A global assessment of the conservation status of the Black Oystercatcher *Haematopus bachmani*

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The Black Oystercatcher *Haematopus bachmani*, a monotypic species, is one of the less studied members of the genus. The global population of roughly 10,000 individuals is scattered unevenly along the North American Pacific Ocean coast from the Aleutian Islands to Baja California, with the vast majority (about 80%) in Alaska and British Columbia. Favouring rocky shorelines in areas of high tidal variation, they forage exclusively on intertidal macroinvertebrates (e.g. limpets and mussels). Because they are completely dependent on marine shorelines, the Black Oystercatcher is considered a sensitive indicator of the health of the rocky intertidal community. Breeding oystercatchers are highly territorial, and nesting densities are generally low; however, during the winter months they tend to aggregate in groups of tens to hundreds. Wintering distribution and seasonal movements are poorly characterized, but some breeding populations in the north are migratory while others are resident. Population estimates are based mainly on incidental observations made during seabird surveys and are insufficient to determine population trends. The Black Oystercatcher is listed as a species of 'high concern' throughout its range for multiple reasons: the small population size and restricted range; threats to its obligatory shoreline habitat; and susceptibility to a suite of ongoing anthropogenic and natural factors that may potentially limit long-term viability. Despite concern for this species, direct conservation efforts have been limited by a lack of information on factors such as the overall population status and trend, demographics, local and regional threats to survival and productivity, the locations and sizes of important wintering concentrations, and migratory connectivity between breeding and wintering sites. To address these concerns, the International Black Oystercatcher Working Group was formed to document existing information and gaps, and to determine and implement high priority action items. Members developed an Action Plan, whose contents are highlighted here. This plan was developed collaboratively as a single strategic planning resource for the conservation of this species throughout its range.

Black Oystercatcher (*Haematopus bachmani*) (photo: Brian Guzzetti / Far Corners Photography).

TAXONOMIC STATUS

Haematopus bachmani is currently considered a monotypic species closely related to the American Oystercatcher *Haematopus palliatus*, a pied form. The majority of the distributions of the two species are allopatric; however, there is overlap in Baja California, Mexico. The Black Oystercatcher and American Oystercatcher are considered discrete species by the American Ornithologists' Union (1998). Nonetheless, hybridization does occur within a 500-km long zone in central Baja and has been noted in the Channel Islands of California (Sowls *et al.* 1980).

LIFE HISTORY

The large bodied Black Oystercatcher is sexually dimorphic; the female is larger, heavier, and has a longer bill (Webster 1941). The sexes may be distinguished in the field by the presence and extent of black "flecks" in the yellow iris (iridial depigmentation) of females (Guzzetti *et al.* 2008). Males and females form seasonally monogamous pair-bonds, which may last the lives of the birds. Some divorce occurs between breeding seasons; about 5% of returning banded birds change mates from one year to the next, but divorced pairs may reform pair-bonds in subsequent years (Tessler & Garding 2006). Banding data indicate high breeding site fidelity − 92% of surviving banded adults (n = 219) in Alaska returned to the same nesting territory from 2003 to 2007 (Tessler *et al.* 2007). Consistent territory occupation for more than five years is common throughout Alaska, and in central California (D. Tessler unpubl. data, G. Falxa pers. comm.). Due to the continuity of territory occupation and presumed longevity, successful establishment of new territories is probably an uncommon event (Andres & Falxa 1995). Both pair members share in aggressive defence of their territory against conspecifics during the breeding season.

Black Oystercatchers are generally not colonial nesters; breeding pairs tend to segregate themselves in discrete territories dispersed along areas of suitable habitat. By contrast, during the winter months they tend to be gregarious and aggregate in groups of tens to many hundreds (van Vliet 2005, D. Zwiefelhofer unpubl. data). Nesting densities (pairs/km of shoreline) are generally low, 0.03–9.85 pairs/km (Poe 2003, Gill *et al.* 2004), and appear to be dictated by shoreline characteristics. Density is lower along northern rocky outer coast shorelines (e.g. Strait of Georgia, British Columbia = 0.06 pairs/km; western Prince William Sound, Alaska = 0.03–0.38 pairs/km (Poe 2003) than on small islands with numerous productive feeding areas and few terrestrial predators (e.g. Destruction Island, Washington = 4.56 pairs/km, Middleton Island, Alaska = 9.85 pairs/km). Occasionally, several pairs nest within a few meters of one another, but this typically occurs in Alaska only on Middleton Island and small, sandy islets where habitat is otherwise limited (e.g. the Beardslee Islands in Glacier Bay and Low Island in Sitka Sound, Alaska, D. Tessler unpubl. data), and in British Columbia on Cleland Island, Seabird Rocks, Florencia Island, and Wilf Rocks (P. Clarkson unpubl. data).

The nest is usually a shallow circular depression lined with shell fragments, rock flakes, or pebbles (Andres & Falxa 1995). Pairs often build more than one nest within their territory, and the female chooses in which to lay (Webster 1941, Purdy 1985). Females lay one to three eggs, rarely four, and range-wide average first clutch size varies from 2.07–2.80 (Vermeer *et al.* 1991, Morse *et al.* 2006, Spiegel *et al.* 2006, Tessler & Garding 2006, Tessler *et al.* 2007). Both sexes incubate. Eggs are often left unattended until the clutch is completed (D. Tessler unpubl. data), but from then on are attended 90–98% of time (Helbing 1977, Purdy 1985). The female spends more time on the nest initially, but the male equalizes duty later in the incubation period. Incubation is typically 26–28 days; newly hatched chicks are brooded almost continuously during the first 24–48 hours, and intermittently until day 20–23 (Helbing 1977). The precocial chicks are able to leave the nest bowl within one day of hatching and are capable of flight at 38–40 days. Excessive human disturbance is known to prolong both incubation and fledging (Nysewander 1977). Because of the long duration of parental care, only one brood is raised per season; however, when a clutch is lost, pairs can lay up to two replacement clutches, which tend to be smaller than initial clutches (Andres & Falxa 1995).

Hatching success and overall productivity vary widely among years and breeding areas. Annual hatching success varies from 12–90% across the range (Nysewander 1977, Vermeer *et al.* 1992, Gill *et al.* 2004, Morse *et al.* 2006, Spiegel *et al.* 2006, Tessler and Garding 2006, Tessler *et al.* 2007, Elliott-Smith *et al.* 2008). Within a single year, the proportion of successful nests varied markedly (10–70%) among islands in Prince William Sound, Alaska (B. Andres unpubl. data). At four Alaskan breeding areas (Prince William Sound, Glacier Bay National Park, Kenai Fjords National Park, and Middleton Island; 2003–2007), hatching success varied significantly between years within and among sites; however, when averaged across years, most sites did not differ significantly from a global average hatching success of 33% (Morse *et al.* 2006, Spiegel *et al.* 2006, Tessler & Garding 2006, Tessler *et al.* 2007, Guzzetti 2008). Middleton Island, Alaska, was the exception with a two-year average hatching success of nearly 70%. The same study found overall productivity also varied significantly between years and sites (range = 0.15–0.89), but when averaged across years, overall productivity was 0.43 fledglings per pair, with no significant differences between breeding areas (Morse *et al.* 2006, Spiegel *et al.* 2006, Tessler & Garding 2006,

