Recovery Strategy for the Northern Goshawk, *laingi* subspecies (*Accipiter gentilis laingi*) in British Columbia

Prepared by the Northern Goshawk *Accipiter gentilis laingi* Recovery Team

BRITISH COLUMBIA
The Best Place on Earth

Ministry of Environment

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About the British Columbia Recovery Strategy Series

This series presents the recovery strategies that are prepared as advice to the Province of British Columbia on the general strategic approach required to recover species at risk. The Province prepares recovery strategies to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

A recovery strategy represents the best available scientific knowledge on what is required to achieve recovery of a species or ecosystem. A recovery strategy outlines what is and what is not known about a species or ecosystem; it also identifies threats to the species or ecosystem, and what should be done to mitigate those threats. Recovery strategies set recovery goals and objectives, and recommend approaches to recover the species or ecosystem.

Recovery strategies are usually prepared by a recovery team with members from agencies responsible for the management of the species or ecosystem, experts from other agencies, universities, conservation groups, aboriginal groups, and stakeholder groups as appropriate.

What's next?

In most cases, one or more action plan(s) will be developed to define and guide implementation of the recovery strategy. Action plans include more detailed information about what needs to be done to meet the objectives of the recovery strategy. However, the recovery strategy provides valuable information on threats to the species and their recovery needs that may be used by individuals, communities, land users, and conservationists interested in species at risk recovery.

For more information

To learn more about species at risk recovery in British Columbia, please visit the Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

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Mike Stini. Adult female Northern Goshawk (*Accipiter gentilis laingi*) on Vancouver Island, British Columbia.

Additional copies

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Disclaimer

This recovery strategy has been prepared by the Northern Goshawk *Accipiter gentilis laingi* Recovery Team, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The British Columbia Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Canada*, and the *Canada – British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies that are deemed necessary, based on the best available scientific and traditional information, to recover Northern Goshawk, *laingi* subspecies, populations in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new objectives and findings.

The responsible jurisdictions and all members of the recovery team have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals on the recovery team.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this strategy. The Ministry of Environment encourages all British Columbians to participate in the recovery of the Northern Goshawk, *laingi* subspecies.

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RESPONSIBLE JURISDICTIONS

The recovery strategy for Northern Goshawk, *laingi* subspecies was developed by the Northern Goshawk *Accipiter gentilis laingi* Recovery Team on behalf of the Province of British Columbia.

Northern Goshawk *laingi* subspecies populations occur throughout coastal forests of British Columbia, including some provincial and national parks. The British Columbia Ministry of Environment is responsible for producing a recovery strategy for this species under the *Accord for the Protection of Species at Risk in Canada.* Parks Canada Agency and Environment Canada's Canadian Wildlife Service participated in the development of this recovery strategy. In addition, Northern Goshawk *laingi* subspecies occurs in southeast Alaska and Washington and so their populations are considered trans-boundary to the United States. The U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game also participated in the preparation of this recovery strategy.

ACKNOWLEDGEMENTS

The recovery team thanks Ian Dodd, Jamie Smith, Mike Stini, Russ Dawson, Louise Blight, Barb Johnson and Wayne Wall, and former members of the recovery team for their assistance in discussions and feedback that helped form earlier versions of this recovery strategy. External reviews provided by Trish Hayes, Pat Kennedy, Marie-Joseé Laberge, Dave Lindsay, Richard Pither, and Karen Wiebe greatly improved the quality of this strategy. As well, Tanya Dunlop and Linda Sinclair assisted in creating the range map.

EXECUTIVE SUMMARY

The Northern Goshawk is a raven-sized predatory bird with short, rounded wings and a long tail. Immature birds differ from adults in their plumage colouration for the first 2 years, after which all individuals ≥3 years are indistinguishable. Two subspecies of Northern Goshawk reside in Canada: *Accipiter gentilis laingi* and *A. gentilis atricapillus*. They were formerly referred to as Queen Charlotte Goshawk and Northern Goshawk, respectively. Originally, separation of the two subspecies was based on size and plumage colour, with *A. gentilis laingi* being smaller and having darker colouration than *A. gentilis atricapillus*. More recently, preliminary results from genetic analyses suggest coastal populations may be genetically distinct from interior populations and this difference may be greatest for populations inhabiting Haida Gwaii (Queen Charlotte Islands), British Columbia (B.C.) — the location of the original *A. gentilis laingi* type specimen. The focus of this recovery strategy is on the Northern Goshawk *laingi* subspecies, although the recovery team has also included relevant literature from studies on *A. gentilis atricapillus* and European Goshawks (*A. gentilis gentilis*).

Accipiter gentilis laingi is listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) because of its estimated small breeding population size (<1,000 mature individuals) and perceived threats to its habitat, primarily from forest harvesting. Population estimates and trends are uncertain for this subspecies because it breeds at low densities and can be difficult to detect. *Accipiter gentilis laingi*'s selection of relatively large amounts of mature and old forests for nesting and foraging has caused conservation biologists to raise concerns. This has challenged resource managers to balance coastal forest management for timber resources and the maintenance of healthy *A. gentilis laingi* populations.

Accipiter gentilis laingi occurs within the Northwest coast of North America. In the United States, *A. gentilis laingi* occurs within coastal areas of Alaska and Washington and possibly Oregon and California. Within Canada, 100% of the range of *A. gentilis laingi* occurs within B.C., where it inhabits Haida Gwaii/Queen Charlotte Islands; Vancouver Island and coastal islands between Vancouver Island and mainland B.C.; and portions of the coastal mainland, west of the Coast Mountains. The recovery team has mapped the range of *A. gentilis laingi* to follow the Coastal Western Hemlock biogeoclimatic zone maritime variants. The precise range boundaries are unclear and there is likely some overlap between *A. gentilis laingi* and *A. gentilis atricapillus* where coastal forests transition to interior forests. To mitigate threats and implement recovery actions, the recovery team has divided *A. gentilis laingi*'s range into six conservation regions: (1) southeast Alaska (SEAK); (2) Haida Gwaii (HG); (3) North Coast, B.C. (NC); (4) South Coast, B.C. (SC); (5) Vancouver Island (VI); and (6) Western Washington (WA). The recovery team did not include California and Oregon in conservation regions because the occurrence of *A. gentilis laingi* within these areas is less certain. This document is a Canadian recovery strategy, so only those conservation regions within Canada (HG, NC, SC, and VI) will be addressed in this strategy, although the development of this strategy was based on relevant data collected within the United States and Canada. Until more information is available through habitat suitability and supply modelling, it is thought that approximately 54% of this subspecies current range (based on total landmass) is within Canada. Within B.C., about 47% is within the NC Conservation Region, 27% within the VI Conservation Region, 17% within the SC Conservation Region, and 9% within the HG Conservation Region.

No data exist on the historic or current changes in the distribution of *A. gentilis laingi*. There is no evidence to suggest major range contractions have occurred; however, small portions of its range (ca. 5%) have been permanently lost as a result of clearing forest lands for urbanization and agriculture, primarily within the VI, SC, and WA Conservation Regions. Harvesting of mature and old forests throughout this subspecies' range, reduced rotation periods between harvests, and changes in distributions and composition of prey species (e.g., introduced species) have likely influenced the distribution patterns of *A. gentilis laingi* over the past century.

Current and historic estimates of population abundance for *A. gentilis laingi* are imprecise. Estimates of population trends are uncertain for this subspecies because nest areas are difficult to monitor (low detection rates, high annual variability in occupancy, large distance between alternative nests) and survivorship data are lacking. Therefore, most estimates of abundance are inferred from relationships between breeding success and habitat characteristics, rather than from population parameter estimates and population modelling. Using estimates for the number of nest areas, the density of adjacent breeding pairs, and known annual occupancy rates, the recovery team estimated the number of breeding pairs within each conservation region as: 261–336 for SEAK, 48 for WA, 10–18 for HG, 71–75 for NC, 106–116 for SC, and 165 for VI. From these estimates, 661–758 breeding pairs are present range-wide: 352–374 in Canada and 309–384 in the United States. The recovery team and Recovery Implementation Groups (RIGs) will refine estimates of population abundance in B.C. using advanced techniques for modelling habitat and population levels as outlined in the critical habitat section. This work will contribute toward critical habitat delineation, which will be presented in an action plan.

The most imminent threats to populations of *A. gentilis laingi* within B.C. are related to the loss and fragmentation of nesting and foraging habitat, and subsequent reductions in prey diversity and availability. As well, increased forest fragmentation leads to more open habitats and a subsequent increase in edge-dwelling species. This may result in greater depredation of adults, young, and eggs, and competition for nests sites. Within the HG Conservation Region, introduced species threaten *A. gentilis laingi* but are also a source of prey. Consequently, the overall effect of introduced species within this conservation region is unclear. Currently, the level of each threat within conservation regions is not well understood and more work will be necessary to evaluate these perceived threats.

Notwithstanding these threats, the recovery team considers the recovery of *A. gentilis laingi* to be biologically and technically feasible throughout its B.C. range. The recovery team based this assessment on the estimated size of the current breeding population, evidence of successful breeding throughout the species' B.C. range, and the ability to mitigate perceived threats and to recruit suitable habitat where necessary. The recovery team anticipates that there will be trade-offs between maintaining a sufficient amount of habitat for survival and recovery of populations of *A. gentilis laingi* and continuing to manage forests at current allowable annual cut levels and rotation periods within coastal B.C.

The long-term goal of this recovery strategy is to ensure that viable populations of *A. gentilis laingi* persist in each conservation region in coastal B.C. The recovery objectives are to (1) manage and, where necessary, conserve and recover habitat that meets the needs of *A. gentilis laingi* through its annual cycle; and (2) conserve and, where necessary, recover a well-distributed

and viable population of *A. gentilis laingi* within coastal B.C. These objectives are broad at this time because the recovery team lacks basic information on the amount of suitable habitat available historically, relative to current supply and predicted future supplies (under different management scenarios), as well as population responses to habitat supply over time. Therefore, the recovery team has outlined a number of activities in the critical habitat section that will help close these information gaps, refine population and habitat objectives, and delineate critical habitat for *A. gentilis laingi*.

Current recovery actions already underway include habitat suitability models that are being developed and verified by the Habitat Recovery Implementation Group (RIG) to determine habitat supply and distribution within the four Canadian conservation regions. Once habitat suitability is mapped, the RIG will use a territory model to predict how many pairs could potentially be supported within each conservation region. Habitat and territory models can be overlaid with a population model to estimate viable population size for each conservation region. The recovery team will use this information to set measurable population and distribution objectives, and to delineate habitat for the survival and recovery of populations within each conservation region.

Critical habitat will be defined within an action plan which will be completed within 2 years after approval of this recovery strategy. Ongoing and new inventory and monitoring programs enable the recovery team to evaluate breeding populations. Stewardship and outreach will be important components to the success of implementing this recovery strategy and subsequent action plan recommendations.

Terms in boldface type appear in the glossary at the end of this document. As well, unpublished reports cited within this document are available, where possible, at the Ministry of Forests website: <http://www.for.gov.bc.ca/hfd/library/index.htm>. Data statistics are reported as means ± standard errors, unless otherwise specified.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BACKGROUND

Status Rankings

Species assessment information from COSEWIC

Common Name: Northern Goshawk, *laingi* subspecies
Scientific Name: *Accipiter gentilis laingi*
Status: Threatened
Reason for Designation: This small, **sedentary**[1] goshawk population has been negatively impacted by degradation of forested habitat.
Last Examination and Change: November 2000 up-listed from Special Concern to Threatened
Canadian Occurrence: British Columbia
Status History: Designated Special Concern in April 1995. Status re-examined and designated Threatened in November 2000. Last assessment based on an updated status report.

B.C. Conservation Data Centre

The Northern Goshawk, *laingi* subspecies, is ranked a globally (T2) and provincially imperilled subspecies (S2B; Natureserve 2007; B.C. Conservation Data Centre 2005).

United States

The status of *A. gentilis laingi* in southeast Alaska has had an extensive litigation history in U.S. courts beginning in 1994 and this debate is ongoing (Squires and Kennedy 2006; S. Brockman, pers. comm.). Currently, the Alaska Department of Fish and Game consider *A. gentilis laingi* as a species of Special Concern and the U.S. Fish and Wildlife Service (USFWS) consider *A. gentilis laingi* to be a Sensitive species in southeast Alaska (http://wildlife.alaska.gov/index.cfm?adfg=concern.goshawk). The Washington Department of Fish and Wildlife (WDF&W) only recognizes *A. gentilis atricapillus* to occur in Washington (Desimone and Hays 2004), although several researchers believe *A. gentilis laingi* reside in the coastal forests of western Washington (S. Finn, pers. comm.; S. Desimone, pers. comm.). The WDF&W consider Northern Goshawks[2] in Washington to be a State Candidate species because of concerns about its population status (Desimone and Hays 2004).

