

HISTORICAL DISTRIBUTION AND CURRENT POPULATION STATUS OF TUFTED PUFFINS *FRATERCULA CIRRHATA* IN CANADA'S CALIFORNIA CURRENT SYSTEM

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ABSTRACT

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Unpublished accounts indicate that the number of Tufted Puffin colonies in western Canada has declined in recent decades. However, a lack of recent colony count data makes it impossible to determine current trends. Here we compile published and unpublished information for Tufted Puffins in the Canadian portion of the California Current System (i.e., from the vicinity of the Scott Islands south to the Canada-US border) to update understanding of the species' status in the region, and to assemble available information in a single source. We found historical records of three additional colonies over those in pre-existing compilations, bringing the total count for the region to 19. However, 11 of these are currently extirpated and another three likely so. All but one of these extirpated colonies are 'very small' (historical mode of counts, 1–3 pairs), reflecting patterns of Tufted Puffin colony loss in US waters to the south. Two larger puffin colonies (historical counts, 20–50 pairs) underwent abandonment in the 1990s, but one of these appears to have been recolonized recently. Tufted Puffin numbers at Canada's largest colony, Triangle Island, are likely stable. A lack of standardized monitoring of these colonies, with the exception of Triangle Island, makes it challenging to understand population trends, undertake restoration work, or mitigate current threats.

Key words: Alcidae, British Columbia, California Current, historical ecology, monitoring, seabirds

INTRODUCTION

Biologists in the early twentieth century considered Tufted Puffins *Fratercula cirrhata* a "very common" species on the southwestern coast of the province of British Columbia (BC), Canada, and on the western coast of the US state of Washington including the San Juan Islands (Dawson 1908, Palmer 1927). Estimates for Washington in the early 1900s placed Tufted Puffins among the most common of the seabirds nesting on the outer coastal islands (Dawson 1908, Dawson & Bowles 1909). Although it appears that the species was never as common in south coastal BC as it was in Washington, Tufted Puffins are known to have occupied several small colonies there, including at least one in the inland waters of the Gulf Islands (Canada's extension of the US San Juan Islands; Drent & Guiguet 1961). At Mandarte Island, the Gulf Islands locality, the species was first recorded breeding in the late nineteenth century (Anonymous 1890, Fannin 1891), with regular observations of nesting birds over the following 100 years until sightings of pairs and individuals dwindled in the 1990s (Blight 1994, Allinson 1995, Butler 1995; Table 1). Tufted Puffins were also recorded by earlier observers as nesting in low numbers at several seabird colonies on the west coast of Vancouver Island (e.g., Young 1930, Summers & Campbell 1978).

The past and present status of this species has been well-documented in Washington and further south in the US, with long-term patterns of significant population declines, breeding colony abandonment, and northward range contractions seen throughout the US California Current System since at least the early 1900s. Trends in Washington show an increasing rate of decline that was

most recently estimated at 8.9% annually (Hanson & Wiles 2015, Hart *et al.* 2018, Hanson *et al.* 2019, USFWS 2020). A similar northward contraction is also occurring in Japan (Osa & Watanuki 2002, Hanson & Wiles 2015).

Given these patterns, it is important to understand the status of this species in adjacent Canadian waters. Although information on population trends and breeding biology are available for Canada's largest Tufted Puffin colony on Triangle Island, at the northern extreme of the California Current System (Gaston *et al.* 2009, Rodway & Lemon 2011, Government of Canada 2019), a recent overview of trends and occupancy patterns is lacking for the region. On the basis of previous published accounts and unpublished observations, the species appears to have disappeared from several of the small southern colonies off Vancouver Island that were first recorded in the late 1800s or early 1900s (e.g., Drent & Guiguet 1961, Carter *et al.* 2012). However, with few exceptions, these small populations have not been surveyed in more than 30 years and the information that does exist is piecemeal, meaning that their current status is unknown (Carter *et al.* 2012, Rodway *et al.* 2016). Here, we compile published and unpublished information for Tufted Puffins in the Canadian portion of the California Current System (Fig. 1) to update understanding of the species' status in this region and to assemble available information into a single published source.

