

Maintaining the Integrity of Northern Goshawk Nesting and Post-fledging Areas in the Ecosystem Based Management Plan Area of Coastal British Columbia: Guidance for Forest Professionals



Coast Forest Conservation Initiative (CFCI)

June 22, 2012



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1.0 Objectives

The primary objective of this document is to provide forest professionals with sufficient information to help them make appropriate decisions to maintain the integrity and long-term occupancy of goshawk breeding areas¹ over space and time. As such, this document incorporates information from a wide body of literature relevant to the ecology and management of Northern Goshawk (coastal subspecies - *Accipiter gentilis laingi*) nesting and post-fledging habitat.

In some situations, there may be previously established landscape-level plans and objectives and associated conservation tools in place, which influence the choice of habitat management practices around goshawk nests (see sec. 4.3.1.1).

The guidance provided in this document applies to the Crown tenure areas operated by Coast Forest Conservation Initiative member companies (CFCI, see <http://www.coastforestconservationinitiative.com/>), and within the coastal region of British Columbia covered by the central and north coast land use orders (i.e., the coastal Ecosystem Based Management (EBM) plan area (often referred to as 'The Great Bear Rainforest'), see <http://ilmbwww.gov.bc.ca/slrp/lrmp/nanaimo/cen coast/plan/objectives/index.html>, Schedule 1).

Through adoption of the guidance provided in this document, CFCI licensees have committed to managing for conservation of goshawk breeding habitat, which in turn will contribute positively to overall conservation of goshawk habitat throughout the EBM plan area. However, recommendations about managing goshawk foraging habitat and associated guidance (applicable at the landscape scale), are outside the scope of this document (refer to Appendix sec. A 2.2 for a discussion of the characteristics of goshawk foraging areas).

Refer to sec. 4.2 and sec. 4.3 for specific management guidance for goshawk breeding areas. Additional background information relevant to goshawk ecology, status, and research relevant to the guidance and practices cited herein, is provided in Appendix 1.

The guidance provided in this document may be revised in the future as new information and data become available.

¹ The term "breeding area" was first discussed conceptually by McClaren et al. (2005), and then described in detail by the Interior British Columbia Goshawk Science Team (see IBCGST 2012) to mean a combination of the nesting area and post-fledging area (with biologically similar functions); this term has not previously been used in this context within the goshawk literature.

2.0 Application

The guidance and practices described provided in this document are intended to afford some site-specific operational flexibility while still protecting and maintaining the integrity and long-term functionality of goshawk nesting areas (NA) and surrounding post-fledging areas (PFA). From an ecological perspective, the NA and surrounding single or multiple PFAs, collectively form a single functional unit (termed the breeding area (BA) by IBCGST 2012).

For the purpose of guidance to forest professionals as provided in this document (see sections 4.0-6.0), the term "Goshawk Management Area" (GMA) will be used in the context of habitat management recommendations and options applicable to currently known and newly discovered goshawk nest trees and their surrounding nesting and post-fledging areas, in the EBM plan area.

2.1 Exceptions

The guidance and practices described below do not apply to nest trees which occur in or immediately adjacent to cutblocks which have already been harvested or approved prior to the time of adoption of this document [i.e., the block has already been “declared” under the Forest Planning and Practices Regulation (sec. 14), or the block has been previously sold under a timber sale license, or the block is transitional from a Forest Development Plan to a Forest Stewardship Plan (as per Forest and Range Practices Act sec. 196)]. However, given these exceptions, **the forest tenure holder or licensee still has the option of modifying a block boundary, or adjusting within-block retention practices or the timing of forestry activities, in order to minimize damage or disturbance to a newly discovered goshawk nest and surrounding breeding area.** Also refer to “*When to manage nest areas only*” (see sec. 6.0).

3.0 Goshawk Breeding Areas – What are they Ecologically?

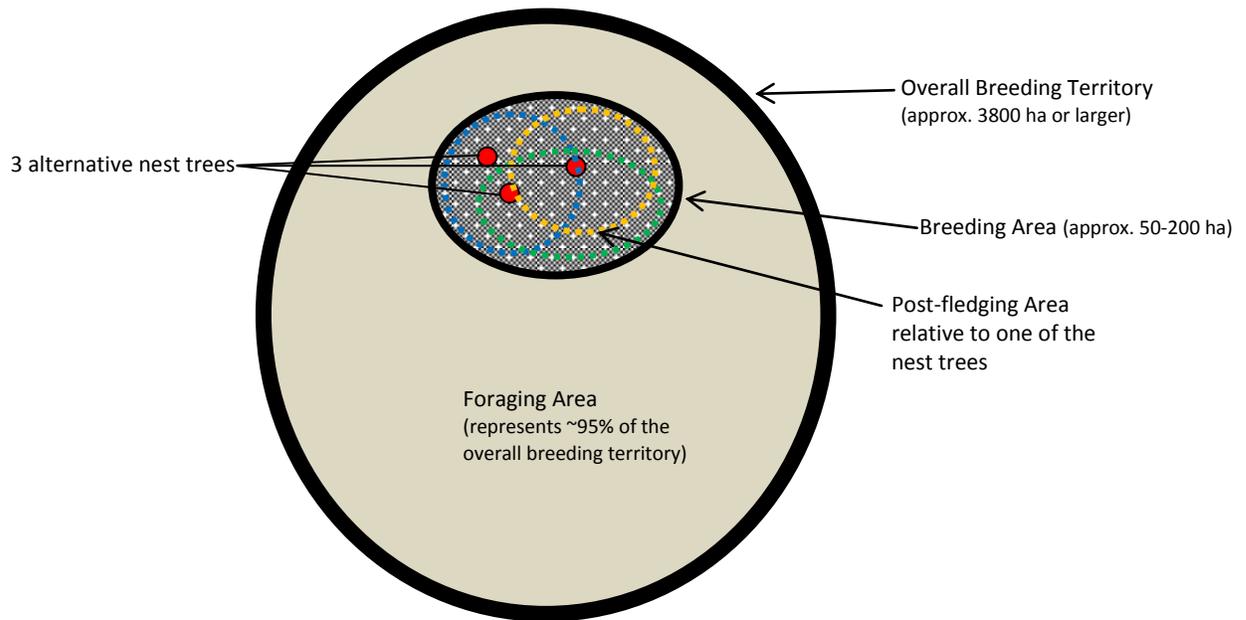
- Goshawks normally build multiple nests within a breeding area (potentially 2-9 alternative nests) and usually alternate amongst nests in successive years. On Vancouver Island, McClaren et al. (2005) reported a mean number of 3.0 ± 0.2 nests per nesting area. Alternative nests can sometimes occur in the same tree or be relatively close together (i.e., as little as 15-50 m), but are normally within a maximum of 500-800 m of each other, but can be farther. Based on radio-telemetry data from Vancouver Island, McClaren et al. (2005) found a mean distance between nest trees (n=65) of $274 \text{ m} \pm 37.2 \text{ m}$. From west-central B.C., Mahon and Doyle (2005) found a mean spacing of 188 m between nest trees, and from northern California, Woodbridge and Detrich (1994) found that nest trees were clumped within 2 or 3 adjacent nest stands with a mean distance between nests of 273 m.
- The nesting area (NA) is the forest stand that immediately surrounds the active nest tree, and often includes alternate nest tree(s), roost trees and prey plucking posts (Reynolds *et al.* 1992). It is the immediate core use area where most adult courtship behavior occurs, where nests are constructed, and where fledglings first learn their flying and hunting skills.
- The post-fledging area (PFA) is the area used by juveniles for 6-8 weeks once they have left the nest (i.e., learning to fly and hunt before they disperse more widely around the end of August or early September), but are still largely dependent on adults for food. The PFA also provides protection from predators.
- The breeding area (BA) consists of the area around the nest trees (i.e., the nesting area), plus a surrounding post-fledging area relative to each nest (Figure 1). In this context, the biological role of the nesting area and post-fledging area is functionally similar (Reynolds et al. 1992, McClaren et al. 2005, NGRT 2008). Thus, the term **breeding area can be used to represent the combined nesting and post-fledging areas.**
- A BA usually has multiple PFAs (depending on how many nest trees there are). These PFAs are offset from the nest area (i.e., not centered circularly around the nest tree) and usually overlap; they can be offset in different directions each year and are often highly directional in relation to the nest tree (i.e., based on factors such as habitat quality and availability, topography, prey abundance and distribution (which influences adult food provisioning), and individual fledgling movements and behavior).
- The BA is also an area of concentrated adult breeding activities including courtship, and is used for roosting and food deliveries to the juveniles (once fledged).

