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LANDSCAPE USE AND RANGING PATTERNS OF HAIRY WOODPECKERS IN THE MANAGED FORESTS OF WESTERN WASHINGTON

Preliminary Report of Field Results to
the Cooperative Monitoring, Evaluation, and Research Committee

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Summary

This paper reports the findings of the first season of a two-year project. The primary objective of this research is to describe Hairy Woodpecker (*Picoides villosus*) landscape and microhabitat use of the industrial forests in western Washington. Habitat associations of the Hairy Woodpecker will be investigated by radio-tracking nesting woodpeckers to determine what types of forest stands they utilize for foraging, and by assessing the characteristics of specific trees on which they feed. During the spring and summer of 2000, we captured six adult and two fledgling Hairy Woodpeckers at their nest cavities and outfitted them with radio transmitters. Using triangulation from three fixed receiver sites, we located birds within forest stands primarily during the post-fledging period. We also used homing techniques to obtain visual locations of the woodpeckers in order to identify specific foraging trees.

The home range of each bird was determined using point locations obtained by triangulation. We conducted Minimum Convex Polygon analyses that removed 10% of outlying points, producing home range estimates that excluded low-use areas. Home range size varied a great deal between birds (6.7 – 113.3 ha), but all of the woodpeckers remained near to the cavity tree (< 1.5 km), during the post-fledging period. Vegetation data collected on specific foraging trees showed several significant differences from random trees. Hairy Woodpeckers foraged on both dead (45.5% of used trees) and live trees (54.5%), but our findings indicated that the birds tend to utilize trees with some decay. The amount of moss covering of branches was significantly greater (60.0%, $p = 0.039$), the proportion of dead branches higher (0.636, $p = 0.023$), and the presence of fungal conks was more frequent (0.364, $p = 0.009$) on used trees compared to random trees (moss on branches = 35%, proportion of dead branches = 0.382, proportion with fungal conks = 0.045). A higher proportion of Hairy Woodpecker foraging trees (0.55) contained insect exit holes than random trees (0.23, $p = 0.030$). We are currently in the process of analyzing woodpecker use areas using Geographic Information System (GIS) forest stand databases; this landscape analysis will allow us to determine the forest stand types used by foraging Hairy Woodpeckers.

Introduction

In the timberlands of western Washington, the Hairy Woodpecker is a keystone cavity-excavating species that supplies cavities for other wildlife. In the Pacific Northwest, at least 54 species utilize cavities excavated by woodpeckers (Brown 1985). Forest management practices that address the habitat requirements of the Hairy Woodpecker, the most common primary cavity-excavator on the Olympic Peninsula, would therefore help to conserve many other species of wildlife. Most of the previous research that has been conducted on the Hairy Woodpecker in Washington forests has focused upon the nesting ecology of this species (McClelland and Frissell 1975, Nelson 1989, Ohmann et al. 1994). These studies indicate that Hairy Woodpeckers require large snags for nesting and tend to be associated with old-growth forest.

Very little information is available regarding the foraging habits of the Hairy Woodpecker in Washington forests. Mannan et al. (1980) investigated the use of forest stands, ranging in age from 35 to > 200 years old, by several species of cavity-nesting birds, including Hairy Woodpeckers. Their findings show that the density and diversity of cavity-nesters increased with older stands, and that foraging sign and visual observations of foraging birds also increased as a function of stand age. Hairy Woodpeckers showed a tendency toward using large snags (>50 cm DBH); 81% of the used foraging trees found in this study were large snags located within, or on the edges of, old-growth stands (Mannan et al. 1980).

Lundquist (1988) studied the foraging preferences of Hairy Woodpeckers in the Douglas fir (*Pseudotsuga menziesii*)/ Western Hemlock (*Tsuga heterophylla*) forests of the southern Washington Cascades. The forest stands investigated by Lundquist were also relatively old (55 to 730 yr) compared to industrial forests. No correlation was found between the abundance of foraging Hairy Woodpeckers and the age of forest stands, though snags used by foraging woodpeckers were significantly larger than random trees.

In many of the industrial forests of western Washington, stands tend to be relatively young, with a majority of stands being <100 years old. Recent work by Huss et al. (1999) in western Washington indicated that the Hairy Woodpecker inhabits and may prosper in managed, secondary forests, at least in certain circumstances. This research determined that Hairy Woodpeckers tended to nest at stand edges between mature second-growth (50-80 yr) and clear-cut areas or young stands. Over the course of three seasons, Huss et al. (1999) documented the nesting microhabitat of the Hairy Woodpecker in a working forest matrix. A high nest success rate over those three years, 88.2%, suggested that the reproduction of these birds is adequate for population replacement. The present study seeks to further quantify the habitat and landscape features required by this keystone species.

The ranging behavior, landscape preferences, and foraging requirements of the Hairy Woodpecker are mostly unknown. Documentation of this bird's landscape needs is required to understand what management strategies would be most suitable for maintaining populations of this bird in industrial forests. Furthermore, knowledge of the Hairy Woodpecker's macrohabitat requirements will allow land managers to determine the landscape situations in which the application of management techniques (e.g., snag creation, fungal inoculation) will be most economical and conservation-effective.

Over the course of two years, this study will address both the macro- and micro-habitat associations of foraging Hairy Woodpeckers in industrial forests by focusing on the following research questions:

1. What characteristics of foraging trees are important to Hairy Woodpeckers?
   H_O: Trees used by Hairy Woodpeckers for foraging do not differ from random trees.
   H_A: Trees used by foraging Hairy Woodpeckers have characteristics different from random trees.

2. What vegetative structure is characteristic of Hairy Woodpecker foraging tree areas (e.g., tree density, species composition, snag density)?
   H_O: Hairy Woodpeckers forage in stands with characteristics no different than random plots.
   H_A: Hairy Woodpeckers select stands with specific characteristics for foraging.

3. What stage of forest growth (e.g., mature, secondary, clear-cut) do Hairy Woodpeckers prefer to forage in?

H_O: Hairy Woodpeckers forage in a variety of forest stands in equal proportion to their availability.

H_A: This species uses primarily mature/old growth stands to forage (Mannan et al. 1980).

4. Do Hairy Woodpeckers more often use relatively large forest patches or are they able to forage in a variety of habitat patch sizes?

H_O: Hairies are able to utilize a mosiac of different forest stand sizes effectively.

H_A: Hairy Woodpeckers primarily use relatively continuous tracts of forest for foraging.

5. Is edge or forest interior preferred for foraging?

H_O: Hairy Woodpeckers use edge habitats and forest interiors in proportion to their availability.

H_1: Hairy Woodpeckers forage mostly in forest interiors.

H_2: Hairies use forest edges frequently.

In this report we present a preliminary analysis of data collected in the first year of a planned 2-yr study. Thus far, we have collected and analyzed data primarily addressing the first two hypotheses described above. We have established a GIS database and received habitat data layers from Rayonier. In addition, we have completed the development of a data layer for Hairy Woodpecker use locations documented in 2000. At this time, we still have gaps in our GIS coverage of woodpecker home ranges, and are in the process of obtaining additional landscape data from the Washington Department of Natural Resources. With the second year of field data collection, and after additional landscape data layers are obtained, we will be able to address hypotheses 3 through 5 listed above.

Study Areas

In May of 2000, we initiated nest-searching in the managed forests throughout an approximately 60 km^2 area 4 km north and 2 km west of Forks, Clallam County, Washington. Nest-searching was concentrated along the main logging roads of D2000, D5200, and RY5000, as well as intersecting secondary logging roads. These forests are maintained by both public and private landowners primarily for timber harvesting, and consist of a heterogenous matrix of recent clear-cuts, young stands, mature growth (>50 yr), and a small proportion of old growth (>100 yr) concentrated mainly in riparian areas. Forest stands are dominated by Western Hemlock (*Tsuga heterophylla*), with the secondary species being Sitka spruce (*Picea sitchensis*).