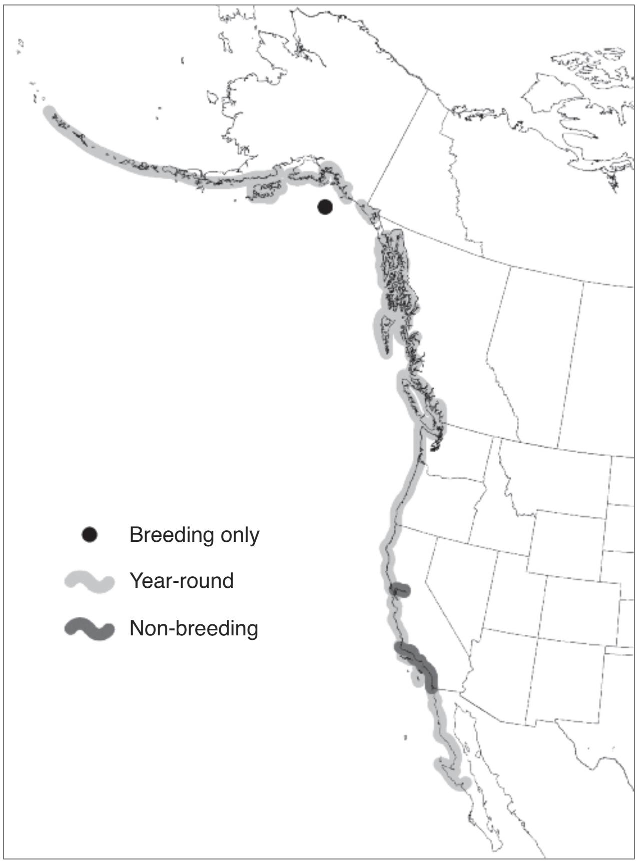

Fig. 1. Global distribution of the Black Oystercatcher (*Haematopus bachmani*) after Andres & Falxa (1995). Areas occupied year-round are indicated in light grey; areas occupied solely during non-breeding are indicated in dark grey, and areas occupied only during breeding are indicated in black.

Guzzetti 2008, D. Tessler unpubl. data). Productivity data are largely lacking in the southern portion of the range; however, a two-year study in 2006–2007 (n=50, n=62 respectively) across Oregon determined that average productivity for that year was 0.74 and 0.61 fledglings per pair in those years (Elliott-Smith *et al.* 2008).

Few banded Black Oystercatcher chicks have been resighted, making estimates of natal philopatry and subadult survival rates difficult. No chicks banded on Cleland Island, British Columbia from 1970–1972 were found breeding on the island in subsequent years (Groves 1982). Only 10 of 216 chicks banded at sites across Alaska from 2003–2006 were ever resighted in subsequent years, and none were seen in more than one year. Only four chicks were resighted in close proximity to their natal sites, all in Kenai Fjords National Park (J. Morse unpubl. data). The remaining six were observed between 30 km and 3080 km from the sites where they hatched (D. Tessler unpubl. data). This paucity of data prevents any clear determination about age of first reproduction, though limited information from chicks banded on Farallon Island, California, indicates that it may be five years (W. Sydeman pers. comm.). Once individuals reach breeding age, it is generally assumed that they attempt to breed every year. Apparent annual adult survival, based on resightings of 261 banded adults in Alaska between 2003 and 2007, was 87% (D. Tessler unpubl. data). Apparent annual adult survival at Pacific Rim National Park, Vancouver Island, British Columbia, during 2008–2013 was 90 ± 3% (P. Clarkson & Y. Zharikov unpubl. data). Lifespan has been determined for only a few individuals: one adult banded in Prince William Sound, Alaska, was at least 10 years old when recaptured in 2004 (B. Andres & R. Lanctot unpubl. data), and in the Queen Charlotte Islands, one bird banded as an adult returned to the same breeding territory on Reef Island for 11 years, and another bird banded on the Skedans Islands in 2000 was resighted in 2012 (Pattison & Brown 2012). Five chicks banded on Farallon Island, California, lived 15.5, 15, 12, 12, and 9 years (W. Sydeman pers. comm.). Lifetime reproductive success remains unknown.

HABITAT AND FOOD

The Black Oystercatcher is an intertidal obligate, spending its entire life history in this narrow ecological zone. They feed exclusively on intertidal invertebrates, particularly mussels (*Mytilus* spp.), limpets (*Diadora aspera, Puncturella* spp.), whelks (*Nucella* spp.), littorine snails (*Littorina* spp.), and chitons (*Katharina tunicata*, *Tonicella lineata, Mopalia* spp.). Although small gastropod molluscs dominate the diet numerically, mussels contribute the greatest prey mass (Hartwick 1976, Falxa 1992, Andres 1996). Foraging habitats are limited to those areas where prey are most abundant: rocky shores exposed to surf action; sheltered gravel, cobble, or sandy shores; and soft sediment shores in protected bays and sounds.

Access to foraging habitat is strongly dependent on tides and surf action. Oystercatchers often forage in the mid-intertidal zone where mussel populations are dense. When lower intertidal zones are inundated, they will forage on rocky substrates in the high-intertidal where limpets and chitons are numerous. Mussel beds and aquatic beds of the macrophytic algae *Fucus gardneri* are essential foraging habitats for Black Oystercatchers. Both mussels and *Fucus* exist under similar physical conditions of substrate and tidal regime, and often co-occur (Lubchenco 1983, Menge 1976). The *Fucus* canopy supports many key prey species including limpets, littorines and other snails, and chitons (McCook & Chapman 1991). Rocky benches are a particularly important foraging habitat for oystercatchers as they provide a contiguous and temporally stable substrate for sessile macroinvertebrates (mussels), sessile macrophytic algae (e.g. *Fucus*), and the communities of grazing, mobile macroinvertebrates they support. Cobble beaches support faunal communities similar to rocky benches. However, because cobbles are not a fixed substrate, these sites are often subject to disturbance by wave action and winter storms, creating a dynamic seasonal component to intertidal algal and macroinvertebrate communities in these habitats (Ferren *et al.* 1996).

Although Black Oystercatchers frequently travel distances greater than 200 m to feed, and may commute to foraging areas well over one km from their territories (Hartwick 1976, Andres 1998), the juxtaposition of adequate nesting habitat and foraging habitat appears essential. Breeding territories are usually in close proximity to low-sloping shorelines with dense mussel beds. Adequate habitat is unevenly distributed and occurs in a variety of shoreline types. Nesting sites include mixed sand and gravel or cobble and gravel beaches, shell beaches, exposed rocky headlands, rocky islets, rock outcroppings, low cliffs, colluvial and alluvial outwashes, and tidewater glacial moraines. In the northern portion of their range, oystercatchers often nest on gravel beaches, wave-cut platforms, rocky headlands, and small rocky islets. In the southern portion of their range, nesting occurs primarily on rocky headlands, islets, and islands.

Breeding pairs avoid wooded or shrub covered shorelines and are most abundant on non-forested islets and islands. Gravel and shell beaches appear to be the preferred nesting habitat in Alaska and British Columbia, although exposed cliff sides and rocky islets are also important (Nysewander 1977, Vermeer *et al.* 1992, Andres 1998). In the southern region where beaches are predominantly sandy, and gravel shores are often exposed to high human disturbance, rocky headlands and rock outcroppings are favored. In Washington, birds occasionally nest on gravel beaches on offshore islands, but there are few nests found on gravel in Oregon or California. Nests on gravel beaches are generally located just above the high tide line. Nests on cliffs and islands, however, may be located 30 m or more above the high tide line (E. Elliott-Smith unpubl. data).

Wintering habitat is much the same as breeding habitat (i.e. areas near productive mussel beds). In Alaska and British Columbia, winter flocks concentrate on protected, ice-free tidal flats or rocky islets with dense mussel beds (Hartwick & Blaylock 1979, Andres & Falxa 1995); elsewhere, wintering birds often occur in exposed areas with mussel beds (Andres & Falxa 1995). Flocks of 400–500 are frequently found in the winter roosting on the rocks of the man-made breakwater protecting Kodiak Harbor, Alaska (D. Zwiefelhofer & D Tessler unpubl. data).