- Even if a nest becomes damaged, dilapidated or falls from the tree, or the nest tree itself falls down, goshawks may either rebuild or construct a new nest in the original tree, or construct an alternate nest somewhere else in the BA, provided the overall habitat suitability and integrity of the BA remain intact.
- Goshawks do not necessarily breed every year, so nest stands which appear to be inactive (birds present but with no evidence of breeding/nesting) or unoccupied (no birds present) for one or more years, may likely be reoccupied in future years. Ongoing monitoring may be required (see sec. 5.0).
- Goshawks have very strong fidelity to breeding areas and will continue to occupy the same area for many years or decades, including continued use after failed breeding years. New birds will often move in once a single member of a pair has died or relocated, or if both members of the original pair have died or relocated.
- All key breeding requisites and activities (nest trees, concealment from predators and competitors, adult roosting, perches, juvenile post-fledging activities, and foraging opportunities), are associated with the presence of suitable forest structure within the BA. While some heterogeneity of forest age classes and stand conditions can occur, goshawks normally select areas of old (structural stage 7) and mature (structural stage 6) forest² for nesting areas within their breeding territories.
- Depending on the presence of suitable stand structural characteristics (i.e., tree height, canopy closure, tree species composition, stem density and basal area), and relative supply and distribution of suitable nesting habitat in the surrounding landscape, some younger forests (i.e., >50 years) can also be used as breeding areas.

The combined area and shape of overlapping post-fledging areas and nest areas, associated with multiple alternative nest trees, define the overall breeding area (Figure 1).

² In B.C. coastal forest ecosystems, structural stage 7 is defined as >250 years in age; structural stage 6 is 80-250 years.

Figure 1. Conceptual diagram (not drawn to scale) of a goshawk breeding area (BA) in relation to the overall breeding territory³. Displays three nest trees (small red circles) and an overlapping offset post-fledging area for each nest (colored dashed ovals), which together comprise the breeding area. The BA is a relatively small component of the breeding territory (which is primarily composed of foraging habitat). BAs can range in size from approximately 50 to 200 ha (see Appendix A 4.2).



³ The breeding territory (also referred to as the breeding home range) is the total area which goshawks occupy and defend during the breeding season. This area includes the breeding area (nesting area + post-fledging areas), but is comprised mostly of the foraging area.

4.0 Goshawk Management Areas

For the purposes of this guidance, those areas which are intended to be managed in order to maintain the functionality of nesting and post-fledging habitats (collectively defined in sec. 3.0 as breeding areas), will be termed “Goshawk Management Areas” (GMA) for operational, management and administrative purposes.

Deviations from this guidance can occur on a site-specific basis (e.g., where no other practicable location for a road exists which would have the effect of barring access further up-valley), but in such cases an appropriate rationale and provisions for protection of the nesting and post-fledging habitat, must be documented by a qualified professional biologist.

4.1 Surveys around Identified Nests

When a goshawk nest is discovered it is very important to conduct a survey of the surrounding area to help define the extent and shape of the BA and subsequent GMA design. **This involves systematic searching for alternative nests where suitable habitat exists, generally within 300 m from the new nest, but up to 800 m.** An extended radius search of this latter distance is particularly important when a new cutblock, road or other development is scheduled in the vicinity (i.e., within 800 m of a previously known nest AND is within suitable nesting habitat). As well, this area may need to be resurveyed if a breeding season or more has passed since planning for the cutblock or other development.

In terms of survey effort (and especially if resources are limited), it is more important to search for alternate nests which might be located in nearby cutblocks scheduled for harvest, as opposed to looking for alternate nests outside of areas scheduled for development.

Surveys should be conducted by qualified biologists or resource technicians who have experience in goshawk ecology. Survey effort will vary depending on the habitat and terrain at each breeding area, but generally the initial survey requires one or two days of effort by a two person field crew.

For additional information on goshawk survey protocol and procedures, refer to RIC (2001).

Locating as many nest trees and alternative nests as possible, particularly in areas proposed for development, and verifying nesting habitat quality are key to defining the size and orientation of the breeding area and designing an effective GMA (refer to sections 4.2 and 4.3 below).

Failing to properly identify and define the nesting and post-fledging areas could result in a GMA that is offset from the actual breeding area and/or be of insufficient size to adequately protect and maintain long-term occupancy of the GMA.

4.2 Maintaining the Integrity of the GMA

In general, it is important to maintain the stand structure and connectivity of nesting and post-fledging areas to the surrounding matrix of forested foraging habitat.

If the integrity and functionality of the GMA is maintained such that long-term occupancy by goshawks can occur, then potential management conflicts may be minimized in other areas. **By only protecting the immediate nesting area (and not the surrounding PFA), the likelihood of long-term occupancy of the breeding area is diminished** – in this instance, inadequate protection of the PFA(s) may result in goshawks simply moving and establishing another breeding area elsewhere in the broader landscape (provided that a suitable territory is available in adjacent habitat/landscapes).

Consequently, it is important to not manage single nest trees in isolation, but to manage the entire GMA as a relatively distinct functional ecological unit (see exception sec. 6.0).

GMA Size

The overall size and integrity of the GMA is the primary factor affecting long term occupancy by breeding goshawks. The potential risk of goshawks abandoning the GMA increases as the size of the management zone which incorporates the breeding area decreases.

For the purposes of this document and from a forest management perspective, the GMA is considered to consist of a core reserve + a surrounding management zone (see Figure 2).

Table 1 provides a range of recommended sizes for areas which can be managed as GMAs, including recommended sizes of core reserves and adjacent management zones.

4.2.1 Core Reserves

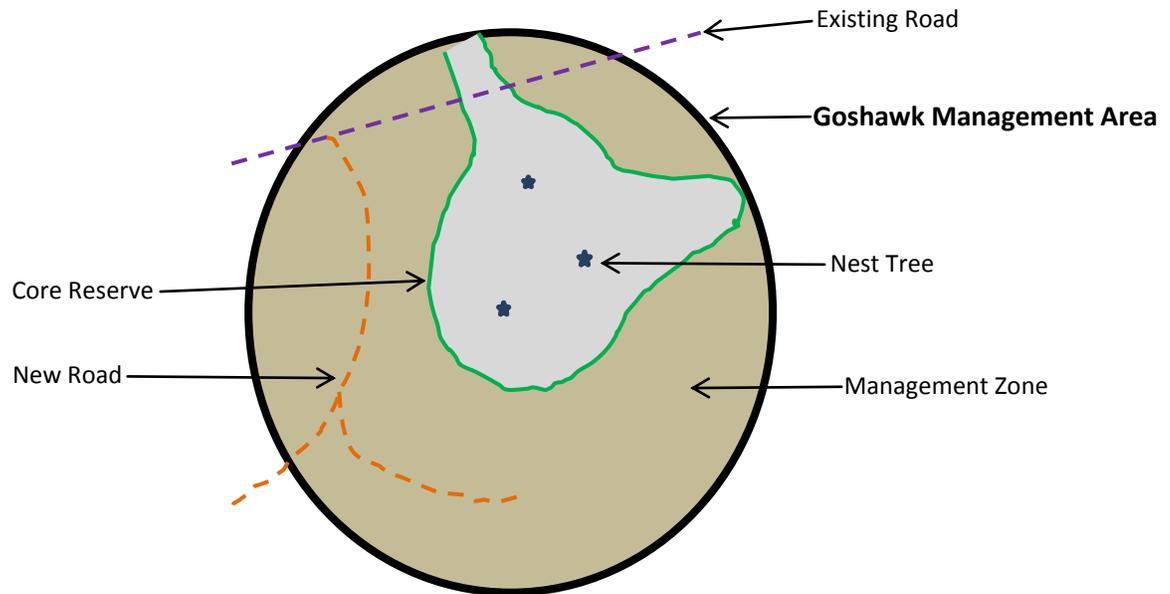
The purpose of the core reserve is to provide high quality (currently suitable) forested nesting habitat (see Appendix sec. A 2.1) and protect the nest area around each nest tree, and to provide additional forested habitat for juvenile goshawks during the first 3 weeks post-fledging (i.e., the early fledgling dependency period when juveniles have limited flying ability and tend to stay closer to the natal nest tree).