STUDY AREA AND METHODS

We searched published and unpublished sources for information on nesting Tufted Puffins in the California Current System in Canadian

TABLE 1
Colony localities and counts for historical Tufted Puffin colonies in southern British Columbia, Canada
(from the Scott Island group and south).

Location name	Latitude	Longitude	Count	Type of observation	Year	Source	Notes
Mandarte Island (historically known as Bare Island)	48°38'N	123°17'W	5	Eggs ^a	1858	Carter & Sealy 2011	Collected in "Haro Channel, Vancouver Island"; authors state that likely locality is Mandarte Island, but that eggs may have been collected at > 1 colony in the area (e.g., including from localities now in US San Juan Islands). Note that collected egg count does not equal a nest count.
			Breeds	-	1890	Anonymous 1890	Likely Mandarte Island: "on a trip to Sidney and adjacent islands...found [Tufted Puffins] breeding within twenty miles of Victoria" with the trip including "Bare Island."
			Breeds	-	1904	Kermode 1904, in Drent & Guiguet 1961	Year of publication; observation year not noted.
			1	Egg ^a	1908	Drent & Guiguet 1961	1 egg collected; not a nest count.
			3-4	Pairs	1910	Drent & Guiguet 1961	"3-4 pair at most."
			3	Pairs	1915	Drent & Guiguet 1961	
			4	Pairs	1916	Drent & Guiguet 1961	
			2	Pairs	1922	Drent & Guiguet 1961	
			15	Pairs	1927	Munro 1929, Drent & Guiguet 1961	"Had increased from the five or six pairs, usual in recent years, to an estimated fifteen pairs." (Munro 1929). Validity of this estimate questioned by Drent & Guiguet (1961) and others.
			2	Pairs	1936	Drent & Guiguet 1961	
			1	Pair	1940	Drent & Guiguet 1961	
			1	Nest	1953	Drent & Guiguet 1961, Drent <i>et al.</i> 1964	
			2	Pairs	1955	Drent & Guiguet 1961	
			2-3	Pairs	1957	Drent & Guiguet 1961	
			2-3	Pairs	1958	Drent & Guiguet 1961	
			2	Pairs	1959	Drent & Guiguet 1961	
			2	Pairs	1960	Drent & Guiguet 1961	
			2	Nests	1962	Drent <i>et al.</i> 1964	
			2	Pairs	1973	Manuwal & Campbell 1979	
			1	Pair	1983	Rodway <i>et al.</i> 2016	
			1	Pair	1985	Whittington 1985	One of 16 eBird records for the locality (1960–1995), with only those records relating to nesting or apparent nesting included here. "Near...mouth of [apparent] burrow."
			2	Birds	1991	BC CDC 2014c	
			3	Birds	1995	Butler 1995	"3 reported on Mandarte this year." One of 16 eBird records for the locality (1960–1995).
			1	Pair	1995	Allinson 1995	Record includes a photo of "one of a pair that were breeding". One of 16 eBird records for the locality (1960–1995).
			1	Bird (partial, depredated)	1996	Szabo 2016	Upper mandible. "Found on ground under gull/eagle roost; fresh blood."
			0	Birds	2008 – 2010	LKB pers. obs.	During three summers of fieldwork at this locality.
Seabird Rocks	48°45'N	125°09'W	1-2	Adults	1943	Carter <i>et al.</i> 2012	Reports T. Pearse obs. of "one or two birds flying in with fish" in addition to "half a dozen" on the water off the island.
