"Queen Charlotte" Goshawk

Accipiter gentilis laingi

Original prepared by Erica McClaren

Species Information

Taxonomy

Two subspecies of goshawks are recognized in British Columbia: *Accipiter gentilis atricapillus* and *A. gentilis laingi* (AOU 1957; Palmer 1988). The subspecies *A. gentilis laingi*, referred to as the Queen Charlotte Goshawk, was described from a type-specimen from the Queen Charlotte Islands by Taverner (1940). Taverner (1940) described the subspecies as being faintly to distinctly darker than *A. gentilis atricapillus*. Adults were described as sootier grey ventrally with the black cap and nape extending over the shoulders and interscapulars, dorsally (Taverner 1940). He described juveniles as having breast streaks that were very broad and deeper in colour than *A. gentilis atricapillus* and as darker brown, dorsally (Taverner 1940). This subspecies was thought to inhabit islands of coastal British Columbia, primarily the Queen Charlotte Islands and Vancouver Island (Taverner 1940). Later, *A. gentilis laingi* was also described as having shorter wing lengths (based on wing curvature) (Johnson 1989; Whaley and White 1994) and smaller toes than *A. gentilis atricapillus* (Whaley and White 1994). Whaley and White (1994) speculated that the ecological significance of *A. gentilis laingi*'s smaller size was for increased manoeuvrability through the dense coastal forests and an increased component of avian prey relative to mammalian prey in its diet.

Gavin and May (1995) conducted a genetic analysis of goshawks throughout North America using allozymes, random amplified polymorphic DNA (RAPDs), restriction fragment length polymorphism (RFLPs) of monomorphic RAPD generated bands, and microsatellites in their analyses. They concluded that goshawks exhibited very little genetic variation throughout their range but acknowledged that they did not include genetic samples from the Queen Charlotte Islands or Vancouver Island thus were unable to address whether *A. gentilis laingi* was a genetically distinct subspecies. Currently, the debate over the subspecific designation of *A. gentilis laingi* continues while further genetic analyses are being conducted by Sandra Talbot in Alaska. These analyses include blood samples from Vancouver Island, southeast Alaska, and the central coast of British Columbia, but only one sample from the Queen Charlotte Islands. Preliminary analyses suggest that goshawk populations in southeast coastal Alaska and Vancouver Island are genetically differentiated from populations in interior Alaska and British Columbia (S. Talbot pers. comm.).

Description

Queen Charlotte Goshawks are raven-sized (53–66 cm length; NGS 1999) forest-dwelling raptors with short rounded wings and long tails. Adults (>2 years) have a conspicuous light grey supercilium flaring out behind the eye that separates their black crown from their blue-grey back. Underparts are white with dense grey barring that appears light grey from a distance. In general, females are darker brown above as adults than males and have coarser grey barring on their undersides. The tail has bands of alternating light and dark. Adults have white and grey flecked undertail coverts that flare out when individuals are agitated or when they are conducting aerial displays. Adult eye colour varies from yellow to dark red and generally becomes darker with age. Immature goshawks (<2 years) have a faint light grey supercilium and are brown above and buffy below with thick, dark brown streaks. The tail has alternating brown and black bands, with white edges. Immature undertail coverts are white with brown tear-shaped streaks. Tarsi and toes are greenish grey to pale yellow as immatures, becoming yellow as adults, while talons appear bluish-black to

Northern Goshawk - subspecies *laingi*
(Accipiter gentilis laingi)

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

black (Squires and Reynolds 1997). Feathers continue approximately midway down the front of the tarsus (Squires and Reynolds 1997). Intermediate plumages between immature, subadult, and adult ages are described by Bond and Stabler (1941) and Squires and Reynolds (1997). These descriptions are based on those outlined by Squires and Reynolds (1997), NGS (1999), and Sibley (2000).

References to goshawks throughout the remainder of this account apply to *A. gentilis laingi* unless reported as Northern Goshawk (*A. gentilis atricapillus* or *A. gentilis gentilis)*.

Distribution

Global

Queen Charlotte Goshawks occur along the Pacific Coast from Vancouver Island north to the Alexander Archipelago in southeast Alaska, coastal mainland Alaska and Lynn Canal (Webster 1988; Titus et al. 1994; Iverson et al. 1996; Ethier 1999).

British Columbia

British Columbia contains the majority of the Queen Charlotte Goshawk population worldwide. The Queen Charlotte Goshawk occurs on Vancouver Island, the Queen Charlotte Islands, and smaller coastal islands between Vancouver Island and mainland British Columbia. Their distribution throughout coastal mainland British Columbia is unknown, but radio-tagged individuals from Vancouver Island have moved to breed on adjacent coastal islands (McClaren 1997, 1999). As well, two goshawks from Vancouver Island have moved to adjacent coastal mainland during the winter (McClaren 2000, 2001). Most likely, Queen Charlotte Goshawks also inhabit forests on the west side of the Coast Mountains throughout coastal mainland British Columbia.

Forest region and districts

Coast: Campbell River, North Coast, North Island, Queen Charlotte Islands, South Island, Sunshine Coast

Ecoprovinces and ecosections

COM: NIM, NWL, QCL, SKP, WIM, WQC, (CBR, HEL, OUF, SBR – possible)

GED: LIM, NAL, SGI, SOG, (GEL – possible)

Biogeoclimatic units

CDF: mm

CWH: dm, mm, vh, vm, wh, xm

MH: mm, wh

Broad ecosystem units

CB, CD, CH, CR, CW, DA, FR, HL, HS, SR, YB

Elevation

Documented to breed between sea level and 900 m (Iverson et al. 1996; McClaren 2003) but may use higher elevations for foraging throughout the year (McClaren 1997, 1998, 1999; D. Doyle, pers. obs.).