Description of the Species

Identification characteristics

Northern Goshawks are raven-sized (55–61 cm in length; Squires and Reynolds 1997) raptors with short, rounded wings and long tails; males are smaller than females. Although individuals

[1] **Terms in boldface type** appear in the glossary at the end of this document.
[2] "Northern Goshawk" within this document refers generically to both subspecies (*A. gentilis laingi* and *A. gentilis atricapillus*), unless the subspecies is specified.

may become sexually mature within their first year (Squires and Reynolds 1997), plumage characteristics differ between birds <3 years old (immatures) and ≥3 years old (adults). Adults have a conspicuous white eye-stripe that separates their black crown from their blue-grey back. Their chests are white with dense grey barring that appears light grey from a distance; their tails have bands of alternating grey and black. Adult eye-colour varies from orange to dark red, and generally becomes darker with age. Immatures have a faint white eye-stripe and are overall brown with chests that are buff-coloured with dark brown vertical streaks. Immature Northern Goshawks start with a blue-grey eye colour that turns yellow in their first year. These descriptions are based on those outlined by Squires and Reynolds (1997), National Geographic Society (1999), and Sibley (2000). Intermediate plumages between immature and adults are described by Bond and Stabler (1941) and Squires and Reynolds (1997). Goshawks can be aged from plumage characteristics until they are 3 years old; individuals ≥3 years have similar feather colouration and patterns (Bond and Stabler 1941).

Northern Goshawks may also be distinguished from most other raptors by their flight pattern of flap-flap-flap-glide and direct powerful flight within forests (Dunne *et al.* 1988), although other *Accipiter* species (*A. cooperii*, *A. striatus*) have similar flight patterns.

Taxonomic position

Two **subspecies** of Northern Goshawks are recognized in British Columbia based on morphological distinctions: *Accipiter gentilis atricapillus* and *A. gentilis laingi* (AOU 1957, 1983; Palmer 1988; COSEWIC 2000). The subspecies *A. gentilis laingi* was described from a type-specimen collected on Haida Gwaii/Queen Charlotte Islands (hereafter Haida Gwaii) by Taverner (1940) and was therefore formerly referred to as the Queen Charlotte Goshawk. Originally, *A. gentilis laingi* was considered a unique subspecies because adults and immatures had darker plumage than *A. gentilis atricapillus* (Taverner 1940). Later, *A. gentilis laingi* was also recognized to be smaller (Johnson 1989; Whaley and White 1994; Flatten and McClaren, in prep.). *Accipiter gentilis laingi* likely hybridizes with *A. gentilis atricapillus* along the range boundary between these two subspecies.

The ecological significance of the darker plumage and smaller size of *A. gentilis laingi* may be an adaptation to inhabiting the darker, denser coastal forests. Within coastal **habitats**, darker plumage may increase camouflage and enhance thermoregulation, and a smaller size may improve manoeuvrability. Compared with the interior subspecies of Northern Goshawk, *A. gentilis laingi* appears to consume more and smaller avian prey, and their smaller size may aid in the capture of such prey (Whaley and White 1994; Watson *et al.* 1998; Ethier 1999; Lewis *et al.* 2006).

Early genetic analyses of Northern Goshawks throughout North America detected little genetic variation throughout their range (Gavin and May 1996). However, early genetic techniques are now considered to be inappropriate for delineating subspecific differences (Andersen *et al.* 2003). Additionally, no genetic samples from Haida Gwaii or Vancouver Island were included in early analyses. More advanced genetic techniques are currently being conducted by the U.S. Geological Survey in Anchorage, Alaska (Sonsthagen *et al.* 2004; Talbot *et al.* 2005; S. Talbot, pers. comm.) and by UC Davis, California (Bayard de Volo *et al.* 2005; R.T. Reynolds, pers.

comm.). These analyses include samples of blood, eggshells, and feathers collected by researchers from areas within the range of *A. gentilis laingi* (Vancouver Island, Haida Gwaii, southeast Alaska, and the mainland coast of B.C.) and areas along the range boundary (interior Alaska and interior B.C.). Recent genetic analyses suggest that coastal populations of Northern Goshawks may not be **panmictic**, especially individuals from Haida Gwaii, which may be genetically isolated from adjacent populations (Talbot 2006). Preliminary results from mtDNA suggest that populations in Haida Gwaii have two unique haplotypes and may have been isolated for >9,000 years (Talbot 2006).

To understand the genetic relationship among coastal populations, S. Talbot is conducting more detailed genetic analyses. To date, microsatellite DNA analyses suggest that Vancouver Island and coastal mainland B.C. populations are interbreeding. However, Vancouver Island and coastal mainland B.C. populations appear not to be interbreeding with interior B.C. populations. Although the recovery team requires more genetic samples from coastal mainland B.C., especially along the range boundary, it recognizes that an intergradation zone is likely along the range boundary of the subspecies where genetic delineations will be less clear.

Although the recovery team is not yet able to interpret the significance of Talbot's (2006) genetic analyses with respect to the status and distribution of *A. gentilis laingi*, it will consider these results to inform recovery actions within different conservation regions.

Distribution

Global distribution

Accipiter gentilis laingi occurs within the Pacific Northwest coast of the United States and Canada (Figure 1). In the United States, *A. gentilis laingi* occurs within coastal areas of southeast Alaska and Washington and possibly, Oregon and California (Jewett *et al.* 1953; Beebe 1974; Flatten and McClaren, in prep.). In southeast Alaska, the core range for *A. gentilis laingi* occurs from Dixon Entrance, through the coastal mainland and islands of the Alexander Archipelago, north to Icy Strait and Lynn Canal (Iverson *et al.* 1996); a small portion of the range may also occur north of Yakutat Bay. The recovery team produced a map that reflects the best available information on the potential range of *A. gentilis laingi* using a combination of morphometric data, radio-telemetry data, and base mapping that reflected coastal habitat and prey types for this subspecies (Figure 1). Within this range map the recovery team identified a zone where coastal habitat types transition to interior habitat types, which reflects an area where differences between *A. gentilis laingi* and *A. gentilis atricapillus* are likely less clear. *Accipiter gentilis laingi* may occur within coastal Oregon and California but, until better information becomes available, these areas are not considered to be part of the range of *A. gentilis laingi*. Habitat base mapping data were extracted from ecoregional mapping from the Shining Mountains Project database[3] and biogeoclimatic ecosystem classification mapping for British Columbia (MacKinnon *et al.* 1992). The recovery team used base thematic mapper satellite imagery from B.C. and coverage produced by the WDF&W[4] to map the extent of urbanization and agriculture to reflect potential permanent range loss for *A. gentilis laingi*. Although there is currently no evidence of breeding

[3] <http://srmwww.gov.bc.ca/ecology/bei/shiningmtns.html>
[4] <http://wdfw.wa.gov/wlm/gap/landcov.htm>

by *A. gentilis laingi* within the urban/agricultural zone on the range map (see Rutz *et al.* 2006), the recovery team acknowledges that scattered pairs may breed within the area it is considering to be historic.

To mitigate threats and implement recovery actions, the recovery team identified six conservation regions within the global range of *A. gentilis laingi*: (1) southeast Alaska (SEAK); (2) Haida Gwaii (HG); (3) North Coast, B.C. (NC); (4) South Coast, B.C. (SC); (5) Vancouver Island (VI); and (6) Western Washington (WA) (Figure 1). The recovery team chose these conservation regions because they reflect differences in habitat types, prey species composition, and land use pressures, and therefore have unique threats (see Table 2).

Because this is a Canadian recovery strategy, only those conservations regions within Canada (HG, NC, SC, and VI) will be addressed in this strategy. However, this strategy was developed based on data collected within the United States and Canada.

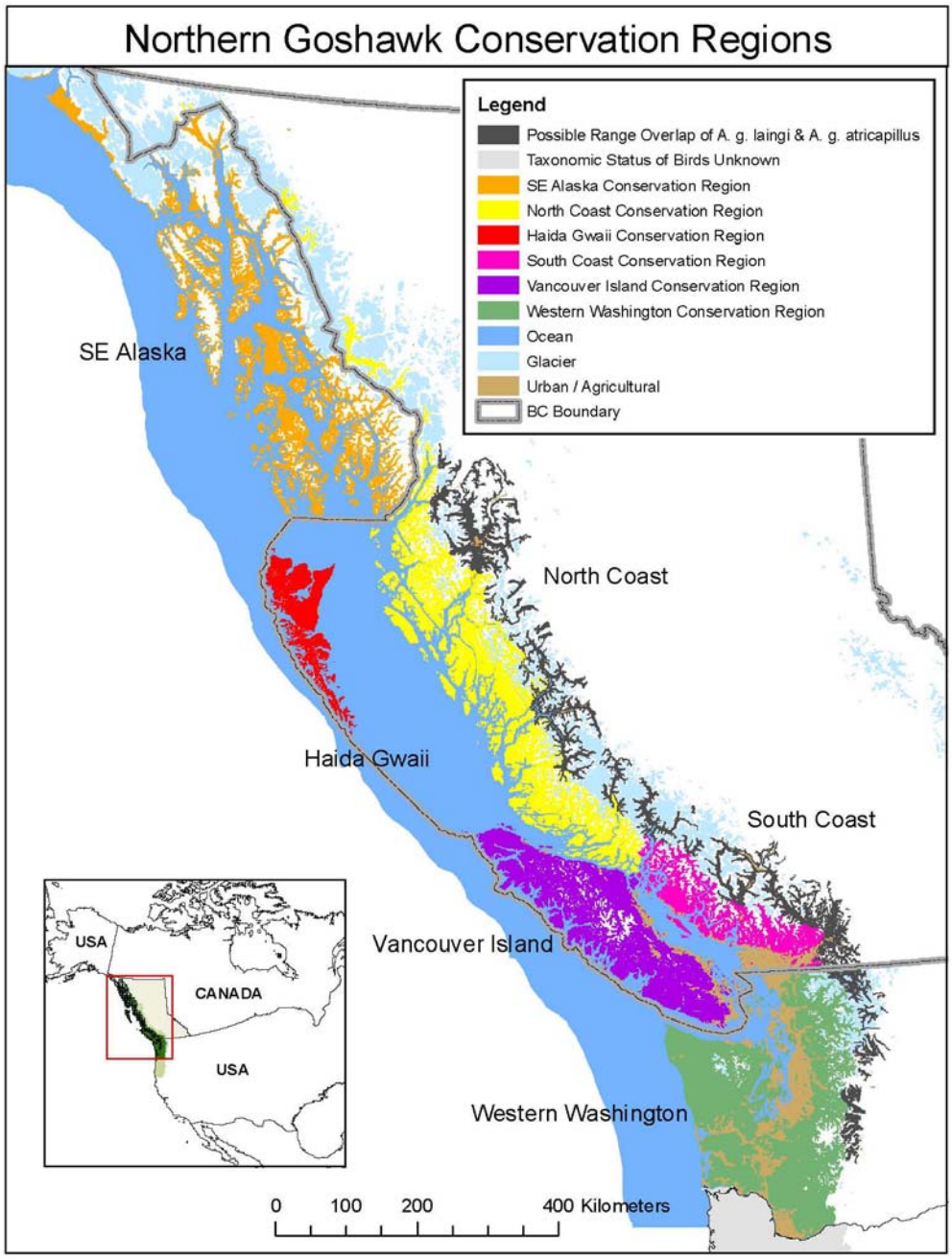

Figure 1. Range map for Northern Goshawk, *Accipiter gentilis laingi*. The British Columbia portion of the range of *A. gentilis laingi* reflects the distribution of wet Coastal Western Hemlock (CWH) biogeoclimatic subzones/variants and the Coastal Douglas-fir (CDF) biogeoclimatic zone. The recovery team has identified a zone (the drier variants of CWH on the coastal mainland) where *A. gentilis laingi* and *A. gentilis atricapillus* likely overlap. The recovery team used urbanization and agriculture as the best way to approximate the portions of the range of *A. gentilis laingi* that have been permanently lost, although the recovery team recognizes scattered pairs may be breeding within these areas. Four conservation regions (Haida Gwaii, North Coast, South Coast, and Vancouver Island) occur within Canadian jurisdiction (British Columbia) and two occur within U.S. jurisdiction (Western Washington and SE Alaska). The taxonomic status of individuals within coastal Oregon and California remains unknown. This recovery strategy will only address the Canadian portion of the range of *A. gentilis laingi*.

Canadian distribution

Within Canada, 100% of the range of *A. gentilis laingi* occurs within B.C. (Figure 1). Within B.C., this subspecies inhabits Haida Gwaii, Vancouver Island, the coastal islands, and the coastal mainland west of the Coast Mountains (AOU 1983; Campbell *et al.* 1990b; COSEWIC 2000; McClaren 2003). Within B.C., the range of *A. gentilis laingi* is divided among four conservation regions such that approximately 47% of current range (all of which may not be suitable habitat) is within the NC Conservation Region, 17% within the SC Conservation Region, 27% within the VI Conservation Region, and 9% within the HG conservation region. Until further information is available, the recovery team assumes the Canadian range of this subspecies follows the distribution of the Coastal Western Hemlock (CWH) and Coastal Douglas-fir (CDF) **biogeoclimatic subzones/variants** (Green and Klinka 1994). Within the NC and SC Conservation Regions, glaciated regions of the Coast Mountain Range likely form a divide between *A. gentilis laingi* and *A. gentilis atricapillus* populations. However, in less glaciated areas, drier CWH subzones link coastal forests to interior forests. The recovery team considers these drier CWH subzones/variants (CWHds1, CWHds2, CWHms1, CWHms2, CWHws1, CWHws2) to be transitional between subspecies. This transitional area accounts for 18% of the total B.C. range. A lack of substantial populations of Snowshoe Hare (*Lepus americanus*) within the CWH biogeoclimatic zone (Nagorsen 2005) suggests these forests may be less suitable for *A. gentilis atricapillus*. Using spatial data layers discussed in the "Global distribution" section, the recovery team calculated that about 3% of the B.C. range of *A. gentilis laingi* has been lost to urbanization and agriculture.