DISTRIBUTION

The Black Oystercatcher occurs uncommonly along the North American Pacific coast from the Aleutian Islands to Baja California (Fig. 1). During the breeding season they are most abundant in the northern portions of their range (Alaska and British Columbia), with 20% of the population found in the southern half of the geographic range (northern

Washington to the central Pacific coast of Baja California). They occur along the Aleutian Islands, the Alaska Peninsula, inner and outer marine shorelines of south-central and southeast Alaska, British Columbia, and Washington, and the outer coasts of Oregon. In California, oystercatchers occur primarily on offshore islands (e.g., Channel Islands, Farallon Islands) and small rocky islets. They are locally distributed on the Pacific coast of Baja California and offshore islands. The southern range limit coincides with the change from rocky shores to predominantly sand beaches (Jehl 1985).

Although the overall wintering and breeding ranges entirely overlap, the non-breeding distribution of the Black Oystercatcher is poorly characterized. When the end of the breeding season approaches, the once territorial and widely dispersed breeding pairs begin to aggregate into flocks that frequently persist through winter. These localized winter concentrations, ranging from tens to hundreds of individuals, represent significant proportions of the population. A post breeding flock of approximately 600 Black Oystercatchers concentrated in a small portion of Geike Inlet, Glacier Bay, Alaska was observed in September 1992 (van Vliet 2005).

Incidental observations suggest that oystercatchers in the southern portion of the range are generally considered resident; individuals are believed to undergo only a short-distance migration coincident with winter flock formation. These winter flocks stay relatively close to their general breeding areas, and some individuals may maintain territories year-round (Nysewander 1977, Hartwick & Blaylock 1979, Falxa 1992). A number of marked birds have been observed year-round in Pacific Rim National Park, Vancouver Island, British Columbia, and although they don't appear to defend a territory during the winter months they are often observed at or near their nesting territory (Johnson et al. 2010, P. Clarkson unpubl. data). However, the absence of banded individuals across most of the southern region makes it impossible to determine with certainty that the same individuals are indeed present year-round.

In contrast, winter surveys, observations of banded birds, and telemetry studies confirm that northern breeding populations exhibit variation in migratory strategy; birds from some northern breeding populations exhibit year-round residency while individuals in other populations undertake relatively long seasonal migrations (Johnson *et al.* 2010). Roughly 1,700 Black Oystercatchers were detected in both winter and summer surveys of Kodiak Island, Alaska, suggesting a resident population (Tessler *et al.* 2007). Similarly, in Pacific Rim National Park, Vancouver Island, British Columbia, non-breeding oystercatcher numbers appear comparable to those documented during breeding surveys (P. Clarkson unpubl. data). By contrast, 75% of Black Oystercatchers breeding in Prince William Sound, Alaska, appear to migrate after breeding (Andres 1994a), and on Middleton Island, Alaska, all of the roughly 700 oystercatchers present during the breeding season (Gill *et al.* 2004) leave the island (Tessler *et al.* 2007).

Post-breeding flocks in Glacier Bay, Prince William Sound, and Middleton Island, Alaska, are known to depart during the non-breeding season (Andres & Falxa 1995, Tessler *et al.* 2007, Guzzetti 2008); however, the destinations of most of these birds remain unknown. A recent satellite and VHF telemetry study (Johnson *et al.* 2010) documented medium to long-distance migration (range 130–1667 km) in three populations (Prince William Sound, Middleton Island, and Juneau, Alaska) and year-round residency in two others (Kodiak Island, Alaska, and Vancouver Island, British Columbia). Telemetered oystercatchers from the most northerly breeding areas in the study departed their breeding areas sooner, arrived at their non-breeding locations earlier, and migrated farther than did oystercatchers breeding farther south. If substantial seasonal migration among northern breeding populations occurs, the distribution within the range is likely to be a shift southward over winter.

The few observations of banded oystercatcher chicks seen in subsequent seasons suggest both local and long-distance dispersal of juveniles. Five percent of chicks banded in the Queen Charlotte Islands, British Columbia, between 1992 and 2000 returned to breed in the same area (Hazlitt & Gaston 2002). A small number of chicks banded in the Gulf Islands of British Columbia have been resighted within the region, although none specifically at natal nesting areas (T. Golumbia unpubl. data). Four of 216 chicks banded in Alaska 2003–2006 were observed in later breeding seasons within a few kilometers of their hatch sites in Kenai Fjords National Park (J. Morse unpubl. data). Only six more of those 216 chicks were observed again, all at distances ranging from 30 km to 3080 km, from their natal areas. Three of these chicks were observed during subsequent breeding seasons: a chick banded in Kenai Fjords July 2004 was observed at the head of Resurrection Bay 30 km away June 2007; a chick banded in Harriman Fjord in Prince William Sound June 2005 was resighted August 2007 100 km away on Green Island; and another Kenai Fjords chick banded June 2005 was spotted June 2006 at Graham Island, British Columbia, 1,300 km away (Johnson *et al.* 2010, D. Tessler unpubl. data). Three chicks were later seen only during the winter months: a chick banded in Glacier Bay National Park July 2005 was seen January 2006 in Clayoquot Sound on Vancouver Island, a distance of 1230 km; a chick banded June 2006 in Harriman Fjord was resighted 1550 km away on Ivory Island, British Columbia, September 2008; and a chick banded on Middleton Island, Alaska June 2004 was observed near Carmel, California, December 2013, 3080 km from where it hatched (Johnson *et al.* 2010, D. Tessler unpubl. data). Because the species is long-lived and exhibits high breeding site fidelity, long distance juvenile dispersion may have important implications for maintaining genetic diversity in the global population, and may play an important role in repopulating suitable habitats following disturbance.

POPULATIONS: SIZES AND TRENDS

The global population is estimated to be between 8,300 and 12,500 birds (midpoint = 10,000; Andres *et al.* 2012). This estimate, however, is based largely on opportunistic observations from seabird surveys that do not specifically target Black Oystercatchers. These seabird surveys have generally been sub-optimal for detecting oystercatchers; they are commonly conducted later in the breeding season when oystercatchers are less vocal and visible; and more importantly, many focus primarily on large seabird colonies, not the widely distributed islets and rocky intertidal areas where oystercatchers commonly occur. Available data come from a variety of sources that vary both temporally and spatially, as well as in methodology and effort, making standardized comparisons over a broad geographic scale difficult (Table 1).

