Productivity, Mortality, and Response to Disturbance of Nesting Swainson's Hawks on the Hanford Site

L. D. Poole N. V. Marr S. M. McCorquodale

March 1988

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PRODUCTIVITY, MORTALITY, AND RESPONSE TO DISTURBANCE OF NESTING SWAINSON'S HAWKS ON THE HANFORD SITE

L. D. Poole N. V. Marr S. M. McCorquodale

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Pacific Northwest Laboratory Richland, Washington 99352

PREFACE

In 1986, the U.S. Department of Energy (DOE) selected the Hanford Site, Washington, for further study as a permanent repository for commercial spent nuclear fuel and high-level radioactive waste. The DOE then initiated a site characterization program to obtain the information necessary for evaluating the suitability of locating a repository at the Hanford Site. These characterization activities were part of the Basalt Waste Isolation Project (BWIP). Pacific Northwest Laboratory (PNL) was contracted by the DOE to do the environmental studies. The DOE was required by Section 113(A) of the Nuclear Waste Policy Act (NWPA) to "conduct site characterization activities in a manner that minimizes any significant adverse environmental impacts identified . . ."

This document is part of the Environmental Topical Report series. Each report presents the results of the environmental monitoring studies at the BWIP site, up until BWIP was closed in response to the enactment of the Nuclear Waste Amendments Act of 1987. Some of the reports are preliminary because not all task objectives were completed at project close-out. However, they can serve as a reference source for other BWIP environmental reports related to site closure and reclamation. These Environmental Topical Reports are listed below:

- 1. Cold-Blooded Vertebrates at the Proposed Reference Repository Location in Southeastern Washington, by R. E. Fitzner, January 1988, PNL-6440.
- 2. Natural Vegetation at the Proposed Reference Repository Location in Southeastern Washington, by W. H. Rickard, February 1988, PNL-6402.
- 3. Bird Associations With Shrubsteppe Plant Communities at the Proposed Reference Repository Location in Southeastern Washington, by C. A. Schuler, W. H. Rickard, and G. A. Sargeant, March 1988, PNL-6493.
- 4. Descriptions of Plant Communities at the Proposed Reference Repository Location and Implications for Reclamation of Disturbed Ground, by W. H. Rickard and C. A. Schuler, March 1988, PNL-6494.
- 5. Habitat Associations of Vertebrate Prey Within the Controlled Area Study Zone, by N. V. Marr, C. A. Brandt, R. E. Fitzner, and L. D. Poole, March 1988, PNL-6495.
- 6. Productivity, Mortality, and Response to Disturbance of Nesting Swainson's Hawks on the Hanford Site, by L. D. Poole, N. V. Marr, R. E. Fitzner, and S. M. McCorquodale, March 1988, PNL-6496.
- 7. Water Quality: Historic Values and Impact of Drilling Activities During FY1988 at the Reference Repository Location in Southeastern Washington, by P. A. Eddy, W. H. Biershank, S. S. Teel, and J. R. Raymond, March 1988, PNL-6497.

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SUMMARY

The objectives of this study were to characterize Swainson's hawk (<u>Buteo swainsoni</u>) use of the U.S. Department of Energy's (DOE) Hanford Site and to evaluate the potential for engineering and other human activities on the Hanford Site to negatively affect the nesting Swainson's hawk population. Activities associated with the Basalt Waste Isolation Project (BWIP) were used as the primary external stimuli in studying hawk responses to potential human disturbance.

The number of nesting pairs of Swainson's hawks has increased from 17 to 36 pairs since 1978. During 1987, 36 of 38 nesting territories located on the Hanford Site were occupied by nesting Swainson's hawks. Of these nests, 35 were located in trees and 1 was located on a utility pole crossarm. An average of 1.62 young were raised to fledging per occupied territory; an average of 2.0 young were fledged per successful nest. In a sample of 11 territories used to evaluate mortality patterns, 1 of 22 adult hawks and 10 of 30 juveniles died prior to migration. Of juvenile mortalities, 8 of 10 occurred between the egg stage and fledging. Starvation and/or dehydration appeared to be the cause of all 11 deaths detected. The Hanford Site Swainson's hawk population appears stable at present and may be limited by nest site availability.

Perching and flying were the dominant Swainson's hawk activities. Adult hawks spent more time flying than did fledgling juveniles. Most perching occurred in the morning and evening, while flying peaked near midday. Swainson's hawks roosted in trees and on utility poles during the night. Hawks changed roost locations during dark hours in only 3 of 45 hawk observation nights.

Home ranges of radiotagged Swainson's hawks averaged 6.97 km² based on radiotelemetry data. On the average, hawk home ranges consisted of 25.7% shrubland, 68.6% grassland, and relatively small proportions of industrial areas and standing water.

Parked and moving vehicles were the most common disturbance sources observed in Swainson's hawk territories. Hawks appeared to be sensitive to disturbance from pedestrians and slow-moving vehicles near nests. Novel stimuli were much more likely to evoke strong responses than were recurring events. Adult hawks reacted more frequently and vigorously than did juveniles. When disturbed, adult hawks usually flew toward the location of the disturbance; juvenile hawks usually flew away from disturbances.

Human activity associated with BWIP may have had negative effects on one pair of nesting Swainson's hawks and may have precluded the use of an additional traditional nesting territory.