Proportion of distribution in Canada

Range boundaries for *A. gentilis laingi* are imprecise; therefore the exact percentage of the global population distribution within Canada is unknown. Using the *A. gentilis laingi* range map (Figure 1), it is estimated that approximately 50–60% of the total land mass occurs within Canada and 100% of Canada's distribution of this subspecies is within B.C.

Distribution trend

Historic and current changes in the distribution of *A. gentilis laingi* are unknown. Although small amounts (ca. 5%) of the range of this subspecies has been permanently lost from clearing forest lands for urbanization and agriculture along the southeast coast of Vancouver Island, lower mainland B.C. and Seattle, WA, there is little evidence to suggest this habitat loss has resulted in major range contractions. Nevertheless, the distribution patterns of Northern Goshawks in North America have likely been influenced over the past century by harvesting of mature and old forests, reduced rotation periods between harvests (second and third pass relative to first pass), and changes in distributions and composition of prey species (e.g., introduced species) (DeStefano 1998; Andersen *et al.* 2003; Kennedy 2003).

Population Abundance

Global abundance

Current and historic estimates of population abundance for *A. gentilis laingi* are imprecise because it is very difficult to estimate their survival and recruitment. Therefore, estimates of population abundance have been inferred from the number of pairs that a given amount of suitable habitat could support, breeding densities, as well as habitat suitability and supply modelling. Habitat suitability modelling has not been completed for VI, WA, and SEAK conservation regions, and therefore population estimates for these conservation regions are less certain than those for HG, SC, and NC conservation regions. The recovery team estimated the range of breeding pairs within each conservation region using the estimated number of **territories,** breeding densities, and measured annual occupancy rates (Table 1; see "Population trends" section). It is important to integrate occupancy rates and estimated number of pairs because not all **nest area**s are occupied annually by breeding pairs and research suggests that individuals, especially adult females, may use more than one nest area to breed over successive years (Iverson *et al.* 1996; McClaren 2003). This methodology assumes that breeding pairs are territorial and do not pack into available suitable habitat. Estimates of population abundance in B.C. will be refined with advanced techniques used to model habitat and populations (see "critical habitat" section).

COSEWIC's designation of Threatened for *A. gentilis laingi* was based on an estimate of <1,000 mature individuals within Canada combined with imminent threats posed from degradation of forested habitat (COSEWIC assessment criterion D1; COSEWIC 2000). There is strong evidence to suggest that breeding densities of *A. gentilis laingi* are lower than those of *A. gentilis atricapillus* (Reynolds *et al.* 1994; Titus *et al.* 1994; Woodbridge and Detrich 1994; Doyle 2003a; McClaren 2003). Non-breeding individuals may play an important role in buffering populations of *A. gentilis laingi* from decline (Newton 1991; Iverson *et al.* 1996; Hunt 1998). In Finland, Lindén and Wikman (1983) estimated 35–52% of a population of European Goshawks (*A. gentilis gentilis*) to be non-breeders. Non-breeding floaters within populations play an important role to fill vacancies in nest areas when breeding individuals die; during periods of high prey availability, more individuals are available to occupy nest areas and produce young (Doyle and Smith 1994).

Until further genetic work suggests otherwise, the recovery team will assume that coastal populations of *A. gentilis laingi* are panmictic, except for individuals from Haida Gwaii, which may be genetically isolated from adjacent populations (Talbot *et al.* 2005; Talbot 2006).

Percentage of global abundance in Canada

Estimates of population abundance for *A. gentilis laingi* are imprecise. Based on the best available population estimates provided in Table 1 and the following population trends section, approximately 50% of the global population of *A. gentilis laingi* resides within Canada.

Population trends

Estimates of population trends are uncertain for *A. gentilis laingi* because nest areas are difficult to monitor (low detection rates, high annual variability in occupancy, large distance between alternative nests) and survivorship data are lacking from several conservation regions (Doyle 2003a; McClaren 2003; McClaren *et al.* 2003).

Table 1. Estimated number of breeding pairs of *A. gentilis laingi* within each conservation region.

Country	Conservation region	Estimated # of potential territories	Territory occupancy rates	Territory spacing $\bar{x}$ ± se (range)	Estimated # of breeding pairs
Canada	Haida Gwaii	24–43[a]	43%[b]	10.8 ± 0.6 km[c]	10–18
Canada	North Coast, B.C.	130–136	unknown, applied VI's 55%[d]	unknown, used HG's estimate of 10.8 km	71–75
Canada	South Coast, B.C.	193–210	unknown, applied VI's 55%	unknown, used VI's estimate of 6.9 km	106 - 116
Canada	Vancouver Island	300[e]	55%	6.9 ± 0.7 km[f]	165
TOTAL	**CANADA**				**352–374**
USA	Southeast Alaska	580–747[g]	45%[h]	10.5 (7–15.2)[i]	261–336
USA	Washington	120[j]	40%[k]	unknown	48
TOTAL	**UNITED STATES**				**309–384**
TOTAL	**RANGE WIDE**				**661–758**

Note: The number of potential territories modelled for HG, NC, and SC conservation regions was based on a medium habitat threshold of >40% moderate and high foraging habitat suitability within territories (Mahon *et al.* 2007; Smith *et al.* 2007).

[a] Holt (2004); [b] Doyle (2005); [c] Doyle (2003a); [d] McClaren (2003) [e] COSEWIC (2000); [f] McClaren (2003); [g] USFWS (2007); [h] Flatten *et al.* (2001); [i] Iverson *et al.* (1996); [j] S. Finn, pers. comm., 2005; T. Bloxton, pers. comm., 2005 [k] Finn *et al.* (2002).

Habitat Needs of the Northern Goshawk

Home ranges of breeding Northern Goshawks are described as a hierarchical arrangement of biological components including the nest area (nest trees), **post-fledging (family) area** (PFA), and **foraging area** (Reynolds *et al.* 1992; Kennedy *et al.* 1994; McClaren *et al.* 2005; Figure 2). Threats to these habitat components should be mitigated simultaneously, because all components

are necessary to ensure successful breeding and survival, and to facilitate dispersal of juvenile Northern Goshawks. See the "Critical habitat" section for action plan.

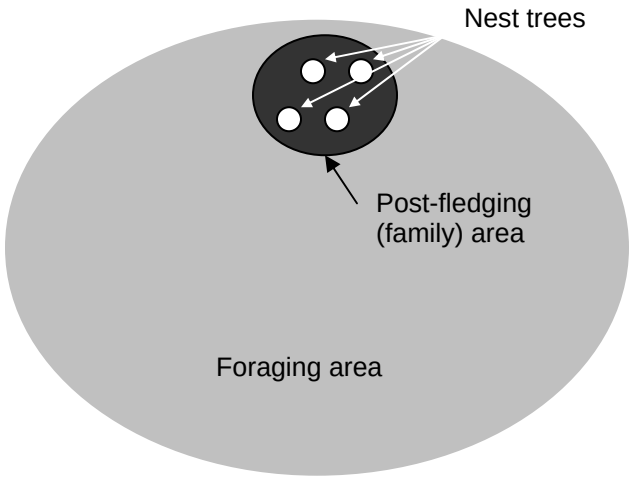

Figure 2. Graphical representation of the hierarchical components within home ranges of Northern Goshawks (revised from Reynolds *et al.* 1992). The location of nest trees and post-fledging areas are not necessarily centred within foraging areas.

Nesting habitat

Nest areas function to provide multiple nest trees, roost trees, and prey plucking posts, and they act as centres for courtship behaviours and fledgling movements during the post-fledging period (Reynolds *et al.* 1992). PFAs surround and include active nest trees and may correspond to the **core-use areas** of adult females and the area young birds use before they become independent of adults and leave their natal areas (Kennedy *et al.* 1994). The spacing pattern of alternative nest trees within home ranges, coupled with information from radio-telemetry of fledglings from 12 nests on Vancouver Island, suggests the size of the PFA for *A. gentilis laingi* is about 100–200 ha (McClaren *et al*. 2005). Because the biological role of post-fledging areas and nest areas appear to be functionally similar (McClaren *et al.* 2005), these areas will be considered as one in this document.

In general, *A. gentilis laingi* select nesting habitat based on stand structure rather than on stand age and species composition per se. Universal characteristics of nest stands of Northern Goshawks throughout North America include mature and old forests, closed canopies (≥50%), and relatively large diameter trees (Iverson *et al.* 1996; Squires and Reynolds 1997; Daw *et al.* 1998; Ethier 1999; Andersen *et al.* 2003; Kennedy 2003; Greenwald *et al.* 2005). Goshawks select nest trees with structural attributes that will support their relatively large stick nests (ca. 1-m diameter; E. McClaren, unpublished data) and these often include trees with deformities and sometimes snags. Within VI and SC conservation regions, forests may reach these characteristics on productive growing sites at >50–60 years whereas within NC and HG conservation regions, forests do not obtain these characteristics until >80–100 years (McClaren 2003; Doyle 2006). At

a larger scale, *A. gentilis laingi* typically nest >200 m from **hard edges** and in stands that are >100 ha (Ethier 1999; McClaren and Pendergast 2003). *Accipiter gentilis laingi* nest at elevations between 0 and 900 m, on moderate slopes (<50%) and typically within the mid- to lower mesoslope position (McClaren 2003; Doyle 2005). Suitable biogeoclimatic zones for breeding throughout the range of *A. gentilis laingi* include the Coastal Western Hemlock and Coastal Douglas-fir biogeoclimatic zones (McClaren 2003). Maritime variants of the Coastal Western Hemlock zone constitute the core part of the range of *A. gentilis laingi,* whereas submaritime variants form the transitional zone where both subspecies likely occur.

Foraging habitat

Foraging areas make up the majority of Northern Goshawk breeding home ranges; within these areas, adults and dispersing immatures hunt. Foraging areas may include nest trees and PFAs. As well, individuals within a pair may have entirely different foraging areas from each other (Boal *et al.* 2003) and they may change their foraging areas among seasons and years (Titus *et al.* 1994; McClaren 2003). Foraging areas vary in size among localities and among individuals according to experience, hunting efficiency, food requirements (brood size), and the availability of food within home ranges (Kennedy *et al.* 1994).

Few studies have estimated the size of foraging areas for *A. gentilis laingi* because limited information is available on foraging activities. Most often, the size of the foraging area is based on the estimated home range size, with the assumption that individuals forage widely throughout their home range. However, Bloxton (2002) reported that *A. gentilis laingi* on the Olympic Peninsula, Washington, concentrated foraging activities within 5 km of active nests and within only 15% of their entire breeding home range. On the Olympic Peninsula, average breeding season home range size for males and females (breeders and non-breeders combined) was 3710 ± 688 ha (n = 14; range: 844–8676 ha; Bloxton 2002). In southeast Alaska, median breeding home ranges for *A. gentilis laingi* were 4,300 ha (n = 16) for females and 4,600 ha (n = 20) for males (S. Lewis, unpublished data). It is important to consider foraging habitat for both members of a pair because Boal *et al.* (2003) reported that breeding home ranges of 10 pairs of *A. gentilis atricapillus* in Minnesota overlapped ≤50% within pairs. Home ranges of *A. gentilis laingi* appear to be larger than for *A. gentilis atricapillus* likely because prey densities are lower throughout coastal forests (Crocker-Bedford 1994; Titus *et al.* 1994; USFWS 1997; Boal *et al.* 2003).

In general, it is more difficult to discern unique patterns of habitat selection by Northern Goshawks at larger scales and as the landscape context around nests becomes more varied (Iverson *et al.* 1996; Ethier 1999; Daw and DeStefano 2001; Finn *et al.* 2002; McClaren and Pendergast 2003; McGrath *et al.* 2003). Within B.C., there is a lack of information on the amount and juxtaposition of foraging habitat required by a breeding pair to support successful reproduction. However, most studies suggest somewhere between 40 and 60% of suitable foraging habitat within home ranges of Northern Goshawks will support a pair over time (Reynolds *et al.* 1992; Patla 1997; Finn *et al.* 2002; Doyle 2005). Northern Goshawks are morphologically and behaviourally adapted for using the flight space between forest canopies and understorey vegetation (see the "Hunting behaviour and prey availability" section). Therefore, foraging habitats are similar to nesting habitats and are characterized by closed

canopies, relatively large diameter trees, and open understoreys (Beier and Drennan 1997; Bloxton 2002; Drennan and Beier 2003; Boal *et al.* 2005) — attributes that provide for flight space and access to prey. Radio-telemetry data suggest that Northern Goshawks also forage in areas where they do not nest, including forest edges, riparian areas, estuaries, and elevations >900 m (Iverson *et al.* 1996; Bloxton 2002; McClaren 2003; Squires and Kennedy 2006).

