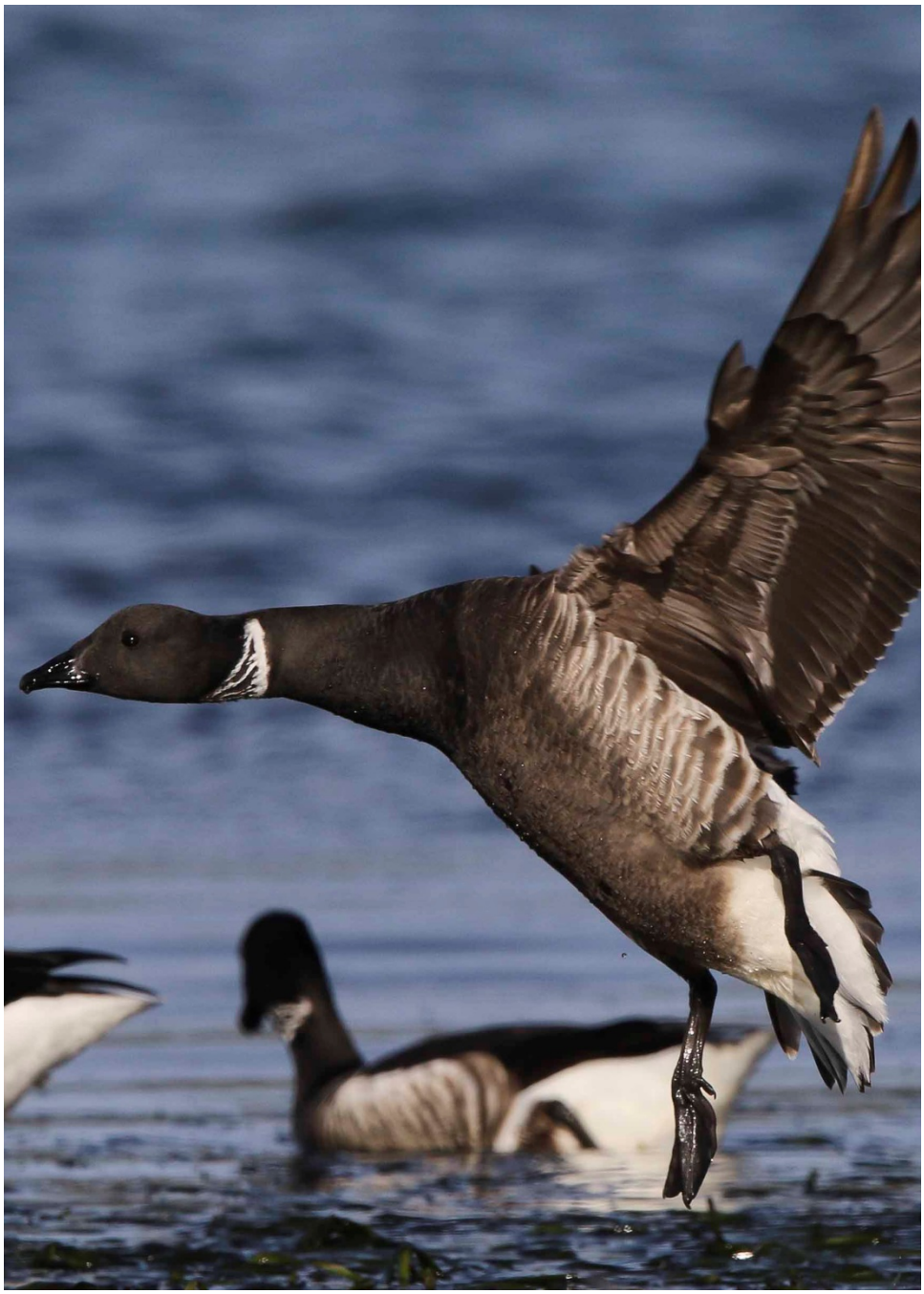
PACIFIC FLYWAY COUNCIL

Management Plan: Pacific Population of Brant



Adopted March 2018

Cover photograph: Black brant, © 2017 Mike Peters.

This management plan is one of a series of cooperatively developed plans for managing various populations of migratory birds in the Pacific Flyway. Inquiries about this plan may be directed to member states of the Pacific Flyway Council or to the Pacific Flyway Representative, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, 1211 SE Cardinal Court, Suite 100, Vancouver, WA 98683-9684. Information regarding the Pacific Flyway Council and management plans can be found on the Internet at PacificFlyway.gov.

Suggested Citation: Pacific Flyway Council. 2018. Management plan for the Pacific population of brant. Pacific Flyway Council, care of U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Vancouver, Washington. 48pp.

MANAGEMENT PLAN

FOR THE

PACIFIC POPULATION OF BRANT

Prepared for the

Pacific Flyway Council
U.S. Fish and Wildlife Service
Canadian Wildlife Service
Direccion General de Conservacion Ecologica de Recursos Naturales

by the

Brant Subcommittee
of the
Pacific Flyway Study Committee

March 1978
Revised March 1981
Revised July 1992
Revised July 2002
Technical Revision July 2004
Revised March 2018

Approved by  March 27, 2018

Chairperson, Pacific Flyway Council — Date

ACKNOWLEDGEMENTS

This plan was prepared by Pacific Brant Subcommittee of the Pacific Flyway Study Committee. During the process of revising this plan, those persons belonging to the Subcommittee and/or contributed significantly to its development include:

Jason Schamber, Alaska Department of Fish and Game
Melanie Weaver, California Department of Fish and Wildlife
Brandon Reishus, Oregon Department of Fish and Wildlife
Kyle Spragens, Washington Department of Fish and Wildlife
Joseph Sands, U.S. Fish and Wildlife Service, Region 1
David Safine, U.S. Fish and Wildlife Service, Region 7
Todd Sanders, U.S. Fish and Wildlife Service, Headquarters
André Breault, Canadian Wildlife Service, Environment and Climate Change Canada

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

PREFACE

The Pacific Flyway Council is an administrative body that forges cooperation among public wildlife agencies for the purpose of protecting and conserving migratory game birds in western North America. The Council is composed of the director or an appointee from the public wildlife agency in each state, province, and territory in the western United States, Canada, and Mexico. Migratory birds use four major migratory routes (Pacific, Central, Mississippi, and Atlantic flyways) in North America. Because of the unique biological characteristics and relative number of hunters in these regions, state and federal wildlife agencies adopted the flyway structure for administering migratory bird resources within the United States. Each flyway has its own Council.

Management plans are developed by Council technical committees and include biologists from state, federal, and provincial wildlife and land-management agencies, universities, and others. Management plans typically focus on populations, which are the primary unit of management, but may be specific to species or subspecies. Management plans identify issues, goals, and actions for the cooperative management of migratory birds among State and Federal agencies to protect and conserve these birds in North America. Management of some migratory birds requires coordinated action by more than one flyway. Plans identify common goals and objectives, establish priority of management actions and responsibility for them, coordinate collection and analysis of biological data, foster collaborative efforts across geo-political boundaries, document agreements on harvest strategies, and emphasize research needed to improve conservation and management. Population sustainability is the first consideration, followed by equitable recreational and subsistence harvest opportunities. Management plans generally have a 5-year planning horizon, with revisions as necessary to provide current guidance on coordinated management. Management strategies are recommendations and do not commit agencies to specific actions or schedules. Fiscal, legislative, and priority constraints influence the level and timing of management activities.

Management plans are not intended as an exhaustive compendium of information available, research needed, and management actions. Plans include summaries of historical data and information from recent surveys and research that help identify: (1) the current state of the resource (i.e., population and associated habitat), (2) desired future condition of the resource (i.e., population goals and objectives), (3) immediate management issues managers face, and (4) management actions necessary and assignment of responsibilities to achieve the desired future condition, including harvest strategies and monitoring to evaluate population status and management progress.

The first Pacific Flyway management plan for the Pacific Brant Population was adopted in 1978. This document is the fourth revision. It was developed by the Brant Subcommittee of the Pacific Flyway Study Committee.

MANAGEMENT PLAN
FOR THE
PACIFIC POPULATION OF BRANT

INTRODUCTION

Current taxonomy recognizes two subspecies of brant in North America: black brant, (*Branta. bernicla. nigricans*) and the Atlantic brant, *(B. b. hrota).* Western high-arctic or gray-bellied brant (hereafter WHA) are recognized as a management unit but their subspecific status is unresolved at this time. For the purposes of this plan, the Pacific brant population (hereafter Pacific brant) is composed of these two stocks of brant that breed in Alaska, the western Canadian arctic, and northeastern Russia and winters along the Pacific Coast from Alaska to northwestern Mexico (Figure 1, Appendix A).

Figure 1. Breeding and wintering range of Pacific brant.

GOAL AND OBJECTIVES

The goal is to maintain Pacific brant to ensure long-term conservation and meet the needs for consumptive and non-consumptive uses.

Objectives:

1. Maintain a minimum population of 102,000 with an overall goal of 162,000 (black and WHA brant combined) as measured by the 3-year running average of the Winter Brant Survey (hereafter WBS; formerly the Midwinter Survey) [1].

2. Maintain, manage, and enhance nesting, migration, and wintering habitats in sufficient quantity and quality to meet population objectives and public use.

3. Encourage and support brant conservation and management in Canada, Mexico, and Russia

4. Monitor Pacific brant on winter and breeding areas to assess changes in distribution and abundance.

[1] *In the 1978 and 1981 versions of this plan, the objective was 185,000. The 2002 plan set a lower objective for Pacific brant (162,000) based on a review of previous WBS results indicating this value was only exceeded twice and most winter surveys in California during the 1950s and 1960s were conducted in February or March when spring migrants were present. The 2002 Pacific brant plan was the first version to specify separate objectives for black brant (150,000) and western high Arctic brant (12,000). This plan reverts to a single overall objective of 162,000 for Pacific brant because of difficulties in monitoring the WHA stock on its remote breeding locations and mixing with other stocks on the wintering grounds.*

STATUS

Abundance

Numerous surveys conducted throughout the year contribute to range-wide Pacific Brant population status assessments. These include: WBS (Figure 2, Appendix B); breeding pair surveys in western and northern Alaska; random nest plot survey in western Alaska; molting bird survey in northern Alaska; and fall population and age ratio surveys at the Izembek Lagoon and adjacent embayments on the lower Alaska Peninsula. The WBS and fall Izembek survey provide annual indices of total population size and indicate a similar long-term mean across the period of years for which data are available (Stehn et al. 2010). The WBS has been the traditional index used to manage Pacific brant, based on the 3-yr average. The fall count at Izembek Lagoon provides a secondary index to monitor the population, if the WBS is not conducted. Disparities in trend data among these survey efforts have created uncertainty about the status of Pacific brant. Aerial photographic counts at five major Yukon-Kuskokwim Delta (YKD) colonies indicate a negative trend in number of brant nests since 1992 (Appendix C) while breeding pair surveys of the YKD coastal zone indicate brant populations have been stable to slightly increasing since 1985 (Swaim and Wilson 2017). Annual waterfowl surveys on the Arctic Coastal Plain (ACP; Appendix A) also indicate that the number of indicated total brant has increased since 1986 (Stehn et al. 2013). The decline in nests at the major colonies of the YKD is widely accepted, but there is not consensus among experts about the extent to which there may be compensation for those declines outside the major breeding colonies.

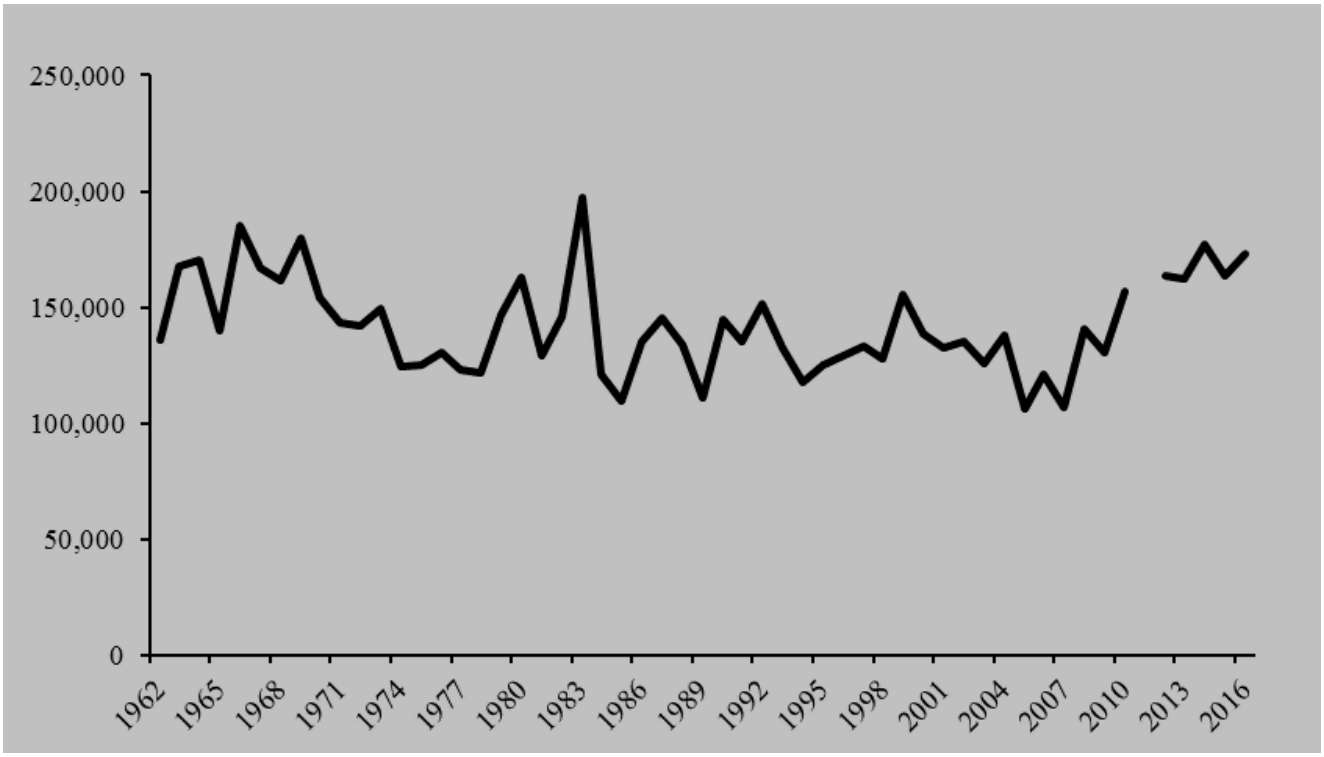


Figure 2. Pacific brant population index as measured by a 3-year running average of the WBS (See Appendix B).

Distribution and Migration

Breeding Distribution.—Most black brant breed on the YKD and ACP of Alaska. Specific colonies on the YKD were identified in 1981 when Byrd (1981) delineated 22 colonies, with largest concentrations occurring at Kokechik Bay, Tutakoke River, Kigigak Island, and Baird Peninsula and Island, and Newtok Island. The known breeding range on the ACP occur between Point Lay and just east of Prudhoe Bay, Alaska, a distance of approximately 520 km. The core breeding areas on the ACP are located between Dease Inlet and Prudhoe Bay (Larned et al. 2011; Appendix A).

