years (1973, 1981). Observations made over the period are summarized in this paper to characterize Buldir's avifauna and to compare it with that of other islands in the Aleutian archipelago.

STUDY AREA

Buldir Island (52°21'N, 175°56'E) is the westernmost of the Rat Islands group of the Aleutian Islands (Fig. 1). The 2000-ha island (Fig. 2) is approximately 6.4 km long and 3.2 km wide. Located about 110 km from both Shemya and Kiska islands to the west and east respectively, it is the most isolated island in the Aleutians, providing the only landfall in a 220 km-wide pass. Buldir is part of the Aleutian Islands Unit of the Alaska Maritime National Wildlife Refuge.

Buldir was built by lava from two main centers of eruption, Buldir Eccentric and Slide Mountain (Coats, 1953). Characteristic features (Fig. 3) include boulder-strewn beaches, frequently backed by steep sea cliffs (over 50% of the 20 km-long coastline); steep mountains; coastal talus slopes; and one alluvial valley near sea level. A large freshwater pond (1.2 ha Kittiwake Pond) occupies a crater at 300 m elevation. Only five other small permanent ponds are present. Just four small streams flow all summer, and two small freshwater marshes occupy the alluvial valley. Although surface water is limited, Buldir is usually wet in summer due to frequent precipitation, dense fog, and constantly high relative humidity (see Armstrong, 1977; Byrd and Woolington, 1983).

Of 29 avian habitats described for Alaska by Kessel (1979), 11 were primary habitats for at least one species at Buldir: lacustrine waters and shorelines, inshore waters, rocky shores and reefs, cliffs and blockfields (separated into two habitats for our purposes), subterranean soil, wet meadows, grass meadows, tall-forb meadows, dwarf-shrubs mats, and artificial habitats. There are two major vegetative complexes (Byrd, 1984): a lowland tall-plant association (approximately 1 m tall) that generally occurs below 300 m elevation, and an upland short-plant association (less than 10 cm tall) occurring at higher elevations. The major lowland plant communities (mostly Kessel's tall-forb meadow habitat) are dominated by beach rye (*Elymus arenarius*), cow parsnip (*Heracleum lanatum*), wild celery (*Angelica lucida*), and a fern (*Athyrium felix-femina*). The common plants in the uplands (mostly Kessel's dwarf-shrub mat) are several species of dwarf willow (*Salix* spp.) and mosses (Byrd, 1984). Buldir is essentially pristine, but several kinds of World War II debris constitute artificial habitats. Buldir has no terrestrial mammals, but Steller sea lions (*Eumetopias jubatus*), sea otters (*Enhydra lutris*), and harbor seals (*Phoca vitulina*) breed there.

¹Present address: Aladdin Route, Box 160 E, Colville, WA 99114, U.S.A.

²Present address: Institute of Marine Science, 200 O'Neill Building, University of Alaska, Fairbanks, AK 99701, U.S.A.

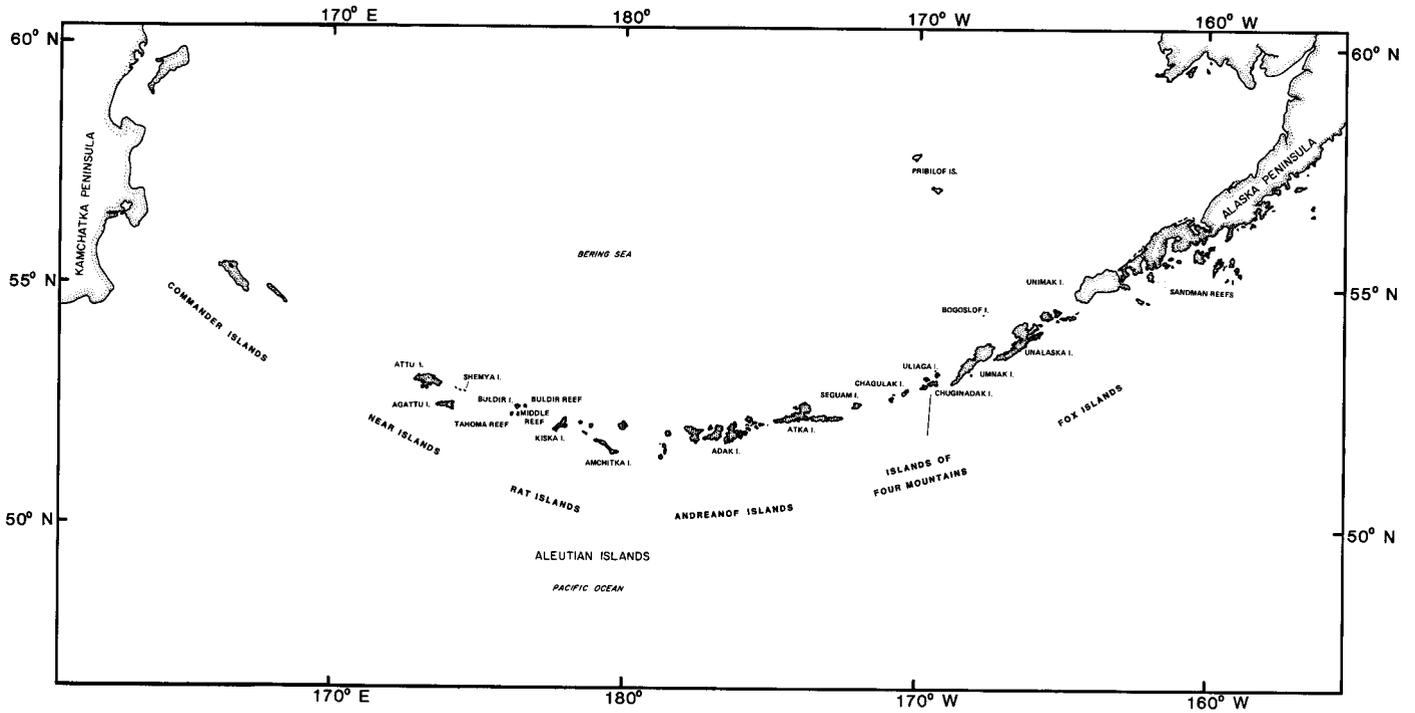


FIG. 1. The Aleutian Islands, Alaska.

