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PROTECTION STRATEGIES FOR PEREGRINE FALCONS AND OTHER RAPTORS ALONG THE PLANNED NORTHWEST ALASKAN GAS PIPELINE ROUTE

VOLUME I

by

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of

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REPORT USE

This report contains detailed information on the nest locations of the endangered peregrine falcon and other raptor species in Alaska. This information is contained in Volume II of this report. Because of the sensitive nature of this information, we recommend that Volume II of this report be considered as confidential and be made available only on a need-to-know basis.

FINAL REPORT

This report has been preceded by two interim reports.* Because of the refinements, revisions and additions in this final version, it should be considered to supersede the earlier draft reports, and those reports should not be quoted.

This report should be cited as:

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* LGL Ecological Research Associates, Inc. 6 Oct. 1980. Development of protection strategies for peregrine falcons: a draft and preliminary version of a single chapter for an interim report. Unpubl. rep. for Northwest Alaskan Pipeline Co. and Fluor Northwest, Inc.

Roseneau, D.G., C.E. Tull and R.W. Nelson. 22 Nov. 1980. Synopsis of peregrine falcon populations and ecology, and development of protective measures with regard to the proposed Northwest Alaskan Gas Pipeline Company gas pipeline project in Alaska: interim report. Unpubl. rep. by LGL Ecol. Res. Assoc., Inc., Fairbanks, Alaska, for Northwest Alaskan Pipeline Co. and Fluor Northwest, Inc.

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1. INTRODUCTION

Northwest Alaskan Pipeline Company (NWA) has proposed to build the Alaskan portion of a large-diameter, chilled-gas pipeline from Prudhoe Bay, Alaska, through Canada to the midwestern United States. The proposed NWA gas pipeline alignment parallels the now-existing and functioning Trans-Alaskan Pipeline System (TAPS) between Prudhoe Bay and Delta Junction. At Delta Junction, the proposed gas pipeline alignment diverges southeastward to follow the Alaska Highway and the nearby (currently decommissioned) Haines Products pipeline right-of-way (ROW) to the U.S.-Canadian border.

In recent years, as large northern developments, particularly highways and pipelines, have been proposed and in some cases constructed, concern has frequently been expressed about the potential impacts of such developments on the raptors (falcons, hawks, eagles, ospreys, etc.) that nest in the vicinity of the developments (e.g., White and Streater 1970b; White and Cade 1975; Berger 1977). Concern has been most frequently expressed for the peregrine falcon (*Falco peregrinus*) because of its endangered status; two subspecies (*F. p. tundrius* and *F. p. anatum*) are considered to be endangered under the U.S. Endangered Species Act (1973). The concern for nesting raptors led to government restrictions and the implementation of protective measures in the case of the TAPS in an attempt to minimize its impact on nesting raptors; and for the same reason, new government restrictions are now being proposed with respect to the NWA pipeline.

The present study was conducted for NWA in order to develop protection strategies to prevent or minimize the impacts of the proposed NWA gas pipeline on nesting raptors. More specifically, the objectives of the study were the following:

1. to review raptor nesting biology with respect to the information needed for protection strategies,

2. to review the information available on the impacts of developments on nesting raptors,

3. to review the various measures that have been proposed to protect nesting raptors from the impacts of developments,

4. to critically examine the government restrictions that are being proposed to protect nesting raptors from the impacts of the proposed NWA pipeline,

5. to delineate the potential conflicts under these restrictions between raptor nest locations and the NWA pipeline alignment, and

6. to make recommendations concerning the proposed government restrictions and these potential conflicts that would prevent or minimize the impacts of the proposed NWA pipeline on nesting raptors.

Emphasis in this report has been placed on the peregrine falcon, because of its endangered status and the consequent concern for this species. The other raptors for which protection strategies have been developed are those species whose nest locations are comparatively traditional, those species whose nest locations are fairly readily detectable, those species whose nest sites are frequently used in subsequent years by other raptor species (especially if they are used by peregrines), and/or those species for whom concern has been expressed either because of their population status or because of their sensitivity to impacts from development. These are the species for which the development of protection strategies is not only important but also practical. The other raptors for which protection strategies are developed are the gyrfalcon (*Falco rusticolus*), rough-legged hawk (*Buteo lagopus*), golden eagle (*Aquila* *chrysaetos*), bald eagle (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*). Other raptor species, for which it was considered either not important or not practical to develop protection strategies, have not been treated in this report.

2. PEREGRINE FALCON

2.1 DISTRIBUTION, POPULATION SIZE AND PRODUCTIVITY

2.1.1 Throughout Alaska

It is not within the scope of this report to treat the statewide population size and distribution of peregrine falcons in detail, nor to reevaluate past estimates of numbers. It is appropriate, however, to provide some perspective on these subjects before providing more detailed information on the distribution, numbers and productivity of peregrines in the vicinity of the proposed NWA gas pipeline corridor.

2.1.1.1. Distribution

The distribution of peregrine falcon nesting habitat throughout Alaska is now relatively well known (e.g., Fyfe *et al.* 1976; Alaska Peregrine Falcon Recovery Team [APFRT] 1979). Scattered occasional nesting habitat for one race, *F. p. pealei*, occurs along the coastline of the Gulf of Alaska and southeastern Alaska, but the vast majority of pairs of this race (which is not endangered) are found from the southern Alaska Peninsula and associated islands westward throughout the Aleutian Islands. Little nesting habitat for peregrines appears to occur along the western coast of Alaska, where this race probably intergrades with others.

One of the two endangered races, *F. p. anatum*, is found predominantly along the larger rivers of Alaska, in the region north of the Alaska Range, northwest of the northern Aleutian Range and south of the Brooks Range. Although occasional nesting habitat of *F. p. anatum* is known to occur along some of the smaller tributaries of the Kuskokwim and Yukon rivers (the principal drainages of this region) and even in a few upland areas of interior Alaska, the vast majority of *F. p. anatum* pairs are restricted to seven important areas of excellent, relatively concentrated nesting habitat that are found along the courses of the upper Porcupine River (lower and upper ramparts), the upper Yukon River (between the U.S.-Canada border and Circle), the middle reaches of the Charley River, the middle Yukon River (between Stevens Village and Tanana), the lower Yukon River (between Ruby and St. Marys), the Tanana River (between Tetlin Junction and Nenana) and the Kuskokwim River (between McGrath and Aniak).

The second of the two endangered races, *F. p. tundrius*, inhabits the region north of the Brooks Range, and parts of northwestern Alaska, where the division between this race and *F. p. anatum* is poorly understood. On the Arctic Slope between the U.S.-Canada border and the Sagavanirktok River, nesting habitat is scattered and relatively limited in extent. The best habitat 'concentrations' are small, and are found predominantly in sections of the Canning and Kongakut rivers. A small, but more important concentration of nesting habitat is found along the middle and lower reaches of the Sagavanirktok River (Sagwon and Franklin bluffs). Between the Sagavanirktok River and the Colville River drainage nesting habitat is again scarce; only a few areas where peregrines have nested are known to occur. The important 'center of distribution' is the Colville River drainage, where the majority of the nest locations and nesting pairs occur. Small amounts of nesting habitat are scattered throughout many of the tributaries of this drainage (particularly along those flowing out of the Brooks Range between and including the Etivluk and Nanushuk rivers), and a very important large concentration of nesting habitat occurs along the Colville River course itself, between the Etivluk River and Ocean Point. Between the Chukchi Sea and the headwaters of the Colville River drainage, the situation appears somewhat similar to that found east of the Sagavanirktok River. The Utukok and Kukpowruk rivers appear to offer the most important nesting habitat in the western portion of the Arctic Slope.

2.1.1.2 Population Size

Cade (1960) estimated that not less than 600 nor more than 1200 breeding pairs of peregrines were present in Alaska. He suggested that an estimate of 1000 breeding pairs was the proper order of magnitude for the number of peregrines present in the arctic, interior and coastal regions (i.e., including all three currently recognized races). He further divided his total estimate into the following regions: the Arctic Slope, ∿ 200-250 pairs ('a reasonable figure'); the Yukon River drainage, ∿ 250-300 pairs ('a conservative estimate'); the watersheds of the Kuskokwim, Nushagak, Susitna and Copper rivers, ∿ 100-200 pairs ('likely'); southeastern Alaska, < 20 pairs; the Aleutian Islands, ∿ 100 pairs ('certainly a minimum estimate'). Since the time of these estimates, a considerable amount of new information has been obtained on the amount of available nesting habitat and the numbers of peregrines in many regions of Alaska. In general, these data suggest that, although Cade's (1960) estimate of the total population was reasonable, the proportions of the population he assigned to various regions of the state were not as reasonable.

Cade's (1960) original estimates of the number of peregrines in the Colville River drainage and the entire Arctic Slope may have been too high. Cade and White (1976) recently contended that the original estimate for the Colville watershed is still realistic, based on more recent data and a review of past data; however, Haugh (1976a) disputed this figure, and contended that, in recent times, the Arctic Slope of Alaska never supported more than ∿ 100 pairs of peregrines. In view of what is now known about the amount and distribution of available nesting habitat east of the Sagavanirktok River and the importance of the Colville watershed to the population as a whole (Roseneau *et al.* 1976, 1980), this latter figure (∿ 100 pairs) appears more appropriate than the original estimate. APFRT (1979) has recently suggested an upper limit of ∿ 150 pairs based on known nesting locations, nesting densities on the Colville and Sagavanirktok rivers, and the physiography of the region.

It also appears that the original estimate by Cade (1960) of the number of peregrines inhabiting the Yukon River drainage was too high. Again, based on extensive survey efforts during the past 5-6 yr, considerably more is now known about the occurrence and distribution of actual available nesting habitat in this drainage. Many of the tributaries are bereft of it. On the basis of the number of cliffs and bluffs now known to occur (while still allowing for occasional nesting cliffs in less well-known smaller tributaries and the odd tree-nesting pair), about one-half of the original estimate seems a more appropriate number of peregrines for this large region (APFRT 1979).

More recent knowledge of the drainage of the Kuskokwim, Nushagak, Susitna and Copper rivers indicates that the original estimate of peregrine pairs in these areas was also quite high. Most of the available nesting habitat is found in only one of these drainages, the Kuskokwim River, for which few historical data are available. The number of cliffs and bluffs along the Kuskokwim River is comparable to that found on the Tanana River, and this information suggests the possibility that similar numbers of peregrines could have occurred there in addition to a smaller number of pairs scattered in various tributary drainages. Only a few nest locations have been documented on the Nushagak River and nesting habitat comparable to that on the Yukon and Kuskokwim rivers does not appear to exist there. The Susitna and Copper rivers both provide even fewer potential nesting locations for peregrines.

The original estimate by Cade (1960) for southeastern Alaska appears fairly accurate. A comparable small number of pairs is also known to inhabit the northern coast of the Gulf of Alaska (e.g., White *et al.* 1976).

Cade (1960) offered what he considered to be a very minimum estimate for the Aleutian Islands; the amount of habitat there appeared substantial but very few data were available. New evidence suggests that the original estimate was indeed a minimum figure. It is now believed that four to six times as many peregrines could inhabit this maritime region, which extends westward from the southwestern Gulf of Alaska (White 1975, 1976).

The current total population size of peregrine falcons nesting in Alaska is still difficult to ascertain, primarily because so few data are available on *F. p. pealei* in important coastal areas, particularly the Alaska Peninsula and Aleutian Islands. However, the current status of the two endangered races, *F. p. anatum* and *F. p. tundrius*, is now relatively well known. During the last five years, a considerable amount of survey work has been conducted by various agencies and others in all the areas of nesting habitat in Alaska important to these two races. These data, including comprehensive data obtained in 1980 (the year of the third North American Peregrine Falcon Survey), indicate that an upward trend has occurred in Alaska during the last four years in both the numbers and the productivity of *F. p. anatum* and *F. p. tundrius* (e.g., Curatolo and Ambrose 1978; Springer *et al.* 1979b; Roseneau *et al.* 1980). The number of *F. p. anatum* birds, in particular, has shown a strong increase throughout most of the important nesting habitat in interior Alaska (and in north-central Yukon Territory). In 1980 the various data indicate that $\sim$ 75 pairs and $\sim$ 10 single individuals occupied cliffs and bluffs in the seven important habitat areas of interior Alaska. Only two of these important nesting areas, the Kuskokwim and Tanana River drainages, were found to still contain only a few pairs each. A total estimate of $\sim$ 100 *F. p. anatum* pairs in Alaska in 1980 is probably not unreasonable.

Increases in the population size of *F. p. tundrius* have not been as large nor as widespread as those of *F. p. anatum*; however, data from the

Colville River and Sagavanirktok River are indicative of such increases (e.g., Springer *et al.* 1979b; Roseneau and Bente 1979; USFWS, unpubl. data). In 1980 additional data were obtained from several drainages between the Canning River and the U.S.-Canada border, and from the western Arctic Slope. (Not all of the latter information has been received or evaluated.) The information available to date suggests that ∿ 50 pairs and several individuals may have been present in the region in 1980, and that most of them occupied nesting locations in the Colville River drainage.

2.1.2 Adjacent to Proposed NWA Gas Pipeline ROW

The proposed NWA gas pipeline route in Alaska runs parallel to major sections of the Sagavanirktok River and the Tanana River, and crosses the Yukon River. The Sagavanirktok River drainage provides important nesting habitat for *F. p. tundrius*. The Tanana and Yukon River drainages provide important nesting habitat for *F. p. anatum*. Two tributaries of the Tanana River also provide nesting habitat. In addition, the proposed gas pipeline alignment passes near a small area of recently discovered nesting habitat for *F. p. anatum* in the interior uplands of Alaska. Two adjacent locations in that area were used by peregrines in 1979 and 1980 (Roseneau and Bente 1979, 1980a). (There is no previous documentation of peregrine use of this area.) Two other areas contain some potential nesting habitat for peregrines.

2.1.2.1 Sagavanirktok River

Numbers Present -- Data on the number of peregrines nesting in the Sagavanirktok River drainage between the late 1950's and 1975 were summarized by Roseneau *et al.* (1976). Two errors occurred in that compilation (Table 9, p. 244). One lone adult peregrine occupying a nest location on Franklin Bluffs in 1974 was omitted from the table, and five pairs of peregrines were listed in the table as being present in 1974, when the correct number, as stated in the text of that report, was four pairs. These data, with appropriate corrections, additional data from 1964, and data from 1976-78 are listed in Table 1. Table 2 lists data obtained during NWA-sponsored surveys in 1979 and 1980.

These data suggest that peregrines were historically more numerous in the Sagavanirktok River drainage than they have been in recent times. Even though the Sagwon Bluffs vicinity and the Slope Mountain vicinity were not checked in 1958, five of six known nesting locations on Franklin Bluffs were occupied by pairs that year. Furthermore, it seems unlikely that the other major section of prime nesting habitat, Sagwon Bluffs, would have been totally unoccupied in 1958. Other data obtained on the Arctic Slope of Alaska in the 1950's, 1960's, and 1970's also provide evidence that peregrines were more numerous in the 1950's (Cade 1960; White and Cade 1971, 1975, 1977).

The incomplete nature of much of the data shown in Table 1 precludes real comparisons among years. Complete or nearly complete survey coverage of the drainage occurred only in 1970, 1972, 1974, 1975, 1979 and 1980. Data from those years, and additional data obtained at Sagwon Bluffs since 1970 suggest that little change has occurred in the number of peregrines inhabiting the Sagavanirktok River since the early 1970's. Since about 1970, the presence of about four pairs appears to be about average in this Arctic Slope drainage.

All known nesting locations used by peregrines in the Sagavanirktok River drainage have been reported by Roseneau and Bente (1979, 1980a). In this report, data from the Sagavanirktok River drainage have not been tabulated by specific nest locations. Instead, these data are reported by specific sections of river drainage. The nearly continuous but frequently changing nesting habitat that is afforded by Sagwon Bluffs and Franklin

TABLE 1. Numbers of peregrine falcons (*F. p. tundrius*) occupying nesting habitat in the Sagavanirktok River drainage, Alaska, 1958-78.[1]

	Total Nest Locations			Number Checked			Occupancy of Nest Locations that were Checked: Unoccupied			Lone Adult			Pair		
Year	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.
1958	6	4	1	5	0	0	0	-	-	0	-	-	5	-	-
1963	6	4	1	1	4	1	0	2	0	0	0	0	1	2	1
1964	6	4	1	0	1	0	-	0	-	-	0	-	-	1	-
1970	6	4	1	3	4	1	1	3	1	0	0	0	2	1	0
1972	6	4	1	5	4	1	2	2	1	0	~~0~~ 1	0	3	~~2~~ 1	0
1973	6	4	1	4	0	0	2	-	-	0	-	-	2	-	-
1974	6	4	1	5	4	1	2	2	1	1		0	2	2	0
1975	6	4	1	5	4	1	4	2	1	0	0	0	1	2	0
1976	6	4	1	0	4	0	-	3	-	-	0	-	-	1	-
1977	6	5[2]	1	4	5	?	3	3	-	0	0	-	1	2[3]	-
1978	6	5[2]	1	0	1	0	-	0	-	-	0	-	-	1	-

[1] 1958 and 1973 data are from J. Koranda (pers. comm. to C. M. White); 1963 data are from M. D. Mangus (pers. comm. to C. M. White); 1964 data are from White and Cade (1975); 1970 data are from White and Streater (1970a,b); 1972 data are from White and Ray (1972); 1974 data are from Roseneau *et al.* (1976) and C. M. White (unpubl. data); 1975 data are from Roseneau *et al.* (1976); 1976 data are from Capodice (1976); 1977 data are from K. P. Whitten and D. Roby (pers. comm.) and L. Sowl (pers. comm.); 1978 data are from C. M. White (pers. comm.).

[2] Includes one site at the small bluffs on the east side of the river opposite the northern terminus of Sagwon Bluffs, that has been designated 'East Sagwon'.

[3] Includes one pair that nested at the 'East Sagwon' location.

TABLE 2. Numbers of peregrine falcons (*F. p. tundrius*) occupying nesting habitat in the Sagavanirktok River drainage, Alaska, 1979-80.[1]

	Occupancy of Nest Locations that were Checked															
	Total Nest Locations			Number Checked			Unoccupied			Lone Adult			Pair			
Year	Franklin Bluffs[2]	Sagwon Bluffs[3]	Slope Mtn.	Franklin Bluffs[2]	Sagwon Bluffs[3]	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	Franklin Bluffs	Sagwon Bluffs	Slope Mtn.	
1979	6	5	1	6	5	1	4	3	1	0	0	0	2	2[5]	0	
1980	7	5	1	7	5	1	5	4	1	0	(1)[4]	0	2	1[5]	0	

[1] 1979 data are from Roseneau and Bente (1979), and B. Durtsche and R. Ambrose (pers. comm.); 1980 data are from Roseneau and Bente (1980a), and Durtsche and Ambrose (pers. comm.).

[2] A pair made some attempt to nest at a new location in 1980 (Roseneau and Bente 1980a) that was unoccupied in 1979. The location has been incorporated into the data base for both survey years.

[3] Includes one site at the small bluffs on the east side of the river opposite the northern terminus of Sagwon Bluffs, that has been designated 'East Sagwon'.

[4] This single adult did not appear to actually occupy a location at Sagwon Bluffs. Instead it was observed several miles south of there, but may have represented one member of a pair that failed to nest successfully on the south end of Sagwon Bluffs in 1979 (Roseneau and Bente 1980a).

[5] Includes one pair that nested at the 'East Sagwon' location.

Bluffs, and the characteristics of the nest sites chosen by arctic peregrines at these nest locations are important reasons why these two areas should be treated as units rather than on the basis of the individual nesting locations found on them.

Productivity -- Data on the productivity of peregrine falcons nesting in the Sagavanirktok River drainage are less complete than the data on the numbers of pairs present over the years. Table 3 summarizes the available productivity data for this drainage for those years when survey coverage was complete or nearly complete. Appendix 5.1 provides more detailed information on the nesting success during each year.

The data indicate that the productivity of peregrines along the Sagavanirktok River in the mid 1970's had declined considerably from that in the early 1970's. Productivity has apparently increased in the late 1970's, but has not yet attained the levels of the early 1970's.

2.1.2.2 Yukon River

Numbers Present -- No data on the numbers of peregrine falcons inhabiting the middle Yukon River prior to 1970 are available (APFRT 1979). White and Streater (1970a), White and Ray (1972) and C. M. White (unpubl. data) report on a few nesting locations during partial surveys in 1970 and 1972. The first complete survey of the peregrine falcon nesting habitat found between Stevens Village and Tanana was conducted in 1974 (White 1974a,b). Subsequent surveys were conducted in 1975, 1976, 1979 and 1980 (Haugh and Halperin 1976; Springer *et al.* 1979b; Roseneau *et al.* 1980; R. Ambrose, pers. comm.). Springer *et al.* (1979b) compiled all the data on occupancy of nesting locations in this section of the river for the years of complete survey coverage (up to 1979). Data obtained in 1980 are reported by Roseneau *et al.* (1980). Table 4 lists the data for the Yukon River.

TABLE 3. Productivity of peregrine falcons (*F. p. tundrius*) nesting along the Sagavanirktok River, Alaska, 1970-79.

	1970[1]	1972[2]	1974[3]	1975[3]	1979[4]
Number of eggs per attempt	? (n=3)	? (n=4)	2.8 (n=4)	3.3 (n=3)	3.3 (n=4)
Number of chicks hatched per attempt	? (n=3)	1.3 (n=4)	2.0 (n=4)	1.7 (n=3)	2.3 (n=4)
Number of large chicks per attempt	1.7 (n=3)	1.0 (est., n=4)	0.8 (n=4)	0.3 (n=3)	1.1-1.3 (est., n=4)
Number of large chicks per successful attempt	2.5 (n=2)	2.0 (est., n=2)	1.5 (n=2)	1.0 (n=1)	1.5-1.7 (est., n=3)
Number of failures	1 (33%)	2 (50%)	2 (50%)	2 (67%)	1 (25%)

[1] Data are from White and Streater (1970b), Roseneau *et al.* (1976).

[2] Data are from White and Ray (1972), Roseneau *et al.* (1976).

[3] Data are from Roseneau *et al.* (1976), Roseneau (unpubl. data).

[4] Data are from Roseneau and Bente (1979).

TABLE 4. Numbers of peregrine falcons (*F. p. anatum*) occupying nesting habitat along the Yukon River between Stevens Village and Tanana, Alaska, 1974-80.

Springer *et al.* (1979b) Location Number	NWA Location number	Occupancy 1974[1] Pair	Lone Adult	1975[2] Pair	Lone Adult	1976[3] Pair	Lone Adult	1979[4] Pair	Lone Adult	1980[5] Pair	Lone Adult
MY-2	P-92.1	1	0	1	0	1	0	1	0	1	0
MY-5	P-95a	0	0	0	0	0	0	0	0	0	0
MY-5.1	P-97	0	0	0	0	0	0	0	0	1	0
MY-6	P-97.1	1	0	1	0	1	0	1	0	1	0
MY-8	P-97.2	1	0	1	0	1	0	1	0	1	0
MY-9		0	0	0	0	0	0	0	1	0	0
MY-12		1	0	0	0	1	0	0	0	1	0
MY-14		1	0	0	1	1	0	0	0	0	0
MY-16		0	0	?	?	1	0	0	0	1	0
		5	0	3	1	6	0	3	1	6	0

[1] Data are from White (1974a,b), White and Cade (1975) and Haugh and Halperin (1976).

[2] Data are from Haugh and Halperin (1976) and R. Ambrose (pers. comm.).

[3] Data are from Haugh and Halperin (1976).

[4] Data are from Springer *et al.* (1979b).

[5] Data are from Roseneau *et al.* (1980).

During the five years that complete surveys were conducted, the number of peregrines present has varied considerably; four to six nesting locations have been occupied each year, and three to six pairs have been present. White (1974a) suggested that more pairs may have occupied this section of the Yukon River at some time in the past. Other potential cliffs are present, and are spaced in a manner that could allow at least a few more pairs to be present (Springer *et al.* 1979b; Roseneau *et al.* 1980).

The location numbers used in Table 4 follow the system developed by Springer *et al.* (1979b). Corresponding NWA nest location numbers are also listed where applicable. The locations in Table 4 that do not have a corresponding NWA location number are more than 15 mi downstream from the proposed NWA gas pipeline alignment.

Productivity -- The productivity of peregrine falcons nesting along the Yukon River between Stevens Village and Tanana also varied among years. Productivity data from all five survey years are listed in Table 5, and are described in more detail in Appendix 5.1.

2.1.2.3 Tanana River

Numbers Present -- The numbers of peregrine falcons occupying nesting locations along the Tanana River course previous to 1976 were compiled and summarized by Haugh (1976b), White and Cade (1975, 1977) and Kessel (1978). White and Cade (1975) suggested that as many as $\sim$ 20-21 pairs could have been present along the river course until the early 1900's. Haugh (1976b) indicated that at least 19 pairs could have been present prior to 1963. Fifteen of those pairs occupied locations between Fairbanks and Tetlin Junction. Other data have been collected along this river since 1975 (Kessel 1978; R. Hemmen, unpubl. data; R. Ritchie and Ambrose, unpubl. data). In 1979 these data and all previous data from Haugh (1976b) were recompiled and reevaluated to determine which cliffs and bluffs in the

TABLE 5. Productivity of peregrine falcons (*F. p. anatum*) nesting along the Yukon River between Stevens Village and Tanana, Alaska, 1974-80.

	1974[1]	1975[2]	1976[3]	1979[4]	1980[5]
Number of eggs per attempt	? (n=6)	? (n=4)	? (n=6)	? (n=4)	? (n=6)
Number of chicks hatched per attempt	? (n=6)	? (n=4)	? (n=6)	? (n=4)	? (n=6)
Number of large chicks per attempt	0.5 (n=6)	1.8 (n=4)	1.5 (n=6)	0.3 (n=4)	1.8 (n=6)
Number of large chicks per successful attempt	1.5 (n=2)	2.3 (n=3)	2.3 (n=4)	1.0 (n=1)	2.8 (n=4)
Number of failures	4 (66%)	1 (25%)	2 (33%)	3 (75%)	2 (33%)

[1] Data are from White (1974a,b), White and Cade (1975) and Haugh and Halperin (1976).

[2] Data are from Haugh and Halperin (1976) and R. Ambrose (pers. comm.).

[3] Data are from Haugh and Halperin (1976).

[4] Data are from Springer *et al.* (1979b).

[5] Data are from Roseneau *et al.* (1980).

Tanana River drainage upstream from Fairbanks represented historical peregrine falcon nesting locations. Part of that process included a site-by-site discussion with J. R. Haugh. The locations that resulted from that reevaluation, and the results of a 1979 NWA sponsored survey of the Tanana River were reported by Roseneau and Bente (1979). In 1980 the Tanana River upstream of Fairbanks was surveyed again for NWA (Roseneau and Bente 1980a). Table 6 lists all known data on occupancy of nesting cliffs along the Tanana River from the early 1960's to the present. Haugh's (1976b) location numbers and NWA nest location numbers are both listed for purposes of reference.

The data in Table 6 indicate that a significant decline in numbers of peregrines occurred in this nesting habitat after about 1968. The lowest number of individuals was reached in 1974. Since about 1975, a small increase has apparently occurred in the numbers of peregrines occupying cliffs and bluffs along this river. This increase is quite small, however, and may only reflect differences in survey techniques since 1975. Recently, only three to four pairs and a few unpaired individuals have been accounted for, even though the number of peregrines inhabiting most of the remainder of the Yukon River drainage has increased substantially over the last several years (Curatolo and Ambrose 1978; Ambrose 1979; Curatolo and Ritchie 1979; Springer *et al.* 1979a,b; Roseneau *et al.* 1980; D. Mossop, pers. comm.). Because the decline in the number of peregrines nesting along the Tanana River was so marked and nearly complete (unlike all other areas in interior Alaska with the possible exception of the Kuskokwim River), any recovery of this population is expected to occur slowly. Based upon current data, it will take several more years to clarify any apparent trends in this drainage.

Productivity -- The productivity of peregrine falcons nesting along the Tanana River prior to 1976 has been summarized by previous authors

TABLE 6. Numbers of peregrine falcons (*F. p. anatum*) occupying nesting habitat along the Tanana River between Fairbanks and Tetlin Junction, Alaska, pre-1963 and 1963-80.[1]

Haugh's Site Number	NWA Location Number	Occupancy pre-1963[3]	1963[3]	1968[3,4] Pair	1968 Lone Adult	1970 Pair	1970 Lone Adult	1971 Pair	1971 Lone Adult	1972 Pair	1972 Lone Adult	1973 Pair	1973 Lone Adult	1974 Pair	1974 Lone Adult	1975 Pair	1975 Lone Adult	1977 Pair	1977 Lone Adult	1978 Pair	1978 Lone Adult	1979 Pair	1979 Lone Adult	1980 Pair	1980 Lone Adult
1	P- 16a	yes	NC[15]	1	0	-[15]	-	-	-	-	-	-	-	-	-	-	-	NC		-	-	-	-	-	-
-	19a(18a?)[5]	possibly	NC	?[15]	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	21a	yes	NC	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
-	25	possibly	NC	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	29b	yes	NC	1	0	1	0	1	0	1	0	1	0	-	-	?	?	1	0	1	0	1	0	1	0
4[6]	[34a][16]	[yes]	[NC]	1	0	1	0	-	-	-	-	1	0	-	-	-	-	1	0	1	0	-	-	-	-
	[38a]			?	?	-	-	1	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	35a[7]	probably	?	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	'C'	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1[8]	-	-
-	41a[7]	probably	?	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	42a[7]	probably	?	?	?	-	-	-	-	-	-	-	-	-	-	[0	1]	-	-	-	-	-	-	-	-
5	47a	yes	yes	yes[9]		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	48a	yes	yes	1	0	1	0	-	-	-	-	-	-	NC		NC		-	-	-	-	-	-	-	-
-	50	?	?	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	-
(7?)[3]	52	yes	NC	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0
8	55	yes	NC	1	0	yes		NC		-	-	NC		-	-	NC		-	-	-	-	-	-	-	-
9	60a	yes	NC	1	0	1	0	1	0	1	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-
-	61	?	?	?	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	-	-
10	63	yes	yes	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	63.1[13]	?	?	?	?	NC		NC		NC		NC		NC		NC		NC		NC		-	-	-	-
11	[68a]	[yes]	[yes]	[1	0]	[1	0]	[-	-]	[-	-]	[-	-]	[-	-]	[one egg][16]		[NC]		-	-	-	-	-	-
	[69a]																			-	-	-	-	-	-
12	70	NC	pair	NC		NC		NC		NC		NC		NC		NC		NC		?	?	-	-	-	-
13	73b	yes	NC	1	0	-	-	-	-	-	-	-	-	-	-	-	-	NC		-	-	-	-	-	-
14	74a	yes	NC	1	0	-	-	-	-	-	-	-	-	-	-	-	-	NC		1	0	1	0	1	0
(15?)[11]	'K'	yes	NC	yes		NC		NC		NC		NC		NC		NC		NC		NC		-	-	-	-
				12	0	6	0	4	0	4	0	4	0	1	0	1	1	3	0	4	0	3	3	4	0

Note yrs prior 1980 - data reported for 74a should be reported for 73b & vice versa!

[1] Pre-1963 and 1963-75 data are from White and Cade (1975), Haugh (1970, 1971, 1972, 1973, 1976b), White and Cade (1977), C. M. White (pers. comm.) and J. R. Haugh (pers. comm.); 1977 data are from Kessel (1978) and R. J. Ritchie (pers. comm.); 1978 data are from R. Hemmen (pers. comm.); 1979 data are from Roseneau and Bente (1979) and Ritchie (pers. comm.); 1980 data are from Roseneau and Bente (1980a).

[2] These location numbers were assigned by Haugh (1976b) and used by White and Cade (1975, 1977). Haugh developed this number system from his own data and from other data he obtained from D. Grisco via White (Haugh, pers. comm.).

[3] Haugh (1976b) obtained pre-1963, 1963 and 1968 data from B. Kessel and L. G. Swartz (pers. comm. to Haugh), and Grisco (pers. comm. to White).

[4] White and Cade (1975, 1977) reported these data as being from 1967. Haugh (1976b) reported these data (excluding an obvious typo) as being from 1968. Haugh (pers. comm.) stated that 1968 is the correct year.

[5] Roseneau and Bente (1979) listed Location 19a as a historical peregrine nest location based on the possibility this location represented 'eyrie #2' reported by Grisco (pers. comm. to White). If Grisco did indeed locate peregrines in this area, it is also possible that NWA Location 18a could have been involved. Presently, there is no way to confirm that NWA Locations 19a or 18a were used by peregrines in the past; however, both certainly appear suitable for that species, and are comparable to other well-documented nesting locations in Alaska (Roseneau and Bente, unpubl. data).

[6] During 1970-74, Haugh found pairs occupying these two cliffs in different years (Haugh 1970, 1971, 1972, 1973). Haugh (1973) states that 'eyrie sites 3 and 4 are probably occupied by the same pair in different years'. Haugh (1976b) and White and Cade (1975, 1977) combined these two locations into one 'site', number 4. Based on observations in other areas of Alaska, including the lower Yukon River, and the distances between NWA Locations 34a and 38a, it seems more likely that these are distinct separate locations that can be used simultaneously or alternately by different pairs in some years.

[7] No firm documentation of peregrines nesting at these locations appears to exist, with the exception of a single peregrine reported 'between eyrie 4 and 5' (NWA Locations 41a-42a) in 1975 (White and Cade 1975). In Haugh (1976b) and White and Cade (1975, 1977) it appears this bird was reported at site number 2. All five locations (NWA 35a,b; 41a,b; and 42a) appear suitable and comparable to other documented nest locations in Alaska. Haugh (pers. comm.), when reviewing this section of the Tanana River, also commented that peregrines could have used these locations in the past, and could use them again in the future.

[8] It has been confirmed that a single peregrine occupied this location in 1979 (Ritchie, pers. comm.). Roseneau and Bente (1979) reported this observation, but did not have knowledge of an exact location at that time.

[9] This location was occupied by a pair of peregrines in 1963 (White, pers. comm.).

[10] Haugh (1976b) site number 7 is now believed to correspond with NWA Location 52, because NWA Location 52 is the cliff that appears to have the greatest potential between NWA Location 48a and NWA Location 55; however, some question as to the accuracy of this interpretation remains.

[11] NWA Location 63.1 was reported by Roseneau and Bente (1979) as a cliff that should be treated as a historical peregrine nesting site. That determination was made on the basis of Alaska Department of Fish and Game maps that indicated peregrines had been reported there by the USFWS. No other back-up information appears available. This area of rock outcrops is judged to offer some potential for nesting, and the proximity of NWA Location 64, with documented use by peregrines, suggests that it may have served as an alternate nesting cliff to NWA Location 63 in some years.

[12] Haugh (1976b) site 11 appears to correspond to NWA Locations 68a and 69a. One abandoned peregrine egg was found in a nest in 1975 by White and Cade (1975) at what must almost certainly be either NWA Location 68a or 69a.

[13] Haugh (1976b) site number 15 is now thought to represent NWA Location 'K', which offers some potential for nesting; however, some uncertainty as to the accuracy of this interpretation still exists.

[14] Roseneau and Bente (1979) reported NWA Location 34a as a historical peregrine site, but inadvertently illustrated it as '34b' on the USGS topographic map series that accompanied their report. The maps should be corrected to show 34a as the peregrine site, and 34b should represent the reported raven nest.

[15] NC implies location not checked; - implies location not occupied; ? implies not known if checked.

[16] This egg indicates the presence of either a lone female or a pair in addition to the other birds listed for this year.

(White and Cade 1975, 1977; Haugh 1976b; Kessel 1978). These and more recent data are listed in Table 7 and are described in more detail in Appendix 5.1.

The productivity of peregrines inhabiting the Tanana drainage also declined markedly after about 1968. By 1975 no nestlings were produced by the few remaining birds (including only one confirmed pair). Since 1975, however, some nestlings have been produced by the few pairs that have been found to be present. Although a few nestlings have been fledged in each of the last few years from nest sites along the Tanana River, all available information on mortality and recruitment suggest that the number of nestlings successfully being produced is probably too low to maintain the current level of the subpopulation. Recovery of this subpopulation may depend on immigration from other Alaskan subpopulations.

2.1.2.4 Salcha River

A pair of peregrines occupied a cliff about 0.7 mi downstream from the TAPS crossing (NWA Locations P-79 and P-80) in June 1970, but this nesting attempt failed and only one adult was found at the cliff in July (White and Streater 1970a). No peregrines have been observed there during subsequent surveys (White and Ray 1972; White 1974b; White and Cade 1975) or during recent surveys of the lower Salcha River in 1979 or 1980 (Roseneau and Bente 1979, 1980a). Development of recreational cabin sites and high levels of human activity, including sport fishing very near the potential nesting cliffs along this small narrow river, are undoubtedly important factors that can be expected to limit the success of nesting peregrines in this area.

