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SKAGIT RIVER BALD EAGLE - SEATTLE CITY LIGHT TRANSMISSION LINE INTERACTION STUDY

FINAL REPORT

Prepared For

Seattle City Light
700 Fifth Avenue, Suite 3100
Seattle, WA 98104-5031

May 29, 2001

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1.0 INTRODUCTION

Transmission lines for the Seattle City Light (SCL) Skagit River Hydroproject cross the Skagit River in an area that provides habitat for large concentrations of wintering bald eagles (*Haliaeetus leucocephalus*). The air space above the Skagit River is a major bald eagle travel corridor for birds flying up- and down-river in search of food, perch, and roost sites. To increase transmission line visibility and minimize the potential for bald eagle-transmission line collisions, aviation markers are sometimes employed at transmission line river crossings.

On November 13, 1995, SCL filed a bald eagle monitoring plan in lieu of the aviation marker plan required by the Federal Energy Regulatory Commission (FERC) in Article 411 of the Order Accepting Settlement Agreement issued May 16, 1995 for the Skagit Project (Federal Energy Regulatory Commission, 1996). Article 411 requires SCL to install transmission line identifiers, such as aviation spheres, to reduce the likelihood of eagle collisions at river crossings. SCL noted a lack of evidence of mortality or other adverse impacts to bald eagles from the Skagit Project transmission lines, and proposed instead to monitor a key river crossing at Corkindale Creek for two seasons to establish patterns of eagle use and assess potential conflicts or hazards. In a letter dated November 29, 1995, the United States Fish and Wildlife Service (USFWS) approved the SCL monitoring plan, and on January 22, 1996, FERC issued an Order approving the bald eagle monitoring plan.

Monitoring at the Corkindale site was completed during winter 1996-1997 and winter 1997-1998. The results from these two seasons revealed that 8 percent of all the observed flights across the lines included sudden, last minute maneuvering (i.e., flaring) by the eagles to avoid the lines (Springwood Associates, Inc., 1998). Further analysis of the 1996 – 1998 data revealed that about 28 percent of the eagles that approached the transmission line Right of Way (ROW) at line level flared to avoid the lines. The US Forest Service determined that this rate was high enough to warrant additional study concerning the efficacy of line markers (US Forest Service, personal communication).

In the fall of 1999, SCL began installation of a fiber-optic cable atop one set of transmission towers leading from the Skagit Project to Seattle. SCL agreed to install markers at key locations along the fiber-optic cable and conduct additional monitoring during winter 1999-2000. Markers were installed at seven sites selected in consultation with the Washington Department of Fish and Wildlife and the National Park Service. The selected sites were chosen based on their history of eagle use and location within eagle travel routes. The selected sites are all located between Rockport and Newhalem and include Corkindale Creek, Illabot Creek, Diobsud Creek, Bacon Creek, Pinky's, Shovel Spur, and Goodell Creek.

Following installation of the markers, a third year of monitoring was conducted at the Corkindale Creek site to observe eagle-transmission line interactions during winter 1999-2000. Monitoring was conducted with the same intensity as the monitoring completed during 1996-1997 and 1997-1998. Limited monitoring was also conducted at the Bacon Creek and Illabot Creek sites during winter 1999-2000. The goal of the monitoring at these two sites was to observe general patterns of eagle use and determine whether additional monitoring may be needed.

1.1 Purpose

The purpose of this study was to document the behavior of eagles flying across the Skagit transmission line ROW. This report summarizes and interprets the data resulting from three winter seasons of bald eagle monitoring at the Corkindale site, and describes observations of eagle-transmission line interactions from limited observations at the Bacon Creek and Illabot Creek sites.

This report also provides background information regarding bald eagles, eagle-transmission line interactions, and devices used to mark lines. Furthermore, this report documents the methods used to monitor bald eagles, describes the observed patterns of eagle use at the monitoring sites, and assesses potential conflicts or hazards due to the Skagit transmission lines at Corkindale Creek, Bacon Creek, and Illabot Creek. Lastly, the results of a review of this study by a panel of experts are presented.

2.0 PROJECT DESCRIPTION

2.1 Background Information

Skagit Right of Way

The Skagit River originates in Canada, and flows southerly through the North Cascade Mountains and westerly through the Puget Lowlands into Skagit Bay. The Skagit Right of Way (ROW) transmission line corridor originates at the Ross Powerhouse located upstream of the study areas, and continues southwesterly to the City of Seattle. The ROW follows roadways and travels cross-country throughout its length.

The Skagit ROW corridor contains two parallel sets of transmission towers. The westerly set of towers supports six electrical conductors, three vertically arranged on either side of the towers. The conductors are 18 feet apart vertically. The easterly set of towers also supports six electrical conductors and additionally supports a fibre-optic cable strung across the tower tops above the conductor cables. Each of the twelve electrical conductors has a diameter of about 1.14 inches. The fibre-optic cable has a smaller diameter of about 0.75 inch. Conductor height above the river or ground varies with the electrical load and air temperature. The higher the load, or the warmer the temperature, the greater the sag in the wires. Although sag can be as great as 30 feet, the lowest wires

at the Corkindale site typically vary between 70 and 85 feet above the river surface (Seattle City Light personal communication, 1996). The fibre-optic cable is strung about 12 feet above the electrical conductors.

Bald Eagle Behavior

Bald eagles and raptors in general, due to their great visual acuity, are uncommon victims of transmission line collisions. However, raptors become vulnerable to collision when weather conditions limit visibility, if blown off course by gusts of wind, or when distracted. Eagles may also be vulnerable to collision if they are alarmed, being pursued, searching for food while flying, or are engaged in courtship (Scott et al., 1972). Data indicate that many avian collisions occur in conditions of good visibility when birds are distracted by human activities or disturbance (Thompson, 1978).

Mortality of bald eagles as a result of interaction with transmission lines can be due to either electrocution or collision impact. However, electrocution of eagles is not considered a problem with high voltage transmission lines because conductors are far enough apart to prevent simultaneous contact of an eagle's extremities with adjacent conductors (Kroodsma, 1977). Twelve of the thirteen SCL lines at the Corkindale site are high voltage transmission lines spaced a minimum distance of eighteen feet apart. The thirteenth line is the fibre-optic cable, which does not conduct electricity. As a result, the potential impacts of the transmission lines and fibre-optic cable on eagles at the Skagit River sites involve injury or mortality due to collision, not electrocution.

Local experts in the Skagit River area consider eagle mortality due to collision with transmission lines a rare event. According to local bald eagle researcher Libby Mills (1995), there has been only one case since 1973 of a bald eagle found dead under the Skagit transmission lines between Rockport and Marblemount. This one case was near Corkindale Creek. However, Willard (1978) reports that most birds that strike a power line do not fall directly beneath it but rather fly off and at some distance from the line either recover or die. Furthermore, carcasses may be quickly washed downstream or scavenged. As a result, it is difficult to assess the rate of eagle mortality from collision with transmission lines at river crossings using carcass surveys.

The Skagit River provides important winter habitat for bald eagles in the Puget Sound region. Numerous studies of the Skagit River have demonstrated the importance of chum salmon (*Oncorhynchus keta*) as a food source for bald eagles (Hunt et al., 1992; Servheen, 1975; Stalmaster, 1987). Chum salmon typically spawn from mid-November until early January in the Skagit system (Hunt et al., 1992). Salmon carcasses provide food for eagles during this period and beyond until high water flows wash carcasses downstream or they are consumed by other wildlife. Coho salmon (*Oncorhynchus kisutch*), which spawn in tributaries of the Skagit, may also serve as a principal food source for eagles after mid-January (Hunt et al., 1992). The segment of the Skagit River

at the Corkindale site contains moderate concentrations of chum salmon and is near the Illabot Slough area, which contains high concentrations of chum salmon. In contrast, coho salmon concentrations within these segments are relatively low (US Forest Service, 1998).