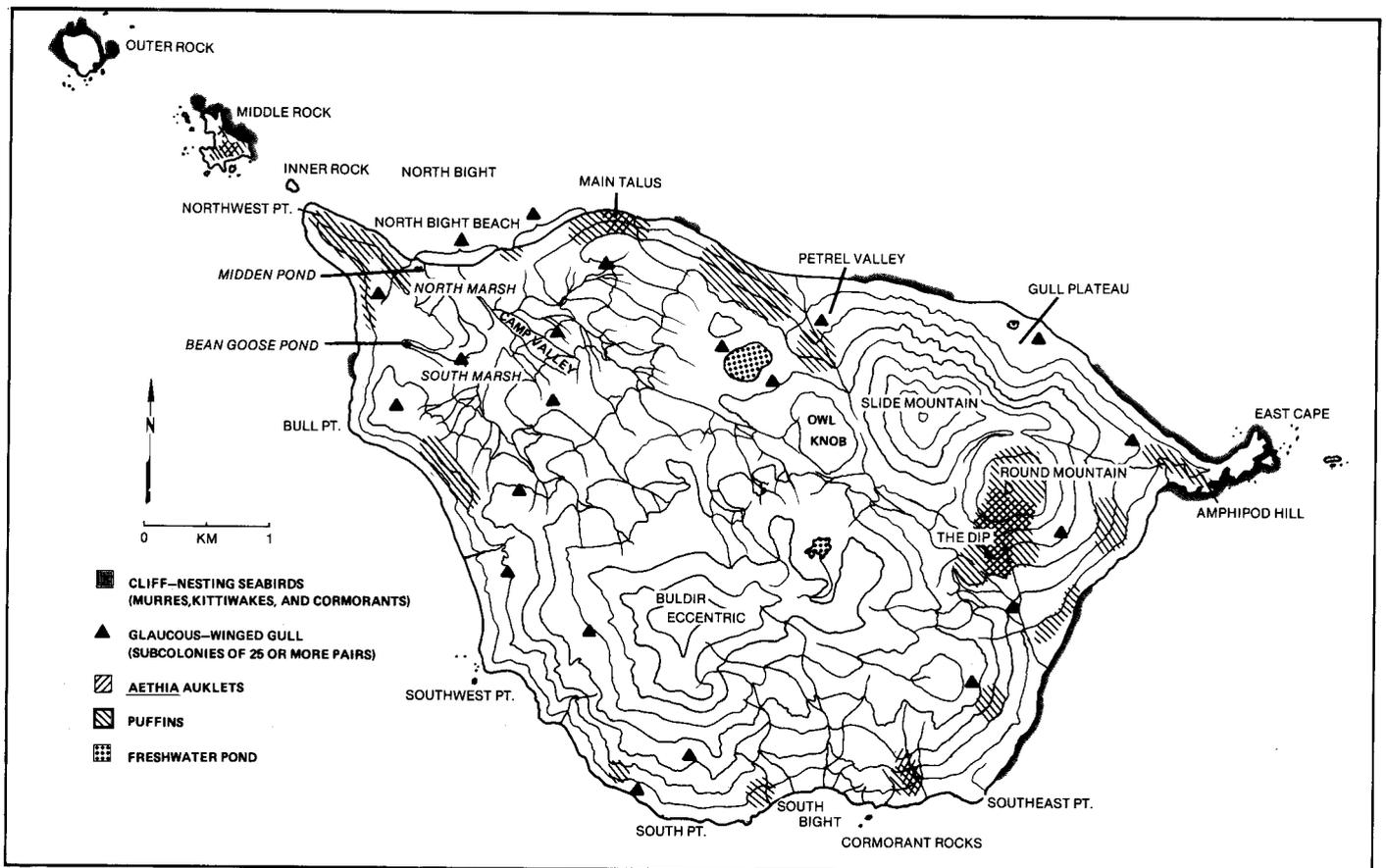


FIG. 2. Buldir Island, Alaska, showing place names used in the text and concentrations of nesting seabirds.

METHODS

Observations were made during the periods 4-8 July 1972, 30 April-6 September 1974, 17 May-5 September 1975, 18 May-28 September 1976, 25 May-2 July 1977, 13-25 July 1978, 4 June-1 July and 25-30 July 1979, 12-17 August 1980, 31 May-27 June 1982, 4 June 1983, and 8-25 June 1984. Our main camp was located in Camp Valley (Fig. 2), and we either walked or used a small boat to visit all parts of the island.

Data on migrant species were gathered opportunistically, but we visited designated plots repeatedly to study most breeding species. We censused cliff-nesting seabirds by making direct counts of birds (murres and fulmars) or nests (kittiwakes and cormorants) and by counting birds in photographs. Although counts were made of some cliff areas in up to three different years, for year-to-year comparisons no plots were counted more than once per year. Counts were made during the late-incubation or early chick-rearing period and always between 1000-1800 h. Except for an area just east of Gull Plateau, which was censused from the beach, all cliff counts were made from inflatable boats. Usually at least two observers counted birds and compared results. If counts diverged more than 10%, areas were recounted. Averages of similar counts were recorded. In contrast to censuses conducted for cliff-nesters, sampling techniques were used to estimate populations of storm-petrels (see Byrd and Trapp, in press), Canada Geese (Byrd and Woolington, 1983), and auklets (Byrd *et al.*, 1983). Linear transects (Emlen, 1971) were used to obtain estimates of breeding longspurs in Camp Valley, and a strip transect was used to get an index for numbers of wrens and sparrows. This 30 m-wide strip ran the length of North Bight Beach (boundaries similar to those of the gull subcolony delineated in this area — see Fig. 2). Generally two observers counted all birds seen from the tide line to about 20 m inland from the vegetation line; thus, the entire beach was included. Populations of other species were estimated by record-

ing all nesting locations and summing general counts of birds or nests for all areas. These estimates ranged from very accurate for conspicuous ground-nesting species such as Parasitic Jaegers and Glaucous-winged Gulls to unknown accuracy for nocturnal burrow-nesting species such as Ancient Murrelets.

RESULTS

An annotated list follows for all species recorded during the study at Buldir. Table 1 provides scientific names and summarizes the status, geographic affinity, and primary habitats used by the species. Information on the timing of various breeding events is illustrated in Figure 4, and the locations of seabird nesting concentrations are included in Figure 2. Phylogenetic sequence and bird species nomenclature follow the American Ornithologists' Union (A.O.U.) (1983), and subspecific nomenclature follows Vaurie (1959, 1965) for Palearctic forms and the A.O.U. (1957) for Nearctic forms.

The geographic affinity listed for various species is the faunal region in which the greatest proportion of the breeding, and usually the wintering, range lies. Forms with disjunct breeding ranges, parts of which also include the northeastern Nearctic or northwestern Palearctic (e.g., Leach's Storm-Petrel, Harlequin Duck, Black Scoter) are discussed in terms of the nearest breeding population. Palearctic and Nearctic are well-known regions, but the third region we recognized (Beringian) needs description. The Beringian (or Aleutican, as it has also been called) region constitutes a discrete biogeographic province, with many species and forms of endemic plants (Hulten, 1937) and animals (e.g., Swarth, 1934; Fay and Cade, 1959; Gibson, 1981). Cut off from the respective continents during Pleistocene glaciation, Beringia had approximate boundaries of the Mackenzie River to the east and the Kolyma River to the west (see Hopkins *et al.*, 1982). Beringia also includes the Kamchatka

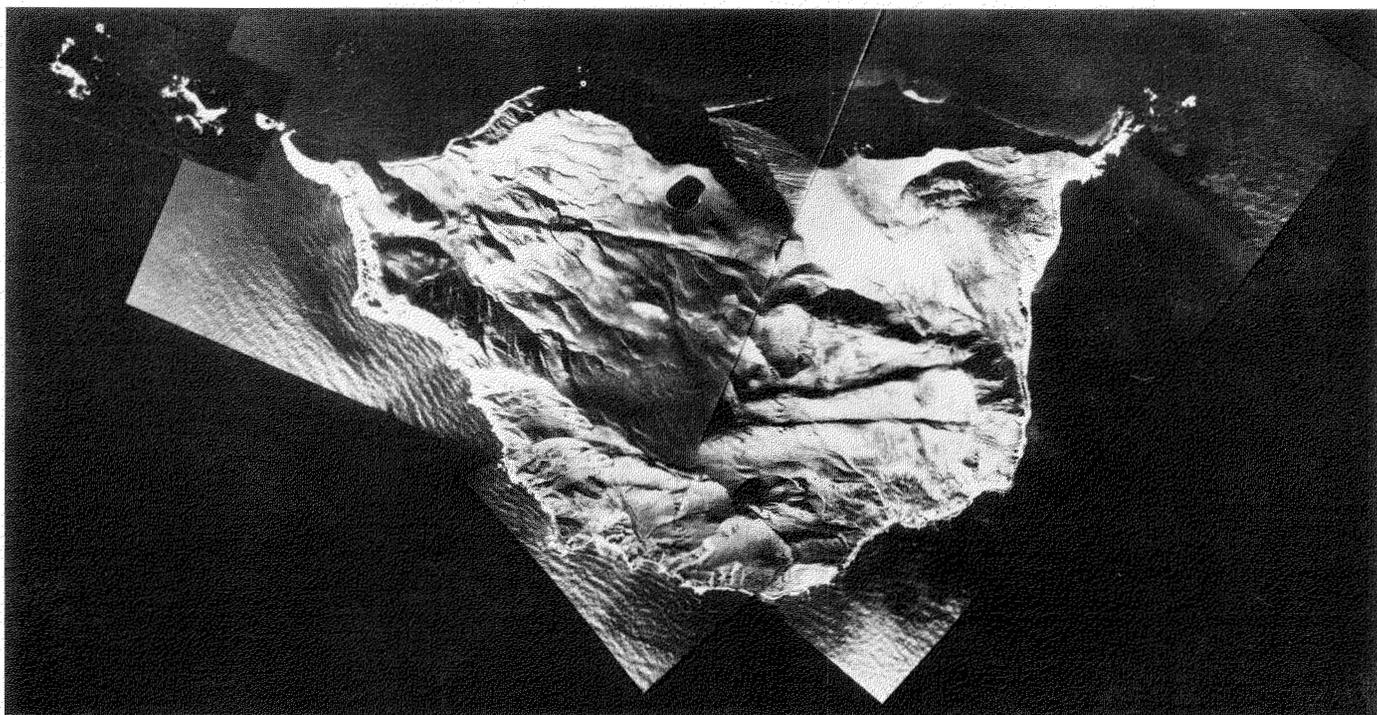


FIG. 3. Composite aerial photograph of Buldir Island, Alaska, made from U.S. government prints taken on an unknown date prior to 1953. (Courtesy of R.R. Coats, U.S. Geological Survey, Menlo Park, California.)