The minimum recommended core reserve size is 30 ha (approx. 310 m radius) – this size provides a minimum forested buffer of 200 m for at least 2 nests, and maintains connectivity and continuous forest cover between these nests. However, **this size may not be sufficient to adequately protect some nesting and post-fledging areas.**

The core reserve can vary in size and may often be >30 ha – this determination will depend on the number and location (spacing) of alternative nests (see Figure 2a), the quality and extent of suitable nesting and post-fledging habitat, and the choice of overall GMA size and associated level of risk (see Table 1 and sec. 4.3.1.1).

There should be no harvesting or other activities within the core reserve which remove trees, unless for documented worker safety or wildfire protection concerns, or where no other practicable location for a road exists (i.e., which would have the effect of barring access further up-valley).

Figure 2. Conceptual Goshawk Management Area (GMA) with a core reserve (outlined in green) around a loose cluster of 3 hypothetical nest trees (stars), and a surrounding management zone which includes overlapping multiple PFAs (one for each nest tree, not illustrated here).



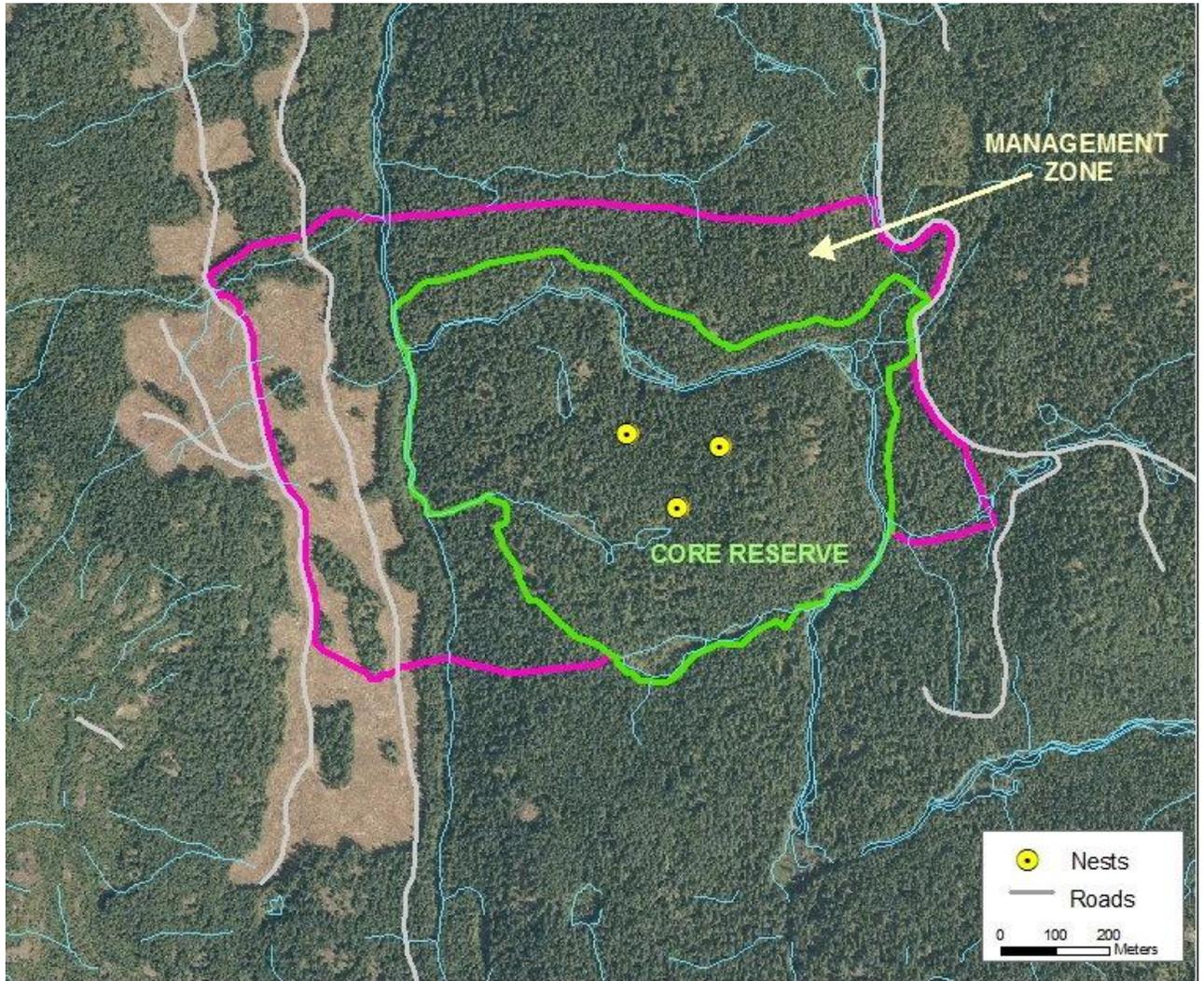
4.2.2 Management Zones

The management zone which surrounds the core reserve area provides additional habitat for multiple alternative nests as well as habitat for fledglings as they venture further from the nest tree (approx. 400-500 m radius) during the late fledgling dependency period (i.e., the 4-5 week period in late July and August, and prior to the fledglings leaving the PFA and dispersing widely around early September).

The management zone will consist of current suitable nesting habitat, but may also include some capable nesting habitat (i.e., forested habitat which is not suitable at the present time but which will develop into suitable habitat), and some unsuitable forested habitat (but which still provides some cover and foraging opportunities).

Determination of the size of the management zone is expected to vary (see Figure 2a and Table 1). This will depend on the extent and quality of available habitat; the number, location and spacing of alternative nests; local topography; local operational factors (e.g., existing roads or development); proximity to other nearby suitable goshawk habitat; consideration of other relevant management plans and objectives; and consideration of other resource values (also refer to sec. 4.3.1.1).

Figure 2a. Hypothetical Goshawk Management Area design (outlined in pink, drawn to scale), which includes a core reserve (outlined in green) and a surrounding management zone.



- 3 nest trees depicted (mean inter-nest tree spacing = 160 m)
- Overall Goshawk Management Area size = 97.2 ha
- Core Reserve Area size = 51.2 ha
- Management Zone size = 46.0 ha
- Total area harvested in the Management Zone = 10.8 ha (or 23.5%) – clearcut with reserves silviculture system
- The GMA design incorporates logical features such as streams and riparian habitats
- Note contiguity with undisturbed forested habitat to the south and north
- This GMA design represents a “Low risk of abandonment” scenario as described in Table 1, with some harvest occurring in the Management Zone

4.3 Goshawk Management Area Sizes and Recommended Guidance and Practices

The recommended default size ranges for GMAs provided in Table 1 below are based upon review and consideration of documented literature on fledgling movements prior to dispersal (including early and late fledgling dependency periods), as well as inter-nest tree distances and resultant formation of nesting areas and post-fledging areas (an average of 3 alternative nests was used in this context). Refer to Appendix sec. A 4.0 for a summary of this literature.

Table 1. Default sizes of forested retention patches (GMAs) intended to protect Northern Goshawk nesting and post-fledging areas, and relative risk of long-term GMA abandonment.

GMA Size ⁴ (ha)	Core Reserve (ha)	Management Zone (ha)	Risk of GMA Abandonment & Relocation ⁵	Relative Risk Gradient	Ecological Functions
111-200 ⁶	71 or more	40-129	Very Low		Provides all nesting and post-fledging functions, including provision for multiple alternative nests and surrounding post-fledging areas.
71-110	51-70	1-59	Low		Protects nesting areas, their associated overlapping PFAs, and related functions for 3 or more alternative nests.
40-70	30-50 ⁷	0-40	Moderate		Protection for 2 or 3 overlapping nest areas. Also provides post-fledging habitat. This size may provide habitat for more alternative nests if they are closely spaced and the habitat is suitable. But it may not be sufficient where there are more nests or they are widely spaced.
25-39	25-29	0-10	High		Protection for 1 or 2 nest areas only. May not provide sufficient post-fledging habitat, especially for the late fledgling dependency period when juveniles tend to range further from the nest tree.
<25	<25	nil	Very High		Some protection to the nest area. Will not provide sufficient post-fledging habitat. Will likely be inadequate for long-term GMA occupancy, with a very high risk of abandonment.

⁴ GMA size ranges are based on an average of 3 nests per breeding area and their associated overlapping PFAs (using mean inter-nest tree distances and mean fledgling flight distances for the early and late post-fledging periods, also refer to sec. 3.0 and App. A 4.1 for further detail). In some cases the qualified professional can choose to adopt a higher risk rating (i.e., choose to manage to a smaller GMA size) if a higher level landscape strategy or other management plan has been prepared and implemented for a landscape or management unit which provides for the conservation of goshawk habitat, including provisions for nesting and foraging habitat supply and management.