Methods

Nest searching

Hairy Woodpecker nests were found by intensively searching forest edges for suitable snags and examining those snags for fresh cavities. Adult and nestling vocalizations, as well as food delivery activities by adults, were used to locate nest sites. If adult woodpeckers were seen in an area, they were observed until a nest cavity was found. When adult birds showed no signs of nesting (e.g., making trips to a nest cavity) after approximately one hour, we discontinued observations.

We concentrated our search efforts along forest edges based on the findings of Huss et al. (1999). This study, which focused on the nesting ecology of Hairy Woodpeckers and Northern Flickers (*Colaptes auratus*), was conducted in the same managed forest lands and population of woodpeckers as this current study. Intensive nest searching by Huss et al. (1999) in both edge habitats and forest interiors resulted in almost all Hairy Woodpecker nests being found on edges. Used nest trees were significantly closer to edges (mean =27.2 m; $p = 0.001$) than suitable but unoccupied random trees (mean =143.5 m). This is consistent with the findings of Nelson (1988), who stated that Hairy Woodpecker nest sites tended to be near clearings within the older forests of her study areas. Huss et al. (1999) often found Hairy Woodpeckers foraging in forest interiors, but these birds were subsequently followed to nest sites on the edges of stands. Based upon these findings, and because we had a limited time in which to locate nests, we attempted to maximize our nest-finding efficiency by searching forest edges for nesting Hairy Woodpeckers. Given the placement of nests near forest edges, the birds had several different habitat types (e.g., clear-cut, young forest, mature growth, forest interior) and stand sizes available to them for foraging.

Nesting Success

After a Hairy Woodpecker nest was documented as occupied, based on hearing chick vocalizations, it was revisited at least every other day. Observations lasted approximately 0.5 - 1 hour. We recorded the activity and vocalizations of the chicks, as well as the feeding activities and other behavior of the parent birds. A nest was considered successful if we observed chicks poking their heads out of the cavity to obtain food, or if we observed the chicks actually fledging from the nest (two occasions). A nest was recorded as "failed" if the chicks, which frequently vocalize during nest observations, disappeared from the cavity before pre-fledging behavior (e.g., heads poking out of cavity) was observed, and before the estimated fledging date. Hairy Woodpecker young fledge at approximately 28 days (Jackman 1975).

Capturing and Radio-tagging Woodpeckers

We initiated trapping at four Hairy Woodpecker nests that contained young after 19 May 2000. Previous research on Hairy Woodpeckers has not involved capturing birds and therefore, no standard methodology for accomplishing this objective was available to us. We were required to locate nests and then develop and refine appropriate capture techniques that would permit us to trap woodpeckers safely at their nest cavities. We successfully developed these techniques within three weeks after we began field work.

Woodpeckers were trapped at their nest cavities using either a hoop net on a pole (Bull and Holthausen 1993), or a canopy net (Munn 1994). The hoop net was fabricated using a 60 x 90 cm black fish net frame, fitted with mist net mesh and attached to a telescopic fiberglass pole that could be extended up to 10 m. The weight of the net frame caused the fiberglass pole to bend and made control of the hoop net over heights of 6 m very difficult. Trapping at higher cavities required the use of canopy nets hoisted up to the cavity height by a pulley system (following Munn 1994). We used modified canopy nets (Avinet, New Jersey) that hung vertically (3 x 6 m) and were attached by loops to horizontal poles on the top and bottom of the net. To further modify these nets, we re-tied the horizontal trammel lines so that they were 30 cm apart, which increased the size of the bags between trammel lines. These two trapping techniques, once refined, were very effective at capturing Hairy Woodpeckers at their nest cavities.

Captured birds were outfitted with 1.5-g radio transmitters that were attached using a modified figure-eight harness (Rappole and Tipton 1991). An elastic thread was secured with super glue in the anterior tube of the transmitter, and was fitted to the bird so that two loops could be positioned around the base of the birds' legs snugly. The thread was then placed through the posterior tube of the transmitter, knotted, and secured with super glue.

Radio-tracking

The woodpeckers were tracked using a combination of triangulation and homing. We initially attempted to use the homing technique exclusively, but this proved to be difficult and provided little data. The rugged terrain, thick forest vegetation structure, and intersecting streams slowed our movements to such an extent that we could not follow foraging birds successfully. The woodpecker most often moved out of the area before we could home to their location and establish visual contact with the subject bird. Therefore, in order to collect landscape use data on each bird, we obtained triangulated locations by recording a compass bearing to the strongest transmitter signal from three established receiver sites within a 5-minute period. Receiver sites were established prior to the tracking sessions and remained fixed throughout the season. We used a Trimble GPS receiver (Sunnyvale, CA) to obtain coordinates for all radio-tracking receiver sites and these locations were then differentially corrected.

Data Analysis

Receiver bearing sets were entered into the OTA Triangulation Program (Hoover 1994), which provided a location estimate based on the convergence of bearings from receiver sites. This program also calculated error ellipses around each point using the Maximum Likelihood Estimate technique (99% probability ellipse), providing an estimate of the accuracy of each location. To eliminate poor triangulations or low-accuracy locations, we only accepted points that had an error ellipse smaller than 50-ha (Usable Locations, Table 1), with most ellipses far below this cut-off (mean = 3.84 ha, N = 399).

Calhome (Baldwin 1994) was utilized to estimate the home range of each bird based on the triangulated locations that met the error ellipse criteria (< 50 ha). The Calhome program was chosen based on its compatibility with our data format and its ease of use. Home ranges were calculated using the Minimum Convex Polygon (MCP) technique, a standard home range estimation method that has been used in previous woodpecker telemetry studies (e.g., Bull and Holthausen 1993). We made 10 MCP home range size estimates on each bird, using 10 - 100% of the telemetry location points. Polygons containing less than 100% of points differentially excluded outlying point locations (e.g., 90% analysis excluded the outlying 10% of points). Average home range size disproportionately increased as the amount of points used in the MCP analysis increased from 90% to 100% (Figure 1). Therefore, we established our definition of woodpecker estimated home ranges as those that contain 90% of the point locations in order to eliminate low use areas from further analyses.

Each use location point will also be entered into a Geographic Information System (GIS) database to determine the woodpeckers' macrohabitat selection patterns. We have obtained databases from Rayonier and have requested databases from the Washington Department of Natural Resources depicting the areas where we tracked woodpeckers, so that we may proceed with the GIS analysis. This analysis will allow us to determine the available habitats within each bird's home range, and to compare the proportions of available habitat with the frequency of actual woodpecker use of habitats.

Foraging Trees

By homing to radio-tagged birds and by opportunistic observations, we also obtained visual sightings of Hairy Woodpeckers on specific foraging trees. Upon sighting the birds, we recorded the sex of the individual, its activity (e.g., pecking, gleaning), the height of the bird's foraging activity, whether the bird was on a branch or the trunk, whether the branch was dead or alive, and the bird's location on the branch (e.g., tip, midsection, or base). We also obtained the location of the tree using a GPS receiver.

These "used" foraging trees were later measured for a number a different microhabitat variables. We followed BBIRD protocol (Martin and Conway 1994) for vegetation sampling, with several modifications. The BBIRD sampling method consists of measuring habitat and vegetation variables (e.g., number of trees in various diameter classes, snags, and percent canopy cover) in an 11.3-m radius around the foraging tree. We added several variables that could potentially be important to a bark-gleaning Hairy Woodpecker. These include the proportion dead branches on the tree, the amount of moss covering on the tree, presence of fungal growth, distance to stand edge (if in a stand), distance to nearest stand (if in a clear-cut), and whether the tree was a snag. We also measured the presence of insect exit holes; designated as present (1) or absent (0). We also modified the size classes of surrounding trees to include 38 – 52 cm DBH and >52 cm DBH classes. Variables analyzed are listed in Table 2.