The winter population of bald eagles on the Skagit River forages on spawning salmon and salmon carcasses floating in the river or stranded at the river's edge. Foraging for this food source involves behavior that is often intent on the river and the riverbanks during flight or when perched. As a result, bald eagles may not always be attentive to power lines while foraging. Also, if eagles fly during low visibility conditions (e.g., at dusk, dawn, and in fog), collision potential may be increased (Kroodsma, 1977). Although resident populations of birds probably reduce their probability of collision through familiarity with line location, seasonal populations may be more vulnerable to collision. There are also inconclusive reports that birds may experience navigational disorientation by passing through electric fields (Willard, 1978).

Transmission Line Markers

Large, brightly colored spheres (commonly called "aviation spheres") are typically used to increase the visibility of transmission lines. However, while birds may see these spheres better than wires during low visibility conditions, they may still strike the wires while swerving to avoid the spheres (Avery, 1978). In addition, eagle researchers have raised concerns about the effectiveness of the spheres since they do not increase line visibility between the spheres. SCL also raised concerns over the aesthetic impact of the spheres in areas where they would be visible from the North Cascades Highway. SCL identified an alternative to aviation spheres after contacting Tacoma City Light and Snohomish Public Utilities. Both organizations have used devices called "Bird Flight Diverters" (BFDs) in areas where eagles and migrating waterfowl cross their transmission lines.

BFDs are manufactured by Preformed Line Products, and consist of 13-inch lengths of gray plastic coil that are mounted on the transmission line, effectively enlarging the diameter of the line and increasing its visibility. The BFDs are considered more effective line markers than aviation spheres because they enlarge the diameter of the line nearly continuously, and because they avoid the aesthetic impact of aviation spheres.

SCL chose to use the BFDs after eagle biologists recommended against the use of spheres, citing the small diameter of the fibre-optic cable between the spheres as the primary hazard. BFDs were installed every 15 feet along the cable where it spans the Skagit River at the Corkindale site and at the Bacon Creek site. BFDs were also installed every 15 feet at the Diobsud Creek, Pinky's, Shovel Spur, and Goodell Creek sites. BFDs were installed every 30 feet at the Illabot Creek site. The closer spacing was used at sites

with the highest levels of eagle activity. The Illabot Creek site was considered less critical and thus received BFDs at the wider spacing.

2.2 Study Site Locations and Conditions

The Corkindale Creek, Illabot Creek, and Bacon Creek sites are located in northcentral Washington State along the upper portion of the Skagit River system (Figures 1, 1a, and 1b).

Corkindale Creek

The Corkindale site is located approximately 2.5 miles west of the town of Marblemount where the Skagit River flows primarily westward along its lower 92 miles into Skagit Bay (Figure 1a).

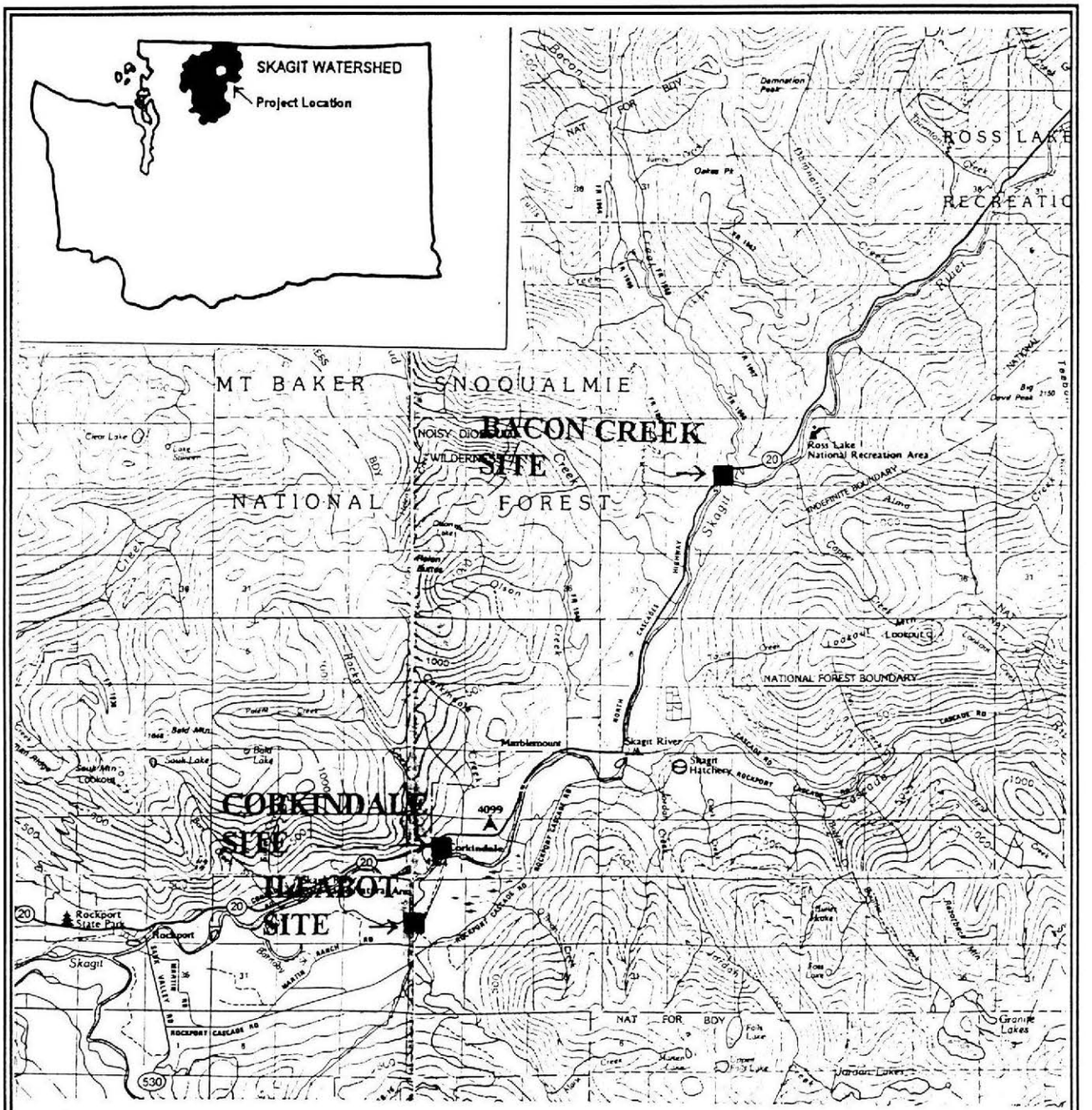
The monitoring site is located on private property on the Skagit River's north bank, which is characterized by open pasture with scattered trees along the riverbank. Corkindale Creek, a relatively small tributary, enters the Skagit River northeast and upstream of the monitoring site. Land use of the area surrounding this segment of the Skagit River includes recreational camping, residential, agricultural, grazing, and forestry practices. The Skagit ROW and associated transmission lines cross the Skagit River perpendicular to its flow. The ROW then enters a forest dominated by a mixture of deciduous and coniferous trees on the south side of the river. The Corkindale site is situated near important bald eagle night roost, staging, perching, and feeding habitat and provides an unobstructed view of the route used by eagles travelling up and down the river. Since the river channel below the lines includes only small gravel bars that are not frequently used for foraging, the primary concern at this site is for eagles crossing the lines as they fly up and down the river corridor.

Illabot Creek

The Illabot Creek site is located across the Skagit River from the Corkindale monitoring site, in an area where Stalmaster (1987) reported high concentrations of foraging eagles (Figure 1a). The Illabot Creek site is also located between an eagle staging area and a nearby night roost site (Washington Department of Fish and Wildlife, personal communication). The primary concern at this site is for eagles flying across the lines as they leave the staging area and fly to the night roost.