In Canada, black brant breed in small, scattered colonies in the low arctic. Specific areas include Tuktoyaktuk Peninsula and in Liverpool Bay region, western Banks Island, the Queen Maud Gulf region of Victoria Islands and the Kent Peninsula of the mainland (Lewis et al. 2013; Appendix A). The WHA brant breed in high Arctic Canada, primarily on Melville, Prince Patrick, and Eglinton islands of the Parry Islands, NT / Nunavut (Appendix A).

In Russia, brant breed in major river deltas of northeastern Siberia and on islands from the western Bering Sea, west to the Lena River Delta including the New Siberian islands and Wrangel Island (Dementiev and Gladkov 1951–54, Uspenski 1959; Appendix A). Prior to the 1980s, the population was thought to number several thousand breeding pairs (Dementiev and Gladkov 1951–54; Portenko 1981), with an estimated 2,000 pairs on Wrangel Island (Uspenski 1965). By 1989, Wrangel Island supported fewer than 100 pairs and breeding was sporadic (Stishov et al. 1991; Ward et al. 1993a). The Lena River appears to be a location where breeding black brant overlap with other subspecies of brant from Europe and East Asia (Syroechkovski et al. 1998, Lane and Miyabashi 1997).

The first large-scale aerial survey of eastern Arctic Russia was conducted in the mid-1990s, from the Chukotka Peninsula west to the Lena River Delta (Hodges and Eldridge 2001). The survey was conducted over a three-year period (1993–1995) and estimated 16,744 brant but because the survey was conducted in late June and early July, the estimate likely included both molt migrants and breeding birds so the size of this breeding population remains uncertain. A recent report suggests Pacific brant have increased in eastern Arctic Russia and now numbers 37,000–49,000 birds during summer (Fox and Leafloor 2017). A large portion of radio-marked birds on Wrangel Island staged at Izembek Lagoon during fall and were present during fall aerial counts, and brant marked in Russia have been re-sighted in Mexico during winter and Humboldt Bay, CA during spring (Ward et al. 1993a). Therefore, an unknown proportion of brant originating from Russia contribute to the Pacific brant population.

Molt migrants/Nonbreeders.—Failed or non-breeding brant molt in large numbers on lakes in the ACP, arriving to the region in mid-June from various breeding locations. Molting concentrations can be found northeast of and including Teshekpuk Lake, Piasuk River Delta, and near Cape Simpson (Appendix E; Derksen et al. 1979, Shults and Dau 2016). Up to 8,500 molting brant have also been recorded at scattered coastal locations on the ACP (Ritchie and Wildman 2000, Flint et al. 2008). Banding information indicates brant movements to molting sites vary in relation to breeding success (Bollinger and Derksen 1996, Ward et al. 2005a). Pacific brant that do not molt on the ACP may migrate short distances (<100 km) and remain near their breeding site (Fondell et al. 2013).

Large concentrations of molt migrants also occur at various locations throughout the western Canadian Arctic where annual numbers vary dramatically (Alexander et al. 1988). The largest numbers of molting brant in western Canada is believed to occur on Banks Island (Cotter and Hines 2001).

In Russia, molting concentrations occur on Wrangel and New Siberian islands. Historically, a molting population of 10,000 birds was estimated (Uspenski 1965), which declined to an estimated 4,200 by 1990 (Ward et al. 1993a). Few surveys have been conducted in Russia for black brant and there are likely other areas for molt migrants that have yet to be described.

Fall Migration.—Brant depart Arctic molting and breeding areas from late August through early September, staging at Kasegaluk Lagoon near Icy Cape, Alaska (Lehnhausen and Quinlan 1982). Johnson (1993) estimated that up to 49% of the Pacific Brant population used this lagoon between August and early October. An important stopover site for black brant from Russia is Mechigmenski Bay on the Chukotka Peninsula (Ward et al. 1993a).

Safety Lagoon at Nome is near the northern extent of eelgrass (*Zostera marina*) on the west coast of North America and used during fall. Chagvan and Nanvak bays, near Cape Newenham are important spring and fall staging areas. The Seward Peninsula, including Cape Krusenstern, marks the northern extent of eelgrass (*Zostera marina*) on the west coast of North America. The next important area for the Pacific brant is Togiak NWR. Brant bands from all arctic populations have been detected in fall at Chagvan and Nanvak bays, near Cape Newenham, Alaska (Fondell unpubl. data), where the first significant intertidal beds of eelgrass occur in the Bering Sea (Ward et al. 2015). These bays are also used by brant in spring.

Pacific brant continue to migrate to Izembek Lagoon. Breeding birds from the YKD arrive first, followed by those from Russia, northern Alaska, the western Canadian low arctic, and finally by the WHA birds (Reed et al. 1989b, Boyd et al. 2013, Ward unpubl. data). Essentially, all of the Pacific brant use Izembek Lagoon between September and November and individuals remain an average of seven weeks (Lewis et al. 2013).

Beginning late-October, over 60% of the Pacific brant make a nonstop transoceanic flight from Izembek to San Quintin Bay, Mexico that has been estimated to take about 54 hours to travel the 5,300 km distance (Dau 1992). Some migrants, however, make stopovers in coastal areas of southern British Columbia, Washington, Oregon, and northern California, but the majority migrates to coastal lagoons of Baja California and northern Sonora. WHA brant generally depart later and satellite-marked birds flew from Izembek to the wintering area of northern Puget Sound in late November to early December (Boyd et al. 2013).

Winter Distribution.—Pacific brant winter over a vast area of the Pacific Coast from northwest Mexico to southwest Alaska (Appendix A). The WBS indicates approximately 60% of the population winters along the west coasts of Baja California, Sonora and Sinaloa, but that proportion has declined since the 1980s. The remainder of Pacific brant winter in scattered bays from the lower Alaska Peninsula to southern California and they have been increasing over this

time. The greatest increase has occurred at Izembek Lagoon (Appendix B) which may contain an unknown proportion of WHA brant.

The primary wintering area in Canada is southern British Columbia where numbers have increased on the Fraser River Delta over the last two decades. Other major use areas include Haida Gwaii (Sandspit and Masset area) and the East Coast of Vancouver Island (Comox area). A small number of WHA brant also winter in the Fraser River Delta.

Major use areas in Washington include North Puget Sound, notably: Padilla, Samish, Fidalgo, Dungeness bays, portions of the Hood Canal, and Willapa Bay. Steady increases have been noted in certain Washington bays where recent survey averages are nearing historical levels but statewide counts exhibit high annual variation (Appendix B). Reed et al. (1989a) believed that almost all of the brant wintering in Padilla, Samish and Fidalgo bays were WHA brant, however harvest checks indicate a variable proportion of both black and WHA brant in these bays (Appendix D). Band recovery data from WHA birds marked on Melville, Prince Patrick, and Eglinton islands indicates a strong affinity for wintering in the north Puget Sound area (Appendix E).

Wintering brant in Oregon have declined steadily from pre-1950s levels and nearly all wintering birds are found in Yaquina, Netarts, and Tillamook bays (Appendix B). Leg band observations and band recovery data suggest that a higher proportion of brant wintering in Oregon originate from the ACP and low arctic Canada breeding areas rather than from the YKD (Pitkin 2000, Ward et al. 2005b).

Important wintering sites in California include Humboldt Bay, Bodega Bay, locales on Point Reyes (Tomales Bay and Drakes Estero), Morro, Mission, and San Diego bays. Humboldt Bay is considered the most critical wintering and migration site in California. Brant use has generally declined in California (Appendix B). However, survey timing in the 1940s and 1950s ranged from late December to late February preventing an accurate assessment of long-term trend because some of those counts likely included migrants. Both Humboldt and Morro bays have consistent survey data and indicate an overall reduction in brant use. Declining brant use of Morro Bay is likely due to reductions in eelgrass beds (*Zostera marina*, MBNEP 2013).

Baja California is the primary wintering site of Pacific brant (Appendix A) although few WHA brant have been observed in Mexico (Ward et al. 2005b). Band observation data indicate brant observed in Mexico primarily originate from breeding birds on the YKD (Ward et al. 2005b). Most brant use occurs in the four large lagoons on the Pacific coast of Baja California. In Sonora and Sinaloa most brant use the five northernmost bays/lagoons with nearly all of which contain substantial beds of eelgrass. San Quintin Bay is a critical site for brant in Mexico, serving as a primary wintering area and a key staging area during fall and spring migration (Ward et al. 1993b). Wintering population estimates of black brant in Mexico have varied widely (Appendix B), but have exhibited a downward trend since 1980 and a steady shift northward within Mexico (Ward et al. 2005b, Sedinger et al. 2011).

Spring Migration.—In spring, brant make comparatively short migration flights from mid-January through April. In California, Oregon, and Washington, brant congregate in many of the

same estuaries that are used in fall and winter. Humboldt, Tomales and Bodega bays in California and Willapa Bay and northern Puget Sound in Washington support the largest numbers. In western Washington, peak annual counts typically occur in late April when brant are widely distributed throughout coastal and Puget Sound waters. Most brant usually leave Washington by early May, but WHA consistently depart in late May. Peak annual counts in Humboldt Bay, California are generally mid-March.

The three main brant use areas in British Columbia are the east coast of Haida Gwaii, the southeast coast of Vancouver Island, and the Fraser River Delta foreshore and the adjacent bay (Appendix A). Observations of color-banded brant indicate early March migrants are composed of birds that have wintered in British Columbia (67%), Mexico (25%), Washington (5%), and California (3%) (Canadian Wildlife Service, unpublished data).

Spring migrants begin arriving at Izembek Lagoon in April and stage three to six weeks before migrating to breeding areas. Brant arrive on the YKD breeding grounds from late April to early June (Fischer et al. 2017).

Habitat Use and Concerns

Nesting.—In Alaska, black brant nest primarily on the coastal fringe of the YKD and the ACP. Nest sites on the YKD and ACP include wet sedge-grass meadows, islands, pond margins and coastal mud flats with patches of grass and sedge (Lewis et al. 2013). The highest nesting densities of brant on the YKD are found within 5 km of the coast, where the risks of habitat change and or loss are the greatest due to rising sea level and increased storm intensity and frequency (Dau et al. 2011, Saalfeld et al. 2017). Studies of changes in nest habitat on the ACP are limited, but brood rearing habitats on the ACP are considered to be of high quality allowing goslings to grow larger than those on the YKD (Hupp et al. 2017). ACP brant might also benefit from coastal permafrost thawing and subsidence that appear to increase the amount of salt-tolerant vegetation eaten by brant (Tape et al. 2014).

In Canada, brant nest and molt in widely separated coastal areas of the Yukon, Northwest Territories and Nunavut (Appendix A). Nesting occurs in colonies in low-lying areas, typically river deltas, small offshore islands, islands in ponds and lakes adjacent to the coast, and occasionally gravel spits (Cotter et al. 1993, 1994, Wiebe and Hines 1998). Brood rearing takes place in coastal salt marsh areas. Brant nesting on Victoria and Banks islands occur as isolated pairs or in small colonies, as far as 60 miles inland from the coast (Parmallee et al. 1967, Wiebe and Hines 1998).

WHA brant nest on Melville, Prince Patrick, Eglinton, and associated smaller islands and appear to be restricted to coastal areas and stream drainages (Boyd and Maltby 1979, Lewis et al. 2013). Habitats likely to be used by brant consist of only a small fraction of the total area of the islands, with Melville Island providing the most potential habitat and appears to be the western extent of WHA brant in high arctic Canada (Boyd et al. 2013). Ponds, lakes, and river deltas with suitable islands for secure colonial nesting are rare, and brant nest as widely dispersed solitary pairs, often well away from water. During molting and brood-rearing, however, they are rarely found more than 0.5 km from the security of lakes, ponds, or the seacoast.

Habitat quantity and quality.—Eelgrass is an essential requirement of brant habitat at all Pacific Coast migration and wintering areas. Brant numbers are highly correlated with eelgrass availability and abundance (Wilson and Atkinson 1995, Ward et al. 1999) and eelgrass habitat quality at staging/wintering sites likely influences breeding performance (Sedinger et al. 2011, Schamber et al. 2012). In a modeling exercise of spring staging at Humboldt Bay, Stillman et al. (2015) showed that the rate of mass gain and mean stopover duration by brant was most sensitive to changes in total eelgrass biomass. Although Atlantic brant have used upland habitats for foraging (Smith et al. 1985), this option is infrequently used by Pacific brant. Loss in eelgrass extent has been reported at the southern end of the brant wintering range in Mexico (Muniz-Salazar et al. 2006, Riosmena-Rodriguez 2009), and southern California (MBNEP 2013, Merkel 2015), but trends in other parts of the wintering range are less clear, though recent analyses indicated stability in the extent of eelgrass at Izembek Lagoon since the 1990s (Hogrefe et al. 2014). A recent study indicated that survival in both YKD and ACP breeding birds may be influenced by a reduction in the quality of migration and wintering ground habitats (Leach et al. 2017).

Maps of the spatial distribution of eelgrass have been developed for many of the brant staging and wintering areas, including Izembek Lagoon, Padilla, Humboldt, Tomales, Morro, San Diego and San Quintin bays; however, there is no range wide baseline data for eelgrass (Appendix A). In coastal British Columbia large areas (40.2 sq. km.) of eelgrass have been mapped in Boundary Bay and Robert's Bank (Ward et al. 1992). Other data on eelgrass beds in British Columbia are available through fish habitat references collected by the Department of Fisheries and Oceans for the Strait of Georgia and from 10 to 15 seabed Imaging and Mapping System (SIMS) projects in the Strait of Georgia ecoregion (J. Harper pers. comm.).

Morro Bay along the south-central coast of California has been a historically important region for wintering brant, supporting the sixth largest eelgrass ecosystem in the state; however, there has been a significant decline to < 25 ha over the past 10 years (Morro Bay Estuary Program 2013). Brant numbers and use days within Morro Bay have declined considerably concomitant with the declines in eelgrass (Roser 2017). Reestablishment projects as well as measures to reduce contamination within the bay are currently underway to mitigate these recent declines.

The expansion of non-native dwarf eelgrass (*Zostera japonica*), from British Columbia to Washingon (i.e. Padilla and Willapa bays), Oregon (i.e., Yaquina Bay) and northern California (i.e., Humboldt Bay) estuaries, particularly in Padilla and Willapa bays in Washington, has caused concern due to the significant overlap of both native and non-native types of eelgrass. The impacts to native eelgrass density or quality in relation to brant foraging requirements is unknown (Baldwin and Lovvorn 1994, Schafer et al. 2008).

Petroleum Development.—Petroleum development may disturb breeding and molting brant (Gollop et al. 1974) and is considered a primary threat to brant habitat in Arctic Alaska and Canada. A major spill or blow-out, especially in broken ice or ice-free periods, could adversely impact brant nesting and feeding habitat rendering them unusable for many years (Simpson et. al 1980, Derksen et al. 1988; McKnight and Taylor 1989).

The coastal area of the ACP supports the second largest known concentration of breeding brant outside of the YKD. Extensive petroleum exploration and development has occurred in the central coast region between the Colville and Canning river deltas moved into the National Petroleum Preserve-Alaska (NPRA), increasing the risks of habitat degradation, oil spills, industrial disturbance, and artificially elevated predator populations (Day 1998, Sedinger and Stickney 2000).

ACP large lakes and halophytic meadows north and east of Teshekpuk Lake, within the NPRA, support an average of about 12% of the Pacific brant during molt (Shults and Dau 2016; Appendix E). In 2013, the Bureau of Land Management removed approximately 11 million acres, including 3.1 million acres within the Teshekpuk Lake Special Area of the NPRA from oil and gas production lease sales (Federal Register 2013). This action provides protection to molting and breeding brant but is reversible.