Winter habitat

Foraging habitat attributes for *A. gentilis laingi* in the winter are poorly understood. In southeast Alaska, *A. gentilis laingi* expanded its breeding home ranges during winter to a median size of 14,700 ha (n = 18) for females and 13,400 (n = 14) for males (S. Lewis, unpublished data). Radio- and satellite-telemetry work on Vancouver Island and in southeast Alaska suggests foraging habitat characteristics for *A. gentilis laingi* in winter are similar to the breeding season, although some individuals may use subalpine forests to follow altitudinal gradients in prey, and use shoreline habitats (Iverson *et al.* 1996; McClaren 2003). It is unknown whether winter habitat for juvenile Northern Goshawks differs from adults.

Dispersal habitat

Habitat characteristics that facilitate successful dispersal for *A. gentilis laingi* are unknown. The recovery team assumes these characteristics are similar to foraging habitat characteristics because some studies suggest immature *A. gentilis atricapillus* are more vulnerable to depredation and starvation in areas with low canopy closure and low prey abundance and availability (Wiens *et al.* 2006). The spatial configuration between dispersal habitat of Northern Goshawks and where individuals first breed is unknown, but it is reasonable to assume that large distances between suitable breeding areas will reduce successful dispersal.

Roosting habitat

Little information is available for the habitat characteristics of roost sites for *A. gentilis laingi*. A recent study on *A. gentilis atricapillus* in California reported roost trees to be in stands that had similar canopy closure and tree diameter to nests but had higher tree densities than nest stands (Rickman *et al.* 2005). Roost trees were also smaller in diameter and lower in height than nest trees (Rickman *et al.* 2005).

Habitat trends

Relative to the abundance of mature and old-growth forests that existed before industrialized forest harvesting, there has been a reduction in the amount of habitat for *A. gentilis laingi* (COSEWIC 2000; Doyle 2003a; Holt 2004; Smith *et al.* 2007). It is unclear whether the overall balance of suitable habitat for *A. gentilis laingi* will be stable, positive, or negative in future years as second-growth forests mature and become suitable habitat for this subspecies. However, many of these forests are also becoming commercially viable for harvesting. Current and predicted future amounts of suitable habitat throughout the Canadian range of *A. gentilis laingi*, relative to historic amounts, will be calculated and reported in an action plan (see the critical habitat section). Within southeast Alaska, approximately 15% of productive old-growth forests on national forest and private lands were harvested as of 1995 and second-growth forests are not

yet structurally suitable for nesting (Iverson *et al.* 1996). Coastal forests in Washington have had similar harvesting pressures as VI and SC conservation regions (Finn *et al.* 2002).

Biological Limiting Factors

Reproduction

Population trends and population estimates for goshawks are unclear and, as in many other species this is because the biological limiting factors are likely a combination of several biological traits including relatively low reproductive rates, low first year survival, late breeding age and relatively few reproductive years.

Most individuals initiate breeding at >2 years but some females breed at 1–2 years of age (Squires and Reynolds 1997; McClaren 2003). As the age of birds ≥3 years cannot be reliably determined (Bond and Stabler 1941), the exact age of most breeding birds captured is unknown. In a long-term study of known-age marked birds in Arizona, the average age that *A. gentilis atricapillus* were observed first breeding was 4.2 ± 0.3 years and 3.9 ± 0.3 years for females and males, respectively (Wiens *et al.* 2006). Northern Goshawks are **socially monogamous**, territorial, **non-colonial**, **synchronously breeding** raptors (Kennedy 2003). During the winter and into the courtship period, females must reach a critical body mass required for egg laying (Marcström and Kenward 1981; Newton *et al.* 1983). Therefore, prey availability in late winter and early spring influences the onset of breeding each year (Keane 1999). Females obtain nearly all food from mates during the pre-laying, incubation, and brooding periods (Duncan and Kirk 1994; Iverson *et al.* 1996). Cool, wet weather in the spring may cause egg-chilling and nestling mortality directly or it may indirectly cause nest failure by limiting foraging opportunities of males (Kostrzewa and Kostrzewa 1990; Penteriani 1997; Bloxton 2002). Average clutch size for *A. gentilis laingi* is unknown. The clutches of *A. gentilis atricapillus* in North America average 2.7 eggs with a range from 1 to 5 eggs (Squires and Reynolds 1997). Females lay only one clutch per breeding season (Squires and Reynolds 1997). Lifetime reproductive success for *A. gentilis laingi* is unknown but high turnover rates of adult females within nest areas on Vancouver Island (78.9%, $n = 57$) suggest it could be low (McClaren 2003). A long-term study on European Goshawks reported adult females to breed for a median of 2 years of their lifespan and produce a median of two nestlings over this time (Krüger 2005). Likewise, in Arizona, females and males spent an average of 2.18 ± 0.11 years and 1.96 ± 0.11 years, respectively, as breeders (Wiens and Reynolds 2005).

Mean nest productivity for *A. gentilis laingi* was 1.6 ± 0.1 fledglings per **active nest** ($n = 141$) for Vancouver Island from 1994 to 2002 (McClaren 2003), 1.5 ± 0.2 fledglings per active nest ($n = 15$) for Haida Gwaii from 1995 to 2004 (Chytyk and Dhanwant 1997; Doyle 2005), and 2.1 fledglings per active nest ($n = 87$) from 1991 to 1998 in southeast Alaska (Titus *et al.* 1999). Fledgling Northern Goshawks are fed by their parents for 35–55 days (McClaren *et al.* 2005) within nursery areas near nests called **post-fledging (family) areas** (**PFA**s) (Reynolds *et al.* 1992). The total time from egg laying until young initiate dispersal is between 100 and 127 days (Titus *et al.* 1994; Kennedy and Ward 2003; McClaren *et al.* 2005; Wiens *et al.* 2006).

Annual **occupancy rates** of nest areas for *A. gentilis laingi* are variable (HG: 43%, *n* = 35, Doyle 2005; WA: 40%, *n* = 50, Finn *et al.* 2002; SEAK: 45%, *n* = 283, Flatten *et al.* 2001; VI: 55%, *n* = 163, McClaren 2003), and generally, individual nest areas are occupied by breeding pairs once every 2–3 years. The actual occupancy rates are very difficult to determine because none of these estimates are adjusted for detection probability (MacKenzie *et al.* 2006), so the reported values likely represent minimum estimates. However, long-term monitoring of the same nest areas within each of these study areas has increased the probability of detecting birds earlier in the breeding season and has reduced the chance of detecting only successful breeders.

Breeding pairs space themselves regularly throughout suitable habitat, likely because of territoriality (McGowan 1975; Reynolds and Joy 1998; McClaren 2003; Reich *et al.* 2004; Doyle 2005). Breeding densities likely reflect prey availability and abundance (Newton 1979). Densities of *A. gentilis laingi* are low relative to those of *A. gentilis atricapillus* (Doyle and Smith 1994; Iverson *et al.* 1996; Doyle 2003b; McClaren 2003; Reich *et al.* 2004). Kennedy (1997) estimated the mean distance between adjacent breeding pairs for *A. gentilis atricapillus* to be from 3.0 to 5.6 km in North America whereas this distance is 6.9 ± 0.7 km (*n* = 16) between pairs of *A. gentilis laingi* on Vancouver Island (McClaren 2003) and is 11.3 ± 2.2 km (SD; *n* = 6) on Haida Gwaii (Doyle and McLennan 2003). These estimates need to be interpreted cautiously because they assume a census of the survey area and do not account for effective area surveyed (Roberson *et al.* 2005) or some other estimate of detection probability (MacKenzie *et al.* 2006).

Survivorship

Lifespan for *A. gentilis laingi* is unknown but the maximum lifespan reported for wild *A. gentilis atricapillus* is >15 years (R.T. Reynolds, pers. comm.). Mark-recapture analyses using radio-telemetry data from SEAK suggest mean annual survivorship of *A. gentilis laingi* adults (genders combined) to be 0.72 (*n* = 39; 95% CI: 0.56–0.88; Iverson *et al.* 1996), and 0.59 ± 0.10 (*n* = 31) for adult males only (K. Titus, unpublished data). Mean annual survival estimates reported for *A. gentilis atricapillus* (see review in Squires and Kennedy 2006) varies from 0.75 ± 0.02 in Arizona (Reynolds *et al.* 2004) and 0.86 ± 0.09 in New Mexico (Kennedy 1997) compared with 0.81 for *A. gentilis gentilis* (Kenward *et al.* 1999). Comparisons among subspecies are difficult because different studies employ different methods with different assumptions to calculate survivorship estimates. Although survival estimates after the first year do not exist for juvenile Northern Goshawks, mean survival for up to three months post-fledging for *A. gentilis atricapillus* hatched in Arizona was 0.71 (*n* = 89; 95% CI: 0.60–0.93; Wiens *et al.* 2006). In New Mexico and Utah, survival estimates ranged from 0.93 ± 0.06 (5.5 months post-fledging) to 0.56 ± 0.12 (3 months post-fledging; see review in Squires and Kennedy 2006). These studies suggest that food availability has the largest influence on fledgling survival during this time (Ward and Kennedy 1996; Dewey and Kennedy 2001; Wiens *et al.* 2006). Squires and Reynolds (1997) predict that survival of Northern Goshawks, like most raptors, is probably lowest during the first year of life. Sensitivity analyses of demographic parameters within population models for *A. gentilis laingi* suggest persistence of this subspecies would be sensitive to fluctuations in both adult and juvenile survivorship and to the proportion of females successfully nesting each year (Broberg 1997; USFWS 1997). Wiens *et al.* (2006) also suggested that populations of *A. gentilis atricapillus* are sensitive to juvenile survivorship because dispersing juveniles serve as an important mechanism for gene flow among populations.

Mortality

Populations of *A. gentilis laingi* experience the same general causes of mortality as other medium-sized raptors, including: starvation; depredation of adults, young, and eggs; **ectoparasites** and infectious diseases; prolonged periods of poor weather; competitive interactions; collisions; felling of active nest trees; and **persecution** (Marcström and Kenward 1981; Kostrzewa and Kostrzewa 1991; Patla 1997; Penteriani 1997; USFWS 1997; McClaren 2003). Individually, none of these factors are currently considered to threaten the subspecies. Pesticides and other contaminants, which were historically important causes of mortality, are no longer considered significant (Snyder *et al.* 1973; Havera and Duzan 1986; USFWS 1997; Cooper and Stevens 2000). Potentially new sources of mortality for *A. gentilis laingi* include epidemic disease from West Nile Virus (WNV) and other emerging diseases (see "Disease" under the "Threats" section). The degree to which each of the above mortality factors regulates *A. gentilis laingi* populations is unknown and probably varies by conservation region.

Recruitment and dispersal

Information on **recruitment** and **natal dispersal** in populations of Northern Goshawks is limited (USFWS 1997; Cooper and Stevens 2000; COSEWIC 2000; Squires and Kennedy 2006). No marked fledglings from VI (n = 59) or SEAK (n = 86) have joined their natal breeding populations (McClaren 2003; C. Flatten, unpublished data). Data from an 11-year study in Arizona suggest recruitment rates in *A. gentilis atricapillus* are very low (11%: 69 of 614 marked individuals; Wiens 2004).

Radio-tagged juvenile *A. gentilis laingi* were reported 11–162 km from natal sites on VI (n = 2; McClaren *et al.* 2005) and in SEAK (n = 14; Titus *et al.* 1994) during their first year. Distances between natal sites and breeding sites are unknown for this subspecies, although the median distance for *A. gentilis atricapillus* was 15 km (0.1–58.1 km) in Arizona (Reynolds *et al.* 2000; Wiens *et al.* 2006) and recoveries of dead birds up to 442 km from natal areas (Reynolds *et al.* 2000) suggest Northern Goshawks are capable of long-distance natal dispersal. However, water bodies between several populations of *A. gentilis laingi* may limit successful long-distance dispersal (e.g., nearest distance between HG and SEAK and between HG and NC Conservation Regions is 60 and 90 km, respectively).

Breeding dispersal of adult females appears to be more common in populations of *A. gentilis laingi* than in other subspecies and may result from poor-quality nesting areas or mates, the death or departure of a mate, low breeding densities, low annual productivity, or annual variation in food availability. For example, in SEAK, approximately 45% of radio-tagged adult females (n = 19) exhibited breeding dispersal compared with 5% for adult female *A. gentilis atricapillus* breeding in Northern Arizona (Reynolds and Joy 2006). Iverson *et al.* (1996) suggested that above-average site fidelity of males and higher breeding dispersal rates of female *A. gentilis laingi* in SEAK, compared to *A. gentilis atricapillus*, may reflect nest site scarcity for males and food stress for females. In general, both males and females exhibit site fidelity to nest areas, although pairs frequently use different nest trees within nest areas in consecutive breeding years. As long as sufficient nesting and foraging habitat exists within and near nest areas, *A. gentilis*

laingi pairs will continue to use nest areas over long periods (>10 years) (McClaren 2003; Doyle 2005).