Peninsula, the Aleutian and Commander islands, the islands of the Bering Sea, and the now-submerged continental shelf of the Bering Sea. The term Holarctic refers to all the other regions combined. Four polytypic species (Common Goldeneye, Rough-legged Hawk, Glaucous Gull, and Bank Swallow) were listed as Holarctic because subspecific identification could not be determined without specimens. All species we recorded at Buldir are

listed for completeness, but data for some of the accidental and very rare migrants has been published previously. For these, the list includes only the appropriate reference. Data on clutch sizes are expressed as the mean \pm 1 standard deviation. All specimens indicated by brackets around the scientific name in Table 1 were deposited at the University of Alaska Museum, Fairbanks, Alaska.

TABLE 1. The status, geographic affinities, and primary habitats of birds recorded at Buldir Island, Alaska

Species	Status ¹	Geographic affinity ²	Primary habitat ³	Species	Status ¹	Geographic affinity ²	Primary habitat ³
Red-throated Loon (<i>Gavia stellata stellata</i>) ⁴	CaSuV	H	IW	Common Greenshank [<i>Tringa nebularia</i>]	VRM	P	WM
Red-necked Grebe (<i>Podiceps grisegena holbollii</i>)	CaSuV	EP/WN	IW	Lesser Yellowlegs [<i>Tringa flavipes</i>]	CaM	N	WM
Northern Fulmar (<i>Fulmarus glacialis rogersii</i>)	UB	B	SC	Marsh Sandpiper [<i>Tringa stagnatilis</i>]	Ac	P	WM
Fork-tailed Storm-Petrel [<i>Oceanodroma furcata furcata</i>]	AbB	B	SS	Spotted Redshank [<i>Tringa erythropus</i>]	CaFM	P	WM
Leach's Storm-Petrel [<i>Oceanodroma leucorhoa leucorhoa</i>]	AbB	B	SS	Wood Sandpiper [<i>Tringa glareola</i>]	R-CoSpM/ CaSuV/RFM	P	WM
Pelagic Cormorant [<i>Phalacrocorax pelagicus pelagicus</i>]	UB	B	SC	Wandering Tattler [<i>Heteroscelus incanus</i>]	RM	B	RS
Red-faced Cormorant [<i>Phalacrocorax urile</i>]	UB	B	SC	Gray-tailed Tattler [<i>Heteroscelus brevipes</i>]	CaSpM/ RFM	EP	RS
Bean Goose (<i>Anser fabalis serrirostris</i>)	CaSpM	EP	LS	Common Sandpiper [<i>Actitis hypoleucos</i>]	RM	P	RS
Emperor Goose (<i>Chen canagica</i>)	UWV	B	RS	Terek Sandpiper (<i>Xenus cinereus</i>)	CaM	P	RS
Brant (<i>Branta bernicla nigricans</i>)	Ac	B	IW	Whimbrel [<i>Numenius phaeopus variegatus</i>]	VRSpM/ RFM	EP	RS/DS ⁵
Canada Goose (<i>Branta canadensis leucopareia</i>)	CoB	B	TF	Bristle-thighed Curlew (<i>Numenius tahitiensis</i>)	CaSpM	B	RS
Green-winged Teal (<i>Anas crecca nimia</i>)	RB	B	GM	Black-tailed Godwit (<i>Limosa limosa melanuroides</i>)	CaSpM	EP	WM
Green-winged Teal (<i>Anas crecca carolinensis</i>)	CaSpM	N	WM	Bar-tailed Godwit (<i>Limosa lapponica baueri</i>)	VRSpM	B	WM
Mallard (<i>Anas platyrhynchos platyrhynchos</i>)	RSpM/ VRSuV/ CaFM	H	WM	Ruddy Turnstone (<i>Arenaria interpres interpres</i>)	RSpM/ CoFM	P	RS
Northern Pintail (<i>Anas acuta acuta</i>)	U-CoSpM/ CaSuV/RFM	H	WM	Red Knot (<i>Calidris canutus canutus</i>)	CaSpM	H	WM
Garganey [<i>Anas querquedula</i>]	RM	P	WM	Sanderling (<i>Calidris alba</i>)	CaM	H	RS
Northern Shoveler (<i>Anas clypeata</i>)	CaSpM	H	WM	Rufous-necked Stint (<i>Calidris ruficollis</i>)	RM	B	RS
Eurasian Wigeon (<i>Anas penelope</i>)	U-CoSpM/ CaSuV/CaFM	P	WM	Little Stint (<i>Calidris minuta</i>)	CaFM	P	RS
American Wigeon (<i>Anas americana</i>)	CaSpM	N	WM	Temminck's Stint [<i>Calidris temminckii</i>]	VRSpM/ CaFM	P	WM
Common Pochard [<i>Aythya ferina</i>]	CaSpM	P	IW	Long-toed Stint [<i>Calidris subminuta</i>]	R-U/M	EP	WM
Tufted Duck [<i>Aythya fuligula</i>]	RSpM/ CaSuV	P	IW	Baird's Sandpiper [<i>Calidris bairdii</i>]	VRFM	N	RS
Greater Scaup (<i>Aythya marila</i>)	USpM	H	IW	Pectoral Sandpiper [<i>Calidris melanotos</i>]	VR-RM	EP/N	WM/RS ⁵
Common Eider (<i>Somateria mollissima v-nigra</i>)	UB	B	TF	Sharp-tailed Sandpiper (<i>Calidris acuminata</i>)	RFM	EP	RS
Harlequin Duck (<i>Histrionicus histrionicus</i>)	CoWV/ USuV	B	IW	Dunlin [<i>Calidris alpina sakhalina</i>]	RM	B	WM
Oldsquaw (<i>Clangula hyemalis</i>)	UWV/CaSuV	H	IW	Spoonbill Sandpiper [<i>Euryornhynchus pygmeus</i>]	Ac	B	RS
Black Scoter (<i>Melanitta nigra americana</i>)	RM	B	IW	Ruff (<i>Philomachus pugnax</i>)	CaSpM/ VRFM	P	RS
Surf Scoter (<i>Melanitta perspicillata</i>)	CaSpM	N	IW	Common Snipe (<i>Gallinago gallinago gallinago</i>)	RSpM/ CaSuV/ VRFM	P	WM
White-winged Scoter (<i>Melanitta fusca deglandi</i>)	USpM/ CaSuV/RFM	N	IW	Red-necked Phalarope (<i>Phalaropus lobatus</i>)	RFM	H	IW
Common Goldeneye (<i>Bucephala clangula</i> ssp.)	RSpM/ CaSuV	H	IW	Red Phalarope [<i>Phalaropus fulicaria</i>]	CaSpM/ U-CoFM	H	IW
Bufflehead (<i>Bucephala albeola</i>)	CaSpM	N	LS	Parasitic Jaeger (<i>Stercorarius parasiticus</i>)	AbB	H	DS
Common Merganser (<i>Mergus merganser merganser</i>)	VRSpM/ CaSuV	P	WM	Common Black-headed Gull [<i>Larus ridibundus</i>]	RSpM/ CaSuV	P	WM
Red-breasted Merganser (<i>Mergus serrator</i>)	RSpM	H	IW	Mew Gull (<i>Larus canus kamtschatschensis</i>)	CaFM	EP	RS
Bald Eagle (<i>Haliaeetus leucocephalus alascanus</i>)	RB	N	CB	Herring Gull (<i>Larus argentatus vegae</i>)	CaM	EP	RS
Rough-legged Hawk (<i>Buteo lagopus</i> ssp.)	CaM/CaSuV	H	F	Slaty-backed Gull (<i>Larus schistisagus</i>)	CaSpM	B	RS
Peregrine Falcon (<i>Falco peregrinus pealei</i>)	CB	B	SC	Glaucous-winged Gull (<i>Larus glaucescens</i>)	AbB	B	GM
Gyr Falcon (<i>Falco rusticolus</i>)	CaSpM	H	F	Glaucous Gull (<i>Larus hyperboreus</i> ssp.)	RSpM	H	RS
Sandhill Crane (<i>Grus canadensis canadensis</i>)	CaSpM/ CaSuV	N	DS	Black-legged Kittiwake [<i>Rissa tridactyla</i>]	AbB	H	SC
Lesser Golden-Plover [<i>Pluvialis dominica fulva</i>]	RSpM/ R-CoFM	P	RS/DS ⁵	Red-legged Kittiwake [<i>Rissa brevirostris</i>]	CoB	B	SC
Mongolian Plover [<i>Charadrius mongolus stegmanni</i>]	RSpM/ CaFM	B	RS	Common Tern (<i>Sterna hirundo longipennis</i>)	CaSpM	EP	WM
Semipalmated Plover [<i>Charadrius semipalmatus</i>]	CaFM	N	WM	Arctic Tern (<i>Sterna paradisaea</i>)	CaSpM/ CaSuV	H	LS
Little Ringed Plover [<i>Charadrius dubius curonicus</i>]	Ac	P	WM	Common Murre (<i>Uria aalge inornata</i>)	UB	B	SC
American Black Ospreycatcher (<i>Haematopus bachmani</i>)	CaSuV	WN	RS	Thick-billed Murre (<i>Uria lomvia arra</i>)	CoB	B	SC
				Pigeon Guillemot [<i>Cepphus columba kaiurka</i>]	UB	B	CB

