Alaska Department of Fish and Game
Division of Wildlife Conservation
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Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

1 October 1999–30 September 2000

Kimberly Titus
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Annual Research Performance Report
Endangered Species Conservation Fund
Federal Aid Study SE-4-2-5

This is a progress report on continuing research. Information may be refined at a later date.

FEDERAL AID
ANNUAL RESEARCH PERFORMANCE REPORT

PROJECT TITLE: Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

AUTHOR: Kimberly Titus and Stephen B. Lewis

COOPERATORS: US Forest Service and US Fish and Wildlife Service

GRANT AND SEGMENT NR.: SE-4-2-5

SEGMENT PERIOD: 1 October 1999 – 30 September 2000

STATE: Alaska

WORK LOCATION: Douglas and Ketchikan

I. PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: Monitoring of northern goshawk nesting areas in cooperation with USDA Forest Service.

Goshawks are an important monitoring component associated with the 1997 revision of the Tongass Land and Resource Management Plan for the FS. The FS has instituted an interagency goshawk-monitoring plan associated with their requirement to protect and conserve habitats for goshawks to ensure that they remain viable and well distributed on the Tongass National Forest. Resource agencies are also interested in conserving and managing for goshawks so that there is no need to list the species under the Endangered Species Act (ESA). This project is the primary data-gathering component of a multi-agency effort devoted to long-term monitoring of goshawk nesting areas and determination of goshawk movements based on radiotelemetry data. After the 1999 field season, it was decided that ongoing field efforts by ADF&G staff would be downgraded to a supportive role that entailed assisting the FS in nest monitoring efforts.

OBJECTIVE 2: Reanalysis of goshawk radiotelemetry data and update of vegetation mapping and GIS data layers.

Patterns of goshawk movements, habitat use, and habitat selection based on radiotelemetry were analyzed previously using data collected from 1992 to 1995 (Iverson et al. 1996). Since these analyses, additional telemetry locations have been acquired that will allow a more thorough analysis of movement patterns and home range. Based on these home range data, an analysis of the types of vegetation used by goshawks is pertinent. This analysis is dependent on Forest Service GIS coverages and vegetation data.

OBJECTIVE 3: Description of breeding season diet of goshawks.

The second and final field season of a goshawk diet study by Boise State University M.S. student Steve Lewis was completed during 1999. ADF&G, FS and FWS jointly funded this study; Lewis used small, remote cameras and video recorders to identify prey brought to goshawk nests. From these data, we will determine the types of goshawk prey species that are associated with old-growth coniferous forests in Southeast Alaska. During the winter of 1999/2000, analyses of these data were to take place to provide a quantitative description of goshawk diet.

OBJECTIVE 4: Preparation of reports for publication.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 1: Searching for active goshawk nests and capturing goshawks.

This objective was partially met because fewer nest areas were visited than in previous years in accordance with ADF&G's decision to allow FS staff to take the lead on monitoring efforts.

Ten active goshawk nests were identified on the Tongass in 2000 (Tables 1-3). Nine occurred within previously documented nesting areas and 1 occurred within a new nesting area (Shady, Wrangell Island) located this year. At several locations (Eagle River, MacDonald Lake, Turner Lake), goshawks were seen during the breeding season but an active nest was never found. With the discovery of 1 new nesting area in 2000, the cumulative number of nesting areas documented in Southeast Alaska increased to 62.

During 2000, ADF&G personnel captured 3 goshawks (2 adults, 1 juvenile) at 2 nest sites in Southeast Alaska. We attached a tail-mounted transmitter to 1 adult goshawk captured for the first time. In addition, 2 goshawks (1 adult, 1 juvenile) were instrumented with satellite transmitters (PTTs) during 2000. An adult female from Heceta Island (Timber Knob nesting area) and a juvenile female from Douglas Island (Blueberry Hill nesting area) were tagged with PTTs. This was performed as a pilot study to determine whether PTTs could be used in the rugged topography and dense forests of Southeast Alaska. Through February 2001 we obtained 170 and 55 locations (Argos location classes, 3,2,1; high, medium and low quality) from the Timber Knob and Blueberry Hill birds, respectively. We determined that satellite tracking provided a more cost effective approach to acquiring goshawk location information than traditional aerial radiotelemetry. There are significant tradeoffs however. Satellite locations data has built-in accuracy error factors, there is no visual estimation of habitat associations as acquired by an observer in an aircraft, and the technology does not allow ground relocation of the signal, such as to find a nest or dead bird.

JOB 2: Analysis of radiotelemetry data to assess goshawk movements, followed by an analysis of vegetation use and selection using a geographic information system (GIS).

The first portion of this objective was met, as there was a re-analysis of the radiotelemetry data including all locations acquired through 1999. We had a reduced aerial tracking effort during 2000 because of reduced funding. We also experienced a higher rate of radiotransmitter failure during this period. As a result, little additional data were collected. Summaries of home range estimates are provided in another report (Flatten et al. 2001).

A number of types of home ranges were summarized in GIS (e.g., 100% MCP, 90% convex polygon, various pooling of sexes and nesting areas). These spatial data were transferred to the FS but an updated vegetation map of the Tongass has not been completed. ADF&G staff members are unable to complete the vegetation analysis without this updated map.

JOB 3: Analysis of prey delivery, prey remains, and pellet data to quantitatively describe the diet of goshawks in Southeast Alaska and examine variation in the diet throughout the area. This objective was partially completed but the amount of information to be analyzed was greater than anticipated and additional analyses were warranted.

M.S. student Steve Lewis documented >1540 prey deliveries, and collected 285 bags of prey remains and 146 bags of pellets during the 1998 and 1999 field seasons. During the winter of 1999/2000, he reviewed all videotapes and began analysis of these data and the identification and analysis of prey remains and pellet data gathered throughout Southeast Alaska by ADF&G and FS personnel. In general, goshawks in Southeast Alaska eat similar prey to those goshawks nesting in other parts of their range. Goshawks preyed on birds more often than mammals in Southeast Alaska.

JOB 4: Analysis of data and preparation of reports for publication.

ADF&G personnel began analysis of data collected since the beginning of this interagency project in 1991. Emphasis was placed on determining home ranges, habitat associations, and inter-year movements using radiotelemetry data. In addition, an analysis of the subspecific status of goshawk in Southeast Alaska was initiated, based on morphological data gathered since 1991. Nothing was submitted for publication pending completion of analyses.

III. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

Resource agencies are interested in conserving and managing for goshawks so that there is no need to list the species under the Endangered Species Act (ESA). Because of forest management and ESA issues, the US Fish and Wildlife Service (FWS) has needed information about the Queen Charlotte goshawk (*A. g. laingi*) as related to ongoing litigation about the status of the subspecies related to an ESA petition. During the fall of 1999, FWS was required by court order to generate an estimate of the size of the population of goshawks that are within Southeast Alaska. The FWS requested the assistance of ADF&G staff in helping meet their legal requirements. ADF&G staff spent significant time during the winter of 1999/2000 contributing to this population estimate. Tasks included the scheduling, facilitating, and leading an interagency workshop to estimate goshawk population size using habitat and home range size modeling methods. At the interagency workshop we reviewed a number of possible approaches including combining home range size estimates and habitat types as a habitat capability approach. Biologists were uncomfortable with all approaches because of numerous untested assumptions involved in making these extrapolations. Our final interagency approach estimated a maximum habitat capability of up to 747 nesting pairs of goshawks on the Tongass National Forest. These results were not amenable to the calculation of confidence intervals.

IV. RECOMMENDATIONS FOR THIS PROJECT

The tenth field season of this cooperative study was completed in 2000. After discussions with FS staff, objectives of the ADF&G staff were altered after the 1999 field season to take a secondary role to FS personnel for monitoring goshawk nests. During this period we recommended that the FS begin considering how they would conduct goshawk monitoring efforts as ADF&G staff devoted less time to fieldwork and interagency coordination and more time to data analysis and report preparation. Several discussions among division staff and between division and FS staff were held to discuss other data needs for this project, to shape the future of this project, and to direct ADF&G's role in the research.

V. PUBLICATIONS

None

VI. FEDERAL AID TOTAL PROJECT COSTS FOR THIS SEGMENT PERIOD

$ 22,500

VII. PREPARED BY:

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APPROVED BY:

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Wayne L Regelin, Director
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APPROVAL DATE: __________________

Table 1. Activity status of known northern goshawk nest areas in the Ketchikan Area of the Tongass National Forest in Southeast Alaska, 1998-2000; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Butterball Lake, Heceta Island				O	N A R	O	O	O	O	O
Carroll River, Revilla.Island						G	N A	G	G	O
Convenient Cove, Hassler Island		G	G	N A	G	G	O	O	O	O
Derrumba Ridge, Heceta Island							N O	O	O	O
Logjam Creek, P.O.W. Island			N A R	O	O	O	O	O	O	O
Margaret Lake, Revilla.Island				N A	G	B R	B R	B R	O	O
McDonald Lake, Cleveland Peninsula									N A	G
Port Refugio, Suemez Island	O	G	G	B	G	G	O	O	O	O
Rio Roberts/Cutthroat Creek, P.O.W. Island					N A R	B R	B R	B R	O	O
Sarheen Creek, P.O.W. Island	G F	G	G	O	O	O	O	O	O	O
Sarkar Lake, P.O.W. Island		N A R	O	O	G	O	O	O	O	O
Timber Knob, Heceta Island						N A	B	C(96) R	B R	C(97)
Traitors Creek, Revilla.Island				N A R	B R	O	O	O	O	O
Twelvemile Arm, P.O.W. Island						N O	O	O	O	X

A = active nest first located.
C = previously known active nest reused; ( ) = year first active.
G = goshawk(s)/activity observed during breeding season, active nest not located.
O = no goshawk/activity observed, active nest not located.
X = area not checked.
B = active alternate nest located.
F = fledgling(s) observed, active nest not located.
N = nest area documented this year.
R = adult(s) radiotagged and/or present.

Table 2. Activity status of known northern goshawk nest areas in the Stikine Area of the Tongass National Forest in Southeast Alaska, 1998-2000; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Big John Creek, Kupreanof Island		N A	B R	O	O	O	O	O	O	O
Brown Cove, Petersburg Mainland								N A	B R	O
Camp Carl, Etolin Island							N A R	B R	B R	C(99)
Cat Creek, Cape Fanshaw Mainland				N A R	O	O	X	O	O	O
Doughnut, Wrangell Island									N A R	B
Duncan Creek, Kupreanof Island				N A	O	O	G	O	B R	B R
East Bay of Pillars, Kuiu Island				N A R	B R	X	B R	O	O	O
Elena Bay, Kuiu Island								N A R	B R	B
Farragut Bay, Petersburg Mainland									N A R	B
Irish Lakes, Kupreanof Island						N A	G	O	O	O
Kadake Bay, Kuiu Island						N A R	O	O	O	O
Kake, Kupreanof Island (cut in 1989)	X	X	X	X	X	X	X	X	X	X
Kuakan, Deer Island							N A	B	B R	O
Madan Bay, Wrangell Mainland								N G F	B R	C(99)
Mitchell Creek, Kupreanof Island				N A R	B	O	O	O	O	O
Mossman Inlet, Etolin Island	X	O	O	X	X	X	X	X	O	X
Mountain Point, Kupreanof Island				N A R	O	X	O	O	O	O
Negro Creek, Port Houghton Mainland				N A	G	O	O	O	O	X
Rowan Creek, Kuiu Island			N A R	R T	G	O	G	O	O	X
Sanborn Canal, Port Houghton Mainland				N A	O	O	X	G	O	X
Security Bay, Kuiu Island							N A R	O	O	X
Shady, Wrangell Island										N A
Starfish, Etolin Island	N A	O	O	O	O	X	O	O	B R	O
Totem Camp, Kupreanof Island				N A	O	X	O	O	O	X
Tunehean Creek, Kupreanof Island								N A	B R	O
Upper Totem, Kupreanof Island			N O	O	O	X	G	O	O	O
West Bay of Pillars, Kuiu Island				N A R	B R	X	O	O	O	O
Zim Creek, Kupreanof Island									N A	X

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nest area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged adult present but did not nest.
X = area not checked.

Table 3. Activity status of known northern goshawk nest areas in the Chatam Area of the Tongass National Forest in Southeast Alaska, 1998-2000; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Auke Bay, Juneau Mainland								N A R	O	O
Blueberry Hill, Douglas Island			N A R	B R	C(93) R	R T	C(94) R	B R	B R	C(94)
Dewey Lake, Skagway Mainland	X	X	X	X	X	X	X	X	X	X
Distin Lake Trail, Admiralty Island				N A	X	X	B	O	B	O
Duffield Peninsula, Baranof Island				N A	C(94)	C(94)	O	X	B	O
Eagle Creek, Douglas Island			N A R	R T	O	O	O	O	O	O
Eagle River, Juneau Mainland							N G F	A R	B R	G
Fish Creek, Douglas Island				N A R	B R	B R	B R	C(96) R	B R	O
Florence Bay, Chichagof Island						N A R	O	O	O	O
Green Cove, Admiralty Island						N A R	B R	B R	C(96) R	B
Lace River, Berners Bay Mainland				N A R	R T	O	O	O	X	O
Mud Bay River, Chichagof Island			N A	G F	O	X	O	C(93)	O	O
Nugget Creek, Juneau Mainland			N A R	B R	R T	O	C(93) R	C(94) R	O	O
Pavlof River, Chichagof Island					N A R	R T	R T	O	O	O
Point Bridget, Juneau Mainland		N A	B R	O	G	G	G	B R	B	O
Ready Bullion Creek, Douglas Island	N A	B R	O	O	O	O	C(91) R	B R	C(92) R	O
Sitkoh River, Chichagof Island									N A	O
Tolch Rock, Juneau Mainland									N A R	O
Turner Lake, Juneau Mainland						N G F	A	G	G F	G F
Whitestone, Chichagof Island					N G F R	A R	O	O	O	X

A = active nest first located.
C = previously known active nest reused; ( ) = year first active.
G = goshawk(s)/activity observed during breeding season, active nest not located.
O = no goshawk/activity observed, active nest not located.
T = radiotagged adult present but did not nest.
B = active alternate nest located.
F = fledgling(s) observed, active nest not located.
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Alaska Department of Fish and Game
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Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

1 April 1991–30 September 2001

Craig Flatten
Kimberly Titus
Richard Lowell

Final Research Performance Report
Endangered Species Conservation Fund
Federal Aid Grant SE-4, studies 2 to 6

RESEARCH FINAL PERFORMANCE REPORT

STATE: Alaska **STUDY:** SE-4-2-6

COOPERATOR: USDA Forest Service, US Fish & Wildlife Service

GRANT: SE-4

TITLE: Northern Goshawk monitoring, population ecology and diet on the Tongass National Forest

AUTHORS: Craig Flatten, Kimberly Titus, and Richard Lowell

PERIOD: 1 April 1991–30 September 2001

Editor's Note: Although the grant for this project began in 1995, in this final research report authors discuss nesting data as far back as 1991 during the program's onset when the USDA Forest Service and Alaska Department of Fish and Game funded this project. The title for Grant SE-4-2-6 includes additional focus on diet brought to this project through contract amendment.

SUMMARY

There is a need to evaluate the status, population, and habitat ecology of the northern goshawk (*Accipiter gentilis*) on the Tongass National Forest (Tongass). The northern goshawk was a key design species in the revision of the Tongass Land and Resource Management Plan (TLMP; US Forest Service 1997), and the US Fish and Wildlife Service reviewed this species for possible listing under the Endangered Species Act. TLMP has a number of requirements for monitoring goshawks on the Tongass and for maintaining goshawk habitat across the landscape. During 1991–1999, the Alaska Department of Fish and Game (ADF&G) and the US Forest Service (USFS) located and monitored goshawk nesting areas across the Tongass as part of an interagency study of the ecology and habitat relationships of this species in Southeast Alaska. Sixty-one nesting areas were documented within a study area approximately 77,000 km^2 (30,000 mi^2). Nesting areas were initially located during activities associated with timber sales (61%), recreation (10%), agency bird surveys (8%), or by tracking radiotagged adult goshawks (21%). Most nesting areas were located in remote areas and the majority (68%) used floatplanes for principal access; more than half (58%) required more than one type of motorized transportation for access. Nesting areas were searched annually 1 to >10 times during attempts to determine occupancy, nesting status, and productivity. Searches were aided by radiotelemetry or by standard goshawk detection methods, including broadcasting conspecific calls, watching for goshawks in flight above the forest canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas by foot to search for clues of goshawks and nesting. We did not test the efficacy of these detection methods or apply them under strict protocol. Annual searches of nesting areas were conducted during a total of 283 nesting

area-years at 59 nesting areas. Across all years 1991–99, a mean of 83% (annual range = 71–96%) of known nesting areas were searched each year; a mean of 14% (annual range = 0–29%) of known nesting areas were searched each year by tracking radiotagged adults, and a mean of 70% (annual range = 53–80%) of known nesting areas were searched each year without the aid of radiotelemetry. Despite extensive efforts each breeding season to detect goshawks and nesting activity, our results from 9 years of nesting area monitoring indicate that nesting area searches done without the aid of radiotelemetry had limited success. This observation is supported by our general field experience and analysis of data from radiotagged goshawks concerning nesting area fidelity and annual movement between nests, both within and between nesting areas (see below). Various factors are believed to have affected the negative outcome of many nesting area searches done without radiotelemetry. These principally include 1) the dense rainforests and 2) frequently inclement weather of our study area, which hindered our ability to access nesting areas and detect goshawks, 3) the potentially large size of nesting areas (see below), and 4) the limited experience of some observers. Additionally, difficult and/or expensive logistics also limited access to many nesting areas and consequently the frequency and area extent of searches at these locations. We conclude that site conditions and logistical constraints in Southeast Alaska generally preclude efficient application of standard detection methods for searching goshawk nesting areas. Because searches of nesting areas among the dense rainforests and remote locations of Southeast Alaska are inconclusive when no goshawks or nests are detected using standard detection methods, and because we experienced low detection rates of goshawks and nests using these methods at known nesting areas, we further conclude that standard detection methods are not effective for reliably monitoring the annual or long-term status of most nesting areas in this region.

During 1992–99, 57 adult goshawks, including 26 females and 29 males, were radiotagged at 28 nesting areas and tracked year-round with airplanes; 88% of females and 69% of males were relocated in ≥ 1 subsequent breeding season. Distances moved between active nests in consecutive years by these birds ranged between 0.05 and 3.20 km within the same nesting area, and 3.67–152 km between nesting areas. We defined the maximum size of nesting areas in Southeast Alaska as 804 ha (1987 ac; 3.11 mi^2), based on the maximum distance of 3.2 km that a radiotagged pair moved between active nests in consecutive years within its home range. We observed that nest sites are generally 5–15 ha (12–37 ac) and that distances separating more than one nest site within the same nesting area can range from a few hundred meters to >3 km. Of active nests found with radiotelemetry within the same nesting areas in consecutive years, 54.2% (13 of 24) were located within a 0.359 km radius and 40.5 ha (100 ac) circular area of the year 1 nest; 79.2% (19 of 24) were located within a 1.0 km radius and 314.2 ha (776.4 ac) circular area of the year 1 nest. Based on these results and the inferred low rate of active nest detection we experienced when searching nesting areas without radiotelemetry, we recommend that the minimum size of "no commercial timber harvest" buffers around goshawks nests be increased beyond the 40.5 ha (100 ac) currently specified in the TLMP if a nest and nesting area based approach to goshawk management is to be used in the future. From our data and observations, we conclude that increasing the size of buffers around known nests will provide greater integrity to nesting areas by protecting more distant (0.359–3.2 km) alternate nests that have a low probability of detection without the aid or radiotelemetry.