Kasegaluk Lagoon on the western edge of the ACP reported about 50,000 brant staging in 1989 and 1991 (Johnson 1993), but does not carry any protected designation. Proposed oil exploration and development that could adversely impact brant and their habitats have been proposed for the Chukchi Sea, particularly offshore of Kasegaluk Lagoon.

Izembek Lagoon is a state-owned tideland inside the Izembek State Game Refuge, within the boundary of the Izembek National Wildlife Refuge (INWR). The two refuges have been designated as Wetlands of International Importance (especially as waterfowl habitat) via the RAMSAR Convention of 1971. Other nearby embayments important to brant, such as Kinzarof Lagoon, and north ends of Morzhovoi and Bechevin bays are also within the borders of INWR but the eelgrass beds and tideflats are managed by the state and are not afforded special protection.

Offshore petroleum exploration was conducted in the North Aleutian Basin north of Izembek Lagoon in the 1980s, but currently, there are no plans for development or further exploration in the region. Other potential threats include an expansion of transportation infrastructure (e.g., the King Cove-Cold Bay road) that increase access and human activities in brant use areas (USFWS 1997).

The Salish Sea (SW British Columbia and NW Washington), is experiencing an increase in ship traffic, particularly from oil tankers. There are five refineries in northern Washington, and one refinery near Burnaby, British Columbia. If implemented, the expansion of oil pipelines in western Canada would further increase in tanker traffic in the Salish Sea.

Aquaculture.—Aquaculture gear and activities are often concentrated in areas used by brant for loafing, feeding and gritting. Mariculture operations (including infrastructure, servicing, maintenance, seeding and harvesting) can negatively affect eelgrass and brant populations (Schmidt 1999; Shuford and Gardali 2008; Wilson and Atkinson 1995). The reliance of Pacific brant on eelgrass makes them responsive to fluctuations in the quality and quantity of this habitat (Moore et al. 2004; Ward et al. 2005a; Wilson and Atkinson 1995).

Aquaculture is a vital part of coastal community economies in British Columbia, Washington and California. Techniques commonly used in California (e.g. Drakes Estero, Humboldt Bay), northern Puget Sound (e.g. Padilla and Willapa bays) and British Columbia (Baynes Sound) include: longline aquaculture that suspends lines in the water column and oyster-bags that are lines of suspended bags close to the intertidal flat bottom. Both may have direct or indirect impacts to the eelgrass beds (Wilson and Atkinson 1995) or prevent brant access to eelgrass beds (Moore and Black 2006). Surveys in Humboldt Bay conducted by H.T. Harvey and Associates (2016) noted that brant no longer fed in areas with longline culture once the tides were low enough for the structures to be an impediment. Given the height of eelgrass in north Humboldt Bay, the height of the gear deployed, and the effective feeding depth of brant - many gear types render areas amongst cultivated beds unavailable for most or all available tidal feeding windows (H.T. Harvey and Associates 2016).

Public Uses

Subsistence Harvest.—Traditional and customary subsistence harvest is important in Alaska and Canada, occurring mostly during the spring and summer months (Wentworth and Wong 2001). The 1997 amendment to the MBTA signed by the United States, Canada, and Mexico provided a regulatory framework for subsistence harvest. In spring of 2000, a system of regional committees and a statewide council was established in Alaska to involve rural subsistence hunters in the management of migratory birds and to develop spring and summer hunting regulations. The system is administered through the Alaska Migratory Bird Co-management Council (AMBCC) in collaboration with the Flyway Councils and the USFWS.

The AMBCC Harvest Assessment Program (HAP) was implemented in 2004 to estimate subsistence harvest across all aboriginal communities. The survey was revised in 2008 and 2015 to restructure data collection, analysis, reporting, and include all of Alaska (Naves 2015) and it was only in 2016 that all regions of Alaska were included in the survey. The species-specific annual harvest estimates produced from HAP tend to be imprecise (Otis et al. 2016) and include an unknown proportion of both black and WHA brant.

For most of the period from 2004 to 2013 brant were harvested primarily in the YKD, Bering Strait, Bristol Bay, Aleutian Islands, North Slope and NW Arctic, regions. The estimated total average take by Alaska subsistence hunters was 14,000 brant (Appendix F).

The most recent subsistence harvest estimates in Canada are from the 1980s and indicate an annual harvest range of 489 to 1,100 birds (J. Hines pers. comm.). However, field data collected directly from hunt camps indicate these interview-based data may give a very low estimate of actual harvest (R. Bromley pers.comm.). Brant harvest in Canada occurs primarily in early spring (May and June) and primarily near Tutoyaktuk; harvest elsewhere is small to unknown.

When the Alaska subsistence harvest is combined with estimates of subsistence harvest in the Northwest Territories of Canada, the total average annual subsistence harvest account for a relatively high percentage of the estimated total average annual harvest of Pacific brant. Effective harvest management of the Pacific brant requires consideration of both spring-summer subsistence and fall-winter harvest and collaboration with the AMBCC.

Fall-Winter Harvest.—During the last decade, an average 3,800 brant were harvested annually in the Pacific Flyway, with most harvest occurring in Alaska and California (Appendix G). Since the inception of the Harvest Information Program (HIP; 1999) for the United States, annual harvest estimates have included a measure of precision, but tend to be imprecise (estimated harvest ± 30 to 120%). Harvest rates calculated from color-marked brant have increased from 0.9% for the 2000–2002 hunting seasons to 3.3% for the 2013–2015 hunting seasons, but recent harvest rates are still lower than the 10% rate reported in the 1950s–1960s (Leach et al. 2017). Fall-winter harvest may be a relatively low percentage of the estimated average total annual harvest of Pacific brant (fall-winter and spring-summer combined; Appendices F and G).

Alaska

About 79 percent of fall-winter brant harvest in Alaska occurs on the Alaska Peninsula, primarily at Izembek Lagoon (USFWS HIP: 2007–2016). The INWR estimated an annual average 1,130 brant retrieved from 1999–2014 (Izembek NWR Annual Narrative Reports). The average statewide estimate of brant harvest, derived from HIP, from 1999–2016 was 1,208 brant. Only a small number of brant are harvested in other regions, likely because the Trans-Pacific migration from Izembek Lagoon excludes southcentral and southeast Alaska. Brant regulations have been stable and conservative in Alaska since 1984 (Appendix I).

British Columbia

The hunting season in early spring (March 1–10) aims at rebuilding the local wintering population by focusing harvest on spring migrants rather than wintering residents. Historically, brant were hunted in all coastal areas of British Columbia but, since 1985, all areas have been closed to recreational hunting except for the Fraser River delta. Since the 1999, the average annual harvest of brant in the Fraser River delta is 100–300 brant are harvested annually in the Fraser River delta (Appendix G).

Washington

Four counties are open to brant hunting in Washington during select days in January: Clallam, Skagit, Pacific and Whatcom. Regulations vary by county to maximize harvest opportunity without negatively impacting wintering WHA brant. The number of days allowed in each county is dependent upon the presence of WHA brant and the proportion of WHA brant within the harvest. The prohibition of hunting from unsecured boats or other floating objects was put into place in the 1970s and the creation of reserves in Padilla Bay were established in the mid-1980s to address the declines in wintering WHA brant. Washington brant hunting regulations have been restricted since 1976 due to population declines and differential distribution of the two Pacific brant stock.

A color composition chart developed by Boyd and Maltby (1979) is used to determine the proportion of WHA brant in the harvest. Using the color criterion for WHA brant (4 or lighter, Munsell 10YR), the percentage of this stock in the north Puget Sound harvest averaged 53% during 2006–2016 (Appendix D). Based on mandatory harvest reports and bag checks during the same period, WHA brant harvest averaged 226 birds annually during this same period. Washington has maintained a WBS closure threshold in Skagit County to trigger an emergency closure for conservation of WHA brant. From 2008–2014 the threshold was 6,000 brant in Samish, Padilla, and Fildalgo bays, but starting in 2015 the threshold was changed to 3,000 for

closure and a restricted 3 day season if the WBS was between 3,000–6,000. If more than 6,000 brant were counted on the WBS, a full 8-day season would occur. The season was canceled in January 2001, 2003, 2014, and 2017 when the index fell below the respective threshold. A 3-day season occurred in 2015. Since 2006 annual harvest in Skagit County has averaged 382 Pacific brant (Appendix G).

Oregon

Brant seasons in Oregon historically occurred from late-November through mid-February with an average season length of 78 days and three or four brant. Brant seasons were closed from 1983 through 1986 but resumed in 1987 with a 16-day season and two-bird bag limits, which have been maintained through 2017 (Appendix I). From 1987 to 1997, the seasons were held in December and January. In 1998, frameworks were modified restricting Oregon seasons from occurring after December 15 in an attempt to increase the number of wintering brant and to reduce the number of adult birds in the harvest (Henry 1980). Additionally, Oregon implemented a policy that brant seasons must occur during the seasons offered in California, as a disincentive for non-resident hunters to participate in the Oregon hunt.

Harvest monitoring in Oregon has been conducted by several methods, including: random state telephone surveys of hunting license holders (pre 1987), free brant permits with voluntary report cards (1987–1994), yes/no identification of potential brant hunters at the time of license purchase (1999–2003), and requiring brant hunters to purchase a brant hunting permit to identify potential brant hunters (2004–2016). Currently, the Oregon Department of Fish and Wildlife sells between 140–170 brant permits per season while the HIP estimates <50 hunters pursue brant in Oregon. Currently, agency officials assume fewer than 25 brant are harvested annually in Oregon (B. Reishus; per. comm.) and nearly all harvest has been primarily limited to three northern coastal bays: Tillamook, Netarts, and Yaquina with sporadic harvest occurring in Coos Bay.

California

Brant harvest in California has declined precipitously since the 1970s, when the hunting season occurred in late January and February. Beginning in 1983, the hunting season was moved to November (Appendix I) and extending no later than December 15. This action was implemented to increase the number of wintering brant in California and to reduce the number of adult birds in the harvest (Henry 1980). Season lengths were reduced from about 40 days to 30 days, and bag limits were reduced from four per day (eight in possession) to two per day (four in possession). Additionally, area-specific closures were established in Humboldt and Morro bays.

Establishing hunting seasons in the fall during migration reduced hunter participation because brant use is lower and less predictable in California bays that time of year. Harvest estimates were historically based on field reports and interviews with brant hunters. Since the inception of the HIP survey, brant harvest estimates are much higher; likely an over estimate resulting from the relatively small sample size of brant hunters. The average harvest from the HIP data from (1999–current) is 1,606 (Appendix G).

Mexico

Since the 1970s, restrictions have been applied to brant seasons, bag limits, importing firearms,

and hunting in Mexico. In 1980, brant hunting was reduced from four days per week to three. In 1984, shooting hours were reduced from all day to morning only (dawn–noon). Procedures for obtaining gun permits were restricted in January 1985 and again in 1990. In 2000, the system of Unidades de Manejo Ambiental (UMA) was implemented in Mexico, establishing local management of brant hunting on estuaries.

Brant harvest has not been monitored regularly or completely in Mexico, but periodic studies and surveys are provided in Appendix H (Eldridge and Kramer 1985, Kramer 1988). The majority of brant harvest in Mexico takes place at San Quintin Bay in Baja California. About 95% of brant hunters are from the United States (over 90% from California) (Kramer et al. 1979). Harvest of brant at San Quintin Bay has ranged from 823 to 2,875 and averaged 1,400 birds per year over the past 30 years.

Hunting in the protected reserves of Ojo de Liebre and San Ignacio lagoons has been negligible or nonexistent since 1997. Hunting pressure at other areas in Baja California has been minimal, with most activity occurring at three locations: Bahia Magdalena, Estero Coyote/Bahia Ballenas, and Laguna Manuela.

Currently, brant hunting occurs at a limited number of sites on the mainland west coast of Mexico. Periodic hunter surveys of mainland Mexico suggest that there has been an increase in brant harvest in Sonora, primarily in the Canal del Infiernillo/Bahia Kino area. Brant harvest increased in 1997–98 from about 5–50 to 200–300 birds annually. Harvest in other parts of Sonora and Sinaloa likely has remained low and similar to estimates reported 1984–85 (Eldridge and Kramer 1985).

Wildlife Viewing.—Brant are of interest to the public because of their relative rarity and ecological specialization. An annual Brant Festival in British Columbia attracts participants for a three day event that includes several communities. The Washington Brant Foundation participates in two events in the spring. The Black Brant Group in Morro Bay, California holds an annual fundraiser in March. In addition, some coastal National Wildlife Refuges highlight brant and use as an education tool to demonstrate migratory connectivity and estuarine-dependent species.

HARVEST STRATEGY

The harvest strategy is intended to maintain a minimum Pacific brant population of 102,000 (black and WHA brant combined) and to allow the population to increase toward the goal of 162,000 while maintaining fall-winter harvest opportunity. Similar to the population objective, harvest guidelines are based on a 3-year running average of the Winter Brant Survey (WBS) index. If any regional component of the annual WBS is not completed, the most recent 3-yr average for that location will be substituted for the missing year. Ground / boat based surveys in Mexico have replaced the former aerial surveys as the metric for the Mexico portion of the WBS.

A prescriptive harvest strategy is established as follows for fall/winter harvest seasons in Alaska, Washington, Oregon, and California.

Regulation Package	WBS (3-year average)
Closed[1]	<102,000
Restrictive	102,000–122,000
Moderate	122,000–147,000
Liberal	>147,000

Regulation Package	Restrictive	Moderate	Liberal	Framework Dates (All Packages)
AK	51 days 2 daily bag	107 days 2 daily bag	107 days 4 daily bag	September 1 through January 26
OR/CA	16 days 2 daily bag	27 days 2 daily bag	37 days 2 daily bag	Saturday closest to September 24 through December 15
WA	16 days 2 daily bag	27 days 2 daily bag	37 days 2 daily bag	Saturday closest to September 24 through last Sunday in January

[1]*If the population declines to a level which prescribes a closed brant season, a restrictive hunting season may not resume until the 3-year average population index surpasses 112,000 brant.*

Additional Harvest Guidelines for WHA Brant in WA

Most harvest of WHA brant is occurs in Padilla, Samish, and Fidalgo bays in northwest Washington and season restrictions are currently in place. The season in these areas is designed to limit harvest of WHA brant and will be canceled by emergency action when the annual pre-season WBS survey estimate is less than 3,000 in Padilla, Samish, Fidalgo bays. Since 2008, Washington has held distinct seasons in Skagit and Pacific counties coincident with mandatory harvest reporting by all hunters that have acquired a valid migratory bird hunting authorization for brant. From 2008–2014 an emergency closure was triggered in Skagit County when the WBS fell below a threshold of 6,000 brant in Samish, Padilla and Fidalgo Bays. Beginning in 2015, a restricted season option was adopted in Skagit County, requiring an emergency closure if the WBS was below 3,000 brant, a restricted 3-day season if the WBS was between 3,000–6,000

brant, and a full 8-day season if more than 6,000 brant were counted during the aerial survey. These thresholds are maintained for conservation of WHA brant wintering in these three adjacent bays.