Populations of *A. gentilis laingi* are characterized as non-migratory (Iverson *et al.* 1996; Bloxton 2002; McClaren 2003), although in some years adults may move from **breeding home ranges** to completely different **winter home ranges;** in other years adults will include their breeding home range within their winter home range (Iverson *et al.* 1996; McClaren 2003).

Hunting behaviour and prey availability

Northern Goshawk populations are described as being food-limited; prey availability and abundance are closely associated with landscape alterations, climate, and annual weather patterns (Squires and Reynolds 1997; McClaren *et al.* 2002; Keane *et al.* 2006; Reynolds *et al.* 2006). As well, food supply can indirectly be linked to competition for nest sites, siblicide rates, and depredation of adults or eggs (Estes *et al.* 1999; Dewey and Kennedy 2001).

Northern Goshawks possess morphological and behavioural adaptations for hunting within forested habitats (Squires and Reynolds 1997). Unlike Buteo hawks (e.g., Red-tailed Hawks, *Buteo jamaicensis*), Northern Goshawks generally do not soar in open habitats while hunting; they use a stop-and-go, short-stay perched-hunting pattern (Kenward 1982; Kennedy 2003), manoeuvring between trees below the forest canopy. Northern Goshawks are generalist predators of medium-sized birds and mammals (Squires and Reynolds 1997). Pronounced differences in body size between the sexes (males are smaller than females) may help mates to partition food resources and reduce competition. Prey caching may also assist individuals in meeting their energetic requirements during times of low prey availability or low hunting success (Schnell 1958; Lewis *et al.* 2006).

Populations of *A. gentilis laingi* inhabit islands and dense coastal forests with a low abundance and diversity of prey available compared with the drier, interior forest habitats occupied by *A. gentilis atricapillus* (Roberts 1997; Ethier 1999; Doyle 2003b; Lewis *et al.* 2006). Mammalian prey items comprise a lower proportion of the prey of *A. gentilis laingi* than *A. gentilis atricapillus* (Watson *et al.* 1998; Ethier 1999; Bloxton 2002; Andersen *et al.* 2003; Lewis *et al.* 2006). Nevertheless, Red Squirrels (*Tamiasciurus hudsonicus*) dominate breeding season diets of *A. gentilis laingi* (Roberts 1997; Ethier 1999; Doyle 2003b; Lewis *et al.* 2006). Introductions of prey species and land use activities may have altered prey composition and availability throughout the range of this subspecies. Such changes may not have been uniform across conservation regions (see prey diversity and availability under the threats section). Little information is available on the winter diet of *A. gentilis laingi*.

Competition

The degree to which *A. gentilis laingi* populations are limited by **intra-specific and inter-specific competition** for nest sites and for food is unknown.

Ecological Role

Accipiter gentilis laingi are a top avian predator within mature and old forests. As such, they likely play a complex ecological role and humans may never completely understand the mechanisms and associations of this role. However, it is known that *A. gentilis atricapillus* and *A. gentilis gentilis* can regulate prey populations, especially in areas where they select a few key prey species (Doyle and Smith 1994; Tornberg and Colpaert 2001; Kennedy 2003). Furthermore, *A. gentilis laingi* functions as a primary nest builder for other birds such as large forest owls (including Spotted Owls; Forsman and Giese 1997), Common Ravens (*Corvus corax;*, E.L. McClaren, pers. observation 1998), and Great Blue Herons (*Ardea herodias;* F. Doyle, pers. observation 2000). As a large forest raptor, *A. gentilis laingi* likely influences the spacing and distribution of other forest raptors (Krüger 2002). Northern Goshawks are often considered to be an indicator of mature forest ecosystem health because they require the structural complexity of these forests to breed and forage.

Importance to People

Northern Goshawks are prized by birdwatchers and wildlife photographers because they are a rare sight and an impressive forest predator. They are also an important indicator of old and mature forest biodiversity, which is valued by many Canadians. *A. gentilis laingi* were a part of the St'aawaas Xaaydagaay (Haida Cumshewa ruling family name) culture and were referred to as the "Blue Hawk," likely a result of its blue-grey plumage (Barb Wilson, pers. comm. 2004). Northern Goshawks are sought by falconers for their aggressive nature and impressive flight and hunting skills (Squires and Reynolds 1997).

Known and Perceived Threats

The threats and rankings in Table 2 are based on the best available scientific information and, where data were unavailable, are based on expert opinion and data-derived estimates. Some threats within this table are interrelated but have been separated to focus recovery actions. Rankings within this table will need to be re-evaluated over time and additional threats may need to be added.

Table 2. Identification and ranking (0 = no threat; 1 = low; 2 = moderate; 3 = high) of threats posed to *A. gentilis laingi* within each B.C. conservation region.

Threat	Conservation region rankings			
	HG	NC	SC	VI
Habitat loss-nesting	2	1.5	2	2.5
Habitat loss-foraging	3	1.5	2	3
Habitat fragmentation	3	1.5	2	3
Prey diversity*	3	1	1	2
Prey availability	3	1.5	2	2.5
Genetic isolation*	3	0.5	0.5	0.5
Introduced species	2	0	0	0
Depredation of adults, eggs, and young	1	1	1	1
Competition for nest sites	1	1	1	1

Climate change*	1	1	1	1
Human disturbance	1	1	1	1
Disease*	1	1	1	1
Persecution	1	0	0.5	0.5

*The recovery team considers that it will have limited success at mitigating these threats.

Nesting and foraging habitat loss and fragmentation

Two major threats to populations of *A. gentilis laingi* are the conversion of mature and old-growth forest to young **seral stages** (i.e., **habitat loss**) and **habitat fragmentation**. Land use activities that create small, isolated patches of suitable habitat surrounded by young, dense, even-aged stands with few large diameter trees and reduced tree, shrub, and herb diversity may be detrimental to *A. gentilis laingi* and its prey populations (Iverson *et al.* 1996; Cooper and Stevens 2000; Krüger and Lindström 2001; Kennedy 2003). The consequences of the reduction in habitat quantity and quality discussed above include (1) reduced availability of nest sites; (2) reduced ability for immatures to disperse; (3) increased risk of depredation of adults, eggs, and young; (4) reduced gene flow among local populations; (5) reduced prey abundance and availability; (6) increased inter-specific competitive interactions with edge-adapted and open habitat species for prey and nest sites; (7) decreased survival and productivity; (8) decreased carrying capacity of landscapes for breeding pairs; (9) increased disturbance from humans; and (10) loss of suitable microclimate conditions at nest sites (Iverson *et al.* 1996; Squires and Reynolds 1997; COSEWIC 2000; Cooper and Stevens 2000; Kennedy 2003). The USFWS (1997) hypothesized that populations of *A. gentilis laingi* may be more energetically stressed than *A. gentilis atricapillus* because of lower prey densities throughout their range, and therefore, they may be more sensitive to reductions in habitat quality.

The primary cause of habitat loss and fragmentation for populations of *A. gentilis laingi* within productive coastal forests is large-scale forest harvesting. As well, harvest rotation periods (which in productive forests may be 50–80 years) coincide with forests developing suitable characteristics for *A. gentilis laingi*. Extensive forest harvesting in eastern North America and parts of Europe dramatically reduced populations of Northern and European Goshawks in the late 1800s (Petty 1989; Widén 1997; Kennedy 1997, 2003). In comparison, large-scale harvesting is much more recent in coastal B.C., and most harvesting before 1940 was small-scale and occurred near human settlements (Mackie 2000; Pearse 2001). Industrialized forestry was adopted between 1940 and 1980 within coastal B.C. and the allowable annual cut (AAC) steadily increased during this time, causing accessible, low elevation old-growth forests to be converted to younger forests through clearcutting (Marchak *et al.* 1999; Pearse 2001). Within the VI and SC conservation regions, second-growth forests are being recruited as habitat for *A. gentilis laingi*, especially within the drier and very productive biogeoclimatic variants (CDF, CWHxm1, CWHxm2), as these forests reach structural characteristics suitable for nesting and foraging (McClaren 2003; Marquis *et al.* 2005). Forests within the NC and HG conservation regions have a more recent harvest history and slower growing conditions, which will likely lengthen the time that second-growth forests will require to become suitable habitat for *A. gentilis laingi* (Doyle 2006).

Ultimately, the rate and extent at which habitat for *A. gentilis laingi* is removed relative to its recruitment, and the levels of protection of currently suitable habitat, will determine the severity

of this threat to populations. The level of threat is not merely a calculation of the balance between habitat loss and recruitment because Northern Goshawks have high fidelity to their breeding areas and so habitat loss within home ranges may have long-lasting effects on breeding pairs. The introduction of the Forest Practices Code of B.C. in 1995 shifted forest practices on Crown forest lands within coastal B.C. from progressive large-scale clearcutting to smaller (<40 ha) cutblocks with variable amounts of wildlife tree retention patches (B.C. Ministry of Forests 1995). As well, the increased use of helicopters as a harvest system for previously inaccessible stands has expanded the accessible timber harvesting landbase. Private forest lands within B.C. have not had to meet the same biodiversity objectives as Crown forest lands. Harvest pressures on private forest lands will pose the greatest threat to *A. gentilis laingi* within the VI conservation region, where 67% of the province's private forest lands exist and comprise approximately 3% of the managed forest landbase.[5] As well, a lower diversity of mammalian prey on Vancouver Island and Haida Gwaii may mean that threats to foraging habitat are greater within these conservation regions.

To a lesser extent, urban development, windthrow (sometimes increased through harvest activities; Kramer *et al.* 2001; Penteriani *et al.* 2002), conversion of forests to agricultural lands, and forest insects and disease may also reduce the habitat quality for *A. gentilis laingi* (Squires and Reynolds 1997; Burleigh and Hodge 2004).

See Appendix 1 for an outline of existing approaches and measures available to protect *A. gentilis laingi* habitat in B.C.

Prey diversity and availability

The theory of island biogeography (MacArthur and Wilson 1967) suggests that species diversity will be lower on smaller than larger islands, and diversity will also be reduced as distances between mainland source populations and islands increases. It is therefore expected that VI and HG conservation regions should have a lower diversity of prey species for *A. gentilis laingi* than NC and SC conservation regions on mainland B.C. This is generally true as VI and HG conservation regions have lower avian and mammalian prey diversity than mainland conservation regions, and HG conservation region has even fewer species than VI conservation region (Campbell *et al.* 1990a, 1990b, 1990c, 1990d; Nagorsen 2002). This reduction in prey diversity may be a further threat to *A. gentilis laingi* populations on the islands, as any reduction in the annual abundance of any one prey may impact the ability of *A. gentilis laingi* to obtain enough food to meet their annual energetic requirements.

Genetic isolation

Genetic work by Talbot (2006) suggests that Vancouver Island and coastal mainland B.C. populations are interbreeding. However, Vancouver Island and coastal mainland B.C. populations appear not to be interbreeding with interior B.C. populations. Therefore, these populations have a small level of threat from genetic isolation. *Accipiter gentilis laingi* from Haida Gwaii have a very high risk of genetic isolation because genetic analyses suggest there is

[5] <www.pmflc.ca>

very little gene flow among these individuals and other populations of *A. gentilis laingi* (Talbot 2006).

Introduced species

It is unlikely that **introduced species** within the VI, SC, and NC conservation regions have posed a threat to *A. gentilis laingi* populations. Instead, this subspecies may use some introduced species such as Eastern Cottontail Rabbits (*Sylvilagus floridanus*; Nagorsen 2002) as prey. However, within the HG conservation region, introduced species may substantially threaten *A. gentilis laingi*. Relevant introduced species include Sitka Black-tailed Deer (*Odocoileus hemionus sitkensis*), Red Squirrels, Raccoons (*Procyon lotor*), and rats (*Rattus* spp.). Black-tailed Deer, first introduced to Haida Gwaii in 1878 and then again in 1911 (Englestoft and Bland 2002), are likely having the greatest impact on prey populations of *A. gentilis laingi* because most of their prey occur within the ground-shrub zone (Reynolds and Meslow 1984) which the deer have over-browsed. With the exception of Black Bears (*Ursus americanus*), there are no predators to help regulate deer populations, resulting in an extremely high density of deer on Haida Gwaii (~30 deer/km^2; Martin and Baltzinger 2002) compared with other conservation regions. Allombert *et al.* (2005a) showed that songbird abundance was 55–70% lower on islands with a >50-year history of deer browsing compared with islands without deer. Therefore, *A. gentilis laingi* may be indirectly impacted by deer overgrazing understorey vegetation, which may reduce nest site availability and food supply for songbirds, which in turn may reduce populations of songbirds (Allombert *et al.* 2005b). Blue Grouse (*Dendragapus obscurus)*, also a prey item of *A. gentilis laingi* (Ethier 1999; Lewis *et al.* 2006), may be particularly affected by understorey vegetation removal by deer (Doyle 2004). Red Squirrels are the main prey of *A. gentilis laingi* throughout their range (Roberts 1997; Ethier 1999; Lewis *et al.* 2006), however they were not present on Haida Gwaii until 1947 when they were introduced to increase the endemic populations of Pine Marten (*Martes americana nesophila*). Red Squirrels are now the main summer prey of *A. gentilis laingi* on the islands (Doyle 2003b). It is unclear, however, how the introduction of Red Squirrels has influenced *A. gentilis laingi* populations, as the squirrels may negatively affect other goshawk prey through nest predation. Raccoons, a predator of *A. gentilis laingi* and their prey (Zwickel 1992; Laskeek Bay Conservation Society 1996; Hewitt *et al.* 2001), were introduced to Haida Gwaii in the 1940s to provide another source of fur for trappers. Furthermore, Black Rats (*Rattus rattus*) and Norway Rats (*Rattus norvegicus*) are two other persistent nest predators that may threaten prey populations of *A. gentilis laingi*. Black Rats were first verified on Haida Gwaii in 1919 (Laskeek Bay Conservation Society 1996) and Norway Rats were first observed in 1988, although they were probably introduced during the Second World War (Englestoft and Bland 2002). These possible food-web relationships on Haida Gwaii need to be tested by empirical data gathering and modelling (cf. Gurevitch and Padilla 2004; Clavero and Garcia-Berthou 2005) to better understand the threats they pose to *A. gentilis laingi* populations within the HG Conservation Region.