Life History

Diet and foraging behaviour

Goshawks are considered opportunistic hunters, foraging on a variety of medium-sized birds and mammals throughout the year (Squires and Reynolds 1997). The majority of data on diet has been collected from goshawks during the breeding season (Vancouver Island: Ethier 1999; E.L. McClaren, unpubl. data; southeast Alaska: Iverson et al. 1996; Lewis 2001; Olympic Peninsula: Bloxton, in prep.). Most prey items include forest dwelling birds and mammals. Red Squirrels (*Tamiasciurus hudsonicus*), thrushes, jays, woodpeckers, Marbled Murrelet (*Brachyramphus marmoratus*), and grouse were the main prey in pellets found below active nest sites on Vancouver Island (Ethier 1999; E.L. McClaren, unpubl. data). Goshawk pellets from southeast Alaska contained similar prey species as those from Vancouver Island, but they had a higher component of members from the Alcidae family and Northwestern Crows (*Corvus caurinus*) (Iverson et al. 1996). Only anecdotal evidence is available to describe the prey items goshawks use during the winter. However, because fewer prey species are available to goshawks during the winter, certain species may be critical to goshawks during this time.

The rounded wings and long tail of goshawks make them well suited for manoeuvring through forested habitats while hunting. However, few data have been

collected from radio-tagged birds while they are foraging or at kill sites. Therefore, our knowledge of Queen Charlotte Goshawk foraging habitat characteristics is limited (Squires and Reynolds 1997).

Reproduction

Queen Charlotte Goshawks typically do not breed until they are >2 years although, occasionally, they will breed in their second year (McClaren 2003). Individuals return to their breeding sites between early February and late March (ADFG 1996; E.L. McClaren, unpubl. data). Courtship consists of aerial displays, dawn vocalizations, nest building/repair, and frequent copulation, and occurs between February and early April, with peak activity occurring in March (Beebe 1974; Chytyk et al. 1997; A. Zeeman, unpubl. data). One to four eggs are laid mid- to late April and incubation (by the female primarily) occurs for 30–32 days (Beebe 1974; Iverson et al. 1996; E.L. McClaren, unpubl. data). During late courtship and early incubation, the female is primarily fed by the male (Cooper and Stevens 2000). Hatching occurs between late May and mid-June with typically one to three young fledging after 38–42 days in early to mid-July (ADFG 1996; McClaren and Pendergast 2002). Females assist males with hunting during the second half of the nestling phase; however, the timing varies and is influenced by brood size, food supply, and the male's hunting performance (Squires and Reynolds 1997; Dewey and Kennedy 2001). Fledglings remain near the nest (the post-fledging area [PFA]) for 40–60 days, after which they disperse and become independent of adults (Kenward et al. 1993; Kennedy et al. 1994; McClaren and Pendergast 2002). Dispersal occurs between early August to early September (Iverson et al. 1996; McClaren and Pendergast 2002).

Site fidelity

Nest site fidelity is the occupancy of the same nest area, by the same individual or pair of goshawks, in subsequent breeding seasons (Reynolds and Joy 1998). Nest site fidelity in goshawks is difficult to estimate because breeding goshawks can be secretive, making detection of alternative nest site locations and banded individuals laborious. Overall, site fidelity for the Queen Charlotte Goshawk appears to be greater for males than females, which concurs with studies on Northern Goshawks (California: Detrich and Woodbridge 1994; Arizona: Reynolds and Joy 1998). Studies in southeast Alaska have shown that radio-tagged males exhibit high site fidelity, whereas some females moved to new nest areas and mated with different males (Iverson et. al. 1996). All areas that females dispersed to included a portion of their winter home range (Iverson et al. 1996). On Vancouver Island, turnover rate of marked females was 78.9% (n = 57) with a maximum turnover rate of six consecutive years of occupancy by six different females within one nest area (McClaren 2003). It was not possible to calculate turnover rates for males because trapping success for males was less successful. Similar to southeast Alaska, breeding dispersal movements by radio-tagged males on Vancouver Island have not been observed (E.L. McClaren, unpubl. data). Between 1995–2002, goshawks on Vancouver Island used nest trees 1.6 years ($n = 72$), on average, similar to other studies in North America (Squires and Reynolds 1992; McClaren 2003).

Home range

The size of goshawk breeding home ranges varies according to the familiarity of individuals with their home range, differences in hunting efficiency, food requirements (brood size), and food availability (Kennedy et al. 1994). For example, in California, breeding home ranges averaged 1280 ha ($n = 5$) for Northern Goshawk females and 1880 ha ($n = 5$) for males (Keane and Morrison 1994) whereas in southeast Alaska, breeding home ranges for Queen Charlotte Goshawks averaged 19 215 ha ($n = 8$) for females and 5847 ha ($n = 8$) for males (Titus et al. 1994). In southeast Alaska, female breeding season home ranges were primarily <1000 ha; however, two females made large movements away from their breeding areas during the post-fledging period, dramatically increasing estimates of mean breeding season home range size (Titus et al. 1994). In southeast Alaska, goshawks travel among small islands to forage, thereby increasing travel distances to find food. Breeding home range size estimates for Queen

Charlotte Goshawks in other parts of their range are not available. However, nesting density, the distance between adjacent active nests, may approximate breeding home range size. In the Nimpkish Valley and Gold River on Vancouver Island, mean nesting density for goshawks is 6.9 ± 0.7 (n = 16) (McClaren 2003).