Regulation Package	Restrictive	Moderate	Liberal	Earliest Opening and Closing Day in WA (All Packages)
WA WHA areas[1]	16 days 2 daily bag	16 days 2 daily bag	16 days 2 daily bag	Saturday closest to September 24 through last Sunday in January

[1] *WHA areas include any area where species composition surveys via bag checks indicate >25% WHA brant (3-year average).*

MANAGEMENT ISSUES

Population Assessment

1. Surveys that assess total population abundance lack statistical rigor.

2. Abundance, distribution, trends, and connectivity of breeding brant are not well documented outside of Alaska.

3. Decline of major YKD breeding colonies is not reflected in surveys of the total population.

Harvest Assessment

1. Fall-winter harvest estimates need improvement in Alaska, Oregon, California, and Mexico.

2. Spring-summer harvest estimates need improvement in northern Canada and Alaska.

3. Breeding site affiliation of harvested birds is poorly understood outside the major colonies, and in the Arctic regions of Canada and Russia.

Habitat

1. Aquaculture and coastal development reduce habitat and increase disturbance to marine and terrestrial habitats.

2. Carrying capacity of eelgrass beds to support staging and wintering brant are unknown (consider this as research-review).

3. Effects of disease, contaminants, climate change and invasive species on marine and terrestrial habitats are unknown.

MANAGEMENT ACTIONS

The following actions are recommended to guide cooperative efforts to meet the stated objectives of this plan. The degree and timing of their implementation by the responsible agencies will be subject to staffing, budgetary, and legislative constraints beyond the scope of this plan. Whenever possible, management procedures in this plan should be coordinated and consistent with those for other populations of Pacific Flyway geese.

Population Management and Assessment

1. Continue the WBS in BC, AK, WA, OR, CA and Mexico. This survey is the primary index guiding management for Pacific brant.

   Priority: 1
   Responsibility: USFWS, CWS, ADFG, WDFW, ODFW, CDFW
   Schedule: Ongoing

2. Continue the Fall Izembek Survey. This survey serves as an alternate population assessment if the WBS is not conducted.

   Priority: 1
   Responsibility: USFWS
   Schedule: Ongoing

3. Develop methods to improve the current index for Pacific brant to provide statistically rigorous estimates of population abundance and trends. Examine the feasibility of a combined breeding survey using the YKD Coastal Zone and ACP Breeding Pair surveys, and/or assess the potential to enhance the Fall Izembek or winter surveys, using photography or other methods.

   Priority: 1
   Responsibility: USFWS
   Schedule: New

4. Continue coordinated surveys for WHA brant in north Puget Sound and Fraser Estuary in British Columbia during November through March, including the WBS.

   Priority: 1
   Responsibility: WDFW, CWS
   Schedule: Ongoing

5. Continue the YKD Coastal Zone survey and the ACP Breeding Pair Survey to estimate brant abundance.

   Priority: 2
   Responsibility: USFWS
   Schedule: Ongoing

6. Implement banding programs (based on cost effectiveness), telemetry, or stable isotope in those areas that do not have banding programs for: population assessment and / or to determine connectivity to staging, wintering, and breeding areas.

   Priority: 2
   Responsibility: UAF, USGS, USFWS, ADFG, CWS
   Schedule: New

7. Continue aerial survey of brant at key molting areas on the ACP of Alaska.

   Priority: 2
   Responsibility: USFWS
   Schedule: Ongoing

8. Continue annual photographic surveys to estimate brant nesting at major colonies on the YKD.

   Priority: 2
   Responsibility: USFWS
   Schedule: Ongoing

9. Continue to estimate annual fall age ratios at Izembek Lagoon. This survey provides an estimate of annual productivity of the overall population.

   Priority: 2
   Responsibility: USFWS, USGS
   Schedule: Ongoing

10. Determine extent of brant nesting areas in Russia, Canada, and Alaska (other than YKD colonies).

    Priority: 3
    Responsibility: USFWS, CWS, ADFG
    Schedule: New

11. Determine the presence of WHA brant and monitor at wintering sites in addition to the Fraser River Delta in British Columbia.

    Priority: 3
    Responsibility: CWS, BC, USFWS
    Schedule: Ongoing

Harvest Assessment

1. Continue coordination with the AMBCC to benefit Pacific brant and other Alaska goose populations through cooperative management planning, information exchange, and implementation of conservation measures of Alaska-based goose management plans.

   Priority: 1
   Responsibility: USFWS, ADFG, AMBCC, PF Council
   Schedule: Ongoing

2. Continue village harvest surveys in Alaska to estimate seasonal subsistence harvest on breeding and staging areas.

   Responsibility: USFWS, ADFG, AMBCC
   Priority: 1
   Schedule: Ongoing

3. Determine the magnitude and distribution of subsistence brant harvest in Canada.

   Priority: 2
   Responsibility: USFWS, ADFG, CWS, Yukon, NWT
   Schedule: Ongoing

4. Continue to obtain and improve estimates of fall-winter harvest through HIP, permit reports or other means in the U.S. and through CWS-BC hunter survey in Canada.

   Priority: 2
   Responsibility: USFWS, ADFG, WDFW, ODFW, CDFW, CWS, BC
   Schedule: Ongoing

5. Collect data on color composition, age, and sex of harvested birds in northern Washington and British Columbia.

   Priority: 2
   Responsibility: WA, BC, CWS
   Schedule: Ongoing

6. Coordinate with Mexico to determine brant harvest.

   Responsibility: USFWS, CWS
   Priority: 2
   Schedule: Ongoing

Habitat Management

1. Periodically track eelgrass abundance and consider potential effects to brant carrying capacity.

   Priority: 1
   Responsibility: USFWS, USGS, CWS, ADFG, BC, WDFW, ODFW, CDFW, partner agencies
   Schedule: New

2. Participate in environmental reviews of projects that may affect nesting, molting, staging, and wintering areas for Pacific brant.

   Priority: 2
   Responsibility: All States, USFWS, CWS, Yukon, NWT, BC
   Schedule: Ongoing

3. Promote and coordinate brant habitat management activities with Mexico (via the Tri-lateral Committee) and Russia (via AREA V Agreement).

   Priority: 2
   Responsibility: USFWS, CWS
   Schedule: Ongoing

Research

1. Investigate extent and quality of forage on brood rearing habitat.

   Priority: 2
   Responsibility: USGS, USFWS, ADFG
   Schedule: New

2. Mark WHA brant to delineate the breeding range, determine migration chronology, mortality rates, and any additional wintering areas.

   Priority: 2
   Responsibility: CWS, WDFW
   Schedule: New

3. Determine if predator control is an effective tool to influence brant abundance at the colony level.

   Priority: 2
   Responsibility: ADFG, UAF, UFWS
   Schedule: New

4. Assess effects of winter and spring forage quantity and quality on reproductive performance and population dynamics

   Priority: 3
   Responsibility: USGS, USFWS, CWS
   Schedule: New

5. Assess the potential for contaminants or other factors to adversely affect eelgrass health, distribution or abundance.

   Priority: 3
   Responsibility: USGS
   Schedule: New

6. Further evaluate genetic distinctiveness of WHA brant in relation to other brant stocks.

   Priority: 3
   Responsibility: WDFW, USGS, USFWS,
   Schedule: Ongoing

ANNUAL REVIEW

The Pacific brant Subcommittee shall meet annually, or as needed, to review progress towards achieving the goal and objectives of this plan, and to recommend actions and revisions. The Subcommittee shall report to the Pacific Flyway Council through the Pacific Flyway Study Committee on accomplishments and shortcomings of the cooperative management efforts. The Subcommittee shall be composed of representatives from the Canadian Wildlife Service, U.S. Fish and Wildlife Service, and state and provincial agencies responsible for management of the Pacific brant population, including the Alaska Department of Fish and Game, the California Department of Fish and Wildlife, the Oregon Department of Fish and Wildlife, the Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service Region 7, and the U.S. Fish and Wildlife Service Region 1. It is the responsibility of those subcommittee members to assure that the objectives and procedures of this plan are integrated and coordinated with those plans and activities of the various wildlife and land management agencies and local planning systems within their agency's purview.

Chairmanship will be appointed biennially and rotated among member agencies (except for Canadian agencies). The Subcommittee will exercise its prerogative to invite to attend and participate as an ex officio member at meetings any individual, group, agency, or representative whose expertise, counsel, or managerial capacity is required for the coordination and implementation of management programs

Schedule for rotation of the chair, beginning January 1:

2018 – California
2020 – Alaska
2022 – Washington
2024 – USFWS R-7
2026 – Oregon

LITERATURE CITED

Alexander, S. A., T. W. Barry, D. L. Dickson, H. D. Prus, and K. E. Smyth. 1988. Key areas for birds in coastal regions of the Canadian Beaufort Sea. Canadian Wildlife Service, Western and Northern Region, Edmonton, Alberta. 146pp.

Baldwin, J. R. and J. R. Lovvorn. 1994. Habitats and tidal accessibility of the marine foods of dabbling ducks and brant in Boundary Bay, British Columbia. Marine Biology120:627–638.

Bollinger, K. S., and D. V. Derksen. 1996. Demographic characteristics of molting black brant near Teshekpuk Lake, Alaska. Journal of Field Ornithology 67:141–158.

Boyd, H., and L. S. Maltby. 1979. The brant of the western Queen Elizabeth Islands, N.W.T. Pages 5–21 *in* R. L. Jarvis and J. C. Bartonek, editors. Management and Biology of Pacific Flyway Geese. Oregon State University Book Stores, Inc., Corvallis.

Boyd, W. S., D. H. Ward, D. K. Kraege, and A. A. Gerick. 2013. Migration patterns of western high Arctic (grey-belly) brant *Branta bernicla*. Wildfowl, Special Issue 3:3–25.

British Columbia Marine Conservation Analysis Project Team. 2011. Marine Atlas of Pacific Canada: A Product of the British Columbia Marine Conservation Analysis. Available from www.bcmca.ca.

Byrd, G. V. 1981. Distribution, density, and production of black brant on the Yukon Delta NWR, 1981. Unpublished refuge report, 8 July 1981. 20pp.

California Department of Fish and Wildlife. 2016. Unpublished data. GIS data available at: https://catalog.data.gov/dataset/eelgrass-tomales-bay-cdfw-ds890

Christiaen, B., Ferrier, L., Dowty, P., Gaeckle, J., and Berry. H. 2017. Puget Sound seagrass monitoring report: Monitoring year 2015. Nearshore Habitat Program. Washington State Department of Natural Resources, Olympia, WA. 55pp. Available at: http://file.dnr.wa.gov/publications/aqr_nrsh_psseagrass_report_2017_2015.pdf. Accessed 7/17/2017.

Cotter, R. C., D. G. Kay, and J. E. Hines. 1993. Population survey of Pacific brant on Banks Island, Northwest Territories, in 1992. Unpublished report. Canadian Wildlife Service, Yellowknife, NWT. 75pp.

Cotter, R. C., M. Kornder, and J. E. Hines. 1994. Population survey of Pacific brant and other waterfowl on Banks Island, Northwest Territories, in 1993. Unpublished report. Canadian Wildlife Service, Yellowknife, NWT. 35pp.

Cotter, R. C. and J. E. Hines. 2001. Breeding biology of brant on Banks Island, Northwest Territories, Canada. Arctic 54:357–366.

Dau, C. P. 1992. Fall migration of Pacific brant in relation to climatic conditions. Wildfowl 43:80–95.

Dau, C. P., J. G. King, and C. J. Lensink. 2011. Effects of storm surge erosion on waterfowl habitats of the Kashunuk River, Yukon-Kuskokwim Delta, Alaska. Unpublished report. U.S. Fish and Wildlife Service, MBM, Anchorage, AK. 20 pp.

Day, R. T. 1998. Predator population and predation intensity on tundra nesting birds in relation to human development. Unpublished report, Alaska Biological Resources, Inc., Fairbanks, AK. 106pp.

Dementiev, G. P. and N. A. Gladkov, editors. 1951–1954. Birds of the USSR. Vol. 4. 683 pp. (in Russian).

Derksen, D. V., K. S. Bollinger, M. R. North, D. H. Ward, M. W. Weller, K. C. Jensen, and E. J. Taylor. 1988. Effects of aircraft on the behavior and ecology of molting brant near Teshekpuk Lake, Alaska. Dementiev. U.S. Fish and Wildlife Service, Anchorage, AK. 80pp.

Derksen. D. V. and D. H. Ward. 1993. Life history and habitat needs of the black brant. Fish and Wildlife Leaflet 13.1.15. U.S. Fish and Wildlife Service Waterfowl Management Handbook. 6pp.

Derksen, D. V., Weller, M. W. and Eldridge, W. D. 1979. Distributional ecology of geese molting near Teshekpuk Lake, National Petroleum Reserve-Alaska. Pp. 189–207 in Jarvis, R. L. and Bartonek, J. C., editors. Management and biology of Pacific Flyway Geese. Oregon State University Book Stores, Inc, Corvallis.

Eldridge, W. D. and G. L. Kramer. 1985. Sport harvest of brant in Mexico in the 1984/85 hunting season. Unpublished report. U. S. Fish and Wildlife Service, Anchorage, AK. 22pp.

Federal Register. 2013. Notice of Availability of Record of Decision for the National Petroleum Reserve-Alaska Final Integrated Activity Plan. Volume 78, Number 38.

Flint, P. L., E. Mallek, R. J. King, J. A. Schmutz, K. S. Bollinger, and D. V. Derksen. 2008. Changes in abundance and spatial distribution of geese molting near Teshekpuk Lake, Alaska: Interspecific competition or ecological change? Polar Biology 31:549–556. DOI 10.1007/s00300-007-0386-8.

Fondell, T. F., P. L. Flint, J. A. Schmutz, J. L. Schamber, C. A. Nicolai. 2013. Variation in body mass dynamics among sites in black brant *Branta bernicla nigricans* supports adaptivity of mass loss during moult. Ibis 155:593–604. 10.1111/ibi.12056.

Fox, A. D. and Leafloor, J. O. 2017. A global audit of the status and trends of Arctic and Northern Hemisphere goose populations. CAFF Monitoring Report No. XX. CAFF International Secretariat, Akureyri, Iceland.

Gollop, M. A., J. E. Black, B. E. Felske, and R. A. Davis. 1974. Disturbance studies of breeding black brant, common eiders, glaucous gulls, and Arctic terns at Nunaluk Spit and Philips Bay, Yukon Territory, July, 1972. Pages 153–203 *in* W. W. H. Gunn, and J. A. Livingston, editors. Disturbance to birds by gas compressor noise simulators, aircraft and human activity in the Mackenzie Valley and the North Slope, 1972. Arctic Gas Biol. Series Vol. 14. 305pp.

Harvey, H. T. 2016. Final Environmental Impact Report for the Humboldt Bay Mariculture Pre-Permitting Project. Submitted to Humboldt Bay Harbor, Recreation and Conservation District 601 Startare Drive Eureka, CA 95501. Available at: http://www.pacshell.org/pdf/HBMariFinalEIR.pdf

Henry, W. G. 1980. Populations and behavior of black brant at Humboldt Bay, California. M.S. Thesis. Humboldt State University, Arcata, CA. 111pp.

Hodges, J. I. and Eldridge, W. D. 2001. Aerial surveys of eiders and other waterbirds on the eastern Arctic coast of Russia. Wildfowl 52:127–42.

Hogrefe, K., Ward, D., Donnelly, T., and Fairchild, L. 2011. Eelgrass and seaweed assessments at Yukon Delta NWR, Summer 2010. Unpublished report, U.S. Geological Survey-Alaska Science Center, Anchorage, AK. 17pp.