2.1.2.5 Chena River

Peregrines have nested at NWA Location P-84 in the past (L. G. Swartz pers. comm.; White, pers. comm.), and some evidence of recent occupancy

TABLE 7. Productivity of peregrine falcons (*F. p. anatum*) nesting along the Tanana River between Fairbanks and Tetlin Junction, Alaska, 1968-80.[1]

	1968	1970	1971	1972	1973	1974	1975	1977[2]	1978	1979	1980
Number of eggs per attempt	? (n=12)	? (n=6)	? (n=4)	? (n=4)	? (n=4)	? (n=2)	? (n=3)	? (n=3)	? (n=4)	? (n=6)	? (n=4)
Number of chicks hatched per attempt	? (n=12)	? (n=6)	? (n=4)	? (n=4)	? (n=4)	? (n=2)	? (n=3)	? (n=3)	? (n=4)	? (n=6)	? (n=4)
Number of large chicks per attempt	1.9 (n=12)	2.7 (n=6)	2.3 (n=4)	1.8 (n=4)	2.0 (n=4)	0.5 (n=2)	0.0 (n=3)	>0.0 (n=3)	1.5 (n=4)	0.7 (n=6)	1.3 (n=4)
Number of large chicks per successful attempt	2.1 (n=11)	2.7 (n=6)	3.0 (n=3)	2.3 (n=3)	2.0 (n=4)	1.0 (n=1)	0.0 (n=0)	>0.0 (n=3)	2.0 (n=3)	2.0 (n=2)	2.5 (n=2)
Number of failures	1 (8%)	0 (0%)	1 (25%)	1 (25%)	0 (0%)	1 (50%)	3 (100%)	est. 0 (est. 0%)	1 (25%)	4 (67%)	2 (50%)

[1] 1968-74 data are from Haugh (1976b); 1975 data are from White and Cade (1975) and Haugh (1976b); 1977 data are from Kessel (1978) and R. J. Ritchie (pers. comm.); 1978 data are from R. Hemmen (pers. comm.); 1979 data are from Roseneau and Bente (1979) and Ritchie (pers. comm.); 1980 data are from Roseneau and Bente (1980a).

[2] Only one downy chick was observed at one nest site during 14-16 July, but not all the ledge at that site could be seen. In July all three pairs were still bringing food to the nest ledges, and nestlings were heard; it is thought that all three pairs successfully fledged some nestlings (Ritchie, pers. comm.).

by this species was found there in 1970 (White and Streater 1970a). No peregrines were reported to have occupied the site in 1972, 1974 or 1975 (White and Ray 1972; White 1974b; White and Cade 1975). In 1979 this location was not checked (Roseneau and Bente 1979), and in 1980 only a pair of ravens nested there (W. Tilton, pers, comm.). Although peregrines have not used this nesting location for a number of years, it contains an excellent nesting cliff that is surrounded by still relatively undeveloped land, and it apparently still provides prime nesting habitat for peregrines.

2.1.2.6 Grapefruit Rocks, Mile 39 Elliott Highway

A small complex of rock outcroppings near mile 39 of the Elliott Highway is the only other area adjacent to the proposed NWA gas pipeline route in Alaska where the presence of peregrine falcon nest locations has been documented. Prior to 1979, only golden eagles were observed to nest there, and these interior upland rock outcrops did not have any known previous history of use by peregrines (White, pers. comm.). In 1979 and 1980, however, one pair of peregrines nested there (Roseneau and Bente 1979, 1980a). Two nest sites at two different locations (on two different rock outcrops) were used in the two years.

In 1979, the pair of peregrines successfully fledged three nestlings even though intense construction activities, including the regular detonation of large amounts of explosives, took place about 0.4 mi away (Roseneau and Bente 1979, 1980a). In 1980, what was probably the same pair of peregrines returned, nested at a new location about 0.7 mi farther from the highway, and again successfully fledged three nestlings (Roseneau and Bente 1980a).

2.1.2.7 Jim River Canyon

This relatively well-defined landform lies several miles west of the present TAPS alignment and the proposed NWA gas pipeline route between the Yukon River and the Brooks Range. The area has no documented history of use by nesting peregrine falcons, but it does contain a series of cliffs and rock outcrops that may be suitable for nesting peregrines (Roseneau and Bente 1979; White, pers. comm.). This area may also have been used by peregrines in the past (Roseneau and Bente 1979). In any event, with the increasing trend that has occurred in the numbers of nesting peregrines in interior Alaska during the last several years, this area should be considered as potential nesting habitat.

2.1.2.8 Koyukuk River

The Koyukuk River drainage to the west of both the present TAPS alignment and the proposed NWA gas pipeline route, and between the Yukon River and the Brooks Range has no documented history of use by nesting peregrine falcons. For the same reasons mentioned in the discussion of the Jim River Canyon area, however, some scattered river bluffs and cliffs from the vicinity of Tramway Bar westward may provide potential nesting habitat for this species.

2.2 NESTING HABITAT

The nesting habitat of peregrine falcons can be defined as the land forms and structures they nest on. Peregrines nest most often on cliffs, bluffs or steep banks, but they have also nested on artificial structures (such as man-made ledges and buildings), in trees and on level ground (Cade 1960; Herbert and Herbert 1965; Hickey 1969; White and Cade 1971; Kumari 1974; Newton 1976; Cugnasse 1980). No reports of nesting on level ground or on artificial structures are known in Alaska (cf. White and Cade 1971); almost all nest sites have been located on cliffs or bluffs, and only a few instances of nesting in trees have been reported. A few pairs have used unoccupied stick nests in spruce trees along Birch Creek north of Fairbanks (White and Roseneau 1970), and there is one other report of a pair that nested in a spruce snag in the Yukon River drainage (Cade 1960). More recently, a few pairs have been found that were using bald eagle nests in trees and the cavities of broken off trees along the coast of southeastern Alaska (F. Robards, pers. comm.).

Most cliffs and bluffs used by peregrines in Alaska are associated with the coast or with rivers (cf. Cade 1960, Section 2); only a few upland rock outcrops away from rivers have been used (e.g., along the Elliott Highway). In contrast, gyrfalcons, golden eagles and rough-legged hawks (the three other raptor species that nest principally on cliffs and bluffs in Alaska) use upland cliffs and rock outcroppings much more frequently in these regions.

The elevations at which peregrines nest in Alaska are between sea level and ∿ 2500-2600 ft asl (cf. Cade 1960). No documented nestings to date have occurred in Alaska above that upper contour interval; most nestings have occurred on cliffs or bluffs below ∿ 2000 ft asl. The elevation (asl) at which peregrines will nest is higher in the central

Yukon Territory than in Alaska; some pairs in the central Yukon nest above 3000 ft asl (Mossop, pers. comm.). The upper elevation at which peregrines will nest is much greater in mountain massifs at more southern latitudes. For example, elevations of ~ 11,000 ft asl are attained in the Colorado region of the Rocky Mountains (J. Enderson, pers. comm.). In arctic and interior Alaska, peregrines are clearly more restricted by the elevation at which they can nest than are the other cliff- and bluff-nesting raptors; gyrfalcons, golden eagles and rough-legged hawks are often found at higher elevations than peregrines (cf. White and Cade 1971; Roseneau 1974).

Even though cliffs and bluffs may be closely associated with the seacoast or riverways and may be below the upper elevational limit at which peregrines will nest, they are not all suitable nesting habitat for peregrines. Smooth rock faces without surface relief do not afford nest sites for peregrines, nor do bare, unbroken or unstable dirt faces and gravel slopes. The height, slope and aspect of a cliff are less important than its micro-relief and the presence of a variety of potential nest sites (cf. Cade 1960). Ledges, cavities, potholes and stick nests built by other species are important features. Another important feature is the presence of vegetation on the cliffs and bluffs; it can provide slope stability, create terraces and platforms, and provide some screening or cover to the birds.

2.2.1 Arctic Slope

Cade (1960) and White and Cade (1971) discussed a variety of nest locations and nest sites used by peregrines on the Arctic Slope of Alaska. In general, nest sites are more frequently found on soft rock or soil cliffs and bluffs than on hard rock cliffs or outcrops. No nests have been found above ~ 2200 ft asl in this region (White and Cade 1971). Cliffs and bluffs used by peregrines on the Arctic Slope of Alaska have ranged in height from $\sim$ 10-300 ft (Cade 1960).

The bluffs found along the lower Colville River and parts of the Sagavanirktok River are typical of some of the best nesting habitat. Nest sites chosen by these peregrines vary (cf. Cade 1960). Most nests are cups scraped in the soil substrate at prominent breaks in the profile of the cliff or bluff. They are often near the top of the bluffs, or near the tops of predominant noses left by erosion, are sometimes at the bases of small or large vertical faces, including the break between cliff bottom and talus-soil slopes, and are sometimes in unoccupied rough-legged hawk nests (cf. White and Cade 1971, p. 121 and 124).

Vegetation is usually an important component of the peregrine nest sites that are located on soft, unstable Arctic Slope river bluffs. Grasses and willows form terraces or platforms at and near the tops of these bluffs, at prominent breaks on them, or on otherwise nearly bare soil and gravel slopes. Many of the nest sites are closely associated with these vegetated zones (cf. White and Cade 1971, p. 112 and 131). A single willow bush and a clump of grass formed a nest site at Sagwon Bluffs (NWA Location P-201), a single clump of grass $\sim$ 3 ft in diameter on a bare gravel slope formed another important nest at Franklin Bluffs (NWA Location P-220), and two similar points of vegetation have provided the only stable structure to hold rough-legged hawk nests that have been used subsequently by peregrines at another otherwise nearly unusable barren gravel area along the northern section of Franklin Bluffs (NWA Location P-223).

2.2.2 Interior Alaska

In the Yukon and Kuskokwim river drainages of interior Alaska, where rocky cliffs are more prevalent, peregrines are associated with this type of structure to a greater extent than they are on the Arctic Slope. As a consequence, many interior Alaska nest sites are more inaccessible than those on the Arctic Slope, and are better protected from mammalian predators, including humans (cf. Cade 1960). No nests have been found above ∿ 2500-2600 ft asl in this large region; the highest nesting location known is in the Sheenjek River drainage (Roseneau 1974). Cliffs used by peregrines in the interior have ranged from as low as ∿ 30 ft to more than 300 ft in height. Most cliffs found along the Tanana River and in the middle section of the Yukon River are typical of excellent nesting habitat.

An important feature of many interior Alaska nesting cliffs is the presence of certain kinds of vegetation; terraced zones of *Artemesia* spp. are particularly important (Roseneau and P. J. Bente, unpubl. data). Some grasses and *Epilobium* spp. also help create and stabilize ledges or provide cover. Nest scrapes are commonly made in or behind these vegetated areas against a protective backstop (e.g., firm soil or exposed rock surface). Other features also occasionally provide nest sites. In a few instances, unoccupied raven nests are used (e.g., NWA Location P-73b); golden eagle nests usually provide a more stable substrate than raven nests and they are also used on occasion, especially in the Porcupine River drainage (cf. Curatolo and Ritchie 1979). Within the distributional range of rough-legged hawks along the lower Yukon River, their stick nests are also used from time to time (Springer *et al.* 1979b; Roseneau *et al.* 1980).

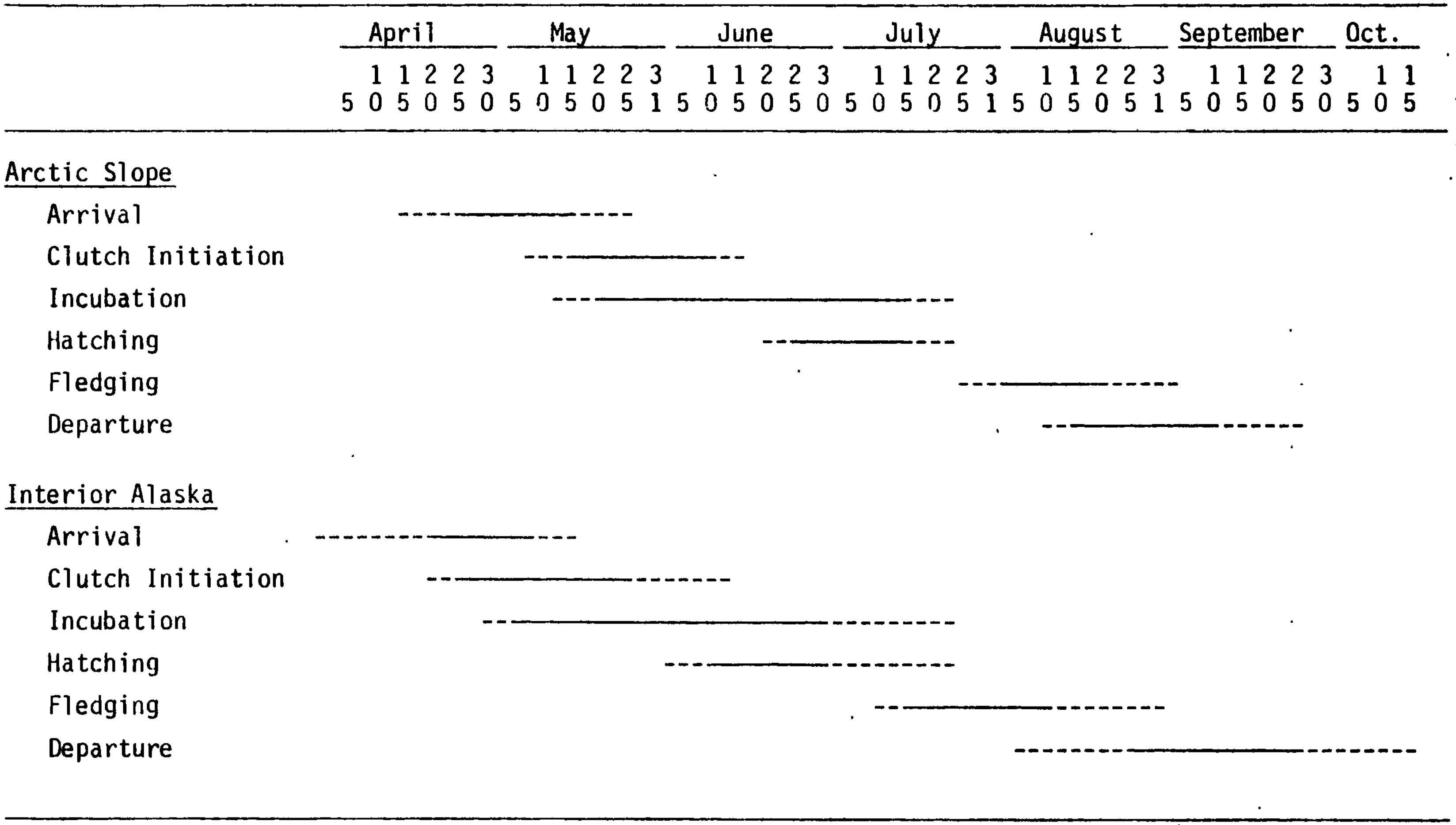
2.3 REPRODUCTIVE PHENOLOGY

Figure 1 presents the reproductive phenology of peregrines on the Arctic Slope and in interior Alaska. The figure is based on a compilation of records from many locations and for many years; these observations are presented in detail in Appendix 5.2. On the Arctic Slope, the main period of arrival is ∿ 25 April-15 May, of clutch initiation is ∿ 15 May-10 June, of hatching is ∿ 25 June-15 July, of fledging is ∿ 1-20 August, and of departure is ∿ 15 August-10 September. In interior Alaska, the main period of arrival is ∿ 20 April-10 May (early extreme of 29 March), of clutch initiation is ∿ 25 April-20 May, of hatching is ∿ 10-30 June, of fledging is ∿ 15 July-10 August, and of departure is ∿ 25 August-25 September. The time required to lay a complete clutch of four eggs is ∿ 7 d; ∿ 34 d are required for incubation and ∿ 40 d for the nestling period.

The two races of peregrines, *F. p. tundrius* and *F. p. anatum*, in Alaska exhibit shorter courtship periods on their nesting grounds than *F. p. anatum* birds do at more southern latitudes (Cade 1960). Cade (1960) suggested that courtship activities of northern peregrines may commence on the wintering grounds and continue during migration to the nesting grounds, and recent evidence from wintering areas in South America supports this suggestion (J. Albuquerque, in prep.; Roseneau, unpubl. data; A. M. Springer, unpubl. data; C. Thelander, unpubl. data; White, unpubl. data). Because some courtship activities may begin before peregrines reach Alaska, and because of the relatively short breeding season, the arrival of peregrines in interior and Arctic Slope regions is usually followed closely (i.e., within ∿ 2 wk) by the initiation of egg-laying. Cade (1960) suggested that the interval between arrival and egg-laying could be as short as 1 wk; however, recent data from captive falcons and some wild pairs indicate that at least 13 d are necessary.

There is considerable variation in the reproductive phenology of

FIGURE 1. Reproductive phenology of peregrine falcons nesting in arctic and interior Alaska.



peregrines in Alaska, and the ranges of dates for various activities in Figure 1 are quite broad. The nesting phenology at individual nest sites may vary from year to year. In 1980, for example, nestling peregrines on the Colville River fledged ∿ 13-15 d earlier than they did in 1979. The fledging schedule of peregrines on the upper Yukon River was similar in 1978 and 1979, but was 7-9 d earlier in 1980 (Ambrose 1979, pers. comm.). Generally, in both interior Alaska and the Arctic Slope, nesting phenologies in 1980 were earlier than average at most locations (Roseneau *et al.* 1980).

Year-to-year variation is probably attributable to a large extent to year-to-year differences in weather conditions, particularly annual differences in snowfall and in average spring temperatures, and the occurrence of storms in May and early June. Year-to-year variations in nesting phenology appear to be more prevalent on the Arctic Slope than in interior Alaska. Arctic Slope weather conditions tend to vary more often through a wider range of extremes. Arctic nesting peregrines tend to have a narrower range within which portions of the nesting cycle must occur in order to be successful; however, within those ranges, the peaks of the phenological events tend to shift more often than the peaks of the same events in interior Alaska.

The reproductive phenology also varies with location within Alaska during a given year. Differences in average regional climates are probably the cause. The average egg-laying, incubation, hatching, nestling and fledging periods of *F. p. tundrius* on the Arctic Slope are generally 1-2 wk later than those of *F. p. anatum* in interior Alaska. However, the ranges of dates for these periods are usually greater for *F. p. anatum*, so that the late extremes for these periods in interior Alaska are usually comparable to those for the Arctic Slope. Phenological dates also vary among locations within both the Arctic Slope and interior Alaska. In 1979, for example, reproduction in peregrines on the Arctic Slope averaged

~ 10-12 d later on the Colville River than on the Sagavanirktok River (Roseneau and Bente 1979; Springer and W. Walker II, unpubl. data). Such variations were probably influenced by localized spring weather conditions (e.g., storms) and local differences in snow accumulation.

The reproductive phenology in a given year will also vary with the individual birds that nest in a general location. Pairs that occupy a nest location for the first time are expected to arrive late at the nest location (Enderson and Kirven 1979). Because there are no definite records of peregrines having renested in Alaska after a nest failure (although they may do so on rare occasions), individual variation in nesting phenology at a general location is primarily a result of individual variation in the commencement of nesting activity.

2.4 FOOD HABITS, HUNTING HABITAT AND HUNTING RANGE

2.4.1 Food Habits

Tables 8 and 9 list the prey species that have been taken by peregrines that nest on the Arctic Slope and in interior Alaska, respectively. Observations on which these tables are based are presented in more detail in Appendix 5.3.

In both regions of Alaska, the majority of the prey taken by peregrines are birds. Although small mammals are regularly taken, they comprise only ∿ 6-10% by number, and even less by weight of the diet. The most significant role played by microtines in the diet of these falcons may, in fact, be a secondary one; an abundance of microtines can attract important avian prey species such as jaegers (Cade 1960). Two species of fish have also been recorded in the diet of peregrines, but these items should be considered as only incidental and very occasional prey.

Peregrine falcons nesting on the Arctic Slope take slightly more than half the number of prey species that peregrines nesting in interior Alaska take (47 vs. 79 species). This difference undoubtedly reflects the lower number of species in arctic regions. Some important prey species are commonly taken in both regions of Alaska.

On the Arctic Slope, the groups of birds that are most frequently taken are shorebirds and passerines. Jaegers, particularly parasitic and long-tailed jaegers, are also very important. Although waterfowl are taken less frequently, they are important food items because of their larger biomass per individual. In some years ptarmigan also play a significant role in the diet of these peregrines. Some annual variation occurs in the kinds of prey taken by peregrines in the Arctic. Variation

TABLE 8. Prey species of peregrine falcons nesting on the Arctic Slope, Alaska.*

Birds (43 species)

arctic loon
Canada goose
pintail
green-winged teal
American wigeon
greater scaup
oldsquaw
red-breasted merganser
rough-legged hawk
ptarmigan spp.**
semipalmated plover
American golden plover**
black-bellied plover
bar-tailed godwit
lesser yellowlegs
spotted sandpiper**
northern phalarope**
red phalarope**
common snipe**
long-billed dowitcher**
semipalmated sandpiper
pectoral sandpiper
pomarine jaeger
parasitic jaeger**
long-tailed jaeger**
Sabine's gull
arctic tern
short-eared owl
Say's phoebe
gray jay
American robin
gray-cheeked thrush**
bluethroat
mountain bluebird
arctic warbler
yellow wagtail**
water pipit
northern shrike
yellow warbler
tree sparrow**
white-crowned sparrow
fox sparrow**
Lapland longspur**

Mammals (3 species)

shrew spp., *Sorex* spp.
arctic ground squirrel, *Spermophilus parryii*
singing vole, *Microtus gregalis*
vole spp., *Microtus* spp.

Fish (1 species)

arctic grayling, *Thymallus arcticus*

* Data are from Bee (1958), Kessel and Cade (1958), Cade (1960), Childs (1969), White and Cade (1971), Springer *et al.* (1979b), Roseneau (unpubl. data), Roseneau and Bente (unpubl. data).

** A species that occurs commonly as prey of peregrine falcons in this region.

TABLE 9. Prey species of peregrine falcons nesting in interior Alaska.*

<u>Birds</u> (70 species)

red-necked grebe
horned grebe
brant
pintail**
green-winged teal**
blue-winged teal
northern shoveler**
American wigeon**
canvasback
scaup spp.
common goldeneye
bufflehead
harlequin duck
white-winged scoter
surf scoter
sharp-shinned hawk
American kestrel
spruce grouse
ruffed grouse
willow ptarmigan
American golden plover
Hudsonian godwit
whimbrel
upland sandpiper**
greater yellowlegs
lesser yellowlegs**
solitary sandpiper
spotted sandpiper**
northern phalarope
common snipe**
long-billed dowitcher
semipalmated sandpiper
least sandpiper
Baird's sandpiper
pectoral sandpiper
mew gull**
Bonaparte's gull**
Sabine's gull
arctic tern
hawk owl
boreal owl
belted kingfisher
common flicker**
Say's phoebe
olive-sided flycatcher
bank swallow
cliff swallow
gray jay**
black-capped chickadee
boreal chickadee
American robin**
varied thrush**
hermit thrush
Swainson's thrush**
gray-cheeked thrush**
wheatear
Townsend's solitaire
ruby-crowned kinglet
Bohemian waxwing**
orange-crowned warbler
yellow warbler
yellow-rumped warbler
rusty blackbird**
pine grosbeak
redpoll spp.
white-winged crossbill
dark-eyed junco**
tree sparrow
white-crowned sparrow
fox sparrow**

<u>Mammals</u> (8 species)

dusky shrew, *Sorex obscurus*
shrew spp., *Sorex* spp.
snowshoe hare, *Lepus americanus*
arctic ground squirrel, *Spermophilus parryii*
brown lemming, *Lemmus sibiricus*
northern red-backed vole, *Clethrionomys rutilis*
tundra vole, *Microtus oeconomus*
singing vole, *Microtus gregalis*
meadow vole, *Microtus pennsylvanicus*
vole spp., *Microtus* spp.

<u>Fish</u> (1 species)

whitefish spp., *Coregonus* spp.

* Data are from Cade (1951, 1960, 1968), Cade *et al.* (1968), Enderson *et al.* (1973), White and Roseneau (1970), Curatolo and Ritchie (1979), Ritchie (1976), Hayes (1977), Dotson and Mindell (1979), Springer *et al.* (1979b), Roseneau and Springer (unpubl. data), Roseneau and Bente (unpubl. data).

** A species that occurs commonly as prey of peregrines in this region.

among pairs also occurs (i.e., some pairs take more passerines, some pairs take more waterfowl), probably as a result of both individual prey preference and local prey availability.

In interior Alaska, shorebirds and passerines are again taken most frequently. Waterfowl are also taken frequently (more so than in the arctic), and they often constitute over 50% by weight of the diet of many pairs. Woodpeckers also play an important role in the diet of these peregrines. A high incidence of forest species can often be found in the diets of interior peregrines; these species become vulnerable as they cross rivers and open areas. As in the Arctic, some annual variation probably occurs in the kinds of prey taken (although possibly not to such a great degree). Variation among pairs also occurs.

The wide range of species taken as prey by both arctic-nesting and interior-nesting peregrines reflects their opportunistic feeding habits. The ability to take such a wide variety and range in size of prey species can be attributed in part to the marked sexual size dimorphism found in peregrines. The smaller male peregrines tend to take smaller prey than do female peregrines. All other northern raptors, including the gyrfalcon, exhibit various degrees of sexual size dimorphism; however, it appears to be most developed in peregrines, and of the large northern raptors, only peregrines reflect this size dimorphism so clearly in their feeding habits (White and Cade 1971).

The fact that arctic-nesting and interior-nesting peregrines take many individuals of a number of species also illustrates their less specialized nature. In contrast, the gyrfalcon, which nests in the same regions, is also quite opportunistic and takes a relatively wide range of prey species, but they are more dependent than peregrines on a few species for the bulk of their diet, even in summer (e.g., Cade 1960; White and Cade 1971; Roseneau 1972).

2.4.2 Hunting Habitat

In general, the preferred and most-used hunting habitats will depend on such things as the relative abundance of vulnerable prey in the various habitats within the falcon's hunting range, the species and sizes of available prey, the vulnerability of the prey-laden peregrine to pirating by other raptors, the prevailing winds, and the locations of the various habitats relative to the nest cliff.

An important concept in dealing with peregrine hunting habitat is that of a 'gulf of air'; it is considered to be the airspace in front of a nesting cliff over an open area that has comparatively little escape cover and that is more or less confined by vertical boundaries (e.g., the air over a river that has a cliff on one side and a forested bank on the other). Peregrines take most of their prey in the air and do most of their hunting either from perches on high points of land that overlook the countryside, or from considerable heights in the air. The hunting strategy employed by some peregrines is more often dependent on waiting for vulnerable prey species to enter their hunting area than it is on the peregrines travelling great distances to specifically seek out prey. As a consequence, the gulf of air in front of the nesting cliffs is important hunting habitat, particularly if it is associated with large bodies of water (e.g., oceans, lakes, wide rivers) or open ground with little vegetative cover (e.g., gravel bars, wide beaches).

Observations of the hunting habitats used by *F. p. tundrius* indicate that they hunt primarily over lakes, marshes and wetlands, and to a lesser degree over upland tundra. In areas where riparian habitat is extensive, they also hunt over this habitat. Observations of the hunting habitats used by *F. p. anatum* in Alaska indicate that they hunt primarily in the gulf of air over river valleys and over nearby lake and marsh areas. Their prey include forest, wetland and riparian species that become vulnerable when they cross the open expanses of rivers, lakes or wetlands. Observations of hunting habitat are discussed in more detail in Appendix 5.4.

2.4.3 Hunting Range

The distance from a nest site that peregrines will travel to hunt depends largely on the type of prey and prey habitat available, the initial abundance of the prey and any changes in prey abundance during the nesting season, and the vulnerability of the prey. The gulf of air above rivers and lakes in forested areas is often an important feature of a nest location that may help to determine whether the falcon hunts in the immediate vicinity of a nest site, or whether it travels to hunt at some distant location.

Many peregrines appear to hunt relatively short distances from their nest sites if prey are abundant nearby, or if the local land forms and the gulf of air between and above these land forms provide sufficient opportunities to obtain prey that are flying near the nesting area. Many nest sites along major rivers in forested interior Alaska appear to fall into this category; prey are either locally concentrated and abundant (e.g. nearby wetlands or marshes) or are sufficiently abundant overall in the surrounding river valley (including all habitat types) to provide a nearly steady supply of exposed prey that pass along or across the river in the vicinity of the nest location and nearby hunting perches (cf. Cade 1960, p. 165 for a discussion of the importance of rivers to peregrines).

However, peregrines can and do travel much longer distances from their nest sites if changes occur in prey composition or abundance, if important concentrations of prey occur at a distance rather than nearby, or if the gulf of air over coverless terrain near the nest location is insufficiently large. In these instances the birds either travel and hunt in distant areas that have vulnerable prey that are abundant or concentrated, or they range over larger areas that have vulnerable prey that are uniformly distributed but less abundant.

In treeless regions (e.g., the Arctic Slope of Alaska), the gulf of air over exposed terrain in front of the nesting location appears to be less important. Vast open spaces surround nest sites in all directions, and much of the area has minimal escape cover for many of the prey species. Although few data are available to substantiate this hypothesis, it appears that in such regions (which often have a less diverse and more patchily distributed prey base) peregrines may be more readily attracted greater distances to concentrations of prey or may range over a broader area on a more regular basis to obtain their food.

There are few detailed observations of hunting ranges of individual peregrines, and these observations are quite varied (Appendix 5.5). A male on the Arctic Slope hunted over a territory that averaged $\sim$ 7 mi in radius, but that extended 9 mi in one direction but only 2.5 mi in another direction (White 1974c). Several *F. p. anatum* birds in interior Alaska and Canada hunted primarily within 1-3 mi of their nest sites, but one such bird was recorded to have travelled 30 mi from its nest cliff (J. Windsor, pers. comm.).

TABLE 10. General types of impacts to peregrine falcons and other raptors.*

Disturbance

Construction and Operation Activities

sudden loud noises (e.g., blasting, gas venting, etc.) can lead to panic flights and damage to nest contents

noise, human presence, etc. can lead to disruption of daily activities

Aircraft Passage

sudden appearance and noise can lead to panic flights and damage to nest contents

Human Presence Near Nests

inadvertent - chance occurrence of people (and dogs) near nests; people may be unaware of nest, raptors or raptor alarm behavior

deliberate - curious passersby, naturalists, photographers, researchers can have impacts if safeguards are not taken

Direct Impacts

Intentionally Destructive Acts (as a result of increased public access)

shooting
legal or illegal removal of eggs, young or adults
rolling of rocks off cliff tops
cutting of nest trees

Man-made Structures and Obstructions

raptors may be struck on roads where they may perch or feed
may strike wires, fences, etc.
may be electrocuted on power poles
raptors sometimes attack aircraft, or may accidentally strike aircraft

Environmental Contaminants

deliberate application and accidental release of insecticides, herbicides, petrochemicals, and toxic industrial materials can affect raptors and prey by affecting hormones, enzymes, shell thickness, bird behavior, egg fertility and viability, and survival rates of nestlings, fledglings, immatures and adults

TABLE 10 (continued)

Direct Impacts

Changes in Prey Availability

decrease in prey abundance or loss of nearby hunting areas may affect territory size, efficiency of hunting, nest occupancy, nesting success, condition of adults and young

changes may result from aircraft overflights, construction and maintenance activities, public access, etc.

Habitat Loss

abandonment of area due to destruction of nest, perch or important hunting habitat

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*Adapted from Nelson and Nelson (1978).

TABLE 11. Factors that affect the sensitivity of peregrine falcons to disturbances.*

1. Characteristics of the disturbance

   a. type of disturbance
   b. severity (speed, loudness, suddenness, persistence, etc.)
   c. frequency of occurrence

2. Characteristics of the bird

   a. the individual (individual differences in response)
   b. sex
   c. age
   d. 'mood' (a factor of recent activities, weather)
   e. territorial status (breeder, territorial non-breeder or non-territorial floater)
   f. stage of annual life cycle (winter, migration, courtship, egg-laying, rearing young, etc.)
   g. occurrence of other disturbances or natural stresses at the same time
   h. previous experience with this type of disturbance (habituation may occur)

3. Topography

   a. nearness of disturbance to raptor or nest
   b. relative elevations (is nest or raptor above or below the disturbance? by what distance?)
   c. presence of screening features (trees, intervening hill)
   d. direction faced by nest relative to sun, wind, disturbance
   e. type of nest (exposed ledge, overhung ledge, cave)
   f. distance of nest above foot of cliff and below lip of cliff (i.e., 'security' of nest)

4. Time of day

5. Weather at time of disturbance

6. Potential predators nearby

7. Type of prey utilized by the bird (species, location, abundance)

*Based on published and unpublished sources and the experiences of the authors.

a disturbed bird. Consequently, each bird may differ to some degree in its responses to disturbance, and in fact the same bird may react differently to the same disturbance at different times (Cade 1960; Kessel 1978). Herbert and Herbert (1965) noted that 'perhaps the most notable fact about them [peregrines] was that they varied greatly as individuals. No two individuals nor pairs were the same in behavior. No two pairs, it would seem, had the same problems. Each eyrie was a world of its own, distinct in pattern.' Although there is a wide range of variation in individual responses to disturbances, it seems likely that the behavioral responses to a particular type of disturbance will follow a general pattern, although they may differ in the degree of response.

The timing of the disturbance relative to the time during the bird's breeding cycle is very important in determining the effect that it may have on the bird (Table 12). Peregrines are apparently most prone to nesting failure that results from disturbance during their territory-establishment, courtship, egg-laying, incubation, and early nestling stages (Kessel 1978). They appear to be more tolerant of the effects of disturbance (but also often more aggressive) in later stages of the nesting cycle, particularly when they have large nestlings or fledglings (Fyfe and Olendorff 1976).

Absence of adults from the nest site as a consequence of disturbance leaves the eggs or young subject to predation or the effects of weather. Adults can be away from eggs or small young for short periods (e.g., 5-10 min) under reasonably good weather conditions without adverse effects (e.g., Roseneau and Bente 1979). However, there appear to be no observations that clearly indicate the maximum times for various temperatures that falcons can safely be off their eggs or small nestlings. The careful attendance of the nest contents by the parent birds during adverse weather conditions, and the results of work with artificial incubation of peregrine eggs and subsequent raising of young both suggest that the eggs and

TABLE 12. Influence of timing of disturbance on the possible effects on peregrine falcons and other raptors.*

Timing	Possible Effects of Disturbance
winter	raptor may abandon nest, roosting cliff or hunting area (e.g., gyrfalcon)
arrival and courtship	migrant raptor may be forced to use alternate nest site (if available), may remain but refuse to breed or may abandon nest site
egg-laying	partial clutch may be abandoned and remainder (or full clutch) laid at alternate nest; breeding effort may cease or site may be abandoned
incubation	eggs may be chilled, overheated, or preyed upon if parents are kept off nest too long; sudden flushing from nest may destroy eggs; male may cease incubating; clutch or site may be abandoned
nestling phase	chilling, overheating, or predation of young may occur if adults are kept off nest; sudden flushing of parent may injure or kill nestlings; malnutrition and death may result from missed feedings; premature flying of nestlings from nest may cause injury or death; adults may abandon nest or site
fledgling phase	missed feedings may result in malnutrition or death; fledglings may become lost if disturbed in high winds; increased chance of injury due to extra moving about; parents may abandon brood or site
night	panic flight may occur and birds may become lost or suffer injury or death
general	undue expense of energy; increased risk of injury to alarmed or defending birds; missed hunting opportunities

* Adapted from Nelson and Nelson (1978) and Mossop *et al.* (1978).

nestlings are susceptible to chilling and overheating (including dehydration) from relatively brief exposures. Serious consequences could result from repeated short absences due to human presence or from single events of comparatively long duration, especially during inclement weather. Even without human disturbance, small and large nestling gyrfalcons have died from hypothermia during periods of especially bad weather (when it is assumed that the adults could not attend to their needs adequately; Roseneau *et al.* 1980; Springer, unpubl. data; Bente, unpubl. data).

Two factors must be remembered when considering the impacts of developments on peregrines. Because most of the information is from observations of very small sample sizes, the observations indicate the manner in which some birds will respond, but the observations may not be conclusive with respect to the behavior of the species as a whole. Also, there may be a bias in the observations toward observations of birds that successfully survive impacts of various types. Such cases are clearly evident, whereas in cases where nesting failures occur, the cause of the failure is frequently not obvious.