(continued)

TABLE 1 (concluded)

Species	Status ¹	Geographic affinity ²	Primary habitat ³	Species	Status ¹	Geographic affinity ²	Primary habitat ³
Ancient Murrelet [<i>Synthliboramphus antiquus</i>]	CoB	B	SS	Northern Wheatear (<i>Oenanthe oenanthe oenanthe</i>)	CaFM	P	DS
Cassin's Auklet [<i>Ptychoramphus aleuticus aleuticus</i>]	UB	WN	SS	Eye-browed Thrush [<i>Turdus obscurus</i>]	CaSpM	EP	TF
Parakeet Auklet [<i>Cyclorhynchus psittacula</i>]	CoB	B	SS	Yellow Wagtail [<i>Motacilla flava simillima</i>]	R-CoSpM/ RFM	EP	RS
Least Auklet [<i>Aethia pusilla</i>]	AbB	B	CB	Gray Wagtail [<i>Motacilla cinerea robusta</i>]	CaSpM	EP	RS
Whiskered Auklet [<i>Aethia pygmaea</i>]	CoB	B	CB	Black-backed Wagtail (<i>Motacilla lugens</i>)	VRSpM/ CaFM	B	RS
Crested Auklet [<i>Aethia cristatella</i>]	AbB	B	CB	Olive Tree-Pipit [<i>Anthus hodgsoni yunnanensis</i>]	CaSpM	EP	MS
Rhinoceros Auklet (<i>Cerorhinca monocerata</i>)	VRB	B	?	Red-throated Pipit [<i>Anthus cervinus</i>]	CaSpM	P	RS
Tufted Puffin [<i>Fratercula cirrhata</i>]	CoB	B	SS	Water Pipit [<i>Anthus spinoletta pacificus</i>]	CaM	B	GM
Horned Puffin [<i>Fratercula corniculata</i>]	CoB	B	CB	Song Sparrow [<i>Melospiza melodia maxima</i>]	CoB	B	TF
Common Cuckoo [<i>Cuculus canorus canorus</i>]	CaSpM	P	TF	Lapland Longspur [<i>Calcarius lapponicus alascensis</i>]	UB	B	TF
Oriental Scops-Owl [<i>Otus sunia japonicus</i>]	Ac	EP	?	Rustic Bunting (<i>Emberiza rustica latifascia</i>)	CaSpM	B	TF
Snowy Owl (<i>Nyctea scandiaca</i>)	VRB	H	DS	Common Reed-Bunting [<i>Emberiza schoeniclus pyrrhulina</i>]	Ac	EP	TF
Short-eared Owl (<i>Asio flammeus flammeus</i>)	RM	H	F	Snow Bunting (<i>Plectrophenax nivalis townsendi</i>)	UB	B	DS
Jungle Nightjar [<i>Caprimulgus indicus jotaka</i>]	Ac	EP	?	Brambling (<i>Fringilla montifringilla</i>)	CaSpM	P	MS
Eurasian Skylark (<i>Alauda arvensis pekinensis</i>)	CaSpM	NEP	TF	Rosy Finch (<i>Leucosticte arctoa griseonucha</i>)	UB	B	SC
Tree Swallow [<i>Tachycineta bicolor</i>]	Ac	N	A	Common Rosefinch (<i>Carpodacus erythrinus grebnitskii</i>)	CaSpM	EP	MS
Bank Swallow (<i>Riparia riparia</i> ssp.)	Ac	H	F	Common Redpoll (<i>Carduelis flammea flammea</i>)	RM/RSuV	H	TF
Cliff Swallow [<i>Hirundo pyrrhonota hypopolia</i>]	Ac	NWN	A	Hoary Redpoll (<i>Carduelis hornemanni exilipes</i>)	CaSpM	H	MS
Winter Wren [<i>Troglodytes troglodytes meligerus</i>]	CB	B	TF	Oriental Greenfinch (<i>Carduelis sinica kawarabiba</i>)	CaM	EP	MS/TF ⁵
Arctic Warbler [<i>Phylloscopus borealis</i> ssp.]	CaSpM	NEP	RS				
Gray-spotted Flycatcher [<i>Musicapa griseisticta</i>]	CaSpM	EP	TF				
Siberian Rubythroat (<i>Luscinia calliope</i>)	CaSpM	EP	TF				

¹Status codes follow Kessel and Gibson (1978): Ac = accidental, Ca = casual, VR = very rare, R = rare, U = uncommon, Co = common, Ab = abundant, Sp = spring, Su = summer, F = fall, W = winter, B = breeder, M = migrant, V = visitant.

²The following habitat names follow Kessel (1979): IW = inshore waters, RS = rocky shores and reefs, CB = coastal blockfields, SC = sea cliffs, SS = subterranean soil, WM = wet meadows, GM = grass meadows, TF = tall forb meadows, DS = dwarf shrub mats and meadows, LS = lacustrine waters and shorelines, A = artificial habitats. Three other abbreviations were also used: F = seen only in flight, MS = edges of melting snow, ? = habitat unknown (usually used when only remains were found).

³Abbreviations indicate the region where most of the world's population of the form occurs: H = Holarctic, N = Nearctic, P = Palearctic, B = Beringian. Letters preceding the region designations indicate portions of the region (e.g., NEP = northeastern Palearctic).

⁴Scientific names enclosed in parentheses indicate that no specimen is available from Buldir. Subspecific names for these species are assigned either because they are recognizable in life or because Buldir is well within the known range. Brackets indicate specimens are available. All are stored at the University of Alaska Museum (UAM), Fairbanks, Alaska.

⁵Habitats are those used in spring and fall respectively.

Red-throated Loon. Single birds were seen 20 May and 4 July 1974 and 7 August 1976.

Red-necked Grebe. The carcass of a breeding-plumaged bird was found on 25 July 1974.

Northern Fulmar. A small, but apparently increasing nesting colony was found near East Cape. Estimates of the number of breeding pairs were: 1972, 50-100; 1976, 115; 1979, 620 (T. Early, pers. comm.). All but 2 birds seen were of the dark color-phase.

Fork-tailed and Leach's Storm-Petrel. We estimated that 650 000 and 850 000 pairs respectively laid eggs annually (1974-76). Both species nested primarily below 300 m elevation, but low densities of Leach's Storm-Petrels were found at higher elevations. Byrd and Trapp (in press) discuss the natural history of these species at Buldir.