Negative impacts to nesting Swainson's hawks from human activity could be minimized by confining activities to the non-nesting period or to distances greater than 2.2 km from nest sites. Tree groves and elevated perches, including utility poles, across the Hanford Site are probably critical to the success of nesting Swainson's hawks. Potential mitigation strategies associated with energy research and development activities on the Hanford Site could include provisions for maintenance and establishment of drought-tolerant trees and native vegetation.

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INTRODUCTION

The Swainson's hawk (<u>Buteo swainsoni</u>) nests in shrub and grassland habitats across western North America (Bowles and Decker 1934) and winters in South America (Fitzner 1978). Swainson's hawks are present on the U.S. Department of Energy's (DOE's) Hanford Site from early April to mid-September (Fitzner 1978). Swainson's hawks are of regulatory concern to federal agencies since they are protected by the Migratory Bird Treaty Act and are also a candidate species for federal protection as a threatened or endangered species.

Studies of Swainson's hawks nesting on the Hanford Site in southcentral Washington State were initiated in 1987 by Pacific Northwest Laboratory (PNL) in association with the DOE's Basalt Waste Isolation Project (BWIP). The overall purpose of these studies were to characterize Swainson's hawk use of the Hanford Site and to evaluate the potential for BWIP engineering activities to negatively affect nesting Swainson's hawks. The study was designed to allow comparisons between hawks nesting near BWIP activity areas and hawks nesting in more remote areas of the Hanford Site. The data presented in this report were collected before the startup of most major site characterization activities and were designed to document pre-BWIP parameters. Additionally, these studies were designed to yield information on potential impact minimization or mitigation strategies that could be employed to avoid or reduce any BWIP impacts to the hawks.

Specific study objectives were to 1) characterize the nesting distribution and density of Swainson's hawks on the Hanford Site, and particularly near potential site characterization areas, 2) document reproductive success of nesting Swainson's hawks, 3) document Swainson's hawks responses to potential disturbances, 4) document the size of nesting Swainson's hawk territories on the Hanford Site, and 5) document the temporal distribution of the hawk's principal activities before the start of most major site characterization activities.

STUDY AREA

The study was conducted on the DOE's Hanford Site, which is characterized by shrub steppe vegetation. Locally near BWIP activity areas, plant communities are typically dominated by an understory of grasses such as bluebunch wheatgrass (Agropyron spicatum), Sandberg's bluegrass (Poa sandbergii), or cheatgrass brome (Bromus tectorum), and an overstory of big sagebrush (Artemisia tridentata). Due to past rangefires, big sagebrush has been eliminated from large areas of the Hanford Site. Several other species of grasses and numerous forb species are commonly associated with the typical dominant grasses or may occasionally dominate small areas themselves due to microclimatic, edaphic, or disturbance factors. Riparian vegetation is found along a few permanent streamcourses in the western and southwestern portions of the Hanford Site and along the Columbia River. Trees used by nesting raptors on the Hanford Site are mostly exotic and are located primarily in former human use areas such as homesteads and abandoned army encampments.

The Hanford Site receives approximately 16 cm of precipitation each year (Stone et al. 1983). Most of the annual precipitation falls between November and March; lengthy summer droughts are common. Climatically, the Hanford Site experiences warm, dry summers and relatively cool winters.

METHODS

The major study elements consisted of nesting surveys, radiotelemetry monitoring of hawk movements, and behavioral sampling (natural and disturbance responses).

NESTING SURVEY

The Hanford Site was surveyed for Swainson's hawk territories between 15 and 30 June, 1987. We visually scanned trees and utility poles for Swainson's hawk nests, concentrating our efforts where Swainson's hawks were seen. Nests built by Swainson's hawks were distinguishable from those built by other species by the size of the nest, the nest materials used and their placement on the nest substrate (Bowles and Decker 1934, Call 1978). All nests located were mapped. Ten nesting territories were subsequently selected for intensive study (Fig. 1); five nests were selected near BWIP activity areas and five were selected in areas removed from these areas.

Status of the breeding territories was described using the terminology of Postupalsky (1974) and Steenhof (1987). A nesting territory was an area containing at least one nest within the range of one mated pair of hawks. Territories were considered occupied if the nest was recently repaired, if two adults were present on or near the nest, or if one bird was seen in incubating posture on the nest. Unoccupied nesting territories showed none of the criteria described for occupied territories. Nests in occupied territories were classified as active or inactive. Nests in which one hawk was seen on the nest in incubating posture or in which eggs or young were seen were considered active; all other nests were considered inactive. Successful nests were those from which at least one young was raised to 80% of fledging age.

Reproductive success of Hanford Site Swainson's hawks was estimated by monitoring the 10 study nests and opportunistically visiting 6 additional nests. Numbers and development of young at individual nests were recorded. Reproductive success was expressed by the mean number of young raised to 80% of fledging age per successful nest and per occupied territory (Postupalsky 1974; Newton 1979, p. 130; Steenhof 1987). In addition to this measure, we also recorded the number of young surviving to fledging and to migration at study nests. All known mortalities were noted.

