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Changes in Abundance and Distribution of Pelagic Cormorants Nesting on Triangle Island, British Columbia, 1949-2010

Michael S. Rodway[1], Ken R. Summers[2], J. Mark Hipfner[3], Jason C. van Rooyen[4] and R. Wayne Campbell[5]

[1]*Wildwing Environmental Research, Box 47, Gold Bridge, British Columbia, Canada V0K 1P0 (msrodway@alumni.sfu.ca)*

[2]*KS Biological Services, 35708 Timberlane Drive, Abbotsford, British Columbia, Canada V3G 1G3*

[3]*Environment Canada, Canadian Wildlife Service, RR #1, 5421 Robertson Road, Delta, British Columbia, Canada V4K 3N2*

[4]*2617 Hawser Avenue, Coquitlam, British Columbia, Canada V3C 4C9*

[5]*2511 Kilgary Place, Victoria, British Columbia, Canada V8N 1J6*

Abstract

Triangle Island, the outermost of the Scott Islands off the northwest tip of Vancouver Island, is one of the most important seabird colonies in the northeast Pacific and supports one of the largest colonies of Pelagic Cormorants in British Columbia. Declines in Pelagic Cormorant nesting populations have been reported throughout British Columbia but trends on Triangle Island have not previously been identified. We identified changes in abundance and distribution of Pelagic Cormorants nesting on Triangle Island by compiling all historical records and by conducting complete surveys in 2009 and 2010. Large numbers of birds were reported in 1949 but numbers nesting were not determined. Actual nest counts showed fluctuating but overall increasing numbers from the 1960s and 1970s to a maximum of 433 nests in 1989, and then a decline to 326 and 335 nests counted in 2009 and 2010, respectively. Number of nests in 1989 was more than double any previous count, and was three times larger than the most recent previous count, in 1985. Such a rapid increase suggests immigration from other colonies; a speculation regarding the high numbers on Triangle Island in 1989 was that birds were re-locating from declining colonies, perhaps in Queen Charlotte Strait or along the west coast of Vancouver Island. Increasing trends on Triangle Island compared to nearby colonies may relate to the proximity of highly productive, upwelled waters just north of the Scott Islands and highlights the importance of those areas to foraging marine birds. Nesting was recorded at a total of 23 locations around Triangle Island, but only five to 17 were used in any particular season. Which locations were used in a season showed no discernible trend over the long term. Inter-annual changes in site use on Triangle Island provide a revealing, small-scale example of the difficulties inherent in monitoring Pelagic Cormorant breeding populations, and demonstrate the need to conduct complete surveys to accurately detect population changes.

Introduction

Pelagic Cormorants (*Phalacrocorax pelagicus*; Figure 1) nest around the North Pacific rim from Baja California to northern Alaska in the east and south to northern Japan in the west (Johnsgard 1993, Hobson 1997). Nests are built on suitable cliff ledges on offshore islands, headlands, and in sea-caves, as well as on a variety of human-made structures such as bridges, wharves, towers, and abandoned ships. Two subspecies are recognized, the larger *P. p. pelagicus* breeds from Haida Gwaii (Queen Charlotte Islands), British Columbia north, and *P. p. resplendens* breeds from the Strait of Georgia in southern British Columbia south along the Pacific coast (Johnsgard 1993). British Columbia is home to around 2% of the world's population with about 4,200 pairs nesting at 145 sites (Campbell et al. 1990). Global populations are considered stable (NatureServe 2010) but local declines in nesting populations have been reported throughout British Columbia over the last few decades (Vermeer and Rankin 1984, Campbell et al. 1990, Rodway 1991, Vermeer et al. 1992, Fraser et al. 1999, Chatwin et al. 2002, Carter et al. 2007). *P. p. pelagicus* is red-listed as a threatened population by the British Columbia Ministry of Environment (British Columbia Conservation Data Centre 2011). Implicated threats to breeding populations include disturbance by humans and Bald Eagles (*Haliaeetus leucocephalus*), which flush adults from nests exposing eggs and chicks to predation by Northwestern Crows (*Corvus caurinus*; Figure 2) and Glaucous-winged Gulls (*Larus glaucescens*), direct predation by Bald Eagles, and changes in prey availability (Chatwin et al. 2002, Carter et al. 2007).

Figure 1. Although global populations of nesting Pelagic Cormorants are considered stable, local declines have recently been reported in British Columbia. *Photo by R. Wayne Campbell, Mitlenatch Island, BC, 25 August 1969*.

Figure 2. Disturbance by humans and natural predators expose Pelagic Cormorant eggs to predation by Northwestern Crows. In this photograph the upper nest was spared. *Photo by R. Wayne Campbell, July 1978*.

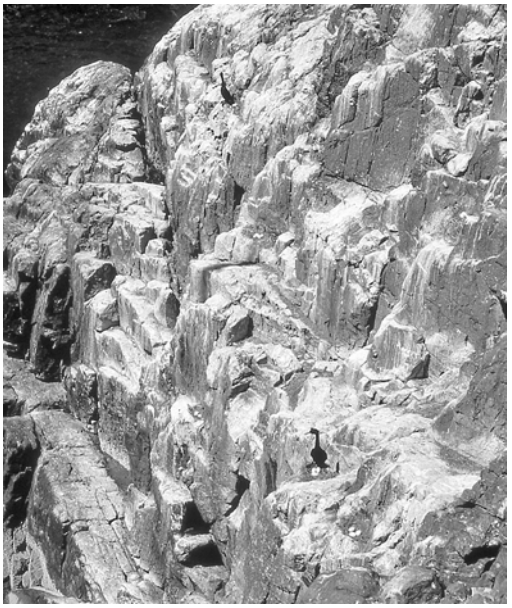

Figure 3. Many cliff-nesting Pelagic Cormorant colonies in British Columbia are inaccessible and difficult to survey completely. *Photo by R. Wayne Campbell, Mitlenatch Island, BC, August 1966*.

Population trends of Pelagic Cormorants are difficult to establish because nest sites are often inaccessible and hidden from view (Figure 3), nesting birds are extremely vulnerable to investigator disturbance (Verbeek 1982, Siegel-Causey and Litvinenko 1993), and there is high inter- and intra-annual variability in the location of nest sites and in the numbers of nests built at particular sites (Carter et al. 1984, Rodway 1991). Most available trend information is based on infrequent and sometimes incomplete survey data. Frequently replicated, region-wide surveys, conducted to minimize disturbance, are required to accurately detect population trends (Carter et al. 1984, 2007).