Bacon Creek

The Bacon Creek site is located at the confluence of Bacon Creek and the Skagit River (Figure 1b), and includes gravel bars that eagles use as feeding sites (National Park Service, personal communication). The transmission line ROW runs along the north bank of the Skagit River, parallel to the river channel, and crosses the Bacon Creek channel where the creek meets the river. The primary concern at this site is for eagles

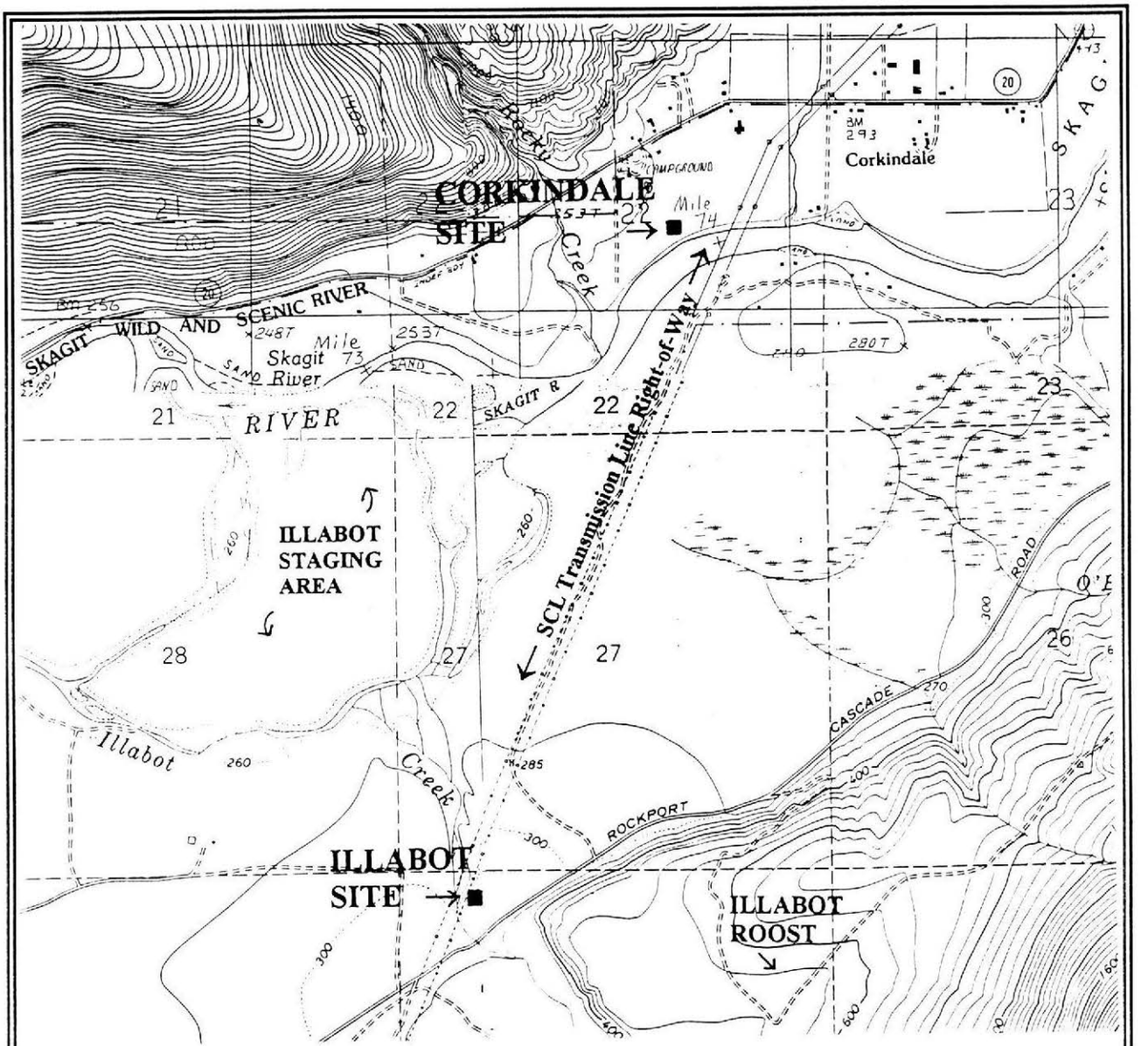


↑ **NORTH**

Scale 1" =12,500'

Base Map: DeLorme Washington Atlas & Gazetteer 1995

SPRINGWOOD ASSOCIATES, INC. **3644 Albion Place North** **Seattle, WA 98103**	**FIGURE 1. PROJECT LOCATION** Bald Eagle/Transmission Line Study Skagit River, Washington
Job No.: 96113 Date: April 11, 2000	

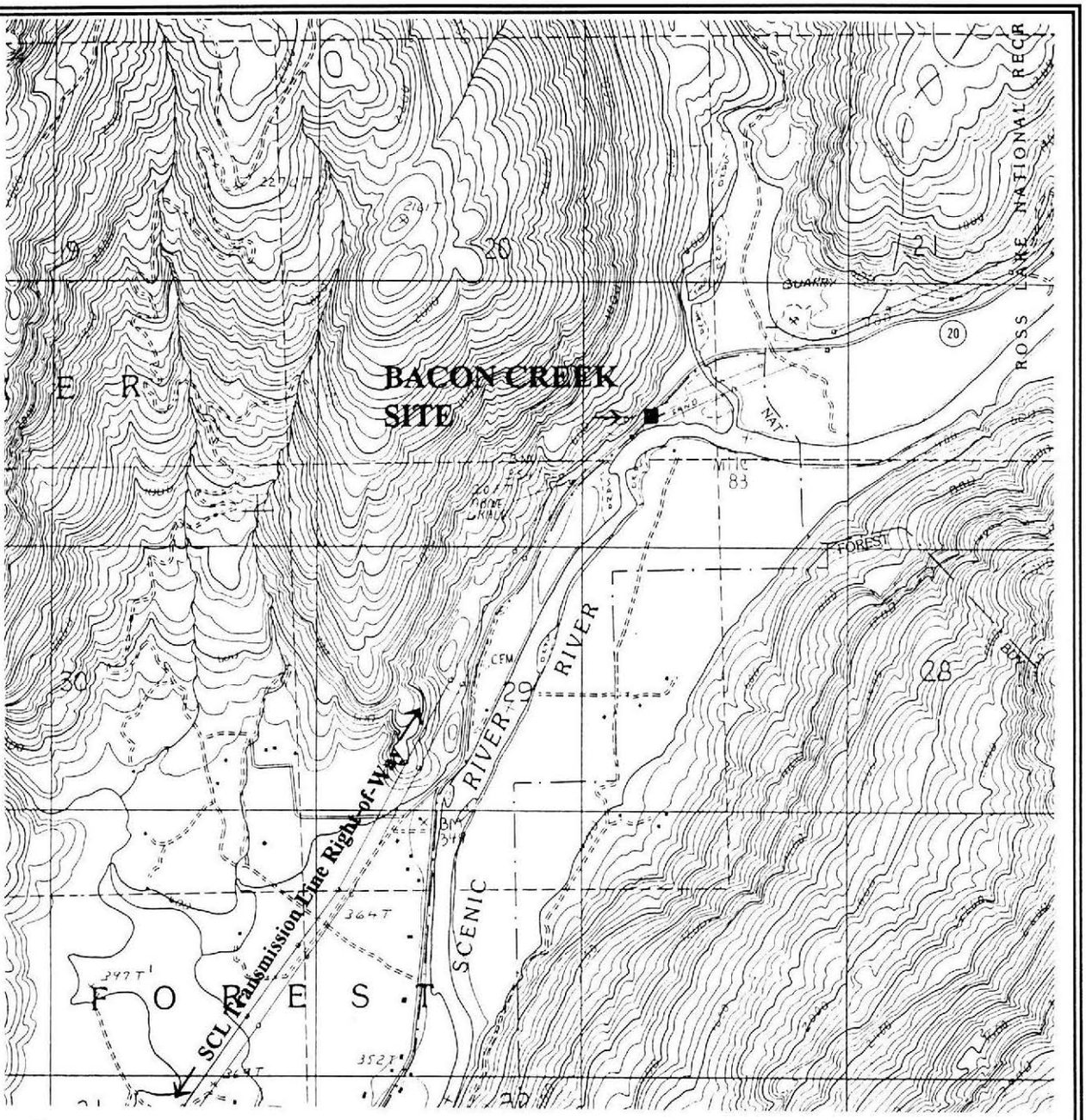


↑ **NORTH**

Scale 1" = 2000'

Base Maps: USGS Marblemount Quad 1989; Illabot Peaks Quad 1966, photorevised 1982; Rockport Quad 1966, photorevised 1982; Sauk Mountain Quad 1989.

