KETCHIKAN FOREST RAPTOR STUDY

PROGRESS REPORT: GOSHAWK RADIO-TELEMETRY

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Abstract

This progress report presents methods and results of northern goshawk (*Accipiter gentilis*) detection, trapping, and radio telemetry efforts for the period January 13, 1992 to March 10, 1993. No goshawks were captured during wintertime efforts using Swedish goshawk traps at selected locations. Trapping at nest sites resulted in capture of ten goshawks, including four adults and six juveniles. Three additional goshawks (one adult, two juveniles) were handled after being recovered or reported by members of the public. Of the total thirteen goshawks handled, twelve were banded and eight were radio-tagged. Blood samples for genetic analysis were collected from eleven, and morphological measurements were taken from all thirteen.

Radio-telemetry was conducted at one nest site on Prince of Wales Island (POWI) and one nest site on Douglas Island at Juneau. A total of seven goshawks were radio-tagged and tracked at these sites.

At the POWI site, a total of 51 adult male and 45 adult female independent relocations were collected. Neither juvenile at this site could be relocated after their presumed post-fledgling dispersal. Analysis of telemetry data from the POWI site was accomplished using the Forest Service Ketchikan Area GIS. The combined nesting home range of the adult male and female was 101,596 ac. (158.7 mi^2), of which 50,798 ac. (79.4 mi^2) was terrestrial habitat. The combined total home range of the adult male and female was 390,042 ac (609.4 mi^2), of which 195,021 ac. (304.7 mi^2) was terrestrial habitat. The male's and female's home ranges contained only 4.4% and 5.9% overlap for the nesting and total home ranges, respectively.

Preliminary analysis of forest volume class use vs. availability for the POWI adult goshawks was done by the Forest Service Ketchikan Area GIS using telemetry relocation data. This pair of goshawks selected mature forests of greater than 8,000 board feet/acre ($\geq$ volume class 4) and avoided unforested habitat and forest stands of less than 8,000 board feet/acre.

At the Douglas Island site, a total of 26 adult male and 28 adult female relocations were collected. A total of 8 post-dispersal relocations were collected for the single juvenile. This information is currently being analyzed.

None of the 4 goshawks (3 adults and 1 juvenile) successfully tracked through the fall and winter migrated from Southeast Alaska. The maximum distance any of these radio-tagged goshawks was relocated from its nest site was 34 miles (54 km), indicating regional year-round residency. The one juvenile goshawk successfully tracked after dispersing from the Douglas Island nest site was found dead 9 miles (14 km) from the nest on March 26, 1993. The two radio-tagged Sarkar Lake juveniles could not be relocated following their presumed dispersal from the nest site.

I. INTRODUCTION

The northern goshawk (*Acciptier gentilis*, hereafter goshawk) is an uncommon, secretive bird of prey associated with northern Holarctic forests. Goshawk nest sites and nesting habitat have been described in a variety of North American locations (e.g., Reynolds et al. 1982, Moore and Henny 1983, Speiser and Bosakowski 1987), but descriptions of their home range size and habitat use patterns remain poorly described (see Kennedy 1989). Describing home ranges and habitat use and selection patterns during the nesting season are important components in assuring that adequate goshawk habitat is maintained into the future. Because these birds are wide ranging and cannot be visually followed away from their nests, radio telemetry is used to estimate their locations on a periodic basis.

Jobs #4, 5, and 6 of the goshawk study plan (ADF&G 1992) call for the gathering and analysis of radio-telemetry data to meet study goals and objectives designed to evaluate home range size, habitat use and spatial distribution of the goshawk on the Tongass National Forest. This report provides a summary of goshawk survey techniques, capture techniques, radio-telemetry methods and preliminary results for the period January 13, 1992 to March 10, 1993.

II. METHODS

1. Goshawk Detection

This report provides only a brief description of the techniques used to locate goshawks and their nests for capture and radio-tagging. For a detailed description of survey techniques and results refer to the Ketchikan Forest Raptor Study, Progress Report: Ketchikan Area Goshawk Surveys (ADF&G 1993).

In 1992, several methods were used to aid in the detection of goshawks and their nests:

A) Broadcast of conspecific vocalizations during foot, vehicle, and boat surveys.

B) Observations from vantage points overlooking forested habitat, and during vehicle travel on roads.

C) Searches conducted on foot in forested areas.

D) Winter trapping attempts with Swedish goshawk traps.

Goshawk surveys aided by these detection methods were conducted in a variety of forested landscapes, including unmanaged old growth stands in wilderness areas and managed commercial forest lands representative of the various stages of seral development.

In addition to methods A, B, C, and D, posters requesting information on goshawk sightings and nest sites were circulated to Forest Service district offices and to the public at large. Consequently some survey efforts were conducted at locations where confirmed or possible goshawk detections were reported by other observers.

2. Capture Techniques

Several techniques were used during attempts to capture goshawks for banding and radio-tagging. The type of trap used varied according to time of year, location of capture attempt, phase of nesting period, and the age of targeted goshawks. In some instances multiple traps and trap types were used simultaneously in order to increase the likelihood of successful capture.

A. Winter Trapping

Efforts to capture and radio-tag goshawks were initiated during January and February, 1992 with the placement and monitoring of Swedish goshawk traps (Bloom 1987) at selected locations. This initial trapping effort prior to the breeding season was attempted to test the effectiveness of winter trapping as a method of 1) detecting goshawk presence and 2) radio-tagging goshawks for both telemetry study and as an aid in locating active nest sites later during the breeding season.

There are a variety of Swedish goshawk trap designs (Bloom 1987). This trap type has a significant advantage over many other types in that a captured goshawk may be safely retained in the trap's netted enclosure for several hours, thereby requiring less frequent monitoring of the traps. Most of these trap designs, however, are too cumbersome and heavy for mobile field use. In order to effectively use this trap in Southeast Alaska, it was necessary to design a light-weight, collapsible and portable version which could be easily transported by automobile, airplane, boat, or while hiking in the field.

Traps were constructed as a cube-shaped framework of 1 in. (2.54 cm) diameter PVC pipe measuring 3.5 ft (106.7 cm) in length, width, and height, and covered with a similarly cube-shaped bag of 4 in. (10.2 cm) mesh nylon netting. The trap's top side consisted of a sliding door powered by elastic cords which could be held open by a spring-loaded perch mechanism inside the trap. A 16 x 20 x 8 in. (40.6 x 50.8 x 20.3 cm) protective wire mesh cage containing up to 3 pigeons or chickens was placed inside the trap beneath the trigger perch to act as a goshawk lure. The weight of a hawk entering the trap's open door to investigate the caged lure birds would depress the trigger perch, releasing the trap door and confining the hawk.

Winter trapping efforts were conducted in several areas on Cleveland Peninsula and Prince of Wales Island. Areas sampled

with Swedish goshawk traps were selected based on previously documented goshawk activity or the presence of suitable forested habitat. Up to six traps were placed a minimum of 0.25 mile (0.40 km) apart in selected trapping areas and visually checked approximately every 3-5 hours. Traps were placed in open locations along shorelines, in estuaries, and in muskegs to increase the likelihood of goshawks visually detecting the traps. Such placement also enabled researchers to monitor traps without approaching and potentially disturbing the sets.