Goshawk breeding home ranges appear to be composed of a nest area, PFA, and foraging area (Reynolds et al. 1992). The nest area often contains several alternative nest trees, roost trees, plucking posts, and is the centre of courtship behaviour and fledgling movements during the early post-fledging period (Reynolds et al. 1982; Kennedy et al. 1994; McClaren and Pendergast 2002). Goshawk nest areas may or may not be contained within the same forest stand (Reynolds et al. 1992; Squires and Reynolds 1992). Nest areas vary in size and shape depending on topography and the availability of suitable habitat (Reynolds 1983; Ethier 1999). On Vancouver Island, 95% of alternative nest trees within a nest area occur within 800 m of each other, suggesting that nest areas on Vancouver Island are approximately 200 ha (McClaren 2001). Although several nest trees occur <800 m from one another, the likelihood of locating nests farther is less. Therefore, 200 ha is a conservative estimate of the actual nest area. Because alternative nest spacing appears to be greater for the Queen Charlotte Goshawk than for the Northern Goshawk (Iverson et al. 1996; McClaren 2001; McClaren and Pendergast 2002), nest area size is more comparable to post-fledging size in this subspecies.

The PFA is the area used by fledglings before they become independent of adults and disperse (Kennedy et al. 1994). The PFA surrounds and includes the active nest area and corresponds roughly with the female core-use area (Kennedy et al. 1994). Post-fledging areas vary in size. Kennedy et al. (1994) reported a mean size of 170 ha for *A. gentilis atricapillus,* whereas estimates from the Kispiox and Lakes areas of British Columbia suggest PFA size is much smaller, averaging <20 ha (Doyle and Mahon 2000; Mahon and Doyle 2001). Both these PFA estimates for Northern Goshawks are smaller than the estimated nest area and PFA size for Queen Charlotte Goshawks. Preliminary data suggest that PFAs on Vancouver Island are similar in size to those originally proposed by Reynolds et al. (1992) and Kennedy et al. (1994) (McClaren and Pendergast 2002). Research on radio-tagged fledglings on Vancouver Island in 2001 and 2002 suggests PFA size for Queen Charlotte Goshawks is approximately equivalent to nest area size (McClaren and Pendergast 2002). Post-fledgling area size estimates from 12 fledglings on Vancouver Island was 58.6 ± 11 ha. Allowing for multiple PFAs around alternative nests and some buffering from edge suggests a nest area PFA size of 200 ha. Larger PFA estimates for Queen Charlotte Goshawks than for Northern Goshawks may result from lower prey densities and larger home ranges in coastal forests than interior forests.

Foraging areas make up most of an individual's breeding home range and they are comprised of the areas where adult male and female goshawks hunt. Foraging areas may include the nest area and PFA. It is believed adult males do not hunt directly within the nest area and PFA to maintain locally abundant food supplies for adult females and for fledglings when they are learning to hunt (Kennedy et al. 1994). Foraging areas vary in size among locales and among individual goshawks according to the experience of individuals within their breeding home range, differences in their hunting efficiency, food requirements (brood size), and the availability of food within their home ranges (Kennedy et al. 1994). Few studies have estimated the foraging area size for Queen Charlotte Goshawks because limited information is available on goshawk foraging activities. Most often, the size of the foraging area is based on breeding home size for goshawks with the assumption that goshawks forage widely throughout their home range. Research conducted on Northern Goshawks suggests that goshawks spend disproportionately more time foraging in mature forests within their home ranges (Bright-Smith and Mannan 1994; Good 1998; Stephens 2001).

Movements and dispersal

It appears that Queen Charlotte Goshawks do not undergo annual large-scale southward migrations (Iverson et al. 1996; McClaren 2003). Rather, males remain closer to nest areas than females and both sexes establish winter home ranges that may include part of their breeding home ranges (Iverson et al. 1996). On Vancouver Island, three females have moved between Vancouver Island, the islands off Vancouver Island's east coast, and the mainland coast (McClaren 2003). It is unknown whether Queen Charlotte Goshawks partake in cyclic massive invasions southward that have been reported for Northern Goshawks (Mueller and Berger 1967; Hofslund 1973; Mueller et al. 1977). Two radio-tagged females on Vancouver Island moved to nest in different nest areas in subsequent years (McClaren 2003). Breeding dispersal ranged from 4–12 km. Minimal information is available for goshawk juvenile dispersal. In southeast Alaska, radio-tagged juveniles (n = 23) were relocated between 11.2–161.6 km from natal areas 9–319 days after dispersal (Iverson et al. 1996). On Vancouver Island, fledglings could not be located from the ground or air within 1 week after dispersal (McClaren and Pendergast 2002). These results suggest that fledglings may move large distances from their natal territories immediately after dispersal.

Habitat

Structural stage

5: young forest (under certain conditions, may be used but is generally not preferred)
6: mature forest
7: old forest

A few nests occur in highly productive growing sites in forests in structural stage 5. Nests in these younger structural stages are typically in red alder (*Alnus rubra*) along creek beds within predominantly coniferous forests or in coniferous trees that have multiple leaders (McClaren 1998).

Important habitats and habitat features

Nesting

Queen Charlotte Goshawks appear to nest in a variety of forest types throughout their range and therefore their breeding habitat associations are difficult to characterize (Iverson et al. 1996; Ethier 1999; McClaren 2003). Although varied, the coastal forests goshawks breed in share common characteristics including: 1) >45 years (structural stages 5–7); 2) multi-layered canopies; 3) structurally diverse; 4) canopy closure >50%; 5) large diameter trees for the locale; 6) snags and coarse woody debris; 7) typically not along forest/non-forest edges; 8) not near urban areas; and 9) generally nests are on the lower 2/3 of slopes where slope gradient is <40° (Iverson et al. 1996; Daw et al. 1998; Ethier 1999).

Within these forest stands, goshawks build their nests in several tree species, and typically, nest trees include the largest trees in the stand (Reynolds et al. 1992; Iverson et al. 1996; Ethier 1999). Most often, goshawks breeding in coastal forests select western hemlock (*Tsuga heterophylla)*, Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), and red alder for nest trees at elevations <900 m (Iverson et al. 1996; Ethier 1999; McClaren 2003). On Vancouver Island, Ethier (1999) reported goshawk nest trees were immediately surrounded by forests with lower tree densities and larger dbh than forests outside the nest stands, whereas forest characteristics not immediately around nests but surrounding nests, were denser and had smaller dbh. He suggested goshawks might breed in forests with these characteristics to increase manoeuvrability within the nest stand while increasing their protection from predators with higher tree densities surrounding the nest stand.