Each used foraging tree was paired with a random tree, which was determined by taking a random compass bearing and a random distance (up to 225 m) from the used tree. Vegetation data from these random trees were then compared to the used trees using two-sample t-tests and chi-square analyses.

Results and Observations

Nesting success

Fourteen Hairy Woodpecker nests were located between 10 May and 6 June, 2000. Of these fourteen, eleven fledged young while three failed, resulting in a success rate of 78.6%. Ten of the fourteen nests were located during the first week of the field season, 8 – 15 May. In a three day period during the second week of the study, eight of these nests fledged young and two failed. The remaining four nests were found in subsequent weeks. Two of these later nests fledged during the first week of June, one nest failed, and the other did not fledge until 24 June. The exact number of fledglings was determined for two nests, wherein one nest fledged three young and the other, one bird. Of the three failed nests, two failed within the first ten days after hatching, and one nest was lost at approximately 14 days post-hatching.

Radio-telemetry

Six adult and two fledgling Hairy Woodpeckers were captured at four nests. We trapped both parent birds at two nests (Nests 00-6 and 00-14). The adult female at Nest 00-6 was trapped on 3 June, when the chicks were approximately 5 days old. The male of that nest was caught on 13 June. Nest 00-6 was an extremely late nesting attempt (the fledging date was 24 June), and may represent a second nesting attempt after an earlier nest failure. This nest fledged only one young bird. Both of the parent birds at Nest 00-14 were captured on 10 June, two days prior to the young fledging on 12 June.

At Nest 00-13, we trapped and radio-tagged the adult male and two fledgling birds on 30 May while fledging was in progress. One adult female at Nest 00-11 was captured on 1 June. This bird appeared to be raising her fledglings alone, as no male was ever observed tending the nest. This nest failed approximately two days after we radio-tagged the bird. During those two days, she continued regular feedings at the nest cavity. We speculate that the demands on this female of feeding her nestlings without assistance caused the nest to fail.

Tracking duration ranged from 48 to 61 days (Table 1), with the exception of the male bird at Nest 00-6. We were only able to track this bird for 37 days, as the transmitter came off the bird and was later recovered. An average of 102 triangulations were attempted per bird. The number of triangulations completed was slightly lower, averaging 97 per bird. Using the calculated error ellipses with a criterion of 50 ha, we accepted a mean of 50 usable locations per bird that were included in the home range analysis (Table 1).

Home range size varied from 26.8 to 361.7 ha (mean = 127.8 ha) when 100% of points were used. The home ranges of all birds became substantially smaller (mean = 58.5 ha) when only primary home ranges (90% of use locations) were included in size estimates (6.7 – 113.3 ha; Figure 1). Based on our field observations, we believe the smaller home range size estimates more accurately reflect the areas of use. We note that the home range size for the female (6F; Figure 2) was substantially larger (109.6 ha at 90% of use locations) than that of the male (13.4 ha at 90% use locations; Figure 3), though both were centered near to the nest. We have included the nest location in these figures as a reference point.

Home range polygons will be utilized as the basis for our GIS landscape use analysis. Home ranges including 100% of points will provide an estimate of the extent of the habitat available to each bird. Point locations within the home ranges will allow for an analysis of habitat use in relation to availability. As this study progresses, we also

also plan further evaluate the telemetry data using alternative home range estimation techniques that focus on areas of high use (e.g., adaptive kernel method).

Foraging Trees

We were able to locate 22 trees on which Hairy Woodpeckers were foraging. Of these, 14 trees were identified by homing to radio-tagged birds, while eight were the result of opportunistic observations of four radio-tagged birds and four unmarked Hairy Woodpeckers. Vegetation characteristics of each foraging tree, including characteristics of the tree itself as well as surrounding vegetation, were compared using two-sample t-tests and chi-square analyses (Table 2). Of the habitat variables measured, we found that four were significantly different ($p < 0.05$) between foraging and random trees. The proportion of dead branches on trees used for foraging (mean = 0.636) was greater ($p = 0.039$) than that on random trees (mean = 0.382). Also, a greater proportion of foraging trees had fungal conks (0.364) than did random trees (0.046, $X^2 = 6.84$, df = 1, $p = 0.009$). The percentage of moss covering on branches was greater ($p = 0.023$) on used trees (mean = 60%) as compared to random trees (mean = 23%). Finally, the presence of insect holes was more frequent (0.545) on used foraging trees than on random trees (0.227, $X^2 = 4.7$, df = 1, $p = 0.030$).

There were only two trees (9%) used by foraging Hairy Woodpeckers that were completely alive. However, snags comprised only 45% of all foraging trees, compared with 22.7% of random trees a difference that was not significant ($X^2 = 2.53$, df = 1,$p = 0.112$). These results suggest that Hairy Woodpeckers may prefer some decay on foraging trees, but that entirely dead trees (snags) are not essential.

Discussion

The reproductive success of Hairy Woodpeckers, 78.6% (N = 14 nests), determined during the 2000 field season was slightly lower than the nesting success of 88.2% (N = 34) determined for Hairy Woodpeckers during previous work in this area (Huss et al. 1999). Most of the nests we located (10 of 14) fledged (8) or failed (2) during the three-day period of 17-19 of May. This fledging event occurred earlier than the mean fledging date of 31 May previously observed by Huss et al. (1999) over the course of three nesting seasons, 1996-1998.

Our telemetry results suggested that Hairy Woodpeckers maintain a relatively small home range in the vicinity of their nest cavities (mean = 58.51 ha using 90% MCP). From our limited observations (N = 1 nest with fledglings), family units remained together within the month after fledging takes place. The home ranges of the two fledglings and the adult male at Nest 00-13 overlapped by approximately 90% (Figures 5 – 7). In the nest areas where we trapped both parent birds, we found that the adults also stayed in the nest area after nesting had concluded. In one case, Nest 00-6, the adult male maintained a small home range near the nest site, while the female ventured into other forest stands and then returned (see Figures 1 and 2). This was reflected in the large home range size of the female, 6F (109.6 ha using 90% of point locations) as opposed to the male, 6M (13.4 ha using 90% of point locations). The adult birds of Nest 00-14 also remained in the same stand as the nest tree and were often located together in the same small area. On one occasion, we located these birds by homing and found them foraging on the same tree. The male left the tree first, then the female followed him. The adult female of Nest 00-11 also remained near to the cavity tree even after her nest failed; during the last tracking session on that bird on 24 July, she was still less than 1 km from the nest tree.

The significant variables obtained in comparisons between foraging and random trees all relate to the decay status of the tree (Table 2). Used trees had a greater percentage of dead branches, more moss covering, and a higher frequency with fungal conks. This suggests that the birds are preferentially foraging on trees with some decayed wood. However, there was no significant difference between used and random trees in terms of their status as snags (Table 2). Of the 22 foraging trees documented, most were at least partially alive (55%), but only two (9%) were completely alive. These results suggest that foraging trees do not necessarily have to be dead to provide good foraging substrate for Hairy Woodpeckers, although some decay may be preferred.

We note that there is potentially a bias towards stand edges with regard to the location of the foraging trees and their distance to stand edge (Table 2). While some of the trees were found by homing to the tagged birds using telemetry, eight of the foraging trees were located when we observed the birds while doing triangulations from roads. Due to large amount of time spent on roads conducting triangulations, we spent proportionately more time near forest edges. Unbiased estimates of interior versus edge use by Hairy Woodpeckers will be possible with the planned GIS analysis.

The habitats utilized by Hairy Woodpeckers will be compared with the proportions of various habitats available to them using GIS stand information databases. We presently have obtained GIS data layers from Rayonier, including files describing stand age, dominant tree species, quadratic mean diameter (QDBH), and tree density (stems per acre). However, we have gaps in our coverage of woodpecker home range areas and have requested additional GIS coverage from the Washington DNR. When all the GIS data are obtained, proportions of different available habitats within defined home ranges will be compared with habitats at point locations to determine whether certain forest stands are disproportionately used.