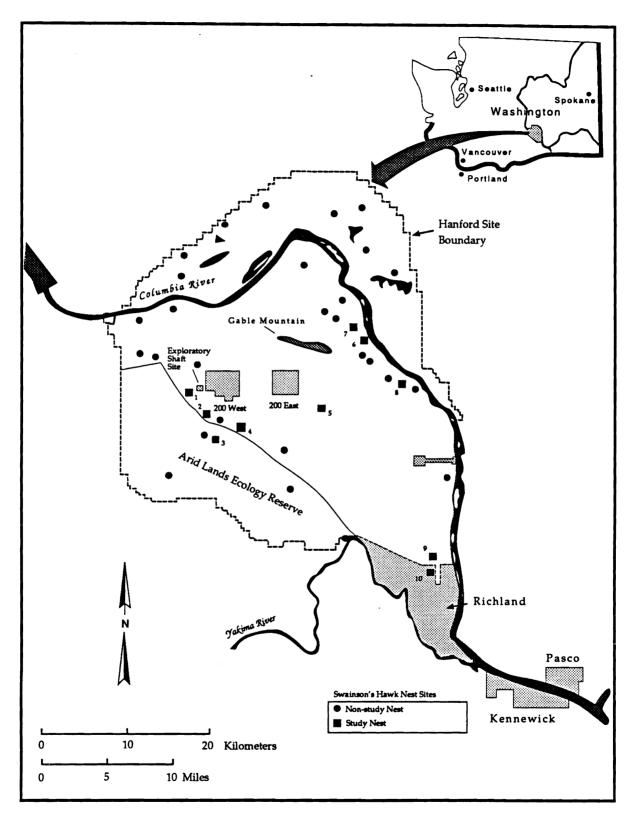


FIGURE 1. The Location of Swainson's Hawk Nest Sites Selected for Intensive Observation in 1987 in Relation to all Swainson's Nest Sites on the Hanford Site

RADIOTELEMETRY TECHNIQUES

Adult Swainson's hawks were captured in a mist net baited with a stuffed great horned owl (Bubo virginianus) (Fitzner 1978). The mist net was placed near the nest tree, and the owl was placed within 1 m of the net. Adult hawks became entangled in the net when they attempted to attack the owl. Juvenile Swainson's hawks were hand-captured from their nests prior to fledging. All hawks captured were banded with individually numbered United States Fish and Wildlife Service locking aluminum leg bands. At each of the 10 nesting territories selected for intensive study, one adult and one juvenile hawk were equipped with backpack-mounted radiotransmitters (150-151 MHz) using techniques described by Fitzner (1978); transmitters weighed less than 20 g. When two or more young were present, the oldest nestling was usually radiotagged.

Portable receivers and hand-held antennae were used to locate radiotagged hawks. Radio signals were primarily used as an aid to visually locate individual hawks. When a hawk was sighted, the hawk's location was determined by landmarks and topography. However, when hawks could not be seen, their location was determined by triangulation. Triangulated position estimates were repeatedly checked early in the study by estimating the distance of a radiotagged hawk from the observer using radiotelemetry, then determining the hawk's actual position by visually locating the hawk and visually triangulating its position. Triangulated estimates of location were used only after each observer became proficient in the technique (i.e., consistent agreement between estimated and confirmed hawk locations).

Minimum Convex Polygon (MCP) estimates of hawk territory sizes were calculated (Odum and Kuenzler 1955). Lines drawn between outermost hawk locations formed a polygon representing the minimum home range.

The areal extent of shrub-dominated (greater than or equal to 10% shrub cover) or grass-dominated (less than 10% shrub cover) vegetation within each radiotagged adult's home range was calculated by placing a grid over low-level aerial photographs of each home range. The areal extent of industrial areas and standing water within each home range polygon was also estimated.

BEHAVIORAL SAMPLING

Scan sampling of focal animals (Altmann 1974) was used to study hawk activity patterns and responses to disturbance. The activity and location of the tagged hawk (focal animal) were recorded instantaneously every 5 min during observation sessions lasting 1-4 hours. Jacobsen and Wiggins (1982) found that time-in-activity as determined by sampling intervals of 5 min corresponds highly with actual time-in-activity, as determined by continuous sampling. Hawk

locations were recorded as X-Y coordinates on a 200-m grid superimposed over low-level 1987 aerial photographs of the Hanford Site. External stimuli such as equipment noise, traffic, and human activity and the focal hawk's reactions to these stimuli were also recorded during the scans. Observer presence was recorded as an external stimulus. Wind speed and air temperature were recorded at the beginning and end of each observation session.

Radiotagged hawks were observed diurnally from 30 July to 11 September (post-fledging), 1987. Observations of each hawk continued until it migrated or died. Diurnal observation sessions were rotated to sample equally all hours of daylight as much as possible. Diurnal observations of each hawk were made once weekly on a rotating schedule. We made roughly equal numbers of observations on weekends and weekdays. All times were recorded in military time (Pacific Daylight Savings Time).

Nocturnal observations of each hawk were conducted at least once weekly from 30 July to 21 August. From 30 July to 3 August, sampling times and frequencies were chosen in the same manner as described for diurnal observations. A preliminary analysis indicated that a less intensive sampling scheme was sufficient for nocturnal sampling. Subsequently, after 3 August, hawks were observed for extended periods of time or relocated during two separate visits to their territories during one night on a less intensive schedule. Nocturnal hawk locations were determined by triangulation of telemetry signals.