⁵ This is an estimate of the risk of abandonment and non-reoccupancy of the GMA. ‘Higher risk’ means that birds may abandon this GMA and relocate and establish a new breeding area elsewhere in the broader territory/landscape. This estimate is based on the condition of the nesting and post-fledging habitat within the GMA, and not the condition of the adjacent foraging area (see Appendix A 2.2 for more information on the importance of foraging habitat relative to long-term goshawk breeding territory occupancy).

⁶ Some GMAs in this size range could be recommended as candidates for designation as a *Wildlife Habitat Area*. This will depend on available *B.C. Identified Wildlife Management Strategy* habitat budgets for the applicable provincial Forest District, and satisfactory fulfillment of applicable Government Actions Regulation sec. 2 tests.

⁷ The size of the Core Reserve can be increased beyond the 30 ha minimum dependent on the number and spacing of alternative nests, and the choice of overall GMA size (which will be influenced by goshawk management objectives and applicable planning tools in that landscape, the supply and distribution of suitable nesting and foraging habitat in the landscape, and recognition of the likelihood of risk of GMA abandonment; also refer to sec. 4.3.1.1).

4.3.1 Recommended Guidance and Practices for Goshawk Management Areas

The following guidance applies to GMAs designed for all levels of risk of GMA abandonment (as per Table 1), except 'Very High' risk.

- 1) **GMA Shape and Connectivity** – the shape and extent of the core reserve and surrounding management zone should maximize coverage of all known nests and surrounding suitable habitat for post-fledging activity, and minimize habitat fragmentation within this area. Wherever possible:
 - a) Include all known nests within the core reserve area. **In many cases the core reserve will need to be larger than 30 ha.**

Although most alternate nests are located within about 300 m of each other (see sec. 3.0), in a few cases nest trees may be very widely spaced (500-800 m or greater). In this latter situation, it may be preferable to design more than one GMA, trying to center each GMA relative to nest tree groupings (i.e., loose clusters of nest trees) and maintaining connectivity between nest trees.
 - b) Maintain at least 200 m of forest retention around all known nests (or equivalent area configured to match suitable habitat).
 - c) Maintain contiguous forest habitat (connectivity) between all known nests.
 - d) Minimize the perimeter-to-area ratio of retention patches by designing patches that are at least 100 m wide.
 - e) Where possible, maintain a direct forested connection between the management zone and adjacent forest in order to provide a linkage to the broader foraging area/breeding territory.
 - f) Some unsuitable forested habitats (e.g., younger/developing forest (capable nesting habitat), sparsely treed rocky outcrops) may be included in the management zone to maintain connectivity between the core reserve area and forested habitat located outside (and adjacent to) the GMA.
- 2) **No Harvesting in the Core Reserve** – unless for documented worker safety or wildfire protection concerns, or where no other practicable location for a road exists which would have the effect of barring access further up-valley.
- 3) **Activities in the Management Zone** – management zones surrounding the core reserve may be managed as limited harvest areas. For GMAs >40 ha in size, some limited timber harvesting (see # 4 below), thinning treatments (to enhance habitat suitability), major windthrow salvage and road right-of-way construction may be conducted in the management zone only. However, such harvest activities will likely impact the post-fledging habitat approximately in proportion to their extent, location and distribution.

In second growth stands, silvicultural treatments designed to specifically enhance habitat suitability for goshawks within the post-fledging areas may be appropriate (e.g., stand thinning “from below” (removal of smallest trees first) to reduce stem density, and pruning to improve subcanopy flyways, see Bloxton 2002, Youtz et al. 2008, Moser and Garton 2009).

A qualified professional biologist, working closely with operational staff, will be required to help design harvest entries in order to minimize impacts to the ecological integrity of the GMA.

Timing restrictions for these activities relative to the goshawk breeding season and goshawk activity should also be observed (see Table 2).

- 4) **Limited Harvesting** – for limited harvesting intended within the management zone, use of alternative silvicultural systems is recommended. The reduction in GMA effective size (applied within the management zone outside the core reserve area) can be estimated using total percentage stem basal area reduction. Some studies have suggested that if partial-cut harvesting is employed, then the total area removal should not exceed 20-30% of the total area of the nesting plus post-fledging habitat (see Penteriani and Faivre 2001, Mahon and Doyle 2005, Mahon 2009, and Moser and Garton 2009, for further discussion on this topic).

Consequently, no more than 30% of the forested area of the Management Zone within the GMA should be harvested (as per the management zone sizes recommended in Table 1).

- 5) **Monitoring GMAs** – follow-up monitoring of GMAs which have had partial harvesting within the management zone should be considered in order to evaluate the effects of harvesting on GMA integrity and long-term occupancy by goshawks (refer to sec. 5.0 for further information on monitoring).
- 6) **Proximity to Other Reserves** – in some cases it may be possible to reduce the “administrative” size of the GMA. This could occur where the GMA is in close proximity and connected to another forested reserve or constrained area (e.g., ungulate winter range, old growth management area, wildlife habitat area, park) which **effectively increases the size of the GMA and provides suitable goshawk habitat** for potential nesting, post-fledging and foraging. For example, a 32 ha GMA (which would be classified as ‘high risk’ as per Table 1), but which is directly adjacent and connected to a large constrained forested area (containing suitable goshawk habitat) such as a Wildlife Habitat Area for Marbled Murrelet, would have a functional size much greater than 32 ha. Therefore, the risk of GMA abandonment would decrease to moderate or perhaps low.

4.3.1.1 Determining Goshawk Management Area Sizes and Appropriate Risk Levels

Based on the above 6 recommendations, determination of the size of the GMA to be managed (and tolerance of level of risk of GMA abandonment), is expected to vary depending on: i) the amount, quality and distribution of available habitat; ii) the number and distribution (spacing) of alternate nest trees; iii) local topography; iv) local operational factors (including existing hard edges and development); v) proximity to other forested reserves which provide suitable goshawk habitat; vi) the overall supply and distribution of suitable goshawk habitat in the corresponding landscape; vii) the existence of higher level plan objectives and associated planning strategies and outcomes relative to goshawk habitat conservation; viii) the existence of a specific goshawk management plan that has been prepared for the landscape unit or management unit; and ix) consideration of other resource values and objectives.

For example, some landscape units may have a higher priority for conservation and management of goshawk territories than other landscapes. One factor in this decision is the supply and condition of foraging habitat in the landscape, which in turn affects overall breeding territory suitability and occupancy and the ability of that territory to support goshawk populations over time (Widen 1997, Mahon and Doyle 2005). For landscape units which have a low to moderate amount of current suitable nesting and foraging habitat (see Appendix sec. A 2.2), it may be a priority for forest managers to design

larger GMAs around goshawk nest areas in those landscapes, and consequently adopt a low or very low risk of abandonment. For other landscapes, perhaps where there is an abundant supply of current suitable nesting and foraging habitat (generally mature and old forest), or where such habitat in the landscape unit is already adequately protected through other mechanisms (e.g., parks, Wildlife Habitat Areas, Old Growth Management Areas), or where there are other higher priority forest management goals or constraints in place, then it may be appropriate to design smaller GMAs and accept a moderate or even high risk of GMA abandonment. **These decisions should be made on a case by case basis and within the context of landscape-level strategies, plans and objectives.**

4.4 Operational Activities near Goshawk Management Areas

Northern Goshawks have low to moderate thresholds for new human disturbance (road construction, blasting, falling and yarding, or repeated low altitude helicopter over-flights), particularly during the more sensitive nest establishment, incubation and nestling phases of the breeding season (**approx. early-April to mid-July**). Unaccustomed levels of noise or human activity near the nest tree can cause pairs to abandon their nests during this sensitive period.

Consequently where forestry activities are being considered within the management zone portion of the GMA, employ lower impact, alternative practices in areas near goshawk nests during the breeding season, and **observe appropriate timing windows for high disturbance activities** (Table 2).

Table 2. Disturbance associated with various activities near Northern Goshawk nests and suggested mitigative measures and timing windows.

Activity	Suggested Lower-disturbance Alternatives ⁸
High Disturbance	
Blasting	Delay or reschedule until after breeding season (~15 August), or restrict blasting to >1000 m from known active nests during the period April 1 to 15 July (i.e., the most sensitive portion of the breeding season).
Road Construction or Maintenance (using heavy machinery). Falling and Yarding	Delay or reschedule until after breeding season (~15 August), or restrict road construction, falling and yarding to >500 m from known active nests during the period April 1 to 15 July.
Repeated Low Altitude Heavy Lift Helicopter Over-flights (<1000 ft. altitude)	For heavy lift helicopters involved in heli-logging, plan and reroute low altitude flight paths to at least 1000 m horizontal distance from known active nest trees during the period April 1 to 15 July.