Mean occupancy of nest sites based on the presence of an active nest detected with or without radiotelemetry was 28.4% ± 7.6 SE per year at Southeast Alaska nesting areas monitored ≥ 5 to 9 years but varied among management areas of the Tongass National Forest (Ketchikan = 13.0% ± 9.2 SE; Stikine = 20.0% ± 13.0 SE; Chatham = 53.2% ± 15.0 SE). Nesting area fidelity and mate fidelity were moderate for radiotagged females and high for radiotagged males. This difference between sexes can be explained in part by mate abandonment and movement to different nesting areas by some females, but not by males. Eleven females moved to a different nesting area in 35.7% of consecutive year events and remained at the same nesting area 64.3% of events. All adult males remained at the same nesting areas in consecutive year events. For radiotagged pairs, both members of a pair nested at the same nesting area in 55.2% of consecutive year events, and in 75.9% of events at least one member of the same pair was present at the same nesting area. Males retained the same mate in 81.0% of (male) consecutive year events; females retained the same mate in 54.8% of (female) consecutive year events. During 1991–99, a total of 223 fledglings were observed at 113 active nests in 55 nesting areas. Mean productivity across all years was 2.0 fledglings per active nest (annual range = 1.5–2.3). Mean rate of success (≥ 1 young fledged) of active nests across all years was 93% (annual range = 87%–100%). We captured and determined the sex of 49 fledglings that represented all young known to have fledged from 23 nests at 15 nesting areas. Male/female ratio of these birds was 1.04. A total of 81 fledglings, including 40 females and 41 males, were captured at 31 nesting areas during 1992–99. We banded all of these birds and 44, including 17 males and 27 females at 24 nesting areas, were also radiotagged with tail-mounted transmitters to study their dispersal movements and survival.

Our results are of interest to Tongass land managers who need to understand the implications of timber harvest on goshawk nesting areas. Our results indicate there is a high probability that not all active goshawk nests will be detected even when goshawk surveys are conducted before and during timber sale development. In addition, movements by goshawks to alternate nests in subsequent years confound survey difficulties. We conclude that a nest-based management approach to conserving goshawks would not be successful. A landscape approach, as adopted in TLMP, that includes both unknown nesting goshawks and sufficient foraging habitat is the cornerstone to a sound, long-term habitat management plan.

Key words: *Accipiter gentilis*, forest management, mate fidelity, nest area fidelity, nest productivity, nest success, northern goshawk, raptor, Queen Charlotte goshawk, Tongass National Forest, radiotelemetry.

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BACKGROUND

During 1991–99 the Alaska Department of Fish and Game (ADF&G) and the USDA Forest Service (USFS) conducted a study of northern goshawk (*Accipiter gentilis*) (hereafter "goshawk") ecology and habitat relationships on the Tongass National Forest in Southeast Alaska. This study was initiated from the need to focus applied ecological studies of the goshawk on the Tongass National Forest to meet requirements of The National Forest Management Act of 1976, which directs the USFS to manage wildlife habitats so that viable vertebrate populations are maintained in a well-distributed manner on National Forestlands. In the early 1990s, concerns about the effects of timber harvest on goshawk populations were first publicized in the southwestern U.S. (Crocker-Bedford 1990), and the U.S. Fish and Wildlife Service subsequently called for a nationwide status review of the species (Federal Register 1991 and 1992). Committees of biologists also identified the goshawk as a species with population viability concerns in Southeast Alaska due to the high levels of timber harvest in this region (Crocker-Bedford 1992, Suring et al 1992). The goshawk was identified as a species of special interest and one in need of study on the Tongass National Forest. The Southeast Alaska population of the northern goshawk is listed as a species of special concern by the Alaska Department of Fish and Game. This species was chosen for study because of its affinity for forested landscapes, its association with larger and more mature forests in the Pacific Northwest (e.g., Reynolds et al. 1992, Squires and Reynolds 1997), its association with large habitat patches (Widen 1989), and the unique Queen Charlotte subspecies (*A.g. laingi*) that occurs in Southeast Alaska (Taverner 1940, American Ornithologists Union 1957, Palmer 1988, Webster 1988, Johnson 1989, Whaley and White 1994). Additionally, before the current study almost no information existed about the goshawk, its populations, or status in Southeast Alaska, and it was recognized that most knowledge of the species' relative abundance and habitat associations from other portions of its range is probably not applicable to the coastal rainforest environment of this region (ADF&G 1992).

Project goals and objectives were first identified in the 1992 ADF&G–USFS project study plan (ADF&G 1992). Objectives were broad in the beginning years of study when the base knowledge of goshawk natural history in Southeast Alaska was limited. For example, only 4 active nests at 10 documented historic and current nesting areas were known on the entire Tongass in 1992, the first full field season of effort. We accumulated some baseline data after several field seasons, allowing goals and objectives to be refocused and revised in updated study plans (ADF&G 1996).

OBJECTIVES

We focused on developing adequate samples of nesting areas and radiotagged goshawks and on determining the annual status and productivity of known nesting areas. We examined goshawk diet during the nesting season and assisted MS candidate Steve Lewis in his study of this objective. We also continued to collect and analyze morphometric data to assess the subspecific status of goshawks in Southeast Alaska.

Objective 1: Determine annual occupancy, nesting status, and productivity of known nesting areas.

Objective 2: Locate additional goshawk nesting areas to increase sample size.

Objective 3: Determine home ranges, habitat associations, and interyear movements of goshawks using radiotelemetry.

Objective 4: Evaluate goshawk diet during the nesting period.

Objective 5: Assess subspecific status of goshawks in Southeast Alaska.

STUDY AREA

Our study area was approximately 77,000 km^2 (about 160 x 480 km; 30,000 mi^2) and encompasses most of the Tongass National Forest in Southeast Alaska, including major portions of the Ketchikan, Stikine, and Chatham Management Areas and 8 of their 10 ranger districts. Goshawks occur in low densities in Southeast Alaska and are difficult to study in the dense temperate rainforests covering this vast region of island archipelagos and mountainous terrain (ADF&G 1993 and 1997, Schempf et al. 1995). Goshawks are also wide-ranging and secretive raptors and are essentially impossible to study away from the immediate vicinity of nest sites in Southeast Alaska without the aid of radiotelemetry (hereafter "telemetry"). In pursuing the goals and objectives of this project, we focused field efforts during 1991–1999 on locating active goshawk nests and developing and maintaining a sample of radiotagged adults over time. We derived nearly all study data from active nests, which allowed us to gather nest-based information on goshawk natural history and ecology and which served as loci where we could capture and radiotag adults and fledglings to investigate their movements, habitat use, and survival. New nesting areas were nearly always confirmed by the discovery of an active nest, and, once identified, these areas were added to the pool of known nesting areas monitored annually to assess nesting activity and productivity. At nesting areas monitored with telemetry, we were able to objectively assess annual occupancy, site and mate fidelity, and movement between alternate nests.

METHODS

Most nesting areas were identified from observations of goshawks and nests reported by USFS personnel conducting wildlife inventory, fisheries, stand exam, or engineering field activities related to timber sales. Other nesting areas were identified from observations by agency biologists conducting goshawk or songbird surveys, from observations by individuals engaged in recreational and other incidental activities, or from historic nest site records. We also tracked radiotagged adult goshawks to previously unknown nesting areas. We did not use random, systematic, or complete searches to identify new nesting areas (e.g., Reynolds and Joy 1998), nor did we attempt to test the efficacy of goshawk detection methods at known nest sites or nesting areas (e.g., Kennedy and Stalecker 1993, Watson et al. 1999).

Methods used to locate new nesting areas and to assess the status of known nesting areas were divided into 2 basic types: searches aided by telemetry and searches not aided by telemetry. Telemetry-aided searches were used whenever a radiotagged adult from a previous year could be tracked during a later breeding season. These efforts included aerial relocation followed by ground-based relocation of transmitters. Telemetry-aided searches located tagged adult females and males that moved between alternate nests within the same nest stand or nesting area, or that were present at the same nesting area but did not nest. These searches also located radiotagged adult females that moved to other distant areas where they did or did not nest. This is unlike many other goshawk studies that do not use telemetry and have much lower probability of locating nesting goshawks that may have moved out of an intensively searched study area or moved a long distance to alternate nests within the same home range (e.g., Woodbridge and Detrich 1994, Reynolds et al. 1994).

Nesting area searches done without telemetry occurred when no adult goshawk wearing an active radio tag was present at a known or suspected nesting area. The method we used most frequently to assist detection of active nests was broadcasting recordings of conspecific vocalizations to elicit vocal or other responses from goshawks (e.g., Kennedy and Stalecker 1993). Other search methods included observing forested areas from vantage points to detect goshawks in flight above the canopy (e.g., Kostrzewa and Kostzewa 1990), listening for unsolicited goshawk vocalizations (e.g., Pentriani 1999), and accessing nesting areas and surrounding areas by foot (e.g., Fuller and Mosher 1987), vehicle, and boat to search for evidence of nesting. During searches done without telemetry at known nesting areas, all known nests were first inspected for activity. If these nests were determined inactive, variable effort was then applied to the surrounding area. Search effort without telemetry varied considerably between years, nesting areas, number of area visits, duration of visits, time in breeding season, number and experience of personnel, and extent of area searches. The number of visits made to a nesting area during a breeding season and the resulting degree of search effort was dictated largely by the remoteness of a location and logistical and cost considerations. We did not attempt to precisely document, summarize, or analyze effort or other method variables for nest searches done without telemetry. Access to many nesting areas we studied required travel by aircraft or boat and was therefore limited by unfavorable weather and cost. We summarized methods of transportation used to access field sites to examine how these logistics affected our ability to monitor nesting areas.

Annual Monitoring of Nesting Areas

ADF&G or USFS biologists and technicians made 1 to >10 visits to most documented nesting areas each year during the breeding season, March 1 to August 15, to determine occupancy, nesting status, and productivity and to collect site data. We summarized results of nesting area annual monitoring efforts for the period 1991–1999. Summary by year was done by tallying the number and proportion of nesting areas known from a previous year that were searched with and without telemetry and the outcome of these searches. Not included in this summary were nesting areas where no active nest had been located in any year, nesting areas where the status of both radiotagged adults from a previous year was "dead" or "unknown," and nesting areas that were first documented in 1999. As noted, we did not attempt to directly compare search methods at nesting areas during monitoring efforts, nor did we attempt to first locate nests without telemetry when radiotagged adults were present at a nesting area.

Distances Moved Between Nests

We examined the distances moved between nests by identifying all occasions in which an active nest was located at the same nesting area in 2 consecutive years. We also identified all occasions that a radiotagged adult moved to a different nesting area and nested there in year 2 of consecutive breeding seasons. Distance between each pair of year 1 and year 2 active nests was measured using USGS topographic maps, aerial photos, or GIS map software. Data was divided into 2 groups: second year nests located with telemetry and second year nests located without telemetry. We examined each data group separately and also made general comparisons between groups. For nests located with telemetry, the identities and home ranges of all individuals were known, and we were able to determine which second year nests were located within the same nesting area and home range and which were located in a different nesting area and home range. For nests located without telemetry, where no adult wore an active radio and many were unmarked and their identities unknown, we assumed that at least 1 member of the year 1 pair was present at the year 2 nest (i.e., the move to the year 2 nest was made by at least 1 adult from the year 1 nest). We also assumed that a second year nest located without telemetry was located within the same nesting area associated with the year 1 nest. See Results and Discussion for information supporting these assumptions.

Occupancy of Nesting Areas

During 1992–99 we monitored individual radiotagged adult goshawks year-round from <1 to 7 years. Radiotagging the adults allowed us to track movements of individuals and pairs and to determine their nesting status during 1 or more subsequent breeding seasons. To summarize adult nesting area occupancy rates, we identified all occasions in which a radiotagged individual was present in 1 or more breeding seasons at the same nesting area. Mean length of occupancy for adult females and males was then calculated for all nesting areas. We also summarized nesting area occupancy by any radiotagged adult. This nesting area-based method is different from bird-based occupancy because it also accounts for new birds replacing mates that died or left a nesting area.

Status of Adults and Pairs in Consecutive Breeding Seasons

The status of radiotagged adults and adult pairs at nesting areas during 1992–1999 was summarized using consecutive breeding seasons (see section *Distance Moved Between Nests* above). We identified all occasions in which an individual adult or an adult pair was known to be alive and nested in 1 breeding season, labeled year 1, and effort was made to determine its status during the following breeding season, labeled year 2. For individual adults, results were divided by sex and the following year into status types: 1) nested at same nesting area, 2) remained at same nesting area but did not nest, 3) moved to other nesting area and nested with a different mate, 4) moved to other nesting area and did not nest, 5) dead, and 6) unknown. Year 2 status types for pairs included 1) pair nested at same nesting area, 2) female moved to different nesting area; male remained and nested with new mate, 3) female moved to different nesting area; male remained and did not nest, 4) one mate died; remaining bird nested with new mate, 5) one mate died; remaining bird did not nest, and 6) status of 1 or both sexes unknown. We also used this information on the status of adults in consecutive years to summarize nesting area fidelity and mate fidelity.

RESULTS AND DISCUSSION

Objectives 1 and 2: Determine annual occupancy, nesting status, and productivity of known nesting areas. Locate additional goshawk nesting areas to increase sample size.

Annual Monitoring of Nesting Areas

We define *nest site* as the nest, nest tree, and forested area surrounding the nest that includes prey-handling areas, perches and roosts, and may contain ≥1 alternate nest. Nest sites in Southeast Alaska are approximately 5–15 ha. We define *nesting area* as the landscape area up to 804 ha (1987 ac; 3.11 mi^2) that includes all nest sites and alternate nests used by a goshawk pair or individual within its breeding home range. This definition is based on 8 years of our radiotelemetry data from adult goshawks in Southeast Alaska. We note that our telemetry-based definition of nesting area is analogous to the term *territory*, when used in other goshawk studies to describe the landscape area encompassing all known nests used by a pair (e.g., Woodbridge and Detrich 1994, Reynolds, et al. 1994). See Table 1 for definitions of these and other terms.

During 1991–1999, a total of 61 goshawk nesting areas were identified within an area approximately 77,000 km^2 (30,000 mi^2) in Southeast Alaska, including 4 nesting areas documented before 1991 and 57 nesting areas identified during project fieldwork in 1991–1999 (Table 2). A total of 56 nesting areas were located on Tongass National Forest land, including 14 on the Ketchikan, 26 on the Stikine, and 16 on the Chatham Management Areas; five other nesting areas were located on land of other ownership. The annual cumulative total of known nesting areas ranged from 7 in 1991 to 61 in 1999. Number of nesting areas known to have an active nest ranged from 3 in 1991 to 23 in 1999. Of the 61 nesting areas, 37 (61%) were identified through reports of goshawks and nests observed during activities associated with USFS or other timber sales. These included observations from wildlife inventory, fisheries, stand exam, or engineering crews. Six (10%) nesting areas were identified from reports from incidental observations or individuals engaged in recreational activities, and 5 (8%) were identified during agency bird surveys or goshawk project surveys. We identified 13 (21%) of the 61 nesting areas by tracking a radiotagged adult to a new nesting area. We monitored nesting areas annually by making 1 to >10 visits during the breeding season to assess occupancy and nesting status. Nesting area searches were aided by telemetry or by standard goshawk detection methods, including: broadcasting conspecific calls, watching for goshawks in flight above the canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas on foot to search for visual clues of goshawks and nesting. We did not test the efficacy of these standard detection methods or apply them under strict protocol.

During 1991–1999, nesting areas were monitored during a total of 283 nesting area-years at 59 nesting areas. Two additional nesting areas, both located on private land, were visited by ADF&G or USFS personnel before 1991; one area contained an active nest site that was clearcut during logging activities. The other is near Skagway at the northern periphery of our study area. Nesting area monitoring included searches during 82 nesting area-years at 40 nesting areas where 1 or more radiotagged adult was present (including the year of radiotagging) and 201 nesting area-years at 51 nesting areas where no radiotagged adults were present. Primary access to nesting areas from the closest ADF&G or USFS office was facilitated by various types of motorized transportation, and access to more than half (58%) of the nesting areas used or required more than 1 type of transportation (e.g., floatplane and road vehicle). For nesting areas monitored during 1991–1999, transportation types used on 1 or more occasions were floatplanes, 68% (40); helicopters, 24% (14); boats, 27% (16); and road vehicles, 51% (30). Of those nesting areas that we used only road vehicles to gain access, eight of twelve (75%) nesting areas were on the Juneau road system. In addition to 1 or more modes of transportation, access to all nesting areas and nest sites required traversing forested areas on foot from transportation departure points (e.g., beaches, muskegs, and roads). Distances traversed on foot to nesting areas ranged from 0.05 to >3km.

Summary by Year

The following results are from annual nesting area monitoring during 1991–1999.

Nesting area searches with and without telemetry. A mean of 83% (annual range = 70–96%) of all nesting areas known from a previous year were searched for nesting activity with or without telemetry on at least 1 occasion during the breeding season. An active nest was located at a mean of 25% (annual range = 19%–36%) of all nesting areas searched across all years. Additionally, a goshawk and other evidence of goshawk activity, such as recent prey remains or molted feathers, were observed and an active nest was not located, or a radiotagged goshawk was present and did not nest at 20% (annual range = 4–40%) of all nesting areas searched.

Nesting area searches with telemetry. A mean of 14% (annual range = 0–29%) of all nesting areas known from a previous year were searched with telemetry, and an active nest was located at 77% (annual range = 40–100%) of these nesting areas. Additionally, a radiotagged goshawk was present but did not nest at 23% (annual range = 0–50%) of these nesting areas. These latter observations involved 6 adult goshawks, including 1 female and 5 males that were radiotracked at 6 nesting areas. The movements of these individuals were focused on their respective nesting areas. These movements and ground checking of telemetry relocations indicated a high confidence that nesting did not occur. The 5 adult males (Blueberry 95–96 and Eagle Creek 93–94, Douglas Is.; East Bay of Pillars 95–96, Kuiu Is.; Lace River 94–95, Juneau mainland) were abandoned (after nesting) by their mates in 1 year and remained at the same nesting area the following year but did not nest. The one adult female (Pavlof River 95–97, Chichagof Island) remained in the vicinity of her nesting area for 2 successive years and did not nest either year. Her mate was not radiotagged. All these observations were made on the Chatham Area (Table 2).

Nesting area searches without telemetry. A mean of 70% (annual range = 53–80%) of all nesting areas known from a previous year were searched without telemetry and an active nest was located at 16% (annual range = 9–25%) of these nesting areas. A goshawk and/or other evidence of goshawk activity were observed, and an active nest was not located at 19% (annual range = 5–40%) of these nesting areas.

These results show that from 1991–1999 most annual monitoring of nesting areas was done without the aid of telemetry and that the mean proportion of nesting areas searched with standard detection methods across all years was 70%, compared to 14% for searches with telemetry. Additionally, the mean proportion of nesting areas searched without telemetry and an active nest was located was 16%, compared to 77% for nesting areas searched with telemetry and an active nest was located. For nesting areas searched with telemetry and nesting areas searched without telemetry combined, the mean proportion across all years of all nesting areas searched was 83%, and an active nest was located at a mean proportion of 25% of these nesting areas.

We present this information as a record of extensive nesting area monitoring efforts that were conducted throughout Southeast Alaska over a 9-year period by ADF&G and USFS personnel. These results are presented by basic search types (with and without telemetry) to give a general accounting of these efforts. We caution against using these results to make direct and quantitative comparisons of the relative effectiveness of each search method for locating goshawk nests. For example, interpreting this information directly would incorrectly imply we observed a five-fold greater effectiveness of searches with telemetry (77% vs. 16%). Although a gross comparison of our field experiences with these search methods shows a relatively low success rate for nesting area searches done without telemetry (see below), we did not conduct a true test of the effectiveness of each search type; therefore, accurate comparisons of these search methods is not possible using this data set.