Greater sample sizes, of both birds and foraging trees, are necessary before we are able to propose management practice recommendations. This study will be continued during the Spring and Summer of 2001. The nest searching and trapping techniques that we developed and refined during this season will be employed to increase our planned sample size of adult Hairy Woodpeckers to approximately 20 birds from 14 different nests. .

Conclusions

Based on the preliminary results of this first field season, we offer a few cautious conclusions:

- Hairy Woodpeckers maintain relatively small home ranges (mean = 58.5 ha) around their nest trees during the late nesting and post-fledging periods.
- Fledglings use home range areas similar to that of their parents within the six week period following fledging.
- Hairy Woodpeckers remain in the area of the nest tree for at least several weeks after young have fledged or following a failed nesting attempt.
- During the summer, foraging Hairy Woodpeckers seem to show some preference for trees that are at least partially dead, though two entirely live trees were also used by foraging birds.

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Table 1. Radio tracking history and triangulations obtained on eight radio-tagged Hairy Woodpeckers from four nests in western Washington

Bird	Date Captured	Date Tracking Ceased	Tracking Duration (d)	Triangulations Attempted	Triangulations Successful	Useable Locations
6F	3-Jun	22-Jul	48	129	113	72
6M	13-Jun	19-Jul	37	98	90	65
11F	1-Jun	24-Jul	54	139	136	42
13M	30-May	29-Jul	61	105	94	68
13FL1	30-May	24-Jul	56	92	89	67
13FL2	30-May	25-Jul	57	90	83	56
14M	10-Jun	28-Jul	48	74	68	16
14F	10-Jun	1-Aug	52	85	84	13

Table 2. Comparison of Hairy Woodpecker foraging trees with paired random trees and surrounding vegetation in an 11.3-m plot in June and July, 2000 in the managed forests of western Washington (for most variables, *p* values were calculated using two-sample *t*-tests).

VARIABLE	Used Tree Mean (N=22)	SE	Random Tree Mean (N=22)	SE	*p*-value
Alive or dead (snag)	0.455		0.227		0.112[a]
Proportion of Branches Dead	63.6	8.40	38.2	8.51	**0.039**
Tree Height (m)	17.59	1.62	14.26	1.74	0.168
DBH (cm)	64.6	9.52	49.6	5.22	0.176
Canopy Diameter (m)	6.9	1.59	7.29	0.94	0.834
Lower Canopy Height (m)	6.08	1.49	7.23	1.30	0.563
Upper Canopy Height (m)	11.3	2.32	13.9	1.83	0.381
% Moss Covering on Branches	60.0	5.76	35.3	7.43	**0.023**
% Bark Remining	98.27	0.83	89.32	6.31	0.174
Insect Holes: presence/absence	0.545		0.227		**0.030**[a]
Distance to Edge (m)	29.3	9.0	41.5	10.7	0.446
Distance to Nearest Stand (m)	18.02	3.75	21.96	7.06	0.639
% Canopy Cover	68.7	5.40	67.9	6.33	0.918
% Ground Cover	65.9	4.67	69.4	4.45	0.596
% Shrub Cover	25.6	3.82	19.9	3.65	0.289
% Other Ground Vegetation	50.9	4.32	57.2	4.92	0.341
% Leaf Litter	8.1	2.59	5.48	0.92	0.357
% Woody Litter	36.1	4.64	35.9	3.94	0.976
Number of Downed Logs	2.08	0.44	1.98	0.26	0.842
Number of Stumps	0.64	0.19	0.42	0.13	0.354
% Bare Ground	0.27	0.14	3.24	1.94	0.141
Total Saplings	12.68	3.35	9.36	3.20	0.481
Total Poles	1.68	0.64	1.77	0.69	0.924
Trees 8-23 cm DBH	2.23	0.39	1.82	0.56	0.552
Trees 24-38 cm DBH	1.50	0.33	2.73	0.84	0.185
Trees 39-52 cm DBH	2.50	0.55	2.23	0.56	0.729
Trees >52 cm DBH	3.23	0.54	2.95	0.57	0.73
Total All Trees	9.45	1.05	9.73	1.45	0.88
Surrouding Snags	4.0	0.62	3.27	0.54	0.383
Conks: presence/absence	0.364		0.045		**0.009**[a]
Conks: number	2.64	1.22	0.182	0.182	**0.0108**

[a] Probability for categorical variables determined with a chi-square test

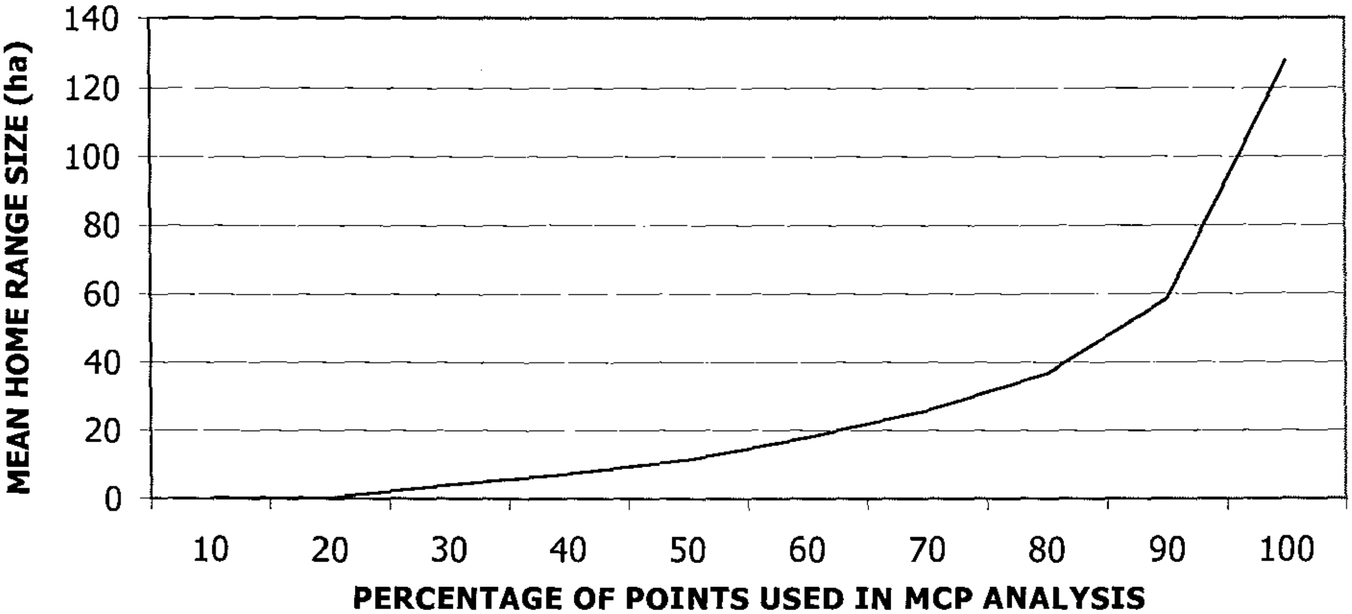

Figure 1: Change in home range size as a function of the number of point locations used in the Minimum Convex Polygon analysis for 8 Hairy Woodpeckers. Point locations collected by radio-telemetry between 30 May and 1 August 2000 in Clallam County, Washington.