Post-fledging

Post-fledging areas are considered important habitat for young goshawks because fledglings are learning to fly and hunt, making them extremely vulnerable to predation during this time (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001). Post-fledging areas are characterized by an

abundance of the habitat attributes critical for goshawk prey (snags, coarse woody debris), and by extensive canopy cover (>50%) which provides protection to fledglings learning to fly and hunt (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001).

Foraging

Minimal information on the habitat of goshawk kill sites is available for Queen Charlotte Goshawks. Goshawks appear to be opportunistic in their hunting habitats as long as prey is available to them. In Arizona, Beier and Drennan (1997) reported that radio-tagged *A. gentilis atricapillus* were foraging in sites that had a higher canopy closure, greater tree density, and a greater density of large diameter trees than forests that were available to them. Importantly, the areas used by these goshawks for foraging did not have the highest abundance of prey species within their study area; foraging occurred in areas where prey were most available to goshawks because the forest structure was conducive for them to capture prey (Beier and Drennan 1997). It is unknown how important habitat edge zones, subalpine/alpine areas, and estuaries are as foraging habitat for the Queen Charlotte Goshawk. As well, it is unclear how patch size influences the suitability of forests for goshawk foraging habitat. In southeast Alaska, radio-tagged goshawks included beach/forest edge zones in their foraging habitat (Iverson et al. 1996). Although most locations of goshawks on Vancouver Island during the winter occurred in large patches of old-growth forests, some locations occurred in high-elevation forests, subalpine areas, and in estuaries (McClaren 1997, 1998, 1999).

Winter

Winter habitat requirements for the Queen Charlotte Goshawk are unclear. In southeast Alaska and on Vancouver Island, it appears that goshawks are partial migrants, remaining within 10–100 km of their nest. In some years satellite-tagged females on Vancouver Island moved to a separate winter area but in other years expanded their breeding home ranges to include their winter range (Iverson et al. 1996; McClaren 2003). Winter locations from a low-intensity radio telemetry study on Vancouver Island suggest goshawks spend disproportionate amounts of time in mature and old-growth forests throughout the winter (McClaren 1997, 1998, 1999). As well, several locations occurred in high elevation older forests, suggesting goshawks forage on grouse and ptarmigan during the winter. In southeast Alaska, 58% of combined breeding and non-breeding season goshawk habitat use was in very high to moderately productive old-growth forests and 30% of habitat use was in mature sawtimber, scrub forest, and low productivity old-growth forests (Iverson et al. 1996). Habitat use patterns did not significantly differ between the breeding and non-breeding seasons in southeast Alaska (Iverson et al. 1996).

Conservation and Management

Status

The Queen Charlotte Goshawk is on the provincial *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	Canada	Global
S2B, SZN	S2	N2	G5T2

Trends

Population trends

Population trends are not known in Alaska and British Columbia (Iverson et al. 1996; Cooper and Stevens 2000). Most goshawk studies have focussed on describing goshawk habitat associations rather than on determining their demographic rates. Birth rates for the Queen Charlotte Goshawk, estimated by the number of young fledged/active nest (the number of young in the nest approximately 1 week prior to fledging; Steenhof 1987), was 1.6 ± 0.1 S.E. (n = 141 breeding events) on Vancouver Island (McClaren 2003). Mean nest productivity on Vancouver Island varied significantly among years within the same nest areas which suggests that prey

and weather are important factors influencing goshawk reproduction (McClaren et al. 2002). Mean nest productivity values could not be calculated for goshawk nests in the Queen Charlotte Islands because sample sizes were too small, but for one to two active nests per year, nest productivity in the Queen Charlotte Islands ranged from 0 to 2 young (Chytyk and Dhanwant 1999). In southeast Alaska, a mean number of two young fledged per nest attempt (Flatten et al. 2001). Adult and juvenile survivorship information is scarce for *A. gentilis laingi*. In southeast Alaska, Iverson et al. (1996) estimated survivorship of radio-tagged adults (sexes combined) to be 0.72 (n = 39; 95% CI = 0.56–0.88) between July 1992 and August 1996. They used a staggered-entry Kaplan-Meier estimator (Pollock et al. 1989) for their data analysis (Iverson et al. 1996). The annual survival rate of juveniles has not been estimated for *A. gentilis laingi.* Radio telemetry data from Vancouver Island for adult goshawks suggest that adults have high overwinter mortality rates (McClaren 2003). However, survival estimates on Vancouver Island may be biased high due to the possibility of elevated mortality rates of birds induced by the extra weight from backpack radio transmitters. Although evidence for detrimental effects of backpack transmitters on goshawk survival throughout North America and Europe is lacking, it may be a concern for radio telemetry studies on smaller *A. gentilis laingi*.

Habitat trends

Typically, Queen Charlotte Goshawks breed in mature and old forests throughout their range (Titus et al. 1994; Chytyk et al. 1997; McClaren 2003), which are economically valuable to forest companies for timber harvest. Thus, with the continued harvest of potential goshawk breeding habitat, there will be a shift in forest age and structural stage class distribution, and increased exposure of interior forest areas to edge influences as the landscape becomes more fragmented and human intrusion expands into these forests through access roads. It is predicted that this will decrease the amount of suitable breeding habitat available to *A. gentilis laingi* throughout its range (Iverson et al. 1996; DeStefano 1998; Cooper and Stevens 2000). Reduced age of forest harvesting (i.e., decreased rotation periods) is expected to further reduce the availability of suitable breeding habitat because forests will be harvested before they obtain the structural attributes that characterize goshawk nest stands (DeStefano 1998). Furthermore, older forests may suffer from increased 'natural' disturbances (e.g., fire, wind-throw, snowpress), as they become more fragmented and vulnerable to the natural elements and to human-induced forest fires.