B. Trapping at Nest Sites

During the breeding season, adult goshawks were captured at active nest sites in a break-away mist net (dho-gazza) set near a live great horned owl (*Bubo virginianus*) decoy. This trap consisted of a 4 in. (10.2 cm) mesh nylon mist net (Avinet Inc., Dryden, New York) measuring 6.5 x 14.0 ft. (2.0 x 4.3 m), held upright by two 8.0 ft. (2.4 m) poles made from 0.5 in. (1.3 cm) diameter metal conduit. Trapping was conducted during the early- to mid-nestling phases when adult territorial aggression is highest and the likelihood of capturing both adults is greatest (Bloom 1987). The net assemblage was made ready near the base of the nest tree by early morning when the adult male often visits the nest before or after foraging (Brian Woodbridge, pers. comm.). The live owl decoy was tethered to a low perch approximately 3 ft. (1 m) from the base of the net and the trapper concealed himself nearby. Adult male and female goshawks were captured individually as they stooped aggressively at the owl decoy and became entangled in the break-away mist net.

Several trap types were used during efforts to capture fledged juvenile goshawks for banding and radio-tagging. These included: bal-chatri, noose carpet, and harnessed lure bird traps (Bloom 1987).

Bal-chatri traps consisted of a 16 x 24 x 7 in. (40.6 x 60.9 x 17.8 cm) wire mesh cage with 25 lb (11.4 kg) test monofilament slip nooses tied to the top and sides and a lure pigeon or pigeons confined inside. These traps were secured in conspicuous locations on the ground, on logs, or on limbs in trees in areas where fledged juveniles were located. Goshawks were captured when their feet became ensnared in the nooses while trying to grab the pigeons in the trap.

Noose carpet traps consisted of a 5 x 8 in (12.7 X 20.3 cm) wire mesh envelope with 25 lb (11.4 kg) monofilament nooses tied on the top with the carcass of a pigeon placed inside. These traps were secured in conspicuous locations on the ground or on logs in areas where fledged juveniles were located. Goshawks were captured when they attempted to feed on the carcass in the trap and their feet became ensnared in the monofilament nooses secured to the trap.

To attract fledgling goshawks to the vicinity of both noose carpet and bal-chatri traps, adult female goshawk food-begging calls were played or imitated. Light-colored pigeon or chicken feathers were also placed on or near these traps as an additional visual attractant.

Harnessed lure bird traps consisted of monofilament nooses tied and glued to a leather protective jacket worn by a pigeon. A short line with one end secured to the jacket and the other end secured to a weighted or immobile object, prevents the lure bird from flying away or being carried off by a raptor. Goshawks are trapped when their feet become ensnared in the jacket nooses while trying to grab the lure bird.

Nestling goshawks were captured for banding and temporary radio-tagging by ascending the nest tree with standard tree climbing techniques, removing the nestlings and lowering them to an assistant on the ground. After processing, the nestlings were returned to the nest.

3. Processing Captured Goshawks

After removal from a trap or nest, goshawks were carried to a pre-determined location near the capture area or nest tree for processing. Each bird was hooded to calm it and to minimize the bird's struggling during handling. A U.S. Fish and Wildlife Service #7A or 7B aluminum lock-on band was attached to one leg and standard morphological measurements were recorded. For genetic analysis, a 0.10 to 0.15 cc sample of blood was drawn from the brachial vein. Each blood sample was mixed with 5 ml of buffer solution in a tightly capped 15 ml test tube and stored at room temperature. Those goshawks selected for radio-telemetry study were then radio-tagged. Finally, all goshawks were photographed prior to release.

4. Radio-transmitter Specifications

All radio-transmitters used in this study transmit within the 150-152 Mhz frequency range, as designated for use by state fish and wildlife agencies. Transmitter packages varied in size and weight depending on the method of attachment, and the age and sex of the bird to be tagged. Regardless of the method of attachment all radio-transmitter packages weighed less than the 3% of body weight as recommended by Kenward (1987) and as specified by the Auxiliary Marking Authorization of the study's U.S. Fish and Wildlife Service Bird Banding Permit.

Two transmitter types were purchased from Biotrack (Dorset, United Kingdom). TW-3 2/3AA transmitters weigh 25 grams and have an average life of 24 months. TW-3 10-35 transmitters weigh 18 grams and have an average life of 12 months. Transmitter ground to ground signal range in lightly wooded terrain is rated at 1.8-2.5 mi. (3-6 km) and 1.3 - 3.8 mi. (2-4 km), respectively for

these units. During actual field use in Southeast Alaska, however, signals from both transmitter types were detected at more than 50 mi. (80 km) during aerial tracking under optimal conditions, although, under most tracking conditions receiving ranges were much less.

5. Radio-Transmitter Attachment

Prior to capture, a decision was made whether or not to radio-tag a specific goshawk based on logistical and financial considerations, such as the proximity of the capture location to existing radio-tracking operations and the cost effectiveness of collecting relocation data from a particular goshawk. Therefore, not all captured goshawks were radio-tagged.

A backpack harness made of 0.25 in. (6.4 mm) PTFE (teflon) tubular ribbon was used to attach transmitters to adult goshawks (Kenward 1987). Transmitter-harness units were held in place by crimping together the four ribbon ends of the harness in a 0.22 in. (5.6 mm) diameter by 0.75 in. (19mm) length of brass tubing at the bird's breast. In adhering to the 3% of body weight limitation, TW-3 2/3AA transmitter-harness units weighing 25 grams were used for adult females, while TW-3 10-35 transmitter harness units weighing 18 grams were used for the smaller adult males.

Fledged juvenile goshawks were radio-tagged by sewing and gluing a TW-3 10-35 transmitter to the two central rectrices (Dunstan 1973; Kenward 1987) once endysis was complete (~3-4 weeks after fledging).

At nest sites located prior to juvenile fledging, nestlings were removed from the nest, fitted with temporary leg-mounted transmitters (Kenward 1987), and returned to the nest. Leg-mounted units consisted of a Telonics (Mesa, Arizona) CHP-1 transmitter modified by the attachment of a bewit (small leather strap) which was sewn together with cotton thread around a nestling's leg. Temporary leg-mounted radio-tags weigh 8 grams and have an average life of 3 months. These small, relatively short-lived transmitters facilitated easy relocation of nestlings after fledging so they could be recaptured and fitted with a larger, longer-lived tail-mounted transmitter once tail feather development was complete. Leg-mounted transmitters were removed when juveniles were recaptured and fitted with tail-mounted transmitters.

6. Radio-Tracking Procedure

Radio-tracking goshawks from ground-based telemetry stations is not feasible in Southeast Alaska. This is due to the region's rugged coastal island geography, the goshawk's extensive movements, and the remote, often roadless areas they inhabit. With the exception of one nocturnal roost location obtained by

triangulation from ground based positions, all relocations were obtained from the air using fixed-wing aircraft (Kenward 1987).

During radio-tracking flights, the pilot and an observer scanned the assigned radio frequencies of tagged goshawks using a Telonics TR-2 receiver and Telonics TS-1 scanner/programmer linked via a switch box to a Telonics RA-2A H-type antenna mounted on each wing strut. When a signal was detected from a radio-tagged goshawk, the pilot and observer would home in on the transmitters signal by using the switch box to isolate the left or right receiving antenna and determine the orientation of the goshawk transmitter in relation to the aircraft. After determining the approximate location of the bird the pilot reduced airspeed, descended to an altitude of approximately 500 feet above ground level, and circled the area in order to more precisely determine the birds location. Once the location of a particular goshawk was determined as accurately as possible, the observer recorded its position on a USGS 1:63,360 topographic map along with an identification code, the date, time, weather, habitat characteristics, and an assessment of the accuracy of the location.