2.5.1.1 Construction and Operation Activities

Many of the activities associated with the construction and operation of a natural gas pipeline have the potential to disturb peregrine falcons (either visually or aurally) if the activities occur in the proximity of nest sites during the nesting period. Construction activities that have the potential to disturb nesting peregrines include pre-construction surveys; transportation of equipment and supplies; construction and operation of access roads, storage areas, and construction camps; operation of material sites (including blasting); the various operations associated with laying the pipe; testing the pipeline; clean-up and revegetation activities; and construction of support facilities. Operational activities that have the potential to disturb nesting peregrines include operation of compressor stations (a continuous source of noise), servicing of support facilities, and pipeline maintenance. There is probably some leeway for delaying normal maintenance requirements that might disturb peregrines; but emergency repairs, such as fixing a line break, would require immediate action that might prove to be a disturbance to nesting peregrines.

There appear to be no detailed studies of the effects of heavy construction on the behavior of raptors. The available observations suggest that the responses of peregrines to construction activities are variable. Blasting and other construction activities associated with the building of the Palisades Parkway in 1950-56 in New Jersey and New York seriously disturbed the peregrines that nested on the adjacent cliffs (Herbert and Herbert 1965, 1969). Some abandoned clutches and non-breeding pairs were fairly clearly due to the effects of construction. Shooting, poaching, increased hiking and picnicking, and insecticides also affected the falcons in this area at this time, however, and the specific effects of construction were difficult to ascertain in most cases. There appeared to be 'some sort of cumulative nervousness' in the falcons, such that slight disturbances would cause them to abandon their clutches.

Blasting is one construction activity whose effects have the potential to be felt at some distance from the construction site. Windsor (pers. comm.) observed a peregrine to 'explode' from its nest ledge in response to a blast; it bolted from the nest ledge in an extremely rapid and disorganized fashion. At some stages of the nesting cycle, this response could have damaged eggs or young.

A pair of peregrine falcons in Alaska provide evidence of a short-term response to blasting without evident long-term effects. The birds established a nest site in 1979 about 0.5 mi in line of sight from, and 400 ft above a highway (Roseneau and Bente 1979, 1980a). Normal peregrine arrival dates suggest that the pair should have arrived at the nest cliff at about the time that major reconstruction activities were initiated and should have begun egg-laying at about the time blasting began (Roseneau and Bente 1980a; Ambrose, USFWS memorandum to A. R. Crane, 24 July 1979). In spite of heavy construction activities along the road bed, approximately weekly detonations of 10,000-16,000 lb of dynamite in the road bed area, and occasional rock climbing in the immediate vicinity, this pair fledged three young. The nesting phenology of this pair was about 2 wk behind that of other pairs that nested in interior Alaska in 1979 (Ambrose, pers. comm.). In 1980 a pair of peregrines (presumably the same pair) returned to this area and successfully fledged three young (in synchrony with many other pairs) from a new nest site that was ∿ 0.7 mi farther from, and out of sight of the highway (Roseneau and Bente 1980a). It can only be speculated whether the disturbance in 1979 caused the delayed nesting phenology in 1979 or the shift in nesting cliff in 1980. It is not known if the nest location was first occupied in 1979, but if so, the peregrines would have been expected to have arrived late (Enderson and Kirven 1979).

The response of the female peregrine to one blast was observed on 20 July 1979, when the nestlings were 18-20 d old (Ambrose, USFWS memorandum to Crane, 24 July 1979; P. Reynolds, BLM memorandum to J. F. Santora, 20 July 1979). Sixteen thousand pounds of dynamite were exploded at a distance of ∿ 0.5 mi from the nest site (and also from the observer) when the adult female was perched on the cliff about 30 ft above the nest site. (The adult male was not present.) At detonation, the female 'flinched away from the source', acted 'as if shot at', and instantly dove from the cliff in rapid flight. The concussion wave may have actually knocked the bird from her perch; one observer who was viewing her through a telescope was knocked aside by the concussion wave and both observers were showered with small rocks (Ambrose, pers. comm.). The female flew ∿ 0.1 mi away from the explosion, and then flew ∿ 0.2 mi toward the blast site. In ∿ 40 sec she returned to her perch and watched as a large dust cloud formed from the blast; she remained at the perch for ∿ 1.5 h. A few minutes after a construction crew had begun to use large hammers to break up rocks, she moved to another perch ∿ 100 yd from the nest site. The adult male appeared ∿ 12 min later and joined the female; a food exchange then occurred. Approximately 11 min later food was brought to the nestlings. Apparently most blasts at this construction site were of a somewhat more controlled nature than the above blast, although they could still be classed as a major disturbance.

Mossop *et al.* (1978) suggested that blasting during high winds might be less disturbing to raptors because of the loud background noise of the wind. Blasting at night could possibly cause abandonment of the nest location or chilling of the eggs or nestlings. Blasting during inclement weather could also cause chilling of the eggs or nestlings.

Reactions of peregrine falcons to other loud noises are also variable. The birds have undoubtedly adapted to intense thunderstorms, which they experience at breeding sites (particularly in the Yukon River drainage) or at wintering areas in some regions of eastern South America (Roseneau, unpubl. data). Numerous observers have seen peregrines and other raptors fly instantly in response to the relatively small explosions of firearms or firecrackers; the reaction in some instances, however, may also involve the visual stimulus of first seeing the people and then associating the loud noise with them. The emergency venting at compressor stations, which might occur as often as once a year and which may create a sudden noise in excess of 130 dB(A) at ∿ 110 yd (Foothills South Yukon 1979), could possibly produce an effect similar to that of blasting.[1]

[1] Equivalent to ∿ 100 dB(A) at 2 mi, or a power lawnmower at 1 yd (Foothills South Yukon 1979).

White (1974c) commented on the effects of vehicular traffic along the TAPS haul road on the hunting range of an adult male peregrine. The haul road and a camp were ∿ 2 mi and ∿ 4 mi, respectively, in line of sight from the nest site on Franklin Bluffs. The traffic and the noise associated with it did not appear to influence the male's hunting range; the bird made a stoop near the camp, and then started to stoop again when a bird was flushed by a passing vehicle.

The effects of construction of the TAPS oil pipeline on nesting peregrines were not clearly evident. White *et al.* (1977) concluded that along the corridor there was, in general, 'no demonstrable negative impact on raptors attributable to pipeline activity. Any impact that may have occurred has been masked by the normal dynamics of the populations.' Although this statement was in general true, specific effects may have been noticeable for peregrines in one particular area -- the Sagavanirktok River. The productivity of peregrines in this drainage reached its lowest level during the pipeline construction years of 1975 and 1976; productivity was also low in 1974, the year the haul road was under construction (Capodice 1976; Roseneau *et al.* 1976; Roseneau, unpubl. data). At Sagwon Bluffs (the closest nests to the construction activities) productivity declined to zero in 1976. However, in 1977 some productivity did occur there (K. Whitten, pers. comm.), and by 1979 productivity in this drainage appeared to be increasing (Roseneau and Bente 1979). Biocide contamination of these birds must also be considered (see Section 2.5.2.3). The curves generated by productivity data from the Sagavanirktok River generally follow those calculated for the undisturbed Colville River (cf. Springer *et al.* 1979b); both data sets had low points during ∿ 1974-76. These data trends suggest that biocide contamination was responsible, at least in part, for the decline. The possibility that pipeline-related impacts were also involved cannot, however, be eliminated.

There is considerable evidence that at least some nesting peregrines are capable of tolerating the activity associated with normal operation of a pipeline or highway. Surveys to locate cliff-nesting raptors in the TAPS corridor between Prudhoe Bay and Delta Junction in 1979 showed that the numbers and productivities of peregrines that nested in and along the corridor in 1979 were comparable to those reported by White *et al.* (1977) for the period 1970-74 (Roseneau and Bente 1979). Raptor surveys 5-7 years after the construction of parts of the Dempster Highway in the Yukon Territory showed a dense and apparently saturated population of golden eagles and several active peregrine nests relatively near the highway. The pre-construction populations are unknown, as is the status of the peregrines with regard to biocide contamination and the overall peregrine decline, but some peregrines were present and producing satisfactorily in 1977, 1978 and more recently (Mossop *et al.* 1978; Mossop, pers. comm.).

A pair of peregrines may have up to six alternate nest ledges in their territory that may be up to 4 mi apart (Ratcliffe 1962; Herbert and Herbert 1965). If a particular pair does have alternate ledges available, it may be able to avoid some types of disturbance by nesting at an alternate ledge that is farther removed from the disturbance. For such an event to occur, however, it is usually necessary that the disturbance be occurring when the falcons return to the nest cliff in spring.

2.5.1.2 Aircraft Passage

A number of pipeline activities involve the use of aircraft, which have the potential to disturb nesting peregrines either visually or aurally. Aircraft (fixed-wing or helicopter) will probably be required for support of pre-construction surveys, for support and supply of construction activities, for aerial re-seeding, for supply of operational facilities (such as compressor stations), and for surveillance and repairs of the operational pipeline.

The sudden appearance of an aircraft from behind a nest cliff can cause an incubating or brooding falcon to flush quickly from the nest scrape either in fear or in order to attack the plane. White and Sherrod (1973) cautioned that eggs or nestlings could be damaged as a result. Peregrines (Olsen and Olsen 1978) and prairie falcons (R. W. Fyfe, pers. comm.) have been seen to knock nestlings almost from the nest ledge when suddenly flushed. A peregrine that suddenly left her nest scrape to attack an eagle that had suddenly appeared near the nest flipped an egg out of the scrape; fortunately the falcon was able to roll the undamaged egg back into the scrape (Nelson, unpubl. data). Peregrines and gyrfalcons have been observed to attack light aircraft in the same manner (Nelson, unpubl. data; Roseneau, unpubl. data), and eggs have been observed to fall from a prairie falcon nest in similar circumstances when an aircraft surprised the bird (Fyfe, pers. comm.). Eggshells that are thin as a result of biocides increase the risk of damage in such circumstances (Nelson 1976).

Windsor (1977) observed the effects on nesting peregrines of a fixed-wing aircraft (Cessna 185) and a helicopter (Bell 206B). Both types of aircraft flew past the nests at speeds of 90-100 mi/h and at altitudes of 250, 500 and 1000 ft above ground level; they flew 500 ft in front of, and parallel to the nest cliff. The birds were acclimatized to some degree to aircraft overflights because of their proximity to an airport. There was no significant difference in reproductive success between tested pairs and control pairs. The birds showed the greatest response to both types of aircraft at altitudes of 250 and 500 ft. Their responses at 1000 ft were considerably less. The birds appeared to respond more during the nestling phase than during the incubation phase.

Instead of fleeing, some peregrines fly toward approaching aircraft when the aircraft is as much as 1 mi from the nest. They may attack the aircraft, presumably as a form of nest defense. Both helicopters and fixed-wing aircraft have been attacked very closely by peregrines, but as yet, there apparently have been no strikes. A peregrine (which may weigh 2 lb) could cause a fatal crash of a light fixed-wing aircraft or helicopter (Nelson 1979), or in the right circumstances, the crash of a much larger aircraft.

In contrast to the panic response and the attack response is the very tolerant response of some peregrines to aircraft that approach relatively slowly and in view of the nest. Raptor biologists, who purposely fly at low speeds, have often flown past an incubating or brooding peregrine without causing the bird to rise from the nest scrape; ground speed may be 50 mi/h or less and the aircraft may be as close as 25 yd from the falcon. White and Cade (1975) reported that 'many peregrines could not be flushed from perches or nest sites by either fixed-wing or helicopter and often left only after we were on the ground and out of the aircraft'. Peregrines have even continued to feed nestlings while a helicopter hovered less than 50 yd away (White and Sherrod 1973). The above observations suggest that the response of peregrines to aircraft may be less at low air speeds than at high ones.

Near Inuvik, Northwest Territories, a pair of peregrines that was apparently habituated to aircraft overflights raised young successfully at a nest site located ~ 1 mi from an airport serving jet aircraft as well as light planes (U. Banasch, pers. comm.).

Several raptor species (but not peregrines) have been tested during the nestling phase in the American Southwest with military jets that approached at very high speed from generally in front of the nest cliffs. Even with jet fighters passing within ~ 100 yd and level with the nest, the raptors (prairie falcons and red-tailed hawks at cliff nests, Cooper's hawks at tree nests), usually tolerated the intrusions; no losses in productivity occurred (Ellis 1980). Habituation to low level jets in training areas probably occurs; the raptors cannot attack such high speed aircraft, the aircraft do not linger near the nest, and aircraft are regularly seen to fly past without any danger. In another study of the effects of low-level jet aircraft on nesting raptors, White (pers. comm.) felt that the birds possibly ignored the intense noise because the visual stimulus of the aircraft had passed the birds before the sound had reached them.

Under certain circumstances, however, larger aircraft may pose a considerably greater danger to nesting peregrines than light aircraft. In 1974, at Sagwon Bluffs, Alaska, unfavorable weather conditions during July occasionally caused Lockheed Electras and Fairchild F-27s that were servicing the TAPS construction camps (not equipped for IFR approaches) to fly the right-of-way between camps in that area at altitudes as low as 300-500 ft above the tops of the bluffs. On a day immediately after a period of heavy rain, vibrations from these multi-engine propeller-driven aircraft (which were readily felt in nearby buildings) appeared to have triggered 10-15 separate landslides in a short period of time. Landslides are relatively common along these inherently unstable bluffs during the summer, but the number of slides following these flights was unusual. One slide caused a peregrine nest with three young to slide into a river (Roseneau, unpubl. data).

2.5.1.3 Human Presence Near Nests

Pipeline construction and operation has the potential to bring workers (or others by virtue of increased access) close to peregrine nest sites either inadvertently or purposely through curiosity. The occurrence of humans near peregrine falcon nest sites has been shown to have widely varying impacts on the birds. There are numerous cases where human presence near nests has resulted in the birds abandoning nest sites. There are also numerous cases where peregrines have nested successfully despite the presence of humans nearby.

Some peregrine falcons are quite aggressive in defending their nest sites against humans. Some individuals have flown as far as ∿ 1 mi from the nest cliff to dive at hikers and protest their presence (Harris and Clement 1975; Windsor 1977). Other individuals have been observed to fly as far as ∿ 0.3 mi from their nests to defend against, and even follow boats (Curatolo and Ambrose 1978; Roseneau and Bente, unpubl. data). Other individuals do not respond by flushing or calling unless the 'intruder' is within a few hundred feet of the nest cliff (Roseneau and Bente, unpubl. data).

Peregrine falcons have also been observed to abandon nest sites as a result of nearby human presence. Two pairs that had tolerated people at distances of ∿ 100 yd for some time suddenly moved more than 0.3 mi to alternate nest cliffs in response in one case to a visit to the cliff top and in the other case to a visit to the prospective nest ledge during the week or so before egg-laying began (Nelson 1973, unpubl. data). These and other observations suggest that peregrines are less tolerant of activities at the top of their nest cliffs, whereas they may tolerate people below their cliffs in the sensitive period if the cliff is sufficiently high (e.g., Herbert and Herbert 1965).

In contrast to the above disturbances, peregrine falcons have demonstrated an ability in many cases to tolerate the presence of humans nearby when this presence has not been directly related to their nest sites. Peregrines have successfully nested within 0.3 mi of major roads, villages, fish camps and nets, and trapping cabins, and in the proximity of regular boat traffic (Nethersole-Thompson and Watson 1974; Cade and White 1976; Curatolo and Ambrose 1978; Nelson and Nelson 1978; Ambrose 1979; Springer *et al.* 1979a,b; Banasch, pers. comm.; L. Johnston-Beaver, pers. comm.; Roseneau and Bente, unpubl. data; D. Weir, pers. comm.). At a nest site on a high cliff ∿ 0.2 mi from a highway in the Yukon Territory, peregrines courted, incubated and reared their young with very little indication of their having noticed pedestrian or vehicular activities

(Nelson and Nelson 1978); peregrines also reoccupied the same site in subsequent years (Mossop, pers. comm.). Two other peregrine nest sites occur above the same highway within ∿ 0.2 mi of it (Mossop *et al.* 1978). Peregrines that nested along the Hudson River usually tolerated people below their nest cliffs that were ∿ 135 yd high, but often became alarmed at people on top of the cliffs (Herbert and Herbert 1965). In Ecuador, a pair of peregrines of the South American subspecies (*F. p. cassini*) that nested in a narrow high-walled gorge tolerated non-mechanical farming activities ∿ 100 yd below the nest (Springer and Roseneau, unpubl. data). Peregrines have also reared nestlings on the ledges of tall buildings in Montreal, New York, Philadelphia, and Baltimore (Hickey 1969; Cade and Dague 1979).

Several pairs of peregrines on the Yukon River, Alaska, have successfully produced young at nest ledges that were less than 20 yd directly above a considerable amount of daily boat traffic, and above active fish-wheels and fishing nets (Springer *et al.* 1979b; Roseneau and Bente, unpubl. data). In one instance, a pair of peregrines successfully produced young at a small river-front cliff in a narrow (∿ 140 yd wide) slough (Roseneau and Bente, unpubl. data). The nest site was ∿ 10 yd above the water line, ∿ 50 yd from an occasionally used fish camp, ∿ 250 yd from another, regularly used fish camp, and ∿ 1.5 mi from a village of several hundred people that used the slough for primary access to the Yukon River (i.e., subject to considerable boat traffic and occasional barges from late May until freeze-up). In another instance, a pair of peregrines successfully nested ∿ 30 yd above fish nets and only ∿ 150 yd around the corner and upstream from a village of over 100 people. Several pairs of peregrines that successfully produced young on the Yukon River ignored diesel-powered freight barges (with super structures nearly as high as the nest ledges) as the barges passed close by the cliffs (Roseneau and Bente, unpubl. data).

Some habituation to certain forms of disturbance has probably occurred in connection with nesting attempts near man or his activities. Several of the pairs that nest successfully near human activities on the lower Yukon River, for example, are not as aggressively defensive or as vocal as many other pairs; instead they appear to be 'quiet' birds that are relatively unobtrusive in their daily activities (Roseneau and Bente, unpubl. data). Peregrines in wilderness areas have shown an ability to become more tolerant of nearby observers if the observers follow a standard procedure that is designed to minimize disturbance (Nelson 1973).

The height of a nest above humans, vehicles or other disturbances appears to be an important factor that may permit falcons to nest in the presence of disturbance. Height appears to place the birds in a 'superior position' that moderates threat. For instance, pairs that regularly tolerate daily human activities at fishwheels below them with minimal response, react strongly to the presence of humans on the bluff tops, even though the humans are considerably farther away. Other factors that may apparently contribute to successful nesting in the presence of disturbance are the lack of sudden loud noises nearby, the lack of close approaches by humans near the nest ledges, some ability to become habituated to activities, and, most importantly, the lack of direct, overt harassment aimed at the falcons. Absence of these conditions does not, however, imply that a pair will be unable to nest successfully; birds that have nested successfully in cities, for example, have done so in spite of the noise levels of the cities.

In addition to inadvertent human presence near nest sites, some human activities may be directed specifically at nesting peregrines. These 'nondestructive' activities may include the curious observations of passersby, activities of naturalists and photographers, and scientific studies of the birds. Such activities frequently cause disturbance. Nelson (1973), White and Sherrod (1973), Fyfe and Olendorff (1976) and Olsen and Olsen (1978) suggest methods for alleviating the potential impacts of disturbance from scientific studies. Fyfe and Olendorff (1976) list the following potential impacts (which apply to all types of disturbance, not only human presence near nests): desertion of the nest site; damage to eggs or young by frightened adults; cooling, overheating, or loss of moisture from eggs; chilling or heat prostration of nestlings; missed feedings; premature fledging; and predation.

2.5.2 Direct Impacts

There are several ways in which the construction and operation of a natural gas pipeline could increase the direct impacts to peregrine falcons (as opposed to the impacts of disturbance or habitat loss). Because the proposed gas pipeline route follows already developed and actively used transportation corridors, however, it seems doubtful that direct impacts will be much increased over the low levels that probably already exist. Direct impacts caused by previous oil pipeline construction were, to our knowledge, minimal and we have no reason to anticipate a significant change for the worse with a gas pipeline.

2.5.2.1 Intentionally Destructive Acts

These impacts may arise secondarily through the activities of the general public that are able to visit raptor areas through increased access (e.g., new roads or airfields), or through the activities of construction or maintenance workers. White and Cade (1975) emphasize the need to prevent deliberate harassment or shooting of peregrines in connection with industrial developments. Shooting is still a significant cause of peregrine mortality (Cade and Dague 1977) and poaching of nestlings for purposes of falconry is also a continuing problem (A. Breitkreutz, pers. comm.; USFWS, unpubl. rec.). However, we know of no intentionally destructive acts that occurred during the construction or operation (to date) of the TAPS.

2.5.2.2 Man-made Structures and Obstructions

Some species of raptors are attracted to roads because of road-killed prey in some areas, but it seems likely that peregrines (even inexperienced young birds) would only scavenge from roads on rare occasions. Peregrines may, however, be attracted to roads in some areas to take advantage of prey that are flushed by passing vehicles (White 1974c) or that are crossing the road. They may also be attracted to roads that, when clear of snow early in the spring, attract large numbers of arriving and resting migrant prey. (Gyrfalcons, rough-legged hawks and short-eared owls were attracted to such roads on the Seward Peninsula in 1968 [Roseneau, unpub. data].) Vulnerability of prey and availability of good perch points along transportation corridors may be among the reasons that various species of raptors are often observed in the north to perch near road or pipeline right-of-ways throughout the breeding season. Peregrines, gyrfalcons and rough-legged hawks have often been observed perched along the TAPS haul road or on above-ground sections of the oil pipeline. Raptors may also be attracted to roads for other reasons; a merlin, for example, was seen dust bathing on the Dempster Highway. Peregrines that are attracted to roads may be subject to collisions or near collisions with vehicles. A juvenile male peregrine in Washington was observed to fly in a manner that suggested that it had been caught and thrown by the slipstream of a passing truck; the bird was stunned but uninjured (C. Anderson, pers. comm.) Raptors perched along roads are obvious targets that are sometimes shot by passersby (Ellis *et al.* 1969).

Peregrines may be killed in collisions with aircraft that they have struck either inadvertently or as the result of attacking the aircraft (see Section 2.5.1.2).

Raptors may be injured by flying into guy wires, power lines, wire fences, etc. Falcons are most likely to do so when they are in pursuit of prey. F. Gudmundsson (pers. comm.) observed a gyrfalcon that was killed when it flew at high speed into a wire fence in pursuit of a small passerine that flew through the fence. Enderson and Kirven (1979) mentioned at least six collisions of peregrines with wires in California and one in Colorado.

Some configurations of power poles, insulators and wires have led to peregrines being electrocuted when they perched on power poles (J. S. Campbell, pers. comm.; Nelson, unpubl. data).

Camps for construction or maintenance workers often attract numbers of common ravens because of the availability of garbage that they can scavenge; the camps may thereby maintain larger populations of ravens in an area than could otherwise survive. Ravens compete with raptors for nest sites on cliffs, and this competition from artificially-maintained ravens could have a serious effect on nesting peregrines (White *et al.* 1977). Although peregrines can attack and harm ravens (Roseneau, unpubl. data), ravens are larger than peregrines and establish their nest territories before peregrines return in spring; it may thus be difficult for peregrines to dislodge nesting ravens from favored nest sites (cf. White and Cade 1971).

2.5.2.3 Environmental Contaminants

Peregrine falcon populations in Alaska are contaminated with organochlorine residues such as DDE, and have shown various degrees of egg shell thinning (Cade *et al.* 1971b; White *et al.* 1973; Peakall *et al.* 1975). DDE, a metabolite of DDT, is the major cause of the shell thinning that has been observed in peregrines (Peakall *et al.* 1975; Peakall 1976). Eggs from the two migratory races in Alaska (*F. p. tundrius* and *F. p. anatum*) have shown the greatest degree of eggshell thinning, and peregrines nesting on the Arctic Slope and along the Tanana River appear to be the most adversely affected. Shell thinning can increase the chance of egg loss by accidental breakage during normal incubation behavior (Nelson 1976). Other substances, most notably dieldrin and the polychlorinated biphenyl compounds (PCB's), are known to be more embryotoxic than DDE (Peakall *et al.* 1975; Peakall 1976), and can reach levels that can kill embryos outright. Levels of dieldrin are very high in eggs from the Arctic Slope, and appear to be sufficiently high to affect embryonic viability (Springer *et al.* 1979b; Springer, unpubl. data). PCB's have also been linked with possible behavioral changes, including changes in nest attentiveness (Peakall *et al.* 1975; Peakall 1976). The presence of these harmful contaminants, and the fact that their levels may increase as a result of changes in agricultural policies in Latin America, where many of the migratory falcons and their prey winter, confounds the management of peregrines in areas where they may also be subject to impacts from developments.

The productivity of peregrines that nested along the Sagavanirktok River was very poor during the years of road and pipeline construction in 1974-76 (and probably 1977), in part because whole clutches failed to hatch (Capodice 1976; Roseneau *et al.* 1976; Whitten, pers. comm.) -- a symptom recognized to be associated with biocide contamination (cf. Cade and Fyfe 1970; Fyfe *et al.* 1976; Roseneau *et al.* 1976). Eggs collected at that time for chemical contaminant analyses contained high levels of DDE and dieldrin, and the shells were very thin (R. C. Stendell, memorandum to Senior Agent, USFWS Div. of LE, Fairbanks, 4 January 1977; G. V. N. Powell, memorandum to V. James, USFWS Div. of LE, Fairbanks, 24 January 1978). These contaminants probably caused, at least in part, the lower productivity that was observed there in 1974-76 (see Section 2.5.1.1), but the possibility that pipeline-related impacts were also involved cannot be eliminated. Furthermore, the two possible causes may together have produced more impact than either cause would have produced separately.

The burning of some substances (e.g., discarded styrofoam or polyurethane) can release compounds such as PCB's, which can then become incorporated into local food chains.

The spilling of a toxic material into a major waterbody during pipeline construction or operation could affect large numbers of prey species (e.g., waterfowl or shorebirds downstream) on which nesting pairs of peregrines may be largely or partially dependent.

2.5.2.4 Changes in Prey Availability

The size of peregrine falcon territories, the distance between adjacent pairs, and hence the number of nesting pairs in an area are all dependent on the abundance of available prey. If the numbers of prey decline, the territories of the falcons enlarge, and the area will have fewer nesting pairs, or no pairs if the prey base becomes too small (Ratcliffe 1962, 1969; Newton 1976; Nelson 1979). Ratcliffe described an inland peregrine population that declined by 20% and then remained stable. The decline was apparently due to very extractive agricultural practices that diminished the prey of the falcons. Although such a change could be the result of natural variation, there is evidence from Europe that peregrine populations that are unaffected by man usually remain quite stable with time and do not fluctuate by more than 15% (Newton 1976). Nelson (1977) studied a coastal peregrine population that declined by about 75% (the territories enlarged greatly) due to a drastic reduction in the seabird prey of the falcons.

Any factors that significantly decrease the numbers or the availability of peregrine prey could reduce the productivity of the falcons in the short term and could reduce the number of nesting pairs in the long term. Factors that could possibly cause such effects are loss of habitat, disturbance, and increased hunting pressure. Unless such changes are large, however, they may be indistinguishable from natural fluctuations in prey abundance and prey availability. The food habits of peregrines indicate that they are relatively well adapted to a wide variety of prey species. Consequently, they are protected to some degree from perturbations that could affect the numbers or availability of a particular prey species.

With the exception of large-scale habitat alterations (e.g., draining of large marshes, clearing or burning of large areas), it seems unlikely that the numbers and availability of a major portion of the prey base would be affected by development activities. Arctic Slope peregrines would probably be more prone than interior birds to impacts that affected prey availability because the number of prey species on the Arctic Slope is smaller and because these prey populations are more variable from year to year.

Habitat 'improvements' that are sometimes associated with developments could lead in some cases to increased prey availability.

2.5.3 Habitat Loss

Because peregrine falcons nest on cliffs and bluffs, their nest sites are unlikely to be physically lost to the pipeline right-of-way or to support facilities. The perch points that they use for hunting and for resting are also primarily on cliffs and bluffs. The one support facility that could cause the loss of a nest site would be the operation of a materials site that took material from the cliff or bluff. Because the number of cliffs and bluffs that are suitable for nesting is limited in any region, the loss of any nesting habitat could limit the number of pairs that could nest within the region.

Hunting areas of nesting birds could be lost or disrupted through construction of the pipeline, support facilities and materials sites or through any drainage problems that might arise from their construction, but unless such habitat losses were large, they are unlikely to have much impact on nesting peregrines (see Section 2.5.2.4).

In a few cases peregrines have accepted artificial nests that have been constructed specifically for them (Olendorff *et al.* 1980). This process might occasionally serve to compensate peregrines for the loss of a nest site.

2.6 PROTECTIVE MEASURES

There are essentially three methods of preventing pipeline activities from affecting wildlife populations or of reducing the magnitude of these effects. The location of the pipeline or support facilities can be altered to avoid sensitive wildlife areas, the timing of pipeline activities can be altered to avoid sensitive periods, and the methods of conducting operations can be altered to avoid activities that may affect sensitive wildlife species.

The information available on the impacts of developments on peregrine falcons is insufficient to provide assured protection through mitigative measures. In particular, there is no information available that will provide the precise distances that are required for spatial and procedural restrictions. Because of the lack of a basis that will guarantee the safety of protective measures, the authors who have recommended protective measures have often urged that a cautious approach be taken and that a safety margin be included in case of error.

A note of caution should be given concerning the formulation and publication of protective measures for peregrines and other raptors. Care should be taken to draw as little attention as possible to the birds (Haugh and Halperin 1976). Restrictions to protect peregrine nest sites can draw their existence to the attention of falconers who may take some birds illegally. Curious people will often investigate wildlife areas that have been posted to prevent their entry. Restrictions to protect peregrines may also prove to be inconvenient, and some individuals may act illegally to remove the inconvenience. In one case in the Northwest Territories, a materials site was temporarily closed to protect a nesting pair of peregrines; however, someone then shot the birds, and the materials site was thereafter allowed to operate again (Fyfe, pers. comm.). It is probably best if restrictions to protect peregrines are simply labelled as restrictions for 'sensitive wildlife'.

2.6.1 Spatial Restrictions

The distance from a peregrine falcon nest site at which operations will not disturb the birds is poorly documented. There are consequently a number of different distances from nest sites that have been proposed as radii within which various activities should not be permitted. Table 13 summarizes the various radii of avoidance that have been proposed in the north for various activities.

Some of the distances by which nest sites should be avoided have been proposed as year-round restrictions; other restrictions have been proposed with specific time periods during which activities would be prohibited within these avoidance radii. This difference is particularly important with respect to pipeline alignment. Construction could be conducted closer to a peregrine nest site than the recommended radius of avoidance if it were done during the non-sensitive period; however, when the pipeline was operational, there would then be a need for surveillance and possibly for emergency repairs during the sensitive period. Such a situation does not arise with year-round restrictions.

The most commonly recommended distances to avoid peregrine nest sites have been 2 mi and 1 mi. Some of the recommendations have called for a 2-mi buffer zone as the ideal distance to be implemented wherever possible, with the further stipulation that a 1-mi distance was the minimum distance of avoidance that could be allowed (e.g., Hayes and Mossop 1978). Generally, a 1-mi distance of avoidance is the minimum such distance that has been proposed for most activities in recent years. Recommended distances of avoidance have often been greater for support facilities that would involve permanent or frequent human use (e.g., compressor stations, access roads) and for sudden disturbing activities (e.g., blasting) than they have been for other pipeline construction activities.

TABLE 13. Recommended minimum distances for ground activities to protect peregrine falcon nest sites in northern areas.

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
15	-	general	Alaska	no land use practices and/or developments that could detrimentally or significantly alter or eliminate habitat or food sources in major feeding areas	recommendation	Alaska Peregrine Falcon Recovery Team (1979)
5	15 April-31 August	highway (Mackenzie Valley)	N.W.T.	no intensive, noisy or off right-of-way activities	recommendation	Fyfe and Prescott (1973)
5	-	gas pipeline (Alaska Highway)	Yukon	no blasting without special approval	recommendation	Alaska Highway Pipeline Panel (1978)
5	-	gas pipeline (Alaska Highway)	Yukon	controlled blasting techniques	recommendation	Windsor (1979)
2.5	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no pipeline or compressor stations	recommendation	Gunn *in* Berger (1975)
2.5	1 April-15 August	highway construction	Yukon B.C.	no construction activity	recommendation	Tull (1979)
2	1 March-15 September	highway (Mackenzie Valley)	N.W.T.	no construction	recommendation	Fyfe and Prescott (1973)
2	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	no ground activities	recommendation	Jacobson (1974)
2	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no roads or facilities without specific approval	recommendation	Jacobson (1974)
2[a]	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no access to area without permit[b]	proposed requirement	Berger (1977)
2	-	geological field camps	N.W.T.	should be beyond 2 mi from cliff face	government guideline	Goodman (1977)
2	-	gas pipeline (Alaska Highway)	Yukon	minimum distance pipeline to nest	recommendation	Mossop and Milligan (1977)

TABLE 13. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
2	-	gas pipeline (Alaska Highway)	Yukon	will maintain minimum distance where possible	commitment by proponent	National Energy Board (1977)
~ 2	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	no construction, etc. without specific approval	recommendation	Alaska Highway Pipeline Panel (1978)
2	-	highway construction	Yukon	no camps, roads, quarries	recommendation	Blood and Chutter (1978)
2	1 May-31 July	highway construction	Yukon	no blasting	recommendation	Blood and Chutter (1978)
~ 2	15 April-31 August	gas pipeline (Alaska Highway)	Yukon	no construction or related activities any activities within radius subject to site-specific limitations	draft requirement	Northern Pipeline Agency (1978)
2	1 May-31 July	gas pipeline (Dempster Lateral)	Yukon	secondary zone no construction activities wherever possible	recommendation	Hayes and Mossop (1978)
2	-	oil pipeline (Trans-Alaskan)	Alaska	buffer zone	government requirement	Oldendorff and Zeedyck (1978)
2	-	gas pipeline (Alaska Highway)	Yukon	will consult agency for blasting will monitor nests prior to and during construction	commitment by proponent	Foothills South Yukon (1979)
~ 2	-	oil pipeline (Alaska Highway)	Yukon	will maintain distance from nest sites wherever possible	commitment by proponent	Foothills Oil (1979)
2	1 May-5 July	gas pipeline (Alaska Highway)	Yukon	no construction wherever possible if construction must occur within 1-2 mi no activities during this period	recommendation	Windsor (1979)
~ 2	during breeding	general	Yukon	given this disturbance-free radius, raptors can be expected to breed successfully	suggestion	Mossop *et al.* (1978)
1.2	during breeding	general	Yukon	area which should remain unviolated	suggestion	Mossop *et al.* (1978)

TABLE 13. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1.2	15 April-31 August	gas pipeline (Alaska Highway)	Yukon	no construction	requirement	Northern Pipeline Agency (1979)
1[c]	1 May-15 August	gas pipeline (Arctic Gas)	Alaska	no blasting, heavy equipment or access roads	recommendation	Renewable Resources Consulting Services Ltd. (1973)
1	15 April-15 September	human activity	Alaska	no human activity	recommendation	Ritchie (1976)
1	-	geological field camps	N.W.T.	should be beyond 1 mi from backside of uplift areas	government guideline	Goodman (1977)
∿ 1	-	hiking trails	N.W.T.	no trails if visible from eyrie	recommendation	Windsor (1977)
1	1 May-31 July	gas pipeline (Dempster Lateral)	Yukon	no construction activities	recommendation	Hayes and Mossop (1978)
1	-	gas pipeline (Northwest Alaskan)	Alaska	safe distance for most activities	discussion	Kessel (1978)
1	-	oil and gas drilling	Alaska Colville R.	no drilling	government requirement	Olendorff and Zeedyck (1978)
1	15 April-31 August	human activities	Alaska	no human activities unless specifically authorized	recommendation	Alaska Peregrine Falcon Recovery Team (1979)
1	-	general (Sagwon Bluffs)	Alaska	no fire suppression	proposed regulation	Capodice (1979)
1	1 April-31 July	gas pipeline (Alaska Highway)	Yukon	will attempt to schedule construction outside period	commitment by proponent	Foothills South Yukon (1979)
1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	no human activities unless specifically authorized	recommendation	Roseneau (1979)[d]
1	15 April-30 August	gas pipeline (Alaska Highway)	Yukon	if construction must occur within 1 mi no activities during this period	recommendation	Windsor (1979)
0.5	-	general	general U.S.A.	no permanent human occupation or disruptive land use	recommendation	Cade (1974)
0.5	-	general	Alaska	should be declared critical habitat	recommendation	White and Cade (1975)

TABLE 13. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
0.5	-	general	Alaska	no permanent structures	recommendation	Haugh and Halperin (1976)
0.5	-	hiking trails	N.W.T.	no trails	recommendation	Windsor (1977)
0.2	-	gas pipeline (Arctic Gas)	Alaska	no human presence	recommendation	Renewable Resources Consulting Services Ltd. (1973)
-	-	recreation	Alaska	no recreational activity on any nesting cliff	recommendation	Haugh and Halperin (1976)

[a] Or of size required to protect nest site.