SPRINGWOOD ASSOCIATES, INC. **3644 Albion Place North** **Seattle, WA 98103**	**FIGURE 1a. CORKINDALE CREEK AND ILLABOT CREEK STUDY SITES** Bald Eagle/Transmission Line Study Skagit River, Washington
Job No.: 96113 Date: April 11, 2000	



↑ **NORTH**
Scale 1" = 2000'
Base Map: USGS Marblemount Quad 1989.

SPRINGWOOD ASSOCIATES, INC. **3644 Albion Place North** **Seattle, WA 98103**	**FIGURE 1b. BACON CREEK STUDY SITE** Bald Eagle/Transmission Line Study Skagit River, Washington
Job No.: 96113 Date: April 11, 2000	

taking off from and landing on the gravel bars to feed on salmon carcasses, and as they cross the ROW travelling between the Skagit River and the Bacon Creek drainages.

3.0 METHODS

Springwood biologists used the following methods to observe and document bald eagle flights across the Skagit ROW transmission lines. Springwood developed the methods in consultation with wildlife biologists affiliated with the Washington State Department of Fish and Wildlife, the US Forest Service, the National Park Service, and The Nature Conservancy.

3.1 Study Plan

Bald eagle monitoring at the Corkindale site was conducted for three years (1996-1997, 1997-1998, and 1999-2000), twice weekly during the winter months of December through mid-February. Actual beginning and ending dates were determined and adjusted each season according to eagle concentration and use of the site. During 1996-1997, observations were recorded from December 13th through February 8th; during 1997-1998, observations were recorded from December 3rd through January 24th. Following the 1997-1998 season, SCL, the US Fish and Wildlife Service, and the US Forest Service agreed that one additional year of monitoring would be completed following the Fall 1999 installation of a new fiber-optic cable marked with BFDs at key locations (USFWS, personal communication; USFS, personal communication). As a result, observations were not recorded during the 1998-1999 season. During 1999-2000, observations were recorded from December 8th through February 9th.

Eagle movements across the lines were monitored during one evening session (two hours before and including sunset) and one morning session (two hours after and including sunrise) each week throughout each monitoring season. Timing of monitoring was set to correspond to low visibility hours and the hours of the greatest potential for eagle movement and activity. Stalmaster (1987) reports that wintering eagles tend to be sedentary for most of the daytime period, except during the early morning and late afternoon when they actively forage and travel to and from night roost areas.

Eagle crossings were recorded at the Illabot Creek and Bacon Creek sites only during the 1999-2000 season since these sites were added to the study after the fibre-optic cable was installed.

An observation during a monitoring session was defined as any eagle flight across the transmission lines. Thus, an individual eagle was counted as more than one observation if its flight path involved crossing the lines more than once during a single flight. These instances were noted when they occurred. Data collected included flight altitude, flight

direction, flight origin and destination, flight behavior, and relative age of the eagle (i.e., adult or sub-adult) crossing the lines.

3.2 Flight Altitude

Flight altitude was recorded at the Corkindale Creek site relative to six predetermined bands of elevation above the river surface (Figure 2). Each of the six bands represented a 40-foot altitude category. Band 1 corresponds to eagle flight altitudes 0-40 feet above the surface of the river. Band 2 corresponds to altitudes 40-80 feet above the river surface. Band 3, which contains the twelve transmission lines and is the primary zone of potential collision, corresponds to altitudes 80-120 feet above the surface of the river. Band 4 corresponds to altitudes 120-160 feet above the river surface, includes the fibre-optic cable, and is another zone in which collisions may occur. Band 5 corresponds to altitudes 160-200 feet above the river surface. Band 6 includes altitudes higher than 200 feet above the river surface.

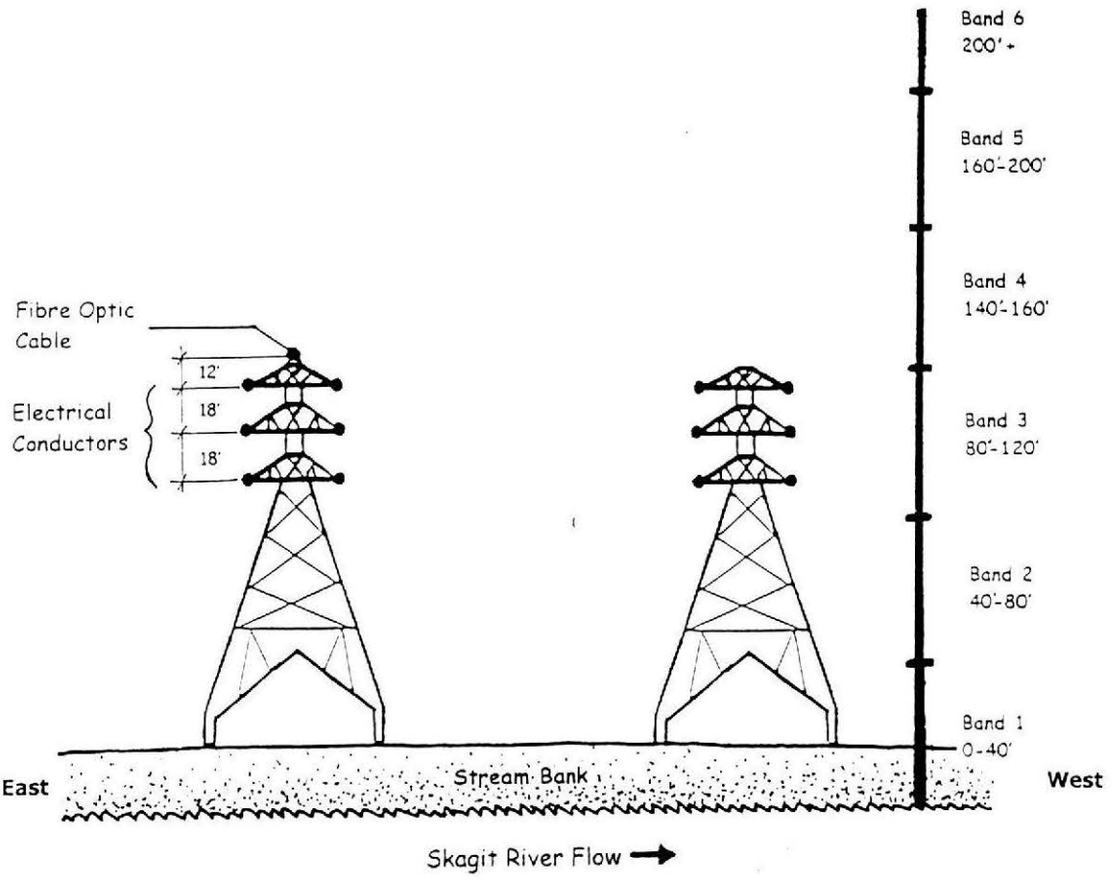


Figure 2. Cross-section of the SCL transmission line ROW at the Corkindale Creek site, showing elevation bands used to characterize bald eagle crossings (not to scale).

The 40-foot elevation band height was chosen at the beginning of the study to roughly correspond to the height of the transmission lines, and thus resulted in one zone of potential collision (until the fibre-optic cable was installed during the third year of monitoring, and produced the potential for collision in a second zone). The relatively large 40-foot categories were also chosen to help diminish and compensate for potential observer error due to fluctuations in river level, transmission line sag, and observer subjectivity.