Upon returning to the office, goshawk locations were transferred from the original USGS 1:63,360 maps used in flight to 1:1,320 low elevation aerial photographs and filed. These relocations were later plotted on high resolution orthophoto quadrangles (1:31,680) and assigned a reference number. All relocations were then digitized on the Forest Service's geographic information system (GIS) and assigned a coordinate using the Universal Transverse Mercator (UTM) system. These data points were then used to analyze home range and habitat attributes.

7. Relocation Sampling Interval

Kenward (1987) recommends a minimum of 30 relocations for statistical analysis of home range. In an effort to collect an adequate sample of relocations during the relatively short breeding season, radio-tagged adult goshawks were monitored with greater intensity during the nestling and fledgling dependency periods than during the post-nesting period.

During the nesting period goshawks were monitored at three to four day intervals. On some tracking flights multiple relocations were recorded at approximately two hour intervals, resulting in as many as five relocations per day for individual birds. After the nesting period, radio-tagged goshawks were monitored less frequently. Approximately one relocation per week was recorded for each bird during this period.

8. Home Range and Habitat Analysis

For the preliminary analysis of home range presented in this report, home range areas were determined by minimum convex polygon (White and Garrott 1990). Polygons were constructed on the Forest Service's Ketchikan Area GIS using the outermost relocations for each individual goshawk to define polygons. The area within each polygon was then calculated by the GIS, giving an estimate of home range.

Forest volume class represents one attribute of interest for analysis of goshawk habitat use on the Tongass National Forest, and was selected for preliminary habitat data analysis. Future reports will include more detailed analyses of this and other habitat components, for example, tree species composition, stand size, land cover type, and topography.

The intent of this habitat analysis was to present information on forest volume class use and availability based on radio-telemetry relocation data. This was done by first overlaying goshawk radio-telemetry relocation points on Tongass Land Management Plan (TLMP) volume class maps resident in the Forest Service's Geographic Information System (GIS) data base. Forest volume class at each relocation point was then determined by the GIS and this information was used to represent goshawk volume class use for each bird. The total area of each volume class present within each bird's home range was calculated by the GIS, and this information was used to represent volume class availability. Bar graphs were constructed for each goshawk, comparing the percent area of each volume class present within a home range (availability) with the percent of telemetry relocations in each volume class (use).

III. RESULTS

1. Survey Efforts and Detections

Between March 1 and August 31, 1992 a total of 139,730 acres were surveyed for goshawks with methods A,B, and C, including 123,090 acres in the Ketchikan Area and 16,640 acres in the Stikine Area. A total of 1300 person-hours were accumulated in this effort. Survey efforts resulted in a total of fifteen independent goshawk detections, including twelve confirmed goshawk detections and three probable detections. Of the fifteen total confirmed and probable detections, six were responses to conspecific calls and nine were sightings during observation periods (Table 1).

No goshawks were caught during the wintertime trapping attempt using Swedish goshawk traps. Approximately 740 trap-hours with six traps were accumulated during this effort.

For a more detailed description of goshawk survey and detection techniques and results refer to the Ketchikan Forest Raptor

Study, Progress Report: Ketchikan Area Goshawk Surveys (ADF&G 1993).

2. Nests Located

A total of four confirmed active nests and one probable active nest site were located during the 1992 goshawk study field season. One confirmed active nest at Sarkar Lake on Prince of Wales Island and one probable nest site at Falls Creek on Mitkof Island were located as a direct result of 1992 survey efforts. The three other confirmed active nests visited this season were, Douglas Island near Juneau, Point Bridget near Juneau, and Big John Creek on Kupreanof Island. The Douglas Island nest site was also active in 1991 when it was first reported to ADF&G. The Point Bridget and Big John Creek nests were located and reported in 1992 by Forest Service biologists.

3. Capture Results

A total of 13 goshawks, including five adults and eight juveniles, were handled by ADF&G personnel in 1991 and 1992 (Table 2). Four adults (two pairs) were captured at the Sarkar Lake and Douglas Island active nest sites. All of these birds were trapped using a dho-gazza mist net with a live great horned owl decoy.

A total of six fledged juveniles were trapped at the Sarkar Lake, Douglas Island, Big John Creek, and Falls Creek nest sites. Three of these juveniles were captured on bal-chatri traps baited with live pigeons, and three were captured on noose carpet traps baited with a pigeon carcass. The Sarkar Lake and Douglas Island juvenile females were initially banded and radio-tagged as nestlings by ascending the nest tree with the aid of tree climbing spurs. No goshawks were captured at nest sites using harnessed lure birds.

Additional goshawks handled in 1991 and 1992 include three birds that were initially recovered or captured by the public. A juvenile male was found stunned after flying into a window in Petersburg on November 23, 1991 and turned in to ADF&G (Table 2). This bird was handled prior to the period of this report, but is included here as part of the Table 2 summary of information on all goshawks handled to date. Petersburg ADF&G and Forest Service personnel collected morphological measurements and a blood sample from this bird and then released it.

An adult female was caught in a Swedish goshawk trap at a private waterfowl breeding project at Sunny Point in Juneau on February 10, 1992, and was reported to ADF&G (Table 2). This bird was banded and morphological measurements and a blood sample were collected before its release at Point Bridget near Juneau. This bird was trapped again at the same location on March 18, 1993. It was radio-tagged and released in the Mendenhall Valley, where

it was subsequently located at its nest.

The last goshawk handled in 1992 was an emaciated immature female found on Mitkof Island near Hungry Point, Petersburg on September 8 (Table 2). This bird was delivered to a raptor rehabilitation center in Sitka where it was restored to health. Before release back to the wild, it was banded and radio-tagged by ADF&G and Forest Service personnel. Morphological measurements and a blood sample were also collected. Funding was not available to track this bird aerially, so ground-based relocation was attempted by Forest Service personnel. This method of relocation, however, has been found to be generally difficult in the rugged and often inaccessible terrain of Southeast Alaska. Consequently, this effort resulted in information on general movements only. This goshawk was found dead on Sasby Island near Petersburg 36 days after its release (see: 5. Mortalities).

Blood samples were collected from eleven of the thirteen goshawks handled in 1991 and 1992 (Table 2) and will be used for genetic analysis when a larger sample size is obtained.

4. Radio-Telemetry Results

Of the ten goshawks captured and banded at nest sites, seven were fitted with radio transmitters. These seven goshawks represent two family groups at Sarkar Lake on Prince of Wales Island and Douglas Island near Juneau. A combined total of 170 radio-telemetry relocation points were recorded between June 17, 1992 and March 10, 1993 from the seven goshawks radio-tagged at these two sites. This total does not include juvenile relocation points prior to dispersal.

A. Sarkar Lake, Prince of Wales Island

Four goshawks were captured and radio-tagged at the Sarkar Lake nest site. These four birds comprised one family group including an adult male, adult female, juvenile male, and juvenile female. The juvenile male and juvenile female fledged successfully from this nest in early July, 1992.

a. Adult Home Range Size

An independently sampled relocation point is generally described as one that is separated in time from other relocation points by at least the amount of time necessary for a tagged animal to cross its range (Swihart and Slade 1985, in: Kenward 1987). For preliminary analysis of radio telemetry data in the current study, a minimum sampling interval of one hour was selected. This amount of time was considered a conservative estimate of the time necessary for a goshawk to cross its home range.