⁸ The buffer distances recommended in this table are default estimates and are not based on empirical data. These may be updated in the future as new data become available.

NOTE – for the above High Disturbance activities, buffer distances can be reduced IF there is a distinct topographic break (e.g., ridge crest) or continuous span of forest which will provide an adequate visual and auditory screen between the nest site and the proposed activity. A qualified professional biologist will be required to make a site-specific determination and provide documented recommendations regarding the circumstances and extent of reduced buffer distances.

5.0 Long-term Occupancy and Monitoring of Goshawk Management Areas

In a given year, only one goshawk nest can be active within a given goshawk breeding territory. However, for various reasons (e.g., low prey abundance, very wet spring weather conditions, parasite loading in the nest), goshawk nests are often not active every year (Bloxtton 2002, Manning et al. 2007, Moser and Garton 2009). This may mean that an alternative nest tree is being used elsewhere in the breeding territory, or birds are occupying the territory but for reasons such as above, are not breeding and have not established a nest during that year, or the original breeding bird(s) may have died. As well, a small proportion of goshawk breeding areas are naturally abandoned/relocated over time (T. Mahon, pers. comm., 2011).

Over a 10 year period from SE Alaska, Flatten et al. (2001) found that goshawk nesting areas were typically occupied by radio-tagged adults for at least 2-3 sequential years (mean 2.03 years, range 1-7 years), and that reoccupancy and nesting at a nest site (5-15 ha around a nest tree) can reoccur after a few to 7 or 8 years of inactivity. From west-central B.C., Mahon (2009) recommended that if a nest area is not occupied for 8 consecutive years, "...it is probably safe to say the area has been abandoned or relocated and the goshawk habitat area could be de-listed".

Determining non-breeding status requires rigorous monitoring because goshawks can occupy a territory for several years in a row without breeding. Determining non-breeding status for a given year requires systematic call-playback and alternative nest searching surveys, repeated during both the nesting period (late May to early June recommended for surveys) and post-fledging period (late June to late July recommended for surveys). See RIC (2001) for more detailed information on goshawk survey protocol.

To assess the long-term status and occupancy of nesting and breeding areas, known nest sites should be visited every 2-3 years. However, in order to conclude that a GMA is no longer being used, all known nests in the GMA must be monitored annually and the GMA surveyed for occupancy for at least 8 consecutive years.

5.1 Shifting Goshawk Management Areas

Occasionally goshawks may construct new nests outside the original established GMA. In this case, if it is possible to shift or expand the GMA to include such new nests, this would be beneficial for maintaining long-term GMA occupancy.

In some cases, and dependent on the results of GMA monitoring and habitat suitability assessments, it may be possible to shift GMA boundaries to reflect the locations of new alternative nests and associated post-fledging areas.

In unusual cases, the ecological integrity of an established GMA may be severely compromised by a natural disturbance event (catastrophic windthrow, landslide or wildfire). In such circumstances, and dependent on the extent of damage, it may be appropriate to relocate a GMA boundary or re-establish the entire GMA elsewhere. These will be case specific decisions.

6.0 When to Manage Nesting Areas Only

The following guidance is NOT intended to be a default practice in place of the guidance provided in sections 4.2 and 4.3 above. Rather, they serve as recommendations where it is **not possible** to design and manage a GMA as a single functional unit (i.e., a core reserve area + a surrounding management zone), due to previous or current activities/development, or other conflicting and documented priority management objectives or activities. In this case it may be necessary to manage individual nest trees and immediate nesting areas as best as possible, including a **rationale for why the nesting area only is being managed in this fashion**. See Appendix A 2.1 and A 3.0 for descriptive information on nest trees and nesting areas.

Establish a forested retention patch around the nest tree(s), with the following characteristics:

- a) Locate/orient the retention patch in such a way that protection is still provided to the nest tree. In this case, the retention patch will likely be offset from the nest tree (i.e., not circular).
- b) Maintain a direct forested connection between the nest tree and adjacent unharvested forested habitat (connection to mature or old forest is preferable). This forested linkage should be as wide as possible in order to minimize edge effects (predation, windthrow risk, weather), and to provide additional protective/security cover, perching and hunting opportunities, post-fledging habitat and dispersal routes to the broader foraging area.
- c) Where there are multiple nest trees (i.e., alternative nests), if possible maintain a direct forested linkage between these trees. However, in this case it is preferable to design a GMA.
- d) Minimize the perimeter-to-area ratio of retention patches by designing patches at least 100 m wide where available suitable habitat exists.

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Figure 3 – Todd Manning

Figure 4 – Pamela Zevit

Figure 5 – Sue McDonald (top), Todd Manning (bottom)

Figure 5a – John Deal

Figure 6 – Sue McDonald, John Deal

Acknowledgements

Thanks to various operational staff at BC Timber Sales, International Forest Products Ltd. and Western Forest Products Inc., for reviewing previous versions of this document and providing constructive input. In particular, thanks to Dave Mogensen (RPF, Western Forest Products Inc.), Bob Craven (RPF, International Forest Products Ltd.), John Deal (RPBio., RPF, Western Forest Products Inc.), Martin Buchanan (RFT, Western Forest Products Inc.), Sue McDonald (RPBio., Western Forest Products Inc.), Dave Mackay (RPF, International Forest Products Ltd.) and Warren Warttig (RPBio., International Forest Products Ltd.), for the numerous helpful comments and feedback they provided throughout development of this guidance document.

Additional thanks are extended to Todd Mahon (RPBio., Wildfor Consultants Ltd.), Erica McClaren (RPBio., BC Parks), Laura Darling (RPBio., BC Ministry of Forests, Lands and Natural Resource Operations), Dave Lindsay (RPBio., TimberWest Forest Corp.), Kari Stuart-Smith (RPBio., Canadian Forest Products Ltd.), Brian Moser (Rocky Mountain Wildlife Institute, Missoula, Montana), and Steve Brockmann and Steve Lewis (USFWS, Juneau, Alaska), for providing valuable expert input, frank discussion and thorough review comments.

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7.0 List of Acronyms

BA	Breeding Area
CFCI	Coast Forest Conservation Initiative
EBM	Ecosystem Based Management
GMA	Goshawk Management Area
NA	Nesting Area
PFA	Post-fledging Area

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Appendix 1. Background and Supporting Information



Wildlife Habitat Area (outlined in red) established around a goshawk breeding area on central Vancouver Island, BC. This 200+ ha area of old and mature forest provides ample nesting and post-fledging habitat, and connectivity to the broader foraging area.

A 1.0 Species Description, Ecology and Status

The Northern Goshawk is a large forest-dwelling raptor, but is smaller than both the Osprey and the Bald Eagle. Adults are mostly blue-gray above, with a dark crown and conspicuously lighter eyebrow (Figure 3). The underparts are white with dense grey barring, giving the appearance of being grey from a distance. The tail has dark, wavy bands and is narrowly tipped with white; fluffy, white undertail coverts are conspicuous. Immature birds are brown above and buff-colored with dense, dark streaking below.



Figure 3. Adult Northern Goshawk perched near nest tree. Note eyebrow stripe.

Breeding Biology

Aerial courtship (above the forest canopy) and breeding can begin in mid-February and extend into late March. Nest construction (or refurbishment of previous nests) usually begins in April and eggs are laid in late April or early May (often dependent on prey abundance and spring weather conditions). Chicks usually hatch in late May or early June, and remain in the nest until they fledge late June or early July. Young fledglings usually remain within the immediate nest stand during the early fledgling dependency period (to approximately 21 days after fledging), generally staying within 100-200 m of the nest tree. During the late fledgling dependency period (the remaining 4-5 weeks before dispersal in late August or early September), juveniles venture further away from the nest tree, often going 200-500 m). These movements are often highly directional (as opposed to random).

In late August or early September, juveniles begin to disperse into the broader foraging area or beyond for the fall and winter period. Both juveniles and adults are year-round residents on the coast of B.C.

Prey

Northern Goshawks are generalist predators of medium-sized birds and small mammals. Preferred prey species hunted by coastal goshawks include red squirrel, members of the thrush and jay families (e.g., Steller's Jay, Gray Jay, Varied Thrush, Hermit Thrush), woodpeckers and grouse. Where available, they will also feed seasonally on waterfowl (i.e., along estuaries).