Pelagic and Red-faced Cormorant. Approximately 100 and 140 pairs respectively bred (1976). Red-faced Cormorants were always found in mixed colonies with murres and kittiwakes, but Pelagic Cormorants usually nested in isolated, single-species colonies. In one study area, the average clutch size for Pelagic Cormorants was 3.1 ± 0.5 eggs (n = 14), and about 50% of the eggs produced fledglings (M.H. Dick, pers. comm.). In another area (between the creek in Petrel Valley and Slide Mt.) that we checked less frequently at least one young fledged from 71% of 45 nests (all data for 1974). If data from both areas are used to estimate reproductive success (fledging success × nesting success), the value was .36 chicks fledged/nesting pair (i.e., a pair that built a nest).

Bean Goose. See Byrd et al. (1978).

Emperor Goose. One or 2 birds were seen 4-20 June 1974 and 9-11 June 1975, and remains of up to 4 birds were found on North Bight Beach each spring. Up to 12 fall birds were seen from 16 September until we left on 28 September (1976).

Brant. A lone subadult swam near shore at East Cape on 6 July 1974.

Canada Goose. We estimated that approximately 170 pairs bred (1977). They nested primarily on steep sea slopes, reared young at the boundary of the lowland and upland plant associations, and congregated in pre-migration flocks in the upland. Byrd and Woolington (1983) discuss the natural history of the species at Buldir.

Green-winged Teal. Three to five pairs of the resident Aleutian race (*A. c. nimia*) bred. Usually 10-25 of these birds were found daily in North and South marshes and at Bean Goose Pond from mid-May to early July each year, but a high of 58 teal were seen on 20 May 1976. Single males of the nearctic race (*A. c. carolinensis*) were observed 19-29 May 1975 and 26 May 1977.

Mallard. Two to 5 were seen each spring, 18 May-late June. In most summers single males were seen (observations ranged from 11-24 July). A lone fall bird appeared 25 September 1976.

Northern Pintail. Pintails occurred each spring from 14 May-early June; high count was 31 birds on 20 May 1976. Two molting males were seen 21 June 1984 (A.R. DeGange and R.A. Wood, pers. comm.), and a single female was noted 13 July 1978. Up to 4 birds were seen regularly 10-25 September 1976.

Garganey. See Byrd et al. (1978).

Northern Shoveler. Two to 6 birds were present 19 May-21 June 1976, a pair was seen 5 June 1977, and a dead female was found in South Marsh on 3 June 1977.

Eurasian Wigeon. These wigeons were recorded in spring from our first arrival to 21 June. The high count was 40 birds on 26 May 1975 in North and South marshes and Bean Goose Pond. Four mid-summer birds were seen 4 July 1975, and the only fall record was of a single bird on 14 September 1976.

American Wigeon. Two males and a female were seen with Eurasian Wigeons in North Marsh on 28-31 May 1975.

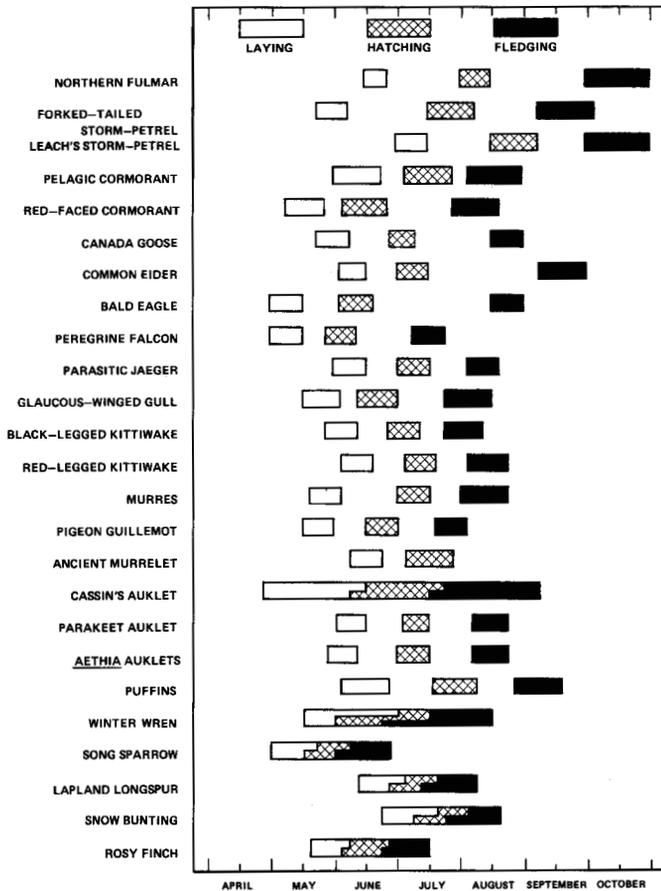


FIG. 4. The timing of peaks in nesting events for various species at Buldir Island, Alaska (at least one event was estimated for most species based on known dates of other events).

Common Pochard. A lone male was seen with a flock of Greater Scaup in North Bight on 7-8 June 1975, and probably the same bird was found emaciated and unable to fly in North Marsh on 11 June.

Tufted Duck. Up to 7 birds were seen each spring, 11 May-21 June, and carcasses of 1 or 2 birds were found each year upon our arrival. The only summer record was of 3 males in North Bight on 12 July 1976.

Greater Scaup. Up to 9 scaup were seen each spring, 19 May-27 June, occasionally with Tufted Ducks.

Common Eider. Approximately 10-15 pairs bred. Eiders may be present at Buldir year around, but populations increased during periods of migration — up to 120 birds in early May (Kenyon and King, 1965) and a peak of 40 birds in late September (1976). From early July to early August flocks of up to 36 eclipse males were seen in the sea along the north side of the island. Scattered nests were found where dense clumps of *Elymus arenarius* occurred near the beach. The average clutch size was 3.7 ± 0.8 eggs ($n=6$).

Harlequin Duck. Up to 100 birds congregated in North Bight each spring 15 May-8 June. Numbers decreased in mid-June to the summering population of 8-15 ducks. The fall buildup peaked at over 40 birds on 27 September 1976.

Oldsquaw. Up to 9 birds were seen each spring or summer (observations ranged from 9 May to 2 July).

Black Scoter. Up to 9 birds were seen 15 May-8 June, with peak numbers occurring the last week of May. A late spring bird occurred 13-23 June 1979. The only fall record was of a lone bird on 20 September 1976.

Surf Scoter. Single birds were seen in North Bight 22-30 May 1974 and 23 June 1979.

White-winged Scoter. Up to 20 birds were present each spring, 9 May-5 June; the peaks each year were 20-25 May. The only summer record was of a single male on 3-13 July 1975, and up to 4 fall birds were seen 21-25 September 1976.

Common Goldeneye. Four to 10 birds were seen each spring, 18-29 May, in North Bight, and up to 2 birds were seen 15-16 June 1984. The single summer record was of a molting male on 13 July 1978.

Bufflehead. A single female was seen at Bean Goose Pond on 25 May 1977.

Common Merganser. One or two spring birds were recorded 24 May-19

June. A single summering female was seen on 28 July 1975. A dead female was found in Camp Valley in June 1984.

Red-breasted Merganser. Up to 3 birds were recorded each spring, 14 May to 15 June.

Bald Eagle. One pair was found breeding each year, except 1979 when two eyries were active (T. Early, pers. comm.). Four additional, apparently non-breeding, adults were present 1974-77. Single young fledged in 1974 and 1975, but the nesting was unsuccessful in 1976, 1977 and 1979. K. Kenyon (pers. comm.) and T. Early (pers. comm.) each reported an eagle in juvenile plumage at Buldir in 1963 and 1979 respectively. In contrast, we never observed a live juvenile. We found decomposed remains of fledglings near nest sites twice. Ten different active and inactive eyries were located during the study. Most were on large promontories (e.g., boulders in talus-fields or coastal pinnacles), but one site was the seat of a bulldozer left after World War II; no nest site was used more than once. Remains of food items at eyries in summer included nearly every species of breeding seabird, but Crested Auklets (29%) and Horned Puffins (16%) were the primary prey items ($n=83$ remains). By mid-September, most seabirds had left Buldir, and eagles were seen hunting Canada Geese daily during the last half of September.

Rough-legged Hawk. A single bird was seen over North Marsh on 19 May 1975, and 2 birds were present there 10 July 1975. The only fall bird was seen 23-24 September 1976.