Hogrefe, K. R., D.H. Ward, T. F. Donnelly and N. Dau. 2014. Establishing a baseline for regional scale monitoring of eelgrass (Zostera marina) habitat on the lower Alaska peninsula. Remote Sensing 6:12447–12477.

Hupp, J. W., Ward, D. H., Hogrefe, K. R., Sedinger, J. S., Martin, P. D., Stickney, A. A. and Obritschkewitsch, T. 2017. Growth of black brant and lesser snow goose goslings in northern Alaska. Journal of Wildlife Management 81:846–857. doi:10.1002/jwmg.21246

Johnson, S. R. 1993. An important early-autumn staging area for Pacific Flyway brant: Kasegaluk Lagoon, Chukchi Sea, Alaska. Journal of Field Ornithology 64:539–548.

Kramer, G. W. 1976. Winter ecology of black brant at San Quintin Bay, Baja California, Mexico. M.S. thesis. Humboldt State University, Arcata, CA. 78pp.

Kramer, G. W. 1988. Mexican brant harvest survey, November 1987–March 1988. Memorandum to Pacific Flyway Study Committee, Subcommittee on brant. U. S. Fish and Wildlife Service, Calipatria, CA. 5pp.

Kramer, G. W., L. R. Rauen, and S. W. Harris. 1979. Populations, hunting mortality and habitat use of black brant at San Quintin Bay, Baja California, Mexico. Pages 242–254 *in* R. L. Jarvis and J. C. Bartonek, editors. Management and biology of Pacific Flyway geese: a symposium. Oregon State University Book Stores, Inc., Corvallis.

Lane, S. J. and Y. Miyabayashi. 1997. Status and distribution of Pacific brant geese *Branta bernicla nigricans* wintering in Japan. Wildfowl 48:108–117.

Larned, W., R. Stehn, and R. Platte. 2011. Waterfowl Breeding Population Survey Arctic Coastal Plain, Alaska 2010. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 54pp.

Leach, A. G., D. H. Ward, J. G. Sedinger, M. S. Lindberg, W. S. Boyd, J. W. Hupp, and R. J. Ritchie. 2017. Declining survival of black brant from subarctic and arctic breeding areas. Journal of Wildlife Management 81:1210–1218; DOI:10.1002/jwmg.21284

Lehnhausen, W. A., and S. E. Quinlan. 1982. Bird migration and habitat use at Icy Cape, Alaska–1981. U.S. Fish Wildlife Service, Anchorage, Alaska.

Lewis, T. L., D. H. Ward, J. S. Sedinger, A. Reed and D. V. Derksen. 2013. Brant (*Branta bernicla*), The Birds of North America Online (A. Poole, editor). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/337doi:10.2173/bna.337

Mallek, E. J. 2010. Teshekpuk lake area molting goose survey 2010. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 14pp.

McKnight, S. K., and E. J. Taylor. 1989. The effects of aircraft disturbance on the bioenergetics of molting Pacific black brant in Arctic Alaska. Unpublished report, Texas A&M University, College Station. 26pp.

Merkel & Associates. 2013. Mission Bay Park 2013 bathymetry and eelgrass inventory. Prepared for: City of San Diego Public Works, San Diego, California. 34pp. Available at: http://www.westcoast.fisheries.noaa.gov/publications/gis_maps/maps/eelgrass/mission-bay-survey-report-2013.pdf.

Merkel & Associates. 2014. San Diego Bay 2014 eelgrass inventory. Prepared for: U.S. Navy and San Diego Unified Port District, San Diego, California. 9pp. Available at: http://www.westcoast.fisheries.noaa.gov/publications/gis_maps/maps/eelgrass/2014-eelgrass-survey-report.pdf.

Merkel & Associates. 2015a. 2015 Monitoring Report, Morro Bay Eelgrass Recovery Program. Prepared for the Morro Bay National Estuary Program. San Diego, California.

Merkel & Associates. 2015b. San Francisco Bay eelgrass inventory 2014. Prepared for: National. Marine Fisheries Service, Santa Rosa, California. 99pp. Available at: http://www.westcoast.fisheries.noaa.gov/publications/gis_maps/maps/eelgrass/2014-baywide-inventory-report.pdf.

Morales-Ramirez, M. C., M. A. Huerta-Diaz, D. H. Ward, and A. Caballo-Pasini. 2001. Heavy metals in sediments and seagrasses from coastal lagoons in Baja California and Alaska. Abstract. 16th Biennial Conference of the Estuarine Research Federation, St. Pete Beach, Florida.

Moore, J. and J. M. Black. 2006. Slave to the tides: spatio- temporal foraging dynamics of spring staging black brant. Condor 108:661–677.

Moore, J., Colwell, M., Mathis, R. and J. Black. 2004. Staging of Pacific flyway brant in relation to eelgrass abundance and site isolation, with special consideration of Humboldt Bay, California. Biological Conservation. 115(3):475–486.

Morro Bay National Estuary Program. 2013. Morro Bay Eelgrass Report 2013. Report. 48pp. Available at: http://www.westcoast.fisheries.noaa.gov/publications/gis_maps/maps/eelgrass/2013-eelgrass-monitoring-report.pdf.

Muniz-Salazar R., S. Talbot, G. K. Sage, D. H. Ward, and A. Cabello-Pasini. 2006. Genetic structure of Eelgrass (*Zostera marina*) meadows in an embayment with restricted water flow. Marine Ecology Progress Series 309:107–116.

Naves, L. C. 2015. Alaska subsistence bird harvest, 2004–2014 data book, Alaska Migratory Bird Co-Management Council. Alaska Department of Fish and Game Division of Subsistence, Special Publication No. 2015-05, Anchorage.

Olson, S. M. Compiler. 2016. Draft Pacific Flyway Data Book, 2017. U.S. Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Vancouver, Washington.

Otis, D. T., L. George, and P. Doherty. 2016. Comparison of alternative designs for the Alaska migratory bird subsistence harvest survey. Unpublished report, Colorado State University, Fort Collins, CO. 32pp.

Palacios, E., and S. A. Farfan. 2013. Pacific brant midwinter ground survey in Mexico: January 2013. Unpublished report to Sonoran Joint Venture, La Paz, Baja California Sur. 3pp.

Palacios, E., and C. G. Avila. 2017. Pacific brant mid-winter ground surveys in Mexico (2017). Unpublished report to the U.S. Fish and wildlife Service. La Paz, Baja California Sur. 14pp.

Parmallee, D. F., H. A. Stephens, and R. H. Schmidt. 1967. The birds of southeastern Victoria Island and adjacent small islands. National Museum of Canada bulletin. no. 222.

Portenko, L. A. 1981. Birds of the Chukchi Peninsula and Wrangel Island. Vol.1. Amerind Publishing Company. PVT, New Delhi, India. 446 pp. (translated from Russian)

Reed, A. V., M. A. Davison, and D. K. Kraege. 1989a. Segregation of brant geese *Branta bernicla* wintering and staging in Puget Sound and the Strait of Georgia. Wildfowl 40:22–31.

Reed, A., R. Stehn, and D. Ward. 1989b. Autumn use of Izembek Lagoon, Alaska by brant from different breeding areas. Journal of Wildlife Management 53:720–725.

Ritchie, R. J., and A. M. Wildman. 2000. Aerial surveys for nesting brant and snow geese, Kasegaluk Lagoon to Fish Creek delta, Alaska, 1999. Report for North Slope Borough, Department of Wildlife Management, Barrow, AK, by ABR, Inc., Fairbanks, AK. 18pp.

Riosmena-Rodriguez, R. 2009. Seagrass beds in Laguna San Ignacio and adjacent areas: an assessment of critical habitats and protected species conservation. Unpublished report.

Roser, J. 2017. Brant counts in Morro Bay, California. Unpublished report, Los Osos, CA. 3pp.

Saalfeld, S. T., Fischer, J. B., Stehn,, R. A., Platte, R. M. and Brown, S. C. 2017. Predicting waterbird nest distributions on the Yukon-Kuskokwim Delta of Alaska. Journal of Wildlife Management 81:1468–1481. Doi:10.1002/jwmg.21322.

Sanctuary Advisory Council Gulf of the Farallones National Marine Sanctuary. 2008. Bolinas Lagoon ecosystem restoration project: Recommendations for restoration and management. San Francisco, California. 102pp. Available at: https://www.nps.gov/goga/learn/management/upload/-1789-Bolinas-Lagoon-Restoration_Jan10.pdf.

Schafer, D. J., S. W. Echeverria, and T. D. Sherman. 2008. The potential role of climate in the distribution and zonation of the introduced seagrass *Zostera japonica* in North America. Aquatic Botany 89:297–302.

Schamber, J. L., J. S. Sedinger, and D. H. Ward. 2012. Carry-over effects of winter location contribute to variation in timing of nest initiation and clutch size in black brant (*Branta bernicla nigricans*). Auk 129:205–210.

Schmidt, P. 1999. Population counts, time budgets, and disturbance factors of black brant (*Branta bernicla nigricans*) at Humboldt Bay, California. Master's thesis. Humboldt State University. 58pp.

Schlosser, S., and A. Eicher. 2012. The Humboldt Bay and Eel River Estuary benthic habitat project. California Sea Grant Publication T-075. 246 pp. Available at: http://www.westcoast.fisheries.noaa.gov/publications/gis_maps/maps/eelgrass/humboldt-habitats.pdf.

Shults, B. S., and C. P. Dau. 2016. Abundance and distribution of molting geese in the Teshekpuk Lake area, July 2015. Unpublished report, U. S. Fish and Wildlife Service, Anchorage, Alaska. 14pp.

Sedinger, J. S. and A. A. Stickney. 2000. Black brant. Pages 221–232 *in* Truett, J. C. and S. R. Johnson, editors. The natural history of an arctic oilfield, development and the biota. Academic Press, San Diego, CA. 422pp.

Sedinger, J. S., J. L. Schamber, D. H. Ward, C. A. Nicolai, and B. Conant. 2011. Carryover effects associated with winter location affect fitness, social status, and population dynamics in a long-distance migrant. The American Naturalist 178:E110–E123.

Shuford, W. and T. Gardali, editors. 2008. California Bird Speies of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Simpson, S. G., M. E. Hogan, and D. V. Derksen. 1980. Behavior and disturbance of molting Pacific black brant in arctic Alaska. Unpublished report, U. S. Fish and Wildlife Service, Anchorage, AK. 27pp.

Smith, L. M., L. D. Vangilder, and R. A. Kennamer. 1985. Foods of wintering brant in eastern North America. Journal of Field Ornithology 56:286–289.

Stehn, R. A., E. J. Mallek, and E. J. Taylor. 2010. Monitoring Pacific brant: A comparison of fall and mid-winter population surveys. Unpublished report to the Pacific Flyway Study Committee. 17pp.

Stehn, R. A., W. W. Larned, and R. M. Platte. 2013. Analysis of aerial survey indices monitoring waterbird populations of the Arctic Coastal Plain, Alaska, 1986–2012. Unpublished report, U. S. Fish and Wildlife Service, Anchorage, AK. 56pp.

Stillman, R. A., K. A. Wood, W. Gilkerson, E. Elkinton, J. M. Black, D.H. Ward, and M. Petrie. 2015. Predicting effects of environmental change on a migratory herbivore. Ecosphere online publication.

Stishov, M. S., V. I. Pridatko, and V. V. Baranyuk. 1991. The birds of Wrangel Island. Russian Academy of Science, Novosibirisk. 256pp.

Svejkobsky, J. 2013. High-resolution nearshore substrate mapping and persistence analysis with multi-spectral aerial imaging – Final report. Ocean Imaging Corp, Solana Beach, California.

Syroechkovski, E. E., C. Zockler, and E. Lappo. 1998. Status of brent goose in northwest Yakutia, East Siberia. British Birds 91:565–572.

Tape, K. D., Pearce, J. M., Walworth, D., Meixell, B. W., Fondell, T. F., Gustine, D. D., Flint, P. L., Hupp, J. W., Schmutz, J. A., and Ward, D. H. 2014. Historical and contemporary imagery to assess ecosystem change on the Arctic coastal plain of northern Alaska: U.S. Geological Survey Open-File Report 2014-1140. 22pp. Available at http://dx.doi.org/10.3133/ofr20141140.

Terenzi, J., M. T. Jorgensen, and C. R. Ely. 2014. Storm surge flooding on the Yukon-Kuskokwim Delta, Alaska. Arctic 67(3): 360–374.

U. S. Department of the Interior, Fish and Wildlife Service. 1997. King Cove Road Briefing Report, Izembek NWR, Cold Bay, AK. 18pp.

U.S. National Parks Service. 2005. Unpublished data. GIS layer available at: http://www.westcoast.fisheries.noaa.gov/maps_data/eelgrass_data.html.

Uspenski, S. M. 1959. The brent goose in the Soviet Union. Wildfowl 11:80–93.

Uspenski, S. M. 1965. The geese of Wrangel Island. Wildfowl 16:126–129.

Ward, D. H., K. Moore, and R. Kistritz. 1992. Wetlands of the Fraser lowland, 1989: an inventory *in* Tech. Rept. No. 146, Canadian Wildlife Service, Pacific and Yukon regions.

Ward, D. H., T. L. Tibbitts, J. D. Mason, K. S. Bollinger, J. S. Pratt, J. M. Pearce, N. Chelgren, L. Lipinski, C. Solek, D. V. Derksen, M. Martinez, F. Heredia, and A. Gerardo. 1993b. Migration patterns and distribution of brant subpopulations in Mexico. Unpublished report, U. S. Fish and Wildlife Service Anchorage, AK. 32pp.

Ward, D. H., T. L. Tibbitts, and E. Carrera-Gonzales. 1999. Effectos del evento del Niño (1997-1998) en la branta negra invernante en México. Abstract. 6th Neotropical Ornithological Congress, Monterrey, Mexico.

Ward, D., Morton, A., Tibbitts, T., Douglas, D., Carrera-Gonzalez, E. 2003. Long-term change in eelgrass distribution at Bahia San Quintin, Baja California, Mexico using satellite imagery. *Estuaries* 26:1529–1539.

Ward, D. H., Reed, A., Sedinger, J. S., Black, J. M., Derksen, D. V., and Castelli, P. M. 2005a. Effects of anthropogenic and climate events on habitats and population dynamics of nearctic brant. Global Change Biology 11:869–880.

Ward, D. H., T.L. Tibbitts, J. S. Sedinger, S. Boyd, and J. Hines. Population Structure and Migration Chronology of Wintering Black Brant. 2005b. 11th North American Arctic Goose Conference and Workshop Reno, Nevada.

Ward, D. H., K. Hogrefe, M. Swaim, and T. Donnelly. 2015. Distribution of Eelgrass in Coastal Waters Adjacent to Togiak National Wildlife Refuge. 2014 Final Report to the Togiak National Wildlife Refuge.

Wentworth, C., and D. Wong. 2001. Subsistence Waterfowl Harvest Survey, Yukon-Kuskokwim Delta, 1995–1999. U.S. Fish and Widllife Service and Yukon Delta National Wildlife Refuge, Anchorage, Alaska.

Wiebe, M. O. and J. E. Hines. 1998. Progress report: status of Pacific brant on the mainland of the Inuvialuit Settlement Region, 1998. Unpublished report, Canadian Wildlife Service, Yellowknife, NWT. 21pp.

Wilson, H. M. and D. K. Marks. 2017. Aerial survey of emperor geese and other waterbirds in southwestern Alaska, spring 2016. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 12pp.

Wilson, H. M. 2014. Aerial photographic survey of brant colonies on the Yukon-Kuskokwim Delta, Alaska, 2013. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 10pp.