			-	Adults	1970	Guiguet 1971 in Carter <i>et al.</i> 2012	"A burrow, excavated, contained an incubating adult and one egg.... A small nesting population is indicated, some 24 individuals were circling and on the sea in the vicinity of the island."
			20	Pairs	1972	Hatler <i>et al.</i> 1978	Estimated based on observed number of burrows and adults with fish in colony; nests "on the knoll supporting the D.O.T light" and "among the drift logs on the lower part of the island".
			20	Pairs	1970 – 1975	Carter <i>et al.</i> 2012	Estimate based on BC Provincial Museum and Pacific Rim National Park surveys during this period.
			12	Adults(?)	1979	Carter <i>et al.</i> 2012	
			8	Adults(?)	1982	Carter <i>et al.</i> 2012	
			4	Pairs	1988	Carter <i>et al.</i> 2012	Revised from the original estimate of 8 burrows in Rodway (1991) and also reported in BC CDC (2014b).
			2	Adults	1998	Carter <i>et al.</i> 2012	"A couple" seen flying around the top of the island.
			1-2	Adults	2011	Carter <i>et al.</i> 2012	"On 25 July, a single adult... circled above the island upon our arrival. As the boat departed, one...also was seen on the water about 200 m off the northwest side....the first observation of Tufted Puffins attending the island area since 1998;"
			0	Birds	2011 – 2019	L. Wilson pers. comm.	In Canadian Wildlife Service Seabird Colony Database, via Yuri Zharikov, Parks Canada.
Florescia Islet	48°59'N	125°39'W	1-6	Adults	1968 – 1970, 1972, 1974	Hatler <i>et al.</i> 1978, Summers & Campbell 1978	Seen flying about island, with one landing; breeding suspected.
			1	Adult	1988	Rodway <i>et al.</i> 2016	Breeding suspected due to presence of adults on island near suitable nesting habitat.
			0	Birds	2011 – 2019	L. Wilson pers. comm.	In Canadian Wildlife Service Seabird Colony Database, via Yuri Zharikov, Parks Canada.
Cleland Island	49°10'N	126°05'W	"Many"	Burrows	1930	Drent & Guiguet 1961	
			50	Pairs	1967	Summers & Campbell 1978	
			10	Pairs	1969	Summers & Campbell 1978	
			Breeds	-	1970	Summers & Campbell 1978	
			30	Pairs	1974	Summers & Campbell 1978	
			20-40	Pairs	1975	Summers & Campbell 1978	
			100	Birds	1975	Campbell <i>et al.</i> 1990	Roosting, 11 August.
			6	Pairs	1988	Rodway & Lemon 1990, BC CDC 2014a, Rodway <i>et al.</i> 2016	
			0	Birds	Early 2000s	Carter <i>et al.</i> 2012	"Since the early 2000s, Tufted Puffins also no longer occur at Cleland Island" (Carter <i>et al.</i> 2012). However, from 2002–2020 there are > 100 eBird observations of Tufted Puffins for this locality, with the exception of the years 2005, 2006, 2007, 2009 (all 0 Tufted Puffin records; eBird 2021).
			20	Adults	2020	Boycott & Froese 2020	One of several eBird observations for this site in 2020; this particular record includes photos of Tufted Puffins flying in with bill-loads of fish.