When hawks were not visible, hawk activity was inferred from variations in the telemetry signal (Kenward 1980). Perched hawks transmitted a monotone signal that was strongest when the receiving antenna was vertically oriented. Signals received from flying and walking hawks fluctuated widely in amplitude. Soaring flight produced rhythmic signal variations. Telemetry signals from walking hawks were characterized by arhythmic signal variations. Signals were best received from flying hawks when the receiving antenna was horizontally oriented. Hawks walking or perched on the ground produced much fainter radio signals than hawks that were perched or flying above ground level at the same distance.

When an external stimulus was followed by an immediate and detectable change in the focal hawk's activity, we classified the stimulus as a disturbance. Two measures of the hawks' reaction to disturbance were made: strength of reaction and direction of flight responses relative to the location of the disturbance.

Reactions were assigned one of three magnitudes, following Ritchie (1987). When no reaction was detected, or when the hawk moved only its head in response to a stimulus, the

reaction was classified as "none/mild," and the stimulus was not considered a disturbance. When hawks cowered in place or exhibited preflight intention movements, the response was labeled "moderate." "Severe" reactions consisted of flying and other escape behaviors and protest calls.

When a hawk changed location in response to a disturbance, the direction of the hawk's movement in relation to the location of the disturbance was recorded. Hawk movements were classified as either movement toward a disturbance, movement away from it, or circling above the area of the disturbance. Whether or not a hawk vocalized following a disturbance was also recorded.

RESULTS AND DISCUSSION

Results are presented and discussed under the following topics: nesting survey, activity patterns, home range, and response to disturbance.

NESTING SURVEY

The results of the nesting survey include data on occupancy of nesting territories, productivity of the occupied nests, and mortality.

Occupancy

Thirty-eight Swainson's hawk nest sites were found on the Hanford Site (Figure 1). Thirty-six (95%) of the territories were occupied in 1987 and contained active nests. Of these active nests, 35 of the 36 nests were built in trees (mainly black locust, Robinia pseudo-acacia, and Chinese elm, Ulmus spp.) planted around decomissioned military installations and abandoned homesteads. One nest was constructed on a utility pole crossarm in a treeless part of the Arid Lands Ecology (ALE) Reserve. Another nest, inactive in 1987, was constructed on a utility pole crossarm late in the nesting season. We suspect this was a "frustration nest" built by a Swainson's hawk pair whose original nesting attempt in another territory had failed. This "frustration" nest fell from the utility pole shortly after construction, but the adults remained in the area until late in the nesting season. It may be noteworthy that one of the two nests located nearest the exploratory shaft was not occupied in 1987 after failing in 1986.

Swainson's hawks elsewhere nest almost exclusively in trees (Olendorff and Stoddart 1974, Call 1978, Tank 1985). Swainson's hawks appear to use utility poles for nesting only in the absence of suitable nest trees; nests built on utility poles frequently fall before young can be fledged.

Others have suggested that Swainson's hawks, common ravens (<u>Corvus corax</u>), red-tailed hawks (<u>Buteo jamaciensis</u>) and great-horned owls may compete for nest sites (Olendorff and Stoddart 1974, Tank 1985). However, there is evidence that Swainson's hawks nest in small trees that may be unattractive to other raptors and ravens (Sharp 1986). At the Hanford Site, interspecific nest site competition does not appear to limit Swainson's hawk nesting densities; our observations indicated no red-tailed hawks nested in typical Swainson's hawk nest trees on the Hanford Site in 1987. On the Hanford Site, nesting populations of ravens and red-tailed hawks have increased from 11 to 23 pairs and 20 to 33 pairs, respectively, between 1978 and 1987

(Fitzner 1980). However, ravens and red-tailed hawks are using about the same number of trees for nesting in 1987 (6 trees) as in 1978 (5 trees). The number of nesting Swainson's hawk pairs has increased from 17 to 36 pairs in the same time period.

Olendorff and Stoddart (1974) reported that nest site availability apparently limited raptor populations in southeastern Washington. A shortage of nest sites for diurnal raptors can be inferred from 1) the absence of breeding pairs from areas of suitable habitat but lacking nest sites, and 2) the fact that breeding density sometimes increases when artificial nest sites are provided (Newton 1976). Using these criteria, nest site availability may have limited Swainson's hawk numbers at the Hanford Site in the past, and almost certainly will inhibit further increases in Swainson's hawk numbers. In 1987 there were no suitable nest trees that were not within a Swainson's hawk territory across most of the Hanford Site. Much of the ALE Reserve and other treeless areas have no nesting Swainson's hawks due to lack of nest trees. Artificial nest platforms could possibly increase the nesting density of Swainson's hawks on the Hanford Site (Olendorff and Stoddart 1974).