By 2014, there had been no systematic effort to survey the entire population of Black Oystercatchers, and large portions of the range lack population data altogether. Consequently, it is not clear how well the current population estimate reflects the actual number of individuals. The median population estimate has increased from 7,600 (Page & Gill 1994) to 8,900 (Morrison *et al.* 2001) to 10,000 (Morrison *et al.* 2006, Andres *et al.* 2012); however, this apparent increase is likely due to the accumulation of information on previously unsurveyed areas, rather than an actual expansion of the population. The population in all likelihood is larger than that reported by Morrison *et al.* (2006) and Andres *et al.* (2012). Although the population is thought to be stable, the lack of standardized sampling and comparable time series data mean that reliable local trend data are virtually non-existent and broad-scale population trends remain unknown. Some local breeding populations where reliable time series data are available (Middleton Island and Glacier Bay, Alaska, and Cleland Island and Pacific Rim National Park on Vancouver Island and the Strait of Georgia, British Columbia) are known to be stable or increasing (Gill *et al.* 2004; Tessler *et al.* 2007; Butler & Golumbia 2008, P. Clarkson & Y. Zharikov unpubl. data). Limited information from Christmas Bird Count data indicates a stable to increasing population (Andres *et al.* 2012). There are some efforts to establish long-term monitoring. For example, the Southwest Alaska Network of National Parks in Alaska has instituted surveys to detect trends in Black Oystercatcher abundance, nest density, productivity and diet in portions of the Kenai Fjords National Park, Prince William Sound, and Katmai National Park and Preserve (Coletti *et al.* 2013). Chugach National Forest which has mapped Black Oystercatcher territories since 1999 revised their protocol in 2011 to monitor occupancy using a split-panel design to detect trends in Prince William Sound (G. Hayward pers. comm.). Chugach National Forest and the Southwest Alaska Network are working to coordinate their complimentary efforts. Parks Canada continues an annual monitoring program in Pacific Rim National Park and Clayoquot Sound, but monitoring efforts in the Gulf Islands have been suspended (P. Clarkson & T. Golumbia pers. comm.). In Oregon US Fish and Wildlife Service has lead a citizen-science based survey effort since 2005, and in 2011 California Audubon instituted a citizen-science survey (using the same protocols as in Oregon) that tallied 1,346 oystercatchers and indicated that the California population may be larger than previously documented (Weinstein *et al.* 2011).

Black Oystercatchers breed throughout their range, with the majority of the breeding population concentrated in the north (Table 1): Alaska (55–80% of global population), British Columbia (10–20%), Washington (5–7%), Oregon (6–7%), California (7–10%) and Baja California (<1%). Unlike colonial nesters, breeding Black Oystercatchers are widely dispersed along areas of suitable habitat; consequently, areas of particular importance tend to be regions, not discrete points. Important breeding areas (>1% of population) include (Table 2): the Aleutian Islands (16%); the southern coast of the Alaska Peninsula (10%); the Kodiak Island Archipelago (19%); Middleton Island (7%); Prince William Sound (5%); Glacier Bay (4%); the Queen Charlotte Islands (7%); Vancouver Island (10%); the Strait of Georgia (1%); Puget Sound (3%); Washington State outer coast (2%); Oregon mainland coast (3%); Oregon outer coast (3%) and the Channel Islands (3%). Cleland Island, British Columbia, (<1%) is notable for its density of breeding oystercatchers: 44 pairs in 8 ha (Clarkson *et al.* 2005).

Little information exists on the locations of important wintering concentrations or the number of birds in those areas. Despite initial efforts to document migration patterns of Black Oystercatchers (Johnson *et al.* 2010), gaps in our knowledge of migratory connectivity and non-breeding distribution are substantial impediments to the conservation of the Black Oystercatcher, and to understanding how the species is likely to respond to natural or anthropogenic perturbations (e.g. climate change, oil spills).

DEMOGRAPHIC AND MECHANISTIC CAUSES OF POPULATION CHANGE

The scarcity of data on historical population size, local and regional population trends, and important demographic parameters (adult survival, recruitment age, and reproductive lifespan) pose a considerable limitation to our comprehension of the factors that may regulate population size in this species. These deficits also hinder the development of models for long term viability or potential recovery following any future decline.

There are few documented population changes in the historical record upon which to draw inferences about underlying mechanisms. The majority of cases involve the rebound

Table 1. Range-wide breeding season population estimates (number of individuals) for Black Oystercatchers.

Location	Population estimate	Source
South-western Alaska / Aleutian Islands	2,000–3,000	Andres & Falxa 1995
South-central Alaska	2,500–3,000	Andres & Falxa 1995, Gill *et al.* 2004
South-eastern Alaska	1,000–2,000	Andres & Falxa 1995
British Columbia	1,000–2,000	Jehl 1985, Campbell *et al.* 1990
Washington	470–720	Speich & Wahl 1989, Lyons *et al.* 2012
Oregon	560–660	Naughton *et al.* 2007, Lyons *et al.* 2012
California	700–1,000	Sowls *et al.* 1980
Baja California	80	Palacios *et al.* 2009
Total	**8,300–12,500** **≈10,000**	Andres *et al.* 2012

of local populations following an external perturbation. In most cases, however, pre-disturbance population estimates were either imprecise or nonexistent. Consequently, estimates of both the magnitude of the disturbance and the subsequent recovery are speculative and based on untestable assumptions about the relationship between historical and present-day population levels. Nonetheless, the scant data suggest that: 1) Black Oystercatcher populations are ultimately regulated by the availability of high-quality nesting and foraging habitat; and 2) that the quality habitat is more or less saturated at the moment. Habitat quality in this sense depends in part on predation risk; some otherwise suitable habitat may remain unoccupied in areas exposed to high densities of avian or terrestrial mammalian predators (i.e. portions of Prince William and Sitka Sounds). When more quality habitat becomes available populations expand, and when habitat is lost or altered populations decrease.

Limited amounts of new habitat may be created through the exposure of gravel moraines by retreating glaciers, isostatic rebound following deglaciation, and by the deposition of rocky debris in intertidal zones by avalanches and landslides (Lentfer & Maier 1995). The small amounts of new nesting habitat made available by these processes are likely to decrease over time as seral development proceeds (Tessler *et al.* 2007). However, tectonic forces can create (or destroy) large quantities of oystercatcher nesting habitat (Gill *et al.* 2004). In 1964, uplift resulting from a massive earthquake created new nesting and foraging habitat on

Table 2. Important breeding sites (>1% of global population) for Black Oystercatchers (*Haematopus bachmani*).

State / Province	Region	Site	Count or estimate (individual birds)	Year(s)	Source
Alaska	Aleutian Islands	Western Aleutians Eastern Aleutians	637 998	1973–2003 1980–1981	NPPSD, Drew & Piatt 2005 Nysewander *et al.* 1982
Alaska	Alaska Peninsula	Shumagin Islands AK Peninsula (E of Pavlov Bay)	148 846	1995 1973–2003	Byrd *et al.* 1997 NPPSD, Drew & Piatt 2005
Alaska	Kodiak Archipelago	Afognak and Shuyak islands Kodiak Island Chiniak Bay	326 ~1,350–1,750 ~100–150	1973–2003 1994–2005 1976	NPPSD, Drew & Piatt 2005 D. Zwiefelhofer unpubl. data Dick *et al.* 1977
Alaska	Middleton Island	Middleton Island	703–750	2006	Guzzetti 2008
Alaska	Prince William Sound	Eastern PWS Western PWS	378 188	1999–2005 1999–2005	A.Poe unpubl. data Meyers 2002
Alaska	Glacier Bay	Glacier Bay	395	2000	Bodkin *et al.* 2001
British Columbia	Queen Charlotte Islands	Various sites (see sources)	679	1986 1986 1990 2006 1991 1988	Rodway *et al.* 1990 Vermeer *et al.* 1992 A.J. Gaston pers. comm. Rodway & Lemon 1991a Rodway & Lemon 1991b
British Columbia	Vancouver Island	Various sites (see sources)	1,028	1989–1990 1989 1988 1989 2000–2005 ~1985	Vermeer *et al.* 1992a Rodway *et al.* 1992 Rodway & Lemon 1990 Vermeer *et al.* 1991 Clarkson *et al.* 2005 Campbell *et al.* 1990
British Columbia	Strait of Georgia	51 islands in the Strait	134 184	1987 2006	Vermeer *et al.* 1989 Butler & Golumbia 2006
Washington	Puget Sound		321	2006	Lyons *et al.* 2012
Washington	Outer coast	Cape Flattery to Point Grenville	200–220	1973–1982	Nysewander 1977 Speich & Wahl 1989
Oregon	Mainland coastline	Entire coast	311	2006	Lyons *et al.* 2012
Oregon	Offshore islands	Entire coast	276	1988–2004	Naughton *et al.* 2007
California	Channel islands	Channel islands	267	1989–1991	Carter *et al.* 1992

Middleton Island in the Gulf of Alaska. Although 405 ha of new supratidal nesting habitat became available immediately, the surrounding intertidal community took some time to develop. Middleton Island was first colonized by oystercatchers in 1976 and by 1994 had 37 breeding pairs. The population continued to expand to a maximum 781 oystercatchers (285 breeding pairs) in 2004, but then apparently decreased slightly to just over 700 (about 240 pairs) in 2005 and 2006 (Guzzetti 2008). Between 20 August and 19 September 2013, observers recorded between 481 and 609 (average = 528.4) birds during five coastal surveys of Middleton; these numbers included hatch-year birds but not any failed breeders that departed the island (L. DeCicco unpubl. data).