Table 1 continued on next page

Table 1 continued from previous page

Location name	Latitude	Longitude	Count	Type of observation	Year	Source	Notes
Cameron Rocks ^b	49°46'N	126°55'W	1	Egg ^a	1925	RBCM 2021	1 egg collected; not a nest count. Collection location description is "Cameron Rocks, Clayoquot Sound". However, Cameron Rocks are in Nuchatlitz Inlet in the Nootka Island area. RBCM catalogue no. E0250.
			-	-	1999	Nootka Resource Board 2001	Notes a seabird colony at Cameron Rocks, with Tufted Puffin not one of the species present. Gives data source as Canadian Wildlife Service 1999 (no citation details).
McQuarrie Islets	49°54'N	127°13'W	1	Pair	1975	Summers & Campbell 1978	
			0	Birds	1988	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	"No Puffins were seen" (Rodway & Lemon 1990).
Clark Island	49°55'N	127°14'W	2	Nests	1958	Drent & Guiguet 1961	"2 nests excavated, 1 egg each."
			7	Pairs	1975	Summers & Campbell 1978	Listed as "Clarke" but in right vicinity (Kyuquot Sound); presumed to be misspelling of "Clark", and not the "Clarke" Island in Barkley Sound.
			5	Adults	1988	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	Breeding suspected due to presence of adults on island near suitable nesting habitat.
Volcanic Islets	49°56'N	127°16'W	1	Nest?	1975	Summers & Campbell 1978	
			2	Nests	1988	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	
Thornton Islands	49°58'N	127°21'W	2	Pairs	1975	Summers & Campbell 1978	
			4	Birds	1988	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	"Nesting was suspected but not confirmed" (Rodway & Lemon 1990).
Moos Islet	49°59'N	127°20'W	2	Nests?	1975	Summers & Campbell 1978	
			0	Birds	1988	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	"No Puffins were seen" (Rodway & Lemon 1990).
Solander Island	50°07'N	127°56'W	"Nesting in large numbers"	-	1954	Drent & Guiguet 1961	"An immense colony comparable to Triangle [Island]."
			3000	Pairs	1975	Summers & Campbell 1978	p. 63
			3138 ± 408	Pairs	1988, 1989	Rodway & Lemon 1990, Rodway <i>et al.</i> 2016	
Gillam Islands	50°26'N	127°58'W	3	Adults	1988	Rodway <i>et al.</i> 2016, Rodway & Lemon 1990	Breeding suspected due to presence of adults on island near suitable nesting habitat. Rodway & Lemon 1990 say suspect 2-3 pairs.
			0	Birds	2012	Halpin <i>et al.</i> 2012 (unpubl. report)	
Storm Islands	51°02'N	127°43'W	3	Eggs ^a	1929	Young 1930, Drent & Guiguet 1961	Eggs collected; not a nest count. At least three nests: "on Storm Islands there were a few pairs... secured two fresh eggs... and a few days later another one... We saw a few birds flying about at Storm Islands; while formerly common, they are becoming scarce [due to hunting and eggling]" (Young 1930).
			0	Birds	1987	Rodway 1991, Rodway & Lemon 1991, Rodway <i>et al.</i> 2016	Status of "Extirpated" assigned after search performed to confirm presence/absence of previously nesting species.
Tree Islets ^b	50°59'N	127°43'W	"One or a few"	Pairs	1929	Carter & Sealy 2011	p. 46
			0	Birds	1986	Rodway & Lemon 1991	None recorded or searched for in their survey; seems not to have been a known site at that time.
Pine Island	50°58'38"N	127°44'W	1	Egg ^a	1930	Drent & Guiguet 1961	Egg collected; not a nest count.
			0	Nests	1984, 1985, 1986	Rodway 1991, Rodway <i>et al.</i> 2016	Status of "Extirpated" assigned after search performed to confirm presence/absence of previously nesting species. 1 adult seen on water near island 11 July 1986 (Rodway & Lemon 1991).
Deserters Island, Deserters Group ^b	50°52'N	127°28'W	"One or a few"	Pairs	1929	Carter & Sealy 2011	p. 46
			0	-	1982	Rodway & Lemon 1991	Tufted Puffins not recorded, i.e., 0 seen.
Triangle Island	50°52'N	129°05'W	-	-	1909	Campbell <i>et al.</i> 1990	First record for this locality. Scott Island group. Original source: BC Nest Records Scheme?
			-	-	1949	Carl <i>et al.</i> 1951, in Drent & Guiguet 1961	"Largest known colony in the province."
			25000	Pairs	1975	Vermeer 1979, in Rodway <i>et al.</i> 1990	
			30000	Pairs	1977	Summers & Campbell 1978	p. 63, Triangle Island count provided by Kees Vermeer, Canadian Wildlife Service.
			21380 ± 2021	Pairs	1982	Rodway <i>et al.</i> 1990	
			26448 ± 2389	Pairs	1989	Rodway <i>et al.</i> 2016	
Sartine Island	50°49'N	128°55'W	-	-	1950	Carl <i>et al.</i> 1951, in Drent & Guiguet 1961	Scott Island group. "Burrows and adults plentiful."
			"100s"	Pairs	1975	Summers & Campbell 1978	
			6359 ± 1410	Pairs	1987, 1989	Rodway <i>et al.</i> 2016	
Beresford Island	50°47'N	128°46'W	-	-	1950	Carl <i>et al.</i> 1951, in Drent & Guiguet 1961	Scott Island group. "Several adults incubating eggs collected from their burrows by the museum party."
			2122 ± 579	Pairs	1987	Rodway <i>et al.</i> 2016	

^a As Tufted Puffins lay only a single egg, an observation of one egg is equivalent to that of one nest.