The altitudes of eagle flights across the lines at the Illabot Creek and Bacon Creek sites were characterized only as above, through, or below the transmission lines.

3.3 Flight Origin and Destination

Flight origin and destination information was collected for each observation. Whether a flight originated from a perch, a gravel bar, or a known roost or staging area, the origin was recorded. Destination information was also recorded using the same designations. Origin and destination data were recorded from the monitoring site, and thus in some cases the observer did not view the actual origin or destination of a flight. The location of the Corkindale Creek monitoring site provides views for approximately 0.5 mile up and down river from the transmission line crossing. Views up and down the river corridor from the Bacon Creek site are similarly unrestricted. The Illabot Creek site is located within the Skagit ROW, and forest vegetation on either side limits views beyond the ROW edges.

3.4 Flight Behavior

Springwood biologists recorded flight behaviors for each eagle crossing observed. Flight behavior was assessed by observing the flight path when approaching, crossing, and leaving the transmission lines. Any alteration in flight path executed to cross the lines was recorded. Flare reactions were specifically noted. Various researchers (e.g., Stalmaster, 1987) describe flaring as a maneuver that can occur whenever eagles attempt to change flight direction suddenly. Researchers have also observed that flaring can occur in response to either dangerous or benign circumstances. During this study, an eagle flight was recorded as including flaring behavior if an eagle approaching the lines abruptly changed its flight path to avoid the transmission lines or fibre-optic cable.

4.0 RESULTS AND DISCUSSION

4.1 Corkindale Creek Site

Number of Crossings

Springwood biologists observed 238 eagle crossings during the three seasons included in the study. One hundred twenty were recorded during the initial monitoring season from

December 1996 through February 1997, 52 were recorded during the second monitoring season from December 1997 through January 1998, and 66 were recorded during the third monitoring season from December 1999 through February 2000 (Table 1).

Factors that influence eagle food availability in the Puget Sound region also influence eagle abundance in the region (Hunt et al., 1992). Researchers have identified a correlation between predicted chum salmon escapement and the number of wintering bald eagles present on the Skagit River (Hunt et al., 1992). Chum salmon escapement numbers were far lower than expected during the 1997-1998 monitoring season, possibly due to climatic factors (Seattle City Light personal communication, 1998). Of the approximately 40,000 chum salmon expected to return to the Skagit system, only about 8,000 did in fact return (Seattle City Light personal communication, 1998).

The reduced number of fish may explain the significantly lower number of eagle observations at the Corkindale site during the second monitoring season as compared to the 1996-1997 season. While The Nature Conservancy's bald eagle counts during the early part of the 1997-1998 monitoring season were initially comparable to their 1996-1997 counts, bald eagle numbers peaked earlier (mid-December) during the 1997-1998 season and steadily declined, perhaps as a result of the diminished food supply (Mills personal communication, 1998). Although eagles were abundant on the Skagit during the early portion of the second season, our observations from late in the season indicate that eagles responded to the scarcity of available chum salmon by vacating the project area earlier than expected. Monitoring for the second season ended the week of January 18-25, 1998 after consistently low numbers of observations were recorded during that and previous weeks. Chum salmon escapement for the 1999-2000 season was approximately 34,000 fish, which represents a moderate reduction (i.e., 15 percent) from the expected return (Seattle City Light personal communication, 2000), and may account for the moderate number of eagle sightings recorded during the 1999-2000 season.

Flight Altitude

Nine crossings (four percent of the total number of crossings) were observed within altitude Band 1, which extends from the river surface up to about 40 feet elevation (Figure 3; Figure 4 also summarizes bald eagle crossing altitudes). Two of these crossings involved the same bird during a single flight. Eight crossings (about three percent) were recorded within Band 2. The eighteen observations recorded in Bands 1 and 2 include four observations of eagles actively foraging beneath the transmission lines at the Corkindale site. Expressed as a percent of all observed crossings, foraging flights constitute about 2 percent of the total. Since eagles may be distracted when foraging and most foraging flights occur at low altitudes, Faanes (1987) recommends placing markers on the lowest wires in areas of known bald eagle concentrations. However, our observations indicate the primary eagle activity in the Corkindale area is travel eastward or westward above the lines, and that eagles infrequently forage in the area.

Table 1. Eagle crossings observed at the Corkindale Creek site, 1996-2000.

				Altitude Band						
	# Flights	**# Flares**	**# Collisions**	**1 (0-40')**	**2 (40'-80')**	**3 (80'-120')**	**4 (120'-160')**	**5 (160'-200')**	**6 (200'+)**	**no crossing**
1996-1997	120	8	0	5	1	9	69	18	18	0
		7%	0%	4%	1%	8%	58%	15%	15%	0%
1997-1998	52	5	0	2	1	5	29	7	8	0
		10%	0%	4%	2%	10%	56%	13%	15%	0%
1999-2000	66	12	0	2	6	3	33	11	10	1
		18%	0%	3%	9%	5%	50%	17%	15%	2%
Totals	**238**	**25**	**0**	**9**	**8**	**17**	**131**	**36**	**36**	**1**
Percentage		**11%**	**0%**	**4%**	**3%**	**7%**	**55%**	**15%**	**15%**	**<1%**

During the three seasons of monitoring, Springwood biologists observed 17 crossings (7 percent) within Band 3, the band that contains the twelve electrical transmission lines and is therefore the band in which collisions would most likely occur. Although all of these observations involved eagles flying through the transmission lines, none of the crossings in Band 3 resulted in collisions. All 17 flights within the collision zone included a flare and twisting motion as the eagle entered the area between the lines.

Band 4 includes the elevations that the majority of eagles at Corkindale used when crossing the transmission lines. One hundred thirty-one crossings, or 55 percent of the total, were observed within Band 4. The lower limit of Band 4 is approximately 120 feet above the surface of the Skagit River and is just above the average height of the trees growing along the river. The lower limit of this altitude band is slightly above the uppermost transmission lines and includes the fiber-optic cable. Many of the crossings at the lower limit of Band 4 occurred when eagles approaching at line level gained altitude to cross over the lines. None of the crossings in Band 4 resulted in collisions with the fiber-optic cable.

Seventy-two birds crossed high over the lines within Bands 5 and 6, with no chance for collision. The 36 crossings recorded within each band comprise 15 percent of the total recorded observations.