Triangle Island (Figure 4), the outermost of the Scott Islands off the northwest tip of Vancouver Island, is one of the most important seabird colonies in the northeast Pacific Ocean and supports one of the largest colonies of Pelagic Cormorants in British Columbia (Rodway 1991). Biological inventory and research have been relatively frequent at Triangle Island and records of nesting Pelagic Cormorants span six decades. These data have only partially been compiled (Drent and Guiguet 1961, Campbell et al. 1990, Rodway et al. 1990, 1992) and population

Figure 4. Aerial view of Triangle Island, BC, one of the most important seabird colonies in the northeast Pacific Ocean. Puffin Rock is in the foreground. *Photo by R. Wayne Campbell, August 1974*.

changes have not been described and interpreted. Our objective was to identify changes in abundance and distribution of Pelagic Cormorants nesting on Triangle Island by compiling all historical records and by conducting complete surveys in 2009 and 2010 to obtain current population estimates. We also compiled records of Bald Eagle and Peregrine Falcon (*Falco peregrinus*) activity to assess their potential negative (Verbeek 1982, Chatwin et al. 2002) or positive (Paine et al. 1990, Hipfner and Greenwood 2009, Hipfner et al. 2011) roles, respectively, in affecting the abundance and distribution of nesting cormorants.

Methods

Historical records of Pelagic Cormorant, Bald Eagle, and Peregrine Falcon nesting on Triangle Island (Figure 5) were extracted from Carl et al. (1951), Beebe (1960), Vermeer et al. (1976), Rodway et al. (1990), British Columbia Nest Record Scheme, British Columbia Seabird Inventory (hereafter BCNRS; Myres et al. 1957), and unpublished field notes from 1974, 1976, and 1977 (K.R. Summers unpubl. data). Collectively, we have conducted surveys on Triangle Island in the 1970s (KRS, RWC), 1980s (MSR, KRS),

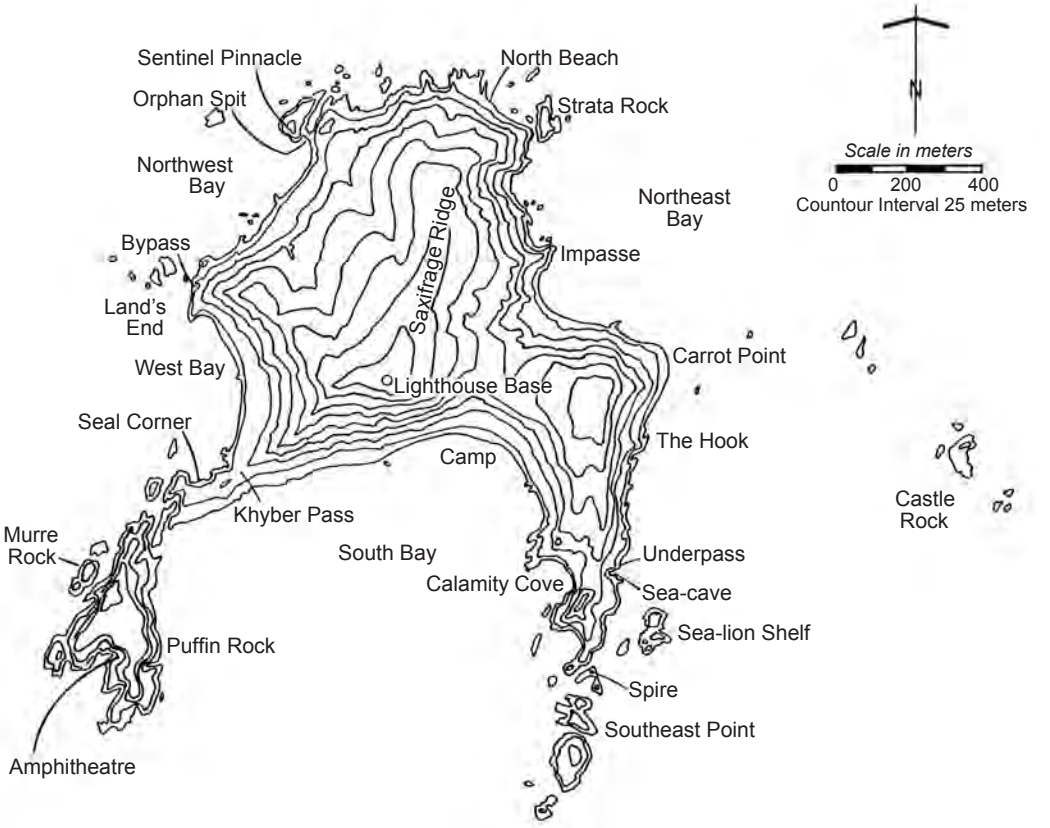

Figure 5. Triangle Island, British Columbia, showing locations mentioned in text. Map reproduced from Rodway et al. 1990.

and recently (MSR, JMH, JVR; Figure 6). In all years, Pelagic Cormorants were counted opportunistically during intensive work focused mainly on alcid species. Survey methods and dates in 1982 to 1989 were described in Rodway et al. (1990). Studies in the 1970s were conducted 23 May to 8 July 1974, 14 May to 31 August 1976, and 21 June to 31 July 1977 by KRS and 20 to 24 August 1974 by RWC (Figure 7). Observations of nesting Pelagic Cormorants during those years were made from land and during one boat trip along the east side of the island on 2 July 1977. In the 1980s, counts were conducted from land plus, in 1989, all nesting areas not visible from land were surveyed by boat.

Figure 7. In late summer, fog frequently shrouds Triangle Island, BC, as it did on 24 August 1974 when Wayne Campbell visited the isolated seabird island. *Photo by Jan Friesen*.

Figure 6. Setting up a research camp on Triangle Island presents many logistic challenges and requires transporting people and field equipment by helicopter or a long boat trip from Port Hardy, about 125 km away on northern Vancouver Island. In this photo, Cara-lyn and Jered Summers are ready to leave the misty island in a boat loaded with gear after the field season. Puffin Rock is visible in the background. *Photo by Michael S. Rodway, August 1989*.