A total of 108 individual goshawk relocation points, including 60 adult male and 48 adult female, were recorded for the Sarkar Lake pair between June 17, 1992 and March 10, 1993. Of these 108 relocations, 96 relocations, including 51 male and 45 female, satisfied the independent sample criterion for inclusion in the home range data set analysis. For the male, 32 nesting and 19 post-nesting independent relocations were recorded. For the female, 24 nesting and 21 post-nesting independent relocations were recorded.

Two separate minimum convex home range polygons were constructed for each adult. One home range polygon consisted of relocation points collected during the nesting period only, while the second polygon included all points collected during the nesting and post-nesting periods (Figure 1). Polygons were constructed and their areas calculated by the Forest Service's Ketchikan Area GIS. Polygon areas were described by total area (including all land, salt and fresh water) and by total land area (including land area only) (Tables 3,4, and 5).

At the Sarkar Lake site, initial relocations were made on June 17 during the mid-nestling period. Nesting period polygons for the adult male and adult female were constructed using all independent relocations collected between this date and 10 August. This latter date coincides with the first known date on which both of the juveniles had dispersed from the nest site, and is considered the end of the fledgling dependency period and nesting cycle. Relocations used to construct the total home range polygons for the adult male and adult female included all independent relocation points collected between June 17, 1992 and March 10, 1993, the last date of field data used in this report.

A minimum convex polygon constructed using adult male relocation points collected during the nesting period, describes a breeding home range containing 46,736 ac (73.0 mi^2) of land and water. When fresh and salt water are eliminated from this polygon, the male's breeding home range contains 26,541 ac (41.5 mi^2) of land (Table 3 and Figure 1, polygon C).

A minimum convex polygon constructed using all independent adult male relocations collected between June 17, 1992 and March 10, 1993 describes a total home range containing 169,153 ac (264.3 mi^2) of land and water. With fresh and salt water eliminated from this polygon, the male's total home range contains 75,734 ac (118.3 mi^2) of land (Table 3 and Figure 1, polygon A).

The minimum convex polygon constructed using adult female relocation points collected during the nesting period describes a nesting home range containing 59,309 ac (97.2 mi^2) of land and water. When fresh and salt water are eliminated from this polygon, the female's nesting home range contains 25,737 ac (40.2 mi^2) of land (Table 4 and Figure 1, polygon D). A minimum convex polygon constructed using all independent adult female relocations collected between June 17, 1992 and March 10, 1993 describes a total home range containing 243,783 ac (380.9 mi^2) of

land and water. When fresh and salt water are eliminated from this polygon, the female's total home range contains 174,675 ac (272.9 mi^2) of land (Table 4 and Figure 1, polygon B).

When the adult male and female nesting home range polygons were combined, the resulting area contained a total of 101,596 ac (158.7mi^2) of land and water habitat. With fresh and salt water eliminated, the combined breeding home range of this pair contained an estimated 50,798 ac (79.4 mi^2) of land (Table 5 and Figure 1, polygons C and D).

When the adult male and female total home range polygons were combined, the resulting area contained 390,042 ac (609.4 mi^2) of land and water. When fresh and salt water were eliminated from these polygons, the combined total home range of this pair for the period June 17, 1992 to March 10, 1993 contained an estimated 195,021 ac (304.7 mi^2) of land (Table 5 and Figure 1, polygons A and B).

Adult male and adult female home ranges had little overlap during both nesting and post-nesting periods. For the nesting and total home range polygons, overlap was 4.4% and 5.9%, respectively (Figure 1). During the nesting season the area of overlap contained 4,449 ac (7.0 mi^2) of land and water. In Figure 1, this area was represented by polygon F. When fresh and salt water were eliminated from this area, the nesting home range overlap contains an estimated 2,225 ac (3.5 mi^2) of land (Figure 1, polygon E).

The area of overlap between the total home ranges of this pair for the period June 17, 1992 to March 10, 1993 contained 22,893 ac (35.8 mi^2) of land and water. When fresh and salt water were eliminated, the total home range overlap was estimated at 11,447 ac (17.9mi^2) of land (Figure 1, polygon E).

b. Volume Class Use

Of the 108 relocations recorded for the Sarkar Lake adult goshawks, 94 relocations, including 50 male and 44 female, were used in analyses of volume class selection. Relocations not used in these analyses included 12 which did not meet the independent sample criterion (see: a. Adult Home Range), and two that could not be placed confidently in only one specific habitat type. The Sarkar Lake juvenile male and female could not be relocated following their dispersal from the nest site and, therefore, no volume class use information is available for these birds.

Both tables and bar graphs were developed to depict comparisons between telemetry relocations and habitat availability within the home ranges of the pair of the adult goshawks nesting on POWI. The terrestrial home ranges and telemetry relocations are compared by forest volume class for the adult male and female in Tables 6 and 7, respectively. All adult male relocations and 91% of the adult female relocations occurred in mature forests of

greater than 8,000 board feet/acre (≥ volume class 4). The total land area of the male's and female's home ranges contained only 54.6% and 40.2%, respectively, of forest cover with greater than 8,000 board feet/acre. A disproportionate number of telemetry relocations occurred in volume class 5 forest (20,000 - 30,000 board feet/acre). Although only 21% of the land area of the adult male goshawk's total home range was volume class 5, 56% of the relocations for this bird occurred in this volume class. Similarly, although only 13% of the land area adult female goshawk's total home range was volume class 5, 52% of the relocations for this bird occurred in this volume class. Relocation data analyzed by the GIS also showed that these birds generally avoided unforested habitat and forest stands of less than 8,000 board feet/acre (Figures 2 and 3).

c. Juvenile Dispersal

The two radio-tagged Sarkar Lake juveniles could not be relocated following their presumed dispersal from the nest site despite extensive aerial searches. Dispersal and survival information are, therefore, not available for these birds.

Signals were last detected from the juvenile male and juvenile female in the vicinity of the nest on August 4 and August 10, respectively. Subsequent aerial searches conducted through 30 September covered more than 20,000 mi^2 without detection of either bird's transmitter signal. It was not known if the juveniles dispersed outside of the searched area, if the unlikely event of failure of both radio transmitters occurred, or if some other factor(s) (e.g., search patterns, topography, mortality) prevented signal reception. Despite continued scanning of the juveniles' transmitter frequencies during all telemetry flights after September 30, no radio signals were detected from these birds.

B. Douglas Island, Juneau

Three goshawks were captured and radio-tagged at the Douglas Island nest site. These three birds comprised one family group including an adult male, adult female, and juvenile female. The juvenile female fledged successfully from this nest in late July, 1992.

In an effort to conserve funding, an attempt was made to "piggy-back" Juneau area goshawk telemetry flights on existing brown bear (*Ursus arctos*), mountain goat (*Oreamnos americanus*), and black bear (*Ursus americanus*) radio-tracking flights. While this proved financially beneficial, it resulted in reduced relocation effort for goshawks radio-tagged near Juneau.

a. Adult Home Range Size

A total of 54 adult goshawk relocation points were recorded at the Douglas Island site between July 10, 1992 and March 10, 1993, including 26 adult male relocations and 28 adult female relocations. These include 7 nesting and 19 post-nesting locations for the adult male, and 7 nesting and 21 post-nesting locations for the adult female. Relocation of the Douglas Island female's radio-transmitter has occurred at the same location since September 23, 1992, indicating that this bird has either perished or dropped the radio package. The high elevation and deep snow cover at this location prevented recovery of the transmitter.