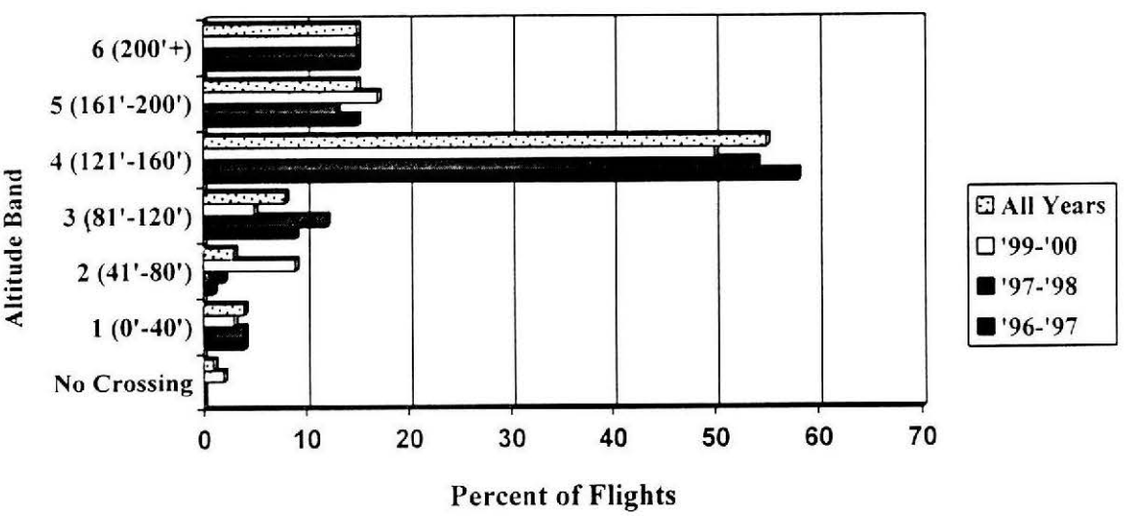
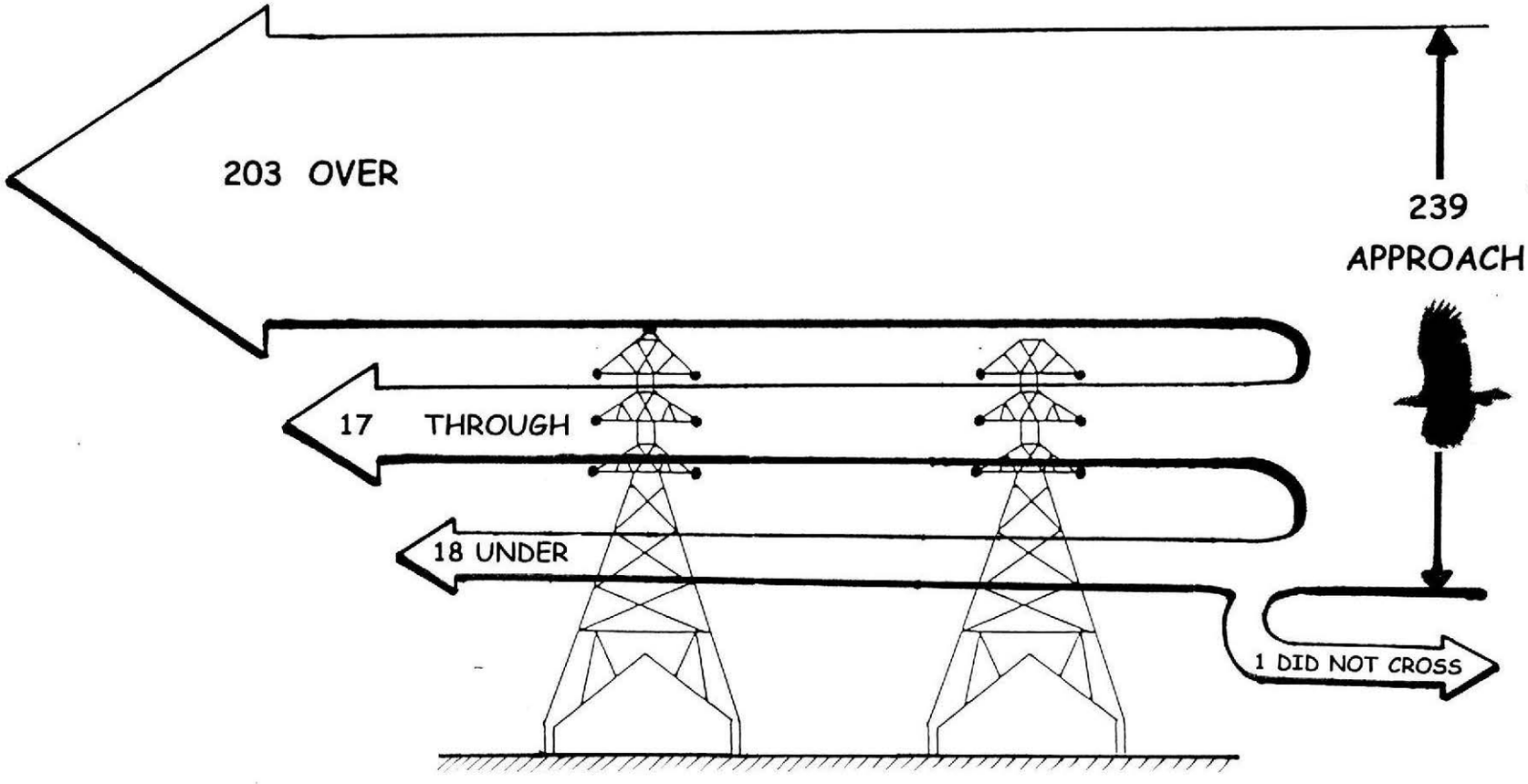


Figure 3. Flight altitude of bald eagles crossing the Corkindale ROW, expressed as a percent of each year's total and as a percent of the total number crossings observed during the three seasons of monitoring.



SPRINGWOOD ASSOCIATES, INC. **3644 Albion Place North** **Seattle, WA 98103**	**FIGURE 4. NUMBER OF BALD EAGLE CROSSINGS OVER, THROUGH, AND UNDER TRANSMISSION LINES AT THE CORKINDALE STUDY SITE, 1996-2000.** Bald Eagle/Transmission Line Study Skagit River, Washington
Job No.: 96113 Date: April 11, 2000	

Flight Behavior

The majority of the eagle flights observed during the three seasons of study crossed above or below the SCL lines (Table 2 and Figure 4). The 221 flights above and below the lines constitute 93 percent of the 238 observed flights. In 213 of the flights above or below the lines, eagles either observed the lines at a great enough distance that they had time to gradually adjust their flight path, or else their flight paths required no adjustment to avoid the lines. The remaining 25 flights were completed by eagles whose flight across the ROW included a flare.

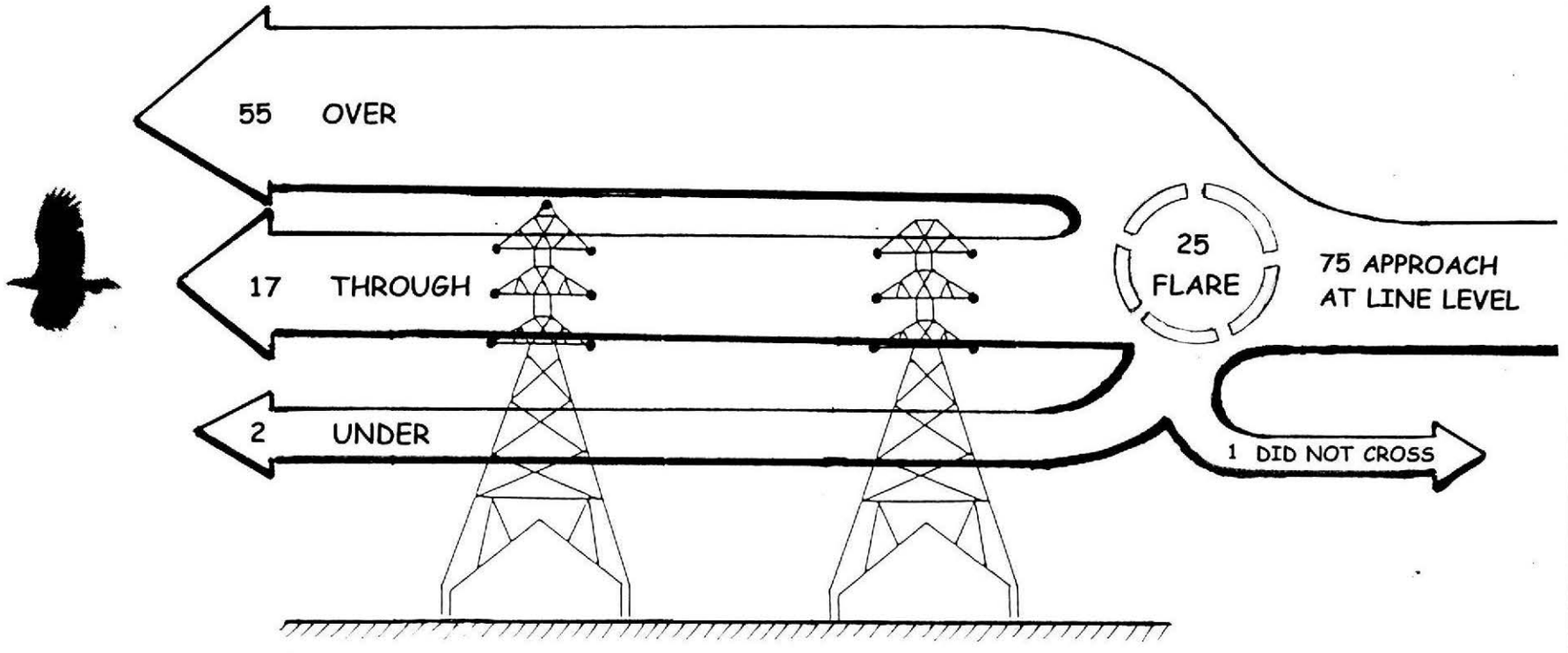
Table 2. Bald eagle flight elevation summary.