Status

In British Columbia, the Northern Goshawk (*laingi* subspecies) occurs on Vancouver Island, Haida Gwaii, and along the mainland coast (west of the Coast Mountain Range) and coastal islands. It is designated as a 'category of species at risk' under the provincial *Identified Wildlife Management Strategy* policy (see <http://www.env.gov.bc.ca/wld/frpa/iwms/iwms.html>), and is Red-listed (i.e., a candidate for listing as endangered or threatened) in British Columbia. It is designated federally under the *Species at Risk Act* as a threatened species (see *Species at Risk Act Public Registry*, Schedule 1, http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1).

For more information on the status and recovery strategy for Northern Goshawk in B.C., see NGRT (2008).

A 2.0 Characteristics of Preferred Habitat

Note – for a comprehensive description of the habitat variables and their ratings which are used as input parameters to goshawk nesting and foraging suitability models used in coastal British Columbia, refer to Mahon et al. (2008). Also refer to the Recovery Strategy for Northern Goshawk (NGRT 2008) for additional information on nesting and foraging habitat.

A 2.1 Nesting Areas

The nesting area is the forest stand that immediately surrounds the active nest tree, and often includes alternate nest tree(s), roost trees and prey plucking posts (Reynolds *et al.* 1992). It is the immediate core use area where most adult courtship behavior occurs, where nests are constructed, and where fledglings first learn their flying and hunting skills.

Goshawk nesting areas vary in size, shape and location, depending on the topography, availability of suitable habitat, and the number and distribution of nest trees present in the stand.

Goshawks usually nest in mature and old forest stands (structural stage 6 and 7) which provide a moderately-high (40-80%) crown closure. Suitable forest types are usually Douglas-fir, western hemlock or Sitka spruce leading stands. Nests are located in forests characterised by some large live trees (>50 cm dbh, and with dominant and co-dominant canopy heights > 28 m), some standing dead trees, canopy gaps, a fairly open lower-middle forest layer (which provides important hunting perches and subcanopy flyways for aerial hunting, Figure 4), a moderate shrubby understory and coarse woody debris which provide habitat for prey species, and presence of nest platform structures (e.g., mistletoe-deformed branches) at middle canopy height.

Where stand structural attributes are suitable, goshawks can nest in younger second growth stands. Higher site index forests (e.g., SI 30 or greater) on Vancouver Island and the more southerly portions of the BC mainland coast and adjacent islands can provide suitable habitat when they are over 50 years old. Forests on the central and north coast are likely not suitable until they are over 80-100 years old. Lower site index stands can take 10-30 years longer to attain suitable structural conditions. Dense, young second growth stands are usually avoided as nesting areas.

The suitability of younger stands as nesting habitat will be dependent on the overall suitability of the site (i.e., provision of adequate crown closure, stand height and sub-canopy structure, as described above), and

other factors such as proximity to foraging habitat and overall habitat supply/condition in the surrounding landscape.

Slope and Elevation – nesting areas are often located on benches or on gentle-moderate slopes (<40%), and are generally less than 900 m a.s.l. in elevation.

A 2.2 Foraging Areas

Note – the following section provides information on stand structure, forest age class composition, and overall size, relative to the characteristics of goshawk foraging areas. However, **specific guidance concerning the management of goshawk foraging habitat, which is crucial to the successful conservation of goshawk populations, must be implemented within a landscape context**; this information is not provided in this document.

Stand Characteristics of Foraging Habitat

In general, it is commonly thought that goshawks prefer to forage in mature and old forest habitats (Iverson et al. 1996; McClaren 2003; Titus et al. 2006). These preferred habitat types are characterized by closed canopies, relatively large diameter trees, and open understoreys that provide clear flight paths and access to prey (USFWS 2007; NGRT 2008). In the Olympic and Cascade Mountains of Washington, goshawk kill sites (n=17) were characterized by higher canopy closure, greater basal area, larger

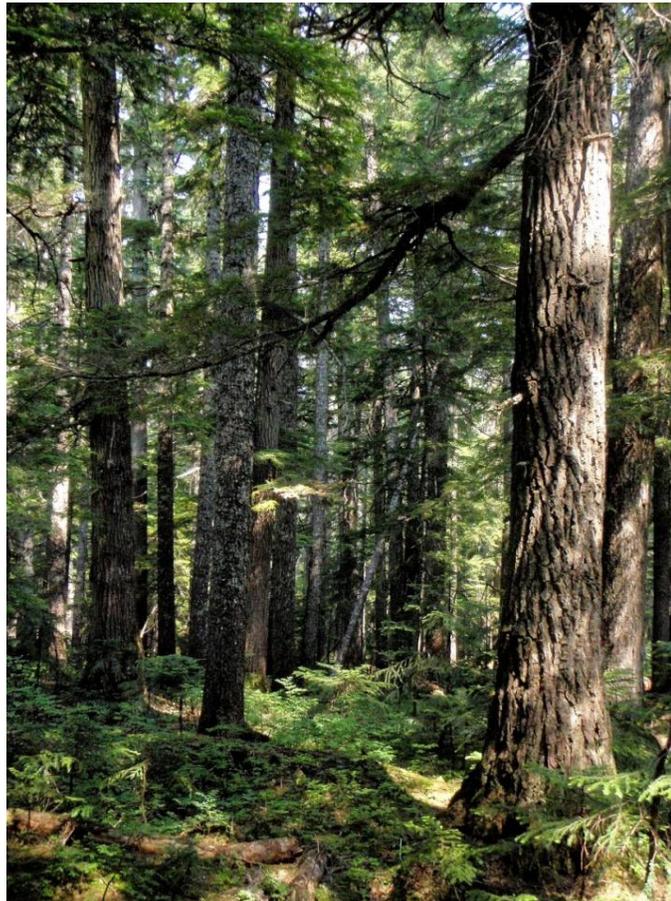


Figure 4. Stand with suitable structure for goshawk nesting and foraging, showing open lower and middle canopy layers with aerial flyways.

diameter trees, and the lack of high pole/sapling densities (Bloxtton 2002). Young forests (<30 years old) typically do not provide the appropriate conditions for effective goshawk foraging (i.e., (large trees with well developed canopies, adequate flight space beneath the canopy), and are generally avoided. On Vancouver Island (Ethier 1999; McClaren 2003; Manning et al. 2006), Haida Gwaii (Roberts 1997; Doyle 2005), and in southeast Alaska (Iverson et al. 1996; Lewis et al. 2006), prey remains and pellets collected at nest sites indicated that goshawk diets were dominated by prey associated with mature and old forests (e.g., red squirrels, forest grouse, woodpeckers and forest passerines) (Mahon et al. 2008).

Preferred Northern Goshawk foraging habitat may be selected more for prey availability than for the amount of prey present (USFWS 2007). Prey availability is likely affected by the amount of vegetative cover in both the subcanopy and understory (Reynolds et al. 1992; Bloxtton 2002; Doyle 2006; USFWS 2007). Goshawks use the advantage of surprise when hunting and often use vegetative cover to conceal their approach to prey (Beebe 1976; Squires and Reynolds 1997). However, dense vegetation can reduce prey availability by interfering with goshawk subcanopy flight paths and manoeuvrability, and thus reduce overall hunting success by providing escape cover for prey (Squires and Reynolds 1997; USFWS 2007).

On Haida Gwaii, goshawk prey abundance and availability were identified as probable limiting factors to goshawk abundance (Doyle 2006). Most known goshawk nest territories on Haida Gwaii occur in mature and old forest habitats (Doyle 2005). Second growth stands on Haida Gwaii, even under good growing conditions, did not typically become suitable goshawk nesting and foraging habitat until they reach ~100 years of age (Doyle 2006). However, thinned and pruned second growth stands provided greater goshawk foraging suitability than non-thinned stands. Overall, an increase in foraging suitability was seen in thinned versus non-thinned stands for both 25-40 year-old and 40-50 year-old second growth age classes on Haida Gwaii. On Vancouver Island, successful goshawk nest territories can occur in 50-60 year old second growth stands on rich growing sites (McClaren 2003; Manning et al. 2006).

In southeast Alaska (Iverson et al. 1996; Titus et al. 2006) and on Vancouver Island (McClaren 2003), radio-telemetry studies indicated that goshawks preferentially selected mature forest habitats for foraging in proportion to its relative availability across the landscape. However, preferred goshawk foraging habitat likely varies both regionally and temporally across its range, but also by sex and perhaps for individual birds or pairs (USFWS 2007; Mahon et al. 2008). Radio-telemetry data suggest that goshawks also forage in areas where they do not nest, including: forest edges, old scrub forest (i.e., old forest at the fine scale, found in dispersed patches such as on rocky outcrops, gullies and other “inoperable” sites, and within areas of younger forest), estuaries, coastal shorelines and elevations >900 m (Iverson et al. 1996; Bloxtton 2002; McClaren 2003; Titus et al. 2006). These are all habitats which are generally rated as low suitability for goshawk.