[b] Permit would require biological evidence that raptors would not be jeopardized.

[c] Tentative.

[d] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

2.6.2 Temporal Restrictions

The starting dates recommended for imposing restrictions near peregrine nest sites in Alaska, Yukon and the Northwest Territories have ranged from 1 March to 15 May; the dates recommended for terminating these restrictions have ranged from 31 July to 15 September (Tables 13 and 14). Some of these time restrictions, particularly those in March, are probably a result of blanket recommendations for all raptors (including the early-nesting gyrfalcon), rather than specific recommendations for peregrine falcons. The most sensitive times for nesting peregrine falcons are the early part of the nesting season (return to the nest site, courtship, egg-laying, incubation, and early nestling stage; Kessel 1978). A conservative concensus of the various temporal restrictions that have been proposed would provide for restrictions during the period 15 April-31 August.

2.6.3 Procedural Restrictions

In some cases where it may be necessary to conduct activities that contravene both spatial and temporal restrictions, restrictions have been recommended for the procedures of conducting these activities. The majority of such procedural restrictions have been with regard to aircraft flights past nest sites. Such flights would be needed during planning, construction and operation of the pipeline. Table 14 lists the various procedural restrictions that have been proposed for aircraft flights past peregrine nest sites.

The minimum altitude of an aircraft above a peregrine falcon nest site at which the nesting birds are not disturbed is poorly known. Consequently, there is considerable variability in the minimum altitudes that have been recommended in order to prevent disturbance. The most commonly recommended minimum altitudes for aircraft overflights over peregrine nest sites have been 2,000, 1,500 and 1,000 ft.

TABLE 14. Recommended minimum distances for aircraft activities to protect peregrine falcon nest sites in northern areas.

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
3300	-	-	gas pipeline (Alaska Highway)	Yukon	height above lowest suspected elevation within 2 mi	recommendation	Windsor (1979).
3000	2	nesting period	gas pipeline (Arctic Gas)	Yukon N.W.T.	maintain altitude near sites no landings or takeoffs	proposed requirement	Berger (1977)
2700	-	-	gas pipeline (Alaska Highway)	Yukon	height above nearest ground level	recommendation	Windsor (1979)
2500	2.5	15 May - 31 August	gas pipeline (Arctic Gas)	Yukon N.W.T.	only essential flights within radius	recommendation	LGL Ltd. (1975)
2000	-	1 March - 1 Sept.	gas pipeline (Arctic Gas)	Yukon N.W.T.	minimum altitude above ground level	recommendation	Jacobson (1974)
~ 2000	-	-	airport near nest sites	N.W.T.	reroute low flying aircraft other aircraft maintain altitude	recommendation	Windsor (1977)
2000	-	1 March- 31 August	gas pipeline (Alaska Highway)	Yukon	minimum altitude	recommendation	Alaska Highway Pipeline Panel (1978)
2000	1	1 May - 31 July	gas pipeline (Dempster Lateral)	Yukon	if cannot avoid 1 mi radius, maintain minimum altitude wherever and whenever safe	recommendation	Hayes and Mossop (1978)
1500	-	-	geological operations	N.W.T.	numerous guidelines (see Appendix 5.6)	government guidelines	Goodman (1977)
1500	-	1 April 30 August	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Kessel (1978)
1500	1	15 April - 1 Sept.	general	Alaska	minimum altitude	recommendation	Alaska Peregrine Falcon Recovery Team (1979)
1500	1	15 April - 15 August	general (Sagwon Bluffs)	Alaska	minimum altitude curtail use of nearby airport	proposed regulation	Capodice (1979)
1500	1	15 April - 1 Sept.	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Roseneau (1979)[b]
1500	1	-	gas pipeline (Alaska Highway)	Yukon	height above nest level for surveillance of line if numerous nests make routing complex, bypass nests by minimum of 0.6 mi	recommendation	Windsor (1979)

TABLE 14 (continued)

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1000	-	15 April - 15 Sept.	gas pipeline (Mackenzie Valley)	N.W.T.	minimum altitude	commitment by proponent	National Energy Board (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Kochert (1977)
1000	1	-	general (aeronautical chart)	Alaska	minimum altitude and distance[c]	government recommendation	Federal Aviation Administration (1978)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Zeedyck (1978)
-	1	15 May - 10 August	oil pipeline (Trans-Alaskan) (Sagavanirktok R.)	Alaska	no flights within 1 mi of nests	recommendation	White *et al.* (1977)
-	0.6	-	gas pipeline (Alaska Highway)	Yukon	no flights within 0.6 mi of nests	recommendation	Schmidt (1977)
-	-	-	gas pipeline (Arctic Gas)	Alaska	avoid use of aircraft in immediate vicinity of nests no helicopter landings near nests	recommendation	Renewable Resources Consulting Services Ltd. (1973)

[a] Metric altitudes have been converted and rounded to the nearest 100 ft.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

[c] Although the recommendation is that minimum altitude and distance both be maintained, it undoubtedly means that one or the other should be maintained.

Minimum altitudes have usually been expressed in terms of the altitude above ground level. For a nest site on a cliff, however, these recommendations have frequently not specified whether the altitude referred to is the height above the cliff top, the nest site, or the land at the base of the cliff. Presumably, in order to protect the birds at the nest site, the altitude should refer to the height above either the cliff top or the nest ledge.

Recommendations concerning minimum altitudes for pipeline aircraft are in practice often difficult to implement. The pipeline airstrip and many of the smaller pipeline aircraft are not equipped for IFR (instrument flight rules) flights. Because of the relatively short distances between camps (e.g. $\sim$ 50 mi) and the lack of IFR facilities, those aircraft that are equipped for IFR flights generally fly VFR (visual flight rules) at fairly low altitudes between these airfields. Furthermore, low cloud ceilings or fog are particularly frequent on the Arctic Slope of Alaska during the spring, summer and fall, and it is common to have acceptable VFR conditions beneath a low cloud base. Because of such conditions, restrictions concerning minimum flight altitudes over important wildlife areas have usually contained the phrase 'whenever possible'. Some recommendations (e.g., APFRT 1979) have suggested that a minimum distance of 1 mi from nest sites be maintained whenever the minimum altitude over the nest sites could not be maintained.

2.7 PROPOSED PROTECTIVE MEASURES FOR NWA PIPELINE

2.7.1 USFWS Recommended Protective Measures

2.7.1.1 General Restrictions

Table 15 lists the September 1980 USFWS peregrine falcon protection measures recommended for the Northwest Alaskan pipeline.

Restrictions 1, 2 and 3 concerning aircraft overflights and construction activities apply for the period from 15 April to 31 August. This timing restriction generally agrees with most of the timing restrictions that have been recommended for various developments in the north. In particular, it agrees with the recommendation of the Alaska Peregrine Falcon Recovery Team (AFPRT 1979), which carefully reviewed the nesting phenology of peregrines in interior and arctic Alaska before making its final recommendation. Peregrines rarely return to interior Alaska before mid-April (Section 2.3); some arrive on the Arctic Slope by late April. The final date of 31 August provides protection during the fledgling period for peregrines whose nesting may be delayed for reasons such as inclement weather (particularly on the Arctic Slope).

Restriction 1 prohibits aircraft flights during the sensitive period (15 April-31 August) below an altitude of 1500 ft above nest levels and within 1 mi of peregrine nest sites. In this case no provision is made for any exceptions to this rule. This restriction falls roughly in the middle of the various recommendations that have been proposed for aircraft overflights (Table 14). In particular, it is in agreement with the recommendations of the APFRT (1979), with the exception of a one day difference in the final date for which the restriction would apply, and the fact that the recovery team would permit exceptions to the rule if specifically authorized. We are in general agreement with restriction 1, but would also permit specifically authorized exceptions on a case-by-case basis,

TABLE 15. September 1980 USFWS recommended restrictions for protection of peregrine falcons.*

A. Restrictions

1. Aircraft maintain 1500 feet altitude (above nest level) within 1 mile horizontal distance of nest sites (eyries) from April 15 through August 31.

2. Use of explosives and other activities or facilities, having noise levels sufficiently high to disturb nesting efforts, is prohibited within 2 miles of nest sites from April 15 through August 31, unless specifically authorized.

3. All ground level activity is prohibited within 1 mile of nest sites from April 15 through August 31 (except on the Haul Road - Prudhoe to Livengood), unless specifically authorized.

4. Additional permanent facilities and long term habitat alterations (such as material sites, roads, and airstrips) are prohibited within 1 mile of nest sites, unless specifically authorized.

B. Application of Restrictions to Nest Sites *Likely* to be Occupied.

Our analysis of nesting records for peregrine falcons in the vicinity of the proposed project indicates that the following nest sites have a reasonable probability of occupancy in the near future. Therefore, all of the above restrictions should apply to these nest sites and to others where peregrine falcons are subsequently found to be present. Should any of these nest sites not be occupied by June 1, they may, with U.S. Fish and Wildlife Service concurrence, be considered inactive and subject only to restriction (4) for the remainder of that nesting season.

Northwest Eyrie No's.

P-21	P-95a
P-29b	P-194
P-34b	P-205
P-42a	P-211
P-47a	P-216
P-50	P-220
P-86	P-223

C. Application of Restrictions to Nest Sites *Not Likely* to be Occupied.

The following nest sites have a low probability of occupancy in the

TABLE 15 (continued)

immediate future but will be essential in providing nesting habitat as peregrine falcon populations recover. Consequently, until these sites are again used by peregrine falcons, only Restriction (4) should apply.

<u>Northwest Eyrie No's.</u>

P-16a	P-60d
P-19	P-61
P-25	P-79
P-38a	P-183a
P-48a	

* D. Money, USFWS, pers. comm., September 1980.

Restriction 2 concerns the use of explosives and other activities or facilities that have noise levels that are sufficiently high to disturb peregrine nesting efforts. The restriction prohibits such activities within 2 mi of nest sites during the sensitive period (15 April-31 August). Provision is made for exceptions to this rule if specific authorization is granted. This restriction is in agreement with many of the recommendations that have been proposed (Table 13), but it is more conservative than many other recommendations, including those of the APFRT (1979). It seems in keeping with some recommendations concerning activities near nest locations that call for an outer buffer zone in which activities can be authorized after review and an inner 1 mi prohibited zone (Hayes and Mossop 1978; Banasch, pers. comm.). Because this restriction is directed at those particularly noisy activities that would disturb nesting peregrines, we are in general agreement with it, but believe it should be clarified. The restriction does not adequately list the activities that would be prohibited under this restriction (which was partially done in the Oct. 1979 USFWS recommended restrictions). In particular, it is not clear whether compressor stations would be allowed within 2 mi of nest sites. Presumably, discussion with USFWS will be required to determine which specific activities are prohibited in the zone between 1 mi and 2 mi from peregrine nest sites.

Restriction 3 prohibits all ground level activity within 1 mi of nest sites during the sensitive period (15 April-31 August). Provision is again made for exceptions to this rule if specific authorization is granted. Again this restriction is more liberal than many of the recommendations that have been proposed (Table 13), but is in keeping with many recommendations, including those of the APFRT (1979). One exception to this restriction is specifically granted; ground activities are permitted within 1 mi of nest sites on the Haul Road between Livengood and Prudhoe. As we interpret this restriction, it permits only hauling of goods (or any other activity) *on* the Haul Road, as opposed to any activities *beside* the Haul Road.

Restriction 4 prohibits permanent facilities and long-term habitat alterations such as materials sites, roads and airstrips within 1 mi of nest sites. (The meaning of the word 'additional' in the restriction is not clear.) Provision is again made for exceptions to this rule if specific authorization is granted. The prohibition of such activities is year-round, rather than just for the sensitive period. Although this restriction is more liberal than a number of the various spatial recommendations that have been proposed (Table 13), it is in keeping with many of these recommendations. It is more restrictive than the recommendations of the APFRT (1979), which can be interpreted as permitting permanent facilities or long-term habitat alterations, provided that there is no human activity at these areas during the sensitive period (15 April-31 August) unless specifically authorized. We feel that Restriction 4 is justifiable and that it should generally provide adequate protection to peregrine nest sites.

Restriction 4 may be interpreted as prohibiting the pipeline right-of-way from passing within 1 mi of peregrine nest sites. This interpretation is arrived at by considering the pipeline *per se* as a permanent facility. In pipeline parlance, however, the pipeline is often referred to separately from the support facilities, which are needed for construction and operation of the pipeline; this parlance might permit an interpretation of restriction 4 whereby the pipeline right-of-way was permitted within 1 mi of nest sites because it was not considered a 'facility'. NWA should discuss with USFWS whether the pipeline right-of-way is prohibited from passing within 1 mi of nest sites. In our discussion we have assumed that restriction 4 includes the pipeline right-of-way.

If the right-of-way is built within 1 mi of peregrine nest sites, either through the second interpretation or through specific authorization, we foresee two potential problems. Restriction 1 would limit surveillance aircraft to a minimum altitude of 1500 ft above nest sites within 1 mi of the sites (unless exemption by specific authorization is added to restriction 1). NWA would have to determine whether they can in fact monitor the line from such an altitude near nest sites. In particular, under conditions of low ceiling (quite common on the Arctic Slope), they would have to remain 1 mi from nest sites, which would probably preclude their monitoring that portion of the line from the air. Restriction 3 would preclude any maintenance activities, including emergency repairs, within 1 mi of peregrine nest sites during the sensitive period, unless specific authorization to do so were granted.

The Sep. 1980 regulations provide two lists of nest sites. The lists are of sites considered 'likely' to be occupied and of sites considered 'not likely' to be occupied. For nest sites that are 'likely' to be occupied, and for any new sites at which peregines are found (including finding them at any sites considered 'not likely' to be occupied), all four of the restrictions would apply. Sites that are considered 'not likely' to be occupied are still considered to be essential nest sites in order to protect them from permanent encroachment; this would permit the site to be used in future years as peregrine populations recover. Any such sites that are occupied would be transferred to the 'likely' to be occupied category, and would be subject to all of the four restrictions. We concur with this division of nest sites into the two categories, because it permits much less stringent restrictions at those peregrine nest locations that have a low probability of occupancy at this time, but still provides long-term protection for these sites. Our specific comments as to which sites are in which list are presented in Section 2.7.1.2.

The Sep. 1980 regulations provide a relaxation of restrictions 1, 2 and 3 after 1 June for nest sites that are not occupied during that year. The term 'occupied' is not defined. We have interpreted the term to apply to any nest sites for which either a pair of peregrine falcons or a single bird demonstrates an affinity at any time during the nesting season (15 April-31 August). Implementation of this provision to relax restrictions 1, 2 and 3 will require that a thorough program to monitor the nest sites be conducted during construction years in order to determine which sites are active. The date of 1 June appears to be a safe date; it seems highly unlikely that peregrines would first occupy a nest cliff after this date. Restriction 4, which applies to permanent facilities, would not be affected by this relaxation provision. It is the only restriction that could not be reimplemented if an unoccupied nest were to be occupied at some future date.

Our definition of 'occupied' nest is derived from the definition in the Oct. 1979 USFWS recommended restrictions (Table 16). The definition includes considering a nest site to be occupied if it is occupied by a single bird. Although a single individual does not represent a breeding unit that can produce young, single individuals that occupy cliffs attempt to nest; they make scrapes, perform courtship flights and in the case of females, occasionally lay one or two infertile eggs. Some observations suggest that subadult birds may establish themselves at an available cliff for one or more breeding seasons prior to acquiring a mate and breeding. Similarly, the reoccupation of former nest cliffs during a population recovery may include single adults that occupy a location for one or more years before they successfully attract a mate. Occupancy of cliffs by single birds may thus play an important role in the recruitment process in a given area.

The Sep. 1980 USFWS recommended restrictions should be considered in conjunction with the Oct. 1979 USFWS recommended restrictions (Table 16). Both sets of restrictions are intended to apply to the NWA pipeline (D. Benfield, USFWS, pers. comm.). Sep. 1980 restrictions 1, 2 and 3 are essentially modified from Oct. 1979 restriction I. Restriction 4 of Sep. 1980 is new. The more recent set of restrictions (Sep. 1980) deal only with

TABLE 16. October 1979 USFWS recommended terms and conditions for protection of the endangered peregrine falcon in Alaska.*

I. Recommended Protection Standards for Nesting Activities:
The following standards apply to all active peregrine falcon nesting sites during the nesting season (April 15 - August 31). All known nesting sites shall be considered active (whether or not birds are present) between April 15 and June 1. Nesting sites not having a peregrine falcon present by June 1 will be considered inactive and, therefore, not subject to these restrictions.

A. Within one (1) mile lateral distance of peregrine falcon nesting sites the following are prohibited unless specifically authorized:

1. Aircraft flying lower than 1500 feet above nest level.
2. All other human activities.

B. Within two (2) miles of peregrine falcon nesting sites the following are prohibited unless specifically authorized:

1. Major construction or other noise producing activities such as mining, blasting, and operation of aggregate grinders.

II. Recommended Protection Standards for Hunting Habitat:
The following standards apply to all peregrine falcon nesting sites (active and historic) and at all times.

A. Within fifteen (15) miles of nesting sites the following are prohibited unless specifically authorized:

1. Ground surface disturbance on a large scale which could detrimentally and significantly alter peregrine falcon prey habitat.

2. The use of pesticides or other environmental pollutants which could be detrimental to the peregrine falcon or its food source.

III. It is understood that the above standards may not be appropriate in all situations and that a qualified biologist should review specific cases and determine appropriate protective measures. It is further understood that protection standards for hunting, as listed above, do not preclude all development within a fifteen (15) mile radius of a nesting site; rather, they are intended to preclude major changes such as draining of marshes, or other extensive habitat alteration.

TABLE 16. (continued)

IV.* Peregrine falcon surveys, studies and all variances to the above standards require prior approval of the Alaska Area Director, U.S. Fish and Wildlife Service or his designated representative.

V. Definition:

A. Nesting Site - Any cliff, bluff, tree or other structure which could reasonably be used as an eyrie by peregrine falcons and for which a pair or single bird demonstrates, or has in the past demonstrated, an affinity.

B. Active Nesting Site - All known peregrine falcon nesting sites during the period April 15 - June 1 and those nesting sites for which a pair or single bird demonstrates an affinity at any time during the current nesting season (April 15 - August 31).

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* As given in letter from M. J. Sotak, FERC to Northwest Alaskan Pipeline Co., 26 October 1979.

peregrine falcon nest sites. The Oct. 1979 restrictions that deal with hunting habitat (II), the need for consultation (III), and the need for USFWS approval (IV) were not included in the Sep. 1980 set, although they are intended to apply. To avoid further confusion, there is a need to consolidate the two sets of restrictions into an integrated document.

Restriction II of the Oct. 1979 recommendations prohibits large-scale surface disturbances that could detrimentally and significantly alter peregrine prey habitat within 15 mi of nest sites, and also prohibits the use within 15 mi of nest sites of pesticides and other pollutants that could harm peregrines or their prey. Provision is made for exceptions to this rule if specific authorization is granted. Because the restriction is concerned with long-term habitat changes, there is no provision for relaxation of the restriction after 1 June if a 'likely' nest location is not occupied. This restriction is essentially in agreement with the recommendation of the APFRT (1979), who have made the only other recommendation concerning protection of hunting habitat that we are aware of. As mentioned in Restriction III, this restriction does not preclude development within 15 mi of nest sites, but only *major* changes, such as draining or filling in of wetlands or marshes, or other extensive habitat alterations. In our opinion, the pipeline right-of-way and associated activities and facilities should not be considered as major changes in that sense, unless in some case the pipeline activities should have a major effect on an important drainage system. Our interpretation is in general agreement with the APFRT (1979), who considered that linear disturbances such as roads probably do not cause sufficient damage to be of consequence to hunting habitat. Restriction II does not specify the pesticides and other pollutants that are prohibited within 15 mi of nest sites; presumably the individual substances can be specified when NWA's plans concerning the use of pesticides or other environmental pollutants are complete.

Restriction III of the Oct. 1979 recommendations requires that a qualified biologist should review plans, activities, etc., near nest sites to ensure that the restrictions or any modifications thereto are appropriate for protecting the birds. Because of the wide range of possible biological experience that such a person could have, we would recommend that the biologist assigned to this task be one who, among his qualifications, has had some experience with raptors. Such experience would permit him to make necessary decisions efficiently without having to frequently refer to biologists experienced with raptors for advice or assistance.

Restriction IV of the Oct. 1979 recommendations specifies that all surveys and any exceptions to the restrictions must first be approved by USFWS.

One of the most important roles that protective measures can fill is to ensure that peregrine nest cliffs are protected. Although such protection is not explicitly stated in the USFWS recommended restrictions, it is, in our interpretation, provided by restriction 4, which prohibits long-term habitat alterations within 1 mi of nest sites. It would probably be preferable if the protection of nest cliffs (including alternate sites) were explicitly stated in restriction 4. There is not, however, any protection for potential (as opposed to documented) nest cliffs in drainages frequented by nesting peregrines. We recommend that the physical integrity of such potential nest cliffs should be ensured.

In summary, we are in agreement with the recommended USFWS restrictions (1) under the interpretations that we have made, (2) provided that restrictions II, III and IV from the Oct. 1979 recommended restrictions are included with the Sep. 1980 recommended restrictions, (3) with the modification that we have suggested to Sep. 1980 restriction 1, and (4) with the addition of a restriction to protect the physical integrity of potential nest cliffs in drainages frequented by peregrines. While we are in agreement with these restrictions, we recognize that there are exceptions that may be made at specific nest sites because of particular circumstances.

The potential site-by-site conflicts and our recommendations concerning these conflicts are addressed in Section 2.8.

2.7.1.2 Specific Sites

The Sep. 1980 USFWS recommended restrictions list a number of locations that are considered 'likely' to be occupied and a number of locations that are 'not likely' to be occupied. The two lists are based on the USFWS analysis of nesting records in the vicinity of the proposed pipeline. Locations 'likely' to be occupied are those with a reasonable probability of occupancy in the near future. Locations 'not likely' to be occupied are those that have a low probability of occupancy in the immediate future, but would be valuable for a future recovery of the peregrine population.

Our analysis of peregrine nest location histories (Section 2.1) in the vicinity of the pipeline corridor would suggest that some changes and a number of additions should be made to the two lists. There appear to be three typographical errors in the USFWS lists; Location P-21 would be more correctly referred to as P-21a, Location P-19 as P-19a, and Location P-60d as P-60a. Furthermore, there is a typographical error in Roseneau and Bente (1979) that affects the lists. In the text of that report, Location P-34a was listed correctly as a historical peregrine location, but on the USGS topographic maps accompanying the report the location was shown as 'P-34b'. To maintain consistency with the text, the map should be corrected to show the peregrine location as P-34a, and the raven nest at the same location should be designated as 34b (as it is in the text). As a consequence it would be preferable for the USFWS to list this location as P-34a, not as P-34b.

We are aware of 53 documented or reported peregrine falcon nesting locations within 15 mi of the pipeline corridor (as per the NWA Environmental Master Guide alignment sheets dated April 1980). Of these, 32 are within 2 mi of some facility or activity; 2 mi includes the distances within which restrictions 1-4 apply, and is thus the only distance within which the categories of 'likely' and 'not likely' need be distinguished. Eighteen of our 32 locations are listed on the two USFWS lists. Their other 5 locations are 2-15 mi from pipeline activities or facilities.

The designation of what constitutes a peregrine falcon nest site, and hence which sites have been included in the two USFWS lists, is a matter that is subject to several interpretations (in part because the documentation of some historical sites is weak). The criteria that the USFWS has used to select their locations and to assign them to the two lists are not clear from their definitions. We feel that the other 14 locations within 2 mi of the corridor should be reconsidered for possible inclusion in their two lists. Some of these locations are currently active or are, in our opinion, likely to be occupied in the near future.

In Section 2.8, in which we consider potential conflicts on a location-by-location basis, we have done so for all of the 53 locations that we are aware of within 15 mi of the corridor.

2.7.2 Other Recommended Restrictions

The Office of the Pipeline Coordinator, State of Alaska, has prepared a preliminary list of sensitive wildlife areas along the proposed NWA pipeline (C. E. Behlke, State Pipeline Coordinator, letter to E. A. Kuhn, NWA, 15 July 1980). Included with the list is a series of protection measures for sensitive wildlife species, including the peregrine falcon. The protection measures for raptors are listed in Table 49.

The state protection measures for peregrines are generally similar to the USFWS recommended restrictions. In several respects, however, the state measures are more restrictive than the USFWS measures. The state measures would prohibit major ground activity within 2 mi of nest locations during 15 April-31 August, whereas in the range 1-2 mi from nest location, the USFWS measures would prohibit only blasting and other activities making sufficient noise to disturb peregrines. The state measures would prohibit permanent facility sites within 2 mi of nest locations, whereas in the range 1-2 mi from nest locations, the USFWS measures would prohibit only those permanent facilities that make sufficient noise to disturb peregrines. The state measures would apply to all peregrine nest locations during the period 15 April-1 June, after which time they would apply only to occupied locations, whereas the corresponding USFWS measures would apply only to nest locations considered 'likely' to be occupied. Unlike the USFWS restrictions, there is no provision for any specifically-authorized exemption to the state measures at a given nest location.

In recent years state authorities have normally followed USFWS guidelines in dealing with endangered species. It is our understanding that the state authorities were required to prepare their guidelines before they had full input from the USFWS and that the state authorities are likely to modify their protection measures to follow the USFWS recommended restrictions (C. Yanagawa, State Pipeline Coordinator's Office, pers. comm.). For these reasons, we have evaluated potential conflicts between nest locations and the pipeline alignment on the basis of the USFWS recommended restrictions. If the stricter state measures remain in force, then the nest location conflicts should be reevaluated.

Protection for the physical integrity of actual (and possibly potential) nesting cliffs of peregrine falcons could be provided by two pieces of legislation; one is a portion of the U.S. Endangered Species Act (1973), and the other is a statute of the State of Alaska. Article

402.04 (Consultation) of Section 7 of the U.S. Endangered Species Act (1973) states that 'it is the responsibility of each federal agency to review its activities or programs and to identify any such activity or program that may affect listed species or their habitat'. Consultation would then have to occur in order to ensure that the species and/or habitat would be protected. Section 16.20.185 of Alaska Statutes Title 16 (p. 98) states that 'on land under their respective jurisdictions, the Commissioner of Fish and Game and the Commissioner of Natural Resources shall take measures to preserve natural habitat of species or subspecies of fish and wildlife that are recognized as threatened with extinction'. Because nesting cliffs are the most important habitat to preserve for present or future nesting peregrines, we recommend that these two pieces of legislation be used to protect the physical integrity of actual and alternate nesting cliffs (both active and historical) of peregrine falcons, and that, if possible, these statutes should also be used to protect the physical integrity of potential nesting cliffs in drainages frequented by peregrines.

[Sections 2.7 and 2.8, in which we discuss the USFWS recommended restrictions and the potential conflicts that these restrictions would generate between peregrine nest locations and the current NWA pipeline alignment, were completed as a draft version of a portion of this report on 6 October 1980 at the special request of Fluor Northwest, Inc. On 17 November 1980, the Office of the Federal Inspector, Alaska Natural Gas Transportation System, Anchorage, completed a report entitled 'Biological Assessment of the Endangered Peregrine Falcon'. This report contains a series of proposed protection measures for peregrine falcons. These measures would modify some of the USFWS recommended restrictions and would add some additional restrictions. The report also differs from both the USFWS recommended restrictions and our designations as to whether some peregrine nest locations are 'likely' or 'not likely' to be occupied. Because our sections were completed prior to the publication of this report, the proposed protection measures of OFI and the potential conflicts under these protection measures are not discussed in this report. There is a need, however, to evaluate these proposed protection measures and the potential conflicts that would arise under them.]

2.8 POTENTIAL PIPELINE CONFLICTS WITH NEST LOCATIONS

This section discusses, on a site-by-site basis, nesting locations that are found in the vicinity of the proposed Northwest Alaskan pipeline alignment (NWA Environmental Master Guide alignment sheets, April 1980). Potential conflicts between NWA plans and the USFWS restrictions (as we have interpreted them in Section 2.7) are discussed, and we have made a number of site-specific recommendations concerning these conflicts.

Because of the sensitive nature of this material we have placed it in Volume II of this report. We have recommended that Volume II be considered as confidential and be made available only on a need-to-know basis.

2.9 RECOMMENDATIONS

The following recommendations, which have, for the most part, been developed in Sections 2.7 and 2.8, are summarized here as a protection strategy for peregrine falcons along the proposed NWA gas pipeline.

2.9.1 Recommendations re Restrictions

We are in general agreement with restrictions 1, 2, 3 and 4 of the Sep. 1980 USFWS recommended restrictions and restrictions II, III, IV and V of the Oct. 1979 USFWS recommended restrictions. Accordingly, we recommend that these restrictions be adopted provided that the following changes are made.

1. The two sets of restrictions should be combined into a single set of restrictions.

2. Restriction 1 should be modified to permit specifically-authorized exemptions.

3. Restriction 2 should be modified to list the activities and facilities that are included. In particular, compressor stations should be included.

4. Restriction 4 should be modified to explicitly include the pipeline *per se* as a permanent facility and to explicitly include any alteration of nest cliffs under long-term habitat alterations.

5. The term 'occupied' nest location should be defined consistent with our interpretation of the term (i.e., it should include occupancy of a nest location by a lone bird).

6. The provision to relax the restrictions after 1 June for unoccupied nest locations should include the requirement of monitoring these locations prior to 1 June to determine if the locations are occupied.

7. The nest locations to be protected should be those listed in Table 38 and protection should be provided according to the listed likelihood of occupancy.

8. Restriction II should be modified to list the pesticides and other pollutants that are prohibited and this particular portion of the restriction (pesticides and pollutants) should be applied to the entire pipeline. In particular, the burning of substances that can produce PCB's should be prohibited, as should the use of any electrical transformers that may contain them.

9. Restriction III should be modified to ensure that the responsible biologist be someone who, among his qualifications, has had some experience with raptors.

2.9.2 Recommendations re Potential Conflicts

This section is contained in Volume II of this report because of the sensitive nature of the nest site information.

2.9.3 Other Recommendations

1. The U.S. Endangered Species Act of 1973 (Section 7, Article 402.04) and Alaska Statute 16.20.185 (Alaska Statutes Title 16) should be used to protect the physical integrity of actual and alternate peregrine nesting cliffs (both active and historical), and should, if possible, be used to protect the physical integrity of potential nesting cliffs in drainages frequented by peregrines.

TABLE 38. Recommended status of peregrine falcon nest locations.

Nest locations within 2 mi

'Likely' to be occupied

P-21a	P-196[1]	P-212[2]	P-221[2]
P-86	P-201[1]	P-215a[2]	P-222[2]
P-95a	P-205[1]	P-216[2]	P-223[2]
P-97	P-206[1]	P-218.1[2]	P-224[2]
P-194[1]	P-211	P-220[2]	P-225[2]

'Not likely' to be occupied

P-19a	P-41a	P-48a	P-63.1
P-25	P-42a	P-61	P-79
P-38a	P-47a	P-63	P-183a

Nest locations between 2 and 51 mi (need not be classified as 'likely' or 'not likely')

P-16a	P-50	P-69a	P-80
P-29b	P-52	P-70	P-84
P-34a	P-55	P-73b	P-88.1
P-35a	P-60a	P-74a	P-92.1
P-'C'	P-68a	P-'K'	P-97.1
			P-97.2

1 Sagwon Bluffs

2 Franklin Bluffs

2. If the above legislation cannot be used to provide protection for the physical integrity of potential nesting cliffs, then some other provision should be made to protect the physical integrity of potential nest cliffs in drainages frequented by peregrines.

3. During construction and operation of the pipeline the restrictions concerning peregrine falcons should be subject to a program of rigorous scientific evaluation to determine how successful they have been in reducing the actual impacts of the pipeline on nesting peregrines. Such information would be invaluable in future years for any modifications to the NWA pipeline and for the design of protective measures for other development projects.

3. OTHER RAPTORS

In addition to the peregrine falcon, five Alaskan raptor species (gyrfalcon, rough-legged hawk, golden eagle, bald eagle and osprey) nest at locations that are comparatively traditional and that can be comparatively readily detected. The nest locations of some of these species (especially the rough-legged hawk) are also important because they may be used in later years by peregrine falcons or gyrfalcons. The nesting habits of these five raptors make it practical to develop protection strategies for them.

None of these five raptor species is considered to be endangered in Alaska under the Endangered Species Act of 1973. All raptors are, however, protected by federal and state law, and bald and golden eagles are further protected under the Bald Eagle Act of 1940 (as subsequently amended).

3.1 DISTRIBUTION AND POPULATION SIZE

3.1.1 Gyrfalcon

3.1.1.1 Throughout Alaska

The gyrfalcon is a circumpolar arctic and subarctic species. Many individuals winter in the breeding areas, but some migrate further south in winter (Platt 1976). Gyrfalcons are distributed throughout most of the tundra and alpine regions of Alaska (e.g., Cade 1960; Roseneau 1972). Small numbers of nesting gyrfalcons are found throughout parts of the St. Elias Range, the Wrangell Mountains, the Talkeetna Mountains, the Chugach Mountains, parts of the Alaska Peninsula (including the Aleutian Range), possibly parts of the Aleutian Islands, the Alaska Range, the Tanana Hills, the White Mountains, the Ray Mountains, and the northern Kuskokwim Mountains. The largest concentrations are found in western and northern Alaska, including the Ahklun Mountains - Kilbuck Mountains region, the Nulato Hills, the Seward Peninsula, the Brooks Range (including the De Long and Baird Mountains), and the foothills province of the Arctic Slope from the Lisburne Peninsula to the U.S.-Canada border (especially west of the Sagavanirktok River drainage).

Cade (1960) estimated the total Alaskan population of gyrfalcons to be ∿ 200-300 pairs (including breeders and non-breeders). This number may be an underestimate (Roseneau 1972); however, it is doubtful whether the population exceeds ∿ 500 pairs. As much as ∿ 70% of the total population may occur in northwestern Alaska (including the Seward Peninsula), the Brooks Range, and the foothills province of the Arctic Slope.

3.1.1.2 Adjacent to Proposed NWA Gas Pipeline ROW

The distribution and numbers of gyrfalcons in the vicinity of the proposed NWA gas pipeline corridor have been reported by White *et al.*

(1977) and Roseneau and Bente (1979). All known nest locations are north of the Yukon River; no nests occur between the Yukon River and the U.S.-Canada border in the general vicinity of the alignment. Five nest locations that have or may have been used by gyrfalcons have been reported within ~ 2-3 mi of the corridor between the Yukon River and the crest of the Brooks Range and 11 locations (five of which were active in 1979) have been reported from the continental divide to the northern terminus of Sagwon Bluffs (including one by G. Elliott, USFWS, in 1980). To our knowledge gyrfalcons have never been documented to nest on Franklin Bluffs.

In general, the numbers of gyrfalcons nesting within the Sagavanirktok drainage and in much of the region between the Anaktuvuk River and the Canning River are small relative to the Arctic Slope populations. Within that region, gyrfalcons are somewhat more common east of the Sagavanirktok River. (Greater concentrations are found east of the Canning River and west of the Anaktuvuk River.) Similarly, on the south side of the Brooks Range, gyrfalcons are more common in the eastern and western Brooks Range than they are in the central section of the south flanks of the Brooks Range.

3.1.2 Rough-legged Hawk

3.1.2.1 Throughout Alaska

The rough-legged hawk is a migratory circumpolar species that breeds in arctic and subarctic habitats. In Alaska, it nests throughout much of the Aleutian Islands, portions of the Alaska Peninsula, western Alaska, northwestern Alaska, and northern Alaska north of the crest of the central and eastern Brooks Range (cf. Gabrielson and Lincoln 1959). Although the rough-legged hawk is primarily associated with tundra and alpine habitats, it does penetrate the forested valleys of western

Alaska for a limited distance inland from the coast. It is found along the lower Kuskokwim River (Ritchie and Ambrose, unpubl. data; Weir, unpubl. data), and along the Yukon River as far upstream as the mouth of the Koyukuk River (Roseneau *et al.* 1980).

The rough-legged hawk has been incorrectly described as 'the most common hawk of the interior of Alaska' (Gabrielson and Lincoln 1959). Although rough-legged hawks are common in interior Alaska during migration, particularly in spring, we know of no documented nests south of the Brooks Range and east of 156° W.

No estimates are available of the population of rough-legged hawks in Alaska. Rough-legged hawks are common throughout much of their range in the state. Over 80 active nests were found in one year on the Seward Peninsula (Roseneau and Walker, unpubl. data). Rough-legged hawks are also very abundant along the Colville River in most years (cf. White and Cade 1971, 1975; Springer *et al.* 1979b), and throughout the remainder of the Colville region (cf. Ritchie 1978). The numbers of rough-legged hawks in an area may fluctuate considerably from year to year.