Figure 8. East side of Puffin Rock, Triangle Island, BC. *Photograph by Michael S. Rodway, 26 July 2009*.

Recent surveys were conducted between 22 July and 10 August 2009, and 18-30 June 2010. In 2009, only areas visible from land were surveyed. Outer sections of Puffin Rock (Figure 5) not visible from land and the rest of Triangle Island were surveyed by helicopter on 30 June 2010. Nests were counted on Puffin Rock on 2, 4, and 8 August in 2009 and on 25 and 27 June 2010. Nests on the east side of Puffin Rock (Figure 8) were viewed by telescope from the south beach of Triangle Island. Nests on the west side of Puffin Rock (Figure 9) were viewed by binoculars from atop Puffin Rock, except for the sites north of the west point and north of Murre Rock (Figure 10), which were counted from the intertidal area below. One site not visible from land on the south end of the west point of Puffin Rock was photographed from the helicopter and nests were subsequently counted on the photograph (Figure 11). The minimum of six

Figure 9. Amphitheatre cliffs on the west side of Puffin Rock, Triangle Island, BC, with visible Pelagic Cormorant nests. *Photo by Heidi M. Regehr, 27 July 2009*.

Figure 10. View of the north end of Puffin Rock and Murre Rock, Triangle Island, BC. *Photo by Michael S. Rodway, 25 July 2009*.

Figure 11. Pelagic Cormorant nesting site on the south end of the west point of Puffin Rock, Triangle Island, BC, photographed from a helicopter. *Photo by J. Mark Hipfner, 30 June 2010*.

counts by three observers of the number of nests visible on the photograph was used. Nesting sites on the east side and the southeast point of Triangle Island were surveyed from the shoreline in the 1970s and 1980s, but we did not walk those shorelines in 2009 or 2010 because they are now occupied by large numbers of Northern [Steller's] (*Eumetopias jubatus*) and California (*Zalophus californianus*) sea lions (Figure 12). In 2009, observations of those areas were made from the slopes above but the actual nesting cliffs were not visible. Those sites, as well as sites on the north side of the island, were viewed from the helicopter in 2010.

Nest contents were determined opportunistically in a few nests early in the season, but we tried not to flush birds when surveying nest sites. Later in the season, large young were more readily observed. Nest contents were determined in a sample of 30 nests on 9 August 2009 and in 9 nests on 18 June 2010.

Accuracy of counts and locations of Bald Eagles and Peregrine Falcons nesting and present on the island likely depended on observer effort, timing of visits, and where work was being conducted in any particular year, and thus numbers presented here cannot be considered definitive. For example, the maximum number of falcon eyries recorded in 2010 reflected the fact that a focused survey by provincial wildlife staff was conducted for falcons that year. Observations in other years were more opportunistic. However, records were kept of raptor activity, especially in areas where cormorant nests were surveyed, and thus we think that compiled data for eagles and falcons are adequate for our purpose.

Figure 12. Sea-lions in northeast bay and along the east side of Triangle Island, BC. *Photo by Heidi M. Regehr, 29 July 2009*.

Results

Carl et al. (1951, p. 42) estimated over 2,400 breeding individuals in 1949, and reported that "Pelagic Cormorants were using all available niches on Triangle Island for nesting." Since then, numbers of confirmed active nests have varied from a low of 33 in 1984 to a maximum of 433 in 1989 (Table 1). Counts of nests in the 1960s and 1970s indicated a breeding population of about 200 pairs or less per year during that period. Vermeer et al. (1976) reported a maximum of 500 birds in 1974-1975. The maximum nest count in 1989 was more than twice as large as any previous count. A maximum of 330 roosting birds that were not associated with nests was also observed around the island in early August 1989. Our recent, complete count in 2010 revealed a decline of 23% from the maximum numbers recorded in 1989, but still larger numbers than all other estimates obtained in the 1960s, 1970s, and 1980s.

A total of 23 locations was identified where Pelagic Cormorants have nested around Triangle Island (Table 1; Figure 5). Number of sites used has varied among years and only some of the sites were used in any particular year (Figure 13). Nests were built at a maximum of 17 sites in 1977 and 15 sites in 1989, although two sites were later abandoned in 1989. Seven sites were used in 1985, and nests were built at only five sites in 1984, two of which were later abandoned. Areas of nesting concentration have also varied: Strata Rock was an important site in 1977 and 1982; most nests were on Puffin Rock in 1976, 1985, 2009, and 2010; and the majority of nesting occurred at sites around the main island in 1977, 1984, and 1989. Although nesting sites on the east side and southeast point of Triangle Island could not be viewed directly in 2009, we suspect that they were not used for nesting that year based on observations made from the slopes above. Several hours were spent on these slopes and no cormorants were seen flying

Figure 13. Sentinel Pinnacle, one of 23 sites on Triangle Island, BC, that showed intermittent use for nesting, was not used by Pelagic Cormorants in 2009. Moira Lemon (left) and Heidi Regehr are in foreground. *Photo by Michael S. Rodway, 24 July 2009*.

to or from the area. This was in marked contrast to continuous activity observed around Puffin Rock of many adults flying to and from nesting sites. Thus, all sites on the main island appeared unused, and nesting was concentrated on Puffin Rock, especially the east side, in 2009. All nesting was again concentrated on Puffin Rock in 2010, but nests were more abundant on the west than the east side, similar to the pattern observed in 1985 (Table 1).

Recorded nest contents indicated that eggs were laid in at least some nests in all survey years. Complete, or almost complete, failure later in the season occurred in 1976 and 1984. Carl et al. (1951) reported that birds were incubating and eggs were fresh during their visit of 24 June – 1 July 1949. Nests with eggs were observed on 14 and 20 June and small chicks were seen on 1 and 4 July 1974. Vermeer et al. (1976) observed eggs from the beginning of June to the second half of August, and chicks were present from the last week of June to mid-September in 1974 and 1975. In 1976, adults were sitting on nests on Puffin Rock on 3 June 1976, but were flushed from all nests on 24 June when a helicopter chartered by Environment Canada personnel to place reference markers for aerial photography landed on Puffin Rock. Nests were abandoned and many depredated eggs were found when the area was next surveyed on 4 July. Young were observed in several nests on 21 July 1977, some about two-thirds adult size. In the 1980s, nests with eggs were recorded on 10 and 18 July 1982, 12 July 1984, and 20 June 1989 (Rodway et al. 1990). Adults were incubating 11-20 July 1985. Depredated eggs were found below abandoned nests on the east side of the island on 14 July 1984. Chicks were seen on 19 and 23 July 1982, and most nests contained large young by early August 1989. Hipfner and Greenwood (2009) review some of these data and provide detailed nesting phenology for the years 2003 to 2008.