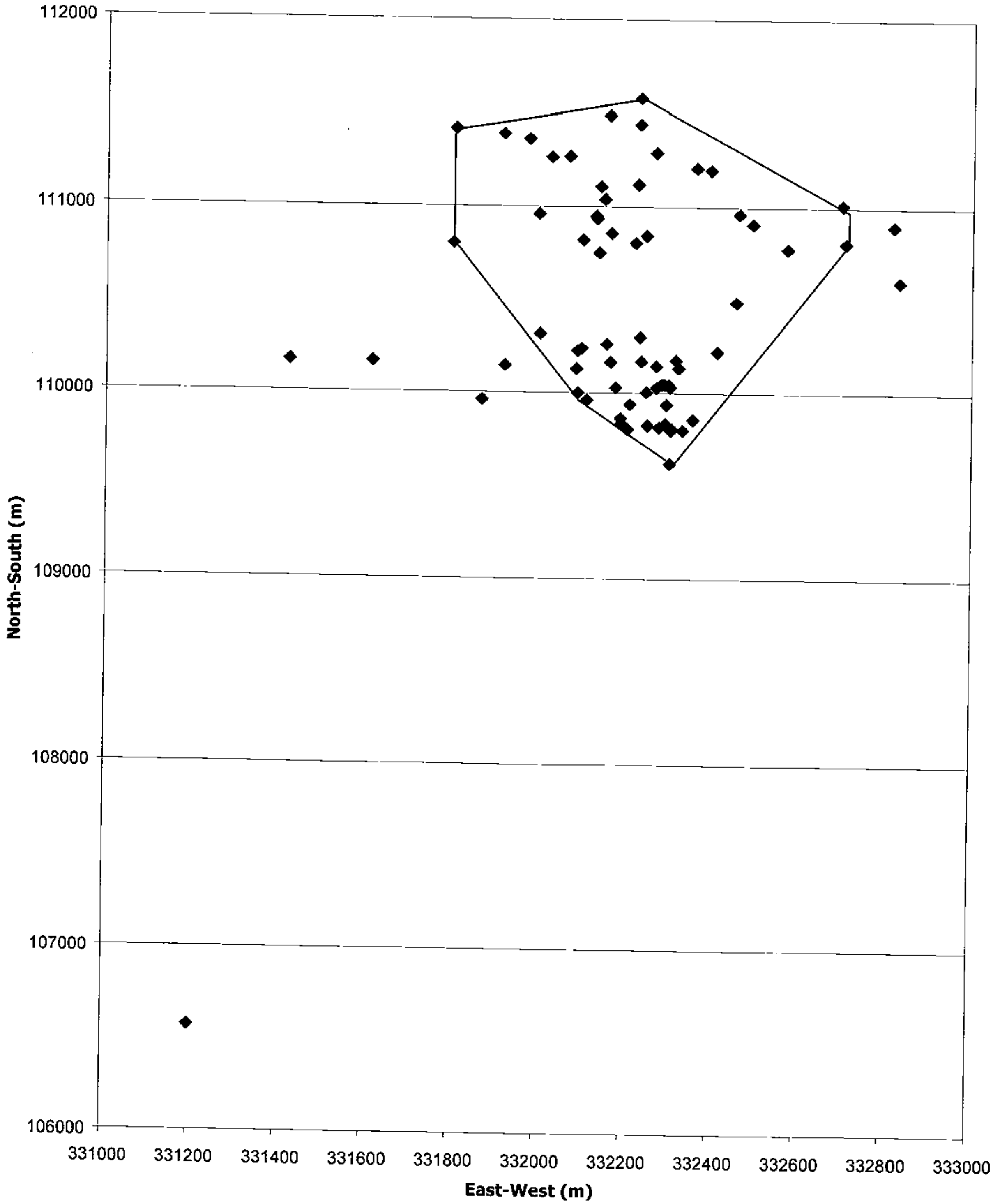

Figure 2: Home range of Hairy Woodpecker 6F based on the 90% Minimum Convex Polygon estimation technique. Points collected by radio-telemetry between 3 June and 22 July 2000 in Clallam County, Washington.

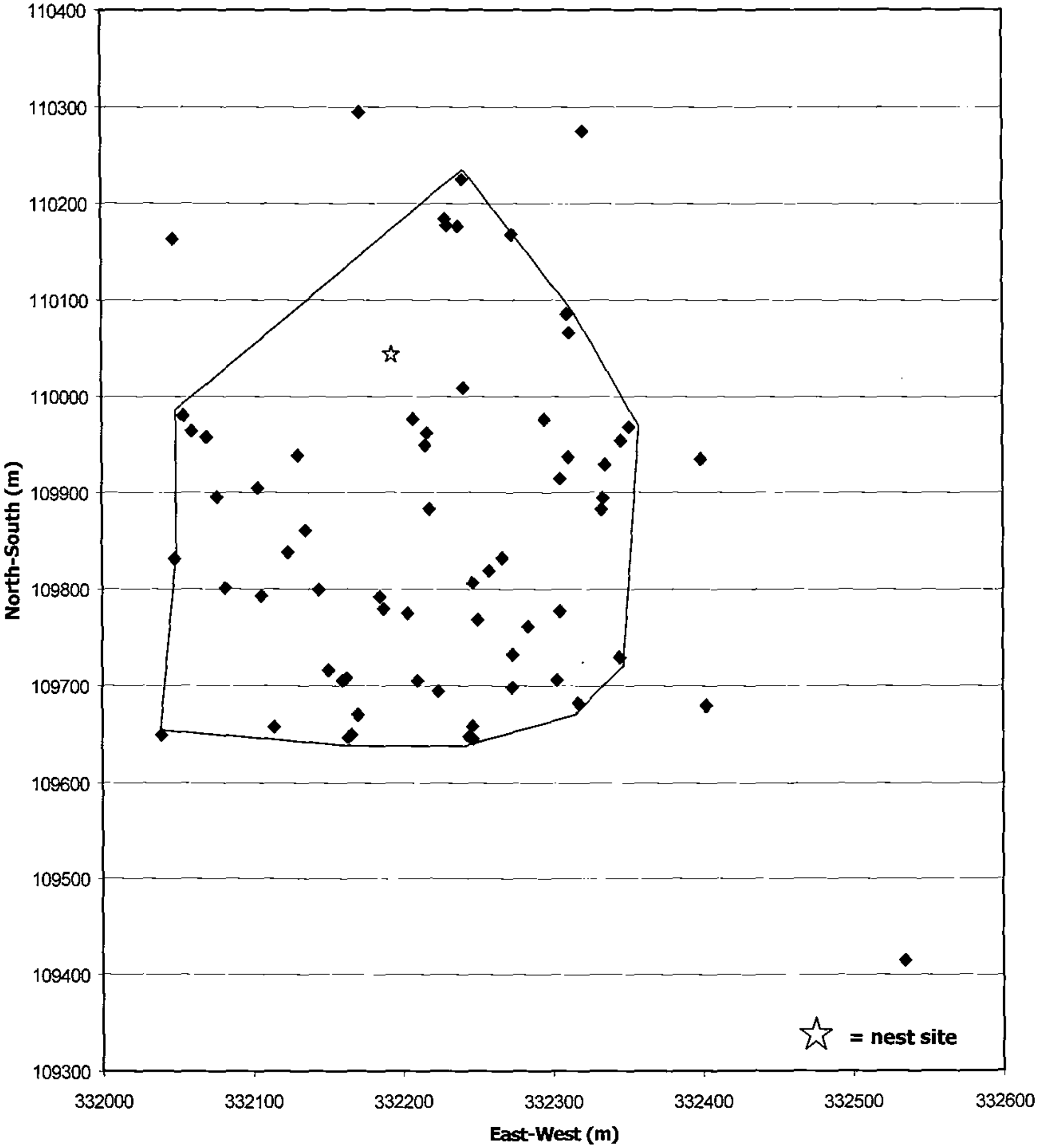

Figure 3: Home range of Hairy Woodpecker 6M based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 13 June and 19 July, 2000 in Clallam County, Washington.