Productivity

Sixteen of the 36 occupied nesting territories were checked for productivity when young were 80% of fledging age. The number of young raised to 80% of fledging age at Hanford in 1987 (1.62 young per occupied territory) was similar to Swainson's hawk productivity in three counties in eastern Washington in 1986 (1.5 young per occupied territory, n=25; based on data collected by L. D. Poole and N. V. Marr). Swainson's hawk productivity at the Hanford Site between 1975 and 1978 was 1.85 young fledged per completed clutch (n=39; Fitzner 1980); in 1987, 1.67 young were fledged per completed clutch (n=15). The average number of young fledged per successful nest in 1987 was 2.0, which is similar to the 2.1 young fledged per successful nest between 1975 and 1977 on the Hanford Site (Fitzner 1978). Only 3 of the 16 occupied territories examined failed to fledge any young. Six territories fledged one young, 2 territories fledged 2 young, 4 territories fledged 3 young, and one territory fledged 4 young. No young survived to migrate from the two nest sites located nearest the exploratory shaft in 1986 or 1987.

Mortality

Mortality patterns were determined for 11 nesting territories in 1987. These territories consisted of the 10 study nests (Table 1) and the Leaning Ladder territory. Eleven mortalities and

<u>TABLE 1.</u> Reproductive Success and Mortality of Swainson's Hawks at Study Nests on the Hanford Site in 1987. (Territory numbers correspond to Figure 1.)

Territory Name (No.)	Nestlings or Eggs	Number of 80% Fledging Age/Fledged ^(a)	Young Mortalities(b)	Migrated
Treatment Nests Exploratory Shaft (1) Gate 118 (2) Benson Ranch (3) 120 MM Guns (4) 200 East (5)	3 3 3 3 _3	1 3 3 3 _2	2/1 0/0 0/0 0/0 1/1	0 3 3 3 _1
Total	15	12	3/2	10
Control Nests Big Elm (6) Mountain View (7) Hanford (8) Battelle Boulevard (9) Pit Six (10)	2 2 2 2 4	1 1 1 2 4	1/0 0/0(c) 1/0 0/0 <u>0/0</u>	1 1 1 2 4
Total	12	9	2/0	9

⁽a) All juveniles that reached 80% of fledging age subsequently fledged.

one infertile egg were detected; 10 of the hawks that died were juveniles and 1 was an adult. These mortalities represent 4.5% of the adults and 33.3% of the juveniles present in the sample territories during the 1987 nesting season. This number should be interpreted as a minimum, as the disappearance of hawks late in the nesting season was attributed to migration unless there was evidence of death. The one infertile egg was found at the Mountain View nest site.

Eight (80%) of the ten juvenile mortalities occurred between the time young first became visible in the nest (several days old) and fledging. Young in at least two nests (Leaning Ladder and Exploratory Shaft) succumbed during an extended period of hot (temperatures exceeding 100°F daily), dry weather. Young that died on the nest were cannibalized by the remaining juveniles at both nests. The nest trees at these two territories are dying and have fewer leaves than other successful nest trees. This limited the protection of nestlings from exposure to direct sunlight. Swainson's hawks pant when heat stressed, which increases water losses and can result in dehydration-related mortality. Additionally, young at the Exploratory Shaft nest were extremely emaciated when they were banded, implicating starvation as a probable cause of death. No young that survived to 80% of fledging age died prior to fledging. This finding supports

⁽b) Nestling mortalities / post-fledging mortalities.

⁽c) One infertile egg found at this territory.

Steenhof's (1987) assumption that little mortality occurs after juvenile hawks reach 80% of fledging age.

Two (20%) of the ten juvenile mortalities occurred between fledging and migration. As mentioned above, this number should be viewed as a minimum, since hawks disappearing late in the season were assumed to have migrated, unless proven otherwise.

Of the 11 nests that were used to evaluate mortality, 6 nests (55%) lost at least one young between egg laying and fledging. No instances of a complete clutch loss were noted at the 11 nests we examined. However, three additional occupied territories that were cursorily examined during the fledging period fledged no young. It is unknown whether eggs were ever layed in these nests. Five nests lost no young between laying and hatching, and these five nests (45% of nests examined) produced 68% of the young raised to fledging age. Four of the five nests from which no young were lost had clutch sizes of three eggs or more.

The single mortality detected in the adult population was the radiotagged adult at the Exploratory Shaft. Like the nestlings in this territory, the adult was extremely emaciated when banded and radio-equipped. This adult was repeatedly flushed from the nest area by human activity (pedestrians and vehicles) during incubation and post-hatching periods. When flushed from the nest, the hawk would typically fly away from the nest, circle over it once or twice while gaining altitude, and then fly at least one mile to the west. The bird would remain away from the nest at least 20 min after being disturbed, apparently flying the entire time. This was a significant energy expenditure, and may have contributed to the death of the hawk. Of the three young hatched at the Exploratory Shaft nest, two died after banding (25 to 29 days old at banding) and prior to fledging. The remaining nestling died within a few days after fledging, at about the same time the radiotagged adult died.

Our data are insufficient to conclusively establish that disturbance associated with exploratory shaft activities precluded use of one of the two territories nearest the shaft site and caused the reproductive failure of the other in 1987; however, these data do lend credence to such an hypothesis. It may be prudent for federal action agencies to consider impact minimization strategies for Swainson's hawks nesting near activity areas early in engineering programs.

ACTIVITY PATTERNS

Diurnal

During diurnal hours, Swainson's hawks spent 57.1% of their time perching, 36.7% flying, 4.2% preening, 1.2% feeding and 0.7% walking.

Figure 2 illustrates the daily activity pattern of radiotagged Swainson's hawks. Hawks usually perched until about 1030, spending part of this time preening. After 1030 hawks became more active, usually flying about with interspersed periods of perching. By about 1800, perching was again the predominant behavior.