Almost all nests counted in 2009 contained large young attended by one adult (Figure 14). No empty, unattended nests were observed. Of a sample of 30 nests inspected by telescope on the east side of Puffin Rock on 9 August, 7 had three young, 12 had two young, 10 had one young, and one nest was empty but attended by an adult. All nests with young had one adult present except for one nest with three unattended young. Because this sample of nests was viewed by telescope from the shoreline, eggs or small young in nests would not be visible, but it was unlikely that they were present because no incubating birds or small chicks were seen during the entire survey. Emerging primary feathers were seen on chicks exercising their wings, and some young had primaries almost fully grown. Nests were conspicuous and adults carrying nesting material to refurbish nests were frequently observed. Birds were incubating in 2010; adults were sitting on 237 of the 286 nests counted from land. A single adult was present at 255 nests, two adults were attending 25 nests, and six nests were unattended. Of the nine nests whose contents were recorded on 18 June, one was empty, two had at least one egg, two had at least two eggs, three had three eggs, one had at least three eggs, and one had four eggs.

Figure 14. Pelagic Cormorant nests with large young and attending adults on the east side of Puffin Rock, Triangle Island, BC. *Photo by Heidi M. Regehr, 26 July 2009.*

Possible roles of Bald Eagles and Peregrine Falcons

There have been fluctuations but no overall trends in the numbers of Bald Eagles and Peregrine Falcons nesting on Triangle Island from 1949 to 2010. Two to four pairs of Bald Eagles (Table 2) and two to seven pairs of Peregrine Falcons (Table 3) have been recorded. Large numbers of nonbreeding eagles were present in 1949. Beebe (1960) reported over 50 Bald Eagles present on the island throughout his visit (Table 2). In other years, largest numbers were recorded in 1989 to 2010. In 1989, 14 to15 immature and subadult eagles were observed from 8 June to early July, in addition to the three nesting pairs. In 2009 and 2010, 20+ juveniles were frequently seen soaring over the slopes in South Bay (Figure 15).

Figure 15. Soaring and hunting Bald Eagles may impact nesting Pelagic Cormorants, both directly through predation or indirectly through disturbance and predation of nests and nestlings by Northwestern Crows (*Corvus caurinus*) and Glaucous-winged Gulls (*Larus glaucescens*). *Photo by R. Wayne Campbell.*

Our data suggest little relationship between abundance, distribution, and success of nesting Pelagic Cormorants and the numbers and nesting locations of Bald Eagles and Peregrine Falcons on Triangle Island (Tables 1-3). Largest numbers of eagles were observed in the same years that large numbers of cormorants were recorded nesting. Most cormorant nests produced young in 1989, even though three pairs of Bald Eagles raised young and large numbers of immature and subadult eagles were frequently seen soaring around the island during the incubation period when cormorants were most vulnerable to disturbance. Cormorants experienced similar success in 2009 when large numbers of immature eagles were present. Although falcons frequently chased Bald Eagles, there was little evidence that this behaviour conferred a protective advantage to nesting cormorants or that the cormorants preferentially nested under the halo of falcon territorial defence. Data suggested a possible association between nesting cormorants and falcon territories on Puffin Rock in 1985, 1989, and 2009. In those years, cormorant nests were more abundant on the side of Puffin Rock where falcon activity was recorded: east side in 1989 and 2009, and west side in 1985 (Tables 1 and 3). However, there was no evidence that cormorants nesting in the vicinity of falcon territories were more successful than others; almost all nests produced large young in 1989 and 2009. Also, attendance by falcons at sites on Puffin Rock was intermittent and infrequent in 2010. In 1974, cormorants nested all around Puffin Rock (where we spent much of our time), but falcons were recorded there infrequently, though they were commonly seen in other locations where cormorants were not recorded nesting. Nesting cormorants were absent from most or all main island sites and clustered on Puffin Rock in 1976, 1985, and again in 2009 to 2010. Of those years, falcons nested on Puffin Rock only in 2009 and 2010, yet defended territories in the vicinity of unused cormorant nest sites on the east and northeast sides of the main island in 1976, 1985, and 2010. Cormorants abandoned nests in 1976 after a helicopter landed on Puffin Rock in late June, but cormorants were present and falcons were absent there before that event. In 1977, cormorants were present in many locations around the island, as were falcon activity centres, but there was no obvious association or avoidance.

Table 1. Changes in numbers and locations of Pelagic Cormorant nests counted on Triangle Island since 1949. Abandoned nests are given in brackets and are not included in tallies. Areas where active nests were confirmed present but not counted are indicated by "X". A dash indicates that the area was not observed. Except where noted, records for 1974, 1976, and 1977 are from Summers (unpubl. field notes; see text). Data for 1982 to 1989 are from Rodway et al. (1990).