Depredation and competition

The conversion of forests to younger seral stages and increased fragmentation of forests may favour edge and open habitat species such as Red-tailed Hawks (*Buteo jamaicensis*), Barred Owls (*Strix varia*), and Great Horned Owls (*Bubo virginianus*) over interior forest species such

as *A. gentilis laingi*. Kenward (1996) hypothesized European Goshawk populations may be more adaptable to forest fragmentation than North American populations because of raptor guild differences. Red-tailed Hawks and several large owl species use Northern Goshawk nests for breeding and they often initiate breeding before Northern Goshawks and so there may be indirect competition for nest sites among these species (Campbell *et al.* 1990b; Doyle 2000). La Sorte *et al.* (2004) compared habitat characteristics around nests of Red-tailed Hawks and *A. gentilis atricapillus* in Arizona and found that their breeding habitats overlapped. However, Red-tailed Hawks selected more open forest nest sites adjacent to clearings whereas Northern Goshawks typically nested in denser forests, farther in from edges. Therefore, if nest sites of *A. gentilis laingi* occur in small (i.e., 12 ha), isolated fragments of forests, they may become more suitable for Red-tailed Hawks and this has been observed on Vancouver Island (Lindsay *et al.* 2004; E.L. McClaren, pers. observation, 1999. *Accipiter gentilis laingi* may compete for food with Red-tailed Hawks and large owls, although these potential competitors do not eat as many birds and they typically hunt in different habitat types (Bosakowski and Smith 1992). In Arizona, 48% of the diet of Red-tailed Hawks consisted of species that also occurred in the diets of *A. gentilis atricapillus* (Gatto *et al.* 2005). As well, Red-tailed Hawks, Great Horned Owls, and Bald Eagles (*Haliaeetus leucocephalus*) have been observed to kill adult, fledgling, and nestling Northern Goshawks (Rohner and Doyle 1992; Squires and Ruggiero 1995; Wiens 2004). It is difficult to predict the influence that habitat fragmentation and loss will have on predator/competitor communities, and the level of threat posed to *A. gentilis laingi* will vary by conservation region.

Climate change

The threats caused by climate change within coastal forests are unknown and are difficult to mitigate through this recovery strategy. Climate change may affect Northern Goshawk populations positively or negatively. Negative impacts may include altered microclimate conditions within coastal forests, changes in vegetation and species composition of forests (Hamann *et al.* 2006), altered prey abundance and availability, increased likelihood of forest fires, and diseases such as West Nile Virus and forest pest outbreaks (Hansen and Biringer 2003). Because weather and prey availability influence the reproduction and survival of Northern Goshawks (Doyle 2000; Dewey and Kennedy 2001; Bloxton 2002; Salafsky 2004; Wiens *et al.* 2006), climate change may impart a higher degree of annual **environmental stochasticity** on demographic rates, which may ultimately result in these relatively isolated populations of *A. gentilis laingi* becoming more susceptible to extirpation (Caughley and Gunn 1996). Alternatively, *A. gentilis laingi* may benefit from climate change if changes result in larger expanses of forest types that provide the structural attributes necessary for nesting and foraging, and support a greater abundance and diversity of prey species.

Human disturbance

Anecdotal evidence suggests that *A. gentilis laingi* are sensitive to disturbance at nest and roost sites (COSEWIC 2000), although some individuals are more tolerant than others (McLaughlin 2002; E.L. McClaren, pers. observation, 1998). The effect of human disturbance near nest and roost sites of *A. gentilis laingi* depends on the timing, intensity and proximity of the disturbance (Toyne 1997; COSEWIC 2000). The level of this threat may increase along with more road networks through forests, enabling greater levels of human access into remote areas.

Disease

West Nile Virus has not yet been documented within B.C.; however, it is as far west as Alberta in Canada and Washington and Oregon in the United States (H. Schwantje, pers. comm., 2005). West Nile Virus occurs in several bird species (including raptors; Nemeth *et al.* 2006) and the threat it poses to populations of *A. gentilis laingi* is unknown and difficult to predict (Komar *et al.* 2003; Marra *et al.* 2004). More information can be gained regarding the prevalence of infection from West Nile Virus to wild *A. gentilis laingi* by collecting tissue samples via feathers from captured individuals (H. Schwantje, pers. comm., 2005).

Human persecution

Although historic bounty hunting programs may have reduced populations of *A. gentilis laingi* near urban and agricultural centres in coastal areas, human persecution toward *A. gentilis laingi* is currently considered to be low and not a major threat (Table 2). There is a small chance that this threat is underestimated because of the recovery team's lack of knowledge of illegal persecution, especially of immature birds pursuing domestic fowl and racing pigeons (E.L. McClaren, pers. observation, 1999. B. Wijdeven, pers. observation, 2004; M. Buelow, pers. comm., 2005).

Actions Already Completed or Underway

Habitat Recovery Implementation Group (RIG)

The habitat RIG was formed in 2005. One of the first tasks of the RIG was to oversee development of a habitat model for *A. gentilis laingi* within each conservation region in B.C. Between 2005 and 2007, the habitat RIG developed models for nesting, foraging, and territories for HG, NC, and SC conservation regions (Marquis *et al.* 2005; Smith *et al.* 2007). As well, species experts in B.C. outlined habitat characteristics of *A. gentilis laingi* (Mahon *et al.* 2007). In 2007/2008, the Habitat RIG plans to complete habitat models for each conservation region, depending on funding and data availability. Between 2007 and 2009, the habitat RIG also plans to ground verify habitat model predictions for each conservation region to determine the accuracy and precision levels of models. To improve model predictions, habitat RIG members will revise habitat models based on the results of ground verification, where necessary. Refined habitat models will then be used to help the habitat RIG and recovery team to identify and delineate critical habitat in the action plan.

Inventory and monitoring

Structured inventory work for *A. gentilis laingi* occurred for 9 years on Vancouver Island (McClaren 2003) and is ongoing in Haida Gwaii (Doyle 2005). Monitoring programs are being carried out by forest licensees within some areas of Vancouver Island and throughout Haida Gwaii as part of an adaptive management strategy (Manning *et al.* 2003). The recovery team has initiated inventory work for *A. gentilis laingi* on the coastal mainland of B.C. in 2007.

Stewardship

The recovery team has initiated a program in Haida Gwaii to work with poultry farmers to report trapped *A. gentilis laingi*, to facilitate the collection of DNA samples and to assist the recovery team to assess the severity of this threat and to mitigate it, where necessary. As well, the recovery team is working to develop "science-based guidelines for working in and around *A. gentilis laingi* nesting and foraging habitats."

Knowledge Gaps

The recovery team has identified knowledge gaps that are directly related to recovery planning and the success of recovery activities. Although the recovery team has a good knowledge base in several areas for *A. gentilis laingi*, there are many unknowns around what limits the population size of this subspecies. As well, the recovery team has better information on the habitat requirements of *A. gentilis laingi* at small scales relative to large scales. Data deficiencies were prioritized within each topic listed below based on perceived risks to our ability to recover *A. gentilis laingi* populations.

Habitat availability and requirements

1. Amount, distribution, and characteristics of critical habitat.
2. Relationship between habitat components and the reproduction and survival of *A. gentilis laingi*, and how forest harvesting affects these. This includes the degree of surrounding landscape contiguity that maintains successful breeding over time (e.g., the spatial relationship between foraging areas and PFAs).
3. Winter habitat associations.
4. Relationships between prey assemblages and foraging habitat characteristics.
5. Dispersal habitat characteristics.
6. Relationship between characteristics of breeding habitat and competition for nest sites.
7. Amount of suitable breeding and foraging habitat throughout the range of *A. gentilis laingi*, and the number of breeding pairs this habitat could support historically (pre-industrialized logging), currently and under future harvest scenarios.

Diet and prey availability

1. Breeding season diet in NC and SC conservation regions.
2. Winter diet in all conservation regions.
3. Change in prey abundance as a result of introduced species in HG conservation region.
4. Effects of annual fluctuations in weather patterns (e.g., El Niño and La Niña, on prey).

Population abundance and demographic parameters

1. Determine population abundance and trend estimates (i.e., population viability analyses and parameter sensitivity analyses):
   a. annual occupancy rates of nest areas in NC and SC conservation regions;
   b. monitoring of occupancy rates of known nest areas over time;
   c. breeding density within NC and SC conservation regions;
   d. average life span and number of reproductive years;
   e. survival estimates (adult and juvenile);
   f. immigration, emigration, dispersal, and recruitment rates; and
   g. dispersal distances.

2. How competition for nests sites, siblicide, depredation of adults, young, and eggs, and climate regulate populations.

Population genetics and distribution

1. Genetic flow among conservation regions and refinement of the range boundaries for *A. gentilis laingi*.

Miscellaneous threats

1. Degree of risk posed by diseases/viruses such as West Nile Virus.
2. Degree of risk from climate change and the associated changes in habitat and prey assemblage that may follow.
3. Level of threat posed by human persecution and disturbance near nest sites.

RECOVERY

Recovery Feasibility

Based on its answers to criteria outlined in Environment Canada's draft policy on the feasibility of recovery (Environment Canada 2005), the recovery team determined that *A. gentilis laingi* was biologically and technically feasible to recover in B.C.:

1. **Are individuals capable of reproduction currently available to improve the population growth rate or population abundance? Yes.**
   - An estimated 352–374 breeding pairs are present within B.C. (see Table 1) and some pairs are present in all conservation regions.
   - Average offspring gender ratios of 50:50 within the VI conservation region (McClaren and Pendergast 2003) suggest an equal number of males and females entering the population (assuming survival and recruitment rates are approximately equal).
   - There is evidence of successful breeding within each conservation region.
   - Evidence of younger (<2 years) individuals reproducing suggests that the breeding population is not skewed towards only older individuals.

2. **Is sufficient habitat available to support the species or could it be made available through habitat management or restoration? Yes.**
    - Individuals breed in mature second- and old-growth forests and so it is possible to recruit habitat after harvest.
    - Permanent habitat loss (agriculture/urbanization) is minor (ca. 3%) throughout the Canadian range of *A. gentilis laingi*.

3. **Can significant threats to the species or its habitat be avoided or mitigated through recovery actions? Yes.**
    - Significant threats listed in Table 2 and their mitigation actions include:
        - Habitat loss can be mitigated through reduced harvest levels, lengthened rotation periods, reforestation, and stand treatment activities to improve the structure of younger stands (e.g., spacing, pruning, and fertilization).
        - Habitat fragmentation can be mitigated through landscape-level planning, reduced harvest levels, lengthened rotation periods, and reforestation.
        - Introduced species within the HG conservation region that may result in increased depredation of adults, eggs, and young, and reduced prey availability can be mitigated through population control measures. Eradication of introduced species may not be technically feasible or economically viable.
        - Genetic isolation within the HG conservation region may be mitigated through translocation of individuals from surrounding conservation regions (although this may not be desirable if they are genetically distinct from adjacent populations) or re-introduction from captive breeding programs.

4. **Do the necessary recovery techniques exist and are they demonstrated to be effective? Yes.**
    - Both *A. gentilis gentilis* and *A. gentilis atricapillus* exhibit the ability to rebound and re-establish themselves (naturally or via re-introduction) when populations have been reduced and excluded from portions of their range due to persecution and habitat destruction (Speiser and Bosakowski 1984; Petty 1989; Lensink 1997; Kennedy 1997, 2003), providing threats to populations were mitigated.

Recovery Goal

The long-term goal of this recovery strategy is to ensure viable populations of Northern Goshawk *A. gentilis laingi* persist in each conservation region in coastal British Columbia.

Recovery Objectives

This recovery strategy has the following objectives:

Objective 1:
To manage and, where necessary, conserve and recover habitat that meets the needs of Northern Goshawk *A. gentilis laingi* through its annual cycle.

Objective 2:
To conserve and, where necessary, recover a well-distributed and viable population of Northern Goshawk *A. gentilis laingi* within coastal B.C.

These objectives are broad at this time because the recovery team lacks basic information on the amount of suitable habitat available historically, relative to current supply and predicted future supplies (under different management scenarios), as well as population responses to habitat supply over time. Therefore, the recovery team has outlined a number of activities and associated timelines, which will help close these information gaps at which time the recovery objectives can be refined and updated.