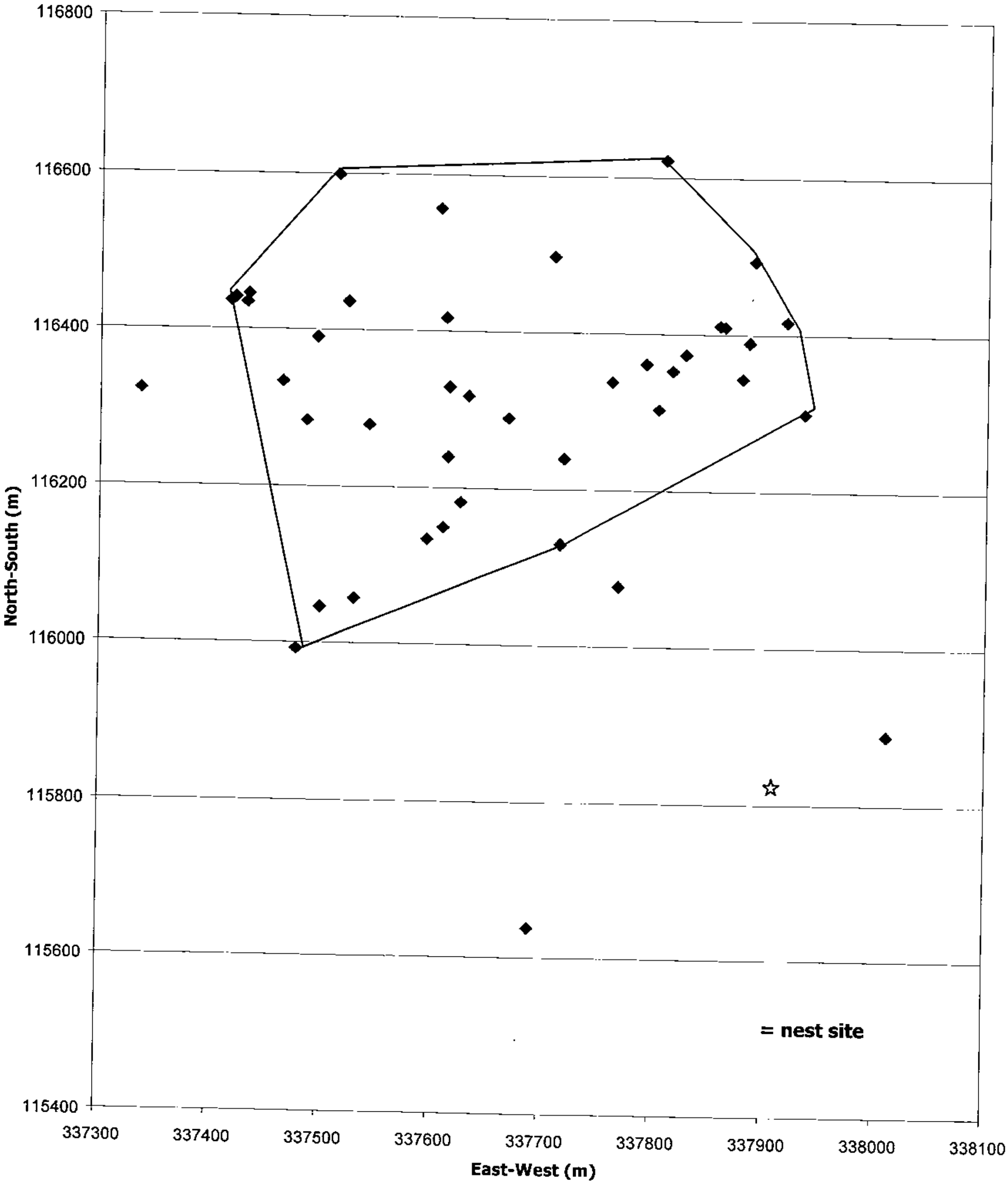

Figure 4: Home range of Hairy Woodpecker 11F based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 1 June and 24 July 2000 in Clallam County, Washington.

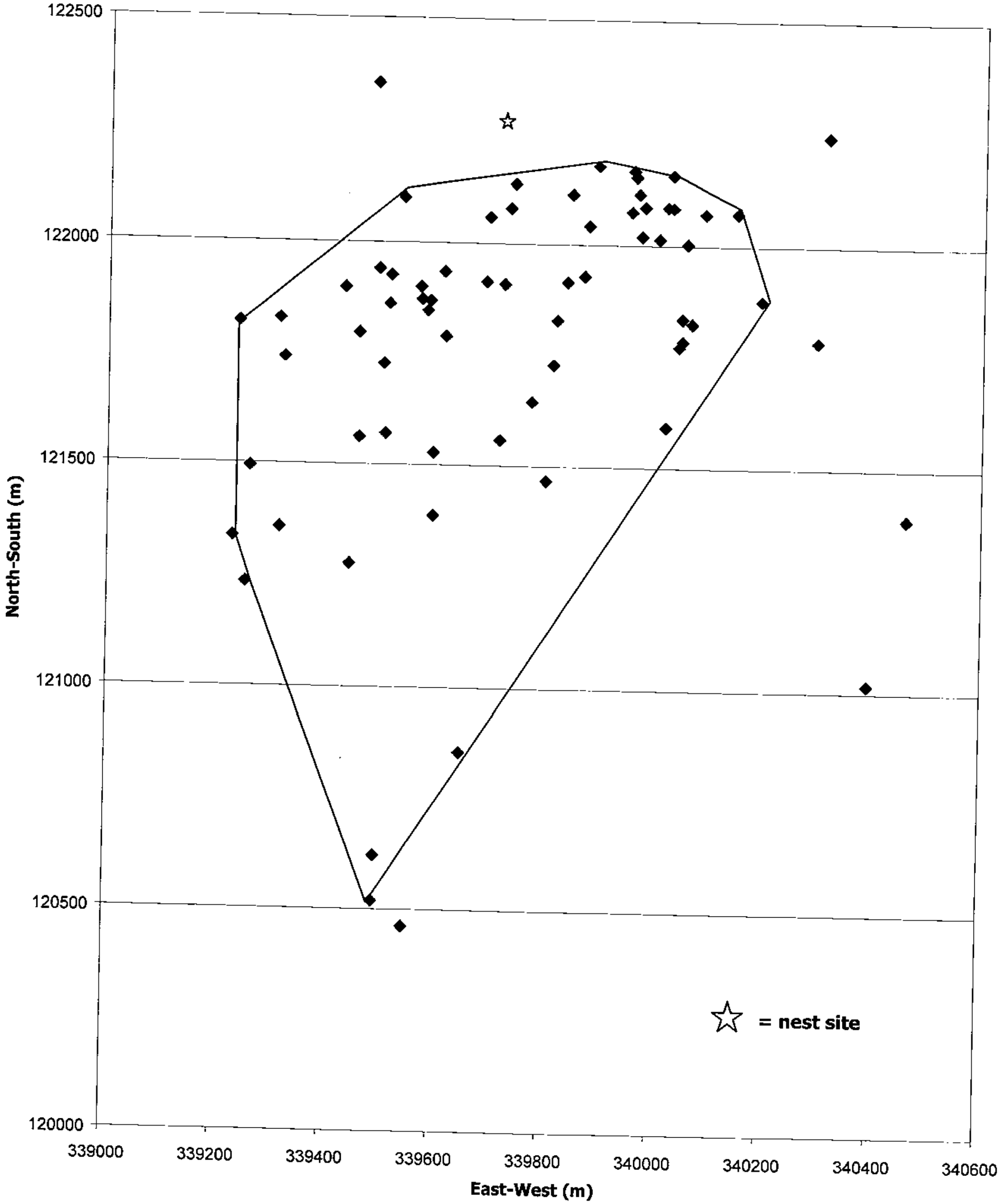

Figure 5: Home range of Hairy Woodpecker 13M based on 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 30 May and 29 July 2000 in Clallam County, Washington.