Peregrine Falcon. Four to 5 pairs bred each year. Except for one on a ledge of an outcrop 100 m inland, all eyries were on ledges of sea cliffs. We found the remains of 5 subadults during the study; 3 examined closely showed no fat and greatly shrunken pectoral muscles, suggesting starvation. Of eight species of birds found at eyries, Least Auklets constituted 70% of the prey remains ($n=75$).

Gyr Falcon. Single birds were observed hunting alcids over talus slopes on 30-31 May and 19 June 1974. The decomposed remains of another bird were found 20 June 1974.

Sandhill Crane. A single bird was present 11 May-19 August 1974, 2 birds were seen 25 May 1976, and 1 was observed 13 July 1978.

Lesser Golden-Plover. Up to 7 birds were seen each spring, 25 May-9 July. The earliest fall record was of a single bird, 27-30 July 1976, but up to 30 plovers (peak on 5 September 1976) were seen 19 August-24 September each year.

Mongolian Plover. See Byrd *et al.* (1978).

Semipalmated Plover. Single birds were present at the Midden Pond on 21 August 1974 and inland on 11 September 1976.

Little Ringed Plover. See Byrd *et al.* (1978).

American Black Oystercatcher. Two birds were seen on 7 July 1972, and 1 or 2 were seen around the island 12-26 July 1976.

Common Greenshank. See Byrd *et al.* (1978).

Lesser Yellowlegs. Single birds were seen 4 June 1976 and 31 August 1974.

Marsh Sandpiper. See Byrd *et al.* (1978).

Wood Sandpiper. Up to 16 birds were seen each spring, 17 May-9 June, except in 1976, when a major movement of Wood Sandpipers occurred in the western Aleutians (Gibson and Byrd, 1976). That year's peak count was 77 birds on 29 May and 2-10 birds remained until early July. Summer records were of single birds from 17-23 July 1974 and 8-28 July 1976. One to 3 birds were seen each fall, 19 August-13 September.

Wandering Tattler. Spring migrants were seen 21 May-24 June; peak was 10 birds on 31 May 1975. Up to 3 fall birds were seen 20 July-5 September. Tattlers often flushed too far ahead of observers to make identification possible, so numbers of Wandering Tattlers reported here may be high; unknown tattlers were reported as this species rather than as Gray-tailed Tattlers.

Gray-tailed Tattler. See Byrd *et al.* (1978).

Common Sandpiper. See Byrd *et al.* (1978).

Terek Sandpiper. See Byrd *et al.* (1978).

Whimbrel. Single birds occurred in spring, 28 May-23 June, and up to 2 birds were recorded in fall, 19 July-3 September.

Bristle-thighed Curlew. Two birds were on North Bight Beach 19-28 May 1975.

Black-tailed Godwit. See Byrd *et al.* (1978).

Bar-tailed Godwit. Single birds were seen 21-28 May most years, and a late bird was observed 5-14 June 1979.

Ruddy Turnstone. Spring birds were recorded 17 May-11 June; the peak was 10 birds in late May-early June. Fall birds were seen from 12 July onward each year; numbers peaked at 20-25 birds by mid-August and decreased thereafter.

Red Knot. Six knots were seen on 31 May 1982 (F. Deines, pers. comm.).

Sanderling. Single birds were seen 25-30 May 1977 and 22-30 August 1974.

Rufous-necked Stint. See the following discussion of Little Stint and Byrd *et al.* (1978).

Little Stint. Single juveniles were collected 13 and 18 August 1975. These specimens (UAM 3422, 3423) were originally identified as Rufous-necked

Stints and were included with other fall Rufous-necked Stints in Byrd *et al.* (1978). In 1981 they were identified as Little Stints by P.J. Grant, P. Hayman, J. Marchant, and T. Prater at the British Museum of Natural History.

Temminck's Stint. See Byrd *et al.* (1978).

Long-toed Stint. See Byrd *et al.* (1978).

Baird's Sandpiper. Single birds were recorded each fall, 15 August-5 September.

Pectoral Sandpiper. Up to 3 birds were seen in spring, 22 May-7 June. Fall records were 1 bird from 26-28 August 1975 and 2-7 birds from 11-26 September 1976.

Sharp-tailed Sandpiper. One to 4 birds were seen on North Bight Beach and in the uplands from 17-22 September 1976, the only year we remained late enough to see this species.

Dunlin. Up to 9 birds were seen in spring, 18 May-10 June, and 1 or 2 fall birds were observed 3-24 September 1976.

Spoonbill Sandpiper. See Day *et al.* (1979).

Ruff. See Byrd *et al.* (1978).

Common Snipe. In addition to the records in Byrd *et al.* (1978), a late spring migrant was seen on 25 June 1977.

Red-necked Phalarope. Five birds fed in North Bight on 23 August 1974, and a single bird was seen at Midden Pond 17-18 September 1976.

Red Phalarope. The only spring record was of a female at Midden Pond 8-13 June 1976. Fall birds occurred from 11 July onward, with a peak of 200 birds seen off Outer Rock on 17 July 1975.

Parasitic Jaeger. Approximately 50 pairs nested, almost exclusively on upland plateaus; only one nest was found in the lowlands. Jaegers arrived the first week in May and departed by mid-September.

Common Black-headed Gull. Individuals were recorded in spring 18 May-23 June; peak count was 8 birds on 13 June 1982. A freshly dead subadult was found 10 July 1974, and 1 subadult spent the period 6 July-25 September 1976 in North Marsh.

Mew Gull. See Byrd *et al.* (1978).

Herring Gull. Lone birds were seen in spring on 17-18 May 1974 and 30 May 1975, and fall records were a single bird on 18 September and 2 birds on 25 September (both 1976).

Slaty-backed Gull. Single adults were seen 27 May 1974, 4 June 1975, and 10 June 1984.

Glaucous-winged Gull. Approximately 2500 pairs bred. Gulls were at colony sites by early May, and 90% of the summer population had left by 25 September. They nested in 25 distinct colonies (Fig. 2) from just above sea level to approximately 350 m elevation. Nearly every lowland habitat was used for nesting, but the *Carex*-fescue community was preferred. Clutches ranged from one to four eggs ($\bar{x} = 2.97; \pm 0.5; n = 100$). As chicks fledged, they congregated near Kittiwake and Bean Goose ponds, in North and South marshes, along rocky shores, and in patches of *Empetrum nigrum*. Trapp (1979) provided details on food habits of these gulls on Buldir.

Glaucous Gull. Single subadults were recorded each spring, 14 May-23 June. Carcasses were found of 3 birds that apparently had died during the winter.

Black-legged and Red-legged Kittiwake. Approximately 10 800 and 2200 pairs respectively bred at Buldir in 1976. Both species were on cliffs by late April, and most were gone by mid-September. Both species nested in mixed colonies with murres and cormorants. Red-legged Kittiwakes used smaller ledges for nesting than did their congeners; they frequently chose nest sites under overhanging rocks or soil projections. Black-legged Kittiwake clutches averaged $1.6 (\pm 0.5; n = 74)$ eggs, and Red-legged Kittiwake clutches averaged $1.1 (\pm 0.4; n = 21)$ eggs in 1976, the only year in which we had sufficient data to calculate averages.

Common Tern. A single bird was seen in North Marsh from 8-9 June 1976.

Arctic Tern. One bird was observed on 7 June 1974, and 2 were seen on 6 July 1972.

Common and Thick-billed Murre. Approximately 13 400 murres were counted on cliffs at Buldir in 1976. We estimated that 92% (12 300) were Thick-billed Murres. The distribution of murres (and kittiwakes) on the island (Fig. 2) apparently included all suitable cliffs.

Pigeon Guillemot. Approximately 100-150 pairs bred in 1976. The largest concentration we saw was a flock of 46 near East Cape on 3 June 1977. Guillemots were present by the end of April, and most had left the island by 20 August.

Ancient Murrelet. We subjectively estimated that 4000-5000 pairs bred, most within the lowland tall-plant complex. Large flocks were seen each spring in North Bight (e.g., 3000 on 9 May 1974, 1500 on 25 May 1975, and 1500 on 26 May 1976). After the birds moved to inland nest sites (as early as 19 May), they became nocturnal in colony attendance. Peak movements of downy chicks to the sea occurred during the second week of July (1974-76); most Ancient Murrelets had left the island by the end of July each year. The downy young moving from

earthen burrows to the sea averaged just 27.9 g ($\pm 2.0; n = 128$) in 1975; Glaucous-winged Gulls ate many chicks during this period.