Douglas Island goshawk telemetry relocation data was entered into the Forest Service's GIS but it has not been analyzed. Though too few relocation points were collected to construct complete nesting home range and total home range polygons, this data will be useful in examining other attributes important to understanding goshawk ecology on the Tongass National Forest, for example, movements and habitat use. Home range estimates are a function of the number of locations used to generate the estimates and two estimates are not comparable if the sampling effort is not equal (White and Garrott, 1990).

b. Volume Class Use

Volume class use data may not be available for all of the data points because some relocations occurred on non-Forest Service lands.

c. Juvenile Dispersal

A total of 15 relocation points were recorded for this bird between July 10, 1992 and March 10, 1993, including 7 pre-dispersal and 8 post-dispersal locations. The juvenile's first recorded significant movement away from the nest site occurred on August 28, and the greatest recorded distance from the nest was 11 miles (17.6 km) on September 23, 1992.

On November 22, 1992 this bird was relocated 9 miles (14.4 km) from the Douglas Island nest. During subsequent tracking flights on January 13 and February 10, 1993, relocation was again recorded at the same place indicating that this bird had died or lost its transmitter. On March 26, 1993, the transmitter and remains of the bird were recovered at this same location following ground-based radio tracking. Cause of death was not determined.

C. Movements

The Sarkar Lake adult female's nesting home range, including land and water, was calculated to be 27% larger than the nesting home range of the adult male at this site (Tables 3 and 4). The greater size of the female's nesting home range may be accounted for, in part, by the fact that she began movements to the northern portion of her range during this period (Figure 1, polygon D) as soon as the nestlings fledged in early July, while the male did not begin similar movement to the southern portion of his nesting home range until after juvenile dispersal in early August (Figure 1, polygon C). Yet, the total land area of the male's and female's nesting home ranges differed by only 3%.

The adult male's continued foraging for the juveniles though their dispersal may account for his later movement away from the nest site. Food deliveries to the juveniles by the male during this period are implied by repeated relocations of the male in the proximity of the nest site and by direct observation. In contrast, after her first recorded movement away from the nest site on July 13, 1992, the female was relocated again near the nest site only three times through March 10, 1993: July 14, July 16, and February 11. Based on these observations, it is believed that the adult female did little or no foraging for the juveniles after July 16.

A general range expansion was recorded for both the Sarkar Lake adult male and adult female after the nesting period (Figure 1, Tables 3 and 4). This increase in home range area between the end of the nesting period (August 10, 1992) and the end of the recorded post-nesting/winter residency period (March 10, 1993) was 362% for the adult male and 411% for the adult female. These increases reflect distant movements away from the vicinity of the nest site by both the male and female. The greatest distance from the nest recorded during this period was 19 miles (30.4 km) for the male on October 13, 1992, and 34 miles (54.4 km) for the female on December 3, 1992.

Three radio-tagged adult goshawks from the POWI and Douglas Island sites were relocated through the fall and winter within 34 miles of their nests, documenting their winter residency in Southeast Alaska. Relocations of the fourth radio-tagged adult goshawk has occurred at the same location since September 23, 1992, indicating that this bird died or dropped the radio package prior to winter. The juvenile at the Douglas Island site, prior to its death, also failed to exhibit movements indicative of migratory behavior. As noted, the juveniles at the POWI nest site could not be relocated after dispersal and, therefore, no information regarding their post-dispersal or survival was collected.

5. Mortalities

Two mortalities of radio-tagged goshawks were recorded and a third was probable. The Sarkar Lake adult male's transmitter, along with a number of feathers, were recovered at Shipley Creek on Kosciusko Island on March 10, 1993. Little evidence was present to enable a determination of the cause of death, however, the location and appearance of the collected remains indicate that this bird may have been killed here by another raptor between March 2 and 10.

The juvenile female radio-tagged at the Douglas Island nest site was found dead 9 miles (14.4 km) from the nest on March 26, 1993. The remains of this bird were in a decomposed state and cause of death could not be determined.

The Douglas Island female's radio-transmitter was relocated at the same place on Douglas Island since September 23, 1992. This location remains inaccessible at time of writing due to high elevation snow cover, but it is probable that this bird has died.

A juvenile female goshawk originally recovered in an emaciated condition near Petersburg on August 18, was released near the same location on September 8. Although not included as part of the telemetry data set, this rehabilitated bird was radio-tagged to track its progress after release. On October 14, 36 days after its release, this bird was found dead by Forest Service personnel on Sasby Island at Petersburg. When located, the corpse of this bird had a full crop and weighed 875 g. This weight is approximately 265 g less than the bird's weight when it was released. The loss of weight and the obviously thinner condition of the bird indicate that successful foraging was not regular. Cause of death, however, has not been determined. This bird was excluded from mortality figures because it was originally found in an emaciated condition and would have perished earlier without human intervention.

IV. DISCUSSION

Goshawk home range sizes were based on a preliminary analysis of data collected from a single pair of birds at Sarkar Lake on Prince of Wales Island during the nine month period between June 17, 1992 and March 10, 1993. Home range estimates were calculated by the Forest Service's Ketchikan Area GIS and based on the area of simple minimum convex polygons. Applying this relocation data to, for example, harmonic mean or bivariate models (White and Garrot 1990) in future analyses may result in some modification of home range estimates.

A full year of relocation data is desirable to accurately determine total home range size for radio-tagged goshawks and could increase the total home range estimates. The preliminary analysis of nine months of relocation data given in this report does, however, provide a good indication of nesting home range

and total home range size for this pair.

The land area of the nesting home range for the Sarkar Lake pair was 50,798 ac (79.4 mi^2). This area is more than eight times the 6,000 ac (9.4 mi^2) foraging area which must be managed for a known goshawk pair as specified in the USDA Forest Service's "Management Recommendations for the Northern Goshawk in the Southwest United States" (Reynolds, et al. 1992). Although these standards were developed in the southwestern U.S., they are currently being implemented on the Tongass National Forest (USDA Forest Service 1992). Within this 6,000 ac. foraging area, 20 percent (1200 ac), must remain in stands which meet the most important or moderately important habitat structure utilized by young and adult goshawks.

The land area of the total home range of the Sarkar Lake goshawk pair was calculated to be 195,021 ac. (304.7 mi^2) and is 39 times larger than the assumptions used by the "Interagency Viable Population Committee" (Suring, et al. 1993). This committee, when developing a strategy for maintaining viable wildlife populations on the Tongass National Forest, proposed establishing 40,000 acre Habitat Conservation Areas (HCAs) to provide and maintain habitat for eight pairs of goshawks. We were unable to locate and radio-tag adajacent nesting pairs of goshawks to determine spatial overlap and if more than one pair used this large area.

Although no rigorous tests have been conducted to evaluate the accuracy of telemetry relocations used in home range and habitat analyses, sightings of radio-tagged goshawks during radio-tracking flights and the recovery of the Sarkar Lake adult male's transmitter approximately 20 yards (18 m) from its estimated position, suggest that these locations have an acceptable margin of error. Prior to any final analyses of telemetry data, however, accuracy tests will be conducted to establish error estimates.