3.1.2.2 Adjacent to Proposed NWA Gas Pipeline ROW

The distribution and numbers of rough-legged hawks in the vicinity of the proposed NWA pipeline have been reported by White *et al.* (1977) and Roseneau and Bente (1979). All known nest locations in the vicinity of the alignment are north of the crest of the Brooks Range between the Slope Mountain area and the Sagavanirktok River delta. Twenty-four nesting locations were located and at least 18 of these were active in 1979.

3.1.3 Golden Eagle

3.1.3.1 Throughout Alaska

The golden eagle is a migratory species that is widely distributed throughout the mountainous and tundra regions of Alaska (e.g., Gabrielson and Lincoln 1959). Territories are generally large (Brown and Amadon 1968), and although they are common in many regions (e.g., the Alaska Range, the Aleutian Range, the Seward Peninsula, the Brooks Range), golden eagles are not as abundant as either gyrfalcons or rough-legged hawks.

The rolling uplands of the Seward Peninsula (west of ~ 162° W) usually supported at least 15-20 active nests and about the same number of inactive nests during 1968-72 (Roseneau, Walker and Springer, unpubl. data). The highest densities are probably reached in the Brooks Range (cf. White *et al.* 1977; Roseneau and Bente 1979). Golden eagles also nest north of the Brooks Range in the foothills zone of the Arctic Slope (cf. White and Cade 1975); however, they appear to be uncommon north of the Brooks Range between the Chandler River and the Canning River. Most of the nests north of the Brooks Range occur east of the Canning River, where the species reaches its northernmost limit in Alaska, and west of the Chandler River in the uplands associated with the Colville, Utukok and Kukpowruk river drainages (Roseneau 1974; Ritchie 1978).

The Arctic Slope is also important to a summer concentration of subadult golden eagles -- a phenomenon that is probably related to the calving of the Porcupine, Central Arctic and Western Arctic caribou herds on the Arctic Slope (Roseneau and Curatolo 1976; Ritchie 1978).

No estimate is available of the population size of golden eagles in Alaska. North of the Arctic Circle, the population may be of the order of 100-200 pairs.

3.1.3.2 Adjacent to Proposed NWA Gas Pipeline ROW

The distribution and numbers of golden eagles in the vicinity of the proposed NWA gas pipeline corridor have been reported by White *et al.* (1977) and Roseneau and Bente (1979). Nests occur in the general vicinity of all segments of the alignment with the exception of the section on the Arctic Slope between Prudhoe Bay and the Slope Mountain area. More than 80 nest locations have been reported. At least 13 nests are known in the Tanana Drainage (including one located at Tower Bluffs in 1980). Two nest locations occur between Fairbanks and the Yukon River. At least 35 nests have been located between the Yukon River and the crest of the Brooks Range; and several more probably exist in this section. At least seven more nests occur from the crest of the Brooks Range north to the vicinity of Slope Mountain. The greatest number of nests (and of active nests) occurs in the southern Brooks Range (White *et al.* 1977; Roseneau and Bente 1979).

3.1.4 Bald Eagle

3.1.4.1 Throughout Alaska

The bald eagle is a North American species that has declined in numbers over much of its range in the lower 48 states of the United States. The northern subspecies of bald eagle (the subspecies that breeds in Alaska) is not considered to be endangered, however, and bald eagles are abundant and widely distributed throughout most of Alaska (Gabrielson and Lincoln 1959; Brown and Amadon 1968). Large numbers nest and winter in coastal areas of southeastern Alaska, along the coast of the Gulf of Alaska and Bristol Bay, and in the Aleutian Islands.

Bald eagles also nest and sometimes winter in smaller numbers in interior Alaska, where they are most often associated with rivers and wetland areas of lakes, streams and ponds (e.g., the Yukon and Kuskokwim river drainages). The northern limits of their Alaskan nesting distribution occur in northwestern Alaska along portions of the Noatak River and in central and northeastern Alaska in the river valleys on the south side of the Brooks Range. A few nests in the East Fork Chandalar, Sheenjek and Coleen rivers are among the known nests that are farthest north (RRCS 1973). No nests have been reported from the Arctic Slope of Alaska, and only occasional individuals have been seen there (D. D. Gibson, pers. comm.).

In eastern interior Alaska most nesting bald eagles occur in two important areas -- the Tanana River drainage, where some wintering also occurs (Ritchie, pers. comm.) and the Yukon Flats upstream from Stevens Village. Surveys for nesting bald eagles have not, to our knowledge, been conducted in the Yukon Flats. Casual observations suggest, however, that this area may not be as important to nesting bald eagles as is the Tanana drainage.

The population of bald eagles in Alaska is large. Lincer *et al.* (1979) estimated that ∿ 7500 pairs occur in the state. The estimated breeding population of southeastern Alaska alone is ∿ 4000 (King *et al.* 1972). Isleib and Kessel (1973) reported ∿ 1800-2000 pairs in the north gulf coast - Prince William Sound region. Comparable data are generally not available for other coastal regions of Alaska. White *et al.* (1977) reported the presence of about 70 nests, of which ∿ 70% had young, on only one of the Aleutian Islands (Amchitka). His observations and various other data suggest that a large population exists throughout the western Gulf of Alaska, Bristol Bay and the Aleutian Islands.

In interior Alaska the number of breeding pairs is undoubtedly much smaller. Various observations suggest that concentrations of a similar magnitude to that found in the Tanana drainage (i.e., between 20 and 100 pairs) occur in only a few other areas (in particular the Kuskokwim, Susitna, and Copper river drainages). Thus, although the bald eagles that nest in the Tanana drainage constitute only a relatively small proportion of the total state-wide population, they do constitute an important segment of that portion of the Alaskan population that nests inland from the southern coastal regions.

3.1.4.2 Adjacent to Proposed NWA Gas Pipeline ROW

The distribution and numbers of bald eagles in the vicinity of the proposed NWA gas pipeline corridor have been reported by Roseneau and Bente (1979, 1980b). Although a few individuals have been seen north of the Yukon River, no nests have been documented in this section of the corridor. A few pairs may nest along the Yukon River on either side of the alignment, but the nearest reported nest location is downstream near the mouth of Hess Creek. No nests have been found upstream as far as Fort Hamlin, but some pairs may nest near Stevens Village. Between the Yukon River and Fairbanks one nest (active in 1980) was found near the Chatanika River crossing. Forty-four nests have been found in the Tanana River valley between Fairbanks and the U.S.-Canada border. Pairs were present at 25 of these nests in 1980.

3.1.5 Osprey

3.1.5.1 Throughout Alaska

The osprey is a migratory species that is widely but locally distributed throughout Alaska south of the crest of the Brooks Range (Gabrielson and Lincoln 1959). The two regions of Alaska that may have more ospreys than other areas are portions of the Kuskokwim River drainage and the upper Tanana-Tetlin Lake area.

No estimates of the population of ospreys in Alaska are available. Their total numbers are probably relatively small, however, and the proper order of magnitude is probably at most a few hundred pairs.

3.1.5.2 Adjacent to Proposed NWA Gas Pipeline ROW

The distribution and numbers of ospreys in the vicinity of the proposed NWA gas pipeline corridor have been reported by Roseneau and Bente (1979, 1980b). Ospreys are only occasional visitors north of the Brooks Range. The osprey is a generally uncommon nesting species throughout the upper Yukon River drainage, but appears to occur more frequently in the Tanana River drainage. Only four nests have been located near the proposed alignment; all occur in the Tanana drainage. Two of the four nests fell down between the spring of 1979 and the spring of 1980 (Roseneau and Bente 1980b). Other osprey nests also occur in the Tanana drainage, but at greater distances from the proposed alignment (e.g., the Tetlin Lake area).

3.2 NESTING HABITAT

3.2.1 Gyrfalcon

Gyrfalcons nest in a wide variety of habitat types in Alaska. They are not as restricted to coastlines or river courses as are peregrines, and are common in many upland areas. In northwestern Alaska and on the Arctic Slope gyrfalcons prefer to nest in rolling upland areas or areas along rivers, rather than in mountainous areas.

Gyrfalcons nest over a wide range of elevations. Most Alaskan nests are found between sea level and ∿.4000 ft asl (White and Cade 1971). The greatest elevation known (∿ 4500 ft asl) is in the eastern Brooks Range (Roseneau 1974).

In Alaska gyrfalcons nest almost exclusively on a wide variety of cliffs and bluffs. Nesting cliffs have ranged from small (∿ 15 ft high) upland rock outcroppings to cliffs as high as ∿ 400-500 ft in mountainous or coastal areas. Rocky cliffs or bluffs are preferred (cf. White and Cade 1971). Only a relatively small number of gyrfalcons have nested on dirt/soil bluffs in northwestern Alaska and on the Arctic Slope (e.g., Sagwon Bluffs). In some regions of Alaska (e.g., the Alaska Range, south-central Alaska) gyrfalcons construct typical falcon scrapes in soft substrates that accumulate on ledges or in potholes on cliffs. However, in most of subarctic and arctic Alaska, they prefer to scrape in and utilize stick nests that have been constructed by other cliff-nesting raptors (rough-legged hawk, golden eagle) or ravens (cf. Cade 1960; White and Cade 1971; Roseneau 1972). Common ravens provide the fewest usable stick nests, because their nests are loosely constructed on small ledges that provide marginal support; such nests have often fallen from the cliffs by the following spring.

Although gyrfalcons have used stick nests in trees in other regions of the world (cf. Kuyt 1980), we know of only one reported instance in Alaska; a raven nest in a balsam poplar tree along a river on the Seward Peninsula was used by gyrfalcons in 1967 (Roseneau 1979). In western Alaska, gyrfalcons occasionally make use of the stick nests of other species that have been built on man-made structures, such as gold dredges, large sluice boxes, pile-drivers and wooden towers (White and Roseneau 1970; Roseneau, unpubl. data).

Gyrfalcons may shift in consecutive years from a nest site to a nearby alternate nest site, or may shift to a new breeding area that is a long distance from the original nest location. Long shifts, which may involve many pairs moving out of an area, are undoubtedly in response to reduced food availability (Roseneau 1972).

3.2.2 Rough-legged Hawk

Rough-legged hawks nest in a wide variety of habitat types in Alaska. They nest in habitats similar to those used by gyrfalcons, along seacoasts and rivers, and in upland areas. However, they do not nest over such a wide range in elevations; most nests have been found below ∿ 2500 ft asl (cf. Roseneau 1974; Ritchie 1978).

In Alaska rough-legged hawks nest almost exclusively on cliffs, bluffs, rock outcrops and steep banks, but occasionally they nest on low pingos and mounds. The size of the cliffs, outcrops and bluffs that they will accept is smaller than that accepted by gyrfalcons. In some instances rough-legged hawks have nested on the gravel shoulders of roads (Roseneau, unpubl. data).

Although rough-legged hawks have been reported to nest in trees (cf. Bent 1937; Brown and Amadon 1968), only one tree nest has been clearly documented in Alaska -- in a balsam poplar tree along the Chandler River (White and Cade 1975) -- and a further possible tree nest has been reported from the lower Kuskokwim drainage (Weir, pers. comm.). Rough-legged hawks also construct nests on a variety of man-made structures, including gold dredges, sluice boxes, pile drivers, wooden towers, and bridges (Roseneau, unpubl. data).

Although rough-legged hawks occasionally nest in old golden eagle nests, they usually either build new nests each year or repair and reuse old nests that they have built in earlier years. The numerous stick nests built by rough-legged hawks within their nesting range are frequently chosen as nest sites by peregrine falcons and gyrfalcons.

3.2.3 Golden Eagle

Although golden eagles nest in a wide variety of habitat types in Alaska, they are generally most numerous in mountainous areas. Golden eagles nest over a wide range of elevations from sea level to perhaps 5000 ft asl (cf. Mosher and White 1976). In the Alaska Range, we suspect that some nests may be as high as ∿ 6000-7000 ft asl. In the Brooks Range in northern Alaska, nests have been found up to ∿ 4400 ft asl (Roseneau 1974; Roseneau and Bente 1979). Most nests in northern Alaska have been found below ∿ 3500 ft asl.

In mountainous areas, nest locations are often well above the valley floors (cf. Roseneau and Bente 1979). Nesting cliffs have ranged from ∿ 20-25 ft high (upland rock outcroppings) to ∿ 500 ft high (mountains and sea cliffs). A few Arctic Slope nests have been located near the tops of rocky-soil bluffs.

Golden eagles typically construct large stick nests. Some of these nests become immense; one nest in the Tanana drainage (not the largest known) is ∿ 6 ft in diameter and ∿ 6 ft high. Even reindeer and caribou antlers may be incorporated into the nests (Roseneau, unpubl. data).

Although golden eagles commonly construct their nests in trees at more southern latitudes, only ∿ 10 instances of nesting in trees are known in Alaska -- one in the Kuskokwim drainage, one in the Alaska Range, one in the southern Brooks Range, and the remainder in the Yukon Drainage (Gabrielson and Lincoln 1959; J. McGowan, pers. comm.; Swartz, pers. comm.; Weir, pers. comm.; Roseneau and Bente, unpubl. data; White, pers. comm.).

Golden eagles usually have 2-4 nests and alternate nests per pair, but may have up to 14 nests per pair (Brown 1976). They may move 0.5-5 mi to an alternate site in consecutive years (Nelson and Nelson 1978).

Golden eagle nests are occasionally used by nesting peregrines in interior Alaska and by rough-legged hawks in northern and western Alaska; they are often used by gyrfalcons in northern and western Alaska (e.g., Cade 1960; Roseneau 1972; Curatolo and Ritchie 1979).

3.2.4 Bald Eagle

In Alaska, bald eagles have constructed their nests in a variety of trees and on tundra mounds, cliffs, bluffs, sea stacks and the ridge tops that connect sea stacks with larger islands, and the tops of small islands (e.g., Gabrielson and Lincoln 1959; Murie 1959; Robards and Hodges 1977; White *et al.* 1977). Nests constructed in trees are used almost exclusively when trees are available, even in coastal regions.

Nesting habitat is limited in interior Alaska. The principal tree species available and most often used for nesting by bald eagles are balsam poplar and white spruce; occasionally nests are constructed in large aspens (cf. Roseneau and Bente 1979). Nesting trees are usually closely associated with river and stream courses, lake shores or large expanses of wetlands that contain lakes, ponds, streams, sloughs and marshes.

Stick nests are usually large and are added to each year. Only some of the trees found within the general habitat favored by bald eagles are suitable as structures on which the stick nests can be built. The most frequently used trees are large mature trees that have tops that are broken or deformed, or that are unusually bushy (a particularly important feature of spruce trees that are used), or that have lost sufficient limbs to have partially opened the canopy cover. The conformation of the tree tops is an important feature because bald eagles require a relatively open but solid platform on which to build. Trees of the appropriate size and conformation are frequently uncommon in the interior. If a nest is lost, some years may elapse before another tree is suitable as a nest location. In some instances, however, human modification of nearby trees can provide acceptable conditions.

Bald eagles may have up to 6 nests and alternate nests per pair (Brown 1976). Alternate nests may be as much as 2 mi from the nest site (Howell and Heinzman 1967).

3.2.5 Osprey

Ospreys are closely associated with water (e.g., Gabrielson and Lincoln 1959; Brown and Amadon 1968). Nests are usually found along sea coasts, rivers or lake shores, or in wetland areas of marshes, ponds and streams. Nests may, however, be up to 2-3 mi from open water (Henny 1977).

Ospreys build large stick nests that with time can become so large that the structures they are built on may eventually collapse. Osprey nests have been built in a variety of alive or dead trees, on cliffs, and on a variety of man-made structures, including telephone poles, abandoned buildings, abandoned but still turning windmills, neon signs on buildings, and artificially-constructed towers or platforms placed to provide nesting locations for them (Bent 1937; Gabrielson and Lincoln 1959; Brown and Amadon 1968; B. Olendorff, pers. comm.). Ospreys may have alternate nests that are as much as 4 mi away from the nest (Green 1976).

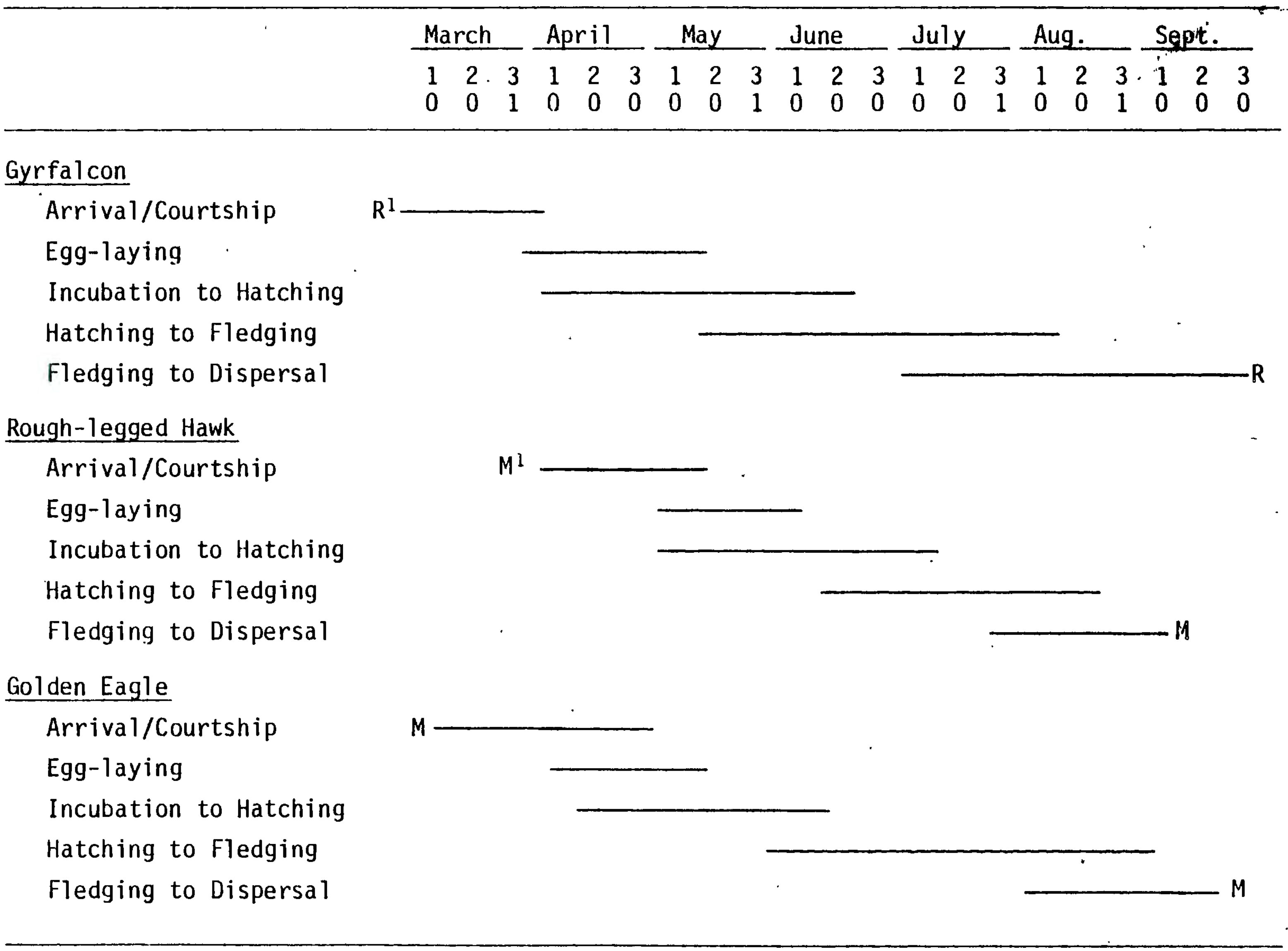
In Alaska, relatively few nests have been located and described, and all known nests have been in trees. In interior Alaska, the most frequently used trees are white spruce and balsam poplar. The nests in the Tanana River drainage have all been constructed in dead, dying or living spruce (Roseneau and Bente 1979). Only one of the four nests near the pipeline corridor is a 'classic' type -- a large platform of sticks atop a completely dead spruce that no longer has limbs. The others, in partially alive spruce, have been smaller structures on top or somewhat below the top of trees that have a somewhat bushy conformation.

Three of the four nests were found along the banks of the Tanana River or on islands in it. Only one nest was on a lakeshore. The small size of that nest and its location atop a living spruce in the 'cup' of a moderately bushy crown suggests that some nests could be difficult to locate, especially if they are relatively new.

3.3 REPRODUCTIVE PHENOLOGY

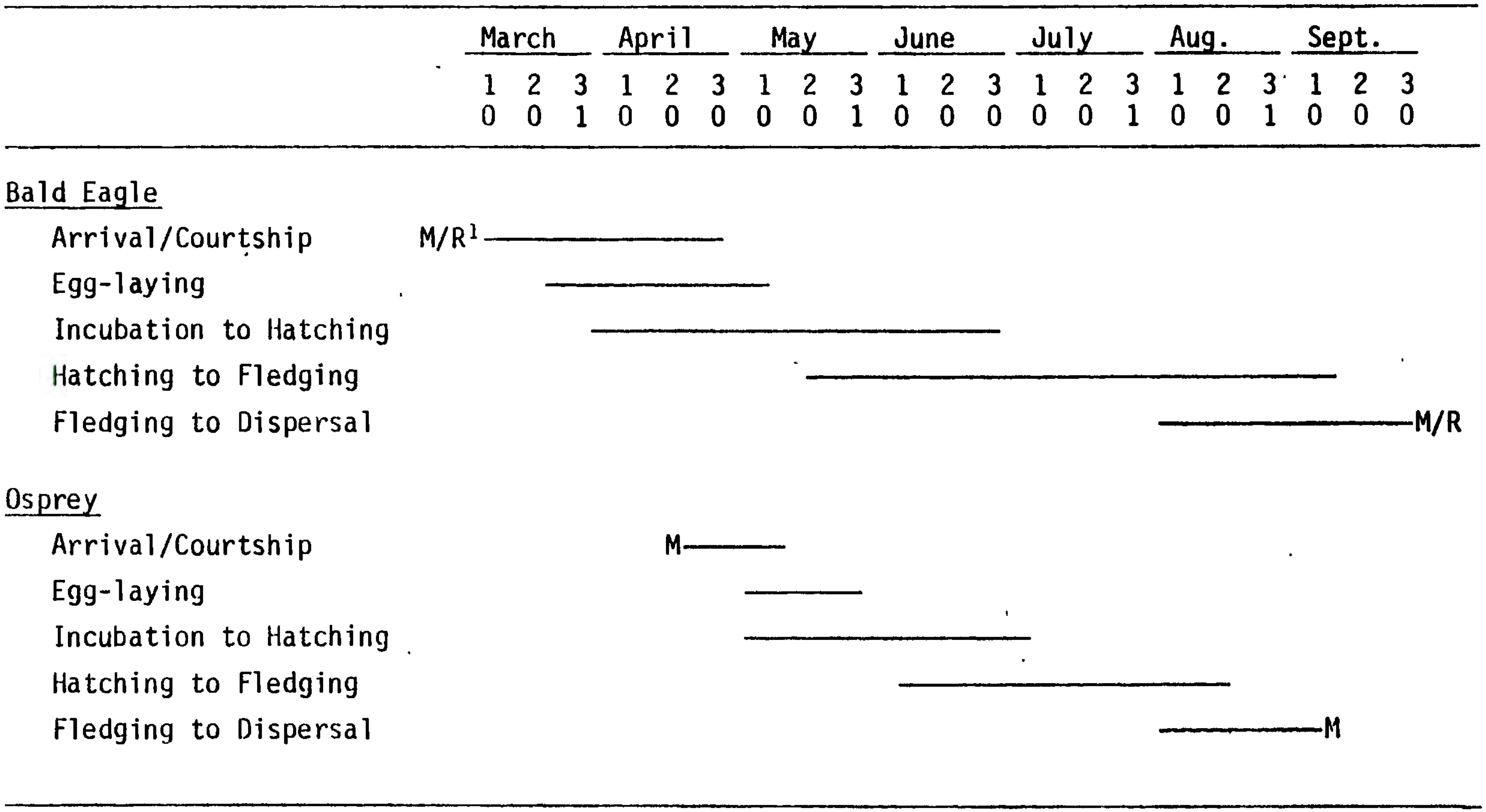
Figures 2 and 3 present generalized nesting phenologies for gyrfalcons, rough-legged hawks, golden eagles, bald eagles and ospreys in interior and arctic Alaska. They are based on a compilation of records from many locations and for many years. Gyrfalcons may be present at nest sites during ∿ 1 March-30 September, rough-legged hawks during ∿ 15 April-10 September, golden eagles during ∿ 10 March-15 September, bald eagles during ∿ 10 March-30 September, and ospreys during ∿ 20 April-10 September. Arctic Slope birds can be expected to be later in their breeding activities than birds of the same species that breed in interior Alaska. Gyrfalcons often remain in the vicinity of their nest locations throughout the year, and some bald eagles also do so in portions of the Tanana River drainage.

FIGURE 2. Reproductive phenology of gyrfalcons, rough-legged hawks and golden eagles in arctic and interior Alaska.



[1] R = resident, M = migrant.

FIGURE 3. Reproductive phenology of bald eagles and ospreys in interior Alaska.



[1] R = resident, M = migrant.

3.4 HUNTING HABITS

3.4.1 Gyrfalcon

Gyrfalcons, which are year-around residents of the arctic and subarctic, are opportunistic hunters. During the summer their diets may vary according to the prey availability and vulnerability (cf. Roseneau 1972). However, their diet is not as varied as the diet of peregrines, and they typically rely on only a few principal prey species for the bulk of their food (cf. Cade 1960; White and Cade 1971; Roseneau 1972).

The principal summer prey species include ptarmigan (often 70-90% by weight of their diet), arctic ground squirrels, and, in some regions, long-tailed jaegers (cf. White and Cade 1971; Roseneau 1972). In some regions of interior Alaska (e.g., the Alaska Range) ground squirrels surpass ptarmigan in importance (cf. Cade 1960; Roseneau 1972). Migratory birds usually constitute no more than 15-20% by weight of their summer diet. In the winter, gyrfalcons are almost solely dependent on ptarmigan (cf. Platt 1976; Walker 1977), although in some regions arctic hares are also an important component of the diet (Muir 1973).

Despite the reliance on a few principal prey species, gyrfalcons are capable of shifting to other food sources during the breeding season if the availability of a few prey species should change dramatically -- provided that other prey species are present (cf. White and Cade 1971; Roseneau 1972). It has also been suggested that gyrfalcons may not breed in some years when prey availability is low (cf. Hagen 1952; Cade 1960; Roseneau 1972).

The reliance on ptarmigan, and the high utilization of small mammals, particularly ground squirrels, in the summer diet are important factors that have helped gyrfalcons to avoid serious biocide contamination and thus maintain healthy, non-endangered populations in the arctic (cf. Cade *et al.* 1971b; Walker 1977).

Gyrfalcons may hunt up to at least 15 mi from their nest locations. Nelson (1978) used a helicopter to follow a male that hunted as far as 15 mi from the nest. Another male hunted at or beyond 5.5 mi from a nest in the Alaska Range, but the female hunted only within 1-2 mi of the nest (Bente 1980).

3.4.2 Rough-legged Hawk

Rough-legged hawks, which generally catch their prey on the ground, are largely dependent on small mammals as their source of prey (cf. Bent 1937; Brown and Amadon 1968). Microtines constitute an important part of their diet during the nesting season, and are very important prey during the winter at more southern latitudes (e.g., White and Cade 1971).

Birds, particularly passerines and ptarmigan (including fledglings), may be more important in years of low microtine abundance, and may generally constitute a greater proportion of the summer diet of rough-legged hawks than had previously been thought (Springer 1975).

Although the importance of avian prey on the nesting grounds may have been underestimated, rough-legged hawks are strongly dependent on microtines. Their distribution, abundance and reproductive success within a region can vary considerably from year to year in response to fluctuations in the abundance and availability of these prey (cf. White and Cade 1971; Swartz *et al.* 1975; White *et al.* 1977). Only a few pairs may be present in a region one year, but tens of pairs may be present in the next year (White and Cade 1971; Roseneau, unpubl. data; Springer, unpubl. data). When prey (microtines) are abundant, clutch sizes and brood sizes are large, but when prey are not abundant, clutch and brood sizes are smaller (Roseneau, unpubl. data; Springer, unpubl. data).

3.4.3 Golden Eagle

Golden eagles are opportunistic hunters. When available, mammals are an important component of their diet (up to 70-98% by weight), but birds and carrion can also be important (cf. Brown and Amadon 1968).

In Alaska there are few reports of prey items found at nests. Common items found in nests have included ground squirrels, marmots, snowshoe hares, ptarmigan, ducks and other waterfowl. Occasionally both arctic and red foxes are taken; one pair on the Seward Peninsula took possibly as many as 5-6 red foxes during the summer, and the fledgling from that nest attacked a red fox ∿ 1-2 wk after it had left the nest (Roseneau and Springer, unpubl. data). Pairs nesting along sea coasts also take a variety of seabirds (both alive and as carrion).

Carrion, often in the form of large game animals, is particularly important during the early spring and the fall. Carrion also appears to be very important to subadult golden eagles. Large numbers of subadults frequent the calving and post-calving grounds of caribou herds. Up to six subadults have been found feeding at one time on wolf-killed and bear-killed caribou, and subadults also occasionally have been observed to kill caribou calves (Roseneau and Curatolo 1976).

Non-breeding of golden eagles occurs in some years, and there is some evidence to suggest that prey availability may influence breeding success (cf. Brown and Amadon 1968; Mosher and White 1976).

3.4.4 Bald Eagle

Bald eagles are opportunistic in their feeding habits, and diets may vary from region to region according to the availability and vulnerability of prey species. Although they take a variety of live prey, bald eagles often rely heavily on local sources of carrion (they may be attracted to dumps), and they also pirate prey from other raptors, particularly ospreys (cf. Bent 1937; Brown and Amadon 1968; Sherrod *et al.* 1976). Fish are a principal component of their diet in most regions.

In Alaska, bald eagles rely heavily on dead or dying salmon when they are available, and take other species of fish as they can in shallow water or as carrion along shorelines. Waterfowl and seabirds (alcids and larids) are also important components of their diet, particularly in some coastal regions (e.g., the Aleutian Islands). Dead, dying or injured birds are often taken from the water surface, but eagles are also capable of surprising and taking uninjured waterfowl and seabirds from the water surface or in the air. Geese may also occasionally be taken in flights (Brown and Amadon 1968), and swans and sandhill cranes have sometimes been taken (D. Haynes, pers. comm.; Springer, pers. comm.).

In the Tanana River valley salmon are undoubtedly important to bald eagles in late summer, fall and winter. Earlier in the year, other fish species (particularly whitefish, suckers and grayling) and waterfowl probably constitute the bulk of their diet. Snowshoe hares and muskrats may also be taken on occasion.

3.4.5 Osprey

Ospreys prey almost exclusively on live fish (cf. Gabrielson and Lincoln 1959; Brown and Amadon 1968), but occasionally may take birds (usually waterfowl, shorebirds or alcids) and crustaceans. The principal prey species in the Tanana drainage probably include whitefish, suckers and grayling.

Ospreys may forage up to 7 mi from their nests (D. Weir, cited in Newton 1976).

3.5 IMPACTS OF PIPELINE ACTIVITIES

The general types of impacts to raptors that can result from development activities have been listed in Table 10. Construction and operation of a natural gas pipeline could affect nesting gyrfalcons, rough-legged hawks, golden and bald eagles, and ospreys in similar ways to those described for peregrines. As in the case of peregrines, disturbance from various pipeline activities is the most likely type of impact to these birds.

3.5.1 Disturbance

The other raptor species have received as little in-depth study of their responses to disturbances as have peregrines. Few studies have directly investigated the responses of these species to disturbances. Several authors (Mathisen 1968; Grier 1969; Juenemann and Frenzel 1972; Gerrard *et al.* 1973; and Fraser *et al.* 1980) have studied the effects of human presence and other activities (including recreational use of resorts and campsites, construction of rice paddies, blasting of potholes, and tree plantations) on the productivity of nesting bald eagles. Platt (1975) and Platt and Tull (1977) conducted experimental overflights of gyrfalcon nests in light helicopters. One of the few studies of the effects of controlled disturbance (including noise, human presence and vehicles) was conducted on ferruginous hawks (White *et al.* 1979). In addition, there are other accounts of the effects of some disturbances to various raptor species that can be related to the five species of interest, and there are empirical observations of the responses of the five species to individual cases of disturbance.

Responses of these raptors to various types of disturbance may depend on the many factors that have been listed in Tables 11 and 12 and discussed in Section 2.5.1. The ways in which disturbance can act to affect the reproductive success of these species may also be similar to the ways disturbance can affect peregrines (Section 2.5.1). The cautionary note concerning the interpretation of the information on impacts (Section 2.5.1) must also be considered for the other raptor species.

3.5.1.1 Construction and Operation Activities

The various construction and operational activities that have the potential to disturb nesting gyrfalcons, rough-legged hawks, golden and bald eagles, and ospreys are the same as those discussed with respect to peregrines (Section 2.5.1.1). As in the case of peregrines, the responses of these species to construction activities are quite variable.

The construction of the TAPS oil line and haul road apparently did not produce any demonstrable negative impact on nearby raptor populations (White *et al.* 1977). Realignments to provide buffer zones around nest locations no doubt contributed to minimizing the impact. However, one gyrfalcon nest location and another probable nest location are unlikely to be used again (White and Cade 1975; White *et al.* 1977; Roseneau and Bente 1979).

In Ontario, a bald eagle pair that was relatively used to human activities nearby tolerated the rather swift construction of a pipeline within ∿ 100 yd of their nest tree (E. Baddaloo, pers. comm.). The eagles were well into the nesting cycle when the disturbance occurred, and this may have contributed to their nesting success.

A 35-mi section of the Dempster highway was built through virtual wilderness in the Yukon Territory during the winter and spring of 1977-78. Two pairs of golden eagles and two pairs of gyrfalcons had nested within ∿ 1.2 mi of the alignment in 1977. The construction of the highway did not alter the occupancy or productivity of these four pairs between 1977 and 1978, but it may have caused two pairs to shift nest sites and it may have caused one brood to have a diminished chance of survival (Nelson and Nelson 1978). One eagle nest that was within ∿ 1 mi of and in view from the road was successfully reoccupied in 1978; blasting occurred ∿ 2-4 mi from the site until mid-March (by which time the birds might have returned to the area) and construction occurred until 10 June. One gyrfalcon nest that was within ∿ 0.5 mi but just out of sight of the road was reused in 1978; it was within ∿ 1.2 mi of the same area of blasting. The three gyrfalcon nestlings were very underweight when weighed in late June, and the adults were very nonaggressive toward human intruders at the nest. The poor condition of the nestlings may have been related to the adults' lack of aggressiveness, or the condition of the nestlings (and possibly the adults' behavior) may have been related to impacts from the nearby construction. The second pair of gyrfalcons did not nest in 1978 at their 1977 sites (within ∿ 275 yd of but out of sight from the road); instead they moved ∿ 3.1 mi from the road and used the 1977 nest site of the second golden eagle pair. The eagles (presumably the same pair) nested in 1978 ∿ 2.5 mi from the road.

Construction of a bridge during spring and summer of 1950 in Mount McKinley National Park caused a pair of gyrfalcons in mid-season to desert a regularly-used nest site that was ∿ 500 yd from the bridge (Cade, in Platt 1975). The nest site has not been used since 1950, but this may have been the result of continued disturbance along the nearby road or it may have been due to a preference by birds in later years for another nest site ∿ 2 mi downstream of the abandoned location (Roseneau, unpubl. data).

Other types of construction activity have also been tolerated in some cases. A pair of bald eagles in Alaska apparently tolerated the construction of an oil refinery ∿ 2 mi from and in sight of the nest

(L. Peet, pers. comm.). Nesting birds at this site have tolerated a nearby gravel pit operation for a number of years and the construction of a 4000 ft runway ∿ 1.4 mi away.

The Seward Peninsula is an area that has been subjected to heavy mining activity for many years. Although some impacts probably occurred to gyrfalcons, golden eagles and rough-legged hawks in the course of this activity, there is no evidence of any long-term impacts to these species. The Seward Peninsula has one of the largest populations of gyrfalcons, and in some large areas has some of the densest concentrations of gyrfalcons in Alaska (Roseneau 1972; Swartz *et al.* 1975). Gyrfalcons and rough-legged hawks nest in most years throughout the most intensively mined districts, wherever suitable nesting habitat exists; they also nest on at least one cliff that was created during a mining operation, on one that was enlarged by road construction, and on several abandoned mining structures. Gyrfalcons nested for a number of years on a gold dredge on the Seward Peninsula. Nesting commenced before the mining operation started each year, and in order for the operation to start, the large young had to be removed from the dredge. The young were either placed in a new location where they were reared by the adults or they were partially hand-reared in the presence of the adults and were then returned to the adults. The adults became relatively tame and would accept ground squirrels that were thrown to them (Roseneau 1969; D. Tweet, pers. comm.).