Location	1968	1974	1975	1976	1977	1982	1984	1985	1989	2009	2010
Puffin Rock East side:											
- S of N sea-cave					0		0	0	0	23	9
- N of crevice					p[1]		0	0	0	18	19
- middle crevice					29[1]		0	0	12	32	2
- S of crevice					p[1]		0	0	3	22	18
- above S sea-cave					33[2]		(18)	0	89(8)	144	62
- S of S sea-cave					p[2]		0	21	8(3)	14	14
Total east side		X		X	62	X	0	21	112	253	124
Puffin Rock West side:											
- S end					5		0	104[4]	12(1)	22	34
- S side amphitheatre				~80[3]	0		0	p[4]	0	12	38
- middle amphitheatre				p[3]	0		0	p[4]	(14)	32	50
- SE side W point					0		0	5	0	0	38
- S end W point					-		-	-	22	-	49[5]
- N of W point					0		0	4	2	6	20
- Murre Rock					8		0	0	0	0	0
- N of Murre Rock					20		0	0	0	1	
Total west side		X		X	33	X	0	113	36	73	211
Total Puffin Rock		**X**		**~150**	**95**	**X**	**0**	**134**	**148**	**326**	**335**
Around main island:											
- Sentinel Pinnacle				-	3	X	17	0	0	0	0
- North Pinnacles		X		0	10		7	0	4	0	0
- Strata Rock				-	68	64[6]	9	0	(19)	0	0
- N of Impasse [7]				-	12		0	0	0	-	0
- S side of Impasse				-	1		0	10	6	-	0
- The Hook				-	5[8]	X	(21)	0	35	-	0
- S of the Hook				-	p[8]	X	0	0	68	-	0
- E side SE point	~150			-	4		0	0	108	-	0
- W side SE point				-	7		0	0	64	-	0
Total around main island	~150	X		0[9]	110	>64	33	10	285	0[9]	0
Total Triangle Island	**~150[10]**	**164[11]**	**75[12]**	**~150**	**205[13]**	**>64**	**33**	**144**	**433**	**326**	**335**

[1] Counts were not separated for these three sites; total of 29 nests in the vicinity of the crevice.
[2] Counts were not separated for these two sites; total of 33 nests above the sea caves and vicinity.
[3] Counts were not separated for these two sites; total of at ~80 nests in the amphitheatre (KRS field notes). Total of 100-150 for Puffin Rock (BCNRS – Ken Summers, Dan Bingham). Eggs were laid but all nests were abandoned by 4 July.
[4] Counts were not separated for these three sites; total of 104 includes nests in the amphitheatre.
[5] Counts of nests on photograph of this site ranged from 49 to 56.
[6] Note that the location for these 64 nests was erroneously listed as Sentinel Pinnacle in Rodway et al. 1990.
[7] Between Impasse and Strata Rock, including north side of Impasse.
[8] Counts location not specified for the mid-east side of Triangle Island; the five nests may have been near the Hook.
[9] No nesting was suspected in this area (1976 and 2009) even though some sites were not observed (see text).
[10] 100-150 pairs on east end of island on rocky islets above sea lion colony (BCNRS – Robin Best; 28 June).
[11] Population certainly < 180 pairs; 164 nests counted (BCNRS - Wayne Campbell; 20-24 August). Note that there is a nest record card reporting 2,000 pairs of Pelagic Cormorants in 1974 (BCNRS – Ken Summers, Dan Bingham). We (KRS) now consider this a mistake, likely referring to an estimate for Common Murre and not Pelagic Cormorant.
[12] Vermeer et al. (1976) reported about 75 nests for 1974/1975. No locations were specified.
[13] This total has been revised from the 194 nests previously reported (BCNRS – Ken Summers, Ray Billings, Leo Cullen).

Table 2. Bald Eagle activity recorded on Triangle Island in years that Pelagic Cormorant nesting populations were assessed.

Year	Active nests[1]	Birds (maximum)	Source
1949	(2)	50+	Carl et al. 1951; Beebe 1960
1974	3	8	KRS field notes
1974-75[2]	1-4	14	Vermeer et al. 1976
1976	2[3]	10	KRS field notes
1977	1[4]	6	KRS field notes
1982	1	11	Rodway et al. 1990
1984	1(1)	14	Rodway et al. 1990
1985	2	7	Rodway et al. 1990
1989	3	21	Rodway et al. 1990
2009	1	25+	this study
2010	3	25+	this study

[1] "Active nests" indicates that two adults were in attendance. Laying or success were not necessarily confirmed. Numbers of inactive nests are given in brackets.
[2] Vermeer et al. (1976) lumped data for 1974 and 1975 for a total of 4 nests. Data from 1975 alone are not available.
[3] One defended empty nest (Khyber Pass pinnacle), and one pair frequented SE point, but no nest was observed.
[4] One pair frequented the SE Point area, but no nest was observed.

Table 3. Peregrine Falcon activity recorded on Triangle Island in years that Pelagic Cormorant nesting populations were assessed.

		Number of adults observed						Total	
	Occupied	Main island				Puffin Rock		birds	
Year	sites	north	south	east	west	east	west	(maxima)	Source
1949	4							8 + young	Beebe 1960
1974	3-4	2	2	2	0	1	0	7+ young	KRS field notes
1974-75	several							several	Vermeer et al. 1976
1976	3-4	2	2	2	2	0	0	8 + young	KRS field notes
1977	4-6	2-3	2	2	1-3	0	0	10 + young	KRS field notes
1982	2	0	0	4	0	0	0	6	Rodway et al. 1990
1984	2	0	0	4	0	0	0	5	Rodway et al. 1990
1985	2+	2	0	2	0	0	1	10	Rodway et al. 1990
1989	5-7	3	2	4	1	2	0	12 + young	Rodway et al. 1990
2009	2+		2			2	0		this study
2010	7[1]	2	4	2		2[2]	2[2]	12	this study[1]

[1] Count of occupied sites from Peregrine Falcon survey conducted by Myke Chutter and Don Doyle, British Columbia Ministry of Environment.
[2] Attendance was intermittent at these sites and birds may not have bred or may have failed early.

Discussion

Changes in abundance

Compiled records suggest a major decline in numbers of nesting Pelagic Cormorants on Triangle Island between 1949 and 1968. However, records also indicate a large discrepancy between estimated population sizes and actual nest counts. Counts show fluctuating but overall increasing numbers from the 1960s and 1970s to the maximum count of 433 nests in 1989. In 1974 to 1975, Vermeer et al. (1976) reported 75 nests (although RWC counted 164 nests in 1974) and a maximum of 500 birds, suggesting that only 30% of the total were nesting. If this was true in 1949, then the 2,400 birds reported by Carl et al. (1951) would have represented 360 nests. Such large numbers of cormorants were not observed in other years; 330 birds not associated with nests were seen in 1989 (Rodway et al. 1990). It is therefore difficult to explain the apparent changes in numbers between 1949 and 1968. An abundant food supply around Triangle Island may have attracted large numbers of cormorants in 1949. Carl et al. (1951) attributed the large numbers of eagles to an abundant food supply, observed schools of Sandlance (*Ammodytes hexapterus*) surfacing off the island, and they saw several large flocks of Sooty Shearwaters (*Puffinus griseus*) feeding in those areas. Large numbers of eagles in 1949 may also reflect population level pre-declines due to DDT (Buehler 2000), although only two old nests were found in 1949, indicating a small breeding population. The lack of nest count data from 1949, the example of a large proportion of non-breeding birds (Figure 16) reported by Vermeer et al. (1976), the potential attraction of large numbers of birds by an abundant food supply in 1949, and the fact that all nest counts from other years were much lower than the 1200+ pairs estimated to be present in 1949, precludes the conclusion that suggested changes represent a real population decline between 1949 and the 1960s.