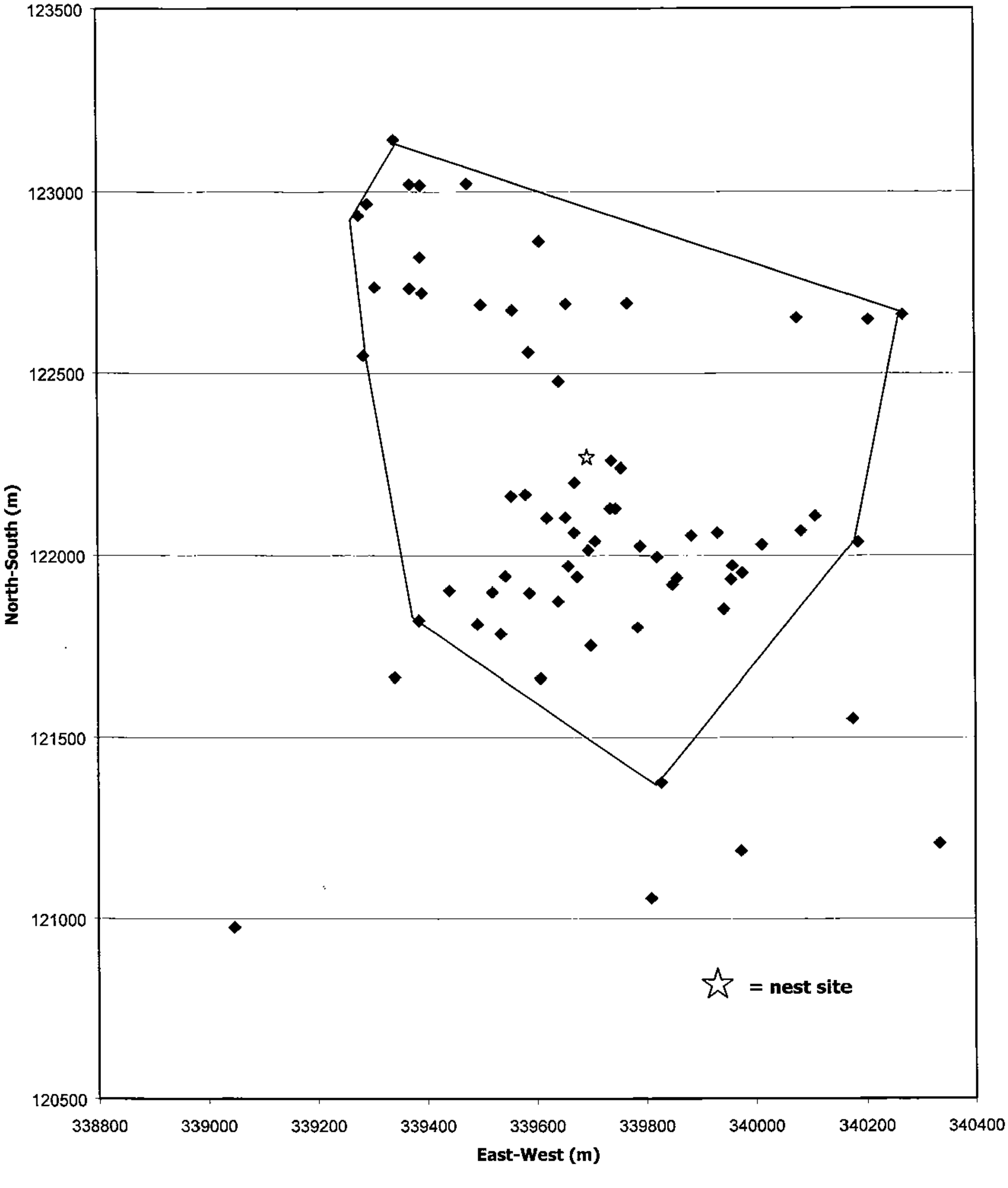

Figure 6: Home range of Hairy Woodpecker 13FL1 based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 30 May and 24 July 2000 in Clallam County, Washington.

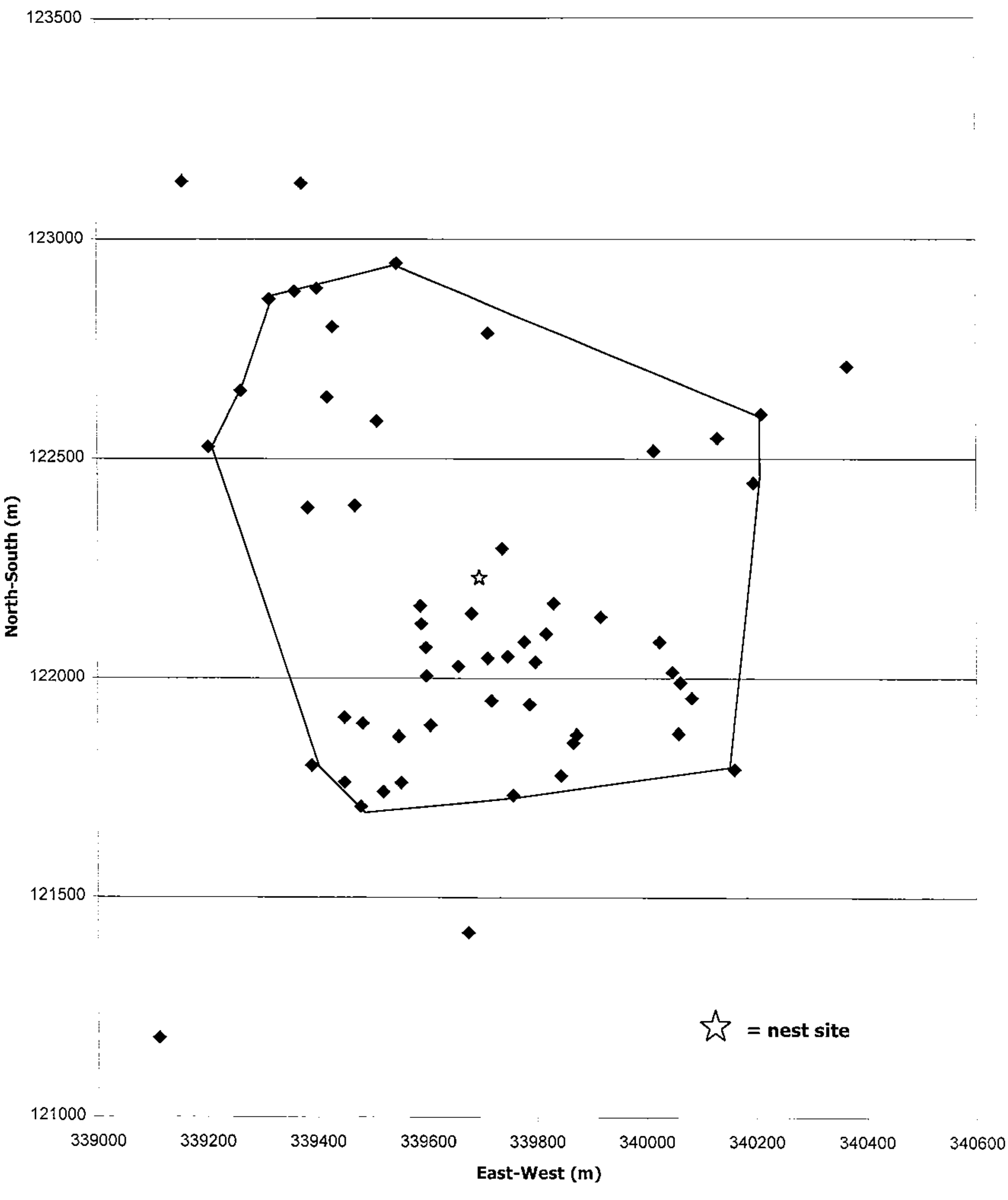

Figure 7: Home range of Hairy Woodpecker 13FL2 based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 30 May and 25 July 2000 in Clallam County, Washington.