^b Colonies not included in previous seabird colony catalogues (Drent & Guiguet 1961, Summers & Campbell 1978, Rodway 1991, Rodway *et al.* 2016).

waters (i.e., the coastal upwelling zone extending southwards from approximately 50.5°N, off the northern end of Vancouver Island; Ware & McFarlane 1989). This includes the Canadian portion of the Salish Sea, a marginal sea spanning BC and Washington waters. Specifically, we reviewed publications compiling records of breeding BC seabirds (primarily Drent & Guiguet 1961, Summers and

Campbell 1978, Campbell *et al.* 1990, Rodway 1991, Carter & Sealy 2011, Rodway *et al.* 2016), along with the publications and survey reports referenced therein. We also accessed museum records for the region via the Global Biodiversity Information Facility database and searched for additional records submitted to the BC Conservation Data Centre (BC CDC) and eBird (2021), although we included these

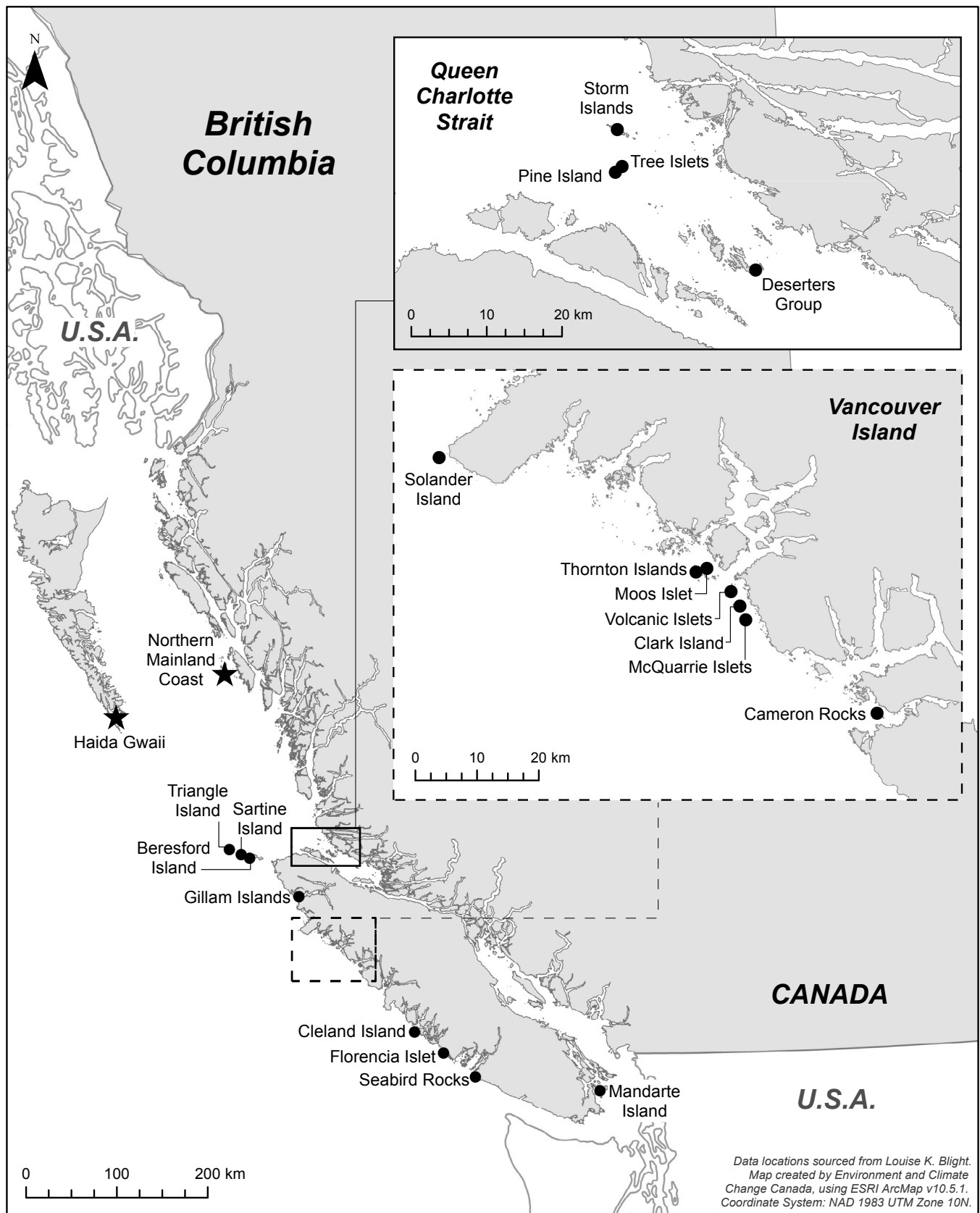


Fig. 1. Extant and extirpated Tufted Puffin *Fratercula cirrhata* colonies in British Columbia, Canada. Stars indicate areas of colonies that are outside of the California Current System and not discussed in this paper. Map produced by Alexandra King, Environment and Climate Change Canada.

records only if they provided information additional to that found in published papers or unpublished reports. We performed internet searches for recent population counts at known colonies if these were not available in any of the above sources. We excluded Canadian colonies outside of BC's portion of the California Current System (i.e., northern mainland coast and Haida Gwaii; Fig. 1). We did not consider breeding-season observations of Tufted Puffin adults at or near seabird colonies as evidence of a new nesting site in the absence of other information; for example, we excluded records of single adults at Mitlenatch Island, Strait of Georgia (14 June 1966, 11 May 1983, 23 July 1985; Campbell & Kennedy 1966 in Campbell *et al.* 1990; Verbeek 1998), as there has been no corroborating evidence of breeding activity there. Published historical or recent accounts that appeared to repeat information originally available elsewhere (e.g., in distributional lists such as Brooks & Swarth (1925); observations of apparently non-breeding birds reported to eBird (eBird 2021)) were also excluded from our compilation.

RESULTS