Cassin's Auklet. We estimated that 200 pairs bred, but the total of this nocturnal seabird may actually have been much higher. The only nesting colony we found was on a bluff near the east end of North Bight Beach, but at least 100 birds came aboard a boat anchored near the south side of the island on the night of 13-14 June 1983, indicating a colony may be there also.

Parakeet Auklet. We subjectively estimated that 4000-6000 bred, primarily in burrows and rock crevices near the periphery of talus slopes. Some also used crevices among beach boulders. The species was present by late April, and most of these auklets had left Buldir by 22 August.

Least, Whiskered, and Crested Auklet. Approximately 70 000, 1000-1500, and 14 000 pairs respectively bred. All three species were common near Buldir by the end of April, and pairs were engaged in courtship on talus slopes by mid-May. Most had left the island by 12 August, but a few (mostly Crested Auklets) were seen as late as 22 August. The natural history and colony attendance patterns at Buldir have been discussed by Knudtson and Byrd, 1982, and Byrd *et al.*, 1983, respectively.

Rhinoceros Auklet. Possibly 10-15 pairs bred. Single birds in breeding plumage were seen 7 and 18 July 1975 and 24 June, 2 and 15 July, and 4 August 1976. A single winter-plumaged bird, perhaps a subadult, was seen on the rocks of Main Talus on 24 July 1975. We were unable to locate nests of this nocturnal species.

Tufted and Horned Puffin. Approximately 8000-10 000 pairs of each species bred. Tufted Puffins were present by the end of April, but Horned Puffins did not arrive until 15-20 May each year. Colony establishment for both species occurred during the last week in May, and most puffins had departed by mid-September. The food habits and breeding biology of these species at Buldir has been discussed by Wehle (1976, 1980, 1982).

Common Cuckoo. In addition to the records in Byrd *et al.* (1978), a single cuckoo (either this species or an Oriental Cuckoo) was seen on 22 June 1982.

Oriental Scops-Owl. See Day *et al.* (1979).

Snowy Owl. At least one pair bred. Three to 5 birds were seen each year in upland areas, primarily in the vicinity of Slide and Round mountains. Although no nest was found, a recently fledged bird was observed 30 July 1974.

Short-eared Owl. Single birds were seen on 23 May and 7 June 1975 and occasionally from 11 June to 15 September 1976. The remains of a bird were found near Main Camp on 20 May 1976.

Jungle Nightjar. See Day *et al.* (1979).

Eurasian Skylark. See Byrd *et al.* (1978).

Tree Swallow. A lone bird was collected on 7 June 1977.

Bank Swallow. A single bird was seen near Main Camp on 24 June 1977.

Cliff Swallow. Lone males were collected near Main Camp on 4 June 1974 and 28 June 1977, and a single bird was observed on 15 June 1984.

Winter Wren. Approximately 50-75 pairs bred, mostly along beach fringes in hummocks of *Elymus arenarius*, among drift logs, and in rock crevices on sea cliffs and in talus. The wide range in nesting dates (Fig. 4) suggests that birds were double-brooded. Wren numbers on a 0.5 km-long transect along North Bight Beach were recorded 3-9 times during May and June 1974, 1975, 1976 and 1984. Annual means did not differ significantly (T test, $P > .05$) among years, so we lumped all samples ($n = 19$), $\bar{x} = 13.2 \pm 5.6$ wrens-km. Transect totals increased during August and September, as territories disintegrated and wrens concentrated on rocky shores, particularly near patches of decomposing kelp where insects were abundant. Numbers continued to increase on North Bight Beach throughout the fall; wrens may come to this area from some distance, as we noted a concomitant decrease in populations along beaches elsewhere on the island.

Arctic Warbler. One bird was seen at North Bight Beach 6-12 June 1976, and the remains of another were found 18 July 1978. The wing length of the specimen, 66.5 mm, eliminates the possibility of the Beringian subspecies *P. b. kinnicottii*. It is probably *P. b. borealis* or *P. b. xanthodryas* (D.D. Gibson, pers. comm.).

Gray-spotted Flycatcher. In addition to the specimen reported by Byrd *et al.* (1978), single birds were observed 1 and 24-29 June 1977.

Siberian Rubythroat. See Byrd *et al.* (1978).

Northern Wheatear. Two birds were seen in the upland 13 and 18 September 1976.

Eye-browed Thrush. See Byrd *et al.* (1978).

Yellow Wagtail. The species was seen regularly in spring, 17 May-1 June; annual high counts varied from 2 birds in 1974 to 32 on 20 May 1976. Fall birds were seen on 29 August 1974 (2) and 9 September 1976 (1).

Gray Wagtail. See Byrd *et al.* (1978).

Black-backed Wagtail. See Byrd *et al.* (1978).

Olive Tree-Pipit. See Byrd *et al.* (1978).

Red-throated Pipit. See Byrd *et al.* (1978).

Water Pipit. Spring birds were seen on 30 May 1974 (2) and 20-30 May 1976 (1). Fall birds were recorded 29 August 1974 (1) and 15-23 September 1976 (2).

Song Sparrow. Approximately 200-300 pairs bred. This resident sparrow was on territory by early May. The species nested throughout the *Elymus*-umbel and *Elymus*-umbel-fern plant communities, especially near beaches. All nests were found in clumps of *Elymus arenarius*. Clutch sizes ranged from two to five eggs ($\bar{x} = 3.8 \pm 0.5$; $n = 36$). After chicks fledged, families remained in the vicinity of nesting territories until at least late August; thereafter they moved to rocky beaches.

Lapland Longspur. Approximately 200-300 pairs bred, primarily in *Carex*-fescue meadows and *Elymus*-umbel areas, particularly near streams. All nests found were in clumps of *Elymus arenarius*. Males began arriving the first week of May, with females at least one week later; by 21 May singing males were on territories. Birds began to flock in upland areas by 17 August. Migrating flocks were leaving by 18 September, but some birds were still present when we left on 28 September (1976). Clutches contained either four or five eggs ($\bar{x} = 4.8 \pm 0.4$; $n = 10$). The average density of longspurs along two transects in Camp Valley was 2.7 birds·ha in 1976.

Rustic Bunting. See Byrd *et al.* (1978).

Common Reed-Bunting. See Byrd *et al.* (1978).

Snow Bunting. Approximately 20-25 pairs bred among crevices in scattered rocky areas in the upland. Snow Buntings were present when we arrived, and most had departed by mid-September.

Brambling. A pair was seen at South Marsh on 24 May 1976, and a female was noted in Petrel Valley on 28 May 1976.

Rosy Finch. Approximately 75-100 pairs bred in a variety of sites including crevices of rocky sea cliffs, cavities left by eroded puffin burrows, and in the wrecked airplane and bulldozer in Camp Valley. Pairs were on territories by 19 May, but some flocks were still seen as late as 26 May. A dispersal of Rosy Finches occurred by 10 September; only two adults were seen from 10-28 September.

Common Rosefinch. See Kessel and Gibson (1978).

Common Redpoll. Up to 6 birds were seen 31 May 1974 and 5-8 July 1972, and up to 30 remained in Camp Valley from 23 June-12 August 1975.

Hoary Redpoll. Three were seen at The Dip on 31 May 1974.

Oriental Greenfinch. See Byrd *et al.* (1978).

DISCUSSION

As one of very few islands in the Aleutians that has remained free of introduced mammalian predators, Buldir is a relatively pristine remnant of the Aleutian ecosystem. On most of the Aleutians, species of birds that nest on the surface of the ground or in earthen burrows are restricted to islets in wetlands or lakes, or offshore (see Murie, 1959; SOWLS *et al.*, 1978; SEKORA *et al.*, 1979). In contrast, terrestrial habitats normally unsuitable for nesting birds due to predators are used extensively at Buldir. For example, Buldir has: the largest Aleutian breeding populations of storm-petrels, Canada geese, and Glaucous-winged Gulls; the densest Aleutian breeding population of Parasitic Jaegers; the largest populations of Ancient Murrelets, Horned Puffins, and Tufted Puffins in the central and western Aleutians; the only known nesting population of Cassin's Auklets, other than on Agattu Island (D. Forsell, pers. comm.) and the only known population of Rhinoceros Auklets in the Aleutians.