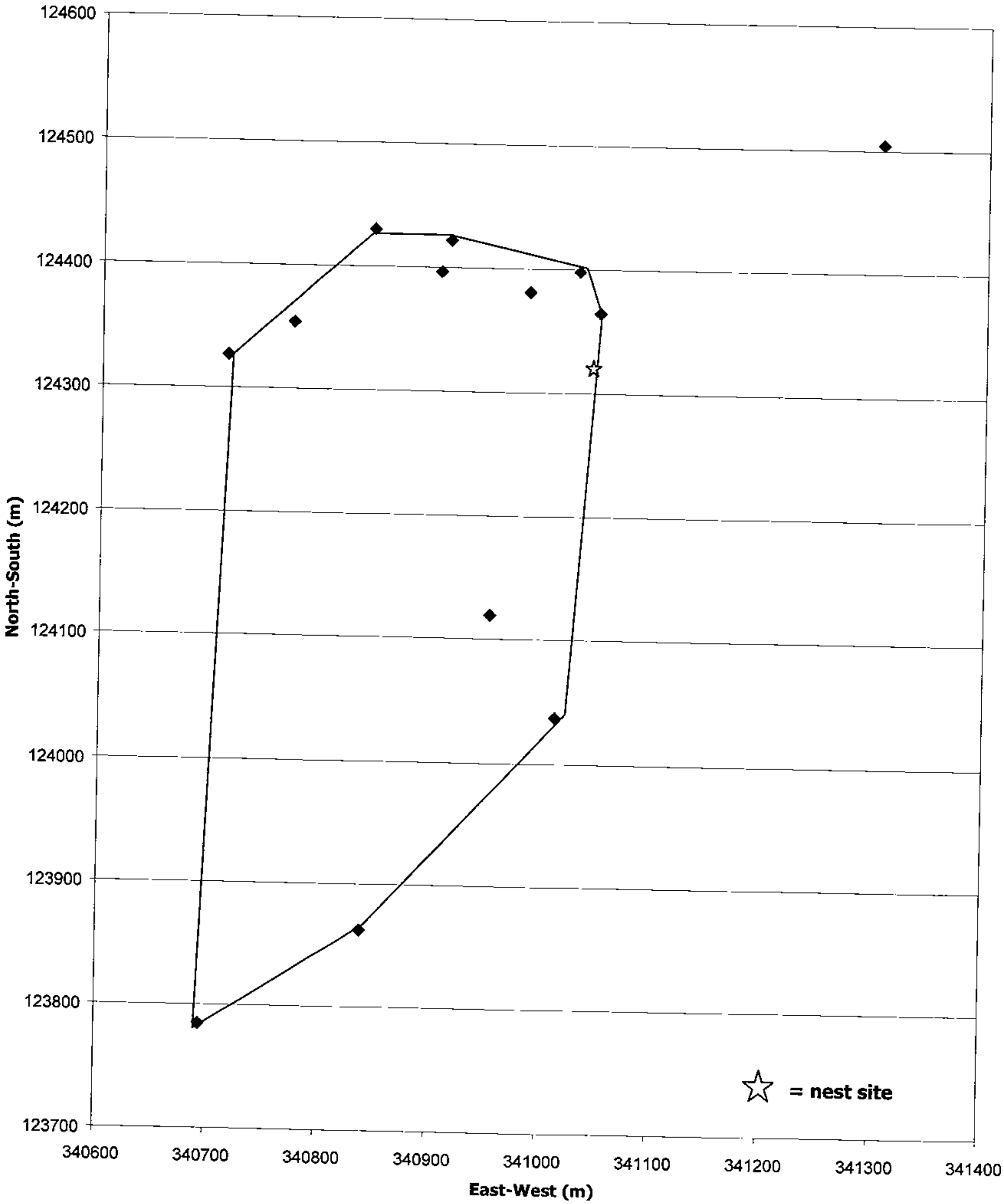

Figure 8: Home range of Hairy Woodpecker 14F based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 10 June and 1 August 2000 in Clallam County, Washington.

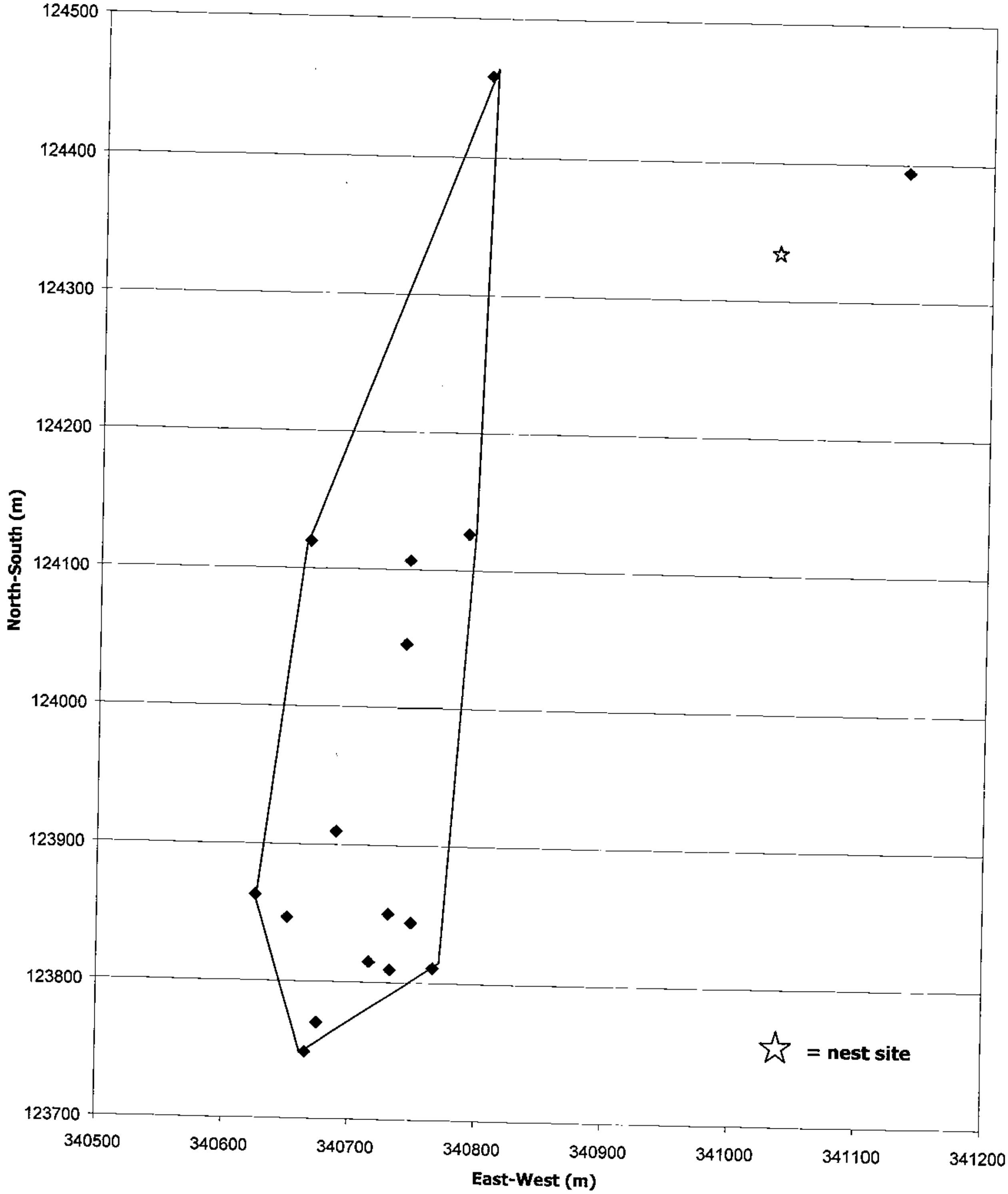

Figure 9: Home range of Hairy Woodpecker 14M based on the 90% Minimum Convex Polygon estimation technique. Points were collected by radio-telemetry between 10 June and 28 July 2000 in Clallam County, Washington.