Additionally, during forest volume class typing of relocation points by the GIS, it was found in some instances that points did not appear to be accurately typed when compared with volume class information from aerial photos and field notes. Consequently, although we agree with others that there appears to be some inaccuracies in the TLMP volume class maps resident in the Forest Services GIS (Brickell 1989), a more thorough analysis of relocation data may be done by using the greater resolution of aerial photographs. Relocation point volume class, stand volume class, timber-type, and slope, for example, may be determined in finer detail on aerial photos than is currently possible using the existing GIS data base. For the purpose of this report, however, only the results of preliminary GIS-based analyses are presented (Tables 3, 4, 5, and Figures 1, 2, 3).

Nesting adult goshawks captured and radio-tagged during the summer of 1992 did not migrate. The one juvenile which was monitored through early winter also did not migrate.

This appears to confirm the opinion of ornithologists who have suspected that goshawks found in this region may maintain their residency year-round (Taverner 1940, Gabrielson and Lincoln 1959).

The initial phase of this radio-telemetry study may be viewed as a determination of the feasibility of collecting relocation data from radio-tagged goshawks in Southeast Alaska. The effort yielded valuable and previously unknown information about home range size, habitat associations, and winter residency of goshawks in this region. Though sample sizes are yet too small for meeting the study plan goal of preparing management recommendations, this is the first time that this kind of information has been obtained for goshawks in Southeast Alaska. As such, the data and other pertinent findings do provide managers with a stronger base of knowledge than has been previously available.

The home range of one pair of goshawks monitored in this study exceeds the allowances made by the Interim Management Guidelines currently being implemented on the Tongass National Forest (USDA Forest Service, 1992). We also found selection by this pair for mature forests of greater than 8,000 board feet/acre. Habitats are sufficiently different in Southeast Alaska, and preliminary analysis of data suggests, that knowledge of this species' relative abundance and habitat associations from other portions of its range may not apply to the coastal rainforest environment. The continuation of research to acquire more data on the goshawk in Southeast Alaska is desirable and appropriate. The interpretation of the new data resulting from this study will serve to enhance natural resource management capabilities.

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Table 1. 1992 Survey Results: Goshawk Detections.

Goshawk Detection[1]	Date	Description
a[P]	3/26/92	Thorne River, POWI, 3015 road adjacent to unit #575-121. Probable goshawk response (wailing call) to playback recording alarm call. No visual, unconfirmed.
b[C]	3/30/92	Sarkar Lakes, POWI. Adult female goshawk vocal response and visual observation following playback recording of alarm call.
c[C]	4/07/92	Grant Creek, Misty Fjords Nat. Mon. Adult male goshawk soaring up from suspected nest stand.
d[C]	4/08/92	Grant Creek, Misty Fjords Nat. Mon. Adult male goshawk soaring up from suspected nest stand. Bird flew to treetop on an adjacent ridge.
e[C]	4/09/92	Grant Creek, Misty Fjords Nat. Mon. Adult male goshawk perched in snagtop in suspected nest stand. Bird later soared up and out of sight to southeast.
f[C]	4/21/92	Sarkar Lakes, POWI. Vocal response to playback recording of alarm call.
g[C]	4/22/92	Sarheen area, POWI. Goshawk (unidentified age and sex) flying along ridge in response to playback recording of alarm call (?).
h[P]	4/23/92	Etolin Island. Probable goshawk (unconfirmed) soaring up from forested stand southwest of USFS bunkhouse. Later flew out of sight to the north.

[1] [C] = confirmed detection. [P] = probable detection.

Table 1. (continued)

Goshawk Detection[1]	Date	Description
i[C]	4/24/92	Etolin Island. Adult male goshawk perched in snagtop on mountainside behind USFS bunkhouse. Bird later flew down into forest on apparent hunting flight.
j[C]	4/29/92	Pan Creek, Mitkof Island. Male goshawk (unidentified age) soaring up from forest in vicinity of previous sightings. Bird flew out of sight to the north.
k[C]	6/24/92	Suemez Island. Male goshawk (unidentified age) soaring up from historic nest stand. Bird flew across Port Refugio and out of sight to the northwest.
l[C]	6/26/92	Suemez Island. Adult male goshawk flying along ridge above historic nest stand.
m[C]	7/01/92	Sarheen Creek, POWI. Goshawk (unidentified age and sex) in flight and carrying large prey item along ridgetop.
n[P]	7/07/92	North Revillagigedo Island. Probable (unconfirmed) goshawk vocal response to playback recording of alarm call broadcast from boat in Hassler Pass.
o[C]	8/14/92	Falls Creek, Mitkof Island. Immature male goshawk response (vocalizations and visual) to playback recording of adult female wailing call. Bird was subsequently trapped.

[1] [C] = confirmed detection. [P] = probable detection.

Table 2. Goshawks Handled in 1991 and 1992 in Southeast Alaska: Date, Location, Age, Sex, Band Number, Radio-transmitter, and Blood Sample.

Date	Location	Indiv.	USFWS Band/Leg	Radio	Blood
11/23/91	Petersburg	juvenile male[1]	(none)	no	yes
02/10/92	Sunny Point, Juneau	adult female[2]	1387-02003/L	no[3]	yes
06/10/92	Sarkar Lake, P.O.W. Is.	adult female	1387-64171/R	yes	yes
06/10/92	Sarkar Lake, P.O.W. Is.	adult male	1807-41951/L	yes	yes
06/29/92	Sarkar Lake, P.O.W. Is.	juvenile female	1807-41952/R	yes	no
07/28/92	Sarkar Lake, P.O.W. Is.	juvenile male	1807-41954/L	yes	yes
07/02/92	Douglas Is., Juneau	adult female	1387-64173/L	yes	yes
07/02/92	Douglas Is., Juneau	adult male	1807-41953/R	yes	yes
07/02/92	Douglas Is., Juneau	juvenile female	1387-64172/R	yes	no
08/12/92	Big John Crk Kupreanof Is	juvenile female	1387-64174/R	no	yes
08/12/92	Big John Crk Kupreanof Is	juvenile female	1387-64175/L	no	yes
08/14/92	Falls Creek, Mitkof Is.	juvenile male	1807-41955/R	no	yes
09/08/92	Petersburg	juvenile female[4]	1807-41961/R	yes	yes

[1] Bird handled prior to report period. Was stunned after flying into window. Morphological measurements and blood sample taken, then released.

[2,3] Bird caught in trap near waterfowl ponds. Banded and blood sample taken. Bird caught again at same location on 03/18/93. Morphological measurements taken and radio-tagged.

[4] Bird found in emaciated condition. Rehabilitated and released after banding, radio-tagging, collection of morphological measurements and blood.

Table 3. Sarkar Lake Adult Male Goshawk: Area of Total Home Range and Nesting Home Range.[1]

	Total Home Range[2]	Nesting Home Range[3]
Polygon area with water	169,153 ac. (A)[4]	46,736 ac. (C)[5]
Polygon area without water	75,734 ac.	26,541 ac.

[1] Area of minimum convex polygon calculated by USDA Forest Service, Ketchikan Area GIS.
[2] June 17, 1992 - March 10, 1993. n = 51 telemetry relocations.
[3] June 17 - August 10, 1992. n = 32 telemetry relocations.
[4] Figure 1, polygon A.
[5] Figure 1, polygon C.

Table 4. Sarkar Lake Adult Female Goshawk: Area of Total Home Range and Nesting Home Range.[1]

	Total Home Range[2]	Nesting Home Range[3]
Polygon Area with water	243,783 ac.(B)[4]	59,309 ac.(D)[5]
Polygon Area without water	174,675 ac.	25,737 ac.