The five raptor species have all nested near various types of operating equipment, including vehicular traffic on roads. In addition to the above examples, a pair of gyrfalcons nested regularly near a mining camp where 6-8 people were living and working and where a D-6 Caterpillar tractor was being used (Roseneau, unpubl. data). A gyrfalcon nest in the Yukon Territory was used in spite of its being ∿ 300 yd from and in sight of a highway; no behavioral responses were observed during the incubation, nestling or fledgling periods that indicated the pair was alarmed by passing vehicles (Nelson 1978). Gyrfalcons have also nested successfully on the Seward Peninsula on cliffs that were only ∿ 0.2-0.5 mi from and in sight of roads; one pair used a cliff that faced the road and was only ∿ 0.3 mi from it during four successive years (Roseneau 1972, unpubl. data). No responses to passing vehicles were seen that suggested that the birds might have been disturbed.

Rough-legged hawks have nested close to roads along the Sagavanirktok River and on the Seward Peninsula. In one case a pair nested successfully on a road shoulder just below the surface of the road; the nest was subject to human disturbance from people that stopped to see the birds and to weekly disturbance from a road grader that was forced to lift its blade to avoid covering the nest (Roseneau and Bente 1979; Roseneau, Walker and Springer, unpubl. data). Golden eagles have sometimes nested near oil well pumps, farm facilities, roads and railroad tracks (Olendorff 1975; Nelson 1980; Roseneau, unpubl. data).

Operation of heavy equipment has, however, proved detrimental to nesting raptors in some cases. For example, a golden eagle nest in the Yukon Territory that had been occupied in 1972 was found unoccupied in 1975, probably because of the heavy machinery at a placer mine operation ∿ 30 yd below the nest. When rechecked in 1977, the mining had ceased and the nest was reoccupied (Theberge and Gauthier 1978).

Operation of the TAPS oil line has in most cases also been tolerated by raptors. Although no information is available as to whether a pair of bald eagles nested at a location near (∿ 0.3 mi) the TAPS oil line crossing of the Chatanika River during construction, a pair did nest there in 1980 (Roseneau and Bente 1980a).

Logging activities in southeastern Alaska have temporarily caused bald eagles to leave the vicinity of the activity (Corr 1974). Once the activity ceased, however, eagles returned to the areas and bred there, provided that suitable nesting trees were still present. Some ospreys have abandoned nests because of logging activity, but others have not done so (French and Koplin 1977). In one instance, a pair of ospreys that had previously been exposed to human activity nested successfully even though logging activities had commenced in the late incubation period and had occurred to within ∿ 100 ft of the nest (Melo 1975).

3.5.1.2 Aircraft Passage

Aircraft activities associated with the construction and operation of a gas pipeline have the potential to disturb nesting gyrfalcons, rough-legged hawks, golden and bald eagles, and ospreys. As in the case of peregrines, the sudden appearance of an aircraft near a raptor nest can cause an incubating or brooding bird to flush quickly and to possibly thereby destroy the eggs or nestlings (White and Sherrod 1973).

The responses of raptors to aircraft disturbance are highly variable and depend on the circumstances of the disturbance, the species, the timing during the nesting cycle, the individual bird, and on various other factors. The responses are of three general types -- the birds may flush from the nest and leave the area, the birds may remain at the nest and more or less ignore the aircraft, or the birds may aggressively attack the aircraft.

In the only detailed experimental study of the responses of these raptors to aircraft overflights, Platt (1975) and Platt and Tull (1977) noted the effects on nesting gyrfalcons of helicopter (Bell 206B) overflights. Overflights were made at 100 mi/h parallel to and ∿ 200 ft in front of nest cliffs at altitudes of 500, 1000, 1250 and 2000 ft above the nests. No birds were disturbed by flights at 2000 ft, some birds were disturbed at 1000 and 1250 ft, and all were disturbed at 500 ft. Of the latter birds, 61% showed the most severe response -- they flew from perches in a panic flight (low and weaving). No nest failures resulted from overflights (a maximum of two overflights in each of pre-laying, laying, incubation, and nestling phases), and productivity of tested nests did not differ significantly from that of control nests. A statistically significant number of the overflown (vs. control) 1974 nests were unused in the following year; however, there was no significant difference between the 1976 reoccupancies of nests that were overflown or in 1975 (vs. control). These data suggest that a factor other than disturbance may have caused the difference in the 1975 reoccupancy results.

Most of the other observations of the responses of raptors to aircraft have been incidental observations made in the course of surveys of nesting raptors. Repeated surveys by fixed-wing aircraft of nesting gyrfalcons on the Seward Peninsula did not cause any detectable loss of productivity in the survey year or in successive years (Roseneau and Springer, unpubl. data). These birds underwent some marked shifts in the nests from one year to the next; these shifts were apparently in response to changes in prey availability and to some other factors.

On the Seward Peninsula, helicopter flights near nesting gyrfalcons in the late nesting stage have caused some birds to leave the nest vicinity while the helicopter was present (Roseneau and Walker, unpubl. data). White *et al.* (1979) suggested that ferruginous hawks might be especially sensitive to disturbances when prey numbers were low; gyrfalcons might similarly be quite sensitive when the numbers of ptarmigan are low.

Golden eagles appear to be the most sensitive to aircraft. Windsor (1979) noted an instance of premature fledging of a nestling golden eagle in response to disturbance by a helicopter. Golden eagles may be reluctant to flush during incubation, but they often flush from nests or are either absent from nests or soaring above them when nests are flown past during the nestling stage (Roseneau and Bente 1979; Roseneau, Walker and Springer, unpubl. data).

Although helicopters generally appear to have had little affect on nesting ospreys, at least during incubation (Fyfe and Olendorff 1976), incubating ospreys in Alaska have been observed to fly from a few nests when a helicopter approached to within ∿ 150 ft (Roseneau, unpubl. data). Bald eagles have also occasionally been frightened from nests, but we suspect that this is an infrequent occurrence unless the birds are purposely forced to leave.

Hancock (1966) used a helicopter to flush bald eagles from nests in order to obtain counts of eggs. He suggested (without presenting supporting data) that those pairs had about 50% fewer young in the next year and that about 45% of the pairs had moved to alternate nests. Fixed-wing aircraft were said to be much less disturbing. It is our view that sufficient work has been done with aircraft on nesting bald eagles to show that careful work with aircraft does not cause carry-over effects into the following year. Helicopter counts of bald eagle eggs at Amchitka Island may, however, have been the cause of relatively poor production of young during the year of the disturbance (Sherrod *et al.* 1976).

There have also been many occasions in which raptors did not flush from nests in response to aircraft overflights, but instead either assumed a stressed position, stood up on the nest, merely watched the aircraft, or paid little or no attention to it. Some of these birds are undoubtedly disturbed by the overflights, but it is not known what effects this disturbance may have on the birds.

When overflown, some gyrfalcons on the Seward Peninsula and in northeastern Alaska have watched as the aircraft passed and then continued to do whatever they were doing previously (Roseneau, unpubl. data; Roseneau and Walker, unpubl. data). Others have flushed but remained in the nest area and either perched or circled. White and Cade (1975) observed some gyrfalcons that 'continued to feed their young without looking up as we flew by to check the eyrie'.

Little information is available on the responses of rough-legged hawks to aircraft, but we know of no attacks or strikes in several hundred hours of aerial surveys (helicopter and fixed-wing). Rough-legged hawks that are incubating eggs or small young have almost always refused to leave their nests, and only the occasional bird has stood up (White and Cade 1975; Roseneau, unpubl. data). Later in the nesting season, rough-legged hawks have remained perched or have flushed from perches to soar near the nest when aircraft were nearby.

Incubating golden eagles in the Brooks Range have often been reluctant to flush (Roseneau and Bente 1979), and golden eagles along the Dempster highway in the Yukon Territory appeared to tolerate aircraft well, particularly when their passage past the nest was slow (Mossop *et al.* 1978).

Bald eagles often do not leave their nests in response to aircraft overflights. Sherrod *et al.* (1976) noted that even in an unusually aggressive population some bald eagles that were brooding small young during periods of inclement weather would not leave their nests and would allow the helicopter to approach as close as ∿ 5-10 yd.

Most of the bald eagles in the Tanana River drainage that were overflown by fixed-wing aircraft or helicopters in the course of surveys during the incubation period did not appear to be unduly disturbed. During helicopter surveys (Bell 206B to within ∿ 150 ft) of 17 bald eagle nests, incubating adults did no more than look up, and only two perched adults flushed and landed in nearby trees (Roseneau and Bente, unpubl. data). Similar results were obtained during fixed-wing surveys (PA-18 Super Cub to within ∿ 100 ft) of 26 nests.

On several occasions, ospreys along the Tanana River have remained on nests when overflown, although some birds have stood up in response to the aircraft (Roseneau, unpubl. data).

Instead of flushing and leaving or remaining at the nest, some raptors respond aggressively and attack aircraft as they fly past their nest sites. Gyrfalcons, which are very capable fliers, can seemingly do so with immunity; we know of no cases where gyrfalcons have actually struck aircraft. Eagles and ospreys, which are less skillful fliers, have occasionally collided with helicopters, fixed-wing aircraft and gliders (Bruderer 1976; Scott and Surkan 1976; Nelson 1979).

Gyrfalcons are the most aggressive species, particularly against light fixed-wing aircraft. Light fixed-wing aircraft were attacked at as many as 50% of the nests visited on the Seward Peninsula (Roseneau 1969, 1970). In this and other studies, both sexes attacked aircraft (occasionally together), but males appeared to do so more commonly. On subsequent visits several days later, the same birds usually attacked the aircraft again. In most instances the attacks occurred from above (diving and passing just in front of or behind the wing), or from a rear quarter (flying under the outer portion of the strut or wheels to within ∿ 1 yd), and then rolling and presenting the feet toward the fuselage or tires. In one case, however, a female repeatedly attacked from directly in front of the aircraft, then rolled and dove in an inverted position under the aircraft when it was ∿ 10 yd away. Another female attacked repeatedly from above and to the side until the aircraft left the area. Gyrfalcons were capable of overtaking the aircraft (which were flying at

∿ 70-75 mi/h) from distances of up to ∿ 0.3 mi. Most attacks occurred when the aircraft came within ∿ 200 yd or closer to the nest, but in a number of instances birds attacked aircraft from distances of ∿ 0.5 mi (Roseneau 1969, 1970, unpubl. data). Several other authors have reported attacks by gyrfalcons (White and Sherrod 1973; Mossop *et al.* 1978; Nelson 1979). (Because gyrfalcons can outmaneuver light aircraft, the best method of avoiding collisions appears to be to make no sudden flight changes, and to let the gyrfalcon take evasive action.)

Golden eagles only rarely attack aircraft. We know of only one instance of attack in Alaska, and in that case the aircraft had surprised the birds by rounding a hill and then approaching the nest in a head-on direction at a level slightly below the nest level (Roseneau, unpubl. data).

Bald eagles are sometimes aggressive. They have attacked fixed-wing aircraft and helicopters and have collided with them in a few instances (White and Sherrod 1973; Nelson 1979). Aggressive behavior has occurred during helicopter surveys in the Yukon Territory (Mossop, pers. comm.), and has been particularly common in the Aleutian Islands (Sherrod *et al.* 1976).

Ospreys are often aggressive towards aircraft. They have attacked and struck both fixed-wing aircraft and helicopters, and they have also been struck by military aircraft (Nelson 1979).

3.5.1.3 Human Presence Near Nests

The occurrence of humans near raptor nests has been shown to have widely varying impacts on the birds. There are cases where human presence near nests has resulted in abandoned nest sites and there are cases where raptors have nested successfully despite the presence of humans nearby. Prolonged human presence near nests may result in poor parental care. Malnutrition may occur even though the parent birds are in attendance at the nest and may sometimes feed the young.

Gyrfalcons, rough-legged hawks, golden and bald eagles, and ospreys have all shown some tolerance of human presence near their nests in some cases. They have also been disturbed by human presence near nests in other cases.

Gyrfalcons usually vigorously protest human intrusions near nests, although they occasionally slip away quietly when humans approach (Roseneau and Nelson, unpubl. data). There is little evidence that gyrfalcons may abandon their nests as a result of human disturbance, but this may be due to the remoteness of most of the nesting areas. Fyfe and Olendorff (1976) suggest that gyrfalcons may desert nests if human disturbance occurs just prior to or during egg-laying. Four pairs that were disturbed by the activities of trappers at the start of incubation (early May) may have deserted their nesting cliffs because of those activities (Fyfe 1969).

Intensive geological sampling for several days around a small gyrfalcon nest cliff resulted in the deaths (probably by starvation) of the two almost-fledged young; the adults apparently fledged young the next year when there was no close disturbance (Nelson 1978). Under similar circumstances on the Seward Peninsula, four nearly-fledged young died in a nest from what appeared to be starvation and/or abandonment (Roseneau 1970).

Because of the very low temperatures at which gyrfalcons lay and incubate their eggs (well below 32° F), disturbance that causes the birds to leave their nests could prove fatal to the embryos more quickly than it would for most other raptors (cf. Platt and Tull 1977).

In contrast to the above observations, gyrfalcons have nested successfully in many instances in spite of the activities of researchers who have each year made at least two visits to the nest ledges, once during the late incubation or early nestling stage and once during the late nestling period, when the young were banded (Roseneau 1972; Roseneau, Walker and Springer, unpubl. data). Disturbance was even greater on some visits when adults were trapped for banding and biopsies or chicks were weighed. No nests were deserted as a consequence of these visits (∿ 70 nestings), and only two cases occurred in which productivity was affected by the visits. In these cases, the small young were lost presumably from chilling as a consequence of investigator error; the young were handled for an excessively long period because of the sudden occurrence of inclement weather, and when they could be replaced in the nest they were not attended sufficiently quickly by the adults. In some cases, identifiable pairs that were visited on many occasions in one year returned to nest at the same location during the next year (and in some cases for four successive years). The shifts that occurred at some nest locations from one year to the next appeared to have been in response to changes in prey availability or other natural factors rather than as a consequence of human disturbance.

Platt and Tull (1977) observed five different gyrfalcon nests from blinds that were ∿ 330 yd from the nests for periods of one or more weeks. Each of these nests was also subjected to helicopter disturbance. The productivity at these nests did not differ significantly from that at 11 undisturbed nests. Habituation to the coming and going of the observer occurred at at least two of the five nests.

Rough-legged hawks almost always protest human intrusions. Although they are rarely very aggressive, they will often leave perches or nests to fly toward intruders when the intruder is still as much as ∿ 0.3-0.5 mi from the nest. (Females that are incubating eggs rarely leave their nests until the intruder is ~ 200 yd or closer from the nest.)

Few data exist on the effects of human presence near rough-legged hawk nests. Several birds have been trapped, banded and biopsied at their nests during incubation without desertion or loss of productivity occurring (Roseneau and Springer, unpubl. data), and many nests were visited on the Seward Peninsula prior to hatching, shortly after hatching and at other times during the nestling stage with again no desertion or loss in productivity occurring (Roseneau, Walker and Springer, unpubl. data). Many of the nest cliffs on the Seward Peninsula were successfully occupied in successive years after the visits.

It is not known how tolerant rough-legged hawks may be during the egg-laying and early incubation stages. Other buteos are known to be susceptible to disturbance at this time; some red-tailed hawks near Fairbanks, for example, deserted their clutches after their nest trees had been climbed once even though the experienced investigator was being very careful to minimize disturbance (C. Lowe, unpubl. data).

The golden eagle is apparently the most sensitive species to human presence near nests. Golden eagles often leave the nest area quickly when people come into the area, and they often do so when people are at considerable distances from the nest. Only rarely do they protest intrusions, and people may often be unaware that they have caused a bird to flush and stay off its nest.

Significant proportions of the golden eagle nest failures in some areas have been blamed on human interference (cf. Brown 1969, 1976; Boeker and Ray 1971; Kochert 1972; Snow 1973; Windsor 1979). Only one in eight Scottish nests near houses was successful, whereas 6 of 12 nests that were remote from houses were successful (Brown 1969). Boeker and Ray (1971) attributed ~ 85% of the known nest losses in the

Front Range of the Rocky Mountains during 1964-69 to human disturbance. In Idaho, Kochert (1972) attributed 4-8 of 21 nest failures during incubation to human disturbance, including three failures that may have resulted from his own activities.

A pair that had nested successfully for several years above a busy highway near Anchorage deserted the nest after rock climbers visited the nest ledge and removed the eggs for a short time (Roseneau and Tilton, unpubl. data). A pair on the Seward Peninsula also abandoned a nest after the incubating female was surprised at close range by an observer on the cliff top (Roseneau, unpubl. data).

Golden eagle nestlings can suffer unusual weight losses due to the prolonged intrusion of people at the nest. Ellis (1973) reported such a case; the lengthy presence of people at the nest had caused the adult eagles to remain away from the nest for an unusually long time after the people had left the vicinity of the nest. The weight losses were regained, however, before the young fledged.

In some cases golden eagles have habituated to or at least tolerated human disturbance (Nelson 1980). Several nests, for example, were visited on the Seward Peninsula prior to hatching without desertion occurrring (Roseneau, unpubl. data). However, they do appear to be the most sensitive species and the most susceptible to human interference of the five raptor species treated here.

Bald eagles will sometimes protest the intrusions of people near their nests. Nesting pairs that are disturbed usually remain in the vicinity of the nest, either perched or flying around. They do not slip away from the nest vicinity in the manner of golden eagles, but they are usually much less aggressive than falcons. In the Aleutian Islands, however, bald eagles can be very aggressive towards people, and have struck them on at least two occasions (Sherrod *et al.* 1976).

The removal of tree cover in order to plant crops and the visiting of nests by the public contributed to nest failures of bald eagles in southern Ontario (Weekes 1974, 1975a). Nests in isolated trees may be especially vulnerable to human disturbance, and fledgling eagles may be more prone to leave the nest area earlier (Weekes 1975b).

Studies by Mathisen (1968), Grier (1969), Swenson (1975), Newman *et al.* (1977) and Fraser *et al.* (1980) have indicated that nesting bald eagles can be relatively tolerant of human activity during the nestling stage. In the Chippewa National Forest in Minnesota, there was no significant difference in productivity between nests close to human activities and those in isolated areas (Mathisen 1968). Most of the human activity in this study occurred during the later stages of the nestling phase. Fraser *et al.* (1980) compared disturbances within 1 mi of nests that had failed in Chippewa National Forest with disturbances within 1 mi of successful nests and found no evidence that disturbances were responsible for the nest failures.

Grier (1969) compared the effects of climbing to nests to band nestlings to that of counting nestlings with binoculars from a distance. He found no significant difference in the number of young produced in the nest year from climbed vs. non-climbed nests. Although his sample sizes were too small to be conclusive, his data suggested that climbing may have caused an increased rate of nest changing. Eleven percent of the nests that were climbed were not occupied in the following year. However, Gerrard and Gerrard (1975) found that ∿ 12% of bald eagle pairs would shift nests between years without the trees being climbed, and it thus appears that careful climbing to nests probably does not cause decreased productivity or increased nest shifting.

Human presence can, however, change the behavior of nesting bald eagles. Gerrard *et al.* (1973) found that adult behavior differed significantly at nests that were observed from nearby blinds or time-lapse cameras (< 100 yd) from the behavior at nests that were observed at a greater distance (> 275 yd). Adults spent much less time at the nest and did not visit the nest together. They rearranged the nest material and shuffled on the eggs less often, and they spent more time alertly watching.

Some studies have indicated that nesting densities of bald eagles are lower in areas near disturbance than they are in areas farther removed from disturbance (e.g., Juenemann 1973; Corr 1974). Fraser *et al.* (1980) found that nest distribution was affected by shoreline developments; the eagles tended to select nest sites away from habitations.

Bald eagles have, however, nested near human disturbance in suburbs, near hospitals and schools, and on golf courses (Broley 1952). A nesting population in Washington increased from five to eight pairs in 1963-75, during which time there was a considerable increase in the number of roads and houses within 0.6 mi of active nests (Newman *et al.* 1977).

Ospreys sometimes protest human intrusions near nests, and they have occasionally struck people. They appear to be relatively tolerant of disturbance throughout their nesting cycle (Fyfe and Olendorff 1976; Spitzer 1977), and they appear to be capable of accommodating or habituating to a wide variety of human activities (e.g., Melo 1975; French and Koplin 1977; Grier *et al.* 1977). Ospreys have nested on bridges, near houses, on highway medians, on telephone and power poles, and on a neon sign above a hamburger stand (Zarn 1974; French and Koplin 1977; Olendorff *et al.* 1980; Olendorff, pers. comm.). Reproductive success was not significantly affected by climbing to the nests (Grier *et al.* 1977).

Some ospreys, however, have not accommodated to human presence and disturbance. Increased levels of fishing, boating and hunting may have partially been responsible for a population decline in Virginia (Kennedy 1977). High levels of boating activity may have affected the reproductive success of some ospreys in Chesapeake Bay (Reese 1977; Rhodes 1977).

The number of nesting locations on Yellowstone Lake, Wyoming, has apparently declined since 1924 by ∿ 88% in heavy recreational use areas, but by only ∿ 19% in lightly used areas (Swenson 1975). The nesting success and the number of young per nest were lower within ∿ 0.6 mi of centers of human activity. Most nesting failures were the result of eggs failing to hatch, apparently because adults had spent too much time off their eggs.

3.5.2 Direct Impacts

As in the case of the peregrine falcon (Section 2.5.2), there are several ways in which the construction and operation of a natural gas pipeline could increase the direct impacts to gyrfalcons, rough-legged hawks, golden and bald eagles, and ospreys (as opposed to the impacts of disturbance or habitat loss). However, as with peregrines, it seems doubtful that these direct impacts will be much increased over the low levels that probably already exist along the pipeline corridor.

3.5.2.1 Intentionally Destructive Acts

These impacts may arise secondarily through the activities of the general public who are able to visit raptor areas through increased access, or through the activities of construction or maintenance workers.

Newton (1979a,b) documented some of the impacts of human persecution on raptor populations in Europe. Larger species with slower reproductive rates (such as eagles) were more susceptible to population disruptions at the hands of man than were smaller species. Direct persecution limits the breeding distribution of golden eagles to about half of their potential breeding range in Britain. Shooting and poisoning (both deliberate and accidental) are the main decimating factors.

Illegal shooting of bald eagles continues despite potential fines and jail terms (e.g., Coon *et al.* 1970; Weekes 1974; Postupalsky 1978; Kaiser *et al.* 1980), and golden eagles have been shot in large numbers in some of the western states in recent years. Eagles are large obvious birds that scavenge at carcasses and that may take young livestock or game animals; as such they are probably more likely to be shot than the other species. Golden eagles are often seen feeding on caribou carcasses on the Arctic Slope, and as more people work in and visit the area, it is conceivable that eagles could be subject to shooting.

One of the five species, the gyrfalcon, is more highly prized for domestic and foreign falconry than even the peregrine. Some poaching of nestlings may occur, and adults may be trapped in the winter. Gyrfalcons are also often attracted in winter to people hunting ptarmigan, and some individuals have been shot under those circumstances (J. Burns, pers. comm.).

Rough-legged hawks have also been persecuted by man, and shot in large numbers in some areas (cf. Bent 1937; Gabrielson and Lincoln 1959). They are conspicuous, relatively tame, and easy to approach.

3.5.2.2 Man-made Structures and Obstructions

As in the case of peregrines (Section 2.5.2.2), the other raptors are also subject to collisions with vehicles, aircraft (see Section 3.5.1.2), and various structures. Bald eagles, which are the most likely species to be attracted to camp dumps for scavenging (Sherrod *et al.* 1976), are apparently quite susceptible to collisions with various structures. Injuries from impacts with structures accounted for 18% of the identifiable causes of death in one study (Kaiser *et al.* 1980).

Eagles that have been attracted to dumps may starve if the dump is then closed or they may become nuisances by attacking household pets, etc. (Sherrod *et al.* 1976).

Rough-legged hawks, particularly immatures, may be the most likely species to be attracted to roads in order to catch microtines that cross the roads. Young gyrfalcons have also been seen to perch near roads and to attempt to catch prey on them (Roseneau and Walker, unpubl. data). These birds may be susceptible to collisions with vehicles.

Of the five raptor species, golden eagles (particularly immature birds) are especially prone to electrocutions on power poles that have particular configurations of wires (cf. Benson 1980; Howard and Gore 1980; Peacock 1980). Bald eagles and ospreys are also occasionally killed in this manner. This problem can be avoided by employing various initial design features or by altering the original configuration (Ansell and Smith 1980).

Man-made structures may also supply nest sites for some raptor species. For some tree-nesting raptors (especially ospreys) transmission line towers and poles offer good opportunities for nest-building, and in some regions specially built nest platforms have been installed on transmission towers for use by nesting raptors (Howard and Gore 1980; Van Daele 1980). Some golden eagles have also accepted artificial structures on transmission towers, and ospreys have accepted a wide variety of other artificial nesting structures (cf. Olendorff *et al.* 1980). Rough-legged hawks have also nested on a variety of man-made structures, and it is conceivable that they may attempt to nest in the future on portions of the above ground sections of the TAPS oil line.

3.5.2.3 Environmental Contaminants

All raptor species found in Alaska are contaminated to some degree by various biocides, including organochlorine pesticides and PCB's, but none appear to have been affected to the degree that peregrines have been (Swartz, Walker and Springer, unpubl. data). The need to control the use of these substances in development projects is thus of more concern for peregrines than it is for the other species.

Migratory raptors are generally the species that are most affected by biocide contamination. Of the five species treated in this section, gyrfalcons, which are year-round residents, are the least affected by biocide contamination (cf. Cade *et al.* 1971b; Walker 1977).

The available data do not indicate that any of the four migratory species are unduly endangered by environmental contaminants at this time. Very little is known about the levels of biocide contamination in Alaskan nesting populations of golden eagles, bald eagles or ospreys; however, they are probably less contaminated than populations of these species from more southern latitudes. Because of their food habits and wintering areas, Alaskan bald eagles are unlikely to be in biocide-related trouble. Golden eagles generally appear to be minimally affected at more southern latitudes (e.g., Ellis 1979), and may be less affected in Alaska.

Although rough-legged hawks are migratory, they apparently have never acquired dangerous levels of the more common contaminants (cf. Cade *et al.* 1971b), probably because their diet on their wintering grounds consists principally of microtines. In recent years, a number of Alaskan rough-legged hawk eggs have been analyzed; the level of contamination has continued to remain well below levels that might be considered dangerous (Swartz, Walker and Springer, unpubl. data).

Within Alaska, the sources of chemical contamination to these raptor species are primarily contaminated migratory prey species that have become contaminated on their wintering grounds, and secondarily less contaminated non-migratory species that have become contaminated via atmospheric transport of the contaminants. As a general principle, the use of these chemical contaminants should be avoided in development projects and other activities, even in regions that are still relatively free of them.

The spilling of a toxic material into a waterbody during construction or operation of the pipeline could affect large numbers of fish, and thereby affect nesting bald eagles or ospreys that may be largely dependent on these fish as their food source.

3.5.2.4 Changes in Prey Availability

As in the case of peregrines (Section 2.5.2.4), the numbers of the other raptor species in an area are dependent on the numbers of their available prey species. The dependence is more pronounced in species such as gyrfalcons, rough-legged hawks and ospreys, which are dependent on a comparatively small number of prey species. The prey bases of rough-legged hawks and gyrfalcons both undergo large natural fluctuations, and the numbers of these species nesting in an area will vary greatly from year to year in response to these fluctuations (e.g., numbers of breeding gyrfalcons in an area may decline by up to 75%, and numbers of rough-legged hawks by up to 88% [Swartz *et al.* 1975; White and Cade 1975]). The numbers of breeding golden eagles in northern areas may fluctuate in response to prey availability as they have been shown to do in Idaho (USDI 1979), but there have been no studies to determine whether this does in fact occur. Human impacts on gyrfalcons, rough-legged hawks and possibly golden eagles through impacts on their prey bases would be very difficult to distinguish from these natural fluctuations. The numbers of breeding bald eagles and ospreys in an area apparently do not undergo these fluctuations from year to year.

Human impacts are unlikely to affect the microtine prey base of rough-legged hawks. Ospreys, and to a lesser extent bald eagles, could be affected if the fish were adversely affected at an important feeding area. Gyrfalcons could also be impacted through impacts to their prey base. Such an impact would be most likely to occur in winter, when they are dependent almost entirely on ptarmigan (Roseneau 1972; Swartz *et al.* 1975; Platt 1976; Walker 1977), and would be adversely affected by any development that affected the ability of ptarmigan to winter in areas of shrub willow along streams and rivers.

3.5.3 Habitat Loss

Materials sites are the only pipeline activity that are likely to affect the actual cliff nests of gyrfalcons, rough-legged hawks and golden eagles. Suitable cliff sites for nesting are usually limited, and the loss of any such sites could limit the number of pairs that could nest in the area. The tree nests of bald eagles and ospreys could be destroyed by various construction activities. Because only trees with certain characteristics are suitable for nesting, a lost nest tree may not be easily replaced.

Hunting habitat could also be affected by pipeline construction, but the only cases where it appears likely that raptors might be affected by such impacts would be if construction were to affect an important fishing area of ospreys or important shrub willow areas in river valleys where ptarmigan overwinter and are a critical prey base for gyrfalcons.

The various raptor species have in some cases accepted artificial nests or platforms that have been specifically constructed for them on cliffs, in tree tops or on man-made structures (Olendorff *et al.* 1980). In conjunction with pipeline construction, it would be valuable if suitable ledges for nesting were developed on any cliff faces that are created at materials sites.

3.6 PROTECTIVE MEASURES

The measures that have been proposed to protect the other species of nesting raptors are of the same three basic types as those for peregrines -- spatial restrictions, temporal restrictions and procedural restrictions. Also, as in the case of peregrines, the information on the impacts of developments on other nesting raptors is insufficient to provide precise distances for spatial and procedural restrictions, and consequently, the authors who have recommended protective measures have often urged a cautious approach with the inclusion of a safety margin in case of error.

Most of the protective measures for the other raptor species have been proposed in conjunction with protective measures for peregrines. These restrictions have often been proposed as an overall set of restrictions for raptors generally or for several named species (in northern areas usually peregrines, gyrfalcons, bald and golden eagles and sometimes ospreys). As such, the same distance restrictions have often been recommended for all species, rather than distances that reflect either the sensitivities of the various species or the differing concerns for each species. (In some cases, however, distance restrictions have been separately specified for each species to reflect the differing sensitivities and concerns [e.g., Windsor 1979].) Some of the recommended restrictions that provide a single distance for the various raptor species specify separate time periods for each species during which the restrictions would apply; others have recommended a standard time period for all raptors -- something that is not in keeping with their various reproductive phenologies.

The general characteristics of the various spatial, temporal and procedural restrictions for the other raptor species and the differences among them are similar to those of the peregrine restrictions, as discussed in Sections 2.6.1, 2.6.2, and 2.6.3. The cautionary note in

Section 2.6 concerning the formulation and publication of peregrine restrictions also applies to restrictions for the other raptor species.

Tables 41, 42, 43 and 44 list the various restrictions that have been recommended for ground activities in the north near the nest locations of gyrfalcons, golden eagles, bald eagles and ospreys, respectively. The proposed restrictions are generally similar to those proposed for peregrines, primarily because of the desire of the authors to provide these species with the same degree of protection (with a comparable safety margin). Tables 45, 46, 47 and 48 list the various restrictions that have been recommended for aerial activities in the north in the vicinities of nest locations of gyrfalcons, golden eagles, bald eagles and ospreys, respectively. They are again similar to those for peregrines.

Protective measures for nesting rough-legged hawks have usually not been proposed or else have been proposed in the form of general restrictions for nesting raptors. Five authors have provided specific recommendations or requirements concerning rough-legged hawks. Four authors (Renewable Resources Consulting Services Ltd. 1973; LGL Ltd. 1975; Kessel 1978; Roseneau 1979, as amended in letter of 28 September 1979) have provided recommendations for rough-legged hawks that are identical to their recommendations for golden eagles (Tables 42 and 46). Olendorff and Zeedyck (1978) indicate that government regulations concerning the Trans-Alaskan pipeline provided a buffer zone of 0.5 mi around rough-legged hawk nests, in comparison to zones of 1 mi for eagle nests and 2 mi for peregrine nests.

TABLE 41. Recommended minimum distances for ground activities to protect gyrfalcon nest sites in northern areas.

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
5	-	gas pipeline (Alaska Highway)	Yukon	no blasting without special approval	recommendation	Alaska Highway Pipeline Panel (1978)
5	-	gas pipeline (Alaska Highway)	Yukon	controlled blasting techniques	recommendation	Windsor (1979)
2	1 March[a]- 1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	no ground activities	recommendation	Jacobson (1974)
2	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no roads or facilities without specific approval	recommendation	Jacobson (1974)
2	-	gas pipeline (Alaska Highway)	Yukon	minimum distance pipeline to nest	recommendation	Mossop and Milligan (1977)
2	1 February- 31 July	highway construction	Yukon B.C.	no construction activity	recommendation	Tull (1979)
2	-	gas pipeline (Alaska Highway)	Yukon	will maintain minimum distance where possible[b]	commitment by proponent	National Energy Board (1977)
2	1 February- 31 August	gas pipeline (Alaska Highway)	Yukon	no construction, etc. without specific approval	recommendation	Alaska Highway Pipeline Panel (1978)
2	-	highway construction	Yukon	no camps, roads, quarries	recommendation	Blood and Chutter (1978)
2	1 May- 31 July	highway construction	Yukon	no blasting	recommendation	Blood and Chutter (1978)
2	1 February- 1 August	gas pipeline (Alaska Highway)	Yukon	no construction or related activities any activities within radius subject to site-specific limitations	draft requirement	Northern Pipeline Agency (1978)
2	5 March- 15 June	gas pipeline (Demster Lateral)	Yukon	secondary zone no construction activities wherever possible	recommendation	Hayes and Mossop (1978)

TABLE 41. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
2	-	gas pipeline (Alaska Highway)	Yukon	will consult agency for blasting will monitor nests prior to and during construction	commitment by proponent	Foothills South Yukon (1979)
∿ 2	-	oil pipeline (Alaska Highway)	Yukon	will maintain distance from nest sites wherever possible	commitment by proponent	Foothills Oil (1979)
2	1 April-5 July	gas pipeline (Alaska Highway)	Yukon	no construction wherever possible if construction must occur within 1-2 mi no activities during this period	recommendation	Windsor (1979)
∿ 2	during breeding	general	Yukon	given this disturbance-free radius, raptors can be expected to breed successfully	suggestion	Mossop *et al.* (1978)
1.2	during breeding	general	Yukon	area which should remain unviolated	suggestion	Mossop *et al.* (1978)
1[c]	1 March-1 August	gas pipeline (Arctic Gas)	Alaska	no blasting, heavy equipment or access roads	recommendation	Renewable Resources Consulting Services Ltd. (1973)
1	5 March-15 June	gas pipeline (Dempster Lateral)	Yukon	no construction activities	recommendation	Hayes and Mossop (1978)
1	-	gas pipeline (Northwest Alaskan)	Alaska	safe distance for most activities	discussion	Kessel (1978)
1	-	general (Sagwon Bluffs)	Alaska	no fire suppression	proposed regulation	Capodice (1979)
1	1 April-31 July	gas pipeline (Alaska Highway)	Yukon	will attempt to schedule construction outside period	commitment by proponent	Foothills South Yukon (1979)
1	1 March-1 September	gas pipeline (Northwest Alaskan)	Alaska	no human activities unless specifically authorized	recommendation	Roseneau (1979)[d]
1	15 January-30 August	gas pipeline (Alaska Highway)	Yukon	if construction must occur within 1 mi no activities during this period	recommendation	Windsor (1979)

TABLE 41. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
0.5	-	general	Alaska	should be declared critical habitat	recommendation	White and Cade (1975)
0.5	-	general	Alaska	no permanent structures	recommendation	Haugh and Halperin (1976)
0.2	-	gas pipeline (Arctic Gas)	Alaska	no human presence	recommendation	Renewable Resources Consulting Services Ltd. (1973)
-	-	recreation	Alaska	no recreational activity on any nesting cliff	recommendation	Haugh and Halperin (1976)

[a] Possibly earlier.

[b] For rare or endangered raptors.

[c] Tentative.

[d] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 42. Recommended minimum distances for ground activities to protect golden eagle nest sites in northern areas.