Counts indicated increasing number of nests from the 1960s and 1970s to 1989. This is contrary to declines reported in Haida Gwaii (Rodway 1988), the northern mainland coast (Rodway and Lemon 1991a), Queen Charlotte Strait (Rodway and Lemon 1991b) and the west coast of Vancouver Island (Vermeer et al. 1992) during the same period. Declines on the northern west coast of Vancouver Island detected between 1988 and 1989 and may have reflected annual variability in nesting numbers associated with changes in food supply (Rodway and Lemon 1990, Vermeer et al. 1992). Human disturbance, Bald Eagle predation, and mortality from the *Nestucca* oil spill (Rodway et al. 1989) were not considered important factors contributing to declines on the west coast of Vancouver Island (Vermeer et al. 1992). In contrast to the general trend, numbers of Pelagic Cormorants nesting on Race Rocks off the southern end of Vancouver Island showed no evidence of decline in 1989. Vermeer et al. (1992) speculated that a less variable food supply associated with cooler

Figure 16. Throughout each breeding season, small numbers of non-breeding Pelagic Cormorants frequent Triangle Island, BC. *Photo by Heidi M. Regehr, 26 July 2009.*

and more stable ocean temperatures near Race Rocks than along the west side of Vancouver Island might have been responsible. Proximity of highly productive, upwelled waters just north of the Scott Islands may also be related to the contrary, increasing trend in numbers of cormorants nesting on Triangle Island in 1989.

Number of nests in 1989 was more than double any previous count, and was three times larger than the most recent previous count, in 1985. Such a rapid increase suggests immigration from other colonies, and a possible explanation for the high numbers on Triangle Island in 1989 was that birds were re-locating from declining colonies, perhaps in Queen Charlotte Strait or along the west coast of Vancouver Island. Interestingly, number of nests on adjacent Sartine Island also peaked in 1989, increasing from 137 in 1987 to 168 in 1989 (Rodway et al. 1992). Numbers declined over the same period at all other nearby colonies: for example, from 161 to 6 nests between 1987 and 1989 on Beresford Island (Rodway et al. 1992), and from 464 to 67 nests between 1988 and 1989 on Solander Island (Vermeer et al. 1992; Figure 17). Thus, in 1989, contrary trends were apparent for colonies on the outer two Scott Islands compared to those closer to Vancouver Island. The geographic association of increasing and declining colonies supports the hypothesis that trends were related to food supply and highlights the importance of the productive waters in the vicinity of the Scott Islands to foraging marine birds.

Figure 17. Successful nesting by Pelagic Cormorants at many sites along the British Columbia coast, such as Solander Island, varies among years. *Photo by R. Wayne Campbell, 5 August 1981.*

The decline in cormorants on Solander Island between 1988 and 1989 may be less severe than indicated because 27% of nests counted in 1988 were on inland-facing cliffs not visible from the water (Rodway and Lemon 1990) and surveys of that colony in 1989 were conducted by boat (Ken Morgan pers. comm.). MSR visited Solander Island at the end of May 1989, and cormorants were building and attending nests in most of the same areas that nests were observed in 1988, plus an additional area on the east side of the island (Rodway and Lemon 1990). This suggests that nesting efforts were abandoned by most birds before the survey by Vermeer et al. (1992) a month or so later. We observed some disturbance to that colony in May: two air force jets and one Coast Guard helicopter passing Cape Cook, and our boat approaching the island put all cormorants on the east side into the air. Main nesting areas on other sides of the island were not so affected and those disturbance were unlikely to account for abandonment by most birds, although, if such disturbances are frequent, they may explain the absence of nesting on the east side of the island in 1988.

Concurring with Vermeer et al. (1992), we think that human disturbance, Bald Eagle disturbance or predation, and mortality from the *Nestucca* oil spill were unlikely to be responsible for the contrary trends at Triangle and Sartine islands compared to other colonies in the region. All those colonies are relatively remote, had Bald Eagles present in 1989, and were unlikely to have been affected by the *Nestucca* spill (Rodway and Lemon 1990; Rodway et al. 1989, 1990). Eagle numbers did change on Solander Island, as we saw none in 1988 and five at the end of May 1989 (Rodway and Lemon 1990), suggesting a possible association between eagle activity and cormorant decline. On Beresford Island, however, a pair of eagles nested and fledged one young in 1987 when cormorant numbers were high (Rodway et al. 1990). A pair of eagles also nested successfully, plus we observed three immature eagles perched on the slopes on Sartine Island in 1989, again when cormorant numbers were high. On Triangle Island, largest numbers of eagles were observed in the same years that largest numbers of cormorants nested successfully. Disturbance by humans and Bald Eagles is likely a more important factor impacting

nesting cormorants in the populated areas of the Strait of Georgia and Barkley Sound (Chatwin et al. 2002, Carter et al. 2007), although with increasing tourism in coastal waters, studies are warranted to determine levels of human disturbance at more remote colonies. Carter et al. (2007) suspected that reductions in prey availability may have continued since the 1989 studies by Vermeer et al. (1992) and may have been largely responsible for decreased numbers of Pelagic Cormorants nesting in Barkley Sound through 2007. Repeated and more frequent surveys are required to determine whether the 23% decline on Triangle Island from 1989 to 2010 indicates a long-term trend.