Wilson, H. M. 2016. Aerial photographic survey of brant colonies on the Yukon-Kuskokwim Delta, Alaska, 2015. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK. 11pp.

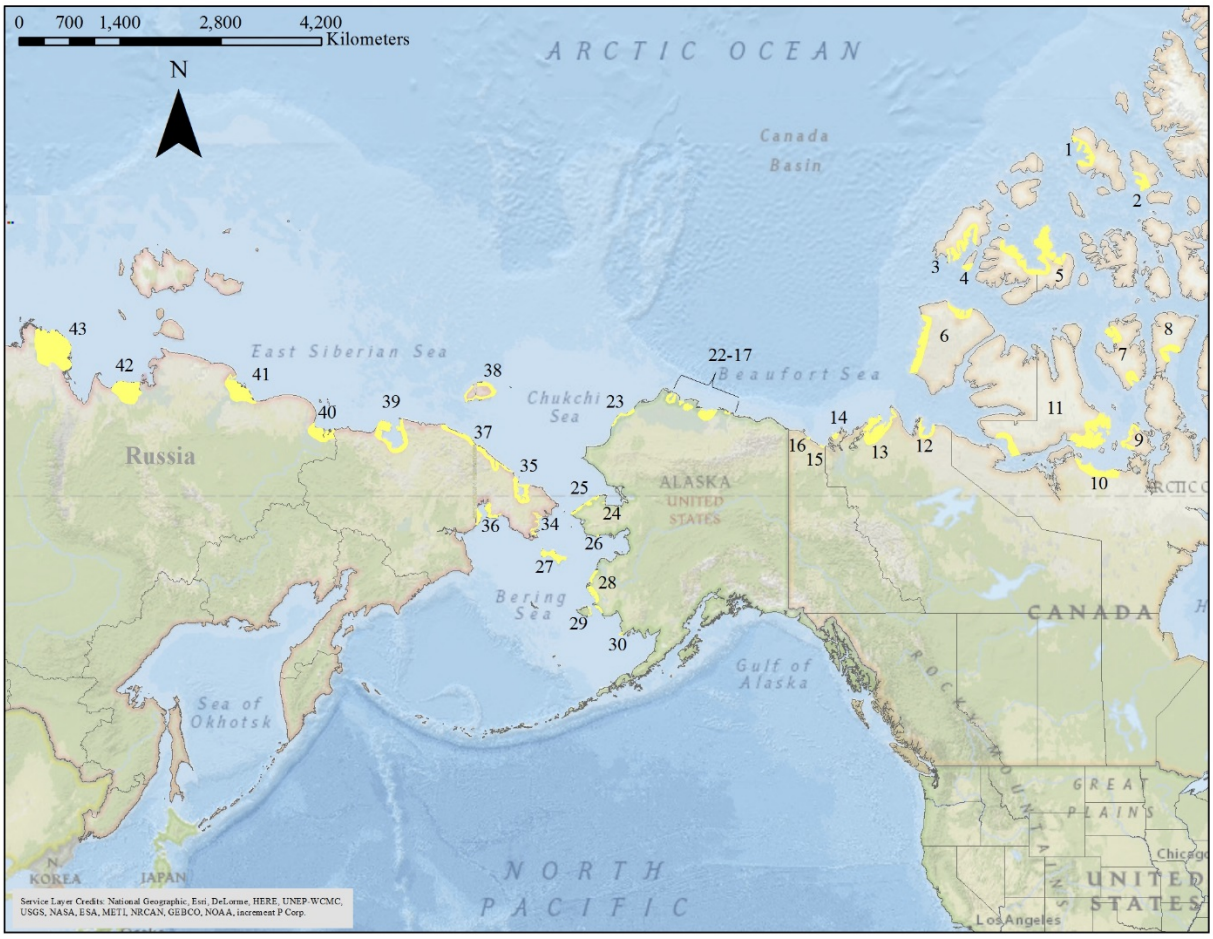
Wilson, U. W. and J. B. Atkinson. 1995. Black brant winter and spring-staging use at two Washington coastal areas in relation to eelgrass abundance. Condor 97:91–98.

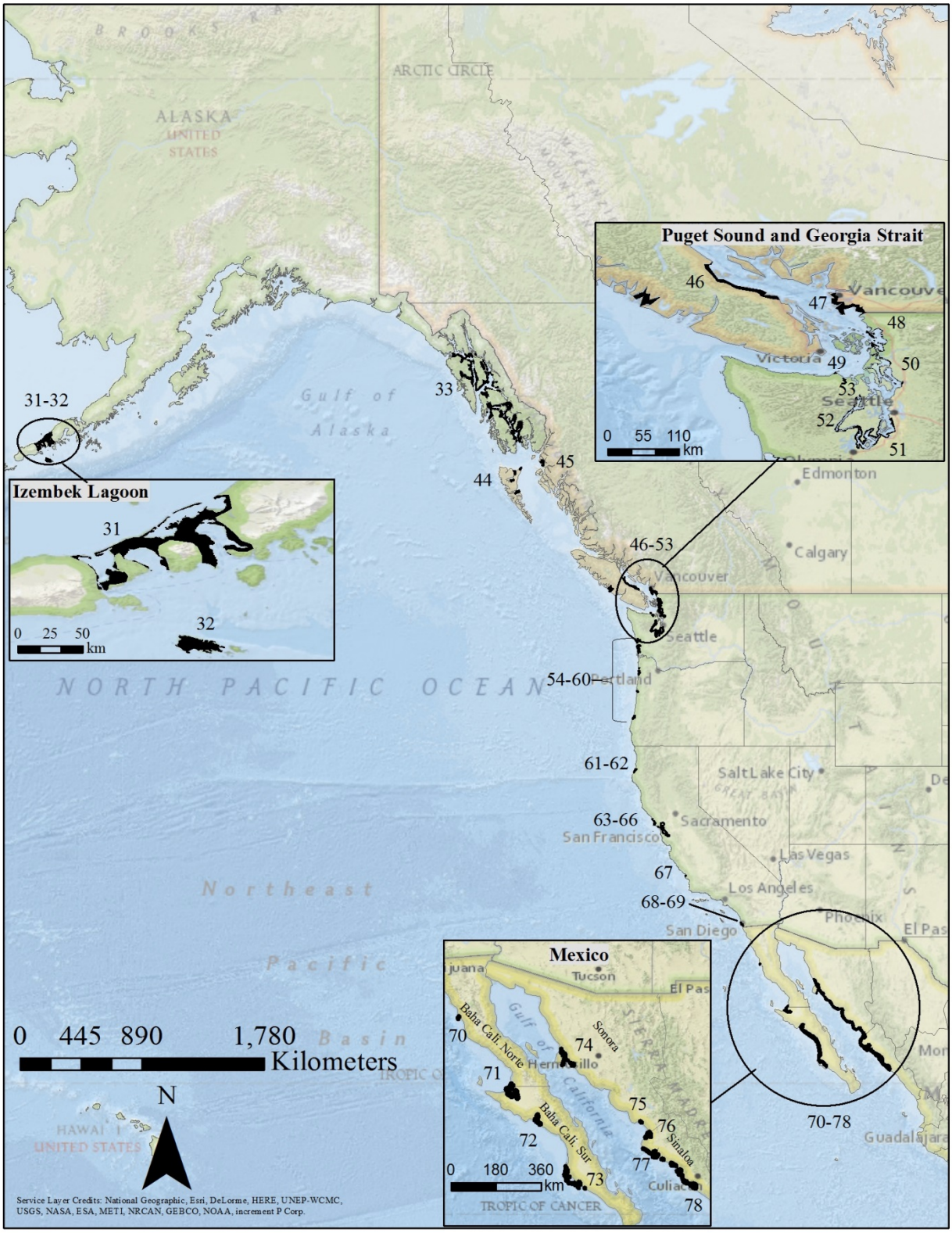
Wilson, H. M. and C. P. Dau. 2015. Aerial survey of wintering Pacific brant and other species at the Izembek NWR Complex and Sanak Islands, Alaska. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK.

Personal Communications

Bromley, Robert, Whole Arctic Consulting, Yellowknife, N.W.T.
Harper, John, Coastal and Ocean Resources, Inc. Vancouver, B.C.
Hines, Jim, Canadian Wildlife Service, Yellowknife, N.W.T.
Reishus, Brandon, Oregon Department of Fish and Wildlife, Salem, OR.
Ward, David, U. S. Geological Survey, Alaska Science Center, Anchorage, AK.

Appendix A. Pacific brant use areas (data accompanying map).




Puget Sound and Georgia Strait
Izembek Lagoon
Mexico
0 445 890 1,780
Kilometers
N
0 55 110 km
0 25 50 km
0 180 360 km
31-32
33
44
45
46-53
54-60
61-62
63-66
67
68-69
70-78
46
47
48
49
50
51
52
53
31
32
70
71
72
73
74
75
76
77
78
Gulf of Alaska
NORTH PACIFIC OCEAN
Northeast Pacific Basin
ALASKA
UNITED STATES
ARCTIC CIRCLE
HAWAII
UNITED STATES
TROPIC OF CANCER
Edmonton
Calgary
Vancouver
Seattle
Portland
Salt Lake City
Sacramento
San Francisco
Las Vegas
Los Angeles
San Diego
Phoenix
El Paso
Tucson
Guadalajara
Victoria
Baja Calif. Norte
Sonora
Baja Calif. Sur
Sinaloa
Culiacán
Service Layer Credits: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Map No.	Country, State/Province	Use Type	Eel grass ha
	Canada, Nunavut/Northwest Territories		
1	Ellef Ringnes Island	Nesting/Molting	NA
2	Amund Ringnes Island	Nesting/Molting	NA
3	Prince Patrick Island[1, 2]	Nesting/Molting	NA
4	Melville Island[1, 2]	Nesting/Molting	NA
5	Eglinton Island[1, 2]	Nesting/Molting	NA
6	Banks Island	Nesting/Molting	NA
7	Prince of Wales Island	Nesting/Molting	NA
8	Somerset Island	Nesting/Molting	NA
9	King William Island	Nesting/Molting	NA
10	Queen Maud Gulf	Nesting/Molting	NA
11	Victoria Island	Nesting/Molting	NA
12	Franklin - Darnley bays	Nesting/Molting	NA
13	Liverpool Bay - Eskimo Lakes	Nesting/Molting	NA
14	Kendall Island Bird Sanctuary	Nesting/Molting	NA
15	Shoalwater Bay	Nesting/Molting	NA
	Canada, Yukon		
16	Phillips Bay	Nesting/Molting	NA
	United States, Alaska		
17	Prudhoe Bay	Nesting	NA
18	Simpson Lagoon	Nesting	NA
19	Colville River Delta and Harrison Bay	Nesting	NA
20	Teshekpuk Lake	Nesting/Molting	NA
21	Smith Bay	Nesting	NA
22	Dease Inlet – Admiralty Bay	Nesting	NA
23	Kasegaluk Lagoon – Icy Cape	Nesting/Migration	NA
24	Nugnugaluktuk River Delta	Nesting	NA
25	Cowpack, Arctic, Shishmaref, Ikpek, Lopp lagoons	Nesting/Migration	NA
26	Safety Sound[*]	Migration	
27	St. Lawrence Island	Migration	
28	Yukon-Kuskokwim Delta[2,3]	Nesting/Molting/ Migration	4,722
29	Nunivak Island - Duchikthluk Bay	Nesting/Migration	
30	Goodnews, Chagvan, Nanvak and Togiak Bays[2]	Migration	3,787
31	Izembek Lagoon[4], Cold, Bechevin and Morzhovoi Bays	Winter/Migration	16,816
32	Sanak Island	Winter	

Map No.	Country, State/Province	Use Type	Eel grass ha
33	Southeast Alaska	Winter	
	Russia, Chukotka		
34	Mechigmenskiy Bay to Strait of Senyavina	Nesting/Molting	
35	Kolyuchin Bay	Nesting/Molting	
36	Gulf of Anadyr - Kresta Bay	Nesting/Molting	
37	Cape Schmidt	Nesting/Molting	
38	Wrangel Island	Nesting/Molting	
39	Chaunskaya Bay	Nesting/Molting	
40	Kolyma River Delta	Nesting/Molting	
41	Indigirka River Delta	Nesting/Molting	
42	Yana River Delta	Nesting/Molting	
43	Lena River Delta	Nesting/Molting	
	Canada, British Columbia		
44	Haida Gwaii[5]	Winter/Migration	505
45	Chatham Sound	Winter/Migration	
46	Coast of Vancouver Island[5]	Winter/Migration	625
47	Fraser River Delta[5]	Winter/Migration	5,514
	United, States, Washington		
48	Northern Puget Sound[6]	Winter/Migration	8,100
49	Strait of Juan De Fuca[6]	Winter/Migration	4,900
50	Saratoga Whidbey Basin[6]	Winter/Migration	3,800
51	Central Puget Sound[6]	Winter/Migration	3,100
52	Hood Canal[6]	Winter/Migration	1,300
53	Dungeness and Sequium bays	Winter/Migration	
54	Grays Harbor	Winter/Migration	
55	Willapa Bay	Winter/Migration	
	United States, Oregon		
56	Nehalem Bay	Migration	
57	Tillamook Bay	Winter/Migration	
58	Netarts Bay	Winter/Migration	
59	Yaquina Bay	Winter/Migration	
60	Coos Bay	Migration	
	United States, California		
61	North Humboldt Bay[7]	Winter/Migration	3,700
62	South Humboldt Bay[7]	Winter/Migration	1,990
63	Bodega Bay[8]	Winter	128
64	Tomales Bay[9]	Winter	1,289
65	Bolinas Lagoon[10]	Winter	0

Map No.	Country, State/Province	Use Type	Eel grass ha
67	Morro Bay[12]	Winter/Migration	10
68	Mission Bay[13,14]	Winter/Migration	885
69	San Diego Bay	Winter/Migration	1,956
	Mexico, Baja California Norte		
70	Bahia San Quintin	Winter	2,069
	Mexico, Baja California Sur		
71	Laguna Scammon	Winter	
72	Laguna San Ignacio	Winter	
73	Bahia Magdalena	Winter	
	Mexico, Sonora		
74	Canal del Infiernillo, Bahia Kino	Winter	
	Mexico, Sinaloa		
75	Estero Yavaros	Winter	
76	Estero de Agiabampo	Winter	
77	Bahia de Navachiste/Bahia de Topolobampo	Winter	
78	Bahia Santa Maria/ Bahia Altata	Winter	

[1] Ward et al. 2015
[2] Hogrefe et al. 2011
[3] Hogrefe et al. 2014
[4] British Columbia Marine Conservation Analysis
[5] Christiaen et al. 2017
[6] Schlosser and Eicher 2012
[7] Svejkobsky 2013
[8] California Department of Fish and Wildlife
[9] Sanctuary Advisory Council Gulf of the Farallones National Marine Sanctuary
[10] U.S. National Parks Service 2005
[11] Merkel & Associates 2015
[12] Morro Bay National Estuary Program 2013
[13] Merkel & Associates 2014
[14] Merkel & Associates 2013
[15] Ward et al. 2003

Appendix B. Pacific brant population indices from the mid-winter waterfowl survey, 1936–current.