A primary focus of this project was to locate goshawk nests as the basis of ecological studies of this species. Our project goals and objectives did not include directly quantifying either goshawk detection rates or goshawk nesting densities. Though our data from annual monitoring of nesting areas provide a general summary of these efforts, more detailed interpretation of this data is confounded by limitations and variation in factors affecting the outcome of searches done without the aid of telemetry, such as variation in observer experience, number of nesting area visits, area extent of searches, and time in breeding season of searches. Additionally, we did not study nor attempt to account for fluctuation in natural factors, such as prey abundance and weather, which may have caused annual variation in nesting area occupancy and nesting status. Based on qualitative comparison of results from nesting area searches we conducted with and without telemetry, and analysis of data on nesting area fidelity and movement by radiotagged adults within and between nesting areas, we conclude that some significant proportion of goshawks and active nests were probably not detected during nesting area searches done without telemetry. Despite these shortcomings in our data from monitoring of nesting areas, we believe that these and other results from 9 years of study of goshawks and their nesting areas throughout Southeast Alaska nonetheless support our observations that goshawks are both uncommon in this region and nest here in densities lower than those reported for some other North American regions, such as Interior Alaska, Arizona, California, and Oregon (e.g., Squires and Reynolds 1997).

Logistical considerations were an important factor determining our ability to access and search nesting areas. Two-thirds of nesting areas we studied used floatplanes for access on 1 or more occasions, and many required more than 1 mode of motorized transportation. This is unlike most studies of goshawk nesting in other North American regions (e.g., southwestern US, California, Oregon, and Washington), where nesting area access is often entirely by vehicle and foot. Our extensive field experiences in Southeast Alaska support our belief that the temperate rainforests and remote island achipelagos of this region present one of the most challenging environments for the study of goshawks and that the dense forest structure and often inclement weather here make goshawk detection more difficult than in other regions having drier and more open forests. These considerations and our observations that goshawks appear to occur in lower densities in Southeast Alaska than in many other areas of North America indicate our data from nesting area monitoring is not directly comparable to similar data from other regions where goshawks occur in higher densities and more open forests and where nesting areas are accessible primarily by road and foot.

Objective 3: Determine home ranges, habitat associations, and interyear movements of goshawks using radiotelemetry.

Home Ranges

We evaluated the home range sizes of goshawks and found wide variation among individuals. These results were presented in detail in Iverson et al. 1996. Subsequent to 1996, we reanalyzed goshawk home range size using all the aerial radiotelemetry data from 1992–2000. This was done to: 1) increase the sample sizes presented in Iverson et al. (*op cit.*), 2) perform a more thorough data editing, and 3) provide additional home range estimates. These results are summarized in Tables 3 and 4.

Habitat Associations

Habitat associations were presented in Iverson et al. (1996), Alaska Department of Fish and Game (1994), and Pendleton et al. (1998).

Interyear movements

Nests Located with Telemetry

Twenty-four year 2 active nests were located with telemetry within the same nesting areas as their year 1 active nests by tracking radiotagged adults in consecutive breeding seasons. For radiotagged females and males combined, median distance moved between year 1 and year 2 nests at the same nesting area by adult goshawks was 0.23 km (inner quartile range = 0.17–0.68); mean distance was 0.73 km ± 1.00 SD (range = 0.50–3.20, n = 24 pairs of year 1 and year 2 nests used by 18 females and 11 males at 25 total nesting areas). The greatest distance that both members of a radiotagged pair moved in consecutive breeding seasons to an alternate nest within its documented home range and nesting area was 3.2 km (Margaret Lake, Revillagigedo Is. 1996–97; Table 2). We used a diameter of 3.2 km to describe the maximum area extent of nesting areas in Southeast Alaska (Table 1). A circular area having a diameter of 3.2 km is equal to 804 ha (1987 ac; 3.11 mi^2). This was also the greatest distance moved between nests in consecutive breeding seasons by a radiotagged adult male. We did not observe any radiotagged adult male move to and nest at another nesting area outside its documented breeding home range. In northern Arizona mean distance moved between alternate nests in the same territory was 0.489 km ± 0.541

SD (range = 0.021 km–3.41 km, *n* = 103 territories). Median distance moved between alternate nests was 0.285 km (Reynolds and Joy 1998).

We observed that all movement between active nests in consecutive breeding seasons greater than 3.2 km was made by radiotagged adult females that abandoned their year 1 mate and moved to a different nesting area in year 2 where they nested with a different mate. All movement by radiotagged females between alternate nests ≤ 3.2 km occurred within the same documented nesting area and home range. During 1992–99, 13 active nests were located by tracking an adult female to a different nesting area in year 2 of consecutive breeding seasons. Median distance moved by these birds from a respective year 1 nest was 18.50 km (inner quartile range = 7.80–36.10; range = 3.67–152 km, n = 13 nests; mean distance moved was not calculated due to the large variance of this data).

In northern California, distances moved to other territories (nesting areas) by banded adults in subsequent years averaged 9.8 km ± 2.7 SD (range = 5.5–12.9 km, *n* = 4) for females and 6.5 km ± 2.7 SD (range = 4.2–10.3 km, *n* = 3) for males (Detrich and Woodbridge 1994). In northern Arizona, distances moved to other territories by banded adults averaged 5.2 km ± 2.66 SD (range = 2.4–8.6 km, *n* = 5) for females and 2.8 km ± 1.06 SD (range = 2.0–3.5 km, *n* = 2) for males (Reynolds and Joy 1998). Unlike our study in Southeast Alaska, these studies observed that some adult males moved to and nested in areas considered different territories. As noted, nesting areas and home ranges in our study were defined with telemetry and we did not observe any adult male to move to and nest in a different nesting area outside of its documented home range. We are uncertain as to how the area extent of territories (home ranges) was defined in these other studies; however, comparing the maximum moved between nests by adult males in our study (3.2 km) with the range of distances moved by males to nests in other territories in California (4.2–10.3 km) and Arizona (2.0–3.5 km) shows that at least in California some males moved greater distances between nests than goshawks in Southeast Alaska. Similar to our study, banded adult females in these other studies were observed to move farther and more frequently than adult males. The observed range of distances and maximum distance moved by adult females between nesting areas, however, was considerably greater in Southeast Alaska than in these other regions (3.67–152 km vs. 5.5–12.9 km and 2.4–8.6 km, respectively). As with our comparisons of intra-nesting area movement between alternate nests, this difference may be explained largely by our use of telemetry to relocate adults both more consistently and at greater distances than is possible with birds marked with only bands.

The tendency for greater territory residency by males than females is widespread among bird species, including birds of prey (Greenwood 1980). Within *Accipiter* this pattern has been observed for goshawks in Southeast Alaska (this study), California (Detrich and Woodbridge 1994) and Arizona (Reynolds and Joy 1998), for Cooper's Hawks (*Accipiter cooperii*) in Wisconsin (Rosenfield and Bielefeldt 1996), and for sparrowhawks (*Accipiter nisus*) in Europe (Newton 1986). Mate abandonment and movement to other territories by females was observed in all of these studies; however, observations of this behavior in males are less consistent. Unlike Detrich and Woodbridge (*op cit.*) and Reynolds and Joy (*op cit.*), who studied goshawks 9 years and 6 years, respectively, we did not observe mate abandonment and movement to other territories or nesting areas by adult male goshawks.

Observations from our 8-year study in Southeast Alaska are consistent, however, with those for Cooper's hawks by Rosenfield and Bielefeldt (1996), who studied this species in Wisconsin over a 16-year period and observed that adult males remained at the same territories while some adult females moved to other territories. Newton (*op cit.*) studied sparrowhawks over a 14-year period and observed mate abandonment and movement to other territories by both males and females. He suggests that greater residency by males may be related to maintaining territories and observed that adult male sparrowhawks appear to be the prime defenders of nesting areas and home ranges where they procure food to support the female and young during the breeding season.

Nests Located without Telemetry

For the group of nests located without telemetry in year 2 of consecutive breeding seasons, all adults were 1) unmarked and their identities unknown, 2) banded and not wearing a radio tag, or 3) banded and wearing an inactive radio tag. Marked birds in this group could be positively identified only if captured. We assume that for nests located in year 2 without telemetry that at least 1 member of the year 1 pair was present at the year 2 nest and that the year 2 nest is located within the home range of the year 1 pair. That is, we assume that the year 1 and year 2 nests are within the same nesting area and occupied by at least 1 member of the same pair. These assumptions have been commonly used in other studies that examined nesting area occupancy and movement between alternate nests by unmarked goshawks (e.g., Reynolds and Wight 1978, Crocker-Bedford 1990). Additionally, in our study we believe these assumptions are supported in part by the observation that the maximum distance moved between nests by adults in this group (no telemetry) is within the maximum intra-nesting area distance moved between alternate nests by a radiotagged adult (1.6 and 3.2 km, respectively). Also, at some nesting areas where adults wore expired radio tags and/or were banded, we did confirm the presence of individuals at a nesting area in consecutive breeding seasons when they were recaptured. Though other data in our study indicate a relatively low success rate for nesting area searches done without telemetry (which weakens the validity of our data set representing the distances moved to year 2 nests located without telemetry), we present these results to allow general comparison of this data with data from the group of nests located with telemetry.

For the 19 active nests located without telemetry in year 2 of consecutive breeding seasons, median distance from a respective year 1 nest was 0.35 km (inner quartile range = 0.25–0.50 km); mean distance = 0.46 km ± 0.42 SD (range = 0 [same nest reused] –1.60 km). Of these 19 year 2 nests, 53% (10 of 19) were located within 0.359 km and a 40.5 ha (100 ac) circular area of their respective year 1 nests, and 84% (16 of 19) were located within 1.0 km and a 314.2 ha (776.4 ac) circular area of their respective year 1 nests. Comparison of year 2 nests located with and without telemetry shows that the maximum distance moved from respective year 1 nests at the same nesting area was 2 times as great (3.2 vs. 1.6 km, respectively) for radiotagged adults as for unmarked adults, banded only, or banded and wearing an inactive radio tag. Although year 2 nests located with telemetry within the same nesting area and >1.6 km from the previous year's nest represent only 17% (4 of 24) of this intra-nesting area group, these more distant moves to alternate nests emphasize both the mobility possible by goshawks within a nesting area and the potential for more distant alternate nests to go undetected in searches without telemetry. Additionally, due to limitations in factors affecting the success of nest searches done without telemetry during 1991–99, such as experience of some observers, number of nesting area visits, area extent of searches, and time in breeding season of searches, we believe that some significant portion of active alternate nests were probably not located during year 2 searches using this method. We believe this is probably especially true for active alternate nests > 0.4 km from inactive known nests, which were most often the starting points for nest searches during annual monitoring efforts at nesting areas done without telemetry.

Occupancy of Nesting Areas

Radiotagged Adults

Telemetry allowed us to directly locate birds that moved to alternate nests within the same nesting area (0.05–3.2 km), birds that moved to other nesting areas (>3.2–152 km), and birds that were present at a nesting area but not nesting. We considered a nesting area occupied when a radiotagged adult was present on ≥ 1 occasion during the breeding season March 1–August 15, including the breeding season in which an individual was first radiotagged or first moved to a new nesting area. We counted 1 year of occupancy when a radiotagged adult was present during the breeding season in a year beginning March 1 and ending February 28 of the following calendar year. For each adult female and each male, we counted the total years of occupancy and then calculated mean occupancy for all nesting areas for each sex. This method of summarizing occupancy is similar to that used by Woodbridge and Detrich (1994), who counted the first breeding season of presence and each subsequent breeding season of presence at a nesting area as 1 "year" of territory occupancy. In our study of radiotagged goshawks, in most cases we monitored adults year-round and detected presence within a nesting area or home range at different times of the year. Though occupancy is expressed here in "years" of presence, because the measure used is actually presence at a nesting area during the breeding season, it may be more accurate to express these results as "breeding seasons" of presence.

During 1992–1999 mean nesting area occupancy by radiotagged adults was 1.6 years ± 1.0 SD (range = 1–6, n = 26 birds at 29 nesting areas) for females, and 1.9 years ± 1.4 SD (range = 1–7, *n* = 28 birds at 25 nesting areas) for males. These occupancy estimates include data from 11 females that made a total of 13 moves to other nesting areas (>3.2 km), where occupancy was counted anew. Mean nesting area occupancy by only adult females that remained at the same nesting area was 1.6 years ± 0.7 SD (range = 1–3, n = 26 birds at 19 nesting areas). We did not document any moves to other nest areas by adult males. In northern California, colored leg bands were used to identify adults at nest sites and assess annual territory (nesting area) occupancy. Territory occupancy averaged 1.8 years ± 1.3 SD (range = 1–7 years, *n* = 40 birds) for adult females, and 1.3 years ± 0.54 SD (range = 1–3 years, *n* = 27 birds) for adult males. Fifty-three percent of adult females and 60% of adult males were not relocated in years subsequent to the year of banding (Detrich and Woodbridge 1994). In northern Arizona, territory occupancy averaged 1.88 years for banded adult females (range = 1–6) and 1.42 years for banded adult males (range = 1–6) (Reynolds and Joy 1998).

Studies using banded birds tend to underestimate actual occupancy rates because of difficulties with locating birds that move to more distant alternate nests or that leave a nesting area and with locating birds present at a nesting area but not nesting. Banded adult males in these studies are also often more difficult to identify than their nest-attending mates because they are frequently foraging away from the nest. Males are also generally less aggressive and therefore less visible than females at the nest site.

Goshawk researchers have traditionally considered observation of 1 or more adults at a nesting area during the breeding season as minimum evidence of occupancy (e.g., Crocker-Bedford 1990). Although we also used this criterion in our study, we did not attempt to estimate nesting area occupancy using this information because we believe detection of goshawks in the rainforest environments of Southeast Alaska is sufficiently low when not aided by telemetry and, therefore, confidence in this estimate is precluded. We could not conclude with high confidence that a nesting area was unoccupied or inactive when no goshawk was detected. To further summarize our efforts to monitor nesting area activities over time, we examined the presence of any radiotagged adult at nesting areas in 1 or more breeding seasons. This method differs from the above analysis that considers occupancy by individual radiotagged adult females and males. At 28 nesting areas monitored during 1992–1999, we observed 33 exclusive occupancy events in which 1 or more radiotagged adults were present at the same nesting area during 1–7 sequential breeding seasons. Of these 33 events, presence by radiotagged adults at nesting areas was distributed as follows (1 = one breeding season, including season of initial radiotagging; 7 = seven sequential breeding seasons): 1 = 15 (45%), 2 = 10 (30%), 3 = 5 (15%), 4 = 1 (3%), 5 = 0 (0%), 6 = 1 (3%), and 7 = 1 (3%). We observed more than 1 single-year or multiple-year event, separated by 1 or more years of apparent inactivity, at only 2 nesting areas. Mean nesting area occupancy by any radiotagged adult during 1992–99 was 2.03 years ± 1.42 SD (range = 1–7 years, n = 56 nesting attempts and 6 occasions of presence only at 27 nesting areas).

Our results show that most (75% of events) nesting area occupancy by radiotagged adults occurred during the first 2 breeding seasons of sequential year use and that few nesting areas were occupied by radiotagged adults for more than 3 sequential breeding seasons. Goshawk studies in other North American regions have observed that most nest sites are occupied from 1 to 3 years and some much longer (Squires and Reynolds 1997). Various factors limited our ability to monitor many goshawks over multiple years. These included factors related to our study methods, such as transmitter failure or normal battery expiration (9–24+ mos., depending on type), loss of tail-mounted transmitters during molt, inability to recapture and retag some trap-shy birds, and inability to relocate some birds due to transmitter failure and/or movement outside of our study area. Other factors related to goshawk survival and behavior were mortality and movement by some adult females to other nesting areas. Consequently, presence of radiotagged adults at nesting areas decreased over time, and we were unable to assess occupancy and nesting activity with telemetry at most nesting areas for more than a few sequential breeding seasons. We estimated annual survival of radiotagged adult females and males (combined) to be 0.72, with a 95% CI of 0.56–0.88 (Iverson, et al. 1996). These results are comparable to those reported for northern Arizona where survival of banded adult females and males during 6 years of study was estimated at 0.866 and 0.688, respectively (Reynolds and Joy 1998).

Our data also show that adult females in Southeast Alaska experience higher survival rates than adult males. These results will be presented in future reports.

Adults without Radio Tags

We documented nesting by unmarked adults in multiple (>2) breeding seasons at the same nesting area in Southeast Alaska on only 1 occasion during 1991–1999. This occurred at the Duffield Peninsula, Baranof Island nesting area (see Table 2), which is also the only location where we observed reuse of the same nest in sequential years. At this nesting area, unmarked adults successfully used the same nest for 3 sequential years during 1994, 1995, and 1996. Goshawks typically alternate between 2 or more nests within the same nest stand or nesting area (e.g., Reynolds and Wight 1978). That we observed reuse of the same nest in only 2 of 51 (4%) occasions where an active nest was located at the same nesting area in consecutive breeding seasons emphasizes the importance of alternate nests in the nesting behavior of goshawks in Southeast Alaska (Table 2). The reason that goshawks alternate between nests within a nesting area is unknown; however, it is thought that nest-switching may reduce exposure to disease and parasites (Squires and Reynolds 1997).

We believe our inability to locate many nests of unmarked adults in years subsequent to documented nesting is due partly to the relatively low rate of success we experienced while conducting nest searches at known nesting areas without telemetry (see *Annual Monitoring of Nesting Areas*). Results of these searches were also affected by the relative preponderance of radiotagged adults at the known nesting areas we studied. This was due to emphasis on our objective to develop and maintain a sample of radiotagged adults, which sometimes reduced opportunities to search nesting areas in subsequent years without telemetry, especially during 1–3 years after initial detection of nesting. For example, during 1992–1999, ≥ 1 radiotagged adult was present during at least 1 breeding season at 63% (27 of 43) nesting areas that were first discovered without telemetry. Additionally, many nesting areas were occupied by radiotagged adults in more than 1 year because we retagged some individuals over periods of ≥ 2 years and newly tagged other individuals that replaced abandoned or dead mates. Consequently, in combination with the inferred low success for nest searches done without telemetry, one effect of our radiotagging efforts was that at many nesting areas the known presence of untagged, nesting adults was often limited to the breeding season of initial nest detection, followed by subsequent years of occupancy by 1 or more radiotagged adults. In some cases, however, we documented unmarked adults nesting at areas previously occupied by radiotagged birds. This occurred when a radiotagged adult female abandoned her mate and was replaced in the following year by a new untagged female that nested with the previous year's untagged adult male. In these instances we were successful at locating the untagged pair's active nest by simply checking a previously known nest or by broadcasting conspecific calls or listening for calls at dawn.

We were unable to quantitatively summarize nesting area occupancy and nesting status by unmarked adults over multiple years due to our inability to confidently make these determinations without telemetry. At some nesting areas we documented periods of apparent inactivity of 1 to 7 years that were both preceded and followed by discovery of an active nest occupied by unmarked birds. At other nesting areas during these intermediate years, no activity was detected during some years, while during other years goshawks were detected and no nest was located (Table 2). Within the smaller area of a nest site in Southeast Alaska (typically no more than 15 ha, or 218.5 m radius; see *Definitions*), we believe the accuracy of our efforts to detect active nests without telemetry was high. For nesting areas monitored ≥ 5 to 9 years, we observed that mean occupancy (active nest present) of known nests sites was 28.4% ± 7.6 SE per year (n = 40 active nests located during 141 nest site-years at 23 nesting areas; nest sites searched with telemetry and without telemetry pooled). We note, however, that mean nest site occupancy varied considerably from south to north among the management areas of the Tongass National Forest: Ketchikan Area = 13.0% ± 9.2 SE (n = 7 active nests located during 54 nest site-years at 8 nesting areas); Stikine Area = 20.0% ± 13.0 SE (n = 8 active nests located during 40 nest site-years at 6 nesting areas); Chatham Area = 53.2% ± 15.0 SE (n = 25 nests located during 47 nest site-years at 9 nest areas). We cannot explain this variation, but note that in the Chatham Area, nest sites within 3 of 9 nesting areas, Blueberry Hill, Fish Creek, and Ready Bullion, Douglas Island, accounted for more than half of nest site-years in which an active nest was present and therefore inflated the mean occupancy estimate for this area. Additionally, one nesting area, Fish Creek, Douglas Island, was the location of the longest duration of sequential years at the same nesting area that we observed in Southeast Alaska (6 years at 2 nest sites). We also note that the Blueberry Hill, Fish Creek, and Ready Bullion, Douglas Island nesting areas are all located within an approximate 3500-ha area (8648 ac; = 13.5 mi^2) and represent the highest nesting area density we observed in Southeast Alaska during 1991–1999 (Table 2). We hypothesize that this relatively high nesting density may be related to higher prey abundance or prey availability in this region of Southeast Alaska (Lewis 2001). In northern California, nest stands in territories that were monitored ≥ 5 years were occupied an average of 46% ± 6 SE of the time (n = 71 nest stands; Woodbridge and Dietrich 1994). In Interior Alaska, annual nest site occupancy ranged from 6 to 56% (n =16 nest sites; McGowan 1975), and in Oregon mean occupancy of nest sites was 40% (n = 63 nest sites; Reynolds and Wight 1978).