On Vancouver Island, 259 locations from 63 radio-tagged goshawks were collected between 1996 and 2001 (McClaren 2003). Tracked birds were located in old-growth forests 74% of the time, second growth forests 20% of the time, and mixed old and second growth forests 4% of the time. Detections in old-growth forests were notably higher than would be predicted by its availability across the landscape.

Foraging Area Composition

Within B.C. there is a general lack of information on the amount and juxtaposition of foraging habitat required by a breeding pair to support successful reproduction (NGRT 2008). However, minimum threshold requirements for the amount of mature and old forest habitats within a goshawk breeding territory have been suggested by several studies, but never substantiated by analyses. On the Olympic

Peninsula in Washington, occupied nest stands were characterized as consisting of > 40% late-seral forest (Finn et al. 2002). In southwest United States, foraging areas for *A.g. atricapillus* were recommended to be managed for 60% in mid-aged to old forest and 40% in mature to old forest (Reynolds et al. 1992).

A 10-year study in west-central British Columbia, including the Kispiox Forest District, recommended three potential habitat thresholds for landscape-scale goshawk habitat management strategies (Mahon 2009). Nest territories with 60% mature forest retention (structural stage 6 and 7; >120 years) corresponded to a high probability of territory occupancy, while those with 40% had a moderate probability and those with 20% had a low probability. On Haida Gwaii, there was a positive correlation between occupancy and territories that contained 40% mature forest, yet a weaker correlation between occupancy with territories that contained 60% mature forest (Doyle 2005).

On Vancouver Island, an analysis of 39 goshawk territories found that the amount of mature and old forest did not significantly influence nest territory occupancy or productivity at any distance from the nest (McClaren and Pendergast 2003). However, there was a positive but insignificant correlation, between the amount of > 120 year old forest and nest area occupancy within an 800 m radius (~200 ha) of the nest area centroid. These findings were similar findings to those from the Olympic Peninsula in Washington, which suggested that more significant habitat relationships occur at scales closest to the nest, and tend to lessen at broader scales (Finn et al. 2002).

Goshawk habitat suitability models developed for coastal British Columbia identified three mature and old habitat categories for suitable goshawk habitat (Mahon et al. 2008). Nest territory areas that had 60% mature and old habitat were rated as having high probability of territory occupancy, territories with 40% were rated as moderate probability, and those with 20% were rated as low probability. McClaren and Pendergast (2003) found that as scale increases, a greater proportion of forest is within the younger age classes.

In conclusion, minimum habitat requirements for the amounts of mature and old forest habitat needed for successful goshawk territories likely vary regionally, influenced by factors such as annual prey abundance and availability (Mahon et al. 2008). Researchers from SE Alaska (Iverson et al. 1996) concluded that overall habitat capability and probable goshawk persistence are likely to be most reduced when landscapes dominated by productive old-growth forests are converted to predominantly early seral habitats and contain little "old scrub forest" in the resulting mosaic that may provide compensatory foraging habitat. K. Titus (Alaska Dept. of Fish and Game, pers. comm., Oct. 2011), suggested that relative to their foraging behavior, goshawks are habitat generalists, not old growth specialists; they can successfully forage (seasonally) in riparian habitats, estuaries and inter-tidal areas, subalpine, non-productive older forest, as well as high quality productive old forest and mid-seral and mature forests; a key common factor is prey abundance, diversity and availability.

Foraging Area Size

Goshawk breeding home ranges include the nest tree area, post-fledging areas (PFAs) and the extended foraging area; all of which are areas that the adults and dispersing immatures hunt (NGRT 2008). Foraging areas vary in size among regions and among individual pairs according to their experience, hunting skills, brood size, and the availability of prey within their territory area (Kennedy et al. 1994; Squires and Reynolds 1997). Individuals within a pair may have entirely different foraging areas from each other (USFWS 2007) and they may also change their foraging areas among seasons and years (Titus et al. 1994; McClaren 2003).

Few studies have estimated the size of foraging areas for goshawks because limited data are available on foraging activities (NGRT 2008). In most studies, the size of the foraging area is equated to the estimated home range size since it is assumed that individuals forage widely throughout their entire home range. However, this may not be an accurate assumption. For example, on the Olympic Peninsula in Washington, goshawks concentrated foraging activities within 5 km of active nests and within only 15% of their entire breeding home range (Bloxtton 2002).

On the Olympic Peninsula in Washington State, average breeding season home range size for males and females combined was $3,710 \pm 688$ ha ($n=14$) (Bloxtton 2002). In southeast Alaska, breeding home ranges were 3,900 ha ($n=24$ tagged birds) for females and 4,300 ha ($n=22$) for males (Titus et al. 2006). Non-breeding (winter) home ranges were notably larger in size at 11,800 ha ($n=30$ tagged birds) for females and 11,900 ha ($n=18$) for males (Titus et al. 2006). In general, home ranges of *A. g. laingi* are thought to be larger than for *A. g. atricapillus* since prey availability and abundance are likely lower in coastal habitats than interior habitats (Crocker-Bedford 1994; Titus et al. 1994; USFWS 2007; McClaren et al. 2009).

On Vancouver Island, breeding home range sizes for goshawks were estimated using mean nest tree centroid distances between adjacent nest territories (McClaren et al. 2009). Average spacing distance between nest territories was 6.9 km ($n=16$) (McClaren 2003), which translated into an approximate 3,800 ha breeding home range size (McClaren et al. 2009). The same calculations were applied for nest territories on Haida Gwaii that had mean inter-territorial distances of 11 km (Doyle 2005), which translated into an approximate 9,200 ha breeding home range size (McClaren et al. 2009).

Winter foraging habitat attributes for goshawks are poorly understood (NGRT 2008). On Vancouver Island and in southeast Alaska, radio- and satellite-telemetry studies suggested that foraging habitat characteristics in winter were similar to the breeding season (Iverson et al. 1996; McClaren 2003). However, some individuals in winter may use subalpine forests and coastal habitats as they follow seasonal movements of some prey species. It is unknown whether winter habitat for juvenile goshawks differs from adults (NGRT 2008).

A 3.0 Northern Goshawk Nests – What to look for?

Generally, the surest way to determine which bird species is using a large stick nest is to observe an adult bird at the nest site. The best opportunity for this is during the breeding season, typically March through August. Goshawks have strong fidelity to nest areas once these are established. Goshawk nests can be confused with the stick nests of other forest-dwelling raptors, such as Great Horned Owl and Red-tailed Hawk; however, the following characteristics summarize what to look for when identifying a nest of a Northern Goshawk. If uncertain as to the identity of a stick nest, consult a qualified professional biologist who has experience in goshawk ecology – in some cases a direct bird observation may be required to confirm the nest identity.

- Nest platforms are made of large sticks and average approximately 100 cm across (generally 90-136 cm range) and 10-40 cm deep (Figure 5). Goshawk stick nests are often relatively shallow in comparison to their diameter.
- Typically built in the largest trees in the stand, although often found in trees that have branch deformities (such as multiple leaders and “hand-like” branching caused by mistletoe, Figure 5a, top).
- Nests typically situated adjacent to the tree trunk and within the middle third of the tree height (i.e., often built on the first branch whorl; ranging from 15-25 m above ground).
- Most nests occur in western hemlock and Douglas-fir. Sitka spruce, western red-cedar and red alder are also used as nest trees.
- Often found in trees on benches or slopes with a gentle to moderate incline (less than 40% slope), and at the bottom two-thirds of the meso-slope (often below 900 m elevation).
- Active nests will often have feathers and down visible on the rim of the nest. Note that young chicks in the nest may not always be visible (i.e., they are concealed below the rim of the nest, see Figure 5, bottom).
- The bases of trees (below nests) should be checked for evidence of recent use (i.e., whitewash (feces), remains of prey and raptor feathers, see Figure 6).

Figure 5. Northern Goshawk stick nests.



Figure 5a. Adult goshawk on stick nest (top); juvenile goshawk in Post-fledging Area (bottom).



Figure 6. Signs of nearby Goshawk nesting activity.



A 4.0 Post-fledging Area and Breeding Area Size

The following information relative to post-fledging area and breeding area sizes, has been compiled from recent relevant literature in western North America.