The major agent for reducing populations appears to be anthropogenic habitat alteration in a variety of forms. In the few cases on record, the declines in habitat quality or availability have been either temporary or reversible, and Black Oystercatchers have demonstrated an ability to reestablish shortly after a disturbance is removed or the missing habitat is restored. The 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska, had dramatic immediate impacts on local Black Oystercatcher populations and persisting contamination slowed recovery by depressing breeding effort and chick survival (Andres 1997). Between 4% and 20% of the population in the *Exxon Valdez* spill area was thought to have been killed by oiling (Andres 1994b). Within four years, breeding pairs occupied territories left vacant in the years immediately after the spill (Andres 1997). Nine years post-spill, local recovery was assumed in part because oystercatcher numbers in oiled zones had increased by 27% while numbers in un-oiled areas remained constant (Murphy and Mabee 1999, 2000). Oil spills are likely to have a severe impact when they occur in Black Oystercatcher habitat, but recovery is likely to occur if oil is removed and previous shoreline conditions are reestablished.

Predation and interference by introduced and feral mammals has had significant, negative effects on Black Oystercatcher populations. Introduction of foxes caused local extirpations from many islands along the coast of Alaska. For example, eradication of introduced foxes on several Aleutian Islands resulted in recolonization of the islands within 10 years (Byrd 1988, Byrd *et al.* 1997). Seven years after domesticated animals were removed from South Farallon Island, California, 20 breeding pairs had become established (Ainley & Lewis 1974). Similarly, the number of breeding birds on Destruction Island, Washington, increased from 8 to 24 individuals seven years after the presence of humans was reduced with the automation of the island's lighthouse (Jewett 1953, Nysewander 1977). Depositions of marine debris have caused abandonment of previously occupied territories on the west coast of Vancouver Island, British Columbia, with nesting becoming reestablished once the debris was removed (P. Clarkson unpubl. data). In Sitka Sound, Alaska, the number of breeding pairs may have declined nearly 80% from 38 pairs in 1940 to 8 pairs in 2007 due in part to beach-cast logs from local timber operations (Andres and Christensen 2009). An unpublished 2006 survey suggests there may be as many as nine additional breeding pairs in the vicinity, which would still represent a 45% decline from 1940 numbers (D. Tessler unpubl. data). Whereas coastal development and the beaching of sawmill logs clearly eliminated some nesting habitat, the lack of occupancy by pairs at other historic nest sites in Sitka Sound is more perplexing.

CONSERVATION STATUS

Haematopus bachmani is listed as a 'species of high concern' in the shorebird conservation plans of the United States, Canada, Alaska, and Northern and Southern Pacific coastlines (Donaldson *et al.* 2000, Drut & Buchanan 2000, Brown *et al.* 2001, Hickey *et al*. 2003, Alaska Shorebird Group 2008). It is a management indicator species in the Chugach National Forest Plan, was selected as a U.S. Fish and Wildlife Service 'Focal Species for Priority Conservation Action', and is an indicator used by Parks Canada to monitor long-term ecological health of coastal shoreline and intertidal areas (U.S. Forest Service 2002, U.S. Fish and Wildlife Service 2002, Tessler *et al.* 2007, P. Clarkson pers. comm.). The Black Oystercatcher is also a 'featured species' in the Wildlife Action Plans for the states of Alaska, Washington, Oregon, and California (Alaska Department of Fish and Game 2005, Washington Department of Fish and Wildlife 2005, Oregon Department of Fish and Wildlife 2005, California Department of Fish and Game 2007). Conservation concern for the Black Oystercatcher is a consequence of the species' small population size and restricted range, threats to its obligatory shoreline habitat, and its susceptibility to a suite of ongoing anthropogenic and natural factors that may potentially limit long-term viability.

In contrast, the International Union for Conservation of Nature (IUCN) evaluated the Black Oystercatcher in 2008 and classified it a taxon of Least Concern (IUCN 2008). The Black Oystercatcher approaches a Near Threatened designation under two IUCN criteria, 'Population Size' and 'Geographic Range' [note: Near Threatened is defined as a taxon that 'does not qualify for Critically Endangered, Endangered, or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future']. The current global population estimate (range = 8,300–12,000; midpoint = 10,000 mature individuals) already verges on the IUCN Population Size threshold for 'concern' (<10,000 mature individuals). The range of the Black Oystercatcher is also small enough to meet the IUCN Geographic Range criteria for concern by both 'extent of global occurrence' (<200,000 km^2) and 'area of occupancy' (<2,000 km^2) measures. The current IUCN determination is based on an erroneously large estimate of 260,000 km^2 for the 'global extent of occurrence'. In actuality, Black Oystercatchers occur along ca. 63,500 linear km of potential habitat, not all of which is suitable. The rocky intertidal is a spatially constricted zone, generally only tens of meters wide. Because this rocky intertidal obligate species is completely confined to this narrow band of habitat throughout its life cycle, the actual 'extent of global occurrence' is likely to be of the order of 2,000 km^2, assuming an average shoreline width of ca. 30 m and all the shoreline is suitable. Because the entire shoreline is not actually suitable for oystercatchers, the actual "area of occupancy" likely approaches 1,000 km^2.

Yet despite its small population and restricted range, the Black Oystercatcher does not currently meet all IUCN criteria for designation as Near Threatened. There is no evidence of a current or ongoing population decline, although we highlight that the current absence of evidence for a decline may just as likely be an artifact of inadequate survey and trend data as it is an indication of true population stability. Neither the current geographic range nor the occupancy of specific sites are suspected to be decreasing or fluctuating. For the moment, the small population size of

Black Oystercatchers distributed from the Aleutian Islands to Baja California remains apparently stable and is unlikely to suffer a dramatic population-level decline from any single stochastic event or local land use action. Parameters associated with global change, however, could potentially have profound effects on population size, distribution, or both, pushing the taxon into a Near Threatened or even Vulnerable IUCN designation. For example, rising sea-levels could diminish the amount of available nesting habitat, especially in the population centers in the north where nesting occurs primarily on low-angle beaches along tidal margins. A change in sea level might also alter intertidal communities and affect the availability of preferred prey. Ocean acidification, as a result of the ongoing oceanic uptake of atmospheric CO_2, also has the potential to substantially impact Black Oystercatchers as a function of the unknown impacts of shell decalcification which could affect all of its primary prey species.

THREATS

See Appendix 1 of the Black Oystercatcher Conservation Action Plan (Tessler *et al.* 2007) for a detailed account of potential threats to the species. The assessment follows a modified version of the *Unified Classifications of Direct Threats and Conservation Actions* (Salafsky *et al.* 2008). The following section combines threat categories and includes only those considered to pose the highest conservation risks.