<u>Objective 4: Evaluate goshawk diet during the nesting period.</u>

This objective was met and resulted in the M.S. thesis of Lewis (2001) and is summarized in the Appendix.

<u>Objective 5: Assess subspecific status of goshawks in Southeast Alaska.</u>

This objective was met and we conclude that the *Accipiter gentilis laingi* continues to warrant subspecific status. Abstracts of papers presented on the subspecific status of Southeast Alaska goshawks are presented in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

Our results from studying and monitoring nesting areas during 1991–1999 indicate that nesting area searches done without the aid of telemetry provided us with limited success in accurately assessing goshawk occupancy and nesting status. This observation is supported by our field observations and quantitative data on nesting area fidelity and movement of radiotagged adults between nests and nesting areas. Nesting area searches we conducted without the aid of telemetry used standard methods for detecting goshawks: broadcasting conspecific calls, watching for goshawks in flight above the canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas by foot. Although we did not test the efficacy of these methods or apply them under strict protocol, we conclude from 9 years of field experience that because nesting areas in Southeast Alaska occur in dense rainforest conditions, in large areas (up to 804 ha), and often in remote locations requiring expensive logistics, it is generally not possible to efficiently access and search these areas or detect goshawks and their nests here with consistency using these methods. An important objective of annual nesting area searches was to locate active nests where we could collect information on goshawk nesting ecology and where we could capture and radiotag goshawks. We were largely successful in meeting this objective, given the hindrances to effective goshawk detection and site access we encountered. However, because we were unable to confidently determine that nesting areas were unoccupied or inactive when no goshawks or active nests were detected during searches without the aid of telemetry, we conclude that it is not possible to accurately interpret results from these searches within the context of monitoring long-term trends in nesting area occupancy and nesting status.

Because our data indicate that annual nesting area searches that used standard goshawk detection methods were often ineffective, unreliable, and often expensive due to aircraft and other transportation requirements at many locations, we recommend that surveys based solely on standard goshawk detection methods be discontinued in future monitoring. If monitoring of goshawk nesting areas is to be included as part of future forest management plans, we suggest a more limited approach be taken that focuses on assessing only long-term status of known nest sites (5–15 ha), where confidence in the outcome of searches is high and more indicative of goshawk nesting area occupancy. Our data show that nesting areas were typically occupied by radiotagged adults for at least 2–3 sequential years (mean = 2.03 years ± 1.42 SD, range = 1–7 years), that a large proportion of adults present in the same nesting area in consecutive years nested, and that reoccupancy and nesting at a nest site can occur after a few to 7–8 years of inactivity. Based on this information, we believe that visiting nest sites every 2 or 3 years may be suitable for generally assessing the long-term status of nesting areas. Our field experience indicates that 1 visit per nest site by experienced observers during an optimal time in the breeding season (June–July) would be sufficient to accurately assess nesting status and productivity of known nest sites and to select adjacent areas. These 1-day visits would provide opportunities for attempting to detect goshawks and nests in the selected areas adjacent to known nest sites by broadcasting conspecific calls or making observations from vantage points. Any detections would be noted for future monitoring at these sites. Alternating nest site visits at different nesting areas in different years would allow reduction in annual logistics costs. Finally, we recommend that the size of "no commercial timber harvest" buffers around known nests be increased beyond the 40.5 ha (100 ac) minimum size currently specified in the Tongass National Forest management plan. Based on our data from radiotagged adults, we conclude that increasing the size of buffers around known nests will provide greater integrity to nesting areas by protecting more distant (0.359--3.2 km) alternate nests that have a low probability of detection without the aid of radiotelemetry.

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Table 1. Definitions of goshawk nesting, nest use and occupancy in Southeast Alaska.

Term	Definition/Comment
nest site	Nest, nest tree, and forested area surrounding the nest that includes prey handling areas, perches and roosts, and may contain ≥ 1 alternate nest. Nest sites in SE Alaska are approximately 5–15 ha.
nest stand	Nest site and the associated contiguous forested area where stand structure is relatively homogeneous. Nest stands in SE Alaska may vary in size from 5 to > 50 ha and include ≥ 1 goshawk nest site.
nesting area	Landscape area up to 804 ha (= 1987 ac; = 3.11 mi^2) that includes all nest sites and alternate nests used by a pair or individual within its breeding home range. Based on 8 years of radiotelemetry data (see *Interyear movements*). The nesting area includes individual alternate nests or clusters of alternate nests located within a few hundred meters of each other (e.g., Crocker-Bedford 1990, 1995), as well as other individual or clustered alternate nests at nest stands that may be separated by 1–3 km but are located within the normal movement patterns and breeding home range of a pair.
breeding home range	Landscape area encompassing all radiotelemetry relocations documented for an individual or pair during the breeding season, March 1 to August 15.
annual home range	Landscape area that includes all radiotelemetry relocations documented for an individual or pair during a year.
territory	Term not used in our analysis as it traditionally defines a use area based on intraspecific defensive behavior, which is largely unobservable for goshawks. In other N.A. goshawk studies (e.g., Woodbridge and Detrich 1994, Reynolds, et al. 1994) the term territory has been used to describe the landscape area encompassing all known nests used by a pair or individual. This use is synonymous with our definition of nesting area.
active nest	Any of the following: presence of defensive adult(s) at a nest, fresh greenery or other evidence of recent nest construction, eggs present in nest, young present in nest, pre-dispersal fledglings located in the vicinity of a nest that was determined active that year by the presence of fresh whitewash, goshawk feathers, prey remains, or pellets.
active nesting area	Any of the criteria for an active nest plus, when the physical nest could not be located – when only fledglings could be observed and other evidence such as prey remains or aggressive adults indicated that the active nest was nearby.
inactive	None of the active nest and active nesting area evidence could be found.
nesting area occupied	Any of the following: adult goshawk(s) present, recent prey remains, molted goshawk feathers located, or ≥ 1 breeding or nonbreeding radiotagged adult goshawk present in the nesting area during the breeding season.
nesting area unoccupied	Unable to determine with high degree of confidence between unoccupied or inactive in a given year. This is due to variability in the ability to detect goshawks in their breeding season home range.

Table 2. Annual status of goshawk nesting areas. Southeast Alaska, 1985–1999.

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Ketchikan Area, Tongass N.F.											
Butterball Lake, Heceta Island					G	NAR	O	O	O	O	O
Carroll River, Revilla.Island								G	NA	G	G
Convenient Cove, Hassler Is.				G	G	NA	G	G	O	O	O
Derrumba Ridge, Heceta Is.									NO	O	O
Logjam Creek, P.O.W. Island					NAR	O	O	O	O	O	O
Margaret Lake, Revilla.Is.						NA	G	BR	BR	BR	O
McDonald Lake, Cleveland Pen.											NA
Port Refugio, Suemez Is.(89)	NA	O	O	G	G	B	G	G	O	O	O
Roberts/Cutthroat Crk, P.O.W. Is.							NAR	BR	BR	BR	O
Sarheen Creek, P.O.W. Island			GF	G	G	O	O	O	O	O	O
Sarkar Lake, P.O.W. Island				NAR	O	O	G	O	O	O	O
Timber Knob, Heceta Island								NA	B	C(96)R	BR
Traitors Creek, Revilla.Is.						NAR	BR	O	O	O	O
Twelvemile Arm, P.O.W. Island								NO	O	O	O

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nesting area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 2. Continued

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Stikine Area, Tongass N.F.											
Big John Creek, Kupreanof Is.				NA	BR	O	O	O	O	O	O
Brown Cove, Petersburg Mainland										NA	BR
Camp Carl, Etolin Island									NAR	BR	BR
Cat Creek, Cape Fanshaw						NAR	O	O	X	O	O
Doughnut, Wrangell Island											NAR
Duncan Creek, Kupreanof Is.						NA	O	O	G	O	BR
East Bay of Pillars, Kuiu Island						NAR	BR	X	BR	O	O
Elena Bay, Kuiu Island										NAR	BR
Farragut Bay, Petersburg Mainland											NAR
Irish Lakes, Kupreanof Island								NA	G	O	O
Kadake Bay, Kuiu Island								NAR	O	O	O
Kake, Kupreanof Island (89)	NA	O	X area cut 89		X	X	X	X	X	X	X
Kuakan, Deer Island									NA	B	BR
Madan Bay, Wrangell Mainland										NGF	BR
Mitchell Creek, Kupreanof Is.						NAR	B	O	O	O	O
Mossman Inlet, Etolin Is.(86)	NA	X	X	O	O	X	X	X	X	X	O
Mountain Point, Kupreanof Is.						NAR	O	X	O	O	O
Negro Creek, Port Houghton						NA	G	O	O	O	O
Rowan Creek, Kuiu Island					NAR	RT	G	O	G	O	O
Sanborn Canal, Port Houghton						NA	O	O	X	G	O
Security Bay, Kuiu Island									NAR	O	O
Starfish, Etolin Island			NA	O	O	O	O	X	O	O	BR
Totem Camp, Kupreanof Island						NA	O	X	O	O	O
Tunehean Creek, Kupreanof Island										NA	BR
Upper Totem, Kupreanof Island					NO	O	O	X	G	O	O
West Bay of Pillars, Kuiu Island						NAR	BR	X	O	O	O
Zim Creek, Kupreanof Island											NA

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
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R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 2. Continued

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Chatham Area, Tongass NF.											
Auke Bay, Juneau Mainland										NAR	O
Blueberry Hill, Douglas Island					NAR	BR	C(93)R	RT	C(94)R	BR	BR
Dewey Lk., Skagway (85)	NA	X	X	X	X	X	X	X	X	X	X
Distin Lake Trail, Admiralty Is.						NA	X	X	B	O	B
Duffield Peninsula, Baranof Is.						NA	C(94)	C(94)	O	X	B
Eagle Creek, Douglas Island					NAR	RT	O	O	O	O	O
Eagle River, Juneau Mainland									NGF	AR	BR
Fish Creek, Douglas Island						NAR	BR	BR	BR	C(96)R	BR
Florence Bay, Chichagof Island								NAR	O	O	O
Green Cove, Admiralty Island								NAR	BR	BR	C(96)R
Lace River, Berners Bay						NAR	RT	O	O	O	X
Mud Bay River, Chichagof Is.					NA	GF	O	X	O	C(93)	O
Nugget Crk., Juneau Mainland					NAR	BR	RT	O	C(93)R	C(94)R	O
Pavlof River, Chichagof Island							NAR	RT	RT	O	O
Point Bridget, Juneau Mainland				NA	BR	O	G	G	G	BR	B
Ready Bullion Crk., Douglas Is.			NA	BR	O	O	O	O	C(91)R	BR	C(92)R
Sitkoh River, Chichagof Island											NA
Tolch Rock, Juneau Mainland											NAR
Turner Lake, Juneau Mainland								NGF	A	G	GF
Whitestone, Chichagof Island							NGFR	AR	O	O	O

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nesting area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 3. Breeding (nesting) season, nonbreeding season, and year-round use areas for adult female northern goshawks, Southeast Alaska, 1992–1999. One hundred percent and ninety-five percent minimum convex polygons (MCP) from radiotelemetry locations.

Adult Females		**Locations**	**100% MCP (ha)**	**95% MCP (ha)**
Breeding season	Mean	31	4,549	4,153
	SD	18	2,465	2,423
(Mar. 1 to Aug. 15)	Median	27	4,304	4,223
	First quartile		2,648	2,108
n = 16 birds [a, b]	Third quartile		5,767	5,455
	Minimum	11	975	871
	Maximum	67	9,986	8,968
Nonbreeding season	Mean	26	33,839	32,961
	SD	14	42,134	42,950
(Aug. 16 to Feb. 29)	Median	24	14,718	12,602
	First quartile		5,630	4,144
n = 18 birds [a]	Third quartile		50,701	59,023
	Minimum	10	2,146	2,146
	Maximum	62	147,113	146,926
Year-round	Mean	43	54,218	49,465
	SD	29	61,756	60,360
(all months)	Median	35	16,619	11,688
	First quartile		9,852	9,048
n = 27 birds [a]	Third quartile		93,886	90,209
	Minimum	10	3,995	3,035
	Maximum	107	180,036	180,036

[a] Includes birds with ≥ 10 locations.

[b] Does not include 1 adult female that moved >44 km from her nesting area on August 3 and returned on August 7, resulting in a 100% MCP breeding season use area of 29,600 ha.

Table 4. Breeding (nesting) season, nonbreeding season, and year-round use areas for adult male goshawks, Southeast Alaska 1992–2000. One hundred percent and ninety-five percent minimum convex polygons (MCP) from radiotelemetry locations.

Adult Males		Locations	100% MCP (ha)	95% MCP (ha)
Breeding season	Mean	27	5,910	4,785
	SD	17	4,776	3,332
(Mar. 1 to Aug. 15)	Median	24	4,258	3,924
	First quartile		3,257	2,886
n = 21 birds [a]	Third quartile		6,579	5,518
	Minimum	10	1,229	1,229
	Maximum	73	19,469	15,361
Nonbreeding season	Mean	27	19,454	16,503
	SD	11	16,464	15,601
(Aug. 16 to Feb. 29)	Median	25	13,358	13,024
	First quartile		7,706	5,946
n = 14 birds [a, b]	Third quartile		24,257	19,684
	Minimum	17	5,996	3,702
	Maximum	57	63,738	63,513
Year-round	Mean	44	15,871	12,508
	SD	28	15,665	14,150
(all months)	Median	43	11,243	6,279
	First quartile		6,320	4,530
n = 22 birds [a, b]	Third quartile		20,261	14,441
	Minimum	13	1,949	1,949
	Maximum	117	67,444	63,908

[a] Includes birds with ≥ 10 locations.

[b] Does not include 1 adult male that dispersed >80 km from its nesting area during the nonbreeding season and whose nonbreeding season and year-round 100% MCPs use areas were 231,509 ha.

Appendix. Selected abstracts of papers presented at professional meetings and of thesis by Stephen B. Lewis on northern goshawk diet in Southeast Alaska.

Abstract of paper presented at annual meeting of the Raptor Research Foundation, Ogden, Utah, 1998.

Northern Goshawks (*Accipiter gentilis*) and Forest Management on the Tongass National Forest – Alaska

K. Titus, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, AK 99824 USA, G.C. Iverson, USDA Forest Service – Alaska Region, Juneau, AK 99802 USA, R.E. Lowell, ADF&G, Douglas, AK USA and C.J. Flatten, ADF&G, Ketchikan, AK USA

The Tongass National Forest (16.9 million acres; 68,000 km^2) contains some of the largest remaining tracts of old-growth temperate coastal rainforest in the world. ADF&G and the US Forest Service began cooperative studies of the Northern Goshawk in the early 1990's. By 1992 interim goshawk habitat management guidelines were issued for the Tongass National Forest and there was an attempt to develop a conservation strategy for maintaining habitats so that old-growth associated wildlife remained viable and well distributed across the Tongass. The 1979 forest plan and interim management guidelines for goshawks were identified as being inadequate to conserve goshawks across the Tongass. In 1994 the Fish and Wildlife Service was petitioned list the Queen Charlotte Goshawk as endangered under the Endangered Species Act. An interagency goshawk conservation assessment was prepared in 1996 to provide the Forest Service with the best available science-based information for decision-making. Study results indicated that goshawks had large use areas (approximate home ranges; 69 km^2 adult ♂ nesting season, n = 16) and that goshawks were selecting for old growth forest. Interpretation of results suggested that the probability of persistence of goshawks has declined over the past 50 years based on past and present forest management practices. The authors felt that a reserve system was an important but incomplete component of a long-term management strategy to maintain goshawks across the forest. Risk assessment panels were held during the forest plan revision in 1996 and 1997 to evaluate the likelihood that goshawk populations would remain viable and well distributed across the forest under alternative management scenarios. Goshawk panel experts suggested that the reserve system should be combined with other approaches including extended timber rotations, management of the intervening forest matrix where timber harvest would occur, and extended riparian and beach habitat protection buffers. The final Tongass forest plan contains elements resulting from the science-based goshawk information base.

Abstract of paper presented at annual meeting of the Raptor Research Foundation, LaPaz, Mexico, 1999

Monitoring, Territory Reoccupancy, and Interyear Movements of Adult Northern Goshawks (*Accipiter gentilis*) on the Tongass National Forest, Alaska: lessons from a long-term Radiotelemetry Study. KIMBERLY TITUS, Richard E. Lowell**,** Alaska Department of Fish and Game, Box 240020, Douglas, Alaska 99824 USA, and Craig J. Flatten, Alaska Department of Fish and Game, 2030 Sea Level Drive, Ketchikan, Alaska 99901 USA.

The Tongass National Forest contains some of the largest remaining tracts of old-growth temperate rainforest in the world. Management of these forestlands includes efforts to conserve and maintain habitats for a variety of wildlife, including goshawks. ADF&G and the US Forest Service began

cooperative studies in 1992 to understand the ecology of goshawks in an old-growth temperate forest ecosystem. As part of these efforts we have been monitoring goshawk nest sites and nest stands with the aid of radiotelemetry. Since 1992 we have captured 135 goshawks, and a total of 51 adults have been fitted with radio tags. We use radiotelemetry to track the interyear movements of adult goshawks. Between 1992 and 1998, 9 adult female goshawks moved to different nesting territories a total of 11 times and nested with different mates. These females move a mean of 34 km (range = 3.2–152 km). Of 26 adult male goshawks radiotagged, none have moved to a new nesting territory. Results from our radiotelemetry data suggest that annual monitoring of nest stands and checking old nest sites for occupancy by goshawks can provide misleading information. Depending on how the monitoring is actually designed, one could conclude that a raptor nesting population is declining simply because of interyear movements by nesting adults to sites that are unknown. This is especially true for studies in dense forests where large, complete censuses of all nesting pairs are impossible. Our radiotelemetry results also indicate that some home ranges are occupied by nonnesting goshawks, and that some pairs move 2–3 km to different nests between years, while maintaining the same home range as previous years. Hence it would be improper to suggest that these territories are "unoccupied," but this would be an often used interpretation in many raptor-monitoring projects.

Abstract of paper presented at annual meeting of American Ornithologists Union meeting – Seattle, 2001.

Color and Size of the Northern Goshawk in Southeast Alaska. CRAIG FLATTEN*, Alaska Dept. of Fish and Game, Ketchikan, AK; KIM TITUS, Alaska Dept. of Fish and Game, Douglas, AK; RICHARD LOWELL, Alaska Dept. of Fish and Game, Petersburg, AK.