	U.S. and Canada						Mexico[b]			MWS Index[c,f]		Izembek Index[d]	
Year	AK	BC[a]	WA	OR	CA	Subtotal	Baja	Mainland	Subtotal	Annual	3-yr Avg	Annual	% Juv
1936			8,202	3,085	19,910	31,197							
1937			13,450	5,935	13,460	32,845							
1938			24,560	10,475	38,200	73,235							
1939			25,595	9,502	16,890	51,987							
1940			35,520	5,350	35,050	75,920							
1941			24,100	5,000	31,785	60,885							
1942			53,950	6,850	28,983	89,783							
1943			37,000	575	18,000	55,575							
1944			33,950	7,250	20,250	61,450							
1945			32,650	3,000	30,100	65,750							
1946			25,462	55	60,452	85,969							
1947			20,250	8,200	39,640	68,090	no survey	0	partial survey				
1948			20,660	2,850	32,750	56,260	no survey	0	partial survey				
1949			20,650	803	66,515	87,968	no survey	no survey	no survey				
1950			15,574	3,600	57,792	76,966	no survey	no survey	no survey				
1951			21,639	2,110	48,131	71,880	93,200	0	partial survey				
1952			16,578	3,200	43,840	63,618	102,945	0	partial survey				
1953			27,473	1,509	37,557	66,539	87,905	0	partial survey				
1954			15,376	1,560	28,750	45,686	86,316	0	partial survey				
1955			21,915	1,686	34,070	57,671	76,679	0	partial survey				
1956			15,914	2,073	38,510	56,497	52,743	0	partial survey				
1957			20,701	1,493	35,848	58,042	73,380	0	partial survey				
1958			25,219	2,778	26,560	54,557	71,305	4	partial survey				
1959			10,815	1,121	10,750	22,686	71,305	1,400	partial survey				
1960			17,614	652	3,771	22,037	113,087	1,115	114,202	136,239			
1961			16,675	1,330	6,853	24,858	138,625	4,355	142,980	167,838			
1962			25,815	2,266	23,510	51,591	116,245	2,400	118,645	170,236	158,104		
1963			20,400	2,639	2,388	25,427	101,575	13,240	114,815	140,242	159,439		
1964			34,169	2,000	8,353	44,522	117,470	23,290	140,760	185,282	165,253		24.0
1965			19,938	1,325	3,372	24,635	117,350	24,915	142,265	166,900	164,141		27.7
1966			22,175	798	3,284	26,257	115,601	19,505	135,106	161,363	171,182		22.5
1967			21,235	1,523	3,824	26,582	111,755	41,315	153,070	179,652	169,305		45.4
1968			15,746	865	1,729	18,340	111,600	24,400	136,000	154,340	165,118		18.8
1969			10,063	382	166	10,611	97,400	35,075	132,475	143,086	159,026		18.9
1970			8,916	963	207	10,086	98,200	33,400	131,600	141,686	146,371		30.5
1971			10,915	1,374	130	12,419	105,800	31,000	136,800	149,219	144,664		40.0
1972			4,328	1,047	0	5,375	91,200	28,200	119,400	124,775	138,560		37.5
1973			5,911	2,544	950	9,405	85,500	30,100	115,600	125,005	133,000		39.8
1974			4,977	1,904	470	7,351	96,900	26,400	123,300	130,651	126,810		34.9
1975			6,163	1,507	480	8,150	80,825	34,455	115,280	123,430	126,362		5.0
1976			7,540	1,769	680	9,989	82,783	29,273	112,056	122,045	125,375		40.1
1977			14,111	2,100	0	16,211	86,534	44,222	130,756	146,967	130,814	107,784	38.9
1978			18,100	1,110	560	19,770	106,469	36,648	143,117	162,887	143,966	116,298	34.1
1979			8,078	1,255	10	9,343	87,860	32,210	120,070	129,413	146,422		16.5
1980			7,665	1,015	135	8,815	89,690	47,860	137,550	146,365	146,222	128,204	18.1
1981	3,271		10,107	1,790	540	15,708	160,560	21,200	181,760	197,468	157,749	127,667	31.6
1982			6,451	706	485	7,642	85,105	28,297	113,402	121,044	154,959	180,734	31.0
1983			3,113	718	565	4,396	81,761	23,157	104,918	109,314	142,609	146,945	14.2
1984	1,611		7,097	930	700	10,338	95,170	29,533	124,703	135,041	121,800	147,933	32.9
1985		283	11,793	641	800	13,517	101,405	30,163	131,568	145,085	129,813	120,122	18.3

	U.S. and Canada						Mexico[b]			MWS Index[c,f]		Izembek Index[d]	
Year	AK	BC[a]	WA	OR	CA	Subtotal	Baja	Mainland	Subtotal	Annual	3-yr Avg	Annual	% Juv
1986	5,338	319	12,026	1,113	706	19,502	92,525	22,200	114,725	134,227	138,118	122,673	21.4
1987	7,550	205	14,371	1,133	736	23,995	73,825	13,088	86,913	110,908	130,073	116,131	23.2
1988	6,180	263	19,831	1,104	947	28,325	99,066	17,630	116,696	145,021	130,052	136,765	47.4
1989	6,918	484	18,538	871	1,033	27,844	89,600	18,121	107,721	135,565	130,498	123,822	24.4
1990	5,303	406	13,756	1,399	992	21,856	107,545	22,320	129,865	151,721	144,102	135,041	27.4
1991	4,742	591	16,221	1,262	1,340	24,156	88,650	19,905	108,555	132,711	139,999	123,551	22.3
1992	7,043	283	13,505	1,397	2,424	24,652	78,280	14,905	93,185	117,837	134,090	128,784	29.9
1993	8,369	180	13,058	1,254	9,415	32,276	68,280	24,444	92,724	125,000	125,183	119,531	19.6
1994	12,125	382	13,595	666	2,299	29,067	83,130	17,135	100,265	129,332	124,056	143,768	28.2
1995	11,381	363	20,231	708	3,987	36,670	74,060	22,755	96,815	133,485	129,272	142,701	17.0
1996	10,278	634	6,941	644	2,008	20,505	87,280	20,205	107,485	127,990	130,269	150,946	39.7
1997	10,049	500	9,753	669	3,598	24,569	108,018	22,720	130,738	155,307	138,927	118,188	26.8
1998	8,562	619	10,881	580	6,091	26,733	97,805	14,300	112,105	138,838	140,712	130,252	20.9
1999	10,354	985	15,252	645	4,296	31,532	84,965	15,795	100,760	132,292	142,146	116,512	30.7
2000	8,120	1,238	13,859	523	3,389	27,129	92,020	16,420	108,440	135,569	135,566	131,134	23.4
2001	17,790	1,254	10,197	695	4,197	34,133	78,850	13,010	91,860	125,993	131,285	151,216	31.8
2002	13,576	1,483	13,478	552	4,092	33,181	93,995	11,055	105,050	138,231	133,264	112,554	10.0
2003	7,677	1,103	11,455	557	3,124	23,916	74,132	8,094	82,226	106,142	123,455	115,839	23.6
2004	12,756	2,117	14,544	528	6,372	36,317	71,685	13,270	84,955	121,272	121,882	135,944	13.2
2005	12,041	1,020	14,286	609	5,224	33,180	59,960	14,068	74,028	107,208	111,541	134,474	19.5
2006	15,404	1,792	16,305	649	5,069	39,219	87,483	14,254	101,737	140,956	123,145	152,712	37.0
2007	28,533	2,078	12,712	702	7,387	51,412	65,250	13,932	79,182	130,594	126,253	124,189	24.3
2008	27,422	1,264	19,775	370	4,827	53,658	83,856	19,443	103,299	156,957	142,836	140,897	27.6
2009	21,482	2,574	29,243	823	6,392	60,514		no survey[e]			143,776	130,294	18.5
2010	28,234	2,699	23,908	no survey	13,553	68,394	71,688	23,389	95,077	163,471	160,214	144,594	30.5
2011	42,937	2,414	21,457	no survey	15,610	82,418	61,153	18,897	80,050	162,468	162,970	130,091	20.7
2012	44,252	1,229	17,502	687	2,227	65,897	101,571	9,873	111,444	177,341	167,760	126,028	24.5
2013	41,821	2,204	16,454	200	7,448	68,127	71,607	23,566	95,173	163,300	167,703	154,481	14.2
2014	48,140	2,104	17,485	511	7,916	76,156	68,290	28,869	97,159	173,315	171,319	157,781	16.8
2015	50,316	1,636	10,706	486	4,906	68,050	44,533	23,899	68,432	136,482	157,699	171,635	16.6
2016	46,772	3,364	11,811	583	5,105	67,635	55,066	17,324	72,390	140,025	149,941	160,984	17.2
2017	44,899	3,677	15,878	405	8,765	73,624	67,386	14,710	82,096	155,720	144,076	203,735	19.1
Averages:													
LTA	17,768	1,190	17,030	1,862	12,648	39,203	89,329	18,954	112,880	142,234	142,458	134,851	25.8
1936-52			25,282	4,579	35,397	65,258	98,073						
1953-60			19,378	1,609	26,977	47,964	79,090						
1961-70			19,513	1,409	5,369	26,291	112,582	22,190	134,772	161,063	161,993		26.8
1971-80			8,779	1,563	342	10,683	91,356	34,037	125,393	136,076	136,220	117,429	30.5
1981-90	5,167	327	11,708	1,041	750	17,312	98,656	22,571	121,227	138,539	137,977	135,783	27.2
1991-00	9,102	578	13,330	835	3,885	27,729	86,249	18,858	105,107	132,836	134,022	130,537	25.9
2001-10	18,492	1,738	16,590	609	6,024	43,392	76,322	14,502	90,824	132,314	131,765	134,271	23.6
2011-16	45,706	2,159	15,903	493	7,202	71,381	67,037	20,405	87,441	158,822	162,898	150,167	18.3
Objective:										162,000			

[a]In British Columbia, totals for 1984-1991 are Christmas Bird Counts, and from 1992-on are from Canadian Wildlife Service counts.

[b]Aerial surveys were not flown (2009, 2011-2012, 2014-2015) in Mexico. Ground-surveys conducted have been conducted since 2011 and have replaced the aerial survey (Palacios and Farfan 2013, Palacios and Avila 2017).

[c]Includes Western High Arctic brant. 3-year average considers most recent 3 years of annual counts.

[d]Izembek index from fall before Mid-winter Waterfowl Survey, includes Western High Arctic brant, and was updated Fall 2016 after extensive review.

[e]No survey conducted due to pilot survey concerns.

[f]The historical Alaska MWS index was recalcutated in 2015, following the reccomendation by Wilson and Dau 2015.

Appendix C. Estimates of brant nests at five major colonies on the Yukon-Kuskokwim Delta from 1992–2016. Data from Wilson (2016). Standard errors (± 1 SE) are indicated in shaded boxes below estimates.

	Tutakoke	Kokechik	Kigigak Is.	Baird Inlet	Baird Pen.	TOTAL
1992	4,600 [b]	6,134 [b]	3,440 [a]	3,258 [a]	2,157 [a]	19,589
	202	295	154	347	151	
1993	4,937 [b]	7,667 [a]	1,727 [b]	4,156 [a]	614 [a]	19,101
	190	577	90	357	77	
1994	4,807 [a]	6,978 [b]	2,260 [b]	4,461 [a]	2,441 [a]	20,947
	400	196	92	454	142	
1995	5,596 [b]	7,573 [b]	[c]	4,720 [a]	2,591 [a]	23,998
	297	351		474	184	
1996						
1997 [b]	4,588	9,144	4,776	1,944	2,259	22,711
	554	1092	595	242	282	
1998 [b]	3,448	5,655	3,105	2,747	1,431	16,386
	292	471	238	264	169	
1999 [a]	4,100	4,072	3,962	1,777	448	14,359
	96	74	402	80	81	
2000	7,437 [b]	8,021 [b]	4,286 [a]	4,088 [b]	1,962 [a]	25,794
	584	866	647	324	142	
2001 [b]	1,212	3,677	1,721	3,604	421	10,635
	73	215	107	198	36	
2002 [b]	4,524	4,634	4,380	3,052	2,708	19,298
	314	362	255	199	147	
2003 [b]	1,622	655	2,474	3,202	547	8,500
	79	52	118	135	46	
2004 [b]	2,704	1,996	3,284	2,759	1,687	12,430
	153	116	208	160	76	
2005 [b]	2,977	3,985	4,728	4,093	[c]	17,023 [c]
	205	177	213	256		
2006 [b]	3,714 [d]	5,280	3,920	3,628	793	17,335
	286	341	240	262	61	
2007 [b]	1,842	4,521	3,924	4,106	2,241	16,634
	137 [d]	304 [d]	304 [d]	264 [d]	203 [d]	
2008 [b]	669	2,062	1,856	1,713	3,695	9,995
	68 [e]	174 [e]	158 [e]	151 [e]	341 [e]	
2009 [b]	2,197	3,958	2,398	2,499	1,154	12,206
	235 [f]	344 [f]	226 [f]	239 [f]	141 [f]	
2010 [b]	1,963	2,560	2,061	1,739	1,146	9,469
	176 [f]	208 [f]	184 [f]	142 [f]	130 [f]	
2011 [b]	2,481	3,682	2,104	3,109	580	11,956
	221 [f]	244 [f]	187 [f]	445 [f]	84 [f]	
2012 [b]	3,332	3,811	2,795	3,440	819	14,197
	256 [f]	269 [f]	258 [f]	285 [f]	125 [f]	

Cont.	Tutakoke	Kokechik	Kigigak Is.	Baird Inlet	Baird Pen.	TOTAL
2013 [b]	1,436	1,847	1,214	2,167	519	7,183
	132 [f]	145 [f]	137 [f]	468 [f]	82 [f]	
2014 [b]	2,378	2,540	1,833	1,795	705	9,251
	174 [f]	176 [f]	176 [f]	153 [f]	92 [f]	
2015[b]	2,078	1,592	1,366	2,308	911	8,255
	176[f]	141[f]	144[f]	181[f]	102[f]	
2016[b]	1,745	3,593	2,360	2,258	1,719	11,675
	177[f]	263[f]	221[f]	154[f]	170[f]	
3 year ave.	2,067	2,575	1,853	2,120	1,112	9,727
Long-term average	3,183	4,402	2,868	3,026	1,459	14,955

[a] Estimates based on Lincoln-Peterson analysis of counts by two observers.
[b] Estimates based on correction factors from ground-truthed transects.
[c] Mean of 1994 and 1997 KI estimates included in 1995 KI total and average, and mean of 2004 and 2006 BP estimates included in 2005 BP total and average.
[d] 2006 TR estimate based on 63% of the images analyzed.
[e] Standard errors in 2007–2009 calculated using the variance of the ratio estimate, rather than the binomial variance (as in 1992–2006).
[f] Standard errors in 2009–2016 were calculated using inter-photo variance (photos as the sample unit), rather than inter-transect variance (as in 1992–2008).

Appendix D. Brant color composition and Western High Arctic winter estimates in Skagit County, Washington, 2006–2017.