The influence of forest harvesting and natural disturbances on the suitability of foraging habitat for goshawks in the future is less clear. Goshawks may be forced to increase their breeding home range size in order to gather sufficient prey to raise young as landscapes become more fragmented around their nest sites. The influence of forest harvest practices on the abundance and availability of goshawk prey species is less clear because goshawks appear to be opportunistic hunters during the breeding season. However, because Queen Charlotte Goshawks typically do not forage within younger forests, access to most forest prey will be reduced as the overall distribution of forest age class across the landscape becomes younger and a shorter harvest rotation time is practiced. In southeast Alaska, Queen Charlotte Goshawks avoided young forests and clearcuts during radio telemetry studies (Iverson et al. 1996).

Because little information regarding the habitat needs of Queen Charlotte Goshawks in the winter is available, it is difficult to predict future trends for their winter foraging habitat. Regardless, the availability of suitable winter foraging habitat is likely essential for the persistence of Queen Charlotte Goshawk populations because they may be heavily reliant on important prey species during the winter when fewer prey species are available to them. Winter foraging success for goshawks determines the body condition that they enter the breeding season in and therefore, determines whether they initiate breeding within a given year.

Threats

Population threats

Since the early-mid 1900s, Queen Charlotte Goshawk populations do not appear to be threatened by shooting and trapping. Pesticides and other contaminants have not been examined in Queen Charlotte Goshawk populations but Snyder et al. (1973) reported pesticide levels in *A. gentilis atricapillus* populations to be low.

The influence of human disturbances on goshawk populations has not been studied in an experimental framework. However, human disturbances around nest sites appear to have caused *A. gentilis atricapillus* to abandon nests during courtship, incubation, and in the early nestling phase (Boal and Mannan 1994; Squires and Reynolds 1997; Toyne 1997), with fewer effects during the late nestling and fledgling-dependency phases (Toyne 1997). Furthermore, Bosakowski and Speiser (1994) and Bosakowski and Smith (1997) reported *A. gentilis atricapillus* avoided urban areas for nesting. The relationship between human disturbance and the ability for goshawks to nest successfully appears to vary according to an individual's tolerance level. Adults are more sensitive early in the breeding season than they are later on, when they have invested more energy in raising their young.

Habitat fragmentation may result in other raptors better suited to edge habitats such as Red-tailed Hawks (*Buteo jamaicensis*), Great Horned Owls (*Bubo virginianus*), and Barred Owls (*Strix varia*) outcompeting goshawks for nest sites. As well, predation rates on adults and young may increase as nest and roost sites become more accessible to edge dwelling predators such as Great Horned Owls, Raccoons (*Procyon lotor*), American Marten (*Martes americana*), and Fisher (*Martes pennanti*). In fragmented landscapes within Wisconsin, Erdman et al. (1998) documented increased competition by Red-tailed Hawks with *A. gentilis atricapillus* populations, and increased nest predation rates from Great Horned Owls and Fisher. On Vancouver Island, no other species have been observed using known goshawk nest sites, suggesting that competition for nest sites with other species is not high at this time. Iverson et al. (1996) reported nestling predation rates to be low in southeast Alaska. Predation on nestlings and fledglings has been observed on Vancouver Island. However, it is unclear how predation regulates goshawk populations (E.L. McClaren, unpubl. data; McClaren and Pendergast 2002). As well, predation rates on goshawks during their first years are unknown. On the Queen Charlotte Islands, one nest was depredated by a raccoon (P. Chytyk, pers. comm.).

Habitat threats

Breeding, roosting, foraging and winter habitat loss, fragmentation, and degradation from forest harvesting pose the greatest threats to Queen Charlotte Goshawk populations (Iverson et al. 1996; Cooper and Stevens 2000). Although the influence of habitat fragmentation on goshawk populations remains unclear, habitat loss through the conversion of older forests to early seral stages will likely affect goshawk reproduction and survival over time. Risks associated with forest fragmentation and the conversion of older forests to younger ones include: 1) a reduced number of suitable nest areas; 2) decreased prey species abundance and accessibility; 3) increased competition and predation from edge-adapted species; 4) reduced juvenile dispersal and gene flow; 5) increased human access and disturbance; and 6) altered microclimate conditions within interior forests. Altered microclimate conditions may expose adults to inclement weather and influence their thermoregulatory capabilities, reducing their survival directly or their ability to successfully incubate eggs and brood young. For example, North et al. (2000) demonstrated that reproduction in "California" Spotted Owls (*Strix occidentalis occidentalis*) was higher when nest site canopy cover was greater because canopy influenced nest site microclimate.

Legal Protection and Habitat Conservation

The Queen Charlotte Goshawk, its nests and eggs are protected under the provincial *Wildlife Act*. Capture of wild birds for falconry has been closed on Vancouver Island and on the Queen Charlotte Islands since 1994 (Cooper and Stevens 2000). Even prior to the 1994 closure, few Queen Charlotte Goshawks were captured for falconry in British Columbia, as most falconers preferred to take the larger, Northern Goshawk individuals (M. Chutter, pers. comm.).

On Vancouver Island, goshawk nests have been located in Walbran, Strathcona, and Gold/Muchalat Provincial Parks and the Nimpkish Island ecological reserve, and likely occur in several other provincial parks and ecological reserves on Vancouver Island. Several parks throughout the Queen Charlotte Goshawk range consist primarily of unsuitable habitat (i.e., >900 m that is steep open forest canopy or non-forested).