The taxonomy of Northern Goshawk (*Accipiter gentilis*) subspecies in N.A. is currently a topic of interest and debate. Resource managers are required to maintain well-distributed, viable goshawk populations and to protect distinct population segments that may be threatened or endangered. The AOU recognizes two Northern Goshawk subspecies in N.A.: *A.g. atricapillus and A.g. laingi.* Some question the validity of Northern Goshawk subspecies that are based primarily on subtle color and size distinctions. The *laingi* subspecies has been described as a smaller and darker race inhabiting the coastal temperate rainforests of British Columbia and Southeast Alaska. Information on plumage coloration and body size was collected from 68 adult and 70 juvenile goshawks captured at nest sites in Southeast Alaska between 1992 and 2000. Phenotypes ranged from dark forms identified as *laingi* to lighter forms identified as *atricapillus*. Mean wing chords were smaller than those reported for Northern Goshawks from other regions of Alaska, but larger than those reported for *laingi* specimens from coastal British Columbia. Slight clinal variation in size within Southeast Alaska was detected in some age-sex classes with smaller birds occurring in the south. Results generally support the original description of *laingi*, noting the occurrence of some clinal variation and probable intergradation of subspecies within Southeast Alaska.

Abstract of paper presented at annual meeting of American Ornithologists Union meeting – Seattle, 2001.

Breeding dispersal of adult Northern Goshawks in Southeast Alaska: implications for conservation.
KIMBERLY TITUS*, Alaska Dept. Fish and Game, Juneau, AK, CRAIG FLATTEN, ADF&G, Ketchikan, AK; and RICHARD LOWELL, Petersburg, AK.

Northern Goshawks nest in the old-growth temperate rainforests of Southeast Alaska and are a conservation concern for forest management activities. We evaluated breeding dispersal (movement from one nest to another in consecutive years), nesting status, and fate of adult goshawks during 1992–99 by tracking them with radiotelemetry. We defined a nest area as a 3.2 km diameter area because this was the maximum distance a pair moved in consecutive years while maintaining the same home range. Multiyear movements were determined for 23 females and 21 males at 27 nest areas. Breeding dispersal was observed only for adult females and no adult male moved to a new home range or nest area. For 13 nests located by tracking adult females to a different nest area in consecutive years, the median distance moved was 18.5 km; maximum distance moved was152 km. In 55% of our consecutive year outcomes the goshawk pair nested in the same nest area as the previous year. Overall, 31% of adult females dispersed to a new home range in consecutive years and either nested with a different mate or did not nest. These complex dispersal patterns by adult female goshawks present challenges to those charged with monitoring goshawks and/or their nests.

Citation and abstract of thesis by Stephen Lewis on northern goshawk diet in Southeast Alaska.

Lewis, Stephen B. 2001. Breeding season diet of northern goshawks in Southeast Alaska with a comparison of techniques used to examine raptor diet. Thesis. Boise State University. Boise, Idaho. 125pp.

Chapter 1
A video surveillance system for monitoring raptor nests in a temperate rainforest environment.

Abstract: I used a video surveillance system to monitor northern goshawk (*Accipiter gentilis*) nests in the coastal temperate rainforest of Southeast Alaska to gather data on their diet. I maintained five systems during the goshawk nesting seasons in 1998 and 1999, installing the cameras an average of 10 days after hatching. At these 10 nests, cameras were maintained for an average of 33 days, recording 5834 hours of nest-time. I captured an average of 69.3% of the daylight hours available from hatching to the day nests were no longer used by juvenile northern goshawks. Technical difficulties associated with maintaining video cameras in this rainforest environment included electronic malfunctions, recurrent battery failure, and problems with the recorded image. However, these video surveillance systems effectively monitored northern goshawk nests and could be adapted for most rainforest raptors that nest on open platforms. I recommend testing the systems under field conditions in which they are to be used prior to deployment.

Chapter 2

Comparison of three techniques for assessing raptor diet during the breeding season.

Abstract: Video recording of prey deliveries at nests is a new technique for collecting data on diet and food habits that has not been compared with results from collections of prey remains and pellet. As part of a study of the breeding season diet of northern goshawks (*Accipiter gentilis*) in Southeast Alaska, I compared data from these three techniques to determine the relative merits of the different methods for assessing diet. I monitored 5 nests during the northern goshawk breeding seasons of 1998 and 1999 and identified 1,541 prey from deliveries, 209 prey from remains, and 209 prey from pellets. The proportions of birds and mammals varied among techniques, as did the relative proportions of prey groups and age groups. Analysis of prey deliveries gave the narrowest diet breadth of the three techniques. Prey remains and pellets gave the least similar diet descriptions. Over two-day intervals during which data was collected using all three techniques, prey deliveries gave more individual prey and prey categories than the other two techniques. I found that prey was not directly tracked through all three techniques. Analysis of prey deliveries collected by remote videography provided the most complete description of diet and I recommend that studies attempting to describe diet use this method or some other direct technique.

Continued on next page

Chapter 3

Breeding season diet of northern goshawks in Southeast Alaska.

Abstract: I provided the first systematic description and quantification of the nesting season diet of northern goshawks (*Accipiter gentilis*) in Southeast Alaska and examined how their diet varied within this island archipelago. I collected data on the diet of goshawks using three techniques. I used remote videography to record prey deliveries at nests in two spatially distinct locations of Southeast Alaska to describe the diet in detail and examine spatial variation in the diet. I used prey remains and pellets collected at nests throughout Southeast Alaska to describe the diet of the goshawk over a broader spatial scale. Goshawks delivered more birds than mammals overall of Southeast Alaska but delivered more birds in the Prince of Wales Island area than in other parts of Southeast Alaska. In northern Southeast Alaska, blue grouse (*Dendragapus obscurus*), red squirrels (*Tamiascurius hudsonicus*), Steller's jays (*Cyanocitta stelleri*), varied thrushes (*Ixoreus naevius*), northwestern crows (*Corvus caurina*) and unknown passerine birds were the prey that contributed the most to the diet. In southern Southeast Alaska, spruce grouse (*Falcipennis canadensis*), Steller's jay, ptarmigan species (*Lagopus* spp.), varied thrushes, and unknown passerine birds were the commonly eaten prey. Diet niche was narrower in the north than in the south and nests in these areas, on average, showed little overlap. The relative proportion of grouse and thrushes in the diet appeared to vary as the nesting season progressed, as did the relative proportion of different aged prey. Data from prey remains and pellets collected over all of Southeast Alaska provided similar results as that from remote videography. In Southeast Alaska, goshawks ate similar types of prey as seen in other locations. My data support the supposition that goshawks are generalist predators and show a certain amount of adaptability in their tolerance to varying prey bases. However, there appears to be a limit to this adaptability, which was apparent on Prince of Wales Island. In this area, an extremely restricted prey base in combination with extensive landscape alteration due to timber harvest appears to have affected goshawks' ability to successfully reproduce. Goshawks in Southeast Alaska rely on a few important prey species that can be affected by timber harvesting activities. Therefore, management should focus on conserving forests that structurally and functionally mimic those that historically covered this region.

Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2001

Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

1 July 2000–30 September 2001

Kimberly Titus
Stephen B. Lewis
Craig Flatten

Annual Research Performance Report
Endangered Species Conservation Fund
Federal Aid Grant SE-4-2, Study 6/7

FEDERAL AID
ANNUAL RESEARCH PERFORMANCE REPORT

PROJECT TITLE: Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

AUTHORS: Kimberly Titus, Stephen B. Lewis and Craig Flatten

COOPERATORS: US Forest Service and US Fish and Wildlife Service

GRANT AND SEGMENT NR.: SE-4-2-6/7

SEGMENT PERIOD: 1 July 2000 – 30 June 2001; 1 July 2001 – 30 September 2001

STATE: Alaska

WORK LOCATION: Douglas and Ketchikan

I. PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: Monitoring of northern goshawk (*Accipiter gentilis*) nesting areas in cooperation with USDA Forest Service (FS).

Goshawks are an important monitoring component associated with the 1997 revision of the Tongass Land and Resource Management Plan for the FS. The FS has instituted an interagency goshawk-monitoring plan associated with their requirement to protect and conserve habitats for goshawks to ensure that they remain viable and well distributed on the Tongass National Forest. Resource agencies are also interested in conserving and managing for goshawks so that there is no need to list the species under the Endangered Species Act (ESA). This project is the primary data-gathering component of a multi-agency effort devoted to long-term monitoring of goshawk nesting areas and determination of goshawk movements based on radiotelemetry data. ADF&G staff continued to play a supportive role in FS nest monitoring efforts.

OBJECTIVE 2: Analysis of 1991 – 1999 goshawk nesting area monitoring data and analysis of goshawk morphometric data with an evaluation of subspecific status of the Queen Charlotte Goshawk (*Accipiter gentilis laingi*).

In previous reports we provided summaries of yearly monitoring efforts, nest occupancy, and nest fidelity data. Compilation of this data over the entire study period (i.e., 1991 – 1999) will provide a more thorough analysis of these important components of goshawk nesting ecology. Because nest-monitoring efforts began to decrease after the 1999 breeding season, data collected since then were excluded from these analyses.

Morphometric measurements (i.e., size characteristics) have been collected from goshawks captured for the radiotelemetry portion of this study. An analysis based on morphometric data collected since 1992 will allow evaluation of the subspecific status of goshawks in Southeast Alaska. This information will assist the FWS in their effort to conserve and manage this subspecies.

OBJECTIVE 3: Description of breeding season diet of goshawks in Southeast Alaska.

ADF&G, FS and FWS jointly funded this study in which M.S. student Lewis used small, remote cameras and video recorders to identify prey brought to goshawk nests. From these data, we will determine the types of goshawk prey species that are associated with old-growth coniferous forests in Southeast Alaska.

OBJECTIVE 4: Preparation of scientific presentations and reports for publication.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB 1: Searching for active goshawk nests and capturing goshawks.

This objective was met to the degree possible. After the 1999 breeding season, ADF&G decided to allow FS staff to take the lead on monitoring efforts. During the 2000 breeding season, a lack of consistent effort among FS District Offices led to fewer nests being checked than recent years.

Nine active goshawk nests were identified on the Tongass in 2001. Six occurred within previously documented nesting areas and 3 occurred within new nesting areas (Big Creek [on Mitkof Island], Thorne Island, and Vank Island) located this year. With the discovery of 3 new nesting areas in 2001, the cumulative number of nesting areas documented in Southeast Alaska increased to 65.

During 2001, ADF&G personnel captured 4 goshawks (2 adult, 2 juveniles) at 3 nest sites in Southeast Alaska. One adult male goshawk captured at Thorne Island nesting area was fitted with a tail-mounted radio transmitter. Two goshawks (1 adult, 1 juvenile) were instrumented with satellite transmitters (PTTs) during 2001; an adult female that nested on Douglas Island (Blueberry Hill nesting area) and one of her progeny, a juvenile female. Satellite tracking of these PTTs indicates that both transmitters were stationary over several months, indicating that both birds had died or dropped their PTTs. A juvenile male goshawk from Mitkof Island (Big Creek nesting area) was captured and banded with USFWS numerical bands but no transmitter was put on this bird. Significant field efforts were made to re-capture an adult female goshawk at Duncan Creek nesting area (Kupreanof Island). There was a desire by FS staff to have the adult female re-captured and the adult male captured so that transmitters (either radio or PTT) could be fit to each bird. We were unsuccessful in these attempts.

JOB 2: Analysis of goshawk nesting area monitoring data to assess nest monitoring efforts, nest occupancy and fidelity and inter-nest movements; analysis of morphometric data to evaluate subspecific status of goshawks in Southeast Alaska.

The first portion of this objective was met. Data gathered from nest monitoring efforts from 1991 – 1999 were compiled and analyzed. Mean occupancy of nest sites was 28.4% ± 7.6 (SE) per year in Southeast Alaska for nesting areas monitored for ≥ 5 years but varied among Tongass Management Areas (Ketchikan = 13.0% ± 9.2; Stikine = 20.0% ± 13.0; Chatam = 53.2% ± 15.0). Nesting area fidelity and mate fidelity were moderate for radiotagged female goshawks and high for radiotagged adult goshawks. This can be explained by mate abandonment and movement to different nesting areas in 35.7% of consecutive year events for females; no males moved to different nesting areas in this study. Distances moved between active nests in consecutive years ranges from 0.05 – 3.2 km within the same nesting area and 3.62 – 152 km between nesting areas. These results have been already reported in detail.

The second portion of this objective was met. Morphometric data gathered from 68 adult and 70 juvenile goshawks during capture events from 1992 – 1999 were used for this analysis. Mean wing cords were smaller in Southeast Alaska than those reported for other areas of Alaska, but larger than those reported from coastal British Columbia. Our results generally support the original description of *A. g. laingi*. These data were presented at the American Ornithologists' Union annual meeting in Seattle, August 2001 (see Job 4).

JOB 3: Analysis of prey delivery, prey remains, and pellet data to quantitatively describe the diet of goshawks in Southeast Alaska.

This objective was completed when Master's student Lewis completed and defended his thesis (Lewis, S.B. 2001. Breeding season diet of northern goshawks in Southeast Alaska with a comparison of techniques used to examine raptor diets. Thesis. Boise State University. Boise, Idaho. 124p.). This thesis contained information on the use of a video surveillance system for monitoring raptor nests in a temperate rainforest environment, a comparison of three techniques used to assess raptor breeding season diets, and a quantitative description of the goshawks breeding season diet in Southeast Alaska. In Southeast Alaska, goshawks exhibit a pattern of adaptability to differing prey assemblages similar to patterns seen at other spatial levels. This flexibility allows goshawks to occupy areas of Southeast Alaska with variable prey bases. However, there is an apparent limit to this adaptability. On Prince of Wales Island, which has the most restricted prey base for goshawks, few occupied nests have been found and use-areas of these goshawks are the largest ever recorded for the species in North America. While other factors (e.g., timber harvest) undoubtedly play a role, this suggests that finding sufficient food is difficult for goshawks attempting to breed on this island.

JOB 4: Preparation of scientific presentations and reports for publication.

This objective was partially met with presentations given at a national ornithology conference. Given the large and variable amount of data gathered on goshawk ecology and movements collected through the 1999 breeding season, nothing was submitted for peer-reviewed publication pending completion of analyses.

Two presentations were prepared and given at the 2001 annual meeting of the American Ornithologists' Union in Seattle, Washington.

1) Color and Size of the Northern Goshawk in Southeast Alaska. Craig Flatten, Kimberly Titus, and Richard Lowell.

2) Breeding dispersal of adult northern goshawks in Southeast Alaska. Kimberly Titus, Craig Flatten, and Richard Lowell.

ADF&G personnel continued analysis of data collected since the beginning of this interagency project in 1991. Emphasis was placed on annual monitoring and occupancy of nesting area, fidelity to nesting areas and movement between nesting areas, and efficacy of different monitoring techniques. This data was in the process of being complied and analyzed for a final report for the FS and FWS describing work from 1991 – 1999. This report was previously submitted.

III. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

Resource agencies are interested in conserving and managing for goshawks so that there is no need to list the species under the Endangered Species Act (ESA). Because of forest management and ESA issues, the US Fish and Wildlife Service (FWS) has needed information about the Queen Charlotte goshawk (*A. g. laingi*) as related to ongoing litigation about the status of the subspecies related to an ESA petition. The FWS contracted Sandra Talbot (USGS-BRD, Alaska Science Center) to examine genetic relationships among goshawks in Southeast Alaska relative to populations in other locations. ADF&G sent blood samples from 131 northern goshawks from Southeast Alaska to Ms. Talbot's lab and spent considerable time facilitating the acquisition of tissue samples (i.e., blood) from goshawk researchers in British Columbia to facilitate this genetic analysis. Information from this analysis may be able to collaborate morphological data that suggests that the goshawks from Southeast Alaska exhibits differences that allow it to be considered a separate subspecies.

IV. RECOMMENDATIONS FOR THIS PROJECT

The eleventh field season of this cooperative study was completed in 2001. During this reporting period, we recommended that the FS continue considering how they would conduct goshawk monitoring efforts as ADF&G staff devoted less time to fieldwork and interagency coordination and more time to data analysis and report preparation. Several discussions among division staff and between division and FS staff, including a meeting with all interagency cooperators, were held to discuss monitoring alternatives and other data needs for this project, to shape the future of this project, and to direct ADF&G's role in the research.

V. PUBLICATIONS

None

VI. FEDERAL AID TOTAL PROJECT COSTS FOR THIS SEGMENT PERIOD

$ 30,000 Federal Share

$ 50,000 State Share

VII. PREPARED BY:

Kimberly Titus
Regional Supervisor

Stephen B. Lewis
Fish and Wildlife Technician IV

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Wildlife Biologist I

APPROVED BY:

____
Steven R Peterson, Senior Staff Biologist
Division of Wildlife Conservation

____
Wayne L Regelin, Director
Division of Wildlife Conservation

SUBMITTED BY:
Kimberly Titus
Regional Supervisor

APPROVAL DATE: __________________

Table 1. Activity status of known northern goshawk nest areas in the Ketchikan Area of the Tongass National Forest in Southeast Alaska, 1991-2001; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Butterball Lake, Heceta Island				O	N A R	O	O	O	O	O	X
Carroll River, Revilla.Island						G	N A	G	G	O	X
Convenient Cove, Hassler Island		G	G	N A	G	G	O	O	O	O	O
Derrumba Ridge, Heceta Island							N O	O	O	O	X
Logjam Creek, P.O.W. Island			N A R	O	O	O	O	O	O	O	O
Margaret Lake, Revilla.Island				N A	G	B R	B R	B R	O	O	O
McDonald Lake, Cleveland Peninsula									N A	G	O
Port Refugio, Suemez Island	O	G	G	B	G	G	O	O	O	O	X
Rio Roberts/Cutthroat Crk., P.O.W. Is.					N A R	B R	B R	B R	O	O	O
Sarheen Creek, P.O.W. Island	G F	G	G	O	O	O	O	O	O	O	O
Sarkar Lake, P.O.W. Island		N A R	O	O	G	O	O	O	O	O	O
Thorne Island, Thorne Island											N A
Timber Knob, Heceta Island						N A	B	C(96) R	B R	C(97)	B
Traitors Creek, Revilla.Island				N A R	B R	O	O	O	O	O	O
Twelvemile Arm, P.O.W. Island						N O	O	O	O	X	X

A = active nest first located.
C = previously known active nest reused; ( ) = year first active.
G = goshawk(s)/activity observed during breeding season, active nest not located.
O = no goshawk/activity observed, active nest not located.
X = area not checked.
B = active alternate nest located.
F = fledgling(s) observed, active nest not located.
N = nest area documented this year.
R = adult(s) radiotagged and/or present.

Table 2. Activity status of known northern goshawk nest areas in the Stikine Area of the Tongass National Forest in Southeast Alaska, 1991-2001; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Big Creek, Mitkof Island											N A
Big John Creek, Kupreanof Island		N A	B R	O	O	O	O	O	O	O	X
Brown Cove, Petersburg Mainland								N A	B R	O	B
Camp Carl, Etolin Island							N A R	B R	B R	C(99)	O
Cat Creek, Cape Fanshaw Mainland				N A R	O	O	X	O	O	O	X
Doughnut, Wrangell Island									N A R	B	O
Duncan Creek, Kupreanof Island				N A	O	O	G	O	B R	B R	B R
East Bay of Pillars, Kuiu Island				N A R	B R	X	B R	O	O	O	X
Elena Bay, Kuiu Island								N A R	B R	B	X
Farragut Bay, Petersburg Mainland									N A R	B	X
Irish Lakes, Kupreanof Island						N A	G	O	O	O	X
Kadake Bay, Kuiu Island						N A R	O	O	O	O	X
Kake, Kupreanof Island (area cut in	X	X	X	X	X	X	X	X	X	X	X
Kuakan, Deer Island							N A	B	B R	O	O
Madan Bay, Wrangell Mainland								N G F	B R	C(99)	O
Mitchell Creek, Kupreanof Island				N A R	B	O	O	O	O	O	O
Mossman Inlet, Etolin Island	X	O	O	X	X	X	X	X	O	X	X
Mountain Point, Kupreanof Island				N A R	O	X	O	O	O	XO	X
Negro Creek, Port Houghton Mainland				N A	G	O	O	O	O	X	X
Rowan Creek, Kuiu Island			N A R	R T	G	O	G	O	O	X	X
Sanborn Canal, Port Houghton				N A	O	O	X	G	O	X	X
Security Bay, Kuiu Island							N A R	O	O	X	X
Shady, Wrangell Island										N A	C(00)
Starfish, Etolin Island	N A	O	O	O	O	X	O	O	B R	O	O
Totem Camp, Kupreanof Island				N A	O	X	O	O	O	X	X
Tunehean Creek, Kupreanof Island								N A	B R	O	X
Upper Totem, Kupreanof Island			N O	O	O	X	G	O	O	O	X
Vank Island											N A
West Bay of Pillars, Kuiu Island				N A R	B R	X	O	O	O	O	X
Zim Creek, Kupreanof Island									N A	X	X

A = active nest first located.
C = previously known active nest reused; ( ) = year first active.
G = goshawk(s)/activity observed during breeding season, active nest not located.
O = no goshawk/activity observed, active nest not located.
T = radiotagged adult present but did not nest.
B = active alternate nest located.
F = fledgling(s) observed, active nest not located.
N = nest area documented this year.
R = adult(s) radiotagged and/or present.
X = area not checked.