Year	Bay	MWS	Harvest Sample	WHA Harvest Ratio	WHA Estimate	Bay	MWS	Harvest Sample	WHA Harvest Ratio	WHA Estimate	Bay	MWS	WHA Estimate
2006-07	Padilla	2260	73	0.73	1650	Samish	3828	115	0.37	1416	Total	6088	3066
2007-08	Padilla	1010	26	0.33	333	Samish	8185	107	0.17	1391	Total	9195	1725
2008-09	Padilla	2860	125	0.55	1573	Samish	13337	74	0.45	6002	Total	16197	7575
2009-10	Padilla	3340	80	0.68	2271	Samish	2652	118	0.32	849	Total	5992	3120
2010-11	Padilla	3350	111	0.64	2144	Samish	5131	85	0.31	1591	Total	8481	3735
2011-12	Padilla	1070	75	0.80	856	Samish	5620	61	0.69	3878	Total	6690	4734
2012-13	Padilla	5705	23	0.78	4450	Samish	3255	61	0.41	1335	Total	8960	5784
2013-14	Padilla	2819	24	0.50	1410	Samish	3667	38	0.39	1430	Total	6486	2840
2014-15	ns					ns					ns		
2015-16	Skagit Co	5043	80	0.79	3984						Total	5043	3984
2016-17	Skagit Co	6359	91	0.68	4330						Total	6359	4330

Appendix E. Adult brant molting in the Teshekpuk Lake area in relation to that year's Winter Brant Survey Indices (WBS; Mallek 2010, Wilson 2014, Shults and Dau 2016, Olson 2016).

Year	Molting Brant	WBS	% of WBS
1976	13,998	122,045	11.5%
1977	21,988	146,967	15.0%
1978	32,732	162,887	20.1%
1979		129,413	
1980		146,365	
1981		197,468	
1982	12,106	121,044	10.0%
1983	24,617	109,314	22.5%
1984	27,035	135,041	20.0%
1985	15,258	145,085	10.5%
1986	19,102	134,227	14.2%
1987	8,184	110,908	7.4%
1988	8,729	145,021	6.0%
1989	13,701	135,565	10.1%
1990	23,395	151721	15.4%
1991	12,574	132711	9.5%
1992	14,953	117,837	12.7%
1993	21,172	125,000	16.9%
1994	20,246	129,332	15.7%
1995	18,994	133,485	14.2%
1996	23,485	127,990	18.3%
1997	21,059	155,307	13.6%
1998	12,116	138,838	8.7%
1999	10,956	132,292	8.3%
2000	3,368	135,569	2.5%
2001	36,817	125,993	29.2%
2002	17,354	138,231	12.6%
2003	21,017	106,142	19.8%
2004	20,267	121,272	16.7%
2005	17,344	107,208	16.2%
2006	17,613	140,956	12.5%
2007	27,109	130,594	20.8%
2008	19,397	156,957	12.4%
2009	18,647		
2010	18,212	163471	11.1%
2011	18,300	165,008	11.1%
2012	20,090	177,341	11.3%
2013	23,725	163,300	14.5%
2014	12,114	173,315	7.0%
2015[1]	12,814	136,482	9.4%
2016	12,089	140,025	8.6%
3 year average (2014-2016)	12,339	149,941	8.3%
Long-term average (1976-2016)	18,228	139,193	13.4%

[1]Observations of geese in coastal units 202, 203, 204, and 205 included in the Traditional Survey Area totals. These units have been completed sporadically since 2005 and hereafter.

Appendix F. Regional estimates of subsistence harvest of Pacific brant in Alaska, 2004–2013.

Year	Yukon-Kuskokwim Delta	Bering Strait-Norton Sound	Aleutian-Pribilof Islands	Bristol Bay	Northwest Arctic	North Slope	TOTAL
2004	3,968	3,194	NS	668*	NS	NS	
2005	4,383	3,876	1,450*	945	NS	1,233	
2006	8,433	NS	NS	2,859*	0*	NS	
2007	5,278	5,867	0*	724	NS	2,704	
2008	3,980	NS	555	219	NS	3,851	
2009	14,542	660*	NS	NS	NS	2,011	
2010	6,279	1,055*	NS	NS	NS	NS	
2011	5,112	11*	NS	1,005	NS	NS	
2012	NS	86*	NS	NS	596*	NS	
2013	6,307*	NS	NS	NS	NS	NS	
Average	**6,476**	**2,930**$^{+}$	**1,002**$^{+}$	**1,070**	**596**$^{+}$	**2,449**	**14,523**

NS = Not Surveyed

* Less than 75% of region households represented in annual sample, region harvest estimates not reported, only sub-region(s) reported

+ sub-region reports under 100 birds were not used to calculate long-term averages for each region in the Table.

Table summarized from Naves, L.C. 2015. Alaska subsistence bird harvest, 2004–2014 data book, Alaska Migratory Bird Co-Management Council. Draft December 2015. Alaska Department of Fish and Game Division of Subsistence, Special Publication No. 2015-05, Anchorage

Appendix G. Estimates of Pacific brant retrieved fall-winter sport harvest in the U.S. and Canada from best available data, 1981–2016.

Year	Alaska	B.C.	Washington (*Undifferentiated Co.*)		Oregon	California	Total
			Skagit Co.	*Pacific Co.*			
1981	--	255	1,670		241	586	2,752
1982	1,767	335	1,100		56	905	4,163
1983	1,931	275	Closed		Closed	565	2,771
1984	1,544	208	Closed		Closed	492	2,244
1985	723	559	Closed		Closed	250	1,532
1986	--	281	Closed		Closed	188	469
1987	328	358	603	0	63	567	1,919
1988	608	162	354	0	16	353	1,493
1989	417	223	599	39	54	360	1,692
1990	463	245	808	73	41	456	2,086
1991	--	250	790	55	98	343	1,536
1992	392	115	950	27	97	750	2,331
1993	309	220	1,347	60	86	550	2,572
1994	550	196	825	23	197	680	2,471
1995	494	250	918	44	106	500	2,312
1996	369	~175	1,493	41	55	500	2,458
1997	504	~175	597	59	34	430	1,624
1998	--	~175	570	18	0	500	1,088
1999	1,400 ±99%	160	581	86	100 ±140%	2,400 ±116%	4,727
2000	300 ±51%	154	0	108	100 ±194%	2,700 ±111%	3,362
2001	500 ±49%	101	403	37	<50 ±188%	700 ±107%	1,791
2002	400 ±32%	95	18	42	0	900 ±99%	1,455
2003	600 ±35%	97	257	77	<50 ±190%	2,300 ±115%	3,381
2004	600 ±41%	68	344	45	0	800 ±81%	1,857
2005	700 ±65%	178	504	53	0	900 ±74%	2,335
2006	1,200 ±73%	197	367	74	<50 ±109%	2,900 ±64%	4,788
2007	900 ±47%	97	341	112	<50 ±194%	1,800 ±88%	3,300
2008	1,700 ±46%	180	328	81	<50 ±112%	1,000 ±36%	3,339
2009	1,100 ±36%	154	545	31	100 ±76%	900 ±37%	2,830
2010	2,100 ±41%	282	253	125	200 ±145%	500 ±37%	3,460
2011	600 ±65%	172	638	80	<50 ±110%	700 ±50%	2,240
2012	1,700 ±45%	250	541	63	<50 ±196%	900 ±31%	3,258
2013	700 ±55%	349	479	26	0	1,000 ±48%	2,734
2014	2,400 ±42%	225	0	40	<50 ±154%	2,200 ±50%	4,915
2015	2,400 ±72%	243	165	34	0	1,500 ±84%	4,342
2016	1,900 ±48%	179	538	46	200 ±196%	4,800 ±79%	7,663
10-yr Ave	**1,501**	**213**	**383**	**64**	**75**	**1,530**	3,800
Long-term Ave (1981-2016)	**972**	**206**	**539**	**53**	**115**	**1,163**	

[1]Alaska state harvest surveys except in 1981, 1986, 1991; HIP survey 1999–present.

[2]CWS/MELP data; bag checks in some areas.

[3]Washington state harvest survey; permit hunt mandatory report data 1990 to present.

[4]Oregon state harvest survey 1981–1998; HIP survey 1999–present.

[5]California data from bag checks and hunter interviews, mostly Humboldt Bay. HIP survey 1999–present.

Appendix H. Hunting seasons, hunter participation and harvest of black brant at San Quintin Bay, Baja California, Mexico.

Hunting Season	Hunt Days	Daily Limit	Possesion Limit	Hunters per Day	Brant per Hunter	No. of Hunters	Estimated Harvest [a]	Illegal Harvest	Total Harvest	Source
1974-75	69	5	15	7.5	2.2	520	1,105	56	1,161	Kramer 1976
1984-85	54	3	9	11.6	2.5	629	1,468	83	1,619	Eldridge and Kramer 1985
1987-88	51	4	12	14.9	3.5	761	2,875	-	2,875	Kramer 1988
1990-91 [b]	51	4	8	4.9	3.4	242	823	-	823	Ward, unpubl. data
1991-92	51	4	8	5.0	3.4	254	864	3	867	
1992-93	51	4	8	8.0	3.8	410	1,558	53	1,611	
1996-97	54	4	11	5.9	3.7	319	1,180	12	1,192	
1997-98	54	4	11	5.1	3.9	276	1,076	285	1,361	
1998-99	54	4	11	6.2	3.6	336	1,210	67	1,277	
1999-00	54	4	11	9.3	3.4	503	1,710	-	1,710	
2000-01 [c,d]	24	5	25	9.4	4.4	225	990	-	990	
Avg	52	4	12	8.0	3.4	407	1,351		1,408	

[a] For seasons 1990 to 2000, estimated harvest = birds/hunter x total hunters.

[b] Price of hunting and gun permits increased dramatically and there was a general boycott of hunting for brant in 1990-91 and 1991-92.

[c] The 2000-01 hunting season was shortened by delays in development of new regulations. Hunting took place from 5 January to 25 February 2001.

[d] UMA (Unidades de Manejo Ambiental) system established for local management of brant hunting on estuaries.

Estimated brant harvest from areas other than San Quintin Bay, based on interviews with residents and outfitters.

Location	1984-85 [a]	1987-88 [b]	2000-01 [c]
Baja California (excluding San Quintin Bay)	125-545	360-545	100-250
Sonora and Sinaloa	75-150	No Survey	400-600
Total	200-695	360-545	500-850

[a] Eldridge and Kramer 1985.

[b] Kramer 1988.

[c] David Ward, unpublished data.

Appendix I. Brant hunting regulations, 1970–2017.

	Bag/Poss Limits	Season Length	Approximate Season Dates	Other Restrictions
Alaska:				
1970–82	4/8	107 days	9/1 – 1/26	
1983–86	2/4	107 days	9/1 – 1/26	
1987	2/4	50 days	9/1 – 10/20	North Zone
			9/1 – 10/31	Gulf Coast & SE Zones
			10/8 – 1/22	Pribilof-Aleut. & Kodiak Z.
1988–2012	2/4	107 days	9/1 – 1/26	
2013–15	2/6	107 days	9/1 – 1/26	
2016–17	3/9	107 days	9/1 – 1/26	
British Columbia:				
Haida Gwaii (formerly Queen Charlotte Is.)				
1971–77	4/8	75-80 days	12/21-25 – 3/10	
1978–80	3/6	80 days	12/21 – 3/10	
1981–83	2/4	80 days	12/21 – 3/10	
1984	2/4	32 days	12/21 – 1/21	
1985–2017	No open season			
Vancouver Is.				
1971–76	4/8	10 days	3/1 – 3/10	
1977–78	3/6	10 days	3/1 – 3/10	
1978–2017	No open season			

Lower Mainland				
1971–76	4/8	93–102 days	11/29 & 12/7 – 3/10	
1977–84	3/6	10 days	3/1 – 3/10	
1985–92	2/4	10 days	3/1 – 3/10	Only in PMU 2-4
1993–2017	2/4	10 days	3/1 – 3/10	Only in PMU 2-4 No land-based hunt
1995–2017	2/4	10 days	3/1 – 3/10	Only in PMU 2-4 No-hunting area increase
Washington:				
1970–79	4/8	93 days	11/20 – 2/20	Only Sat, Sun & Wed
1980–82	3/6	67–72 days	12/16 – 01/21	Only Sat, Sun & Wed & prohibit sculling, etc.
1983–86	No open season			
1987	2/4	7 days	12/8 – 12/23	Only Skagit & Whatcom Counties
1988–93	2/4	9–11 days	12/5 – 12/26	Skagit, Whatcom, & Pacific Counties
1994–96	2/4	9–11 days	12/7 – 12/24	Skagit & Pacific Counties
1997–99	2/4	5–9 days	1/8 – 1/23	Skagit & Pacific Counties
2000	2/4	5 days	1/13 – 1/21	Pacific County
2001-04	2/4	10 days	11/17 – 11/23	Skagit & Pacific Counties
			1/12 – 1/20	Skagit & Pacific Counties
2005	2/4	5 days	1/7-1/28	Skagit & Pacific Counties
2006-07	2/4	7 days	1/10-1/28	Skagit & Pacific Counties
2008-12	2/4	0-8 days	1/12-1/27	Skagit County
		10 days	1/5-1/25	Pacific County
2013-16	2/6	0-8 days	1/6-1/26	Skagit County
		10 days	1/4-1/28	Pacific County
Oregon:				
1970–79	4/8	93 days	11/20 – 2/20	
1980–82	4/8	37–51 days	12/15 – 2/1 & 1/15 – 2/20	
1983–86	No open season			
1987	2/4	16 days	12/26 – 1/10	
1988	2/4	16 days	12/17 – 1/1	
1989	2/4	16 days	12/30 – 1/14	
1990–95	2/4	16 days	1st or 2nd Saturday in Jan.	
1996–97	2/4	16 days	last Saturday in Dec.	
1998–2002	2/4	14 days	1st Saturday in Nov.	
2003	2/4	14 days	2nd Saturday in Nov.	
2004–09	2/4	16 days	2nd Saturday in Nov.	
2010–12	2/4	16 days	3rd Saturday in Nov.	
2013–14	2/6	16 days	3rd Saturday in Nov.	
2015–17	2/6	16 days	4th Saturday in Nov.	

California:

1970–72	4/8	93 days	11/20 – 2/20	
1973–83	4/8	37 days	1/15 – 2/20 (approx)	
1983–86	2/4	40-42 days	10/20 – 11/30 (approx)	
1987–97	2/4	30 days	11/1 – 11/30	
1998–2004	2/4	30 days	11/10 – 12/9	
2005	2/4	15 days	11/16 – 30	Northern Brant
			12/1 – 15	Balance of State Brant
2006	2/4	30 days	1st Saturday in Nov.	Northern Brant
			2nd Sunday in Nov.	Balance of State Brant
2007-09	2/4	30 days	1st Saturday in Nov.	Northern Brant
			2nd Saturday in Nov.	Balance of State Brant
2010–12	2/4	30	11/7	Northern Brant
			2nd Saturday in Nov.	Balance of State Brant
2013	2/6	30 days	11/7	Northern Brant
			2nd Saturday in Nov.	Balance of State Brant
2014–2017	2/6	37 days	11/8	Northern Brant
			2nd Saturday in Nov.	Balance of State Brant

Baja California (Norte)

1978–79	5/15	119 days	11/1 – 2/28	
1980–85	3/9	119 days	11/1 – 2/28 (approx)	(only Fri.– Sun.)
1986	3/9	101 days	11/14 – 2/22	(only Fri.– Sun.)
1987	3/9	115 days	11/13 – 3/6	(only Fri.– Sun.)
1988	4/12	105 days	11/7 – 2/19	(only Fri.– Sun.)
1989	4/8	115 days	11/3 – 2/25	(only Fri.– Sun.)
1990–2000	4/8	54 actual	1st weekend Nov. through last weekend Feb.	(only Fri.– Sun.)
2001–2016	Information Pending			
2017	5		Last Friday in Oct. through 4th Sunday Feb.	(only Fri.– Sun.)