The provisions enabled under the *Forest and Range Practices Act* that may maintain suitable habitat for this species include ungulate winter ranges (UWRs), old growth management areas (OGMAs), wildlife tree retention areas, and riparian management areas. However, the ability of these areas to provide patches that are large enough to be suitable breeding habitat (i.e., 200 ha PFAs) is limited. Preliminary analysis of UWR size on Vancouver Island indicates that roughly <4% of current UWRs are of suitable size for a goshawk PFA (D. Doyle, unpubl. data). Although, these other mechanisms may be useful, particularly when used in conjunction with wildlife habitat areas (WHAs), their stand-alone utility to provide suitable goshawk breeding habitat is limited. They may be used to provide foraging habitat for goshawks around PFAs.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because goshawks have large breeding and winter home ranges and often build multiple nests within breeding areas throughout their lifetime, it may be more effective to address the requirements of this species at the landscape level to ensure that suitable goshawk breeding, foraging, and wintering habitat exists throughout the landscape (i.e., outside of designated WHAs) in addition to maintaining known nest sites. Winter habitat, which is currently not considered in this document, may be equally as important to long-term goshawk persistence as protecting their breeding habitat. However, in the absence of winter habitat data for goshawks, it is difficult to make winter habitat recommendations at this time but should be revisited when data become available.

- Ensure that late structural staged forests (structural stages 5–7) <900 m asl are represented throughout the forested land base so that both established and dispersing goshawks will have an opportunity to breed and forage in favourable habitats.
- Ensure that late structural staged forests exist in large patch sizes equally as often as small patch sizes and that connectivity between late structural staged forest patches is maintained.
- Ensure that suitable breeding habitat for goshawks occurs every 6–8 km, the current goshawk nesting density observed within some areas on Vancouver Island.
- Maximize retention of and connectivity between suitable nesting, post-fledging and foraging habitats.
- Maintain suitable foraging habitat in close proximity to known nests, particularly within the immediate 2200 ha surrounding the PFA. Although foraging areas can be much larger than 2200 ha for goshawks (i.e., goshawks forage throughout their breeding home range), this represents the core foraging area in the breeding season since it is in closest proximity to the PFA.

- ❖ Utilize OGMAs, UWRs, and WTR areas to buffer goshawk 200 ha PFAs to protect their integrity and to provide foraging habitat around PFAs.
- ❖ Minimize the influence of harvesting adjacent to PFAs to maintain the stand's integrity (e.g., wind firmness).

Wildlife habitat area

Goal

Maintain breeding habitat at known goshawk nests to ensure that breeding pairs may successfully raise their young to dispersal.

Feature

Establish WHAs in areas with known goshawk nest trees. Typically, WHAs should be placed around nesting areas where occupancy and nest productivity patterns are known. Determining re-occupancy and breeding success of goshawk breeding areas is extremely difficult given their use of several alternative nest trees within their breeding area in successive years (Squires and Reynolds 1997). As well, goshawks can be very secretive and difficult to detect using existing survey techniques (McClaren 2001). Because goshawks do not breed every year, a nest area may be inactive one year but active in following years. Thus WHAs should only be removed if the habitat has changed since the establishment of the WHA and is now considered unsuitable goshawk breeding habitat.

Foraging areas within 2200 ha of the PFA should be maintained through coarse filter mechanisms such as UWR, OGMAs, WTR areas, riparian management areas, retention harvesting, and other landscape level planning strategies. When these other mechanism cannot address foraging habitat requirements within 2200 ha of goshawk PFAs, foraging areas (amount to be determined on a site specific basis), can be incorporated within the WHA. This may be required in areas such as the Queen Charlotte Islands where UWR areas are not in place.

Currently, information regarding habitat features that enhance goshawk overwinter survivorship is unavailable and therefore, they cannot be addressed in this document.

Size

Approximately 200 ha but will depend on site-specific factors such as the terrain, habitat distribution, the distribution of OGMAs and UWRs, whether foraging habitat is included within the WHA, and the predicted harvesting regime in future years.

Design

The WHA should include suitable post-fledging habitat (see "Important habitats and habitat features"). The size and shape of the WHA should be determined by the existing habitat and future habitat projections for the breeding habitat and surrounding area. The area around the active nest should be searched for alternative nest trees, plucking posts, and roost sites by a qualified biologist. Ideally, observations and vocalizations of juveniles and their sign during the post-fledgling period should also be used to determine WHA boundaries. Sign includes whitewash, plucking posts, down, and pellets. In addition, consider connectivity with larger stands to prevent stand isolation. Fragmentation may lead to higher predation rates and increased competition for nest sites by edge-adapted predators and competitors. Stand isolation may also threaten the WHA integrity through windthrow.

When sufficient foraging habitat cannot be maintained within the surrounding 2200 ha of the goshawk PFA through alternate mechanisms, it should be incorporated into the WHA. Habitat characteristics and prey transects should be used to determine the boundaries of foraging areas within the WHA.

Manage the PFA as the core area and foraging habitat (if included) as the management zone.

General wildlife measures

Goals

1. Prevent disturbance and abandonment of breeding goshawks.
2. Maintain important breeding and foraging habitat features within core area (PFA).
3. When foraging habitat is included within WHA, maintain suitable foraging habitat and habitat features.

Measures

Access

- Do not construct roads within core area.

Harvesting and silviculture

- Do not harvest or salvage (e.g., cedar) within core area.
- Develop a management plan for harvesting and road development within the management zone that is consistent with the general wildlife measure goals.
- Do not commercial thin within core area. Commercial thinning may occur within the management zone provided the activities promote the structural characteristics of forests for goshawk foraging (e.g., low density thinning of young seral stages to promote older structural attributes).

Pesticides

- Do not use pesticides.

Additional Management Considerations

Minimize disturbance when working adjacent to a WHA between 15 February and 1 September. In general, avoid blasting, road construction, helicopter activity or other prolonged disturbance.

Information Needs

1. Relationship between habitat components and goshawk reproduction and survival. These include the minimum patch size of PFAs and degree of surrounding landscape fragmentation that maintains successful (minimum one young fledged) occupancy by breeding goshawks and breeding over time.
2. Influence of forest harvest practices on goshawk prey species abundance/availability during the breeding and non-breeding seasons and ability of forest enhancement techniques (e.g., thinning) to improve younger forests for goshawk breeding and foraging areas.
3. Goshawk winter habitat associations and prey use.