Flying was most common during midday. Preening activity occurred in the same time frame as perching, but was more sharply bimodal across time. Food related activities occurred between 0630 and 1630, peaking between 1100 and 1200. Walking was done throughout the day, reaching a peak at 0900-1000 and tapering off during the late afternoon. Walking was closely related to feeding, since hawks appeared to be stalking and feeding on invertebrates (primarily grasshoppers) as they walked along.

Perch types used by Swainson's hawks are compared in Figure 3. Artifical structures (utility poles and fence posts) were used 52.3% of the time. This is in great contrast to the low rate of use of artificial structures for nest substrates. Although structures like utility poles and fence posts are unsuitable for nest sites, they are extremely valuable as perch sites. Wakely (1974) found that most hunting by ferruginous hawks was done from perches. Swainson's hawks in our

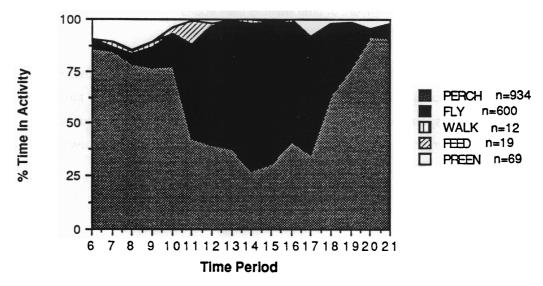


FIGURE 2. The Temporal Distribution of Swainson's Hawk Activity on the Hanford Site in 1987

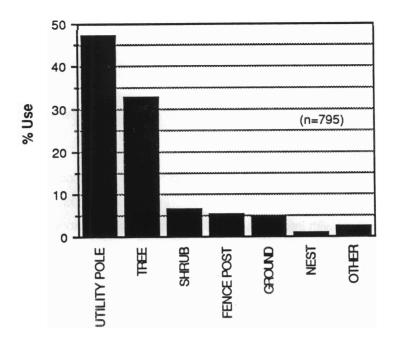
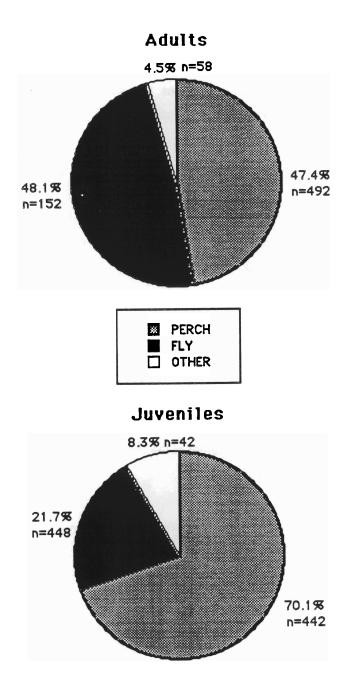


FIGURE 3. Major Perch Types Used by Swainson's hawks on the Hanford Site in 1987

study area frequently made direct hunting flights from perches. Tall trees are very rare at the Hanford Site; the height of utility poles increases the area visible to a perched hawk, likely increasing hunting success from the perch. Utility poles are also well distributed throughout the Hanford Site; hawks hunting from utility poles could forage over a much larger area than they could hunting from the sporadically placed trees.

Activity patterns of adult and juvenile Swainsons' hawks were markedly different (Figure 4). Juveniles spent more time perching, feeding, preening and walking than did adults. Juveniles spent more than fourfold the amount of time walking than adults. This was probably related to the high use of insect prey by juveniles.

The major difference between adult and juvenile activity budgets was in the amount of time spent perching versus time spent flying. Adults spent nearly equal amounts of time flying and perching; juveniles spent more that three times as much time perching as they did flying (Figure 4). However, the proportion of time spent flying increased steadily as juveniles hawks matured; by age 11 weeks, juveniles spent more time in flight than did adults.



<u>FIGURE 4</u>. Time Allocated to Major Activities for Adult and Fledged Juvenile Swainson's Hawks on the Hanford Site in 1987

Nocturnal

Swainson's hawks flew to night roosts at about 2000 each evening. Trees and utility poles were used for roosts. During two nocturnal observations a radiotagged hawk could not be located, possibly indicating use of ground roosts, although this was not confirmed. Hawks remained at their roosts until about 0545, with little movement on the roost during the night. Hawks changed roost locations during night hours in three of 45 hawk observation nights (one

hawk observed for one night = one hawk observation night). No external events or disturbances were recorded at the time of these nocturnal moves; it was unclear if night movements were spontaneous or elicited by some type of disturbance (perhaps the presence of a potential predator).

HOME RANGE

Table 2 shows the MCP estimates of territory size for each of nine radiotagged adult Swainson's hawks. Table 2 also shows the relative areal extent of various vegetation/land types in each of the calculated home range polygons.

The adult female that occupied the nest closest to the exploratory shaft died prior to the initiation of telemetry monitoring, so a territory size estimate could not be calculated for this bird. However, our general observations indicated that the nesting territory was similar in size to one determined by Fitzner (1978) for another nesting pair occupying the same territory during an earlier period. We did note that in comparison with the data of Fitzner (1978), the territory appeared to have dramatically shifted to the west, away from the exploratory shaft by 1987. The nest, rather than being located near the center of the territory (Fitzner 1978), appeared to be near the eastern edge of the territory in 1987.