Approaches Recommended to Meet Recovery Objectives

Recovery planning table

Table 3. Broad strategies that will be used to address threats and to achieve recovery of habitat and populations for *A. gentilis laingi*

Objective 1: To manage and, where necessary, conserve and recover habitat that meets the needs of the Northern Goshawk *A. gentilis laingi* through its annual cycle						
Threat(s) addressed	**Broad strategy**	**Priority**	**Recommended approaches to meet recovery objectives**	**Action**	**Conservation region**	**Timeline (initiation-completion)**
Habitat loss and fragmentation – nesting	Habitat protection	High	Protect known nest trees and PFAs	Pursue available tools for protection on public and private lands. See Appendix 1.	All	1999–2012
Habitat loss and fragmentation – nesting and foraging	Science-based guidelines for habitat management; stewardship	High	Manage nesting and foraging habitat that is required but cannot be included in Wildlife Habitat Areas (WHAs) for required forest attributes & human disturbance impacts	Develop science-based guidelines (incl. stand structure, seral stage distribution, human disturbance, access planning) for nesting and foraging habitat	All	2008
Habitat loss and fragmentation – foraging	Habitat management; stewardship	High	Develop land use designations for *A. gentilis laingi* foraging areas	Develop and implement general wildlife measures to ensure sufficient *A. gentilis laingi* foraging habitat outside WHAs is conserved	All	2008–2017

Objective 1: To manage and, where necessary, conserve and recover habitat that meets the needs of the Northern Goshawk *A. gentilis laingi* through its annual cycle						
Threat(s) addressed	**Broad strategy**	**Priority**	**Recommended approaches to meet recovery objectives**	**Action**	**Conservation region**	**Timeline (initiation-completion)**
Habitat loss and fragmentation – nesting and foraging	Research; habitat management guidelines	High	Identify habitat requirements for population goals	Use landscape modelling to identify the quality, abundance, and distribution of nesting and foraging habitat. This will assist the recovery team to determine where there are habitat deficits and where critical habitat needs to be delineated.	All	2005–2009
Habitat loss and fragmentation – nesting and foraging; prey diversity and availability	Research; habitat management guidelines	High	Recover sufficient habitat to support population goals	Research, develop and implement silvicultural techniques to promote stand attributes for the recovery, maintenance, and diversity of prey populations	All	1999–ongoing
Habitat loss and fragmentation – foraging; introduced species; prey diversity and availability	Research; habitat management guidelines; stewardship; outreach	High	Manage introduced species to minimize habitat impact	Develop and implement management plans for introduced species (e.g., deer) that are affecting foraging habitat and prey of *A. gentilis laingi*	HG	2008–ongoing

Objective 1: To manage and, where necessary, conserve and recover habitat that meets the needs of the Northern Goshawk *A. gentilis laingi* through its annual cycle						
Threat(s) addressed	**Broad strategy**	**Priority**	**Recommended approaches to meet recovery objectives**	**Action**	**Conservation region**	**Timeline (initiation-completion)**
Habitat loss and fragmentation – nesting and foraging; prey diversity and availability; introduced species; human disturbance	Stewardship; outreach	Medium	Engage public and private landowners, and resource managers in conserving habitat for *A. gentilis laingi*	Develop and implement outreach and education strategies for these groups	All	1995–ongoing
Habitat loss and fragmentation	Monitoring; adaptive management	High	Assess the effectiveness of habitat management actions to protect habitat of *A. gentilis laingi*	Conduct effectiveness monitoring as required	All	1995–ongoing
Research; habitat management guidelines	Research; habitat management guidelines	Low	Consider habitat management requirements over decadal time scales	Predict change in habitat attributes and distribution related to climate cycles and climate change scenarios, using climate modelling exercises	All	2012–2017

Objective 2: To conserve and, where necessary, recover a well-distributed and viable population of Northern Goshawk *A. gentilis laingi* within coastal B.C.						
Threat(s) addressed	**Broad strategy**	**Priority**	**Recommended approaches to meet recovery objectives**	**Action**	**Conservation region**	**Timeline (initiation-completion)**
Genetic isolation	Research; Population management guidelines	High	Define population and distribution objectives for each conservation region	• Use **spatially explicit population modelling** for each conservation region • Continue to collect and analyze genetic samples	All	2007–2009
Habitat loss and fragmentation-nesting and foraging; genetic isolation	Implement habitat management guidelines to manage populations; inventory; monitoring	High	Manage populations by conservation region to meet defined population and distribution objectives	• Use habitat conservation and management strategies defined under objective 1 to conserve and recover populations • Conduct inventory and monitoring as required	All	1999–ongoing 1995–ongoing
Introduced species; prey diversity and availability	Introduced species guidelines	High	Manage introduced species to minimize population impacts	• Develop and implement management plan for introduced species interactions affecting *A. gentilis laingi* indirectly (prey diversity and availability) and directly (predation)	HG	2008-ongoing
Prey diversity and availability	Monitoring; research	Medium	Assess and monitor prey abundance and diversity	• Determine primary prey species for *A. gentilis laingi* • Monitor prey populations and assess	NC, SC All	2008–2009 1994–ongoing

Objective 2: To conserve and, where necessary, recover a well-distributed and viable population of Northern Goshawk *A. gentilis laingi* within coastal B.C.						
Threat(s) addressed	**Broad strategy**	**Priority**	**Recommended approaches to meet recovery objectives**	**Action**	**Conservation region**	**Timeline (initiation-completion)**
				impacts of forest harvest techniques on prey		
Persecution	Stewardship; outreach; research	Low	Assess threat to *A. gentilis laingi* from persecution and reduce if required	• Evaluate degree of risk to *A. gentilis laingi* posed by persecution • Address persecution issues through outreach and education strategies, if required	All	2006–2012
Disease	Monitoring; research	Low	Monitor for presence of West Nile Virus and other potential diseases	• Design and implement monitoring program for WNV (model potential impacts)	All	2015–2017
Competition, depredation	Monitoring; research	Low	Monitor populations of edge-adapted predators and competitors	• Design and implement a monitoring program for edge-adapted competitors and predators (e.g., Red-tailed Hawks, Great Horned Owls, Barred Owls)	All	2010–2012

Performance Measures

Key performance measures are identified below.

- Are known nest trees and PFA's protected by 2012?
- Have population and distribution objectives been defined for each conservation region by 2009?
- Have habitat requirements for population goals been identified by 2009?
- Have science-based guidelines been developed by 2008?
- Has prey abundance and diversity been assessed and monitoring been initiated by 2009?
- Have threats from prosecution been assessed and reduced, if required, by 2012?
- Has monitoring of populations of edge-adapted predators and competitors been initiated by 2012?

Critical Habitat

Identification of the species' critical habitat

Critical habitat is defined in the *Species at Risk Act* as habitat that is necessary for the survival (current) or recovery (future recruitment) of a listed species (Environment Canada 2006). Within this recovery strategy, the recovery team describes the biophysical attributes of habitat components for *A. gentilis laingi* (see "Habitat needs" section).

Critical habitat cannot be defined at this time. The recovery team feels that it has insufficient information regarding both the amount and location of suitable habitat within each conservation region to be able to confidently determine which areas are necessary to meet the recovery goal. As well, without population modelling, the team cannot set meaningful population objectives for each conservation region.

Recommended schedule of studies to identify critical habitat

The recovery team lacks information to develop numerically bound and measurable population and habitat targets for *A. gentilis laingi*. Most of the following activities will be carried out by the habitat RIG and the results incorporated into an action plan, with strategic direction and periodic review from the recovery team.

Steps required to establish habitat and population targets for *A. gentilis laingi* are outlined in Table 4.

Table 4. Steps necessary to establish measurable and science-based habitat and population objectives and to delineate critical habitat for *A. gentilis laingi* within each conservation region in B.C.

Activity	Timeline[a]	Status
Develop habitat suitability (nesting and foraging) and **territory models** for *A. gentilis laingi* within each conservation region	2007–2008	In progress
Develop standards for ground **verification** of habitat suitability models	2006–2007	Complete

Verify habitat suitability models within each conservation region and refine models accordingly	2006–2009	In progress
Use habitat suitability models to assess quantity, quality, and distribution of nesting and foraging habitat within each conservation region	2008–2009	In progress
Develop a population model for each conservation region in B.C. and overlay this with the habitat suitability model so that it is spatially explicit	2008–2009	Not yet initiated
Determine viable population targets for each conservation region	2009	Not yet initiated
Determine habitat targets and distribution for each conservation region	2008–2009	Not yet initiated
Delineate survival and recovery habitat (action plan) for populations by conservation region	2008–2010	Not yet initiated

[a] ability to meet anticipated deadlines will depend on funding availability.

Existing and Recommended Approaches to Habitat Protection

See Appendix 1 for existing approaches and measures available to protect habitat for *A. gentilis laingi.*

Effects on Other Species

Several species that select habitat characteristics similar to *A. gentilis laingi* will benefit from implementation of this recovery strategy. Specifically, recovery processes involving Marbled Murrelets, Spotted Owls, and Coastal Douglas-fir (CDFmm1) ecosystems will likely benefit from this recovery strategy. Although *A. gentilis laingi* prey upon Marbled Murrelets and Spotted Owls, they could potentially regulate populations of other predators of these species and they provide nest platforms for Spotted Owls (Forsman and Giese 1997). As well, prey species of *A. gentilis laingi* such as grouse, woodpeckers, small forest owls, and Red Squirrels will benefit from habitat management aimed at improving foraging habitat of this subspecies. To the best of our knowledge, no SARA-listed species will be negatively impacted through implementation of this recovery strategy.

Socioeconomic Considerations

A detailed socioeconomic cost–benefit analysis (SEA) is not required in a recovery strategy but will accompany the recovery action plan(s). The recovery team deemed it prudent, however, to note the scale of potential socioeconomic impacts of recovery.

Because of the extensive spatial requirements for nesting, post-fledging, and foraging, recovery of *A. gentilis laingi* may have a substantial impact on coastal B.C.'s forested landbase (see Figure 1). Activities affected include mainly forest harvesting, but may also include non-timber forest harvesting for mining, power generation, recreation, agriculture, and housing. Recovery may also impact both First Nations economic and traditional use practices. Promoting

stewardship activities and creating incentive packages, especially on private lands, may be required to address action plan needs.

While there are economic costs associated with recovery of *A. gentilis laingi*, the benefits associated with ecosystem maintenance and habitat protection are more difficult to quantify economically. The citizens of B.C. have consistently expressed strong support for protection of species at risk. This support is reflected in the government's stated goal to lead the world in sustainable environmental management (Speech from the Throne, Opening of the Sixth Session, Thirty-Seventh Parliament of the Province of British Columbia, February 8, 2005). Furthermore, substantial social, political, and economic benefits are likely involved in recovery of the species including compliance with the federal *Species at Risk Act* (SARA) and avoidance or reduction of costs related to captive breeding programs.

Anticipated Conflicts

Northern Goshawks have been at the centre of debate surrounding forest harvesting practices throughout North America (Crocker-Bedford 1990, 1998; Kennedy 1997; Daw *et al.* 1998; Andersen *et al.* 2003; Kennedy 2003; McGrath *et al.* 2003) and Europe (Widén 1997) for over a decade. Several petitions have been launched by environmental organizations and concerned citizens to list *A. gentilis laingi* under the U.S. *Endangered Species Act* (see U.S. litigation review in Squires and Kennedy 2006). As soon as forests become structurally mature and suitable for *A. gentilis laingi*, they also become economically viable for timber harvesting. The recovery team anticipates that there may be conflict associated with maintaining a sufficient amount of habitat for the survival and recovery of populations of *A. gentilis laingi* and with continuing to manage forests at current allowable annual harvest levels and rotation periods within coastal B.C.

Threats to *A. gentilis laingi* from introduced species in Haida Gwaii may be challenging to overcome. Forest fragmentation has the potential to increase depredation of adults, eggs, and young, and increase competition for nest sites for *A. gentilis laingi*, which may be difficult to mitigate. As well, the recovery team is unsure how it will be able to reduce threats posed by emerging diseases (e.g., West Nile Virus) and climate change within our action plan. Importantly, the recovery team anticipates challenges associated with obtaining sufficient funding to fill the knowledge gaps that have been identified (see "Knowledge Gaps" section).

Recommended Approach for Recovery Implementation

This recovery strategy for *A. gentilis laingi* was developed for the four conservation regions in B.C. (see "Global distribution" section). Although these conservation regions may not encompass discrete populations, each region has its own suite of threats and management issues. Therefore, recovery activities must occur at multiple scales including conservation regions, watersheds within conservation regions, and potential home ranges. Reynolds *et al.* (1992) have implemented this approach in southeastern Arizona where forested landscapes are managed for foraging and nesting habitats as well as for prey species. Because of the high site fidelity exhibited by this species, conservation measures within B.C.'s conservation regions have historically focused on sites known to contain breeding pairs. However, managing *A. gentilis*

laingi on a nest-by-nest basis is an ineffective management approach at a population scale because individuals have large breeding and winter home ranges and they build multiple nests within breeding areas throughout their lifetime. Additionally, *A. gentilis laingi* are difficult to detect and locating all nests within a breeding home range is virtually impossible because nests will fall out of trees over time and new nests will be constructed. The recovery team recommends addressing the management of *A. gentilis laingi* at a landscape or watershed level to ensure that suitable breeding, foraging, and wintering habitats exist throughout the landscape. Ultimately, a multi-scale approach will be necessary to ensure the recovery of *A. gentilis laingi*. A multi-scale approach will require that sufficient levels of foraging habitat be maintained within close proximity to suitable nesting habitat, and that habitat among pairs is sufficient in amount and distribution to facilitate successful dispersal and mate-pairing to maintain healthy populations.