A 4.1 Post-fledging Area Size

- On Vancouver Island, McClaren et al. (2005) found that 93% of fledglings were within 200 m (12 ha, mean = 107.8 m) of nests during the first 3 weeks after fledging, and as fledglings matured during the remaining 4-5 weeks prior to dispersal, they were generally located farther from nests (mean distance = 261 m (**21.4 ha**), up to a maximum of about 432 m (which translated into a mean PFA size of **59 ha** \pm 16.1 ha)).
- Of note, McClaren et al. (2005) observed that fledglings did not continue to expand their PFA size indefinitely until they departed from nest areas, but instead continued to return to nest trees throughout the 7-8 week post-fledging period.
- From the E. Kootenay region of BC, Harrower et al. (2010) found 95% of fledglings within 298 m (27.8 ha) of the nest within the first 3 weeks after fledging⁹, and prior to their dispersal 95% of fledgling locations were within 450 m of the nest – they found a mean PFA size of **36.7 ha** (range 10.3 – 70.9 ha).
- In west-central BC, using daily mapped locations of juvenile goshawks from post-fledging until dispersal, Mahon (2009) found an average PFA size of **19.3 ha** \pm 2.4 ha (range 3.6-36.9 ha, n=37 PFAs).
- In SE Alaska, seven PFAs averaged **26 ha** in size (Iverson et al. 1996).
- Other studies from the southwestern and northwestern United States have cited PFA sizes ranging from **59 ha to 168 ha** (for multiple PFAs) (Reynolds et al. 1992; Kennedy et al. 1994).

⁹ Goshawks generally fledge in late June or early July. Three weeks post-fledging represents the approximate feather hardening date, after which juveniles can fly out further from the nest tree. After 7 or 8 weeks post-fledging (mid-late August to early Sept.), juveniles disperse into the wider landscape.

A 4.2 Breeding Area Size

- Harrower et al. (2010) recommended that in order to conserve post-fledging areas in the interior montane forests of BC, **forested areas of ≥ 21 ha and preferably >40 ha** with high crown closure be reserved in order to encompass all identified active (occupied) and alternative nest trees. This area can contain some young forest 40-80 years of age, but mostly >80 years of age. They demonstrated a positive relationship between the size of the nesting/post-fledging habitat patch and long-term occupancy following logging around this patch.
- From west-central BC, Mahon and Doyle (2005) used a mean nest area (breeding area) size of **24 ha** to evaluate the effects of timber harvesting near nest areas. This size was based on an average of 3 nests per nest/breeding area, a mean spacing of 188 m between nest trees, and a 200 m buffer applied around each nest.
- From west-central BC, Mahon (2009) recommended “*Goshawk habitat areas*” of **40 ha in size** to provide sufficient habitat (and a buffer) for alternative nests, roosts, perches and juvenile post-fledging movements.

- In the standards and guidelines for management of sensitive species, the US Forest Service (Tongass National Forest, SE Alaska), recommends that nesting habitat for Northern Goshawk be preserved by maintaining “...**an area of not less than 100 acres (40 ha)** of productive old-growth forest (if it exists), and generally centered over the nest tree or probable nest site to provide for prey handling areas, perches, roosts, alternate nests, hiding cover and foraging opportunities for young goshawks “ (USDAFS 2008).
- For the northern region of the United States, the USDA Forest Service (2006) recommended a minimum 40 acre (**16 ha**) no activity buffer be placed around known goshawk nests in order to maintain existing conditions in all or part of the nest area. They emphasized that the size and shape of this buffer can vary depending on topography and presence of multiple/alternative nests found in close proximity to one another.
- From the southwestern United States (Reynolds et al. 1992) recommended a **buffer of 297 acres (118 ha)** to protect the goshawk pair and young from disturbance until fledglings leave the PFA (around Aug. 15). After Aug. 15, some treatment activities can occur in the PFA, but must be **outside of the 40 acre (16 ha) core nest area**.
- In a study of goshawk territory occupancy and habitat patch size in N. California, Woodbridge and Detrich (1994) found that clusters of nests stands (i.e., analogous to the term “Breeding Area”) ranged from **10.5-114 ha in size**. They found that nest stand clusters which were **<20 ha in size had less than 50% occupancy; those in the 40 ha size range had 75-80% occupancy; and those >61 ha had nearly 100% occupancy**.
- In a landscape characterization of goshawk nesting habitat in N. California, Allison (1996) recommended that **80 ha of light density and dense mature/old forest should be contained within 800 m (200 ha)** of goshawk nests.
- In Oregon, Desimone (1997) recommended **52 ha to protect the nest stand and provide sufficient habitat for 2 alternative nest stands**. He suggested that up to 20% of the remainder of the 170 ha post-fledging area can be in very early and early seral vegetation cover types.
- For the Tahoe National Forest in Nevada, Fowler (1988) recommended that protection for nest stands should be a **minimum of 50 ha**, and that stands <50 ha will reduce protection and increase the possibility of inactivity and abandonment.
- In N. Idaho, Moser and Garton (2009) concluded that breeding area reoccupancy was related to the amount of potential nesting habitat available in the 170 ha area surrounding the nest(s). Both this study, and an investigation of long-term breeding area occupancy in south-central Oregon by Desimone and DeStefano (2005), suggested that goshawks will **reoccupy breeding areas if approximately >40% of mid- to late-aged, closed canopy forest is maintained in the 170 ha area surrounding goshawk nests**.
- In fire-adapted ecosystems in the SW United States, Youtz et al. (2008) recommended managing a multiple PFA (breeding area) of **168 ha**. This would provide for **6 alternative nests at a minimum of 12 ha for each nest area** (= 72 ha), plus additional post-fledging habitat.
- Once again from the SW United States, Reynolds et al. (2006) suggested that a **radius of 1637 ft. (504 m or 80 ha) is expected to contain 75% of all alternative goshawk nests**.
- From 2001 through 2010, Stuart-Smith et al. (*in review*) placed mature or old forest reserves (> 80 yrs old with canopy closure > 40 %) of various sizes (1 to > 100 ha), shapes, and distances from contiguous forest, around 28 active goshawk breeding areas in southeastern British Columbia in order to determine characteristics of reserves that were consistently reoccupied following logging,

and to test the hypothesis that reoccupancy was positively related to reserve size. Breeding areas were monitored before and for 4-10 years after logging, and data were analyzed with and without a

2 year post-logging time lag to account for breeding area fidelity. Stuart-Smith et al. (*in review*) found that reserve size and edge:size ratio were the strongest predictors of breeding area reoccupancy, and that reoccupancy was positively related to reserve size. **Reserves > 100 ha had the highest reoccupancy, and reserves less than 23 ha were generally not reoccupied for more than 2 years following logging.** There was a negative linear relationship between reoccupancy and the amount of hard edge (defined as the length of reserve edge bordering forest < 40 years old, brush, talus or water). Reserves with more than 90% of their boundary as hard edge were unlikely to be occupied following logging. Relationships were stronger when data from the first two years following logging were removed from the analysis, indicating the importance of site fidelity on goshawk responses to harvesting.

- For goshawk breeding areas in the interior of BC, the Interior BC Goshawk Science Team (2011) recommended that reserves of **25-50 ha have a high risk of breeding area abandonment, 51-75 ha have a moderate risk of abandonment, reserves of 76-100 ha have a low risk of abandonment, and those >100 ha have a minimal (very low) risk of abandonment** (i.e., they have the highest probability of continued occupancy). They also suggested that reserves <25 ha in size will not maintain long-term occupancy.
- From Vancouver Island and using a measured mean PFA size of 59 ha (n=34 nest areas) applied conceptually to 3 alternative nest trees and their associated overlapping offset PFAs of 432 m radius, McClaren et al. (2005) **recommended conceptual management areas of 96-105 ha in size.**
- On Vancouver Island, McClaren (2003) found that nest areas within fragmented landscapes (**patches <50 ha surrounded by unsuitable habitat**) had significantly lower occupancy rates than nest areas in contiguous mature and old forests. And on the Olympic Peninsula of Washington State, Finn et al. (2002) found that as nest areas become highly fragmented, goshawks often relocated to breed in areas that are not fragmented.
- Based on observed numbers and spacing distances between alternative nests, and post-fledging area sizes determined from local studies (see McClaren et al. 2005), goshawk breeding areas in coastal BC have been estimated to range from **54-204 ha in size** (median = 82.6 ha, n=40 breeding areas on Vancouver Island, T. Mahon and E. McClaren, draft unpub. data, 2012).