<u>TABLE 2</u>. Home Range (Territory) Characteristics of Radiotagged Swainson's Hawks on the Hanford Site, Washington, in 1987.

	_				
Territory Name	Territory Size (km ²)	% Shrubland	% Grassland	% Industrial	% Water
120 mm Guns	7.80	50.2	49.3	0.5	0.0
200 East	5.08	39.0	60.1	0.9	0.0
Pit 6	8.40	9.5	58.8	14.5	17.1
Battelle Blvd.	2.58	18.1	79.5	2.3	0.0
Hanford	6.54	10.1	89.9	0.0	0.0
Mtn. View	2.38	18.4	81.5	0.0	0.0
Big Elm	6.53	28.8	55.9	1.2	14.1
Benson Ranch	14.12	18.3	81.7	0.0	0.0
Gate 118	9.26	<u>38.7</u>	60.5	0.9	0.0
MEAN±1 SE	6.97 ± 1.20	25.7 ± 4.8	68.6 ± 4.8	2.3 ± 1.6	3.5 ± 2.3

RESPONSE TO DISTURBANCE

The number and types of external stimuli observed are shown in Table 3. Parked vehicles were by far the most common stimuli recorded, mainly because we usually observed the hawks from parked vehicles. Moving vehicles were the second most common stimuli. The remaining categories of stimuli accounted for only 3.1% of observed external stimuli.

The strength of reaction by radiotagged Swainson's hawks to the different categories of stimuli is also shown in Table 3. Hawks appeared to be most sensitive to pedestrian and vehicle traffic. Helicopters and airplanes were not particularly disturbing unless they came very near the nests. The opportunities to observe hawk reactions to heavy equipment were limited; however, our general observations indicated that active heavy equipment seemed to disturb hawks at relatively greater distances than many other disturbance sources such as passenger vehicle traffic, perhaps due to the higher noise levels associated with heavy equipment. Parked vehicles appeared to be relatively tolerable by Swainson's hawks as long as they were not very near the nests. We noted

<u>TABLE 3.</u> Observed Frequencies of Stimuli and Hawk Reactions to Stimuli Recorded During Observations of Nesting Swainson's Hawks at the Hanford Site in 1987

Stimuli		Strength of Hawk Reactions, % (n)			
Type	Number of Occurrences	None/Mild	<u>Moderate</u>	Strong	
Vehicle, parked	2026	96.6 (1957)	0.3 (6)	3.1 (63)	
Vehicle, moving	103	70.9 (73)	1.9 (2)	27.2 (28)	
Human, walking	16	62.5 (10)	0.0 (0)	37.5 (6)	
Human, bike riding	2	50.0 (1)	50.0 (1)	0.0 (0)	
Helicopter	6	83.3 (5)	0.0 (0)	16.7 (1)	
Airplane	10	90.0 (9)	10.0 (1)	0.0 (0)	
Train	1	100.0 (1)	0.0 (0)	0.0 (0)	
Heavy equipment	7	71.4 (5)	14.3 (1)	14.3 (1)	
Natural	24	79.2 (19)	8.3 (2)	12.5 (3)	
Other	_3	100.0 (3)	0.0 (0)	0.0 (0)	
Total	2198	94.8 (2083)	0.6 (13)	4.6(102)	

some indications that the movement of humans within parked vehicles increased the probability that hawks would exhibit negative reactions to the presence of parked vehicles.

Strength of reaction to disturbance was influenced by the hawk's age. Less than 5% of juvenile hawk reactions to disturbances were classified as moderate or strong. This may be related to the fact that juvenile hawks spent relatively small amounts of time flying compared to adults, and strong reactions usually involved flight. Vocalizations were also considered a strong reaction to a stimulus; over 90% of vocalizations in response to disturbance stimuli were made by adults. However, the low rates of apparently strong disturbance reactions of juvenile hawks should not be assumed to indicate juveniles are insensitive to disturbance. Since young juveniles may not be proficient at flight, it would probably be maladaptive for them to advertise their location by vocalizing.

The hawks' direction of movement relative to location of disturbances was also markedly different between juveniles and adults (Figure 5). Without exception, juvenile hawks flew away from disturbances. Adult hawks usually flew toward or circled over disturbances (87.9%, n=58). Disturbance of birds of prey during the nesting season may lead to failure to nest, nest desertion, long-term territory abandonment, lowered reproductive success and death of eggs and young (Newton 1979, Levenson and Koplin 1984). Fitzner (1985) reported that construction projects within 1-1.5 km of several Swainson's hawk nest sites commonly lead to their desertion. During this study, we verified the mortalities of four of the five Swainson's hawks in the territory nearest the exploratory shaft (1.4 km from the nest to the exploratory shaft). As mentioned before, human disturbance of the hawks was common in this territory. The second closest territory (3.0 km from the exploratory shaft) was not occupied in 1987, probably as a result of gravel being removed from the borrow pit about 0.2 km from the nest tree.