Changes in distribution

Pelagic Cormorants showed high inter-annual variability in the use of nest sites on Triangle Island. Nesting was recorded at a total of 23 locations around the island, but only five to 17 of those were used in any particular season. Which locations were used in a season showed no discernible trend over the long term. Data from only 1989 to 2010 would suggest abandonment of main island sites and a concentration of nesting on Puffin Rock. However, similar changes in distribution occurred previously: nesting was concentrated on Puffin Rock also in 1976 and 1985, and was widespread around the main island also in 1977. Proximate causes for inter-annual changes in nest site selection by cormorants on Triangle Island are unknown. Evidence did not support the hypothesis that choice of nest sites was related to the location of Peregrine Falcon territories that may provide protection from Bald Eagle disturbance (Hipfner et al. 2011), although we could not rule out possible benefits of falcon territorial behaviour at a small scale for some cormorants in some years (Hipfner and Greenwood 2009). There was strong evidence that the presence of Peregrine Falcons enabled Pelagic Cormorants to breed successfully on the west side of Puffin Rock in the period 2003-2007 (Hipfner et al. 2011). It may be that our distributional data for cormorants and falcons are not fine enough to pick up effects. From 2003 onwards, while the falcon eyrie was active, there were hundreds of cormorant nests in the amphitheatre, more than in any of the years in which formal surveys were conducted (JMH pers. obs.). When the falcons disappeared, there was a huge reduction in the number of cormorant nests in the amphitheatre, which is reflected in the reduced counts of 2009 and 2010. There were major effects on Common Murres (*Uria aalge*; Figure 18) as well, as reported in Hipfner et al. (2011).

Figure 18. Predator-prey relationships on Triangle Island, BC, although not fully understood, impact nesting seabirds including Common Murre. *Photo by R. Wayne Campbell, Triangle Island, BC, 24 August 1974.*

Inter-annual changes in site use on Triangle Island provide a revealing, small-scale example of the difficulties inherent in monitoring Pelagic Cormorant breeding populations, and demonstrate the need to conduct complete surveys to accurately detect population changes. Partial surveys of only Puffin Rock or only main island nesting sites would have suggested contrary trends, increasing populations through 2010, or complete abandonment by 2010, respectively (see Table 1). Contrary trends on Triangle and Sartine islands compared to colonies closer to Vancouver Island in 1989, and dramatic year-to-year changes in nesting numbers on individual colonies seen between 1985 and 1989, reveal the same problem on a larger scale and emphasize the need for repeated region-wide surveys for monitoring provincial populations (Carter et al. 1984, 2007).

Acknowledgements

Surveys in 1974 to 1977 by KRS were funded by Canadian Wildlife Service and supervised by Kees Vermeer. RWC accompanied the British Columbia Provincial Museum display division during a visit in 1974. Colony inventories in 1982 to 1985 were conducted as part of the migratory birds conservation program, supervised by Kees Vermeer in 1982 and by Gary Kaiser from 1984 to 1987, and funded by the Canadian Wildlife Service. In 1989, surveys were funded through contract with Environment Canada, Conservation and Protection, Environmental Protection as part of the impact assessment of the *Nestucca* oil spill on the British Columbia coast. Steve Wetmore, Canadian Wildlife Service, was the scientific authority for the contract. Studies in 2009 and 2010 were funded mainly by the Centre for Wildlife Ecology (Simon Fraser University and Environment Canada).

Permission to work on Triangle Island, in the Anne Vallée Ecological Reserve, was provided by J. Bristol Foster prior to 1985, by Louise Goulet from 1985 to 1989, and by a permit from British Columbia Parks in 2009 and 2010.

We thank our various field companions during cormorant surveys, especially Dan Bingham (1974, 1976), Ray Billings (1977), Leo Cullin (1977), Gail Summers (1976, 1977), Moira Lemon (1982, 1984, 2009), and Heidi Regehr (2009; Figure 19 and 20). Thanks to Heidi Regehr for permission to use some of her photographs taken in 2009.

We would also like to thank the staff at Vancouver Island Helicopters in Port Hardy and West Coast Helicopters in Port McNeill for their assistance and concern during 1974 to 1989, and 2009 and 2010 field seasons, respectively.

Thanks to Myke Chutter and Don Doyle, British Columbia Ministry of Environment, for providing their count of Peregrine Falcon territories in 2010. The manuscript was improved by comments from Spencer G. Sealy. We are grateful to Mark Nyhof for custom preparation of the photographs.

Figure 19. Field crew geared up and ready to depart Port McNeill in helicopter for Triangle Island, BC. From left to right: Michael Rodway, Heidi Regehr, Jasmine Freed, and Moira Lemon. *Photo by Sean Boyd, 21 July 2009.*

Figure 20. Seabird researchers ready for a sunny day's work on Triangle Island, BC. From left to right: Jasmine Freed, Jason van Rooyen, Moira Lemon, and Heidi Regehr. *Photo by Michael S. Rodway, 26 July 2009.*

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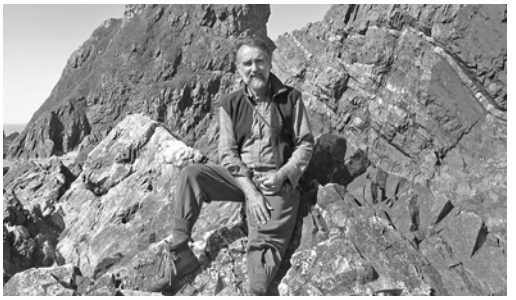
About the Authors

Michael started surveying seabirds in British Columbia in the mid-1970s when Wayne Campbell inducted him into the "British Columbia Seabird Inventory Program" run out of the British Columbia Provincial Museum [now Royal British Columbia Museum]. That program was the first comprehensive exploration for seabird colonies in the province and took Michael and colleagues on the adventure of visiting or discovering most seabird nesting sites along the British Columbia coast. During those surveys, he had the great pleasure of working with Wayne and a number of fellow recruits, especially Harry Carter (Junior and Senior), Trudy Chatwin, and Marilyn Paul. He also had the educational experience of sharing some of the last visits to seabird colonies made by Charles Guiguet, who in association with Rudy Drent helped pioneer seabird studies in British Columbia.

The Canadian Wildlife Service began a detailed study and inventory of burrow-nesting seabird populations in the early 1980s under the direction of Kees Vermeer. Michael was recruited by Kees in 1981 to survey the seabird colony on Langara Island at the northwest tip of Haida Gwai. Following that began a long-standing and rewarding partnership with Moira Lemon who worked with Kees at the Canadian Wildlife Service. Over the next decade, as part of that partnership, and under the supervision of Kees and then Gary Kaiser, Michael conducted surveys of all major colonies of burrow-nesting seabirds in the province. Of course, not without the help of many assistants over the years who shared the adventures and challenges of working on remote islands and who uniquely enriched Michael's experiences.