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
5	-	gas pipeline (Alaska Highway)	Yukon	no blasting without special approval	recommendation	Alaska Highway Pipeline Panel (1978)
5	-	gas pipeline (Alaska Highway)	Yukon	controlled blasting techniques	recommendation	Windsor (1979)
2.5	1 May-15 August	park development	Yukon	no quarries, blasting, heavy equipment	recommendation	Theberge and Gauthier (1978)
2	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	no ground activities	recommendation	Jacobson (1974)
2	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no roads or facilities without specific approval	recommendation	Jacobson (1974)
2	-	gas pipeline (Alaska Highway)	Yukon	minimum distance pipeline to nest	recommendation	Mossop and Milligan (1977)
2	-	gas pipeline (Alaska Highway)	Yukon	will maintain minimum distance where possible[a]	commitment by proponent	National Energy Board (1977)
2	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	no construction, etc. without specific approval	recommendation	Alaska Highway Pipeline Panel (1978)
2	-	highway construction	Yukon	no camps, roads, quarries	recommendation	Blood and Chutter (1978)
2	1 May-31 July	highway construction	Yukon	no blasting	recommendation	Blood and Chutter (1978)
2	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	no construction or related activities any activities within radius subject to site-specific limitations	draft requirement	Northern Pipeline Agency (1978)
2	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	secondary zone no construction activities wherever possible	recommendation	Hayes and Mossop (1978)

TABLE 42. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
2	-	gas pipeline (Alaska Highway)	Yukon	will consult agency for blasting will monitor nests prior to and during construction	commitment by proponent	Foothills South Yukon (1979)
∿ 2	-	oil pipeline (Alaska Highway)	Yukon	will maintain distance from nest sites wherever possible	commitment by proponent	Foothills Oil (1979)
2	1 April-31 July	highway construction	Yukon B.C.	no construction activity	recommendation	Tull (1979)
2	1-15 August	highway construction	Yukon B.C.	no particularly disturbing activities	recommendation	Tull (1979)
∿ 2	during breeding	general	Yukon	given this disturbance-free radius, raptors can be expected to breed successfully	suggestion	Mossop *et al.* (1978)
1.7	18 March-30 June	gas pipeline (Alaska Highway)	Yukon	no construction wherever possible if construction must occur within 1-2 mi no activities during this period	recommendation	Windsor (1979)
1.2	during breeding	general	Yukon	area which should remain unviolated	suggestion	Mossop *et al.* (1978)
1[b]	1 May-15 August	gas pipeline (Arctic Gas)	Alaska	no blasting, heavy equipment or access roads	recommendation	Renewable Resources Consulting Services Ltd. (1973)
1	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	no construction activities	recommendation	Hayes and Mossop (1978)
1	-	gas pipeline (Northwest Alaskan)	Alaska	safe distance for most activities	discussion	Kessel (1978)
1	-	oil pipeline (Trans-Alaskan)	Alaska	buffer zone	government requirement	Oldendorff and Zeedyck (1978)

TABLE 42. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1	1 April-31 July	gas pipeline (Alaska Highway)	Yukon	will attempt to schedule construction outside period	commitment by proponent	Foothills South Yukon (1979)
1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	no human activities unless specifically authorized	recommendation	Roseneau (1979)[c]
1	18 March-29 August	gas pipeline (Alaska Highway)	Yukon	if construction must occur within 1 mi no activities during this period	recommendation	Windsor (1979)
0.5	-	general	Alaska	no permanent structures	recommendation	Haugh and Halperin (1976)
0.2	-	gas pipeline (Arctic Gas)	Alaska	no human presence	recommendation	Renewable Resources Consulting Services Ltd. (1973)
-	-	recreation	Alaska	no recreational activity on any nesting cliff	recommendation	Haugh and Halperin (1976)

[a] For rare or endangered raptors.

[b] Tentative.

[c] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 43. Recommended minimum distances for ground activities to protect bald eagle nest sites in northern areas.

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
5	-	gas pipeline (Alaska Highway)	Yukon	no blasting without special approval	recommendation	Alaska Highway Pipeline Panel (1978)
5	-	gas pipeline (Alaska Highway)	Yukon	controlled blasting techniques	recommendation	Windsor (1979)
2	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	no ground activities	recommendation	Jacobson (1974)
2	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no roads or facilities without specific approval	recommendation	Jacobson (1974)
2	-	gas pipeline (Alaska Highway)	Yukon	minimum distance pipeline to nest	recommendation	Mossop and Milligan (1977)
2	-	gas pipeline (Alaska Highway)	Yukon	will maintain minimum distance where possible[a]	commitment by proponent	National Energy Board (1977)
∿ 2	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	no construction, etc. without specific approval	recommendation	Alaska Highway Pipeline Panel (1978)
2	-	highway construction	Yukon	no camps, roads, quarries	recommendation	Blood and Chutter (1978)
2	1 May-31 July	highway construction	Yukon	no blasting	recommendation	Blood and Chutter (1978)
2	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	secondary zone no construction activities wherever possible	recommendation	Hayes and Mossop (1978)
2	-	gas pipeline (Alaska Highway)	Yukon	will consult agency for blasting will monitor nests prior to and during construction	commitment by proponent	Foothills South Yukon (1979)
∿ 2	-	oil pipeline (Alaska Highway)	Yukon	will maintain distance from nest sites wherever possible	commitment by proponent	Foothills Oils (1979)
2	1 April-31 July	highway construction	Yukon B.C.	no construction activity	recommendation	Tull (1979)
2	1-15 August	highway construction	Yukon B.C.	no particularly disturbing activities	recommendation	Tull (1979)

TABLE 43. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	no construction activities	recommendation	Hayes and Mossop (1978)
1	-	gas pipeline (Northwest Alaskan)	Alaska	safe distance for most activities	discussion	Kessel (1978)
1	-	oil pipeline (Trans-Alaskan)	Alaska	buffer zone	government requirement	Oldendorff and Zeedyck (1978)
1	1 April-31 July	gas pipeline (Alaska Highway)	Yukon	will attempt to schedule construction outside period	commitment by proponent	Foothills South Yukon (1979)
1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	no human activities unless specifically authorized	recommendation	Roseneau (1979)[b]
1	1 April-15 September	gas pipeline (Alaska Highway)	Yukon	if construction must occur within 1 mi no activities during this period	recommendation	Windsor (1979)

[a] For rare or endangered raptors.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 44. Recommended minimum distances for ground activities to protect osprey nest sites in northern areas.

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
5	-	gas pipeline (Alaska Highway)	Yukon	no blasting without special approval	recommendation	Alaska Highway Pipeline Panel (1978)
5	-	gas pipeline (Alaskan Highway)	Yukon	controlled blasting techniques	recommendation	Windsor (1979)
2	1 March- 1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	no ground activities	recommendation	Jacobson (1974)
2	-	gas pipeline (Arctic Gas)	Yukon N.W.T.	no roads or facilities without specific approval	recommendation	Jacobson (1974)
2	-	gas pipeline (Alaska Highway)	Yukon	minimum distance pipeline to nest	recommendation	Mossop and Milligan (1977)
2	-	gas pipeline (Alaska Highway)	Yukon	will maintain minimum distance where possible[a]	commitment by proponent	National Energy Board (1977)
~ 2	1 March- 31 August	gas pipeline (Alaska Highway)	Yukon	no construction, etc. without specific approval	recommendation	Alaska Highway Pipeline Panel (1978)
2	-	highway construction	Yukon	no camps, roads, quarries	recommendation	Blood and Chutter (1978)
2	1 May- 31 July	highway construction	Yukon	no blasting	recommendation	Blood and Chutter (1978)
~ 2	1 March 31 August	gas pipeline (Alaska Highway)	Yukon	no construction or related activities any activities within radius subject to site-specific limitations	draft requirement	Northern Pipeline Agency (1978)
2	-	gas pipeline (Alaska Highway)	Yukon	will consult agency for blasting will monitor nests prior to and during construction	commitment by proponent	Foothills South Yukon (1979)
~ 2	-	oil pipeline (Alaska Highway)	Yukon	will maintain distance from nest sites wherever possible	commitment by proponent	Foothills Oil (1979)

TABLE 44. (continued)

Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1	-	gas pipeline (Northwest Alaskan)	Alaska	safe distance for most activities	discussion	Kessel (1978)
1	1 April-31 July	gas pipeline (Alaska Highway)	Yukon	will attempt to schedule construction outside period	commitment by proponent	Foothills South Yukon (1979)
1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	no human activities unless specifically authorized	recommendation	Roseneau (1979)[b]
1	1 April-15 September	gas pipeline (Alaska Highway)	Yukon	if construction must occur within 1 mi no activities during this period	recommendation	Windsor (1979)

[a] For rare or endangered raptors.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 45. Recommended minimum distances for aircraft activities to protect gyrfalcon nest sites in northern areas.

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
3300	-	-	gas pipeline (Alaska Highway)	Yukon	height above lowest suspected elevation within 2 mi	recommendation	Windsor (1979)
2700	-	-	gas pipeline (Alaska Highway)	Yukon	height above nearest ground level	recommendation	Windsor (1979)
2500	2.5	1 February-31 July	gas pipeline (Arctic Gas)	Yukon N.W.T.	only essential flights within radius	recommendation	LGL Ltd. (1975)
2000	-	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	minimum altitude above ground level	recommendation	Jacobson (1974)
2000	-	1 February-31 August	gas pipeline (Alaska Highway)	Yukon	minimum altitude	recommendation	Alaska Highway Pipeline Panel (1978)
2000	1	5 March-15 June	gas pipeline (Dempster Lateral)	Yukon	if cannot avoid 1 mi radius, maintain minimum altitude wherever and whenever safe	recommendation	Hayes and Mossop (1978)
1500	-	1 April-30 August	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Kessel (1978)
1500	1	15 April-15 August	general (Sagwon Bluffs)	Alaska	minimum altitude curtail use of nearby airport	proposed regulation	Capodice (1979)
1500	1	1 March-1 September	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Roseneau (1979)[b]
1500	1	-	gas pipeline (Alaska Highway)	Yukon	height above nest level for surveillance of line if numerous nests make routing complex, bypass nests by minimum of 0.6 mi	recommendation	Windsor (1979)
1000	-	15 April-15 September	gas pipeline (Mackenzie Valley)	N.W.T.	minimum altitude	commitment by proponent	National Energy Board (1977)

TABLE 45. (continued)

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Kochert (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Zeedyck (1978)
-	0.6	-	gas pipeline (Alaska Highway)	Yukon	no flights within 0.6 mi of nests	recommendation	Schmidt (1977)
-	-	-	gas pipeline (Arctic Gas)	Alaska	avoid use of aircraft in immediate vicinity of nests no helicopter landings near nests	recommendation	Renewable Resources Consulting Services Ltd. (1973)

[a] Metric altitudes have been converted and rounded to the nearest 100 ft.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 46. Recommended minimum distances for aircraft activities to protect golden eagle nest sites in northern areas.

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
3300	-	-	gas pipeline (Alaska Highway)	Yukon	height above lowest suspected elevation within 2 mi	recommendation	Windsor (1979)
2700	-	-	gas pipeline (Alaska Highway)	Yukon	height above nearest ground level	recommendation	Windsor (1979)
2500	2.5	15 May-31 August	gas pipeline (Arctic Gas)	Yukon N.W.T.	only essential flights within radius	recommendation	LGL Ltd. (1975)
2000	-	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	minimum altitude above ground level	recommendation	Jacobson (1974)
2000	-	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	minimum altitude	recommendation	Alaska Highway Pipeline Panel (1978)
2000	1	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	if cannot avoid 1 mi radius, maintain minimum altitude wherever and whenever safe	recommendation	Hayes and Mossop (1978)
1500	-	1 April-30 August	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Kessel (1978)
1500	1	-	gas pipeline (Alaska Highway)	Yukon	height above nest level for surveillance of line if numerous nests make routing complex, bypass nests by minimum of 0.6 mi	recommendation	Windsor (1979)
1000	-	15 April-15 September	gas pipeline (Mackenzie Valley)	N.W.T.	minimum altitude	commitment by proponent	National Energy Board (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Kochert (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Zeedyck (1978)

TABLE 46. (continued)

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
-	0.6	-	gas pipeline (Alaska Highway)	Yukon	no flights within 0.6 mi of nests	recommendation	Schmidt (1977)
-	-	-	gas pipeline (Arctic Gas)	Alaska	avoid use of aircraft in immediate vicinity of nests no helicopter landings near nests	recommendation	Renewable Resources Consulting Services Ltd. (1973)

[a]Metric altitudes have been converted and rounded to the nearest 100 ft.

[b]As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 47. Recommended minimum distances for aircraft activities to protect bald eagle nest sites in northern areas.

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
3300	-	-	gas pipeline (Alaska Highway)	Yukon	height above lowest suspected elevation within 2 mi	recommendation	Windsor (1979)
2700	-	-	gas pipeline (Alaska Highway)	Yukon	height above nearest ground level	recommendation	Windsor (1979)
2500	2.5	15 May-31 August	gas pipeline (Arctic Gas)	Yukon N.W.T.	only essential flights within radius	recommendation	LGL Ltd. (1975)
2000	-	1 March-1 September	gas pipeline (Arctic Gas)	Yukon N.W.T.	minimum altitude above ground level	recommendation	Jacobson (1974)
2000	-	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	minimum altitude	recommendation	Alaska Highway Pipeline Panel (1978)
2000	1	7 April-31 July	gas pipeline (Dempster Lateral)	Yukon	if cannot avoid 1 mi radius, maintain minimum altitude wherever and whenever safe	recommendation	Hayes and Mossop (1978)
1500	-	1 April-30 August	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Kessel (1978)
1500	1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Roseneau (1979)[b]
1500	1	-	gas pipeline (Alaska Highway)	Yukon	height above nest level for surveillance of line if numerous nests make routing complex, bypass nests by minimum of 0.6 mi	recommendation	Windsor (1979)
1000	1	15 April-15 September	gas pipeline (Mackenzie Valley)	N.W.T.	minimum altitude	commitment by proponent	National Energy Board (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Kochert (1977)

TABLE 47. (continued)

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Zeedyck (1978)
-	0.6	-	gas pipeline (Alaska Highway)	Yukon	no flights within 0.6 mi of nests	recommendation	Schmidt (1977)

[a] Metric altitudes have been converted and rounded to the nearest 100 ft.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

TABLE 48. Recommended minimum distances for aircraft activities to protect osprey nest sites in northern areas.

Minimum Altitude (ft)[a]	Distance of Avoidance (mi)	Timing of Avoidance	Activity	Location	Restriction	Type of Restriction	Reference
3300	-	-	gas pipeline (Alaska Highway)	Yukon	height above lowest suspected elevation within 2 mi	recommendation	Windsor (1979)
2700	-	-	gas pipeline (Alaska Highway)	Yukon	height above nearest ground level	recommendation	Windsor (1979)
2000	-	1 March-31 August	gas pipeline (Alaska Highway)	Yukon	minimum altitude	recommendation	Alaska Highway Pipeline Panel (1978)
1500	-	1 April-30 August	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Kessel (1978)
1500	1	15 April-1 September	gas pipeline (Northwest Alaskan)	Alaska	minimum altitude	recommendation	Roseneau (1979)[b]
1500	1	-	gas pipeline (Alaska Highway)	Yukon	height above nest level for surveillance of line if numerous nests make routing complex, bypass nests by minimum of 0.6 mi	recommendation	Windsor (1979)
1000	-	15 April-15 September	gas pipeline (Mackenzie Valley)	N.W.T.	minimum altitude	commitment by proponent	National Energy Board (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Kochert (1977)
1000	1	nesting season	oil pipeline (Trans-Alaskan)	Alaska	minimum altitude	government requirement	Olendorff and Zeedyck (1978)
-	0.6	-	gas pipeline (Alaska Highway)	Yukon	no flights within 0.6 mi of nests	recommendation	Schmidt (1977)

[a] Metric altitudes have been converted and rounded to the nearest 100 ft.

[b] As amended in letter to Fluor Northwest, Inc., 28 September 1979.

3.7 PROPOSED PROTECTIVE MEASURES FOR NWA PIPELINE

3.7.1 State of Alaska Protective Measures

3.7.1.1 General Restrictions

Table 49 lists the State of Alaska temporal and spatial protection criteria for nesting raptors that are currently in force for the NWA pipeline. The state measures apply to other species as well as nesting raptors, but the raptor measures are the only ones discussed here. The protection measures for peregrines are discussed in Section 2.7.2.

The protection measures consist of spatial criteria around nest locations, within which various pipeline activities are prohibited during sensitive periods. In addition to the peregrine falcon, protection measures are applied to the nest locations of five other raptor species (gyrfalcon, rough-legged hawk, golden eagle, bald eagle and osprey). The spatial and temporal protection criteria differ for the various raptor species. The general restrictions are discussed in this section; the temporal and spatial criteria for the individual species are discussed in Sections 3.7.2 and 3.7.3, respectively.

The aerial activity restriction prohibits flights of fixed-wing aircraft and helicopters near nest locations. It restricts aircraft so that they maintain either a specified distance from the nest location or a specified altitude above the nest location during a specified time period. The radii of avoidance, altitudes, and time periods are separately specified for each raptor species. The restriction does not specify whether the altitude to be maintained is the altitude above nest level, cliff (or tree) top or base of the cliff (or tree). The restriction should state that the altitude is the height above either the nest level or the cliff (or tree) top.

TABLE 49. State of Alaska temporal and spatial protection criteria for nesting raptors.[1]

Species	Sensitive Time Period	Protection Criteria: Aerial Activity[2]	Minor Ground Activity	Major Ground Activity	Facility Siting	Habitat Disturbance
Peregrine falcon	15 April-31 August	1 mi h or 1500 ft v	1 mi	2 mi	2 mi	2 mi
Gyrfalcon	15 February-15 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	-
Golden eagle	15 April-31 August	1/2 mi h or 1000 ft v	1/4 mi	1/2 mi	1/2 mi	-
Rough-legged hawk	15 April-31 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	-
Bald eagle	15 March[3]-15 August	1/4 mi h or 1000 ft v	1/8 mi	1/4 mi	1/2 mi	1/8 mi
Osprey	15 March-15 August	1/4 mi h or 1000 ft v	1/8 mi	1/4 mi	1/2 mi	1/8 mi

[1] Extracted from 'Sensitive wildlife areas of the Northwest Alaskan gas pipeline corridor', C. E. Behlke, State Pipeline Coordinator, letter to E. A. Kuhn, NWA, 15 July 1980.

[2] h = horizontal; v = vertical.

[3] 1 March for areas between mileposts 472 and 573 (Tanana River from near North Pole to near Gerstle River).

Explanatory Notes

Raptor nest sites are assumed occupied until June 1 each year. After that date, protection measures for a specific nest site can be withdrawn for the remainder of the year if the nest is documented to be non-active.

It should be noted that any activity, disturbance, or habitat alteration that may affect historic or currently active peregrine falcon nest sites must be reviewed by the U.S. Fish and Wildlife Office, Office of Endangered Species, to evaluate the potential for detrimental impacts to the welfare of this endangered species.

Restrictions - The restriction columns provide temporal and spatial protection measures necessary to minimize disturbance to sensitive wildlife areas from aerial activity, minor ground activity, major ground activity, and the siting and operation of facilities.

Aerial activities include the potential disturbance effects from both fixed-wing aircraft and helicopters. The disturbance and 'startling' impacts of low-level aircraft activity are of particular concern during ...raptor nesting... .

Minor ground activity is characterized by limited, short-term, reconnaissance and exploration-type programs that do not involve significant amounts of personnel, equipment, surface disturbance, or noise. Examples of minor ground activity include foot reconnaissance, field inventories, topographic surveys, resistivity surveys, and some borehole/test pit exploration activities.

Major ground activity is characterized by extensive construction-related disturbance involving significant amounts of personnel, equipment, surface disturbance, noise, or vehicular activity. The duration of this disturbance may be either short-term or long-term, but the magnitude of overall activity is such that sensitive wildlife areas could be adversely affected. Typical major ground activities include clearing, pad construction, blasting, ditching, pipe laying, materials site development, and facility construction.

Facility Siting - The concerns of facility siting in proximity to sensitive wildlife areas include the long-term impacts of facility operation during duration of the project and the effects of habitat alteration on the integrity of wildlife use areas. Continuously occupied or operating facilities may generate noise or activity disturbance that could preclude wildlife occupation of a sensitive use area for the duration of the project. Alteration of adjacent habitats beyond the boundary of a defined wildlife use area may also discourage or preclude continued use of a sensitive area by wildlife.

The minor ground activity restriction prohibits minor ground activity within a specified radius of a nest location during a specified time period. The radii of avoidance and time periods are separately specified for each raptor species. Minor ground activities are considered to be those characterized by 'limited, short-term reconnaissance and exploration-type programs that do not involve significant amounts of personnel, equipment, surface disturbance, or noise'.

The major ground activity restriction similarly prohibits major ground activity within a specified radius of a nest location during a specified time period. The radii of avoidance and time periods are again separately specified for each raptor species. Major ground activity is considered to be 'characterized by extensive construction-related disturbance involving significant amounts of personnel, equipment, surface disturbance, noise, or vehicular activity'. Its duration may be short- or long-term, but 'the magnitude of overall activity is such that sensitive wildlife areas could be adversely affected'. We disagree with this definition because there is a possibility that some ground activities might not fit the definitions of either 'minor' or 'major' ground activities and would then not be subject to any restrictions. We would suggest instead that the definition of major ground activity be any ground activity that does not fit the definition of minor ground activity.

The facility siting restriction would prohibit the location of pipeline facilities within a specified distance (separately specified for each raptor species) of nesting locations. Because the restriction applies to permanent facilities, there is no temporal criteria for this restriction. The restriction is primarily to prevent long-term impacts from the operation of facilities near nest locations.

The facilities that are prohibited are not listed for the general restriction, but the table of site-specific restrictions lists compressor and metering stations and camps. From the activities listed under major ground activities, the pipeline ROW is not included as a permanent facility and can be built within the radius of avoidance for permanent facilities. Two operational problems arise if the ROW is within various radii of avoidance. If the pipeline ROW is built within the radii of avoidance for aerial activity, then operational surveillance flights must maintain the avoidance altitudes within the radii of avoidance during the sensitive periods. Similarly, if the ROW is built within the radii of avoidance for major ground activity, then maintenance activities of a major nature, particularly emergency repairs, could not be conducted within the radii of avoidance during sensitive periods.

There is also a habitat alteration restriction that prohibits habitat alterations within a specified distance of nesting locations. The distance is again specified separately for each species. There is also no temporal criteria for this restriction; it applies year-round. Unfortunately, the term 'habitat alteration' is not defined and the meaning of this restriction is not clear. We have interpreted this habitat alteration restriction to prohibit major ground activity within the radii of avoidance throughout the year.

Although it is not so stated under the general restriction, the habitat alteration restriction is evidently intended to apply only to bald eagle and osprey nest locations (as well as peregrine falcons). This interpretation is evident from the table of site-specific restrictions that accompany the general restrictions. This restriction thus provides protection for the nest trees of bald eagles and ospreys and their immediate vicinities. There is not, however, any protection for the actual nesting cliffs of gyrfalcons, rough-legged hawks and golden eagles.

Unlike the USFWS recommended restrictions, there is no provision in the state protective measures whereby an exemption to a restriction can be granted at a particular location if specific authorization is obtained. There will undoubtedly be instances at specific locations where exemptions are requested and where it is judged that the exemption can be granted without harming the nesting raptors. Accordingly, we recommend that provision be made in these restrictions for exemptions, provided that specific authorization is granted for each exemption on a site-by-site basis.

The state protection measures include the provision to relax the aerial, minor ground and major ground activity restrictions after 1 June at nest locations that are non-active. Documentation of non-activity at a nest location would require that monitoring of the nest locations be conducted each year. The term 'non-active' is not defined; we recommend that nest locations with either a pair of birds or a single bird in attendance be considered as active (as in the definition for peregrines).

The date of 1 June for the relaxation of these restrictions appears to be reasonable in view of the nesting phenologies of the various species; all should be in attendance at nest sites by 1 June (Section 3.3). The restrictions could possibly be relaxed at an earlier date for at least one earlier-nesting species, the gyrfalcon. But because later-arriving species (rough-legged hawks, and in come cases golden eagles) may use the same nest site if it is not in use, it is desirable to use the date of 1 June in all cases. It may also be desired by the State to have a single date whereby all monitoring has been completed and relaxations can be granted on a site-specific basis.

Unlike the USFWS recommended restrictions, there is no provision for further relaxation of the restrictions according to whether the nest location is 'likely' or 'not likely' to be occupied. The nesting histories at the nest locations of these species are more poorly known than the histories of peregrine nest locations, and consequently there is little basis for determining likelihood of occupancy. Because the nests are 'likely' to be occupied and because the radii of avoidance are less than those for peregrines, there is probably less likelihood of exemptions to the restrictions for the other raptors than there is to the restrictions for peregrines.

Unlike the USFWS recommended restrictions, the state protection measures contain no measure to prohibit the use of pesticides and other pollutants in the vicinity of nest locations, no measure to ensure that plans, activities, etc. near nest locations are reviewed by a biologist, and no measure to ensure that all surveys and any exemptions to the protection measures are first approved by the state. We recommend that such restrictions should be added to the state protection measures.

3.7.1.2 Temporal Criteria

The state protective measures concerning aerial activities and minor and major ground activities apply during sensitive time periods that are defined for each species. Our comments on these time periods are based on the breeding phenologies of these species as outlined in Section 3.3

The provision for gyrfalcons precludes these activities in the vicinity of nest locations between 15 February and 15 August. We are in agreement with this timing. Gyrfalcons are often resident at nest cliffs during the winter and may begin their courtship activities during late February. Although their young have often fledged by the latter part of July, some do not fledge until mid-August.

We recommend that two time periods be established for rough-legged hawk nest locations, according to whether the nest site is likely to be taken over by gyrfalcons. Some rough-legged hawk nests are very likely to be occupied in later years by gyrfalcons. These nests can usually be identified from their nest characteristics, and we have designated them as rough-legged hawk (gyrfalcon) nests in Section 3.8. These particular rough-legged hawk nest locations should receive the same temporal protection as gyrfalcons (i.e., beginning 15 February). This protection would then assure that gyrfalcons nesting at these sites (which they are quite likely to do) would receive protection from the impacts of the various procedures during their sensitive period. The monitoring surveys would determine by 1 June the species occupying the site and the corresponding termination time for the restrictions (1 June if unoccupied). For rough-legged hawk nest locations that are unlikely to be occupied by gyrfalcons, we are in agreement with a starting date for restrictions of 15 April. We are also in agreement with a termination date of 31 August for restrictions at all occupied rough-legged hawk nests.

The commencement date for restrictions at golden eagle nest locations is too late. Golden eagles often arrive at their nest locations and begin courtship activities in March or early April. We recommend that the commencement date for restrictions be 1 April. We are in agreement with the termination date for restrictions of 31 August; most young golden eagles have fledged by this date.

We are in agreement with the commencement dates for restrictions near bald eagle nest locations. Bald eagles are early migrants, and the restrictions should be in place by 15 March. Bald eagles may also be resident along parts of the Tanana River in some years, and they could be in attendance at nests in that area at an earlier date. It is for this reason that restrictions on the Tanana between North Pole and the Gerstle River commence on 1 March. We disagree, however, with the termination date for bald eagle restrictions. Some young bald eagles do not fledge until late August or even early September, and we recommend a termination date for these restrictions of 31 August.

The commencement and termination dates for restrictions at osprey nest sites are too early. Ospreys arrive considerably later than bald eagles, and the restrictions need not apply until 15 April. The restrictions should, however, extend until 31 August, by which time most young ospreys will have fledged.

3.7.1.3 Spatial Criteria

The state protective measures prohibit the various activities within various distances of the nest locations. These distances are defined for each species. Because there is no information available that will provide the precise distances at which nesting raptors will not be affected by pipeline activities, the distances in the restrictions are judgements as to the distances needed to ensure that impacts are at levels that can be tolerated by the various species.

The distances of avoidance that are provided in the state protective measures are generally considerably less than the various distances of avoidance that have been recommended for northern projects (Tables 41-48). The various recommended distances have usually not reflected the lessened concern for the other species in comparison with the concern for peregrines; they have consequently included as large a safety margin for the other species as they have for peregrines. We feel that the state protective measures represent a good compromise between the sensitivity of the other raptor species and the lessened concern for them relative to peregrines. We are consequently in general agreement with the distances of avoidance in the state protective measures.

The restrictions prohibit aircraft overflights at altitudes less than 1000 ft over nest locations (presumably 1000 ft above the nest level or cliff top). This restriction applies within a specified distance from the nest location; the distance varies according to the species. The altitude restriction of 1000 ft applies for the five raptor species that are considered. It is a less severe restriction than that for peregrines (1500 ft). The only detailed study of aircraft overflights of these species indicated that some gyrfalcons were disturbed at overflights of 1000 and 1200 ft (Platt and Tull 1977). These were gyrfalcons that were comparatively unhabituated to aircraft; gyrfalcons and other raptors along the NWA pipeline would probably be more habituated. For this reason, and because there is more concern for peregrines than for these species, we are in agreement with a 1000 ft altitude restriction above nest levels (or cliff tops) within the various radii of avoidance.

The restrictions provide that permanent facilities be located at least 1/2 mi from the nest locations of all of the five other raptor species. This restriction is to ensure that the birds do not suffer long-term disturbance impacts from the day-to-day human activities at these facilities, and hopefully, to ensure that the birds are not molested by personnel at the facilities. We are in agreement with this restriction; 1/2 mi should ensure that the facilities are not visible from most nests in trees, and the distance plus the probable higher altitude of nests on cliffs should ensure that cliff-nesting species are comparatively little affected.

The radii of avoidance are greatest for the golden eagle (1/2 mi for aerial and major ground activity; 1/4 mi for minor ground activity). Golden eagles are the most sensitive of the other raptor species to both aerial and ground activities. A distance of avoidance of 1/2 mi is probably the best possible compromise between the concern for the sensitivity of this species and the lesser concern for golden eagles than for peregrines. We agree with the spatial restriction of 1/2 mi for aerial and major ground activity; we also agree with the restriction of 1/4 mi for minor ground activity, provided that the included activities (e.g., some borehole/test pit exploration activities) are short-term, quiet, well below (at least 100 ft) the nest level, and do not occur during incubation.

The spatial restrictions are identical for gyrfalcons and rough-legged hawks (1/4 mi for aerial activity and for major and minor ground activities). Both species are less sensitive than golden eagles, and the restrictions are accordingly less strict. We agree that all ground activity (both minor and major) should be prohibited within 1/4 mi of the nest locations during the sensitive periods, because of the open terrain that these species usually inhabit. It is also good that the protective measures are identical for the two species, because of the likelihood that gyrfalcons will occupy rough-legged hawk nests in successive years.

The state protective measures contain no provision to protect the actual nest locations of the cliff-nesting golden eagle, gyrfalcon or rough-legged hawk. Materials sites or other activities that could destroy a nest cliff or bluff could be permitted under the state restrictions, provided that the activity occurred during the non-sensitive period. We recommend that the restriction that prohibits habitat disturbance within 1/8 mi of bald eagle and osprey nest locations be extended to the nest locations of golden eagles, gyrfalcons and rough-legged hawks. This measure would protect the nest cliff and immediate vicinity (to a distance of 1/8 mi) from all habitat alteration; the additional distance from 1/8 mi to 1/4 mi (gyrfalcon, rough-legged hawk) or 1/2 mi (golden eagle) would be protected during the sensitive periods.

The spatial restrictions are identical for the tree-nesting bald eagle and osprey (1/4 mi for aerial and major ground activity and 1/8 mi for minor ground activity and habitat disturbance). These species are sensitive to disturbance, but less so that golden eagles; the radii of avoidance are accordingly smaller. We are in agreement with the distance of 1/4 mi for aerial and major ground activity and 1/8 mi for habitat disturbance, but we recommend that the distance for minor ground activity be extended to prohibit minor ground activity within 1/4 mi during the sensitive period. This change would prohibit all activity within 1/4 mi of nest locations during the sensitive periods -- a distance that we feel is necessary to protect these birds from human presence near the nest sites during nesting activities.

Although the radii of avoidance for aerial activity near nest locations (1/2 mi for golden eagle; 1/4 mi for other species) are probably sufficient to prevent major disturbance to the birds, they are insufficient to prevent agressive gyrfalcons, ospreys or bald eagles from attacking aircraft. All of these species have been known to attack aircraft. Pilots may consequently prefer to remain farther than the radii of avoidance from these nests. Gyrfalcons are highly maneuverable and can probably avoid collisions provided the aircraft does not change course suddenly, but eagles and ospreys are less maneuverable and there is more likelihood of collisions with these species. Cautious flying near nest locations should be practiced during the appropriate sensitive periods and throughout the year near gyrfalcon nest locations.

3.7.1.4 Specific Sites

The State of Alaska general protective measures are accompanied by a list of sensitive wildlife areas along the NWA gas pipeline corridor. The list of raptor nest locations that they have included is taken from Roseneau and Bente (1979) but is not complete. It apparently lists only the nest locations that were active in 1979 in a corridor of several miles in width. However, it is only those raptor nest locations (other than peregrines) that are within 1/2 mi of the current pipeline alignment (NWA Environmental Master Guide alignment sheets dated April 1980) or facility or materials sites that may possibly be in conflict with the state protective measures. (The other locations must be considered in the event of any realignment.) There are also a few additional nest locations that were found in 1980 within 1/2 mi of the current pipeline alignment or materials sites.

In Section 3.8 we discuss the potential conflicts between the proposed pipeline and facilities and all the nest locations (of gyrfalcon, rough-legged hawk, golden eagle, bald eagle, and osprey) that we are aware of within 1/2 mi of the current pipeline alignment or any facility sites. In Section 3.8 we also make recommendations on a site-by-site basis as to any exemptions that should be granted for any of the specific conflicts between the nest locations and the pipeline alignment.

3.7.2 Other Protective Measures

Bald eagles and golden eagles are specifically protected under the U.S. Bald Eagle Act of 1940 (as subsequently amended). A part of this act prohibits the 'taking' of any bald or golden eagle or the nests or eggs of such birds without a permit. 'Take' is defined to include molest or disturb. There are also state laws that provide similar protection for these and the other raptor species.

It is not clear to what extent such laws will apply to the NWA pipeline with respect to disturbance to raptors, because it may be a matter of opinion whether raptors are still being disturbed in spite of compliance with the state protective measures. It may hence be necessary to obtain additional permits under these laws so that any disturbance at distances greater than those under the state protective measures would be legal.

3.8 POTENTIAL PIPELINE CONFLICTS WITH NEST LOCATIONS

This section discusses, on a site-by-site basis, the nest locations of the other raptors that are found within 1/2 mi of the proposed Northwest Alaskan pipeline alignment or any material or facility sites (according to the NWA Environmental Master Guide alignment sheets dated April 1980). Potential conflicts between NWA plans and the State of Alaska protective measures (as modified according to our recommendations in Section 3.7) are discussed, and we have made a number of site-specific recommendations concerning these conflicts.

This section is contained in Volume II because of the sensitive nature of the nest site information.

3.9 RECOMMENDATIONS

The following recommendations, which have, for the most part, been developed in Sections 3.7 and 3.8, are summarized here as a protection strategy for gyrfalcons, rough-legged hawks, golden eagles, bald eagles and ospreys along the proposed NWA gas pipeline.

3.9.1 Recommendations re Restrictions

We are in general agreement with the State of Alaska protective measures, but there are a number of changes to these protective measures that we recommend.

1. The state restrictions concerning peregrines should be changed to agree with the USFWS peregrine restrictions (as modified by our recommendations in Section 2.9).

2. Provision should be made in the state protective measures for the granting of exemptions to the restrictions, provided that specific authorization is granted for each exemption on a site-by-site basis.

3. Protection should be supplied for the actual nesting cliffs of gyrfalcons, rough-legged hawks and golden eagles.

4. The altitude specified in the aircraft activity restriction should be the altitude above either the nest level or the top of the cliff or tree.

5. Major ground activity should be defined as any ground activity that does not fit the definition of minor ground activity.

6. A specific exemption permitting ground activity on the Haul Road should be permitted under the major ground activity restriction, as in the case of the USFWS peregrine restrictions.

7. Habitat alteration (as employed in the habitat alteration restriction) should be defined to be those alterations that occur in the course of major ground activity.

8. The term 'active' nest location should be defined to be consistent with the USFWS term 'occupied' as per our recommendation in Section 2.9.1 (i.e., it should include occupancy of a nest location by a lone bird).

9. The provision to relax the restrictions after 1 June for non-active nest locations should include the requirement of monitoring these locations prior to 1 June to determine if the locations are active. If the sites are not monitored, relaxation should not be permitted.

10. The list of sensitive wildlife areas should include all of the nest locations listed in Table 78. Each of these nest locations is within 1/2 mi of the ROW or any facility or material site. We are also aware of other nest locations (in Roseneau and Bente [1979] or discovered in 1980) that are within a corridor along the pipeline of several miles in width, but that are more than 1/2 mi from the current alignment or any materials or facility sites. These locations should also be added to the state list of sensitive wildlife areas, in order that they will be considered in the event of any pipeline realignment or relocation of facilities or materials sites.