Season	# Flights	# Flares	# Under Lines	# Through Lines	# Over Lines
1996-1997	120	8	6 (5%)	9 (8%)	105 (88%)
1997-1998	52	5	3 (6%)	5 (10%)	44 (85%)
1999-2000	66	12	8 (12%)	3 (5%)	55 (83%)
Totals	**238**	**25**	**17 (7%)**	**17 (7%)**	**204 (86%)**

Since eagles approaching the ROW above or below line level typically flew level flight paths and therefore were at low risk for collision, an analysis that excludes these flights was conducted to concentrate on the responses of eagles that approached the ROW at line level and as a result were at higher risk of collision (Table 3 and Figure 5). This analysis reveals that during the three seasons of study 75 of the 238 crossings (32 percent) involved eagles that approached at line level and modified their flight path or flight behavior in response to the lines. On a yearly basis, the number of approaches at line level ranged from 17 (33 percent of the yearly total) during 1997-1998, to 29 during both the 1996-1997 and 1999-2000 seasons (24 percent and 44 percent, respectively, of each yearly total). Every approach at line level resulted in flight path modification, either flaring or gradual alteration or, in one case, refusal to cross the ROW. No collisions were observed during the three seasons of observation.

Table 3. Flight path alterations completed by bald eagles approaching the ROW at line level.

Year	Total #Eagle Crossings (a)	# Eagles Approaching at Line Level (b)	Percent Approaching at Line Level (b/a)	# Eagles Flaring (c)	Flare Rate (c/b)	# Under	# Through	# Over	# Did Not Cross	# Collisions
1996/1997	120	29	24%	8	28%	0	9	20	0	0
1997/1998	52	17	33%	5	29%	0	5	12	0	0
1999/2000	66	29	44%	12	41%	2	3	23	1	0
Totals	**238**	**75**	**32%**	**25**	**33%**	**2**	**17**	**55**	**1**	**0**



SPRINGWOOD ASSOCIATES, INC. **3644 Albion Place North** **Seattle, WA 98103**	**FIGURE 5. FLIGHT PATH ALTERATIONS COMPLETED BY BALD EAGLES APPROACHING THE ROW AT LINE LEVEL, 1996-2000.** Bald Eagle/Transmission Line Study Skagit River, Washington
Job No.: 96113 Date: April 11, 2000	

Eagles approaching the ROW at line level demonstrated a strong preference for ascending over the transmission lines rather than flying through them or descending to fly under them (Table 3). Eagles flew through the lines 17 times (about 7 percent of the observed crossings), and only two eagles were observed altering their flight paths to descend below the lines. Thompson (1978) reports that many birds are reluctant to fly under objects of any sort, and our observations suggest that although this may be true for eagles approaching the ROW at line level or higher, eagles that approached the ROW flying low over the river (i.e., below line level) typically maintained a level flight path and passed under the lines.

Springwood biologists recognized three general techniques used by eagles approaching at line level to avoid the transmission lines. In cases where eagles apparently saw the lines from a distance, they typically gained elevation slowly, crossed the two sets of transmission lines and the fibre-optic line, and slowly descended to return to the altitude of the approach flight. No turning, twisting or other changes in flight except a gradual increase in altitude was associated with these crossings.

The second general technique also occurred when eagles approached at the elevation of the lines and again recognized them from a distance. In addition to gaining elevation these eagles also responded by turning to alter their flight direction. Typically, eagles employing this technique slowly turned to fly parallel to the ROW and the transmission lines, gained sufficient altitude to clear the lines, then turned back to their original heading and crossed the lines.

Eagles that approached the lines until too close to use either of the previously-described methods used a third technique to cross the ROW. In these cases, eagles typically flew steadily towards the lines, then abruptly flared to alter flight speed and direction. Twenty-five of the 238 crossings observed throughout the three years of study (approximately 11 percent of all flights) involved flaring. The percentage of crossings during each season of study that resulted in flaring ranged from 7 percent during the 1996-1997 season to 18 percent during the 1999-2000 season (Table 1; Appendix).

Springwood biologists observed flaring specifically to avoid the fibre-optic cable on one occasion. An eagle flying upriver approached at the level of the transmission lines. Upon reaching the west set of lines the eagle flared and struggled to fly up and over the lines. As it began flying east over the next set of lines it encountered the fibre-optic cable, flared again, and again struggled to gain altitude and clear the cable. The eagle successfully completed the maneuver, avoided a collision, and continued flying upriver.

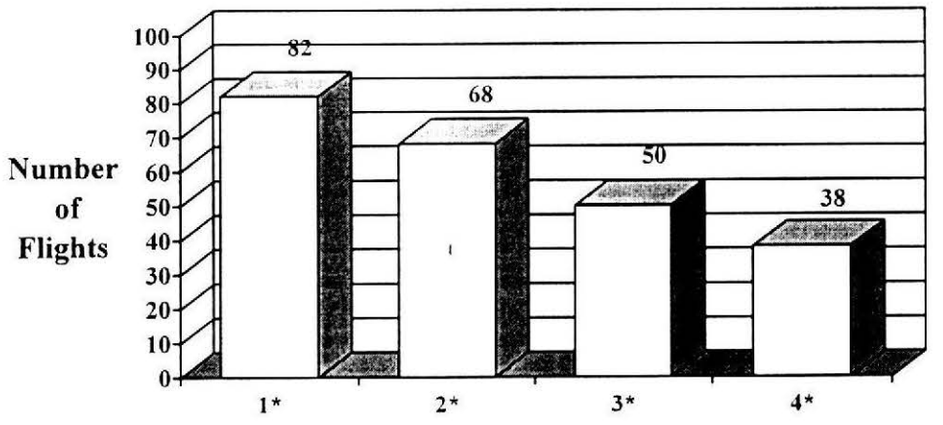
Smaller birds such as gulls (*Larus* spp.), American crows (*Corvus brachyrhynchos*), common ravens (*Corvus corax*) and a red-tailed hawk (*Buteo jamaicensis*) were also

observed flying through the lines during monitoring, and several individuals exhibited flaring behavior when crossing the lines. Crows, being smaller, were also observed to maintain a steady flight through the lines on occasion. One gull during the first monitoring season collided with the lines after flaring and upon maneuvering through the first set of wires. The gull readjusted its flight and successfully passed through the lines apparently unharmed. This was the only observed collision during the three monitoring seasons.

Although refusal to cross the lines is reported as a common behavior by other researchers (e.g., Faanes, 1987), this response was observed infrequently during the present study. In only one instance an eagle approached the lines, flared, reversed direction, and did not cross the lines during the observation period.

Time of Flight

Data from all three seasons of observation were analyzed to determine what time of day line crossings occurred. Four categories were used to characterize the morning and evening observation periods: the first hour following sunrise, the second hour following sunrise, the next-to-last hour before sunset, and the final hour before sunset. During all three study seasons a greater percentage of crossings occurred during the morning hours than during the afternoon hours (Figure 6).



*1 = First hour following sunrise
*2 = Second hour following sunrise
*3 = Next-to-last hour before sunset
*4 = Final hour before sunset

Figure 6. Timing of flights observed during three seasons of monitoring.