Cross References

Great Blue Heron, Marbled Murrelet, "Queen Charlotte" Hairy Woodpecker, "Vancouver Island" Northern Saw-whet Owl

References Cited

Alaska Department of Fish and Game (ADFG). 1996. Goshawk ecology and habitat relationships on the Tongass National Forest. 1995 field season progress report. Alaska Dep. Fish Game, Div. Wildl. Conserv., U.S. Dep. Agric. For. Serv., and U.S. Fish Wildl. Serv., Juneau, Alaska.

American Ornithologists' Union (AOU). 1957. Check-list of North American birds. 5th ed. Am. Ornith. Union, Baltimore, Md. 691 p.

Beebe, F.L. 1974. Field studies of the Falconiformes of British Columbia. B.C. Prov. Mus., Victoria, B.C. Occas. Pap. No. 17.

Beier, P. and J.E. Drennan. 1997. Forest structure and prey abundance in foraging areas of northern goshawks. Ecol. Appl. 7:564–571.

Bloxton, T. In prep. M.Sc. thesis. Univ. Wash., Seattle, Wash.

Boal, C.W. and R.W. Mannan. 1994. Northern goshawk diets in ponderosa pine forests on the Kaibab Plateau. Stud. Avian Biol. 16:97–102.

Bond, R.M. and R.M. Stabler. 1941. Second-year plumage of the goshawk. Auk 58:346–349.

Bosakowski, T. and D.G. Smith. 1997. Distribution and species richness of a forest raptor community in relation to urbanization. J. Raptor Res. 31:26–33.

Bosakowski, T. and R. Speiser. 1994. Macrohabitat selection by nesting northern goshawks: implications for managing eastern forests. Stud. Avian Biol. 16:46–49.

Bright-Smith, D.J. and R.W. Mannan. 1994. Habitat use by breeding male northern goshawks in northern Arizona. Stud. Avian Biol. No. 16:58–65.

Chytyk, P., J. Cooper, and K. Dhanwant. 1997. 1997 northern goshawk population inventory of the Queen Charlotte Islands Haida Gwaii; Pre-nesting standwatch surveys. Draft report prepared for B.C. Min. Environ., Lands and Parks, Smithers, B.C.

Chytyk, P. and K. Dhanwant. 1999. 1998 Northern Goshawk (*Accipiter gentilis laingi*) population inventory of the Queen Charlotte Islands/Haida Gwaii. Report for B.C. Min. Environ., Lands and Parks, Smithers, B.C. Unpubl. 41 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Cooper, J.M. and V. Stevens. 2000. A review of the ecology, management and conservation of the northern goshawk in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. B-101.

Daw, S.K. and S. DeStefano. 2001. Forest characteristics of northern goshawk nest stands and post-fledgling areas in Oregon. J. Wildl. Manage. 65:59–65.

Daw, S.K., S. DeStefano, and R.J. Steidl. 1998. Does survey method bias the description of Northern Goshawk nest-site structure? J. Wildl. Manage. 62:1379–1384.

DeStefano, S. 1998. Determining the status of Northern Goshawks in the west: is our conceptual model correct? J. Raptor Res. 32:342–348.

Detrich, P.J. and B. Woodbridge. 1994. Territory fidelity, mate fidelity, and movements of color-marked northern goshawks (*Accipiter gentilis*) in the southern Cascades of California. Stud. Avian Biol. 16:130–132.

Dewey, S.R. and P.L. Kennedy. 2001. Effects of supplemental food on parental care strategies and juvenile survival of northern goshawks. Thesis. Colorado State Univ., Fort Collins, Colo.

Doyle, F.I. and T. Mahon. 2000. Inventory of the northern goshawk (*Accipiter gentilis*) in the Kispiox Forest District. B.C. Min. Environ., Lands and Parks, Smithers, B.C.

Erdman, T.C., D.F. Brinker, J.P. Jacobs, J. Wilde, and T.O. Meyer. 1998. Productivity, population trend, and status of northern goshawks, *Accipiter gentilis atricapillus*, in northeastern Wisconsin. Can. Field-Nat. 112:17–27.

Ethier, T.J. 1999. Breeding ecology and habitat of northern goshawks (*Accipiter gentilis laingi*) on Vancouver Island: a hierarchical approach. M.Sc. thesis. Univ. Victoria, Victoria, B.C.

Flatten, C., K. Titus, and R. Lowell. 2001. Northern goshawk population monitoring, population ecology and diet on the Tongass National Forest. Alaska Dept. of Fish and Game. Juneau, Alas.

Gavin, T.A. and B. May. 1995. Genetic variation and taxonomic status of northern goshawks in Arizona: implications for management. Arizona Game and Fish. Final Rep. (Draft).

Good, R.E. 1998. Factors affecting the relative use of northern goshawk (*Accipiter gentilis*) kill areas in southcentral Wyoming. Thesis. Univ. Wyoming, Laramie, Wyo.

Hofslund, P.B. 1973. An invasion of goshawks. Raptor Res. 7:107–108.

Iverson, G.C., G.D. Hayward, K. Titus, E. Degayner, R.E. Lowell, C.D. Crocker-Bedford, F.P. Schempf, F. Philip, and J. Lindell. 1996. Conservation assessment of the northern goshawk in southeast Alaska. U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., PNW-GTR-387.

Johnson, D.R. 1989. Body size of northern goshawks on coastal islands of British Columbia. Wilson Bull. 101(4):637–639.

Keane, J.J. and M.L. Morrison. 1994. Northern Goshawk ecology: effects of scale and levels of biological organization. Stud. Avian Biol. 16:3–11.