Predation on eggs, chicks and adults

Predation is the major cause of mortality to eggs and chicks (Morse *et al.* 2006, Spiegel *et al.* 2006, Tessler & Garding 2006, Spiegel 2008, D. Tessler unpubl. data). In a study of productivity at four breeding areas in Alaska from 2003 to 2006, predation accounted for 48% of all egg losses where a cause could be positively identified (range = 31–85%, n = 407 eggs). Because 27% of all egg losses were of unknown cause, egg depredation could be higher. In Alaska, egg predators include mink *Mustela vison*, marten *Martes americana*, river otter *Lontra canadensis*, sea otter *Enhydra lutris*, wolverine *Gulo gulo*, red fox *Vulpes vulpes*, arctic fox *Vulpes lagopus*, brown bear *Ursus arctos*, black bear *Ursus americanus*, Glaucous-winged Gull *Larus glaucenscens*, Northwestern Crow *Corvus caurinus* and Common Raven *Corvus corax*. In the southern portion of the range, the suite of egg predators also includes raccoon *Procyon lotor*, striped skunk *Mephitis mephitis*, and domestic and feral cats and dogs (Webster 1941, Kenyon 1949, Vermeer *et al.* 1989, 1992, Spiegel *et al.* 2006, Spiegel 2008, R. Butler pers. comm., G. Falxa pers. comm., B. Andres unpubl. data). In Baja California, domestic cats and coyotes *Canis latrans* are suspected predators (Kenyon 1949, B. Walton pers. comm.).

Egg predators also prey on small chicks, with chicks being most vulnerable during the first two weeks after hatching (Andres & Falxa 1995). Although average hatching success on Middleton Island, Alaska, was between 65% and 90% in the early 2000s (Gill *et al.* 2004, Guzzetti 2008), predation of young chicks by Glaucous-winged Gulls was largely responsible for reducing fledging success to 16% (B. Guzzetti unpubl. data). Common Ravens, Bald Eagles *Haliaeetus leucocephalus*, and possibly foxes take larger chicks (Webster 1941, Nysewander 1977, B. Andres unpubl. data). Eradication of foxes on several Aleutian Islands resulted in re-colonization by oystercatchers (Byrd 1988, Byrd *et al.* 1997). In the southern portion of the range, predation on eggs and young by both birds and mammals is probably a significant selective force for nesting on offshore rocks; nests are rare on accessible mainland sites (Nysewander 1977, Campbell *et al.* 1990, G. Falxa pers. comm.) and nests on beaches accessible to mammalian predators have higher predation rates than nests on offshore rocks (Vermeer *et al.* 1992). Pinnipeds hauling out on land may also cause decreased reproductive success by crushing eggs and chicks and causing oystercatchers to leave nest sites during incubation or brooding periods (Warheit *et al.* 1984). Predation on free-flying Black Oystercatchers is poorly documented. In California, Peregrine Falcons *Falco peregrinus* have been observed preying on oystercatchers, and Bald Eagles *Haliaeetus leucocephalus* have been twice observed taking adult oystercatchers perched on rocks on Vancouver Island, British Columbia (P. Clarkson unpubl. data).

Human predation may potentially impact Black Oystercatchers in areas where subsistence harvest is allowed. Due to their strong fidelity to breeding territories, easy accessibility, conspicuous behavior, and limited reproductive potential, they are particularly vulnerable to local extirpation through persistent subsistence harvest of either breeding adults or eggs. Subsistence harvest of Black Oystercatchers and their eggs is currently allowed for native peoples in Alaska and Canada. According to the most recent data available from the Alaska Migratory Bird Co-Management Council (AMBCC 2014), there were only 22 oystercatchers and 302 oystercatcher eggs harvested in Alaska between 1992 and 2000. While adults and eggs continue to be harvested legally, contemporary harvest estimates (data through 2010) indicate that the level of take varies among years, with most harvest occurring in the Aleutian, Pribilof, and Kodiak Island regions. There are no estimates of harvest for eggs or adults from 2001–2003. No harvest was reported in 2004, 2007, 2009, and 2010. In 2005 harvest estimates included 39 adults and 294 eggs; in 2006 no adults but 302 eggs, and 2009 64 adults and 172 eggs (Naves 2010a, 2010b, 2011, 2012). It is important to note that these estimates are based upon voluntary household surveys that incompletely canvass the region and participation rates vary annually. As a consequence these estimates must be approached judiciously.

Petroleum contamination of shorelines

Shoreline contamination, especially from petroleum spills, is a threat throughout the species' range. The 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska, killed between four and 20% of the population in the spill area, disrupted breeding activity for 39% of pairs attempting to nest on oiled shorelines, and significantly reduced chick survival (Andres 1997). Post-spill clean-up activities continued to disrupt breeding birds into 1990 (Andres 1997). The presence of elevated hydrocarbon concentrations was detected in faeces of chicks in 1993 (Andres 1999). In a 2004 study, P450 analysis of liver biopsies from oystercatchers nesting in oiled areas of Prince William Sound showed evidence of continued trophic uptake of oil residues for more than 15 years (B. Balachey pers. comm.).

In addition to oil tanker traffic, freight vessels also pose a potential threat of oil and fuel contamination. Currently,

>3,500 ships per year pass through the Aleutian Islands (which support about 16% of the world's Black Oystercatchers) in transit between North America and Asia (Brewer 2006). Ship traffic through this region is projected to increase and account for 5% of global trade volume by 2050 (Arctic Council 2009). This expansion of ship traffic will increase the risk of fuel spills like the *M/V Selandang Ayu*, which in 2004 released >1 million liters of fuel oil and diesel into the near shore waters of Unalaska Island, Alaska (Brewer 2006). Furthermore, oystercatchers and their prey may be at risk from low-level contamination by diesel fuel, gasoline, oil residues, and other contaminants along shorelines resulting from oil tankers expelling water from their ballast tanks and increased use of personal watercraft.

In the southern portion of the range, oystercatchers may face significant pressures from urban growth. Expanding human population and infrastructure may pose management concerns for oystercatchers through attendant effects on increasing vessel traffic and the growing potential for coastal contamination from industrial and residential sources. In northern Puget Sound, Washington, approximately 57 billion litres of oil were transported through the area in 2002. Refineries there are located to the northeast and southeast of the San Juan Islands, a year-round aggregation site for Black Oystercatchers. Six major oil spills occurred in northern Puget Sound from January 1994 to February 2003 (http://www.ecy.wa.gov/ecyhome.html).

Flooding and recreational disturbance at nest sites

Clutches are regularly lost to high tides or wave action, especially in the northern region where the majority of nests occur on low-sloping gravel beaches and wave cut platforms. While Andres & Falxa (1995) found flooding was responsible for less than 10% of losses in Prince William Sound, a three year study of four Alaskan breeding areas demonstrated that flooding was responsible for 28% of attributable nest losses overall (n = 572 clutches), with differences between areas and years ranging between 3–63% (D. Tessler unpubl. data). Periods of particularly high tides, storm surges, tsunamis, and boat wakes may all contribute to nest flooding. In an area of high breeding density (e.g. Harriman Fjord, Prince William Sound, Alaska), a single wave event coincident with monthly high tides could destroy the majority of nests. In Oregon, the loss of two nests built in depressions was attributed to flooding by rain (E. Elliott-Smith unpubl. data).

Growing pressure from recreational activities in and around breeding areas could also have deleterious effects. Oystercatcher productivity was unaffected by low levels of recreational activity, principally kayak camping, in Kenai Fjords National Park, Alaska, during the early 2000s (Morse *et al.* 2006). However, it is possible that an increasing human presence by campers, kayakers, and fishermen in remote coastal areas may directly impact oystercatcher productivity in the future through inadvertent trampling of nests and eggs, or indirectly through interference with foraging, parental care, or causing nest abandonment. Expanding human population and the subsequent increased usage of oystercatcher habitat by recreationists are management concerns in the southern portion of the species' range. Oystercatcher nests in Oregon and Washington have been located in or near areas that receive frequent visits by humans and dogs. In Oregon, the majority of nests accessible to humans failed, presumably as a result of high disturbance levels (E. Elliot-Smith pers. comm.). In Gulf Island National Park, British Columbia, islets with known oystercatcher nesting activity in Gulf Islands National Park are permanently closed to human use. (T. Golumbia pers. comm.).