[1] Area of minimum convex polygon calculated by USDA Forest Service, Ketchikan Area GIS.
[2] June 17, 1992 - March 10, 1993. n = 45 telemetry relocations.
[3] June 17 - August 10, 1992. n = 24 telemetry relocations.
[4] Figure 1, polygon B.
[5] Figure 1, polygon D.

Table 5. Sarkar Lake Adult Male and Female Goshawks: Area of Pair Total Home Range and Nesting Home Range.[1]

	Total Home Range[2]	Nesting Home Range[3]
Polygon area with water	390,042 ac.(A+B)[4]	101,596 ac.(C+D)[5]
Polygon area without water	195,021 ac.	50,798 ac.

[1] Area of minimum convex polygon calculated by USDA Forest Service, Ketchikan Area GIS.
[2] June 17, 1992 - March 10, 1993. n = 96 telemetry relocations.
[3] June 17 - August, 1992. n = 56 telemetry locations.
[4] Figure 1, polygons A and B combined.
[5] Figure 1, polygons C and D combined.

Table 6. Sarkar Lake Adult Male Goshawk: Home Range Land Area and Telemetry Relocations by Forest Volume Class.[1,2]

Volume Class[3]	Area (ac.)	% of Home Range Total Land Area	# Telemetry Relocations	% Telemetry Relocations
<3	12,283	16.2	0	0
3	22,112	29.2	0	0
4	9,607	12.7	9	18.0
5	16,232	21.4	28	56.0
6	10,126	13.4	11	22.0
7	5,373	7.1	2	4.0
Total	75,733[4]	100.0	50	100.0

Table 7. Sarkar Lake Adult Female Goshawk: Home Range Land Area and Telemetry Relocations by Forest Volume Class.[1,2]

Volume Class[3]	Area (ac.)	% of Home Range Total Land Area	# Telemetry Relocations	% Telemetry Relocations
<3	90,127	51.6	1	2.3
3	14,335	8.2	3	6.8
4	40,239	23.0	13	29.6
5	22,285	12.8	23	52.3
6	4,923	2.8	2	4.5
7	2,766	1.6	2	4.5
Total	174,675[4]	100.0	44	100.0

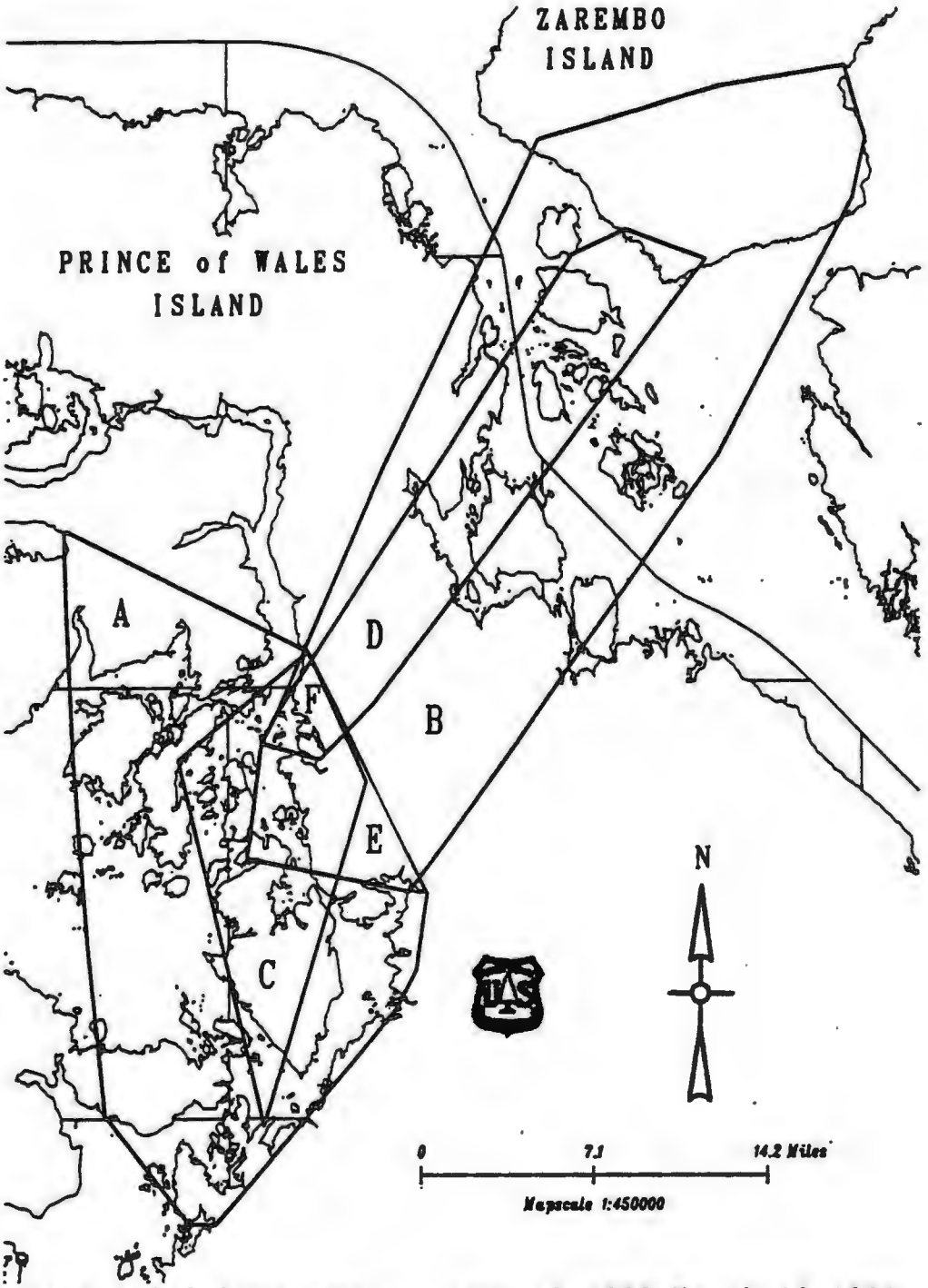
1 Home range area and forest volume classifications by USDA Forest Service, Ketchikan Area GIS.

2 Telemetry relocation data collected June 17, 1992 - March 10, 1993.

3 <3 = low productivity forest and non-forest cover types.
3 = <8,000 bf/ac
4 = 8,000 - 20,000 bf/ac
5 = 20,000 - 30,000 bf/ac
6 = 30,000 - 50,000 bf/ac
7 = 50,000+ bf/ac

4 Equals total land area of home range polygon. For adult male, see Figure 1 polygon A and Table 3. For adult female, see Figure 1, polygon B and Table 4.