Of the 238 crossings observed during the three study seasons, eighty-two (34 percent) occurred during the hour following sunrise, sixty-eight (29 percent) occurred during the second hour following sunrise, fifty (21 percent) occurred during the next-to-last hour before sunset, and 38 observations (16 percent) occurred during the final hour before sunset. These results indicate that eagle movement across the transmission lines at Corkindale tends to occur primarily during the early morning hours, as eagles fly from night roosts to foraging or perching locations along the river.

Flight Direction

The Skagit River flows westward at the Corkindale site and eagles crossing the transmission lines are generally flying up and down the river corridor. During all three monitoring seasons the majority of observed flights involved eagles flying eastward above the river channel or eastward from the Illabot Slough area towards Marblemount and the County Line Ponds area. The majority of eagles crossed the lines at Corkindale over the southern bank of the river. This aspect of eagle flight was not intentionally analyzed, but nonetheless became apparent during the course of the study. More human disturbances and structures occur along the northern bank of the river than on the southern bank and may account for this flight behavior. In addition, the river meanders to the north at Corkindale, and eagles that do not follow the river channel may be following a more direct route up- or downstream by flying over the south bank.

Age Classification

Of the 238 total observations, 120 (50 percent) involved adult eagles, 75 (32 percent) involved sub-adult eagles and 43 (18 percent) involved an unknown age classification. Poor visibility conditions and observer error during instances of several simultaneous crossings all contributed to unknown age classifications.

Adult eagles flew over the lines more frequently, and therefore through or under the lines less frequently, than sub-adult individuals. About 90 percent of the adult birds crossed above the lines, as opposed to about 75 percent of the sub-adult birds. As a result, sub-adult birds flew through or under the lines more than twice as often (on a percentage basis) as adult eagles. However, an analysis of the flaring response by adult and sub-adult birds reveals that adults flared more often than sub-adults (Table 4). Consequently, it appears that although adult eagles are less likely to fly at or below line level, they are more likely to flare when they encounter the lines.

Table 4. Flare response by adult and sub-adult bald eagles.

	# Flights	# Flares	# Adults Flaring	# Sub-Adults Flaring
1996-1997	120	8	5	3
1997-1998	52	5	5	0
1999-2000	66	12	5	7
Totals	**238**	**25 (a)**	**15 (b)**	**10 (c)**
		Percentage	**60% (b/a)**	**40% (c/a)**

4.2 Illabot Creek Site

Sixteen crossings were observed during the one afternoon spent at the Illabot Creek site during the 1999-2000 season. Thirteen of the crossings involved eagles leaving the Illabot staging area in a loose group and flying eastward to the Illabot roost area located on a slope above Illabot Creek. The remaining three crossings were individual eagles flying westbound. In all the observed crossings the eagles flew above the electrical conductors and fibre-optic cable. Since the electrical conductors and fibre optic cable are located beneath the level of the surrounding forest canopy and the eagles flying to the roost area are gaining altitude as they cross the lines, there appears to be little chance of interference. Most of the observed crossings occurred high above the lines, and none of the crossings required flaring or other changes in flight path to clear the lines.

4.3 Bacon Creek Site

Eleven eagle flights through the Bacon Creek site were recorded during the eight morning observation periods completed during the 1999-2000 season. Of these eleven, five flights included flights across the transmission lines and fibre-optic cable. Four of the five eagles that crossed the lines were flying between the Skagit and the Bacon Creek drainage. They all passed high above the lines and did not alter their flight paths to cross the lines. The fifth eagle that crossed the lines flew beneath them after leaving its perch on the south side of the Skagit River and approaching a gravel bar at the mouth of Bacon Creek. The lines did not interfere with this eagle's flight path.

The remaining six flights were completed by eagles travelling up or down the Skagit River corridor. Based on our limited observations, it appears that eagles favor the south side of the river when travelling through this portion of the river corridor. Since the transmission lines are located on the north side of and run parallel to the river, the lines do not appear to present a significant hazard to eagles travelling up or down the Skagit River corridor. However, since the lines are located above gravel bars where eagles have been reported to congregate while feeding (NPS, 1999) the lines could interfere with eagles taking off and landing. Springwood biologists did not observe eagles foraging on the gravel bars.

5.0 CONCLUSIONS

Of the 238 crossings observed during the three study seasons, 11 percent included flares in response to the transmission lines. During the 1999-2000 season 18 percent of all crossings, and 44 percent of the flights that approached at line level, flared to avoid the lines. The 1999-2000 line-level approach flare rate is higher than the 29 percent observed during each of the first two study seasons, and confirms the preliminary conclusion reached after the first two seasons that the lines provide an obstacle to bald eagles crossing the ROW at the Corkindale site. Although the cause of the increased flare rate during the 1999-2000 season was not apparent from our observations, the fiber-optic cable did not appear to be a contributing factor since we observed only one flare directly attributable to the fiber-optic cable.

The fact that eagles avoided the transmission lines 100 percent of the time during the three seasons of observation (i.e., no collisions were observed during this study) suggests that the unmarked electrical conductors are adequately visible to allow the eagles to successfully avoid them. In addition, since none of the crossings resulted in a collision with the fibre-optic cable, it appears that either the line markers on the fibre-optic cable make the cable adequately visible, or that eagles typically clear the transmission lines with enough distance to avoid the fibre-optic cable.

While the results of this study do not guarantee there will be no eagle-transmission line collisions at the Corkindale site, the lack of collision during 238 crossings observed over three seasons suggests that chances of collisions in the future are slight as long as the physical characteristics of the ROW at the site remain unchanged. Although similar conclusions for the Illabot and Bacon Creek sites are difficult to draw due to the lack of an adequate number of observations, patterns of bald eagle use and the physical arrangement of these sites suggest chances for collisions may be similarly slight.

6.0 EXPERT REVIEW

On April 19, 2001, SCL and the USFWS convened a meeting of bald eagle researchers, state and federal agency biologists, and private consultants to review and discuss the results of this study. Participants included Al Harmata (Montana State University), Frank Isaacs (Oregon State University), Michele Lynn (SCL), Steve Negri (Foster Wheeler Environmental Corporation), Fred Seavey (US Fish and Wildlife Service), Ron Vanbianchi (Springwood Associates), and Jim Watson (Washington Department of Fish and Wildlife).

The group discussed potential interpretations of the reported observations, including whether SCL's transmission lines and fibre-optic cable pose a significant risk to bald eagles and whether additional lines need marking. All the participants acknowledged that

the transmission lines present some risk to individual eagles travelling across the ROW. The participants agreed that the period of greatest risk is during low visibility conditions or when birds are distracted, but that line markers would do little to provide protection at these times. The participants also agreed that the lack of observed collisions makes it difficult to determine the degree of risk at the individual level. The group also confirmed that a long-term increase in the wintering bald eagle population in the Skagit River Basin has been documented.

Based on the observations reported from the Corkindale Creek site in this report, knowledge of long-term population trends, and the professional judgement of the reviewers, the group concluded that marking the transmission lines would not significantly contribute to the protection of bald eagles flying in the vicinity of the SCL ROW. The group recommended placing BFDs on all new lines installed in areas of bald eagle activity.

7.0 RECOMMENDATIONS

Although the 33 percent flare rate for eagles approaching at line level indicates that the lines present an obstacle during a significant number of eagle flights, the lack of an observed collision during the three seasons of monitoring leads to the conclusion that the risk of collision is low. Therefore, based on the results of this study and as long as the number and configuration of the transmission lines remain unchanged, we recommend that SCL discontinue monitoring bald eagle-transmission line interactions.

As a precautionary measure at sites where the ROW crosses bald eagle flight areas, we recommend applying Bird Flight Diverters to all new or replacement conductors. In addition, evaluations of potential risk to bald eagles should precede any changes to the number or arrangement of conductors across areas regularly used by bald eagles.

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