Table 3. Activity status of known northern goshawk nest areas in the Chatam Area of the Tongass National Forest in Southeast Alaska, 1991-2001; codes defined beneath table.

Nest Area	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Auke Bay, Juneau Mainland								N A R	O	O	O
Blueberry Hill, Douglas Island			N A R	B R	C(93) R	R T	C(94) R	B R	B R	C(94)	C(99)
Dewey Lake, Skagway Mainland	X	X	X	X	X	X	X	X	X	X	X
Distin Lake Trail, Admiralty Island				N A	X	X	B	O	B	O	X
Duffield Peninsula, Baranof Island				N A	C(94)	C(94)	O	X	B	O	X
Eagle Creek, Douglas Island			N A R	R T	O	O	O	O	O	O	O
Eagle River, Juneau Mainland							N G F	A R	B R	G	B
Fish Creek, Douglas Island				N A R	B R	B R	B R	C(96) R	B R	O	O
Florence Bay, Chichagof Island						N A R	O	O	O	O	X
Green Cove, Admiralty Island						N A R	B R	B R	C(96) R	B	X
Lace River, Berners Bay Mainland				N A R	R T	O	O	O	X	O	X
Mud Bay River, Chichagof Island			N A	G F	O	X	O	C(93)	O	O	X
Nugget Creek, Juneau Mainland			N A R	B R	R T	O	C(93) R	C(94) R	O	O	O
Pavlof River, Chichagof Island					N A R	R T	R T	O	O	O	X
Point Bridget, Juneau Mainland		N A	B R	O	G	G	G	B R	B	O	O
Ready Bullion Creek, Douglas Island	N A	B R	O	O	O	O	C(91) R	B R	C(92) R	O	O
Sitkoh River, Chichagof Island									N A	O	X
Tolch Rock, Juneau Mainland									N A R	O	O
Turner Lake, Juneau Mainland						N G F	A	G	G F	G F	X
Whitestone, Chichagof Island					N G F R	A R	O	O	O	X	X

A = active nest first located.
C = previously known active nest reused; ( ) = year first active.
G = goshawk(s)/activity observed during breeding season, active nest not located.
O = no goshawk/activity observed, active nest not located.
T = radiotagged adult present but did not nest.
B = active alternate nest located.
F = fledgling(s) observed, active nest not located.
N = nest area documented this year.
R = adult(s) radiotagged and/or present.
X = area not checked.

Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2002

Technical assistance, analysis and dissemination of results from an interagency northern goshawk study on the Tongass National Forest

16 May 2001–30 September 2002

Craig Flatten
Kim Titus
Stephen B. Lewis

Final Research Performance Report
Endangered Species Conservation Fund
Federal Aid Grant E-1-1, Project 2.0

Please note: This final report describes work accomplished on ongoing goshawk research using funds from this grant. Information taken from this federal aid report should be cited with credit given to authors and the Alaska Department of Fish and Game.

FEDERAL AID
FINAL RESEARCH PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

PROJECT TITLE: Technical assistance, analysis, and dissemination of results from interagency northern goshawk study on the Tongass National Forest

PRINCIPAL INVESTIGATORS: Craig Flatten, Kim Titus, Steve Lewis

COOPERATOR: USDA Forest Service

FEDERAL AID GRANT PROGRAM: Endangered Species Section 6

GRANT AND SEGMENT NR.: E-1-1

PROJECT NR.: 2.0

WORK LOCATION: Douglas and Ketchikan

STATE: Alaska

PERIOD: 16 May 2001 – 30 September 2002

I. PROGRESS ON PROJECT OBJECTIVES

OBJECTIVE 1: Continue analysis of 1991 – 2001 data, report preparation and manuscript development.

A number of analyses were completed of the 9 – 10 years of goshawk data. Specifically, we conducted analysis of a) morphometric measurements of Queen Charlotte goshawks handled during capture as part of our long-term studies. We had the opportunity to cooperate with Ms.E. McClaren of the Ministry of Water, Land, and Air Protection, Nanaimo, British Columbia, to analyze goshawk morphology data from Vancouver Island as part of the same analysis. This additional data made for an improved morphometric analysis of the subspecies over a broader portion of the birds' range. Progress has been completed on most aspects of the analysis of size and color variation in northern goshawks from Southeast Alaska and Vancouver Island. Significant progress was also made on analyzing the nest site habitat data. We estimated adult goshawk survival rates.

OBJECTIVE 2: Acquire a more complete sample of habitat data at goshawk nest sites.

We obtained information at 37 goshawk nest trees within 22 nest areas during this period. Broader sampling of nest plot data were collected at 30 sites within 21 nest areas. We believe that this sample is representative of the population of known goshawk nest areas in Southeast Alaska. Some goshawk nest sites in remote locations were sampled during this period.

II. SUMMARY OF WORK COMPLETED ON JOBS IDENTIFIED IN ANNUAL PLAN THIS PERIOD

JOB A: Analysis of goshawk morphology as related to the status of the "Queen Charlotte" subspecies – *Accipiter gentilis laingi*

During this period, Federal Aid funds were used in support of staff time to analyze mensural data from northern goshawks previously captured in Southeast Alaska and Vancouver Island, British Columbia. Adult and recently fledged juvenile goshawks were captured at 85 nesting areas across both regions during 1991-1999. We used univariate and multivariate statistical analyses to compare measurement data within and among regions, and across the North American range of the northern goshawk. Adult male goshawks from Vancouver Island were significantly smaller than males from Southeast Alaska across all measurements. Adult female goshawks were also significantly smaller from Vancouver Island, but the pattern was not as strong across all measurements. Examination of geographic size variation by latitude suggested weak but significant correlations between nest site latitude and individual size for males from Southeast Alaska and Vancouver Island, but not for females. Wing chord length was analyzed across many regions and it serves as a useful metric to examine bird size across regions. Mean adult male wing chord was significantly smaller in Vancouver Island than in Southeast Alaska, central interior British Columbia, and Yukon Territory to the north, and the Olympic Peninsula of Washington, northeast Oregon, and northern Arizona to the south of this location. Adult male wing chord was also significantly smaller in Southeast Alaska than all other locations compared except Vancouver Island. Mean adult female wing chord was significantly smaller in Vancouver Island than central interior British Columbia and Yukon Territory to the north, and northeast Oregon and northern Arizona to the south. These and other results from the analysis of goshawk size suggest that clinal variation occurs within the range of the *laingi* subspecies, especially for males. Across western North America, our analyses suggest that *laingi* goshawks are smaller than those examined from other regions. *A. g. laingi* is described as being a smaller and darker goshawk. Results from examination of key plumage characteristics indicated considerable overlap among phenotypes possible between *laingi* and *attricapillus*. Assignment of 45 adult goshawks by phenotype from Southeast Alaska was 40% *laingi,* 33% *atricapillus*, and 27% *laingi* or *atricapillus*. Assignment of 21 adult goshawks by phenotype from Vancouver Island Alaska was 38% *laingi,* 19% *atricapillus*, and 43% *laingi* or *atricapillus*. These results are based on much larger sample sizes than were used to originally describe the *laingi* subspecies. These results support the original descriptions of the subspecies noting population variability in plumage color.

JOB B: Description of nest site habitat data

During this period, Federal Aid funds were used to sample goshawk nest site habitat, perform data entry, and analyze habitat data at multiple scales. The job was accomplished as planned and included the sampling of some goshawk nests in remote locations. We measured nest and nest tree characteristics at 37 nest trees in 22 nesting areas and measured habitat characteristics at 30 nest sites and nest stands from 21 nesting areas. Goshawks appeared to be selecting the location of their nests at different spatial scales. At the stand scale, goshawks nested in large volume, western hemlock (*Tsuga heterophylla*) dominated forests with relatively dense canopy and shrub layer. Within those stands (mean basal area of stands = 48.5 m^2/ha), nest sites occurred in predominately western hemlock forest patches containing larger trees on average and an overall higher basal area (mean basal area of nest sites = 60.8 m^2/ha). Nest trees were either Sitka spruce (*Picea sitchensis;* 54% of nest trees) or western hemlock (41% of nest trees). Mean dbh (diameter breast height; 68.7 cm; SE = 3.7) of nest trees was significantly larger than the mean dbh of nest site trees (51.7 cm; SE = 1.2). Nest trees were either dominant or codominant in the forest canopy. These results are useful to forest managers in southeast Alaska who can ensure that goshawks have nesting habitat into the future by conserving high volume timber stands with large trees and relatively dense canopy.

JOB C: <u>Estimation of adult goshawk survival rates based on radiotagged birds</u>

During this period we used Federal Aid funds to prepare and analyze radiotelemetry data for the survival rate estimates. During 1991 – 1999 there were 41 nesting areas where adult goshawks were radiotagged. A total of 31 males and 32 females were radiotagged and survival rates were determined for each sex separately. For each month over this period the fate of each bird was determined and placed in one of three categories: alive – known to be alive using radiotelemetry, censored - unable to determine status, and dead – remains recovered (n = 18) or static signals (n = 2). Program MARK was used to estimate monthly survival rates and calculate standard errors. For males, 12 of 31 were recaptured and retagged and 9 died during our study period. Mean annual survival for adult males was 0.59 (SE = 0.10, 95% CI 0.38 – 0.77). Survival was not constant across months, with most male mortality occurring in late winter. For females, 21 of 32 were recaptured and retagged and 11 died during our study period. Some of our females moved (termed 'movers') between nesting areas and exhibited breeding dispersal, while other females were resident (termed 'residents') among years. In cases where females were not tracked for at least 2 nesting seasons, we could not determine whether they were 'movers' or 'residents' hence they were termed 'first'. We hypothesized that movement status would effect survival, and we tested this hypothesis using program MARK. Results indicated that survival was not constant across months or groups. Like males, most adult female mortality occurred in late winter. Mean annual survival for all adult females was 0.74 (SE = 0.06, 95% CI 0.59 – 0.85). Separating the three groups, we found that adult females that 'moved' between years had the highest annual survival rate of 0.96 (SE = 0.03, 95% CI 0.84 – 0.99), followed by 'first' with an annual survival rate of 0.81 (SE = 0.08, 95% CI 0.60 – 0.92), and 'residents' having the lowest annual survival rate of 0.57 (SE = 0.12, 95% CI 0.34 – 0.78). The estimated survival rate for adult males was among the lowest estimated for this species. Our results were accomplished as planned, yet the low survival rate estimate for males suggests the need to carefully examine our data, analysis and results prior to peer review.

III. ADDITIONAL FEDERAL AID-FUNDED WORK NOT DESCRIBED ABOVE THAT WAS ACCOMPLISHED ON THIS PROJECT DURING THIS SEGMENT PERIOD

We cooperated with Forest Service staff in disseminating information on our findings and provided expertise on suspected goshawk nests located by agency personnel. In one situation we provided written findings to the Forest Service because of the sensitivity of the location related to proposed logging/thinning. We also conducted some monitoring of goshawk nest sites when Forest Service staff were not available.

IV. PUBLICATIONS

Papers presented directly related to this performance report.

LEWIS, S-B, K TITUS AND C FLATTEN. 2002. Northern goshawk nesting area characteristics in Southeast Alaska. Poster Paper. 3rd North American Ornithological Conference. New Orleans, La.

TITUS K, C FLATTEN, G PENDLETON, R LOWELL, AND S LEWIS. 2002. Northern goshawk survival rates – Tongass National Forest, Alaska. Poster Paper. 3rd North American Ornithological Conference. New Orleans, La.

V. RECOMMENDATIONS FOR THIS PROJECT

We recommend continued data analysis and report writing. Aspects of interest to agencies include

a) submission of the goshawk size (morphology) and color variation manuscript to peer review. These results are of interest to the US Fish and Wildlife Service because of their role in determining the status of the subspecies under the Endangered Species Act.

b) further analysis of the nest site habitat data as related to forest inventory and timber databases for the Tongass. Further comparative analyses will allow better predictions about the number of goshawk nest areas that are of similar size and forest structure as forest stands desired for timber harvest.

c) final analysis of the goshawk survival rate analysis. Initial analysis using program MARK suggests that male goshawks have very low survival rates and that adult female survival rates differ depending on the inter-year movement status of the female. Both results are unusual and require additional data-checking and analyses to verify the findings.

VI. APPENDIX

See copies of poster papers attached.

VII. PROJECT COSTS FOR THIS SEGMENT PERIOD

FEDERAL SHARE $ 39,999.50 + STATE SHARE $ 13,332.50 = TOTAL $53,332

VIII. PREPARED BY:

Kim Titus, Steve Lewis, Craig Flatten
Regional Supervisor, Fish & Wildlife
Technician IV, Wildlife Biologist I

SUBMITTED BY:

Kim Titus
Research Supervisor

APPROVED BY:

____
Tom Paul
Federal Aid Coordinator
Division of Wildlife Conservation

____
Wayne L Regelin, Director
Division of Wildlife Conservation

APPROVAL DATE: ___________________

Northern Goshawk Survival Rates ~~Tongass National Forest, Alaska

Kim Titus, Craig Flatten, Grey Pendleton, Rich Lowell, Steve Lewis
Alaska Department of Fish & Game, Division of Wildlife Conservation, Douglas & Ketchikan

Introduction

Few studies have estimated northern goshawk survival rates (*Accipiter gentilis*). For goshawks, there are two methods to estimate these rates. Birds can be marked and resighted in subsequent years, typically using color bands (e.g., Reynolds and Joy 1998; Arizona). Alternatively, birds can be radiotagged and followed to determine their fate (e.g., Kenward et al. 1999; Sweden). We used radiotelemetry to estimate goshawk survival rates by following adults from 1992 – 2000. We worked with the Queen Charlotte goshawk (*A. g. laingi*).

Study Area

Tongass National Forest – Southeast Alaska 77,000km^2

- Coastal temperate rainforest (125 – 500 cm rain per year)
- 1,000+ islands; 16,600 km coastline
- 90% of Southeast Alaska is public land
- 2,000,000 ha of pristine old growth rainforest
- Sitka spruce, western hemlock dominant trees
- 405,000 ha of old growth forest harvested by clearcut logging

Field Methods

- 61 Total nesting areas
- 41 Nesting areas where adults were tagged
- All adults trapped at nest sites
- 31 Males radiotagged
- 32 Females radiotagged
- Aerial radiotracking used to locate birds
- About 2,500 telemetry locations

Statistical Methods

Estimated survival by MONTH and used 3 fate categories

- *ALIVE – known to be alive (using radiotelemetry)*
- *CENSORED – unable to determine status*
- *DEAD – remains recovered (n = 18) or static signals (n = 2)*

Used program MARK (known fates model) to estimate monthly survival rates and standard errors. Separate models for males and females. Started with general models that allowed survival to differ by group by month (movers, residents, first encounter of bird). Subsequently fit reduced models constraining survival rates among months and/or groups. Selected appropriate model based on AICc (small sample correction factor. Developed separate estimates by month.

Results – Length of Tracking

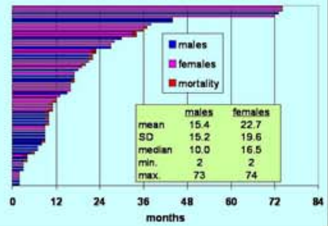
Males

- 12 of 31 were recaptured and retagged
- 9 died

Females

- 21 of 32 were recaptured and retagged
- 11 died

Time Radiotracked

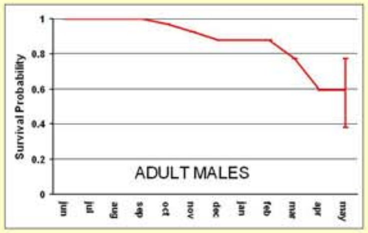


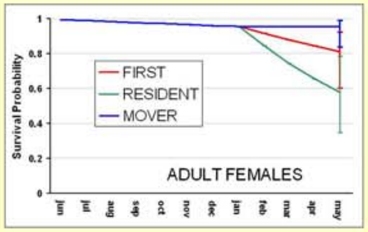
	males	females
mean	15.4	22.7
SD	15.2	19.6
median	10.0	16.5
min.	2	2
max.	73	74

Results – Survival Estimation

Males – Mean annual survival was 0.59 (SE = 0.10; 95% CI 0.38 – 0.77). Because all of our males were residents on their breeding home range, did not test between residents versus movers. Survival was not constant across months, with most male mortality occurring in late winter.

Females – Mean annual survival was not constant across months or groups. Resident female goshawks had lower survival probabilities than movers and the 95% confidence intervals did not overlap (see figures below).





Discussion

MALES – Survival rate estimates are among the lowest reported for the species. We currently have no clear explanation for this result. Possible explanations include transmitter impacts and types of transmitters (tailmounts and 1 – year backpacks on males versus mostly 2 – year backpacks on females).

FEMALES – The model that separated movers, residents and first year tagged birds suggests differences among groups. Females that exhibit breeding dispersal among years had much higher survival than females that remained in the same home across years. Part of this analysis is confounded by differing prey on some islands. Five of 8 resident females that died were on the southern portion of the Tongass and Prince of Wales and other islands that have no red squirrels and no blue grouse; important goshawk prey species.

Acknowledgments

Funding for our long-term studies of the Queen Charlotte goshawk have been provided by the USDA Forest Service, Alaska Department of Fish & Game, and the US Fish and Wildlife Service.

Northern Goshawk Nesting Area Characteristics in Southeast Alaska

Stephen B. Lewis and Kim Titus, Alaska Department of Fish and Game, Douglas, AK;
Craig Flatten, Alaska Department of Fish and Game, Ketchikan, AK

Introduction

A cooperative study of northern goshawk (*Accipiter gentilis*) ecology in the Alexander Archipelago of southeast Alaska began in 1991. During 1995 and 2000, we collected data to systematically describe and quantify goshawk nesting area characteristics at multiple spatial scales. The object of this research was to complement our knowledge of goshawk breeding ecology in Southeast Alaska.

Methods

Study Area

Figure 1. Southeast Alaska; dots show nests at which vegetation data was collected during 1995 and 2000.

Vegetation Sampling

3 spatial scales (Figure 2):

Nest Tree (n = 44 trees from 24 nesting areas):

- measured species, DBH, nest aspect, nest and tree height.

Nest Site (n = 37 sites from 22 nesting areas):

- nest site: 0.05 ha (r = 12.8 m) circle centered on nest (Figure 2).
- measured species, DBH, site aspect, and canopy closure.

Nest Stand (n = 37 stands from 22 nesting areas):

- nest stand: one circular, fixed-radius plot centered 50 m from the nest tree in each cardinal direction (Figure 2).
- measured species, DBH, site aspect, and canopy closure.