11. The temporal and spatial protection criteria should be those listed in Table 79 (as per our discussion in Sections 3.7.1.2 and 3.7.1.3).

TABLE 78. Recommended nest locations for State of Alaska list of sensitive wildlife areas.

Golden eagle:	NWA-78 NWA-87 NWA-98 NWA-108 NWA-109 NWA-151 NWA-175
Gyrfalcon:	NWA-102 NWA-183d NWA-187b NWA-190b
Rough-legged hawk:	NWA-183b* NWA-'YY' (new) NWA-186 NWA-187a* NWA-188* NWA-189 NWA-190a* NWA-193 NWA-202.1* NWA-214 NWA-216.1 (new) NWA-218.1 (new) NWA-223
Bald eagle:	NWA-1 NWA-64 and 64.1 NWA-85.1 (new)

* Rough-legged hawk nests that are likely to be occupied in future years by gyrfalcons.

TABLE 79. Recommended temporal and spatial protection criteria for nesting gyrfalcons, rough-legged hawks, golden eagles, bald eagles and ospreys.

		Protection Criteria				
Species	Sensitive Time Period	Aerial Activity[1]	Minor Ground Activity	Major Ground Activity	Facility Siting	Habitat Disturbance
Gyrfalcon	15 February-15 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	1/8 mi
Golden eagle	1 April-31 August	1/2 mi h or 1000 ft v	1/4 mi[4]	1/2 mi	1/2 mi	1/8 mi
Rough-legged hawk	15 April[2]-31 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	1/8 mi
Bald eagle	15 March[3]-31 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	1/8 mi
Osprey	15 April-31 August	1/4 mi h or 1000 ft v	1/4 mi	1/4 mi	1/2 mi	1/8 mi

[1] h = horizontal; v = vertical.

[2] 15 February for rough-legged hawk nests that are likely to be occupied by gyrfalcons.

[3] 1 March for areas between mileposts 472 and 573 (Tanana River from near North Pole to near Gerstle River).

[4] Provided that these activities are short-term, quiet and at least 100 ft below the nest level and provided that they do not occur during incubation.

12. The USFWS restrictions a) to prohibit the use of pesticides and other pollutants in the vicinity of nest locations; b) to ensure that plans, activities, etc. near nest locations are reviewed by a biologist; and c) to ensure that all surveys and any exemptions to the protection measures are first approved by the responsible agency should be added to the state protection measures, with the changes to these restrictions that we have recommended in Section 2.9.

3.9.2 Recommendations re Potential Conflicts

This section is contained in Volume II because of the sensitive nature of the nest site information.

3.9.3 Other Recommendations

During construction and operation of the pipeline the state restrictions concerning gyrfalcons, rough-legged hawks, golden eagles, bald eagles and ospreys should be subject to a program of rigorous scientific evaluation to determine their effectiveness in reducing the actual impacts of the pipeline on these nesting birds.

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4.2 PERSONAL COMMUNICATIONS AND UNPUBLISHED DATA

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5. APPENDICES

5.1 PRODUCTIVITY OF PEREGRINE FALCONS

The data that have been summarized to prepare Tables 3, 5 and 7 are presented in detail in the following sections.

5.1.1 Sagavanirktok River

In 1970, two pairs that nested on Franklin Bluffs produced five nestlings of advanced age. A third pair that nested on Sagwon Bluffs may have failed in its attempt to nest (White and Streater 1970a,b).

In 1972, two pairs that nested on Franklin Bluffs hatched five nestlings, and a third pair failed in its attempt to nest there. A fourth pair occupied Sagwon Bluffs that year, but failed in its attempt to nest at that location (White and Ray 1972).

Two pairs nested on Sagwon Bluffs and two pairs nested on Franklin Bluffs in 1974. A total of 11 eggs were produced, eight of which hatched (Roseneau *et al.* 1976). Both pairs that nested on Franklin Bluffs failed to fledge any young. One pair that nested on Sagwon Bluffs fledged one young and a second pair at that location fledged two nestlings (Reynolds, unpubl. data; Roseneau, unpubl. data).

In 1975, three pairs of peregrines nested along the Sagavanirktok River, one on Franklin Bluffs and two on Sagwon Bluffs. These pairs produced 10 eggs, five of which hatched, but only one nestling is known to have eventually fledged from these nesting attempts (Roseneau *et al.* 1976). Both nesting attempts on Sagwon Bluffs failed that year (Reynolds, unpubl. data; Roseneau, unpubl. data).

No productivity data were obtained at Franklin Bluffs in 1976. Only one nest site was occupied at Sagwon Bluffs in 1976; it was not successful (Capodice 1976).

The productivity of peregrines nesting along the Sagavanirktok River may have improved in 1979. That year two pairs nested on Franklin Bluffs, one pair nested on Sagwon Bluffs and one pair nested on the east side of the river at a series of small bluffs ('East Sagwon') about 1 mi southeast of TAPS Pump Station No. 2. At least 13 eggs were produced by the four pairs. Nine of the eggs at three of the nests successfully hatched, but the one pair on Sagwon Bluffs abandoned its clutch previous to 7 July (Roseneau and Bente 1979). Data on fledging success were not obtained in 1979; however, it is known that at least one nestling did fledge from the nest site at 'East Sagwon' (Roseneau and Bente 1979, 1980a). If it is assumed that up to 50% of all successfully hatched chicks died (a relatively high estimate, especially considering the favorable weather conditions in 1979), then at least four or five nestlings may possbily have fledged in the drainage in 1979. That same year 2.5 nestlings of advanced age per successful pair (n = 6) were found at Colville River nest sites at a comparable latitude (Springer *et al.* 1979b).

Some productivity data were also obtained in 1980. At Franklin Bluffs one pair probably did not lay eggs at all, but the second pair in this section of the river produced a clutch of four eggs and eventually fledged two nestlings (Roseneau and Bente 1980a). Peregrines did not occupy Sagwon Bluffs in 1980; however, one individual was present a few miles south of the bluffs (Durtsche, pers. comm.). A pair did nest at 'East Sagwon', but productivity data were not collected from that location (Durtsche, pers. comm.). Without data from the 'East Sagwon' nest site, we can only speculate that total productivity in the Sagavanirktok drainage may have been lower in 1980 than in 1979.

5.1.2 Yukon River

In 1974 only two of the five pairs of peregrines present in this section of nesting habitat apparently produced nestlings that may have fledged (White 1974a,b; Haugh and Halperin 1976). In 1975, when one single individual and three pairs were present, the three pairs successfully produced seven large nestlings (Haugh and Halperin 1976; Ambrose, pers. comm.). In 1976, four of the six pairs present produced a total of nine nestlings (Haugh and Halperin 1976; Ambrose, pers. comm.). The lowest known productivity occurred in 1979, when only one single adult and three pairs were present. Only one of the three pairs was successful that year, and that pair produced only one nestling to near fledging age (Springer *et al.* 1979b). In 1980, productivity rebounded, and attained the highest level ever recorded. Four of the six pairs present successfully produced 11 nestlings to near fledging age that year (Roseneau *et al.* 1980).

5.1.3 Tanana River

The productivity of peregrines inhabiting the Tanana drainage declined markedly after about 1968. By 1975 no nestlings were produced by the few remaining birds, but since 1975, some nestlings have been produced by the few pairs that have been found to be present. In 1977 the three pairs present were thought to have successfully fledged nestlings (Kessel 1978; Ritchie, pers. comm.). Only one pair was confirmed to have at least one chick that year (Kessel 1978); however, all three pairs were still bringing food to their respective nest ledges during July, and nestlings were heard begging for food (Ritchie, pers. comm.).

In 1978 four pairs of peregrines were present along this river course (Hemmen, pers. comm.). Two pairs probably fledged one young each, one pair probably fledged four young, and one pair reared three large young (from four eggs), all of which died previous to fledging. In 1979, of three pairs present, two successfully fledged two nestlings each (Roseneau and Bente 1979; Ritchie, pers. comm). Two of four pairs present in 1980 successfully fledged a total of five nestlings, two at one nest site and three at another (Roseneau and Bente 1980a).

5.2 NESTING PHENOLOGY OF PEREGRINE FALCONS

The data that have been used to prepare Figure 1 are presented in detail in this section. Phenological data reported here from Cade (1960) for arctic and interior regions in Alaska were determined using 7 d as the time required to lay a complete clutch of four eggs, 29 d for incubation and 35-40 d for the nestling period between hatching and fledging. All other data reported here are based on 7 d to lay a complete clutch of four eggs, 34 d for incubation to allow for the last egg (usually a female) to hatch, and 40 d for the nestling period to allow the last female to fledge. These new intervals reflect information from recent literature, from field observations and from observations of captive-bred peregrines. Calculations of dates of phenological events are based on the estimated ages of nestlings at the time nest sites were visited; in general, experienced observers can usually estimate the age of broods to within ± 2 d.

5.2.1 Arctic Slope

Cade (1960) gave some information on arrival dates of peregrines on the Arctic Slope of Alaska. He reported that birds were not seen on the Colville River between 25 March and 19 April 1953, but that a pair was present on the nearby Anaktuvuk River on 4 May. That pair had apparently been there since 1 May of that year (Kessel and Cade 1958). Cade (1960) also reported that between 4-10 May 1953, several other pairs became established along the lower Colville River. He suggested that the peak of arrival on the Arctic Slope probably occurred after mid-May, based on comparisons of the other reproductive events in the nesting cycle of arctic and interior Alaskan peregrines.

For the Colville River in 1952, and for other Arctic Slope localities in other years, the peak of egg-laying occurred during about the first week of June (Cade 1960). Cade (1960) reported that a few pairs completed clutches as early as the third week of May, most pairs completed clutches in the first week of June, some pairs completed egg-laying in the second week of June, and a few pairs occasionally completed clutches as late as the third week of June. These data suggested that the earliest clutches laid were initiated in the second week of May, and that the latest clutches were not initiated until sometime in the second week of June. Cade (1960) also reported that the egg-laying schedule was somewhat later in 1959 than in previous study years. In 1959 one pair began laying in the last week of May, 12 pairs began in the first week of June and six pairs began in the second week of June. That year, the earliest clutches to be laid were not completed until about the first week of June, and the latest clutches were not completed until about the third week of June.

Cade (1960) did not give actual dates of observed hatching or fledging. Instead, he generalized Arctic Slope and interior data to describe the following phenological event periods for peregrines breeding in northern Alaska: egg-laying ∿ 15 May-21 June, hatching ∿ 21 June-21 July, fledging ∿ 28 July-1 September, and independence ∿ 1 September-1 October. Kessel and Cade (1958) reported that there were 25 fledged or nearly fledged young at nest sites in the Colville River drainage between 26 July and 15 August 1952.

In recent years, new observations have been made that can be added to the data base on the reproductive phenology of peregrines nesting on the Arctic Slope of Alaska. A few observations from the Colville River drainage suggest that some peregrines may arrive as early as mid-April (APFRT 1979; T. Bendock, pers. comm.; Kessel, unpubl. data). The possibility of mid-April arrival dates on the Arctic Slope in some years is also suggested by the dates that peregrines start migrating from their South American wintering grounds (Roseneau, unpubl. data; Springer, unpubl. data; Thelander, unpubl. data; White, unpubl. data). The peak of arrival probably does not commence until near the end of the first week of May in most years, and as late as the third week of May in some years.

In 1974, one member of a pair of peregrines attending a nest site at Sagwon Bluffs was incubating on 13 May (Roseneau, unpubl. data). That pair had probably arrived at least 2 wk prior to that date. On 4 May 1980 a single peregrine was observed north of Franklin Bluffs, and a pair of peregrines was observed at a nest site near Sagwon Bluffs (NWA Location P-211; K. Persons, pers. comm.).

White and Ray (1972) commented on the late reproductive phenology of raptors nesting on the Arctic Slope in 1972. They found several 5-9-d-old nestling peregrines along the Sagavanirktok River on 21 July of that year. By back calculation, these ages indicated that egg-laying began ∿ 4-8 June, clutches were probably completed ∿ 10-14 June, and hatching occurred ∿ 13-17 July. Fledging would probably have occurred ∿ 17-24 August.

In 1974, a brood of peregrine nestlings at Sagwon Bluffs was estimated to be ∿ 18-21 d old on 19 July (Roseneau, unpubl. data). Egg-laying had probably commenced ∿ 21-24 May, the clutch was probably completed ∿ 27-30 May, hatching probably occurred during ∿ 29 June-2 July, and fledging would probably have occurred ∿ 10-13 August.

Nine nestling peregrines, ranging in age from 2-9 d, were found in three nests along the Sagavanirktok River on 7 July 1979 (Roseneau and Bente 1979). Egg-laying was probably initiated ∿ 20-27 May, and clutches were probably completed during ∿ 26 May-3 June. Hatching probably occurred during ∿ 28 June-5 July, and fledging should have occurred ∿ 7-14 August. At the nest that contained the oldest chicks on 7 July, at least one nestling was observed flying on ∿ 12-15 August (White, pers. comm.). Farther to the west in the Colville River drainage, 15 nestlings were estimated to be between ∿ 14-23 d old on 28-31 July 1979 (Springer and Walker, unpubl. data). These clutches were probably initiated ∿ 29 May-1 June and completed ∿ 4-13 June. Eggs probably hatched ∿ 7-16 July, and fledging probably occurred ∿ 17-21 August. Reproduction in Colville River peregrines averaged ∿ 10-12 d later than reproduction in Sagavanirktok River peregrines in 1979.

On 2 August 1980, two nestlings estimated to be ∿ 36-38 d old were close to fledging age at a nest site on Franklin Bluffs along the Sagavanirktok River (Roseneau and Bente 1980a). The clutch was probably initiated on ∿ 18 May, and completed by ∿ 24 May. Hatching probably occurred ∿ 26 June, and fledging was probably complete by 4 August. Peregrine nestlings on the Colville River had started to fledge at about the same time as the Sagavanirktok nestlings. During 26 July-4 August, 19 of 29 Colville River nestlings were estimated to be between 35 and 40 d old, and a few were capable of flight (Ambrose, pers. comm.). Nine other nestlings appeared to be ∿ 30-32 d old, and one was only ∿ 20 d old. Most Colville River nestlings probably fledged during ∿ 2-12 August, and one nestling may have fledged as late as ∿ 17 August. In 1980, Colville River nestling peregrines fledged ∿ 13-15 d earlier than they did in 1979.

These recent data help to illustrate variation among years in the reproductive phenology of Arctic Slope peregrines. They also help to illustrate phenological differences among different areas of nesting habitat within the same region. The recent data also fit within Cade's (1960) original generalized summary of phenological events for northern peregrines.

5.2.2 Interior Alaska

Interior Alaskan peregrines (*F. p. anatum*) initiate and complete their annual reproductive cycle earlier than Arctic Slope peregrines (*F. p. tundrius*). Cade (1960) specified the last week of April and the first week of May for the arrival of peregrines in interior Alaska. Those two weeks were when nearly all of the first spring observations of peregrines were reported in interior Alaska for the years 1950-59 (B. Kessel; unpubl. rec.). The arrival of peregrines in the Tanana and Yukon river drainages coincided with the arrival of waterfowl and shorebirds, which are both important groups of peregrine prey species (Cade 1960). Cade (1960) further commented that nesting cliffs were immediately occupied by arriving birds. He gave 6 May 1951 and 3 May 1952 as dates when mates appeared to arrive simultaneously at Chena Bluffs, near Fairbanks.

A small sample of records for interior Alaska in the 1950's suggested that a few pairs of peregrines completed their clutches in the second week of May, that most clutches were completed during the third week of May, and that a few were not completed until the last week of May (Cade 1960).

In recent years earlier arrival dates have been obtained in interior Alaska. Data from the Tanana and Yukon river drainages suggest that some peregrines may arrive as early as late March in some years (APFRT 1979; Roseneau *et al.* 1980; Bente, unpubl. data; Kessel, unpubl. rec.). During the period 1960-77, the two earliest arrival dates on record are 1 February 1964, near Clear, Alaska, and 27 February 1965, near Eielson Air Force Base (Kessel, unpubl. rec.). Both these dates must be considered unusual. The earliest annual arrival records from 1950-77 include one on 29 March 1968, near Fairbanks, but the rest (n = 23) fall between 20 April-10 May, and most center around 27 April-6 May (Kessel, unpubl. rec.). These early arrival dates may include sightings of some peregrines that are passing through on their way to the Arctic Slope. The records of first sightings in interior Alaska are probably also biased toward the latter part of the arrival period, because few represent specific regular checks of peregrine nesting locations. However, these records do not appear to be at great variance with the expected effects of normal variation among years, or from recently calculated periods of egg-laying for nesting areas in the Yukon River drainage.

A few early records for the arrival of peregrines in interior Alaska were also obtained during 1978-80. In both 1978 and 1979, a pair of peregrines nesting along the Tanana River opposite the mouth of the Robertson River (NWA Location P-21a) was first observed at the cliff on 20 April (Ambrose and Ritchie, pers. comm.). In both years this cliff had been checked a few days prior to that date, and no peregrines were found. On 24 April 1980, two adult male peregrines were observed migrating separately into the Tanana River drainage near Tok, Alaska, on the front of a large influx of waterfowl and shorebirds (Roseneau, unpubl. data).

The peak arrival date of peregrines in interior Alaska also appears to vary between years, just as it does on the Arctic Slope of Alaska. In most years, the majority of the peregrines nesting in the Yukon River system probably do not begin to arrive until about the last week of April, whereas in some years they may not begin to arrive in large numbers until the first week of May.

Some information is available on the approximate ages of nestling peregrines from several interior Alaskan drainages. On the upper Yukon River between Circle, Alaska, and the U.S.-Canada border, 14 young at 10 nest sites were flying strongly by 2-3 August 1967 (Enderson *et al.* 1968; Roseneau, unpubl. data). These young had probably fledged ∿ 20-26 July, but at least one 14-16-d-old nestling was found at another nest site on

5 August 1967. That nestling would not have hatched until ∿ 21-23 July, and could not have fledged until ∿ 28-31 August. That egg was probably not laid until ∿ 19 June, but most clutches were probably initiated ∿ 3-9 May and completed by ∿ 10-15 May, and most hatching probably occurred during ∿ 11-17 June.

In the same study area, 21 nestling peregrines were estimated to have fledged from nest sites during ∿ 22-30 July, and six other nestlings fledged during ∿ 6-11 August 1978 (Curatolo and Ambrose 1978). In 1979, the fledging schedule for upper Yukon River peregrines was similar to that of the previous year (Ambrose 1979, pers. comm.). In 1980, nestling peregrines fledged an estimated 7-9 d earlier in this section of the Yukon River (Ambrose, pers. comm.). Most eggs were probably laid ∿ 4-12 May and most hatching probably occurred ∿ 13-21 June in 1978 and 1979; the corresponding 1980 dates were ∿ 27 April-4 May and ∿ 5-13 June, respectively.

Farther north, in the Porcupine River drainage, 13 large nestlings that were ∿ 25-28 d old were found at nest sites on 11-13 July 1976 (Springer and Walker, unpubl. data). Fledging probably occurred ∿ 23-28 July. Back calculations suggested that clutches were initiated ∿ 6-12 May and completed ∿ 12-17 May, and that hatching probably occurred ∿ 14-19 June. In 1979, 19 nestlings from the same study area probalby fledged during late July and the first few days of August (Curatolo and Ritchie 1979; Ritchie, pers. comm.). In 1980, a smaller group of nestlings from the Porcupine River drainage probably fledged ∿ 1 wk earlier (Ritchie, pers. comm.).

Along the lower Yukon River in 1979, the following approximate phenological sequence of events for nesting peregrines were reported by Roseneau *et al.* (1980): initiation of clutches, 6-20 May ($\bar{x}$ = 13 May); clutch completion and beginning of incubation, 13-27 May ($\bar{x}$ = 20 May); hatching, 16-30 June ($\bar{x}$ = 23 June);and fledging, 26 July-

9 August ($\bar{x}$ = 2 August). These data were based on back calculations for 39 nestlings with a mean age of 13.3 d (s.d. = 5.4 d) on 5 July. In 1978, Springer *et al.* (1979a,b) reported that the schedule of the nesting cycle was essentially the same. In 1980, however, laying began during 26 April-17 May ($\bar{x}$ = 6 May), clutches were completed and incubation began during 3-24 May ($\bar{x}$ = 13 May), hatching occurred during 6-27 June ($\bar{x}$ = 16 June) and fledging occurred during 15 July-6 August ($\bar{x}$ = 26 July) (Roseneau *et al.* 1980). These dates, which are ∿ 7 d ahead of the 1978-79 schedules, were based on back calculations for 69 nestlings with a mean age of 20.5 d (s.d. = 8.8 d) on 5 July.

In the middle section of the Yukon River, three nestlings in one brood were only ∿ 15 d old on 20 July 1976. That clutch was probably initiated ∿ 26-27 May, completed ∿ 2-3 June and hatched ∿ 5-6 July. The nestlings could not have fledged until ∿ 13-14 August. In 1979 the single nestling found in this section of the river was about 21 d old on 12 July (Springer *et al.* 1979b; Roseneau, unpubl. data). That chick probably hatched on ∿ 22 June from an egg laid ∿ 20 May. Fledging probably occurred ∿ 31 July. In 1980, 11 nestlings with a mean age of 21.2 (s.d. = 3.3 d) on 5 July were observed in the same study area (Roseneau *et al.* 1980). These data suggested that clutches were initiated during 30 April-9 May ($\bar{x}$ = 2 May), completed during 7-16 May ($\bar{x}$ = 9 May) and hatched during 10-19 June ($\bar{x}$ = 12 June). Fledging was calculated to have occurred during 20-29 July ($\bar{x}$ = 22 July).

In the Tanana River drainage, hatching at one nest site occurred on 22 June 1978 (Hemmen, pers. comm.). That clutch was probably initiated on ∿ 14 May and completed by ∿ 20 May. Fledging probably occurred on ∿ 1 August. In 1980, five nestlings were estimated to have fledged ∿ 14-16 July (Roseneau and Bente 1980a). Clutches were probably initiated ∿ 23-29 April and completed ∿ 29 April-5 May, and hatching probably occurred about 1-7 June.

At a nest site along the Elliott Highway, north of Fairbanks, three 18-20-d-old nestlings were found on 20 July 1970 (Ambrose, USFWS memorandum of 24 July 1979 to A. Crane, FWS/LE, District 1). That clutch was probably initiated ∿ 24 May and completed ∿ 30 May. Hatching probably occurred ∿ 2 July and the nestlings probably fledged ∿ 10 August. In 1980, three nestlings fledged ∿ 26-28 July from this location (Roseneau and Bente 1980a); the clutch was probably initiated on ∿ 8-10 May and completed by ∿ 15-17 May. Hatching was calculated to have occured ∿ 17-19 June. The nesting cycle at this location was ∿ 12-14 d earlier in 1980 than it was in 1979.

5.3 FOOD HABITS OF PEREGRINE FALCONS

The sources that have been used to prepare Tables 8 and 9 are discussed in more detail in Sections 5.3.1 and 5.3.2, respectively.

5.3.1 Arctic Slope

A few studies list prey or discuss the food habits of peregrines on the Arctic Slope of Alaska (e.g., Bee 1958; Kessel and Cade 1958; Cade 1960, 1968; Childs 1969; White and Cade 1971; Springer *et al.* 1979b). The two principal sources of information on the prey taken by peregrines nesting north of the Brooks Range are Cade (1960) and White and Cade (1971); both reported data collected on the Colville River.

Some other unpublished data have been obtained since White and Cade (1971). In 1974 a few prey items were collected and identified from a nest site on Sagwon Bluffs along the Sagavanirktok River (Roseneau,unpubl. data). The most interesting item in that collection was a shrew (*Sorex* spp.), which has not been reported in other Arctic Slope collections. During 1979 and 1980, additional small collections of prey items were obtained from a few nest sites at Franklin and Sagwon bluffs on the Sagavanirktok River (Roseneau and Bente, unpubl. data). Although these prey items have not yet been subjected to detailed analysis, they appear to be generally consistent with previous findings; most items appear to be common Arctic Slope passerines and shorebirds. Only one new prey species was found -- mountain bluebird, a scarce vagrant in the region.

Collections of peregrine prey remains were made in the Colville River drainage in 1980 by the USFWS; however, this material has not yet been completely identified (Ambrose, pers. comm.). A considerable number of other prey items were also collected on the Colville River in 1979. A brief summary of these data is given by Springer *et al.* (1979b). These prey remains also have not undergone detailed analysis; however, the species present appear to be generally consistent with previous findings. Springer *et al.* (1979b) reported that jaegers, shorebirds (particularly common snipe, American golden plover, spotted sandpiper, and other small sandpipers), ptarmigan, and one passerine (Lapland longspur) were taken frequently that year. Some passerine species were apparently not as abundant in the prey remains as in the previous collections made by Cade (1960) and White and Cade (1971). Some annual variation in the prey taken by Arctic Slope peregrines must be expected to occur because of annual variations in prey species abundance and vulnerability in this arctic area.

5.3.2 Interior Alaska

A somewhat greater body of information is available on the food habits of peregrines that nest in interior Alaska (e.g., Cade 1951, 1960, 1968; Cade *et al.* 1968; White and Roseneau 1970; Enderson *et al.* 1973; Ritchie 1976; Hayes 1977; Curatolo and Ritchie 1979; Dotson and Mindell 1979; Springer *et al.* 1979b; Roseneau *et al.* 1980). Some other data are also available or becoming available (e.g., Ritchie, unpubl. data; Roseneau and Bente, unpubl. data; Roseneau and Springer, unpubl. data; USFWS, unpubl. data). The majority of the information is from collections made at nest sites along the upper and lower Yukon River and along the Porcupine River. A large proportion of the more recent collections are still undergoing detailed analysis; however, all data obtained to date are generally consistent with previously published or reported findings.

5.4 HUNTING HABITAT OF PEREGRINE FALCONS

5.4.1 *F. p. tundrius*

Franklin Bluffs and Sagavanirktok River -- The male of a pair with small young in a nest was followed by helicopter on his hunting flights, and was observed to make 39 stoops at prey or actual kills (White 1974c). The male hunted especially over lakes and marshes; 97% of the hunting attempts were in this habitat type. Only 13% of the hunts occurred in tussock tundra habitat. Riparian habitat, which is comparatively uncommon in this area, was infrequently used (3 stoops).

Sagwon Bluffs and Sagavanirktok River -- The few data available suggest that lakes, marshes and wetlands are most important (Roseneau, unpubl. data; Ambrose, pers. comm.). Adults have been observed bringing prey from the northeast, and flying toward and returning from the small lakes and wetlands to the east. However, some prey remains indicate that some use is made of tundra uplands (e.g., American golden plover).

Colville River -- This drainage has much more extensive riparian habitat; over 25% of the prey species and approximately 23% of the prey items are normally associated with riparian habitats (White and Cade 1971; White 1974c). The remaining prey species indicate important use of both lake-marsh areas and upland tundra habitat. Springer *et al.* (1979b) obtained similar data.

Northern Keewatin, Canada -- Two pairs with large downy young were observed from distant blinds; birds were seen returning from 70 hunting flights (Alliston and Patterson 1978). Hunting occurred mainly in upland areas within 1/4 mi of the nesting escarpments; it occurred infrequently in the wet lowland areas that extended away from the foot of the escarpments. Other studies showed that the densities of nesting passerines were highest in the area near the foot of the escarpment, somewhat lower in the uplands, and lowest in wet lowlands away from the cliffs. In the 5-d observation period, many recently fledged passerines were present. Their presence may have made the suggested hunting habitat preference atypical of the overall season.

Greenland -- Falcons apparently hunted over tundra with scattered small lakes -- the only habitat available (Harris 1979).

5.4.2 *F. p. anatum*

Yukon River -- All prey remains from the Yukon River nest sites suggest that hunting habitat is predominantly the river valley, including the gulf of air over it (Cade 1960; Cade *et al.* 1968; Springer *et al.* 1979b; Roseneau, Bente and Springer, unpubl. data). Prey include forest, wetland and riparian species, most of which become very vulnerable as they pass by the cliffs along the river, cross over the river, or cross open non-vegetated areas. Adjacent expanses of lake-marsh wetlands are more important downstream of Tanana, Alaska. A few prey items suggest that occasional use is made of nearby upland areas.

Grapefruit Rocks, Elliott Highway -- At this interior upland nest site, prey remains have consisted primarily of wetland, upland and forest species (Ambrose, pers. comm.; Roseneau, unpubl. data). Several hunting flights were observed in 1979; when birds flew toward the Tatalina River wetlands.

Tanana River -- Cade (1951, 1960) reported that prey remains from Tanana River nest sites suggested that hunting habitat is predominantly the river valley, associated wetlands, and the gulf of air over the river. Prey included forest, riparian and wetland species that become vulnerable as they pass along the river, cross the river, or leave, enter or cross open wetlands and lakes. Observations at Round Lake indicate that important use is made of the gulf of air over the river, expanses of open gravel bars and mud flats in the vicinity of the nest site, and lake-marsh wetlands along the north side of the Tanana River that extend from the nest cliff for several miles to the southeast (Roseneau, Bente and Springer, unpubl. data). Falcons appear to favor hunting from perches on top of the nesting cliff or from hilltops to the southeast. Observations at Tower Bluffs indicate important use of the gulf of air over the Tanana and Robertson rivers, and of the expanses of open gravel floodplain of the Robertson River (Ambrose and Ritchie, pers. comm.; Roseneau, Bente and Springer, unpubl. data). Lake-marsh wetlands (north of the Tanana River) that extend from near the nest cliff for several miles northwest toward Round Lake are probably also hunted. Several hunting attempts were observed as prey species crossed from one side of the Robertson River to the other.

Porcupine River -- Prey remains consist primarily of wetland, riparian or woodland species that become vulnerable as they cross the river or follow it (Curatolo and Ritchie 1979; Roseneau and Springer, unpubl. data). Some prey species (e.g., singing vole and upland sandpiper) suggest that upland areas at some distance to either side of the river are also used to some extent. It is important to note that many of the nest sites along this smaller, narrower river are in canyons, and that the over-look and the gulf of air in front of the nests are more restricted. The local topography may accordingly dictate a greater use of uplands in comparison to the use at nest sites on the Yukon or Tanana rivers.

North-central Yukon Territory, Canada -- Two pairs of peregrines that nested on mountain sides overlooking a mostly-forested, 0.5-1.0-km-wide river valley were observed on 62 hunting attempts (Nelson and Nelson 1978). Most hunts were into the valley and were initiated from cliff perches. Prey were attacked over the river, among treetops, over meadows, and at several hundred meters above the valley floor. Some hunts apparently took place at higher elevations, where sparse forests and meadows occurred; upland sandpiper remains were found in nests and some flights to and from such habitats were recorded. In general, the same area was used by the hunting falcons during the spring migration of prey (May) and during the subsequent summer months (until early August).

Colorado -- A radio-tagged adult female with a recently-fledged young foraged over varied habitat types, but tended to prefer river drainages and mixed forest/brushland/meadow habitat. Transition forests were hunted frequently (Enderson *et al.* 1977; Enderson and Kirven 1979).

5.5 HUNTING RANGE OF PEREGRINE FALCONS

5.5.1 *F. p. tundrius*

Franklin Bluffs and Sagavanirktok River -- Data were obtained by 'shadowing' a hunting male with a Bell 206B Jet Ranger helicopter (White 1974c). The male (at a nest with one egg and two just-hatched young) had a hunting range of slightly over 120 mi^2 in the approximate shape of 3/4 of a circle. The longest distance travelled was 9.1 mi to the southwest to hunt over tundra. The southeastern quarter of the circle was used the most; 51% of the 39 kills or attempted kills occurred there. Only about 13% of the 39 kills or attempted kills occurred in the northeastern quarter.

5.5.2 *F. p. anatum* (Alaska and Northern Canada)

Round Lake, Tanana River -- Several observations of hunts, a small sample of prey remains, and observations of abundant nearby prey and prey habitat suggested that this pair did most of its hunting from the nest cliff or from perches on nearby hills (Roseneau, Bente and Springer, unpubl. data). Most hunts appeared to occur within 1-2 mi to the east and southeast of the nest site. Abundant local waterfowl and shorebirds appeared to be the primary prey. Several stoops from the cliff at American wigeon resulted in near misses, and a stoop at a sandpiper was successful. Another stoop into the local march after a duck from a hilltop about 1 mi away was successful.

Mackenzie River, Canada -- A radio-tagged adult was located as much as 30 mi from the nest cliff (Windsor, pers. comm.).

North-central Yukon Territory, Canada -- At two nests on mountain sides overlooking a river valley, many hunts from perches on the cliffs went up, down or across the river to the maximum observable distance (using a telescope) of 2 mi from the cliff (measured on a map; Nelson and Nelson 1978).

Lake Athabasca, Northern Alberta, Canada -- A pair hunted a maximum distance of ∿ 4-5 mi from their nest site; most often they flew only about 1.5-2.5 mi from the nest (Johnston-Beaver, pers. comm.).

5.5.3 Other Peregrines

Pacific Northwest -- During the breeding season, a radio-tagged adult female hunted predominantly within a few miles of her nest site (Anderson, pers. comm.). In the winter, at a separate locality, the adult female hunted over a coastal waterfowl area of ∿ 64 mi^2. Several radio-tagged immature peregrines have ranged over and hunted over an area about four times as large during winter.

Northern California -- A radio-tagged pair hunted regularly within ∿ 2 mi of the nest, but sometimes hunted out to distances of ∿ 5.5 mi (Enderson and Kirven 1979).

Utah -- Peregrines hunted up 17 mi from their nests (Porter and White 1973, cited in Newton 1976).

Colorado -- 'An instrumented female with fledged young ranged most frequently within 5 km of the eyrie, but 10-15 sorties included excursions more distant than 9 km, and up to 18.4 km' (Enderson *et al.* 1977).

Estonia -- Peregrines hunted up to 12.5 mi from their nests (Kumari 1974, cited in Newton 1976).

5.6 NORTHWEST TERRITORIES GUIDELINES FOR GEOLOGICAL OPERATIONS IN AREAS FREQUENTED BY PEREGRINE FALCONS

The following is relevant to camp site selection, air transport of personnel from camps to ground work locations, random air reconnaissance flights, and on-ground activity.

1. Camp sites should be beyond 3.2 kilometers (2 miles) from the cliff face or 1.6 kilometers (1 mile) from the backside of an uplift area. This should avoid conflicts with active nest sites, known or undiscovered. Mode of air support, fixed-wing or helicopter, and their required takeoff and approaches could further restrict camp site selection.

2. Camp sites using fixed-wing air support should be selected so that approach/takeoff paths would not result in low level flights (less than 457 meters [1500 feet] above ground level) over cliff areas from the backside to the cliff face.

3. Helicopter flights to and from a camp site near an uplift area should descend from and ascend to 457 meters (1500 feet) AGL as quickly as feasible and avoid low level activity about cliff areas as above.

4. Aircraft activity within a region should be above 457 meters (1500 feet) AGL whenever possible within safe aircraft operation guidelines.

5. Low level reconnaissance should avoid passing from the backside to the cliff side of an uplift area. Activity should be by approaches toward the cliff face or along the backside 'paralleling' the

orientation of the cliff face. This mode of operation is particularly important prior to July 16, the time by when the young should be 2 weeks old, due to the incubating and brooding behavior of the falcon.

6. Prolonged helicopter or fixed-wing activity about a nest site should be avoided as falcons are aggressive defenders of nest sites and have been known to make swoops at aircraft. An approach to an area and then on-foot reconnaissance would be more appropriate.

7. On-ground reconnaissance activity within view (1.6 kilometers [1 mile]) of a nest site should be limited to as short a time as possible on any day with a two to four day interval between repeated activity. Activity in the vicinity but obscured from the nest site can continue for a longer period of time, however, once your presence has attracted the bird, so it sits on a perch watching you, flies about sounding alarm or swoops at you, then activity should be restricted for that day as above. A definite time per day cannot be given as local weather conditions and orientation of the nest site to those conditions will affect the net impact, from prolonged exposure, on eggs or young (up to 7 weeks of age).

8. Sightings of peregrine falcons should be recorded, plotted on a 1:250,000 scale map if possible, and the birds' reaction to your presence documented. Location, data and behavior response information should be forwarded to N.W.T. Game Branch, Yellowknife, N.W.T., and Canadian Wildlife Service, P.O. Box 2310, Yellowknife, N.W.T.

Diamond drilling, blasting and intensive airborne reconnaissance transects within a region necessitate specific program discussions to account for site specific problems and individual operation peculiarities.

by A. S. Goodman
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24 February 1977

5.7 CHARACTERISTICS OF PEREGRINE FALCON NEST LOCATIONS BETWEEN 2 AND 15 MILES FROM THE ROW

This section is contained in Volume II of this report because of the sensitive nature of the nest site information.