The susceptibility to flooding may be exacerbated by growing boat traffic, especially in Alaska, where important breeding areas in Prince William Sound, Kenai Fjords, and Glacier Bay are receiving ever-increasing pressure from the tourist industry. Growing visitation by private boats, sightseeing vessels, water taxis, and cruise ships heightens the probability that nests will be flooded by large wakes, especially when vessel traffic coincides with periods of the highest tides. Easing vessel size and displacement restrictions in certain protected areas (e.g. Glacier Bay National Park) could further exacerbate this problem.

Deposition of marine debris

The availability of suitable nesting habitat can decline locally as a consequence of debris from a variety of sources being deposited on the shoreline. Large volumes of shorecast logs from local timber operations that piled up on beaches once favored by breeding oystercatchers are thought to be one of the principal factors for a reduction in breeding pairs in Sitka Sound, Alaska (Andres & Christianson 2009). Inundations of miscellaneous marine debris and garbage have caused abandonment of previously occupied oystercatcher nesting territories on Vancouver Island (P. Clarkson unpubl. data).

Amelioration of threats in protected lands

Many of the key breeding and wintering areas for Black Oystercatchers are on lands already in protected conservation status; they are largely federal, state and provincial parks, refuges, and forests. The blanket legal protection of these lands, however, affords little protection from many of the greatest natural and anthropogenic threats facing oystercatchers. Sites on protected lands are not immune to the effects of predation, tidal and wave flooding, recreation, and shoreline contamination.

In Alaska, the practical consequences of federal land protection are unclear for oystercatchers. The state of Alaska retains ownership (and management authority) of all tidelands and submerged lands from mean high tide seaward (to three statute miles), regardless of who owns the uplands. The net result is that the federal government may protect roosting and nesting habitat, but foraging habitat is under the state's control. Where the uplands are within federal conservation units, Alaska often cooperates with federal land managers, but may elect to develop or lease tidelands under several programs. Ultimately, the conservation of this species will depend greatly on our understanding of local populations and on creative management responses to local limiting factors.

Climate change and severe weather effects on prey availability

It is widely recognized that Black Oystercatchers primarily forage on intertidal invertebrates (Hartwick 1976, Falxa 1992, Andres 1996). Little is currently known how these communities may be affected by climate change (Barry *et al.* 1995, Sagarin *et al.* 1999), although it seems likely that ocean acidification will cause physiological changes to intertidal invertebrates (Wolfe *et al.* 2013), and that warming temperatures, sea level rise and increased storm frequency may alter the availability and distribution of these invertebrates (Helmuth *et al.* 2006). These changes may be harmful to Black Oystercatchers given recent stable isotope analyses that suggest their diet varies little across two regions in the Gulf of Alaska (Carney 2013) and has remained consistent over the past 100 years (B. Carney unpubl. data).

RECOMMENDATIONS FOR RESEARCH

1. Assess non-breeding distribution and migratory connectivity between breeding and wintering areas

It is critical to determine the locations of important wintering areas, the number of birds using those areas, routes between breeding and wintering sites, and key stopovers. Concurrently, we need to understand inter-seasonal habitat use, and important limiting factors and threats faced by adults and juveniles during the non-breeding period. Preliminary efforts have begun to address some of these issues by placing VHF and satellite transmitters on oystercatchers in a limited number of locations in Alaska and British Columbia (Johnson *et al.* 2010). Additional movement studies and dedicated surveys throughout the species' range and annual cycle are necessary.

2. Develop and refine breeding habitat suitability models to target survey efforts and improve population estimates

Population estimates are pieced together from a variety of spatially limited and often incompatible data sources, and a considerable portion of the range has never been surveyed. Given that approximately 25,000 km of shoreline in southeastern Alaska and the majority of British Columbia coastline remain un-surveyed, any systematic effort to census oystercatcher populations in these vast areas would be cost prohibitive. Costs could be minimized, however, if surveys were stratified by habitat and targeted primarily at areas likely to support oystercatchers. Furthermore, accuracy of global population estimates could be improved with better understanding of the relationship between breeding density and habitat type. This action item would use geospatial habitat modeling to create spatially explicit estimates of the likelihood of encountering oystercatchers, which in turn could be used to target and stratify surveys, and to extrapolate population densities from randomly sampled areas to the entire survey area.

3. Estimate population size of Black Oystercatchers breeding in the southern portion of the range

A comprehensive, standardized survey to estimate population size is particularly important in the southern portion of the range where oystercatchers are more widely, but sparsely distributed, and population estimates are based on seabird surveys conducted mainly in the 1980s. This action will establish a reliable baseline and strong foundation from which to initiate specific conservation actions and assess changes in trend over time.

4. Initiate coordinated range-wide monitoring to estimate population size and detect trends

Although the species' population is believed to be stable, local trend data are virtually nonexistent, and broad-scale trends remain unknown. Current population estimates are based largely on incidental surveys that are neither standardized nor specifically target oystercatchers. Evaluating the actual population size, status, and trend — and hence the true conservation status — will require a coordinated, range-wide monitoring effort that is not yet in place. Due to the immense cost of systematic coastal surveys, we recommend periodic monitoring of important breeding areas throughout the range (such as those being conducted in portions of Alaska). Periodicity, methods, and timing must be coordinated among the various jurisdictions.

5. Initiate research to assess the impacts of vessel traffic and resulting wakes on productivity

Extremely high levels of nest loss (up to 63%) are due to inundation with seawater at several important breeding areas in Alaska: Prince William Sound, Glacier Bay, and Kenai Fjords (Morse *et al.* 2006, Tessler & Garding 2006, Spiegel *et al.* 2006, Guzzetti 2008, Spiegel 2008, D. Tessler unpubl. data). Because this species nests close to the tidal limits, there is a real concern that when scheduled visits from tour boats or cruise ships coincide with unusually high tide events, entire populations of nests within a geographic area could be destroyed on a recurring basis. We do not yet know the extent of the threat, or with what frequency it occurs; it may be significant enough to warrant some action on the part of management agencies (e.g. staggering vessel visitation schedules to avoid wakes at the times of highest tide events, recommending operators to run slowly at the highest annual tides in May and June, and education and outreach to operators). Periodic nest visits by researchers have not been sufficient to determine whether nest failure was a result of tidal flooding or an overwash from a boat wake. Thus, we suggest initiating research to discriminate between short, abrupt flooding events due to a wave or wake from a slower, consistent tidal inundation, and monitor the effects of wakes on Black Oystercatcher hatching success, re-laying effort, and productivity.

6. Investigate survival and other vital rates by continuing to follow the fate of banded populations

Various banding projects have been initiated at local sites across the range. Pacific Rim National Park is currently banding and monitoring Black Oystercatchers as part of its long term Ecological Monitoring Program. The Laskeek Bay Conservation Society continues to monitor oystercatchers and band chicks in Laskeek Bay and in Gwaii Haanas National Park, in the Queen Charlotte Islands, British Columbia. Between 2003 and 2007, 512 Black Oystercatchers (4–6% of the global population) were individually colour banded in Alaska, including 296 adults and 216 chicks. This coordinated effort took place during the breeding season at Kenai Fjords National Park, Middleton Island, Harriman Fjord in Prince William Sound, and the Beardslee Islands in Glacier Bay National Park. In each of these areas, a collaborative productivity study was conducted between 2004 and 2007. This study provided important preliminary demographic information, but the time span did not allow precise estimation of critical vital rates including adult survival, life span, and age of first reproduction. These marked populations represent a tremendous opportunity to determine fundamental demographic parameters at some of the most important breeding sites in the core of the range. We propose that continued marking (and remarking for those individuals whose bands have fallen off) and annual monitoring of the marked individuals at these sites is a vital step in the continuing assessment of population status.