Analysis:

1. We used DBH as a metric for comparisons among spatial scales within the nesting area:
   a. Compared Nest Tree DBH with that from all other trees in the Nest Site using a mixed effects model (Proc MIXED, SAS).
   b. Compared DBH of Nest Site trees with that from trees in the 4 Nest Stand plots using a mixed effects model.
2. Calculated basal area for Nest Site and Nest Stand; compared basal area of Nest Sites with that of Nest Stand plots.

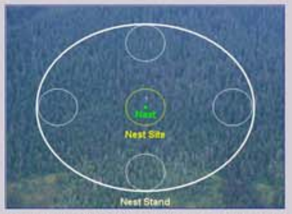


Figure 2. Schematic drawing of sampling design for data collected at goshawk nesting areas in Southeast Alaska, 1995 and 2000.

Acknowledgments

Funding was provided by Alaska Department of Fish and Game, USDA Forest Service, and USDI Fish and Wildlife Service. Rich Lowell (ADF&G), Glen Ith, Kurt Aluzas, and Peg Robertson (USFS) assisted with logistics during data collection. Grey Pendleton (ADF&G) provided statistical assistance. Michelle Kissling helped with poster development.

Results

	Nest Tree	Nest Site	Nest Stand
Tree Species:	54% *Picea sitchensis* 41% *Tsuga heterophylla* 5% *Thuja plicata*	58% *Tsuga heterophylla* 23% *Picea sitchensis* 19% other species	56% *Tsuga heterophylla* 22% *Picea sitchensis* 22% other species
DBH ($\bar{x} \pm s_{\bar{x}}$; cm):	68.7 ± 3.7	51.7 ± 1.2	44.9 ± 0.6
Basal Area (m^2/ha):	N/A	70.1 ± 4.9	55.8 ± 3.2
Canopy Closure (%):	N/A	69 ± 3	60 ± 2
Aspect (°)	147	171	N/A
Height (m):	Nest = 15.5 ± 0.7 Tree = 32.0 ± 1.5	N/A	N/A

1. Nest trees were predominately Sitka spruce while the surrounding forest at both the site and stand scale were dominated by western hemlock (see Tree Species above).

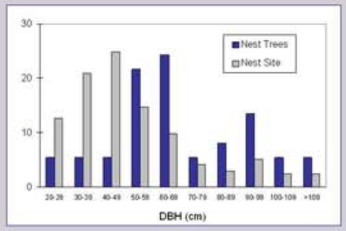


Figure 3. DBH of nest trees and all trees in nest site plots in southeast Alaska.

2. DBH of Nest Trees was larger than that of trees in Nest Site plots (t =21.08, df = 119, $p < 0.0001$) (Figure 3).

3. DBH of trees in Nest Site plots was larger than that of trees in Nest Stand plots (t = 17.86, df = 32, $p < 0.0001$) (Figure 4).

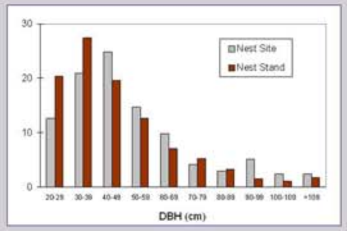


Figure 4. DBH of trees in nest site and nest stand plots in southeast Alaska.

4. Nest Site plots had higher basal area than surrounding Nest Stand plots ($F = 9.41_{1,119}$, $p = 0.0027$) (Figure 5).

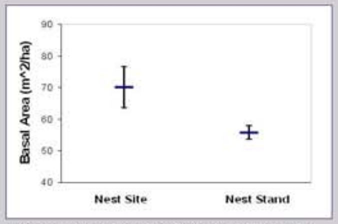


Figure 5. Mean basal area (± SE) of nest site plots and nest stand plots from northern goshawk nesting areas in southeast Alaska.

Summary

Northern goshawks in southeast Alaska appear to be selecting the location of their nests at different spatial scales:

1. At the stand scale, goshawks nests in relatively large volume, western hemlock-dominated forests.
2. Within those stands, nest sites occurs in the larger trees, again predominately western hemlock.
3. The nest tree is one of the largest trees in the site and is often Sitka spruce.

Building on these results, we will perform a principal components analysis to determine which characteristics are most important to goshawks nesting in Southeast Alaska.

Finally, we will compare forest characteristics around goshawk nests to a set of random points (n=884) generated from the Forest Service's Permanent Plot Database.

FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

COOPERATIVE ENDANGERED SPECIES CONSERVATION FUND

STATE: Alaska **GRANT AND SEGMENT NR.:** E - 2 - 1
PROJECT NR.: 1

GRANT TITLE: Nongame Bird Monitoring

WORK LOCATION: Southeastern Alaska

PROJECT DURATION: September 25, 2002 – September 30, 2003

PROJECT REPORTING PERIOD: 1 July 2002–30 June 2003

PROJECT TITLE: Analysis of Queen Charlotte goshawk radiotelemetry and prey-habitat data in conjunction with the USDA Forest Service

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Project Objectives:

The following components will be analyzed and developed into reports or manuscripts as an objective of this study:

a) Coordinate, fund, and work with the Forest Service who will perform the spatial habitat analyses of the 1991-1999 radiotelemetry data.
b) Perform home range analyses by sex, age, and location on the Tongass given varying prey occurrence.
c) Perform resource selection modeling and habitat analyses based on GIS outputs as provided by the Forest Service.
d) Perform exploratory analysis of passerine bird dataset that was previously collected by the Forest Service.

Summary of Project Accomplishments

Accomplishment of the objectives has been delayed because U.S. Forest Service staff members have not completed the spatial habitat analyses in objective a) upon which all other objectives depend. We expect the Forest Service will provide this data with a few weeks and we will be able to proceed with the rest of the project.

Project Costs: Federal share $35,357 + state share $11,038 = total cost $ 46,395

Prepared By: Craig Flatten, WBI

Date: 12 December 2003

FEDERAL AID
FINAL PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

COOPERATIVE ENDANGERED SPECIES CONSERVATION FUND

STATE: Alaska **GRANT AND SEGMENT NR.:** E - 2 - 1
PROJECT NR.: 1

GRANT TITLE: Nongame Bird Monitoring

WORK LOCATION: Southeast Alaska

PROJECT DURATION: September 26, 2002 – June 30, 2004

PROJECT REPORTING PERIOD: July 1, 2003 – June 30, 2004

PROJECT TITLE: Analysis of Queen Charlotte goshawk radiotelemetry and prey-habitat data in conjunction with the USDA Forest Service

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Project Objectives:

The following components will be analyzed and developed into reports or manuscripts as an objective of this study:

a) Coordinate, fund, and work with the Forest Service who will perform the spatial habitat analyses of the 1991-1999 radiotelemetry data.
b) Perform home range analyses by sex, age, and location on the Tongass given varying prey occurrence.
c) Perform resource selection modeling and habitat analyses based on GIS outputs as provided by the Forest Service.
d) Perform exploratory analysis of passerine bird dataset that was previously collected by the Forest Service.

Summary of Project Accomplishments during the current reporting period July 1, 2003 – June 30, 2004

Job A: Coordinate, fund, and work with the Forest Service who will perform the spatial habitat analyses of the 1991-1999 radiotelemetry data.

We contracted with the Forest Service (FS) to perform the spatial habitat analyses of our 1991-1999 goshawk radiotelemetry data using current coverages and layers for the Tongass National Forest. Subsequent to finalization of this contract, the FS encountered significant errors and inconsistencies in their GIS database, and were unable to complete the spatial habitat analysis to a degree of accuracy we found acceptable. Therefore, we were unable to complete this objective.

Job B: Perform home range analyses by sex, age, and location on the Tongass given varying prey occurrence.

This analysis was perfomed on data collected between 1991 and 1999, when ADF&G personnel radiotagged 57 adult goshawks (26 females and 29 males) at 28 nesting areas and 46 fledgling goshawks (17 males, 29 females) at 25 nesting areas (Flatten et al. 2001). Details of the criteria used to screen the data are included in Flatten et al. (2001). We defined a use area as the landscape area encompassing all radiotelemetry relocations documented for an individual during a year; this term is synonymous with home range. We defined the breeding season as 1 March to 15 August and the non-breeding season as 16 August to 29 February. We calculated 100% minimum convex polygons (MCP) using all relocations and 95% MCP to eliminate error associated with outliers (White and Garrott 1990, Samuel and Fuller 1994).

Mean 100% MCP use area sizes for females were 4,549 ha during the breeding season, 33,839 ha during the non-breeding season, and 47,567 ha year-round; mean MCP use area sizes for males was 6,043 ha during the breeding season, 19,454 ha during the non-breeding season, and 15,719 ha year-round (Table 1). During the breeding season, male use areas were larger than female use areas ($mean_{difference}$ = -1,494 ha, 95% CI = -4,210 – 1,222). However, in the non-breeding season, female use areas were much larger than males ($mean_{difference}$ = 14,384 ha, 95% CI = -8,077 – 36,845). Goshawk use area size varied with season (Table 1), being smaller during the breeding season when activity was centered on the nesting area (♀: $mean_{difference\ breeding\ vs\ nonbreeding}$ = -29,290 ha, 95% CI = -50,270 – 8,309; ♂: $mean_{difference\ breeding\ vs\ nonbreeding}$ = -13,412 ha, 95% CI = -23, 960 – 3,728). Within season, use area sizes were similar in prey rich versus prey poor portions of Southeast Alaska, except female use area size was much bigger during the winter for birds that nested in the prey poor area ($mean_{difference}$ = -89,920 ha, 95% CI = -125,168 – 40,673).

Determining the home range sizes for fledgling and juvenile goshawks was not an appropriate analysis tool because they do not have a home range per se during this dispersal period. Nevertheless the data collected allow us to analyze and report attributes associated with juvenile dispersal and movement.

Data from a few birds allowed us to determine what size area juveniles used pre-dispersal. We considered fledglings to have dispersed from their nesting areas when they were located ≥ 1.5 km from the nest and were not located again within this distance of the nest (Kenward et al. 1993). We captured juvenile goshawks approximately 3 – 8 weeks post-fledging and thus, we were not able to collect many pre-dispersal locations from many individual juveniles (7 goshawks with ≥ 5 locations). Mean maximum pre-dispersal distance from the nest for birds with ≥ 5 locations (0 males, 7 females) during this period was 0.75 ± 0.37 km (mean ± SD; n = 72 total locations; range = 0.41 – 1.47 km). Using this distance as the radius of a circular area, we estimated post-fledging area (PFA) size of 177 ha.

Movement of juveniles after dispersal could be better described with 27 radiotagged juveniles (9 males, 18 females) that were located at ≥1 dispersal location. Mean date of dispersal for all individuals was 22 August ± 9 days (SD; n = 9 males, 18 females; range = 1 August – 10 September; date of dispersal estimated by averaging date of last pre-dispersal location with date of first post-dispersal location). We recorded 10 post-dispersal locations (range = 1 – 34 locations per bird) for birds known to have dispersed. Mean duration that these birds were tracked after dispersal was 107 days (median = 88 days, range 1 – 343 days; Figure 1). The majority of these locations were recorded during August through November (Figure 2). Mean maximum post-dispersal distance from the nest was 65.2 ± 43.5 km (n = 9 males, 18 females; range = 16.5 – 162.7 km; Figure 1). Cumulative post-dispersal distance from the nest was calculated for each bird as the summation of distances between successive post-dispersal locations. Mean cumulative post-dispersal distance for birds with ≥ 5 locations was 209.9 ± 93.9 km (n = 3 males, 12 females; range = 31.7 – 368.4 km). Seven (25.9%) of 27 radiotagged juveniles (2 males, 5 females) that were known to have dispersed were confirmed as mortalities (Figure 1). One additional fledgling was found dead in August prior to dispersal.

Job C: <u>Perform resource selection modeling and habitat analyses based on GIS outputs as provided by the Forest Service.</u>

We contracted with the FS to provide the GIS outputs of various habitat coverages required for a habitat analyses and resource selection modeling as noted in Job A above. They were unable to complete this objective because of errors and inconsistencies in their GIS vegetation coverages that could not be rectified in the time allocated. After considering these problems in their coverages and the corrected data that the FS could provide, we decided that an analysis of goshawk habitat selection based on the data that the FS could provide currently was not credible. The FS's Tongass GIS database has high value, but additional funding and technical assistance, is required to correct the errors and inconsistencies. Doing so would allow an accurate and precise analysis of goshawk resource selection to be performed. This remains the highest priority analysis for the goshawk dataset, and completion of this task would improve our knowledge of goshawk habitat use across the Tongass National Forest.

Job D: <u>Perform exploratory analysis of passerine bird dataset that was previously collected by the Forest Service.</u>

We performed the exploratory analysis on data collected during 1990-1992, for a study designed by G. C. Iverson of the FS on the community of songbirds that inhabit forests of Southeast Alaska (G. C. Iverson, USFS, personal communication). The goal of the study was to evaluate habitat associations of the suite of breeding avifauna, particularly upland terrestrial species, in the major forest types of this region, as well as test Habitat Capability Models developed for 3 Management Indicator Species used by the Tongass National Forest, brown creeper (*Certhia americana*), hairy woodpecker (*Picoides villosus*), and red-breasted sapsucker (*Sphyrapicus ruber*; G. C. Iverson, USFS, personal communication). We are interested in these data because of their potential usefulness for an analysis of goshawk prey use versus availability. These data could provide a source of information on availability of some goshawk prey; data on prey use by goshawks were gathered previously, and are available in Lewis (2001) and Lewis et al. (*in review*).

Iverson used the variable circular plot method (VCP; Reynolds et al. 1980) to count birds at points stratified across various forest types (based on plant associations; Pawuk and Kissinger 1989) and landscape positions (Table 2). In 1990, VCP points were spaced 200 m apart along routes on Mitkof Island in 5 habitat types and 3 landscape positions. Points were repeatedly surveyed (range = 4 – 6 replicates) during the breeding season, and counts lasted 10 minutes. In 1991, these points were resurveyed and additional points were established on Mitkof, Kupreanof, and Kuiu Islands. These points were surveyed twice, with each survey lasting 8 min. In 1992, additional points were added on Kuiu Island; all points were surveyed once for 8 minutes.

During each count, observers estimated distance to the bird and the time during the count when it was detected. By the end of 1992, 490 VCP points had been established and surveyed for upland landbirds.

In its current form, the data describe relative abundance of birds in the various habitat types and is not useful for determining use of prey species vs. their availability. However, because distance estimates were made for each observation, these data could be used to identify detection probabilities for various birds and thus generate density estimates, but it would require a time-consuming re-aggregation of the data set. In addition one would need to better link the birds-counted data with the specific habitats in which they were found. If that were done, one could derive relative density and variability estimates for some goshawk prey and various habitat types in Southeast Alaska using these data and other sources (e.g., Kissling 2003).

The Iverson dataset contains unique and useful data on some prey species important to breeding goshawks. Point counts are useful for songbirds, especially if distance estimates are made to each detection, and may provide some information on grouse. Therefore, the data provided by this dataset in combination with other studies (Lewis 2001, Lewis et al. *in review*) would be an important part of the total necessary for an analysis of goshawk prey selection in Southeast Alaska.

Through the exploratory analysis of Job D we have determined what additional work is necessary to further describe goshawk prey availability. Given the work needed to generate densities of birds in the various habitat types, we recommend that this data be analyzed by someone familiar with distance estimation, and analysis of such data. Our preliminary analysis suggests that this large dataset can be used for an in-depth analysis of prey-habitat-predator relationships. We recommend that a detailed study plan be prepared by FWS, ADF&G and/or FS staff for the funding required to analyze this old, but important data. We subsequently learned of an additional 3 years of data collected by Iverson in a variety of forest stands of varying age since clear-cutting. These additional data would be a useful source of information on some goshawk prey in managed landscapes in Southeast Alaska.

In terms of any analysis of goshawk prey use versus availability, several pieces of information need to be gained before we can perform this analysis. First, we need accurate density estimates for the 2 key goshawk prey, blue grouse and red squirrel. For grouse, an understanding of how well point counts estimate grouse numbers would allow us to evaluate the usefulness of datasets such as this Iverson data for grouse density estimation. Some measure of squirrel density is needed before this analysis could be completed, and as yet no such estimation has been undertaken. However, a prey use versus availability analysis would be useful for gaining a better understanding of which prey species are most important to breeding goshawks and potentially to wintering goshawks as well.

Summary of Project Accomplishments during life of the project

During the first year of this project we were awaiting Forest Service spatial habitat analysis of the data set. Besides the activities described above, during the 2-year life of the project we cooperated with FS staff in disseminating information on our findings and provided expertise on suspected goshawk nests located by agency personal. We also conducted some monitoring of goshawk nest sites when FS staff were not available. Note, during this contract period, one biologist long associated with this project left ADF&G. This caused the delay in reporting and necessitated the extension to 27 December.

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Project Costs: Federal share $35,100 + state share $11,700 = total cost $46,800

Prepared By: Stephen B. Lewis, Wildlife Biologist I
Craig J. Flatten, Wildlife Biologist I

Date: 27 December 2004

Table 1. Breeding (nesting), non-breeding, and year-round use areas (100% and 95% MCP) for adult northern goshawks radiotracked in Southeast Alaska, 1992–1999.

		Female			Male		
		Locations	100% MCP (ha)	95% MCP (ha)	Locations	100% MCP (ha)	95% MCP (ha)
Breeding season[a b]	Mean	31	4,549	4,153	27	6,043	4,862
	SD	18	2,465	2,423	17	4,860	3,400
	Median	27	4,304	4,223	24	4,603	4,089
Non-breeding season[a c]	Mean	26	33,839	31,784	27	19,454	16,503
	SD	14	42,134	41,965	11	16,464	15,601
	Median	24	14,718	12,186	25	13,358	13,024
Year-round[c]	Mean	44	47,563	42,451	45	15,719	12,431
	SD	29	57,943	55,694	28	16,036	14,495
	Median	35	15,838	10,945	45	10,603	6,166

[a] Sample size in number of birds monitored: breeding season = 16 females and 20 males; non-breeding season = 18 females and 14 males; year-round = 25 females and 21 males.

[b] Does not include 1 adult female that moved >44 km from her nesting area on 3 August and returned on 7 August, resulting in a 100% MCP breeding season use area of 29,600 ha.

[c] Does not include 1 adult male that dispersed >80 km from its nesting area during the non-breeding season and whose non-breeding season and year-round 100% MCPs use areas were 231,509 ha.

Table 2. Landscape position and habitat type at variable circular plot points used to survey birds in the Petersburg area of Southeast Alaska, 1990–1992.

	Habitat Type [a]									
LANDSCAPE POSITION	CC	TSHE	TSHE / CHNO	PISI	MXD CON	TSME	PICO	MP	AM	TOTAL
Beach	0	50	3	5	13	0	1	0	0	72
Upland	113	43	7	13	35	2	3	35	0	251
Riparian	0	34	0	75	0	0	0	0	0	109
Montane (alpine)	0	1	0	3	0	32	0	1	21	58
Total	113	128	10	96	48	34	4	36	21	490

[a] Habitat types based on Plant Associations (Pawuk and Kissinger 1989): CC = clearcut, TSHE = *Tsuga hererophylla*, TSHE / CHNO = mixed forest of *Tsuga hererophylla* and *Chamaecyparis nootkatensis*, PISI = *Picea sitchensis*, MXD CON = mixed conifer, TSME = *Tsuga mertensiana*, PICO = *Pinus contorta*, MP = muskeg, AM = alpine meadow.