Statement on Action Plans

The Habitat RIG plans to complete an action plan within 2 years after final posting on the B.C. government website of the recovery strategy (as outlined in Table 4).

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GLOSSARY

Active nest: a nest where there is sufficient evidence that a breeding attempt has occurred within a given year. Sufficient evidence includes eggshell fragments at the base of a nest tree, an incubating adult or nestlings on a nest, or evidence that nestlings were present within a nest such as sufficient excrement below the nest tree.

Biogeoclimatic subzone: a climatic or zonal classification system that uses vegetation, soils, and topography to infer the regional climate of a geographic area. Biogeoclimatic subzones are delineated where different plant associations occur; this is the basic unit of this climatic classification system (<http://www.for.gov.bc.ca/hre/becweb/system/how/climatic.html>).

Biogeoclimatic variant: areas that are slightly drier, wetter, snowier, warmer, or colder than that considered typical for the subzone. These climatic differences result in corresponding differences in vegetation, soil, and ecosystem productivity, although the changes in the vegetation are not sufficient to define a new plant association. The differences in vegetation are evident as a distinct climax plant subassociation (<http://www.for.gov.bc.ca/hre/becweb/system/how/climatic.html>).

Breeding dispersal: the movement of adult birds from one breeding site to another between years (Greenwood 1980). For Northern Goshawks, this may include movement between alternative nest sites within a single nest area or between different nest areas.

Breeding home range: the area used by adult birds from courtship until young vacate natal areas (February through early September for *A. gentilis laingi*).

Core-use area: areas of an organism's larger home range where activities (such as breeding) are concentrated.

Critical habitat: the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.

Ectoparasites: parasites that live on a host's outer surface.

Environmental stochasticity: fluctuating environmental conditions such as rainfall, snow levels, temperatures, etc.

Foraging area: the areas where adult and dispersing immature Northern Goshawks hunt. Foraging areas may or may not include nest trees and post-fledging areas and they make up the majority of an individual's home range (Reynolds *et al.* 1992).

Habitat: the resources and conditions present in an area that produce occupancy — including survival and reproduction — by an organism (Hall *et al.* 1997).

Habitat fragmentation: the isolation of parcels of habitat such that suitable habitat patches are separated from other suitable habitat patches by unsuitable habitat.

Habitat loss: a reduction in the amount of area that serves as habitat for a particular species.

Hard edges: the edge between two adjacent forest stands that differ in age and structural characteristics. For example, the edge between one stand that is <20 years and another stand that is >45 years. These types of edges are often created through human disturbances on the landscape rather than through natural processes.

Intra-specific competition: interactions between individuals of the same species for limited resources.

Inter-specific competition: interactions between individuals of different species for limited resources.

Introduced species (also known as an exotic species)**:** is an *organism* that is not indigenous to a given place or area and instead has been accidentally or deliberately transported to this new location by *human* activity.

Natal dispersal: the process whereby individuals move from their natal area to where they first reproduce.

Nest areas: the component of a Northern Goshawk's home range that is occupied by one breeding pair during each breeding season and contains multiple alternative nest trees. Nest area size varies and depends on the topography and availability of suitable breeding habitat.

Non-colonial: individuals that nest singularly rather than in groups (colonies).

Occupancy rates: a nest area of *A. gentilis laingi* is considered to be occupied if at least one adult or fledgling is detected. This metric is calculated using the number of nest areas with active nests divided by the total number of nest areas assessed for occupancy.

Panmictic: a population where all individuals are potential breeding partners (i.e., there are no group structures or mating restrictions in the population).

Partial foraging habitat: a segment or part of a breeding pair's foraging habitat.

Persecution: persistent harassment or mistreatment by humans.

Post-fledging (family) area: the area around nest trees that fledglings use to retrieve food and learn to fly before they become independent of adults and leave their natal areas (Reynolds *et al.* 1992; Kennedy *et al.* 1994).

Residence: defined in the *Species at Risk Act* as a dwelling-place, such as a den, nest, or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating.

Recruitment: the process whereby immature individuals enter into the breeding population.

Sedentary: non-migratory.

Seral stage: stages of forests as they age and progress through a number of successional structural forms.

Socially monogamous: when individuals pair with the same mate for at least one breeding season.

Spatially explicit population model: a model that links vital rates (survival, productivity, lifespan, dispersal) for species to landscape-level habitat characteristics.

Subspecies: a taxonomic subdivision of a species that includes a group of organisms whose behaviour and/or genetically encoded morphological and physiological characteristics differ from those of other members of their species. Members of different subspecies of the same species are potentially capable of breeding with each other and of producing fertile offspring but there are often geographic, behavioural, or other such "barriers" that minimize interbreeding.

Synchronous breeder: individuals of a species that initiate breeding at approximately the same time within the breeding season.

Territory model: a model that uses information from nesting and foraging habitat suitability models to predict where sufficient nesting and foraging habitat is present to support a breeding pair of *A. gentilis laingi* (i.e., territory). This model also uses information about the spacing patterns between adjacent pairs of *A. gentilis laingi* to predict how many breeding pairs could be supported within a given landscape.

Verification: the process of collecting data during site visits to check whether predictions from habitat suitability models, and variables used as inputs for models, are valid.

Winter home range: the area used by birds during the non-breeding season (September through February for *A. gentilis laingi*).

APPENDIX 1. Existing approaches and measures available to protect habitat for *A. gentilis laingi*

Within Table A1, the recovery team has outlined current legislation in Canada, and the mechanisms within the legislation, that may provide habitat protection for *A. gentilis laingi* either through targeted or incidental habitat protection. As well, the recovery team has estimated the scale of habitat protection that may be enabled through each legislation/mechanism. Once critical habitat has been delineated for *A. gentilis laingi*, the recovery team will have a clearer understanding of how useful these tools will be for protecting their critical habitat.

Table A1. Legislation and mechanisms available to protect *A. gentilis laingi* and their habitats.

Legislation	Mechanism(s)	Responsible agency	Scale of habitat protection for *A. gentilis laingi*	Implementation date and status
Wildlife Act <http://www.qp.gov.bc.ca/statreg/stat/W/96488_01.htm> • Section 34	Protection	MOE — provincial[a]	Individual, eggs, active nests	1996
Wildlife Amendment Act[b] <http://www.legis.gov.bc.ca/37th5th/1st_read/gov51-1.htm> • Section 5	**Residences**	MOE – provincial	Individual, eggs, nests	2006 – ongoing development
Forest and Range Practices Act (FRPA) <http://www.for.gov.bc.ca/tasb/legsregs/frpa/frpa/frpatoc.htm> • *FRPA S. 3*	Forest Stewardship Plans	MOFR – provincial[c]	Nest trees, post-fledging area, foraging habitat	Dec. 31, 2006 – ongoing development
• *FRPA S.5(b)(i)(ii)*	Objectives set by government and other FRPA objectives	MOFR – provincial MOE – provincial MAL – provincial[d]	Nest trees, post-fledging area, foraging habitat	Dec. 31, 2006 – ongoing development
• *FRPA S. 180, S. 181 and S. 182*	Grandparented ungulate winter ranges, wildlife habitat areas, general wildlife measures	MOE – provincial	Nest trees, post-fledging area, foraging habitat	Carry-over from Forest Practices Code (FPC)

Legislation	Mechanism(s)	Responsible agency	Scale of habitat protection for *A. gentilis laingi*	Implementation date and status
Forest Planning and Practices Regulation (FPPR) <http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm> • *FPPR S. 7(1)(a)(b)*	Objectives set by government for wildlife • Amount, distribution and attributes for species in S. 7(2) Notices	MOE – provincial	Nest trees, post-fledging area	Notice provided by Forest District – December 31, 2005
• *FPPR S. 8*	Objectives set by government for water, fish, wildlife, and biodiversity within riparian areas • Riparian Reserve Zone • Riparian Management Zone	MOFR – provincial	**Partial foraging habitat**[f]	Carry-over from FPC
• *FPPR S. 9*	Objectives set by government for wildlife and biodiversity – landscape level • Harvest patterns should mimic natural disturbance regimes • Cutblock size	MOFR – provincial	Partial-foraging habitat	Carry-over from FPC
• *FPPR S. 9.1*	Objectives set by government for wildlife and biodiversity – stand level • Wildlife tree patches	MOFR-provincial	Partial-foraging habitat	Carry-over from FPC

Legislation	Mechanism(s)	Responsible agency	Scale of habitat protection for *A. gentilis laingi*	Implementation date and status
Government Actions Regulation (GAR) <http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/govact/gar.htm> • *GAR S. 9*	• General wildlife measures	MOE – provincial	Nest trees, post-fledging area, partial-foraging habitat	Carry-over from FPC
• *GAR S. 10*	• Wildlife habitat area for *A. gentilis laingi* • Wildlife habitat area for other category of species at risk	MOE – provincial	Nest trees, post-fledging area, partial-foraging habitat Nest trees, partial-foraging habitat	Carry-over from FPC
• *GAR S. 11*	Wildlife habitat feature	MOE – provincial	Nest trees	Being developed – 2006
• *GAR S. 12*	Ungulate winter ranges	MOE – provincial	Nest trees, post-fledging area, partial-foraging habitat	Carry-over from FPC
Land Use Objectives Regulation • *Land Amendment Act* <http://www.legis.gov.bc.ca/37th4th/3rd_read/gov46-3.htm> • *S. 93.8 Old-growth Order* <http://srmwww.gov.bc.ca/rmd/oldgrowth/index.htm>	• Land use plans • Land and resource management plans • Order establishing provincial non-spatial old-growth objectives	MAL – provincial	Nest trees, post-fledging area, foraging habitat Nest trees, post-fledging area, partial-foraging habitat	February 1, 2006 June 30, 2004
Park Act <http://www.qp.gov.bc.ca/statreg/stat/P/96344_01.htm>	Management plans	MOE – provincial	Nest trees, post-fledging area, foraging habitat	August 1, 1990

Legislation	Mechanism(s)	Responsible agency	Scale of habitat protection for *A. gentilis laingi*	Implementation date and status
Ecological Reserve Act <http://www.qp.gov.bc.ca/statreg/stat/E/96103_01.htm>	Management plans	MOE – provincial	Nest trees, post-fledging area, foraging habitat	1996
Species at Risk Act (SARA) <http://lois.justice.gc.ca/en/S-15.3/index.html> • SARA S. 32 • SARA S. 33 • SARA S. 57–58	• Individual harm • Residence • Action plan o Safety nets for non-federal lands	Parks Canada, Fisheries and Oceans Canada, Environment Canada (Canadian Wildlife Service) - Federal	Individuals, eggs Nest Nest trees, post-fledging area, partial-foraging habitat	• June 2004 • Being developed by MOE and federal government • After identified by recovery team and published in Canada Gazette
Canada National Parks Act <http://laws.justice.gc.ca/en/n-14.01/251405.html>	National Parks and Heritage sites	Parks Canada – federal	Individuals, eggs, nest trees, post-fledging area, foraging habitat	October 20, 2000
Private Managed Forest Land Act <http://www.legis.gov.bc.ca/37th4th/3rd_read/gov88-3.htm>	Critical wildlife habitat	Private managed forest landholders	Nest trees, post-fledging area	August 2004
Canadian Environmental Assessment Act (CEAA) <http://lois.justice.gc.ca/en/C-15.2/225560.html>	Environmental assessments of projects and listed activities (Inclusion List Regulations)	Canadian Environmental Assessment Agency and other responsible authorities under CEAA	Individual, eggs, nest trees, post-fledging area partial-foraging habitat	January 19, 1995

Note: Several other mechanisms may assist in protecting habitat for *A. gentilis laingi* that do not include legislation. These can be extremely important and include forest certification programs (<http://www.for.gov.bc.ca/het/certification>), professional responsibilities to manage for species at risk (<http://www.abcfp.ca/regulating_the_profession/documents/guideline-species-at-risk.pdf>*)* under the B.C. *College of Applied Biology Act* (<http://www.for.gov.bc.ca/tasb/legsregs/biology/caba.htm>) and the B.C. *Professional Forester's Act* (<http://www.qp.gov.bc.ca/statreg/stat/F/03019_01.htm>), as well as shared stewardship and best management practices.

[a] British Columbia Ministry of Environment; [b] The *Wildlife Amendment Act* will eventually be amalgamated with the *Wildlife Act;* [c] British Columbia Ministry of Forests; [d] British Columbia Ministry of Agriculture and Lands; [e] Partial foraging habitat indicates that only portions of breeding pair's foraging areas will be protected. The amount and distribution are variable and determined by the party who applies the mechanism.