We documented a total of 19 historical and current nesting localities of Tufted Puffins in our study area (Table 1, Fig. 1). This is three more than the 16 colonies documented in the same region by previous compilations (Rodway 1991 (repeated in Rodway *et al.* 2016), see also Summers & Campbell 1978). Eleven of these appear to be extirpated, with no evidence of nesting seen on the most recent surveys in the 1980s or 1990s (7 sites) or 2010s (4 sites). Three others had < 5 individuals or pairs recorded on their most recent visits, all of which occurred in the 1980s. Birds nesting at Cleland Island disappeared in the early 2000s, but the colony shows recent evidence of nesting, i.e., adult birds flying into the colony with bill-loads of fish (Table 1; Boycott & Froese 2020).

The total population at Canada's largest Tufted Puffin colony, Triangle Island in the Scott Island Archipelago, was originally estimated at 25000 pairs (1975 estimate; Vermeer 1979, in Rodway *et al.* 1990). Burrow counts in study plots declined by 1.7% per year from 1984 to 2004 (Gaston *et al.* 2009) but subsequently rebounded somewhat (Rodway & Lemon 2011). Overall, numbers at Triangle Island appear to have remained stable: the annual trend during 1984–2017 was -0.1% , with 95% confidence intervals of -1.5 and 1.6 (Rodway *et al.* 1990, Rodway *et al.* 2016, Government of Canada 2019; Table 1). This is the only Canadian colony in the California Current System for which recent monitoring data are available (Rodway & Lemon 2011, Government of Canada 2019). Anecdotal reports indicate that the other large colonies at Sartine, Beresford, and Solander islands are still extant, though these appear to have last been surveyed in the 1980s (L. Wilson pers. comm.; Table 1).

DISCUSSION

Here we report on the status of Tufted Puffins in the Canadian portion of the California Current System, the first such update in 30 years. Our inclusion of historical distribution records increases to 19 the known number of extant and extirpated colonies in this region, with up to 16 previously included in various seabird colony catalogues and databases (Drent & Guiguet 1961, Summers & Campbell 1978, Rodway 1991, Rodway *et al.* 2016, BC CDC 2021). Of the three additional colonies recorded here, two were found published in a recent account compiling first historical breeding records of alcids in the region (Carter & Sealy 2011) and one came from a museum record of an egg collection (RBCM

2021). Thirteen of these colonies have historically been very small (≤ 7 nesting pairs, modal counts of 1–3 pairs), and through the twentieth century, their trend has been one of decline to extirpation or to likely extirpation (Table 1).