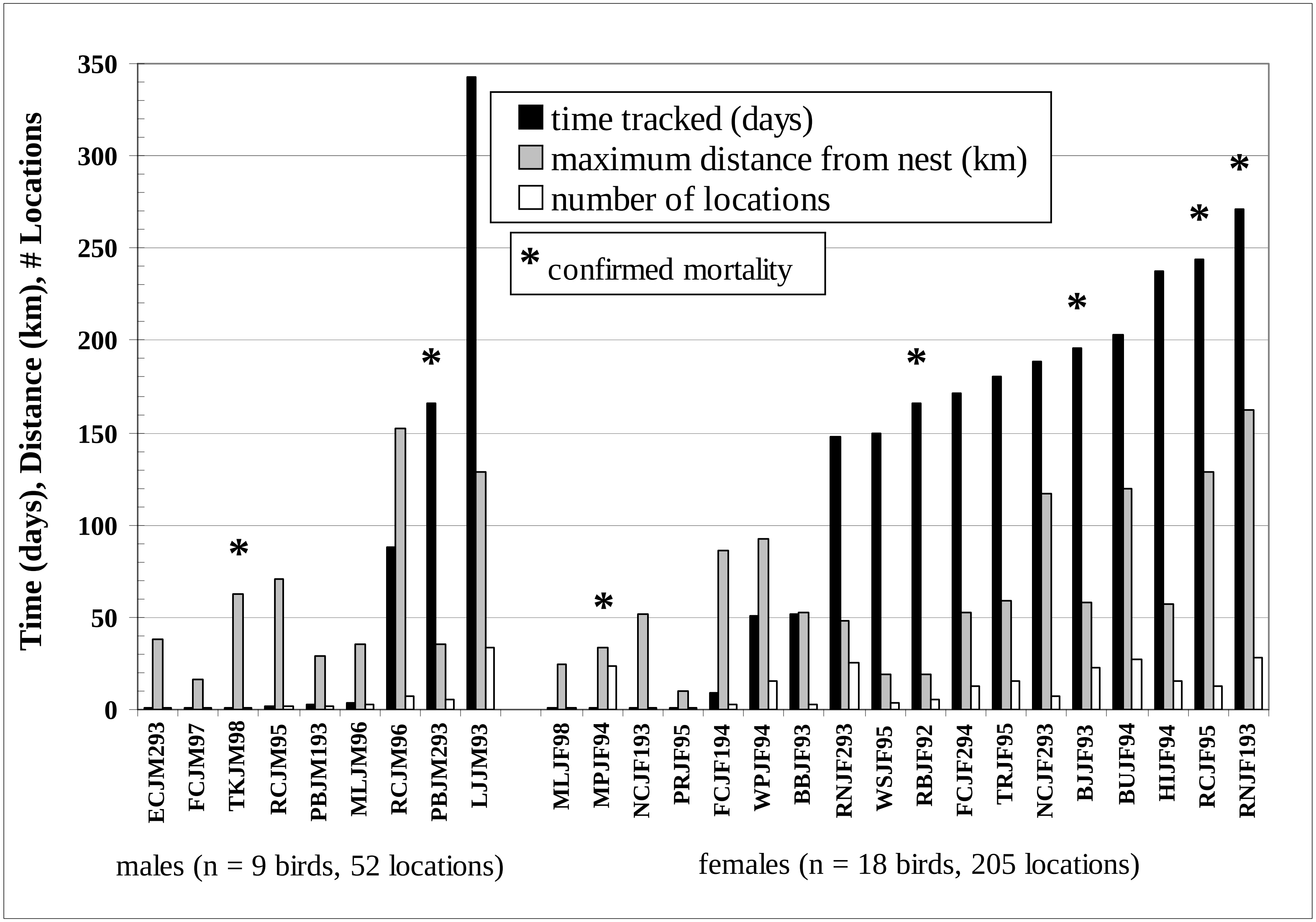

Figure 1. Time tracked, maximum distance from nest, and number of locations after dispersal for juvenile goshawks radiotagged at nesting areas in Southeast Alaska during 1992 – 1999.

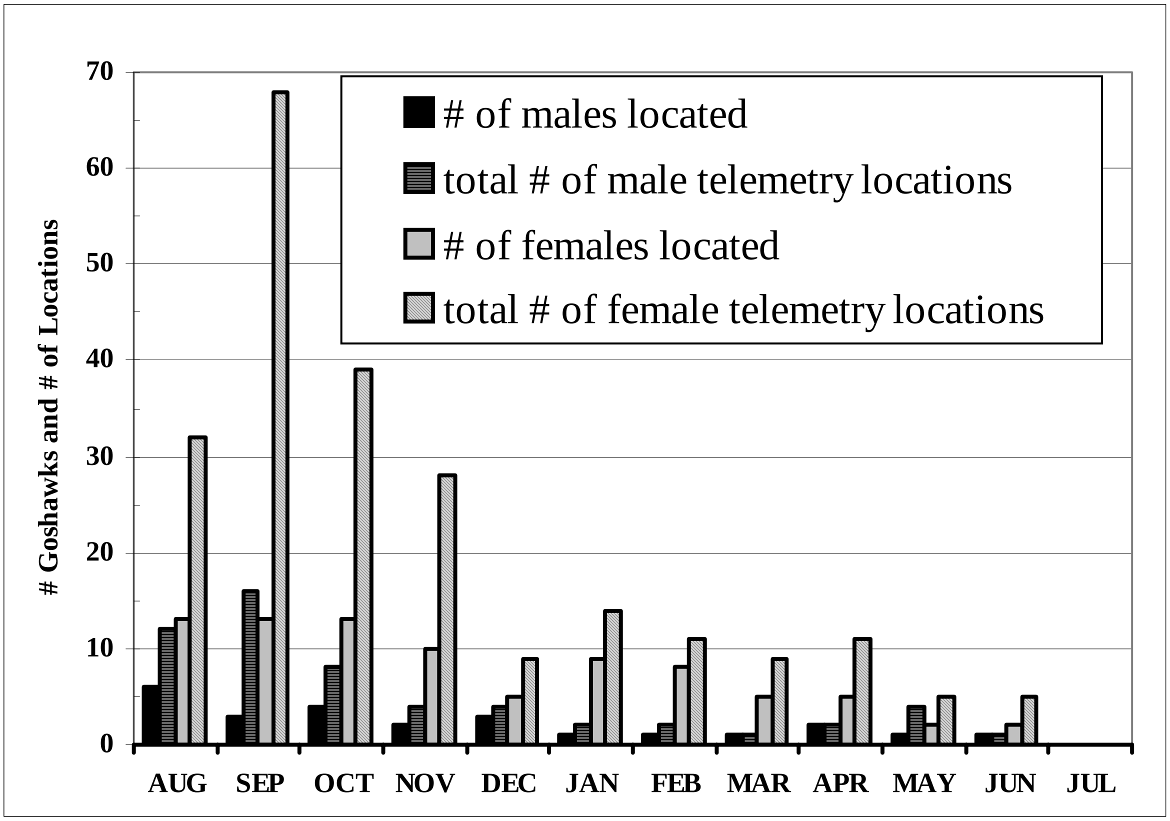

Figure 2. Post-dispersal locations by month for radiotagged juvenile goshawks captured at nesting areas in Southeast Alaska during 1992-99.

FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

COOPERATIVE ENDANGERED SPECIES CONSERVATION FUND

STATE: Alaska **GRANT AND SEGMENT NR.:** E-3-1
PROJECT NR.: 1

WORK LOCATION: Southeast Alaska

PROJECT DURATION: 30 September 2003 – March 31, 2004

PROJECT REPORTING PERIOD: 30 September 2003 – 29 September 2004

PROJECT TITLE: Analysis of Queen Charlotte Goshawk Radio-telemetry and Nest Site Data

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Project Objectives:

1. Complete statistical analyses and resource selection modeling based on radiotelemetry data and complete final report.
2. Coordinate with U.S. Forest Service (FS) photo interpreter to complete analysis of forest structure at additional nest sites. Complete statistical analyses of this data and final report of results.
3. Provide goshawk technical expertise to the U.S. Fish and Wildlife Service (FWS) and FS as needed, and when reasonable given other ongoing study work.

Summary of Project Accomplishments:

1. We contracted with the FS to complete GIS analysis of this data using current coverage and layers for the Tongass National Forest. Subsequent to finalizing the contract errors were found in the FS GIS database that were prevented us from completing and analysis of goshawk habitat-use based on radio telemetry as planned. No acceptable solution could be found within acceptable time and cost constraints. Therefore, this portion of the data analysis will not be included in the final report.

2. We contracted with an air-photo interpreter, Robert C. Smith, to analyze 29 additional nesting sites using aerial photographs supplied by FS. Smith was able to analyze 25 of the nesting sites we requested. The 4 additional sites were not analyzed because FS personal were unable to locate the correct aerial photographs. The analysis and reporting of these data will be completed during the fall and winter of 2004 and will be included in the final report.

3. Technical assistance to both the FS and FWS have been provided in the following areas;
   a. Summarizing and reporting on yearly survey data;

b. Assisting in occupancy checks of known nesting areas;
c. Consulting with District biologist concerning suspected goshawk nesting areas;
d. Assisting with interpretation of goshawk study data for an analysis of the northern goshawk Standards and Guidelines found in the 1999 revision of the Tongass Land and Resource Management Plan; and
e. Commenting on on-going litigation concerning the Queen Charlotte Goshawk.

Project Costs (includes indirect):
Federal share $12,811 + state share $ 4,270 = total cost $ 17,081

Submitted By: Dale L. Rabe, Region I Management Coordinator

Date: October 24, 2004

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 25526
Juneau, AK 99802-5526

COOPERATIVE ENDANGERED SPECIES CONSERVATION FUND

STATE: Alaska

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Project Objectives:

1. Complete statistical analyses and resource selection modeling based on radiotelemetry data and complete final report.

2. Coordinate with U.S. Forest Service (FS) photo interpreter to complete analysis of forest structure at additional nest sites. Complete statistical analyses of this data and final report of results.

3. Provide goshawk technical expertise to the U.S. Fish and Wildlife Service (FWS) and FS as needed, and when reasonable given other ongoing study work.

Summary of Project Accomplishments with regard to the objectives:

1. We contracted with the FS to complete GIS analysis of this data using current coverage and layers for the Tongass National Forest. Subsequent to finalizing the contract, errors were found in the FS GIS database that prevented us from completing an analysis of goshawk habitat-use based on radio telemetry as planned. No acceptable solution could be found within acceptable time and cost constraints. Therefore, this portion of the data analysis will not be included in the final report.

2. We contracted an aerial photograph interpreter, Robert C. Smith, to analyze 29 additional nesting sites using aerial photographs supplied by FS. Smith was able to analyze 25 of the nesting sites we requested. The 4 additional sites were not analyzed because FS personnel were unable to locate the correct aerial photographs. In total, data from 63 nest sites in 50 unique nesting areas were analyzed. Methods of aerial photograph analysis are described in Alaska Department of Fish and Game (1997).

There was significantly more forested area associated within the 12-ha plots centered on goshawk nest sites than in random plots (Table 1). Mean difference in forested area between nest sites versus random plots was 1.2 ha. There was little variability in the amount of forest area surrounding goshawk nest areas but forested random samples had a larger range; only 4 goshawk nest sites had <10.9 ha of forest out of the 12 ha area around them while 17 random plots had <10.9 ha. We found no difference in the amount of forest area surrounding goshawk nests versus nearby random samples at the 65-ha scale (Table 2). The lack of statistical differences found in the sampling of the 65-ha plots may have been due to a decrease in power associated with higher variability.

We also found that the amount of productive forest land area in the 12-ha plot was significantly higher at goshawk nests than a nearby random sample centered on forest (Table 1). The area of productive forest was positively correlated ($r = 0.54$; $r = 0.53$; $n = 63$, $P < 0.001$) with the total area of forest for both the 12-ha and 65-ha plots, respectively. The lack of a very high correlation was due to the fact that total forest area may contain areas of forest that contained small trees that were not of commercial quality; hence they were not defined as productive forest.

Forest cover, and to a lesser extent productive forest land, dominated the area in the 12-ha plot. There was little range in the amount of forested area in the 12-ha plot indicating that few large openings occurred in close proximity to goshawk nests. We found negative correlations between the amount of forest area and the area of non-forest in the 12-ha and 65-ha plots, respectively ($r = -0.94$, $r = -0.64$, $n = 63$; $P < 0.001$).

Beach and riparian cover types occurred in relatively small amounts in both 12-ha and 65-ha plot (Tables 1, 2). Freshwater lakes were absent in the 12-ha nest site plots and only a fraction of the area around nests in the 65-ha plot (Tables 1, 2). Saltwater cover types occupied a small portion of both the 12-ha and 65-ha nest plots (Tables 1, 2).

We found no differences in the distance to land-cover features between goshawk nests and random samples (Tables 1, 2). Our inability to detectable differences in distance measures between nest plots and random plots differed from the patterns found by other researchers that found goshawks nesting farther from forest openings, paved roads and human habitation than random samples of forested habitat (Bosakowski and Speiser 1994, Falk 1990).

We considered border lengths to be indices of cover-type heterogeneity. At the 65-ha scale, we found less forest to non-forest edge at goshawk nesting areas than at random samples (Table 2). This likely occurred because of the lack of other forest cover types at goshawk nest plots. Hence, we found low cover-type heterogeneity at goshawk nests compared with other randomly selected forested areas.

Canopy cover was significantly higher in the 12-ha area surrounding goshawk nests than in other nearby forest areas (Table 1). Although the mean difference was only 8.7%, this was a narrow comparison of forest canopy at and away from goshawk nests. We would not expect great differences in forest canopy cover between goshawk nesting areas and random samples unless goshawks were selecting rare features of the habitat that did not occur elsewhere. Such differences would be unlikely on the highly fragmented and patchy Tongass National Forest. The mean percent canopy cover value of 50% was lower than reported in the literature for this species (Squires and Reynolds 1997). Based on a literature review, Siders and Kennedy (1994) found that nest site canopy cover varied from 60% to 95% for goshawks. In nearly all studies, canopy cover was measured differently from our study that evaluated canopy cover across 12-ha by using sub-samples and aerial photography. Siders and Kennedy (1994) cited studies where canopy cover was likely estimated much closer to the nest tree and by using on-the-ground, under-the-canopy estimates.

We found that there was significantly more hemlock at goshawk nest areas compared with nearby areas (Table 1); the mean difference was 12%. This difference may have been associated with goshawk nesting areas being associated with productive forest lands and hemlock/spruce cover types, whereas some random samples may have contained a greater component of cedar or spruce only.

We did not test for differences in canopy structure or canopy texture between nest sites and random samples. A descriptive summary indicated that multi-story canopies dominated the samples with 89% of the nest sites and 84% of the random samples occurring in multi-story canopy forest stands. The aerial photograph interpreter determined that just 1 of 63 goshawk nesting areas had the majority of 9 sub-samples defined as a single-canopy layer. This was a nest on Douglas Island located in ~70 year old second-growth where 8 or 9 sub-samples were in a single-canopy layer. Our on-the-ground knowledge of these nesting areas supports the notion that nearly all goshawk nests were in stands with multi-layer canopies.

The aerial photograph interpreter found that 60% of the goshawk nest sites had a medium-grained canopy texture, 24% had fine-grained canopy texture, and 16% had coarse-grained canopy texture. In the random samples, we found 57% of the goshawk nest sites had medium-grained canopy texture, 25% had fine-grained canopy texture, and 18% had coarse-grained canopy texture. This canopy cover texture attribute was associated with tree size and canopy heterogeneity, with coarse-grained canopies to be a relative indicator of large trees and higher volume old-growth compared with medium- and fine-grained canopy textures. Inspection of the data indicated no differences in canopy texture between nest sites and random samples considering the sampling variability that was indicative of the forest canopy heterogeneity.

3. Technical assistance to both the FS and FWS has been provided in the following areas;
   a. Summarizing and reporting on yearly survey data;
   b. Assisting in occupancy checks of known nesting areas;
   c. Consulting with District biologist concerning suspected goshawk nesting areas;
   d. Assisting with interpretation of goshawk study data for an analysis of the northern goshawk Standards and Guidelines found in the 1999 revision of the Tongass Land and Resource Management Plan; and
   e. Commenting on on-going litigation concerning the Queen Charlotte Goshawk.

Summary of Project Accomplishments during last reporting period only (30 September 2004 – March 31, 2005):

1. No further progress was made on this objective (see above).

2. Analysis of data from the aerial photographic analysis took place during this reporting period.

3. Technical assistance to both the FS and FWS has been provided in the following areas;
   a. Summarizing and reporting on yearly survey data;
   b. Assisting in occupancy checks of known nesting areas;
   c. Consulting with District biologist concerning suspected goshawk nesting areas; and
   d. Commenting on on-going litigation concerning the Queen Charlotte Goshawk.

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Project Costs during reporting period:
Federal share $17,238.75 + state share $5,746.25 = total cost $22,985

Prepared By: Stephen B. Lewis, Wildlife Biologist I

Date: 24 June 2005

Table 1. Area of different land cover types, distance to landscape features, and length of landscape features within 12-ha plots surrounding northern goshawk nest sites and paired random plots as determined by analysis of aerial photograph analysis, Tongass National Forest, 1995 and 2004.

Variable Type	Variable	Nest Mean	Nest SD	Random Mean	Random SD	*P* value[a]
Land Cover Area	Riparian	0.85	1.42	1.01	1.39	0.439
	Beach	0.20	0.88	0.14	0.84	0.484
	Forest	11.72	0.93	11.19	1.50	0.015
	Non-forest	0.38	0.88	0.80	1.36	0.024
	Productive Forest	10.83	1.70	9.98	2.49	0.006
	Non-productive Forest	0.98	1.48	1.18	2.01	0.708
	Freshwater	0.00	0.00	0.04	0.21	0.180
	Saltwater	0.04	0.30	0.05	0.35	0.593
Distance to Type	Non-forest Edge	462	519	392	476	0.260
	Freshwater Shore	2382	2595	2339	2245	0.910
	Saltwater Shore	3397	3112	3590	2946	0.162
	Stream	373	678	315	457	0.501
	Road	2747	5077	2752	4983	0.112
	Forest Opening	897	907	974	1090	0.271
Length of Type	Non-forest Edge	119	237	158	256	0.179
	Freshwater Shore	12	48	4	29	0.068
	Saltwater Shore	5	40	5	41	1.000
	Stream	151	227	138	195	0.841
	Road	46	137	15	65	0.136
	Trail	17	68	7	44	0.273
	% TSHE	78	13	75	14	0.056
	% Canopy Closure	50	8	45	12	0.003

[a] *P*-value based on Wilcoxon matched-pairs signed-ranks test.

Table 2. Area of different land cover types, distance to landscape features, and length of landscape features within 65-ha plots surrounding northern goshawk nest sites and paired random plots as determined by analysis of aerial photograph analysis, Tongass National Forest, 1995 and 2004.

		Nest		Random		
Variable Type	Variable	Mean	SD	Mean	SD	*P* value[a]
Land Cover Area	Riparian	4.68	4.00	4.91	4.38	0.556
	Beach	2.32	5.41	1.46	4.14	0.148
	Forest	59.33	8.99	57.75	8.17	0.191
	Non-forest	3.08	4.75	5.31	6.35	0.017
	Productive Forest	53.67	9.93	50.67	13.87	0.149
	Non-productive Forest	6.70	8.66	6.70	9.96	0.941
	Freshwater	0.35	1.18	0.74	2.89	0.480
	Saltwater	1.44	4.31	0.82	3.37	0.249
Distance to Type	Non-forest Edge	462	519	392	476	0.260
	Freshwater Shore	2382	2595	2339	2245	0.910
	Saltwater Shore	3397	3112	3590	2946	0.162
	Stream	373	678	319	455	0.649
	Road	2747	5077	2752	4983	0.112
	Forest Opening	897	907	974	1090	0.271
Length of Type	Non-forest Edge	698	878	949	845	0.038
	Freshwater Shore	100	48	69	218	0.638
	Saltwater Shore	110	40	89	261	0.753
	Stream	765	227	698	511	0.854
	Road	192	137	121	329	0.306
	Trail	86	68	69	214	0.799

[a] *P*-value based on Wilcoxon matched-pairs signed-ranks test.