Kennedy, P.L., J.M. Ward, G.A. Rinker, and J.A. Gessaman. 1994. Post-fledging areas in Northern Goshawk home ranges. Stud. Avian Biol. 16:75–82.

Kenward, R.E., V. Marcstrom, and M. Karlbom. 1993. Post-nestling behavior in goshawks, *Accipiter gentilis*: I. The causes of dispersal. Anim. Behav. 46:365–370.

Lewis, S.B. 2001. Breeding season diet of northern goshawks in southeast Alaska with a comparison of techniques used to examine raptor diet. M.Sc. thesis. Boise State Univ., Boise, Idaho.

Mahon, T. and F.I. Doyle. 2001. Inventory of the northern goshawk in the Lakes Forest District. Annual report 2000/2001. B.C. Min. Environ., Lands and Parks, Smithers, B.C.

McClaren, E. 1997. "Queen Charlotte" goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1996/1997). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 1998. "Queen Charlotte" goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1997/1998). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 1999. Queen Charlotte goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1998/1999). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 2000. Northern goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1999/2001). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 2001. Factors influencing northern goshawk detectability and reproduction on Vancouver Island, B.C. Thesis. Colorado State Univ., Fort Collins, Colo.

_____. 2003. Northern Goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia 1994–2002. Min. Water, Land and Air Protection, Nanaimo, B.C.

McClaren, E.L., P.L. Kennedy, and S.R. Dewey. 2002. Do some northern goshawk nest areas consistently fledge more young than others? Condor 104:343–352.

McClaren, E.L. and C.L. Pendergast. 2002. Northern goshawk (*Accipiter gentilis laingi*) post-fledging area size estimation on Vancouver Island, B.C. B.C. Min. Water, Land and Air Protection., Nanaimo, B.C.

McGowan, J.D. 1975. Distribution, density, and productivity of goshawks in Interior Alaska. Alaska Dep. Fed. Aid Wildl. Restor., Juneau, Alaska. Proj. Rep. W-17-4, W-17-5, W-17-6, Job 10.6R. 31 p.

Mueller, H.C. and D.D. Berger. 1967. Some observations and comments on the periodic invasions of goshawks. Auk 84:183–191.

Mueller, H.C., D.D. Berger, and G. Allez. 1977. The periodic invasions of goshawks. Auk 94:652–663.

National Geographic Society (NGS). 1999. Field guide to the birds of North America. 3rd ed. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

North, M., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. J. Wildl. Manage. 64:797–807.

Palmer, R.S. 1988. Northern goshawks. *In* Handbook of North American birds. Vol. 4. Diurnal raptors. R.S. Palmer (editor). Yale Univ. Press, New Haven, Conn., pp. 355–378.

Pollock, K.H., S.R. Winterstein, and M.J. Conroy. 1989. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45:99–109.

Reynolds, R.T. 1983. Management of western coniferous forests habitat for nesting accipiter hawks. U.S. Dep. Agric. For. Serv., Rocky Mtn. Forest Range Exp. Stn., Fort Collins, Colo., Gen. Tech. Rep. RM-102.

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, Jr., G. Goodwind, R. Smith, and E.L. Fisher. 1992. Management recommendations for the northern goshawk in the southwestern United States. U.S. Dep. Agric. For. Serv., Fort Collins, Colo., Gen. Tech. Rep. RM-217.

Reynolds, R.T. and S.M. Joy. 1998. Distribution, territory occupancy, dispersal, and demography of northern goshawks on the Kaibab Plateau, Arizona. Ariz. Game and Fish. Heritage Proj. No. I94045.

Reynolds, R.T., E.C. Meslow, and H.M. Wight. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. J. Wildl. Manage. 46:124–138.

Sibley, D.A. 2000. National Audobon Society the Sibley guide to birds. Alfred A. Knopf, Inc., New York, N.Y.

Snyder, N.F.R., H.A. Snyder, J.L. Lincer, and R.T. Reynolds. 1973. Organochlorines, heavy metals, and the biology of North American *accipiters*. BioScience 23:300–305.

Squires, J.R. and R.T. Reynolds. 1997. Northern goshawk (*Accipiter gentilis*). *In* Birds of North America, No. 298. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C.

Steenhof, K. 1987. Assessing raptor reproductive success and productivity. *In* Raptor management techniques manual. B.A. Giron Pendleton, B.A. Milsap, K.W. Cline, and D.M. Bird (editors). Sci. Tech. Ser. No. 10, Natl. Wildl. Fed., Washington, D.C., pp. 157–170.

Stephens, R.M. 2001. Winter ecology of northern goshawks in the Uinta Mountains. Thesis. Univ. Wyoming, Laramie, Wyo.

Taverner, P.A. 1940. Variation in the American goshawk. Condor 42:157–160.

Titus, K., C.J. Flatten, and R.E. Lowell. 1994. Northern goshawk ecology and habitat relationships on the Tongass National Forest (goshawk nest sites, food habits, morphology, home range, and habitat data). First Annu. Proj. Rep. U.S. Dep. Agric. For. Serv. and Alaska Dep. Fish Game, Juneau, Alaska. Contract 43-0109-
3-0272.

Toyne, E.P. 1997. Nesting chronology of northern goshawks (*Accipiter gentilis*) in Wales: implications for forest management. Forestry: 121–126.

Webster, J.D. 1988. Some bird specimens from Sitka, Alaska. Murrelet 69:46–48.

Whaley, W.H. and C.M. White. 1994. Trends in geographic variation of Cooper's hawk and northern goshawk in North America: a multivariate analysis. West. Found. Vertebr. Zool. 5(3):161–209.

Personal Communications

Chutter, M. 2002. Min. Water, Land and Air Protection, Victoria, B.C.

Chytyk, P. 2001. Manning, Cooper and Associates, Victoria, B.C.

Talbot, S. 2002. U.S. Geological Survey. Anchorage, Alas.