This abandonment of very small colonies has resulted in a northward contraction of the species' range in Canada, a pattern consistent with that observed in the southern portion of the California Current System (in Washington, Oregon, and California; Hanson & Wiles 2015, Hanson *et al.* 2019). There, declining trends were particularly evident from the middle of the 1980s through the late 1990s (Hanson & Wiles 2015). This also appears to have been the case at the three BC colonies for which a time series of population estimates are available (Mandarte Island, Seabird Rocks, Cleland Island; Table 1); Tufted Puffins were extirpated at these three colonies by the 1990s. The larger of these extirpated colonies, with maximum historical population estimates of 20–50 pairs, may continue to be attractive to nesting puffins: in 2011, two adults were seen attending Seabird Rocks, although this site does not appear to have been reoccupied. In 2020, there was again evidence of Tufted Puffins breeding at Cleland Island (Table 1).

In contrast, the numbers at Triangle Island are likely stable (Rodway & Lemon 2011, Government of Canada 2019), perhaps due to high annual adult survival (females: 0.96 ± 0.05 ; males: 0.91 ± 0.06 ; Morrison *et al.* 2011) and the island's remoteness; at about 45 km offshore, it is far from disturbance by humans and populations of mustelid predators. It is worth noting, however, that trend information for Triangle Island comes only from relatively few permanent plots, which were not designed to be representative of the nesting population. In fact, these plots were often placed in high-density areas of the colony, which may be assumed to show any declines later than more marginal habitat. Together, the population in the Scott Islands (Triangle, Sartine, and Beresford islands) has historically contributed nearly 90% of the Tufted Puffins breeding in BC; however, the status of the birds nesting on the latter two islands is unknown.

Accounts from the late nineteenth century indicate that several Tufted Puffin colonies existed in BC's Gulf Islands and elsewhere in the province's southern inland waters. The species "breeds on the islands of the Gulf (of Georgia)" wrote Fannin (1891, in Drent & Guiguet 1961), while Rhoads (1893) noted that the species was "abundant on [the] coast and Islands of Straits of Fuca and Gulf of Georgia." However, we found no museum records or published accounts that could substantiate breeding at any Gulf Islands locality apart from Mandarte Island.

Records of this type prior to 1900 are exceedingly rare. Early qualitative observations may mean that Tufted Puffins once nested more widely in what are now the Canadian Gulf Islands, as they did in the US San Juan Islands until quite recently: 14 colonies existed there during 1886–1977, but only two of these were extant in 2007–2010 (Hanson & Wiles 2015, Hanson *et al.* 2019). It is also unclear whether the population of Tufted Puffins was ever large in BC's inland waters. About 15 years after Rhoads noted that the species was "abundant" in the area, Dawson & Bowles (1909) described it as nesting only "sparingly" there. The warden stationed on the newly protected Bare (now Mandarte) Island in 1915 wrote that "[d]uring my stay on the island I noticed but three pair of puffins. These birds used to be plentiful, but shooting and other causes have brought about their almost entire disappearance from

these islands” (Anderson 1916, p. N15). Alford (1928, in Drent & Guiguet 1961, p. 120) similarly wrote that “many hundreds used to breed” on Mandarte. In later years, the historical population size on Mandarte Island was the subject of some debate; Drent & Guiguet (1961, p. 120–121) wrote that “no definite evidence can be found” for much larger populations of Tufted Puffins in the previous century, noting the absence of burrowing terrain there. However, in 1916, it was also noted that puffins on Mandarte Island had been “driven out of their deep burrows by [introduced European] rabbits” (*Oryctolagus cuniculus*, p. Q12 in Kermode 1917). This is consistent with the competition by non-native rabbits for nesting burrows documented at other seabird colonies, e.g., Brodier *et al.* (2011) and García-Díaz *et al.* (2020). While the evidence is inconsistent, an undocumented turn-of-century population decline of puffins in Canada’s Salish Sea is certainly conceivable, given historically widespread seabird hunting and eggging along the west coast by Indigenous peoples, fishermen, and commercial eggging operations, along with seabird hunting by European colonizers for sport and museum collections (Jones 1908, Dawson & Bowles 1909, Young 1930).