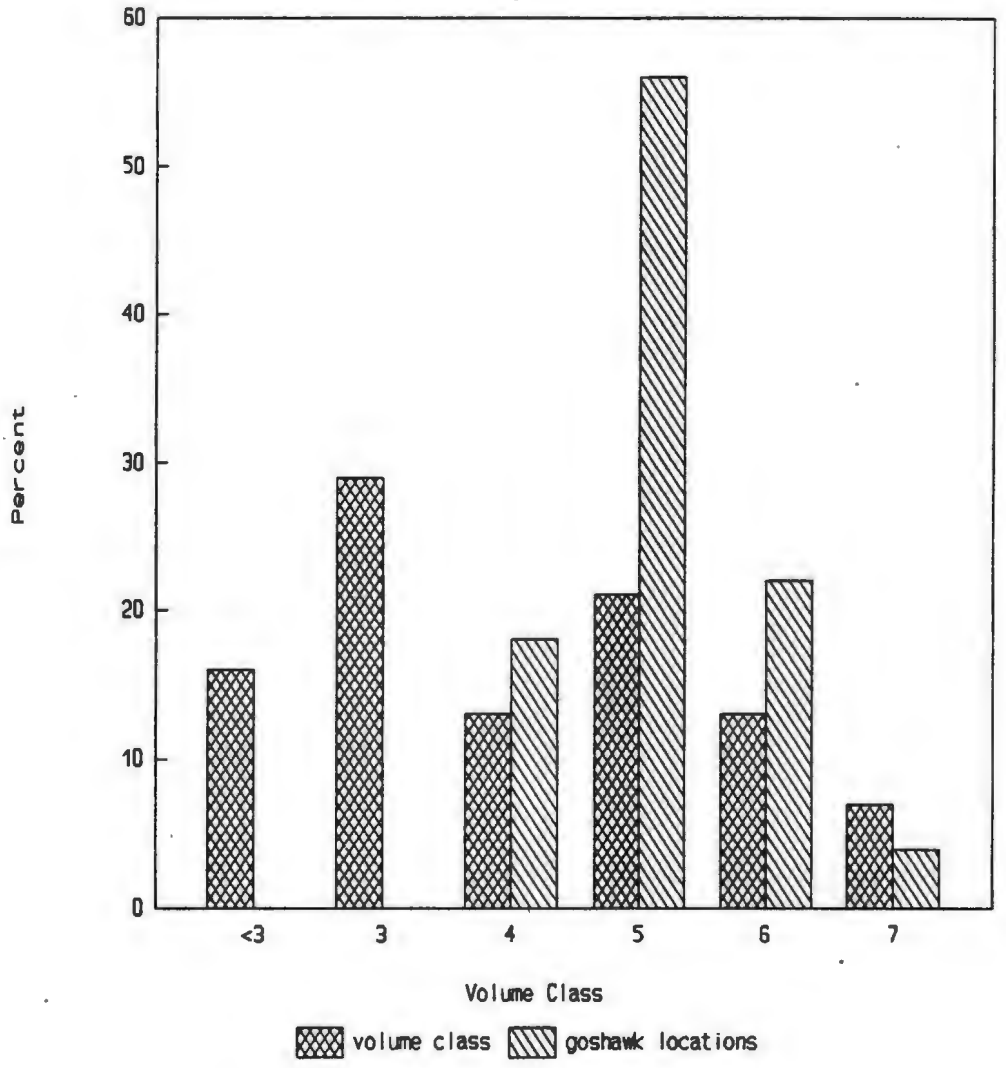
Figure 1. Sarkar Lake Adult Male and Female Goshawk Home Range Polygons. June,1992-March,1993.*



A = Adult male total home range. June 17,1992-March 10,1993.
B = Adult female total home range. June 17,1992-March 10,1993.
C = Adult male nesting home range. June 17,1992-August 10,1992.
D = Adult female nesting home range. June 17,1992-August 10,1992.
E = Adult male and female total home range overlap.
F = Adult male and female nesting home range overlap.

* See text and Tables 3,4 and 5 for description of polygons.

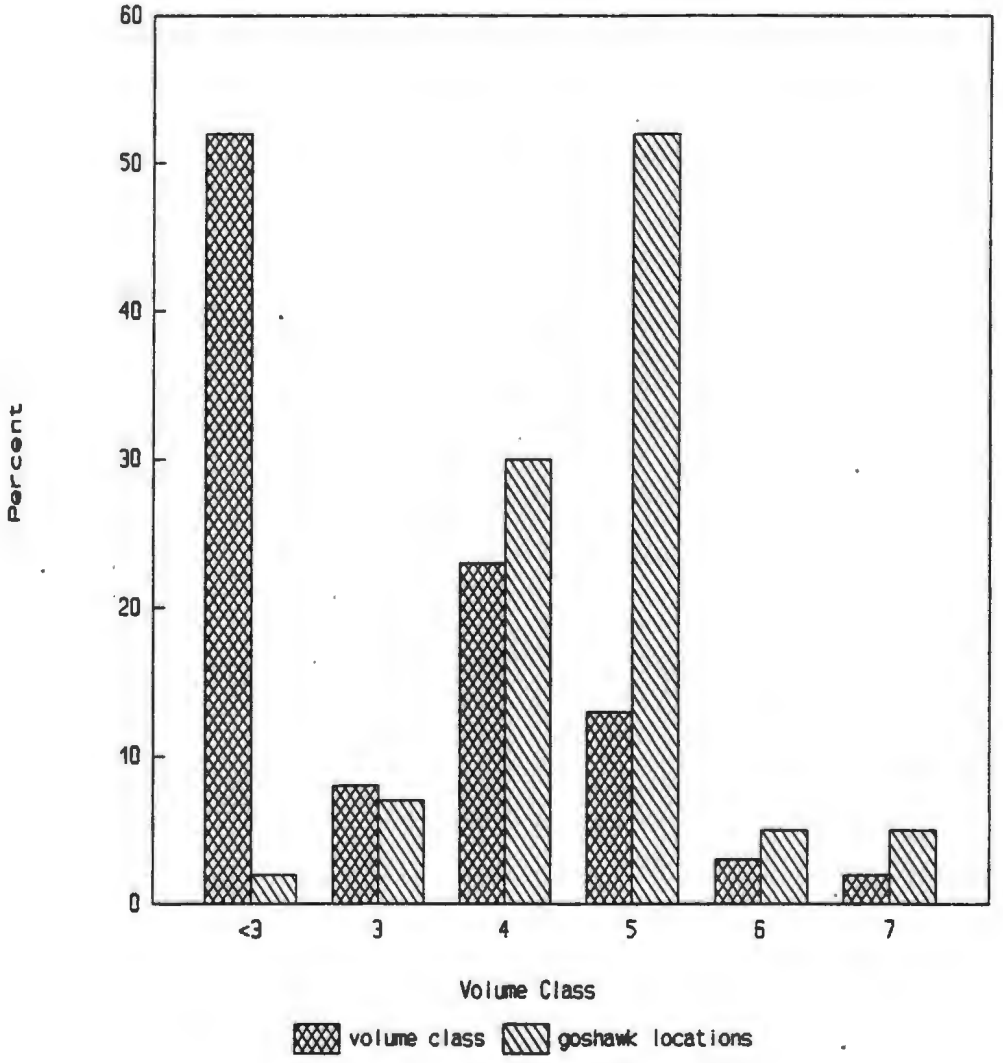
Figure 2. Sarkar Lake Adult Male Goshawk: Home Range[1] Forest Volume Class Availability and Use[2]



1 Home range telemetry data collected June 17, 1992 - March 10, 1993. n = 50 relocations.

2 Home range area and forest volume classifications by USDA Forest Service, Ketchikan Area GIS. Availability of each volume class represented as percent of home range total land area. Volume class use represented as percent of total relocations. See Table 6.

Figure 3. Sarkar Lake Adult Female Goshawk: Home Range[1] Forest Volume Class Availability and Use[2]



1 Home range telemetry data collected June 17, 1992 - March 10, 1993. n = 45 relocations.

2 Home range area and forest volume classifications by USDA Forest Service, Ketchikan Area GIS. Availability of each volume class represented as percent of home range total land area. Volume class use expressed as percent of total relocations. See Table 7.