During the surveys in the 1980s, Michael helped set up a monitoring program for nesting seabirds in British Columbia that has been maintained since largely by Moira Lemon under the supervision of

Gary Kaiser, Tony Gaston, Doug Bertram, and Mark Hipfner of the Canadian Wildlife Service. The visit to Triangle Island in 2009 was conducted as part of that program, and provided an opportunity for Michael and others to repeat surveys of Pelagic Cormorant nesting populations.

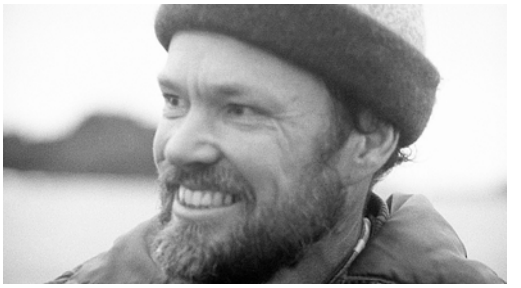


Michael Rodway on Triangle Island, BC. *Photo by Heidi M. Regehr, 24 July 2009.*

Ken's early interest in natural history motivated him to enroll in an undergraduate zoology program at the University of British Columbia (UBC) in Vancouver. During summer employment he discovered enthusiastic and knowledgeable people who helped launch his career. Among these, he credits Rudi Dent, a professor at UBC, who hired him to help with a research project on Rhinoceros Auklet on Cleland lsland near Tofino in the late 1960s and Wayne Campbell, a naturalist at Wickaninnish Provincial Park at Long Beach during the same period who was also interested in seabirds.

This exposure and experience led to four summers on Triangle Island studying nesting marine birds for the Canadian Wildlife Service. Kees Vermeer supervised the first three years of that research.

Ken then worked as a biologist with Ducks Unlimited Canada for seven years and since 1986 has made his living as an independent wildlife consultant on various projects related to biological assessment, management, inventory, and monitoring for industry and government. He still retains a passion for marine birds and has been a member of the Pacific Seabird Group since it was formed in 1972.



Ken Summers at Triangle Island, BC. *Photo by Michael S. Rodway. 16 August 1989.*

Mark is a research scientist with the Wildlife Research Division of Environment Canada, based at the Pacific Wildlife Research Centre in Delta, BC, and is also an adjunct professor at Simon Fraser University (SFU) in Burnaby. His research focuses on the demography, ecology and population dynamics of seabirds in Canada's Pacific Ocean, and the effects of anthropogenic stressors on marine food webs.

After completing a B.Sc. at University of Guelph in Ontario, Mark worked on short-term projects as a biologist with the Metropolitan Toronto Region Conservation Authority, and later Ontario's Ministry of Natural Resources. Thinking there might be more interesting places to work, he then went off to volunteer with the United States Fish and Wildlife Service in Alaska, spending three summers on Buldir Island, in the western Aleutians, site of the richest seabird colony in the northern hemisphere. Those experiences led to a decade of seabird research in Canada's spectacular eastern Arctic, Newfoundland, and Labrador, during which time he completed a M.Sc. at the University of Ottawa and a Ph.D. at Memorial University in Newfoundland. After a year of post-doctoral work at the University of Ottawa, Mark moved west, to Vancouver, to take up a joint Environment Canada (EC)/SFU position with the Centre for Wildlife Ecology. That position morphed first into a seabird population biologist position with EC, and later into the research scientist position he currently holds.

Mark Hipfner on Triangle Island, BC. *Photo by Rachel Darvill, 16 June 2007.*

Jason, a member of the Association of Professional Biologists of British Columbia, graduated from Simon Fraser University in Burnaby, BC, and works as an environmental consultant in western Canada. He completed an undergraduate research project on microclimate in tree canopies in relation to Marbled Murrelet habitat availability. Jason's interests in ornithology and conservation biology have been fostered during many seasons of field work in pristine areas of British Columbia, including two wonderful summers on Triangle Island.

Jason van Rooyen on Triangle Island, BC. *Photo by Heidi M. Regehr, 27 July 2009.*

Wayne's early interest in seabirds was stimulated in the mid-1960s through egg-collecting trips to remote islands (*e.g.*, Langara Island) and surveying nesting islands on the south coast and central mainland coast with Rudi Drent, a professor at the University of British Columbia in Vancouver. This experience led to banding thousands of young birds, mainly Glaucous-winged Gulls and Brandt's, Double-crested, and Pelagic cormorants, on coastal islands in southern British Columbia over the next two decades. Between 1967 and 1969, Wayne surveyed seabird colonies along the central west coast of Vancouver Island while employed as a provincial park naturalist at Wickaninnish Park (now Pacific Rim National Park Reserve). Significant populations and diversity of nesting seabirds discovered on Cleland Island, a 7.7 ha low island 14 km west of Tofino, during this period led to its establishment as British Columbia's first ecological reserve in 1971. Other survey results for the three years were published in *Birds of Pacific Rim National Park, British Columbia* (Hatler et al. 1978).

In January, 1973, Wayne moved to the British Columbia Provincial Museum [now Royal BC Museum] and soon initiated and co-ordinated the first survey of seabird colonies along the entire British Columbia coast. This provincial survey was one of the necessary components to fill in major gaps for *The Birds of British Columbia* project.

Wayne has authored 572 articles on the province's amphibians, reptiles, birds, and mammals of which over 40 titles are books. He is co-founder of the non-profit society *Biodiversity Centre for Wildlife Studies* and has been associate editor of its bi-annual journal *Wildlife Afield* since its inception in 2004.

His present research interests involve enhancing nesting productivity for wetland-nesting Black Terns with artificial platforms and compiling a catalogue of fresh-water colonial-nesting birds in British Columbia.

Wayne Campbell (foreground) with Bristol Foster, Director of British Columbia Ecological Reserves, during a field trip on Solander Island, BC, to assess nesting seabirds. *Photo by R. Wayne Campbell, 5 May 1976.*