7. Assess factors affecting survival and reproductive success in the southern portion of the range and determine the relative importance of each

Although intensive productivity investigations have been conducted in Alaska and portions of British Columbia, productivity is not well studied in the southern portion of this species range. The only productivity information available is from a small study conducted in the inner marine waters of Washington in the late 1970s. As a long-lived species, long-term declines in reproductive success or recruitment could lead to local extirpations. While surveys represent one very important tool for assessing the conservation status of this species, monitoring reproductive success is also essential, as declines may not be immediately apparent if adult survival is high. An assessment of the relative importance of factors limiting productivity in the southern half of the range is integral to maintaining the viability of the species and the extent of its geographic range. This assessment will allow a more comprehensive understanding of the species' ecology and will help determine if specific management actions (predator control, recreation regulations, etc.) might ensure the persistence of local populations.

8. Assess Black Oystercatcher food adaptability and impacts of climate change on the intertidal invertebrates

Stable isotope studies suggest Black Oystercatchers may show little flexibility in their selection of prey. Additional research is needed to verify how adaptable oystercatchers are to changing prey abundance and distribution, and how climate change may impact the prey physiology, distribution, and abundance.

RECOMMENDATIONS FOR MANAGEMENT

1. Develop an Online International Black Oystercatcher Conservation Database

Prior to the development of Black Oystercatcher Conservation Action Plan (Tessler *et al.* 2007), the International Black Oystercatcher Working Group began to develop a range-wide database of 1) distribution and abundance data, 2) current research and conservation actions underway, 3) an assessment of localized threats, and 4) associated literature on the species. However, this database was never completed, nor was it formatted to facilitate sharing with more commonly used North American databases such as the Northern Pacific Pelagic Seabird Database, National Biological Information Infrastructure (NBII – U.S.A.), eBird, the Avian Knowledge Network, Global Biodiversity Information Facility (GBIF), and ORNIS. This action item will create an online, searchable repository of Black Oystercatcher data and methodologies that will be instrumental in identifying information gaps, tracking local or regional population changes, and facilitating trans-jurisdictional collaboration. Methodologies would include detailed, standardized protocols for conducting surveys, productivity assessments, methods for capturing birds, colour banding protocols, etc., to facilitate the use of common practices and to increase the comparability of data collected in the future. The database will be centrally managed, organized, and updated, as well as an index of associated literature that references where the various datasets reside and who owns them. Development of this database would necessarily be a key component for many priority actions listed here.

2. Develop a geospatial risk analysis for regions where human activities potentially overlap the seasonal distribution of Black Oystercatchers

This priority action item will determine areas where human-oystercatcher conflicts are likely to occur by overlaying the distribution of oystercatchers with human use. Existing and new information on Black Oystercatchers (distribution and abundance of breeding, migrating, and wintering birds throughout the range) must first be mapped. Concurrently, relative geographic exposure to various anthropogenic threats must be assessed, compiled, and mapped (e.g. major oil tanker, freighter, and cruise routes; potential point sources of contamination; risk of predation from domestic, feral, or introduced species; areas facing growing recreational disturbance, etc.). Ultimately, these two sources of geographic information can be combined within a GIS to identify the risks faced by various segments of the population throughout the annual cycle. This action item may need to be initially implemented at local or regional levels, especially in cases where known human-oystercatcher conflicts currently exist and immediate action to reduce disturbance is needed.

3. Initiate an education and outreach program to highlight the potential impacts of outdoor recreation and vessel traffic

Expanding human population and growing recreation in coastal areas important to oystercatchers may pose direct and indirect threats to productivity (see *Threats*). We propose a program of education and outreach directed towards mitigating losses at breeding areas from human disturbance. We propose targeting three separate groups with tailored campaigns: 1) boat operators (including recreational boaters, tour operators, cruise lines, water taxis, and other commercial vessel operators) on how to avoid swamping oystercatcher nests with wakes during periods of the highest tides; 2) recreationists and sightseers (including kayakers, campers, backcountry tour operators, and outdoor leadership schools) on recognizing breeding territories and selecting camping sites to avoid oystercatcher territories and mitigating recreational impacts on breeding oystercatchers and other ground nesting shorebirds; and 3) pet owners in coastal areas on how to recognize breeding territories, and keeping pets leashed in breeding areas to prevent losses to eggs and chicks. Each target group will likely require a variety of materials and methods of outreach. To be successful, the approaches will have to be tailored locally. The first steps are to census partners and inventory the educational materials on these topics currently available and in use, and then to work with partners to develop an overall strategy to increase awareness of human-oystercatcher interactions throughout the range. The development of the materials and on-the-ground campaigns will require a high degree of local input from stakeholders and partners. This is a range-wide need; however, partners may feel that approaching it regionally would work best. Eventually, site management plans should be developed in collaboration with partners and users, which could include shoreline site closures for breeding sites that are highly susceptible to human-induced disturbance or have high densities of breeding oystercatchers. Education programs and management plans should be monitored to assess their efficacy in reducing human-induced, negative effects on oystercatcher productivity and survival.

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LEGAL STATEMENT

Haematopus bachmani is protected under international conventions between the United States, Canada, and Mexico that make the taking, killing, or possessing of listed birds unlawful. These conventions decree that migratory birds and their parts (including eggs, nests, and feathers) are fully protected, outside of tightly specified exceptions. The Convention Between the United States and Great Britain (for Canada) for the Protection of Migratory Birds was signed at Washington, D.C., on 16 August 1916, and ratified by the United States on 1 September 1916, and by Great Britain on 20 October 1916. Documents of ratification were exchanged on 7 December 1916. Implementing legislation for the United States was accomplished by enactment of the Migratory Bird Treaty Act and by the Migratory Birds Convention Act in Canada. The Convention between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Mammals was signed in Mexico City, 7 February 1936. This treaty was ratified by the President of the United States on 8 October 1936, and documents of ratification were exchanged on 15 March 1937, in Washington, D.C. Amendments to these conventions to establish a legal framework for the subsistence take of birds in Alaska and northern Canada by Alaska Natives and Aboriginal people in Canada were formally implemented in 1999.

KEY CONSERVATION SITES

A listing of key breeding sites with greater than 1% of the global population may be found in Table 2. Key wintering areas with the exceptions of sites on Kodiak, Green and Vancouver Islands remain largely unknown.

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APPENDIX. OVERVIEW OF RECENT STUDIES AND RESEARCH

This paper is a condensation of the 2007 'Black Oystercatcher Conservation Action Plan'. The Action Plan represents a collaborative effort, drawing on the expertise of professionals from federal and state agencies and NGOs in the United States, Canada, and Mexico , and is intended to be the single strategic planning resource for the conservation of this species throughout its range. The Action Plan includes an exhaustive review of potential threats and conservation challenges, and a much more detailed set of research, policy, and management actions for addressing those challenges. In addition, the Action Plan includes references on recent and ongoing work, much of which has yet to be published, and it contains a complete listing of individuals and institutions involved in the research, management, and conservation of this species. A thorough collection of references may be found in Tessler *et al.* (2007) and Andres & Falxa (1995) – see above in References.