Regardless of their status prior to the end of the nineteenth century, numbers of Tufted Puffins on much of the BC coast appear to have remained low into the twentieth century, when small populations gradually winked out as described above, although the dates of most losses are unclear (Table 1). Causes of most declines are also unknown but have presumably been similar to the historical and recent factors affecting US populations to the south. There, the primary current threats are oiling (an estimated 9% of Washington’s Tufted Puffin population was killed in the F/V *Tenyo Maru* spill in 1991, which occurred in Canadian waters off Cape Flattery), bycatch in net fisheries, and climate change and its effects on the seabird prey base (Hanson & Wiles 2015, Hart *et al.* 2018, USFWS 2020, Bertram *et al.* 2021).

More detailed information on historical and recent threats to the species exists at a colony-specific level for some BC colonies, perhaps shedding light on colony desertions more broadly. At Seabird Rocks, birds are also thought to have been affected by the *Tenyo Maru* spill and two earlier major oil spills (M/V *Vanlene* in 1972 and the barge *Nestucca* in 1988; Carter *et al.* 2012). Tufted Puffins gradually declined there from 1970 to 1998, a trend likely caused by human disturbance at the colony, prey changes, and Bald Eagle *Haliaeetus leucocephalus* predation in addition to oiling (Hatler *et al.* 1978, Carter *et al.* 2012). In the early 2000s, predation by northern river otters *Lontra canadensis* was responsible for the loss of burrow-nesting Rhinoceros Auklets *Cerorhinca monocerata* and Cassin’s Auklets *Ptychoramphus aleuticus* from this locality, as well as a reduction in numbers of nesting storm petrels, cormorants, and gulls. American mink *Neovison vison* were suspected of killing four adult Tufted Puffins in their burrows at Cleland Island in the 1980s, though northern river otters were also present on the island. Given the unmonitored status of these sites, it is not possible to determine the degree to which mustelid predators threaten their puffin populations (Rodway & Lemon 1990, Carter *et al.* 2012, Halpin *et al.* 2012).

Seabird colony surveys conducted by the BC Provincial Museum (currently the Royal BC Museum), Canadian Wildlife Service, and independent researchers provided baseline information on Tufted Puffins from the 1970s and 1980s (Table 1), but those surveys are now 30 years or more out of date. Individual colonies

have been surveyed since then but only on an opportunistic basis (Carter *et al.* 2012). The paucity of trend data highlighted here—with standardized long-term data unavailable for all but one Tufted Puffin colony in BC (Triangle) and a lack of recent surveys at smaller, historically important colonies (Sartine, Beresford, Solander, Cleland)—indicates the need to develop a more robust monitoring program for this formerly widespread species (while acknowledging that it is particularly susceptible to disturbance at the colony; Pierce and Simons 1986). In a period of unprecedented declines of wild bird populations (Rosenberg *et al.* 2019), characterizing species’ long-term trends is a key component of managing the processes that drive such declines, particularly when historical patterns of distribution and abundance may differ materially from modern ones. For seabirds, the difficulty and expense of accessing remote nesting colonies can mean that efforts to collect monitoring data are patchy in time and space. This can lead to decades elapsing between population surveys, often resulting in a poor understanding of changes over time. Knowledge of Tufted Puffin population status, diet, and threats is particularly required now, given modelled trajectories suggesting the species is in danger of disappearing entirely from the California Current System (Hart *et al.* 2018) and potentially from the Gulf of Alaska (Goyert *et al.* 2017). In fact, a region-wide system of more rigorous and standardized surveys is required for burrow-nesting seabirds in general. The California Current System is a large marine ecosystem that spans three countries; monitoring a representative sample of seabird colonies and of habitats within them will allow for an understanding of changes in distribution and abundance of Tufted Puffin and other burrow-nesting seabirds throughout this zone.

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