An important determinant in the hawks' reaction to external stimuli appeared to be the novelty of the stimulus. Hawks reacted strongly to novel stimuli, or those that occurred infrequently. Stimuli that occurred on a frequent basis were less likely to elicit strong reactions by hawks. For instance, fast moving vehicles were common stimuli at Mountain View and Big Elm territories; they elicited no or mild reactions. Slow moving vehicles were uncommon at these territories, and without fail they elicited strong reactions by hawks. Slow moving vehicles were common at the 200 East territory during daily periods of traffic congestion; only mild reactions

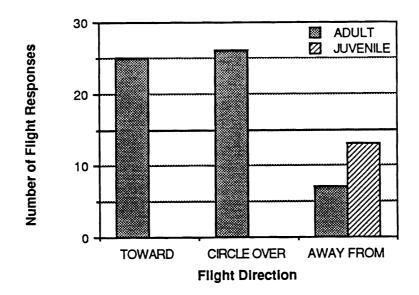


FIGURE 5. Flight Patterns of Disturbed Adult and Fledged Juvenile Swainson's Hawks on the Hanford Site in 1987

were shown by hawks to these slow vehicles. Vehicular traffic was uncommon at Benson Ranch and Hanford territories; any vehicular traffic in these territories elicited moderate or strong reactions by hawks. Apparently Swainson's hawks become habituated to certain recurring stimuli within their territories, and breeding pairs select nest sites that contain tolerable amounts and types of stimuli. Because of this site-specific response pattern to disturbance, the effects of human activities and other stimuli on Swainson's hawks must be examined on a territory by territory basis.

RECOMMENDATIONS

Due partly to the Swainson's hawk's current status as a migratory bird and (mainly) to its potential regulatory status as a threatened or endangered species, negative impacts to its activities and nesting success need to be minimized. Effects of human disturbance on diurnal raptors and protection of nesting pairs has been the subject of recent research (Suter and Joness 1981, Levenson and Koplin 1984, White and Thurow 1985, Fitzner 1985, Ritchie 1987). A common technique to minimize disturbance is to establish of spatial buffer zones around raptor nest sites (Suter and Joness 1981, White and Thurow 1985). A spatial buffer zone is an area in which certain activities are restricted. Our observations indicate that Swainson's hawks confine virtually all of their activities to within 2 km in any direction of the nest site. Swainson's hawks usually reacted to potential disturbances at distances less than 0.2 km. Thus, a buffer zone extending 2.2 km in all directions from a nest site should effectively minimize the effects of industrial activity and other frequent, intense human disturbances on nesting Swainson's hawks. A buffer zone of this size should also protect against impacts to the prey base within the hawk's nesting territory.

Temporal buffer zones are also effective in controlling short-term disturbance of nesting raptors (Suter and Joness 1981). Confining activities of limited duration to the non-nesting period (mid-September to April) would minimize impacts to nesting Swainson's hawks.

We found that Swainson's hawks showed stronger reactions to novel stimuli than to recurring events. If human activities are unavoidable within the buffer area during the nesting season, impacts to hawks might be lessened by 1) beginning the activity prior to arrival of the nesting pair, and 2) continuing the activity in the same manner throughout the nesting season. However, these "last-ditch" measures may not be effective in controlling disturbance of nesting hawks. Levenson and Koplin (1984) found that ospreys responded variably to constant levels of human activity begun before nesting started; some pairs successfully raised young, but others failed to produce young.

Protection of nest trees is essential to the future of Swainson's hawks at the Hanford Site. Protection should extend to all trees within Swainson's hawk territories, so that alternate nest sites will be available if necessary. Elevated perches (trees, utility poles) within nesting territories are also important and should be preserved.

At some point, mitigation for loss of Swainson's hawk nesting territories may become desirable. Sharp (1986) discusses an array of possible mitigative techniques. Those measures which could be applicable to the Hanford Site include the following items:

Specific options which could be employed to mitigate environmental impacts to nesting Swainson's Hawks on the Hanford Site include:

- 1. Planting replacement nest trees in nesting territories where trees are not regenerating or new trees in areas not supporting potential nest trees. Drought tolerant tree species such as black locust and junipers (<u>Juniperus</u> spp.) should be used. Newly planted young trees will probably require supplemental watering for several years in order to become established. Techniques such as planting trees in depressions which funnel rainfall to the root zone, use of water collection shields, and control of other plant growth near the trees may increase survival of trees.
- 2. Experiment with artificial nesting platforms for Swainson's hawks. Although red-tailed hawks and common ravens utilized three of the five artificial nesting platforms present on the Hanford Site in 1987 (personal observation), Swainson's hawks have not nested on artificial platforms here. Use of utility pole crossarms for nest substrates indicates that Swainson's hawks will nest on artificial substrates. Either the present platform design is unsuitable for use by Swainson's hawks or else interspecific competition for the few platforms eliminated the opportunity for use by Swainson's hawks. Additional artificial platforms could be established at intervals of at least 1 km in treeless areas of the Hanford Site. Although Sharp (1986) recommends platforms of 120 x 60 x 20 cm, relatively small platforms (no greater than 60 cm diameter) on short (about 3 m) poles may deter use by red-tailed hawks and ravens. As suggested by Sharp (1986), platforms may be used more readily by Swainson's hawks if disguised to resemble trees. It may be desirable to artificially stabilize nests in wind-prone locations to avoid destruction by wind.

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