Predation by introduced mammals on cliff-nesting and talus-nesting birds is less serious than on surface- and burrow-nesters, but the absence of these predators, coupled with good food resources, has contributed also to substantial populations of these species at Buldir. The island has: one of the largest populations of Black-legged Kittiwakes in the Aleutians; one of only four known breeding populations of Red-legged Kittiwakes in the world (Byrd, 1978); the largest murre population in the central and western Aleutians; one of only five fulmar colonies in the Aleutians; Least and Crested Auklet populations that are exceeded in the Aleutians only by those at Kiska and Gareloi islands; a Whiskered Auklet population that may be the largest in the Aleutians; and a Parakeet Auklet population

exceeded in the Aleutians only by those at Gareloi and Chagulak islands.

Even less well understood than the effects of mammalian predators on cliff- and talus-nesters is their effects on nesting passerines in the Aleutians. The only other data available on the density of passerines for the Aleutians are from Amchitka (White *et al.*, 1977), where there are Norway rats (*Rattus norvegicus*) but no foxes (introduced foxes were removed in the late 1950s — Jones and Byrd, 1979). The species for which comparisons are possible are Winter Wren and Lapland Longspur. At Buldir, wren counts in May and June averaged 13.2 wrens·km of shoreline, compared to 9.6 wrens·km in the best habitat and 3.5 wrens·km in all transects sampled at Amchitka (White *et al.*, 1977). Lapland Longspurs were sampled in three habitats at Amchitka and were found to be particularly abundant in riparian areas (i.e., a stream fringe habitat including wet meadow, grass meadow, and tall forb areas), where an average of 4.8 longspurs·ha occurred, and *Carex* meadow (1.9 longspurs·ha). Riparian areas were very restricted at Buldir, and *Carex*-fescue meadows (the community most similar to the *Carex* meadow at Amchitka) were also limited. Nevertheless, the transects used for estimates of longspurs at Buldir crossed the largest block of riparian habitat on the island and also included *Carex*-fescue meadow habitat. Interestingly the estimate of 2.7 longspurs·ha in the habitats sampled at Buldir was intermediate between the Amchitka estimates.

With all the potential summer food available at Buldir, dense populations of breeding raptors was expected. Indeed, the average breeding density of Peregrine Falcons (1 pair·5 km of shoreline) is among the highest recorded in the Aleutians (White, 1975). Bald Eagles nested less densely than expected. Also there were non-breeding adults present each summer. Nest sites did not seem to be limited, but the mortality rate of fledglings seemed to be high for both eagles and falcons. Subtle factors may have been involved in the lower-than-expected breeding density of eagles because Buldir is the westernmost breeding site in the Bald Eagle's range. Curiously they do not occur in the Near Islands to the west of Buldir, but they are common nesters on islands to the east (Murie, 1959).

Due to Buldir's topography and small size, some habitats that are extensive on many of the Aleutians are very limited or absent at Buldir. Thus, at least 14 species that nest fairly commonly east or west of Buldir in the Aleutians breed sparingly or not at all at Buldir. For example, Buldir has: few ducks and no loons or phalaropes, due to the scarcity of wetlands; relatively few cormorants and guillemots, probably due to limited areas of shallow nearshore water, their favored feeding areas (SOWLS *et al.*, 1978); relatively few Rosy Finches, due to limited artificial habitats, which harbor large populations elsewhere (e.g., Adak—Byrd *et al.*, 1974; Amchitka—White *et al.*, 1977); relatively few Lapland Longspurs (even though they occur in relatively high densities), due to restricted wet meadow fringes and suitable grass meadows; no terns, probably due to the absence of lagoons, protected bays, or large shallow lakes where terns frequently feed elsewhere in the Aleutians (Byrd, pers. obs.); no ptarmigan, due to the scarcity of communities dominated by *Empetrum nigrum*, the habitat the species favors elsewhere (e.g., White *et al.*, 1977); and no Rock Sandpipers, probably due to restricted riparian and *Carex* meadow habitats, which the species favors (e.g., White *et al.*, 1977).

Buldir's breeding avifauna is composed almost entirely (85%) of Beringian species, the remainder being from the Holarctic

(9%) and Nearctic (6%). The Beringian component, largely due to the high diversity of alcids, is higher than that for Amchitka (58%) or Adak (62%) (calculated from White *et al.*, 1977, and Byrd *et al.*, 1974, respectively). These latter islands had 24-26% Holarctic and 13-15% Nearctic species.

Although there were exceptionally early and late species, overall peaks in nesting events at Buldir were: egg-laying, third week in May to third week in June; hatching, late June to late July; and fledging, late July to late August. By the end of September, all species except fulmars and storm-petrels had completed the breeding cycle, and island bird populations were greatly reduced from mid-summer peaks. For common species, the timing of breeding events at Buldir matched well with those from the Commander Islands (Kartashev, 1979), Amchitka (White *et al.*, 1977, C.M. White, unpubl. data), and Agattu (J.L. Trapp, unpubl. data).

Buldir's breeding avifauna contains 32 species totaling approximately 3.5 million breeding birds. Particularly impressive are the seabirds, which constitute 65% of the species and 99.9% of the numbers. According to SOWLS *et al.*, 1978, 4.9 million seabirds are known to nest in the Aleutians west of Unimak Island. Buldir's populations account for about 70% of the total breeding seabirds, but the island contains less than 1% of the land area in the region. This is an over-estimate of the relative importance of Buldir, since estimates for the other, less well-studied islands are probably conservative. Still, the comparison demonstrates the value of this pristine area, and it suggests that Aleutian breeding populations, particularly of surface- and burrow-nesters, may have been far greater formerly than they are presently.

We recorded 95 species of non-breeders (migrants and vagrants) at Buldir. As discussed above, Buldir has relatively restricted amounts of some habitats that are otherwise widespread in the Aleutians. This feature acted to concentrate migrants on narrow beaches (particularly in patches of beach-cast-kelp), in the few wet meadows (e.g., North and South marshes), or in a narrow band of nearshore water. As a result of habitat restrictions, some species (e.g., common migrant ducks and shorebirds) were far less common at Buldir than at Shemya, where more wetlands occur (Gibson, 1981). Nevertheless, most species of migrants occurred in very low numbers at both Buldir and Shemya. Peak counts were of 10 or fewer individuals for over 80% of the species at Buldir, and the same was true at Shemya for species of gulls, terns, and passerines; the percentages were 58% for waterfowl and 74% for shorebirds there.

Gibson (1981) demonstrated that Shemya and the Near Islands (Fig. 1) provide annual landfall for a number of Palearctic species that migrate north and south along a Japan-Kuril Islands-Kamchatka flight path. The geographic affinities of migrants and vagrants at Buldir (and Shemya in parentheses) were: Palearctic, 50% (46%); Beringian, 15% (24%); Holarctic, 20% (19%); and Nearctic, 15% (10%). The largest difference (the Beringian) is primarily the result of alcids, which breed at Buldir, being recorded as vagrants at Shemya. Of 34 species of Palearctic migrants that are annual at Shemya (Gibson, 1981), 21 (62%) were also annual at Buldir during our study. Of the 21 species recorded annually at both islands, however, only 8 (38%) occurred as commonly at Buldir as at Shemya; the remaining 13 species (62%) were less common at Buldir. These data suggest that, like Shemya, Buldir is within the annual migration route of Palearctic migrants, although it is probably much nearer the eastern edge than is Shemya.

Spring migration began in early May, with a movement of waterfowl. The main shorebird movement occurred the last two weeks of May, and this was followed by a wave of passerines from late May to mid-June. Fall migration was much more protracted, extending from late July to probably at least mid-October, as it does elsewhere in the Aleutians (Gibson, 1981). In fall there was no apparent sequence of movement by avian orders, as occurred in spring. As at Shemya (Gibson, 1981), the primary factor determining the abundance and diversity of migrants making landfall at Buldir in a particular year appears to be the occurrence of specific weather patterns, especially low-pressure systems.

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