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Research Progress Report

BROWN BEAR HABITAT PREFERENCES AND BROWN BEAR LOGGING AND MINING RELATIONSHIPS IN SOUTHEAST ALASKA

by
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Project W-23-1
Study 4.17
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SUMMARY

Field work was concentrated on Admiralty Island and 2 females were captured and instrumented during the reporting period. Between the fall of 1981 and June 1988, 96 bears have been captured on Admiralty and Chichagof Islands. In 1987 we recorded 574 relocations of radio-collared bears, primarily in the Greens Creek vicinity of northern Admiralty Island. This brings the total number of relocations for the study to 3,748. A mark-recapture density estimate was completed; results were similar to the density estimate made in 1986. The brown bear density on northern Admiralty Island is estimated to be 0.4 bears per km^2.

A habitat capability model for brown bears in Southeast Alaska was prepared in cooperation with U.S. Forest Service and Alaska Department of Fish and Game biologists. The model (Appendix A) was based largely on habitat preference data from radio-collared brown bears on northern Admiralty Island.

Key words: Admiralty Island, Chichagof Island, brown bear, habitat use, density estimates, reproduction, forestry, clearcutting, old growth, mining, roading, radiotelemetry, Southeast Alaska, *Ursus arctos*.

CONTENTS

BACKGROUND

Once widely distributed across western North America, brown/grizzly bears (Ursus arctos) currently range over a significantly reduced portion of the continent. This is particularly true in the contiguous United States, where the species was declared threatened in 1975. The largest population of brown/grizzly bears (hereinafter called brown bears) in North America occurs in Alaska.

In Southeast Alaska, logging, mining, and outdoor recreation are rapidly expanding throughout the range of the brown bear. To avoid or minimize declines in this valuable resource (identified as a management indicator species by the U. S. Forest Service and Alaska Department of Fish and Game), it is imperative that managers develop techniques to monitor bear population trends as well as management guidelines for habitat protection and human activity in brown bear country.

This study, which began in 1981, was designed to provide baseline ecological data on brown bear seasonal movements and habitat utilization, den site selection, home range characteristics, food habits, and reproductive rates. Particular emphasis was placed on developing an understanding of the relationships of mining and logging to brown bear populations. Preliminary data have been presented in Schoen (1982), Schoen and Beier (1983, 1985, 1986, 1987, 1988), and Schoen et al. (1986, 1987). Additional literature review and problem analysis are provided in Schoen (1986).

OBJECTIVES

To determine weekly and seasonal movement patterns and habitat utilization by brown bears in Southeast Alaska, To locate and describe denning sites.

To determine reproductive rates and their relationship to habitat and harvest levels.

STUDY AREA

The study area is located in the Alexander Archipelago of Southeast Alaska. Specific sites have been selected on Admiralty and Chichagof Islands. On northern Admiralty Island, our specific objectives relate to monitoring relationships of radio-collared bears to the development of the Greens Creek Mine. On southeastern Chichagof Island, we are assessing bear-logging relationships. Additional study site description is included in Schoen (1982) and Schoen and Beier (1983).

METHODS

Detailed methodology was described in Schoen (1982, 1986); a brief summary follows. Bears were captured in the alpine by shooting them with darts from a helicopter. Along beaches and salmon streams, Aldrich leg-hold snares were used. Etorphine hydrochloride (M99, Lemmon Co., Sellersville, Pa.) and its antagonist diprenorphine hydrochloride (M50-50, Lemmon Co., Sellersville, Pa.), were used to immobilize most bears. Sernylan (phencyclidine hydrochloride, Bioceutic Laboratories, St. Joseph, Mo. [no longer manufactured]) was used in a few cases. More recently we have used tilelamine hydrochloride and zolzepam hydrochloride (Telazol, A.H. Robins Co., Richmond, VA) in dosages of 7-9 mg/kg to immobilize bears.

Movements, home range patterns, and habitat use were determined by relocating instrumented bears through aerial radiotelemetry. During the first half of July 1987, we repeated a mark-recapture density estimate of brown bears within our 344-km study area on northern Admiralty Island (Schoen and Beier 1988). We used the modified "Peterson estimate"

$$\underline{N} = \frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} - 1$$

where $\underline{N}$ is the population estimated, n_1 is the number of marked bears in the population, m^2 is the number of marked bears observed, and n^2 is the total number of bears observed (Seber 1982). Following the procedure of Miller et al. (1987), we conducted a series of 5 replicate surveys; from these surveys we calculated the total cumulative bear days and derived our population estimate. Marked bears were, by definition, bears with transmitting radio collars.

RESULTS AND DISCUSSION

This report summarizes data collected during the 1987 field season from spring den emergence to fall denning. We have also summarized data relating to the capture and status of instrumented bears as well as reproductive data from the fall of 1981 through June 1988 (Tables 1 and 2). Two new females were captured and instrumented during this reporting period. One of these was No. 60's 4-year-old cub. At the completion of this reporting period, 11 males and 13 females on Admiralty Island had functional radios and we had recorded 574 relocations. This brings the total number of relocations for the study to 3,748; i.e., 2,881 from Admiralty Island and 867 from Chichagof Island.

Between the fall of 1981 and June 1988, 96 bears have been captured on Admiralty and Chichagof Islands. Of these, 10 radio-collared bears were harvested by hunters, three were killed in defense of life or property, one was killed at a dump, four died during capture, 1 female was killed and eaten by a male bear before she recovered from immobilization, four died from unknown causes, 24 were transmitting, and 49 were unaccounted for, probably because batteries had run down or transmitters had failed.

Habitat Use and Movements

During this reporting period, our major analytical activity was the preparation of a habitat capability model for brown bears in Southeast Alaska (Appendix A). To develop this model, we summarized the seasonal habitat use of radio-collared brown bears on Admiralty Island from 1981 through 1988 (Table 3). We specifically excluded interior bears from our analysis, because they are not directly affected by most forest management activities.

Mark-Recapture Density Estimate

During early July 1987, we conducted 5 replicate mark-recapture surveys within the 344-km^2 Admiralty Island study area. These surveys were conducted in the same area and during the same approximate time period as those surveys completed in 1986. We estimated the population of bears within the study area to be 136 ($\pm$ 20.6 at 95% confidence level) total bears and 94 ($\pm$ 21.3) adults > 2 years old (Table 4). This results in density estimates of 0.4 bears per km^2 or 0.27 adults per km^2. These figures are nearly identical to our estimate of the previous year (Schoen and Beier 1988).

Table 1. Summary and status of brown bears captured on Admiralty Island, fall 1981 through 30 June 1988.

Bear No.	Location	Sex	Age[a]	Capture (recapture) Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1988)
51	Greens Cr.	M	1	60	8-28-81	s	radio lost 9-81
60	Greens Cr.	F	20	160	9-21-81	h	--
60	Greens Cr.	F	21	135[d]	7- 2-82	h	--
60	Greens Cr.	F	24	125[d]	7- 8-85	h	--
60	Greens Cr.	F	25	125	7- 3-86	h	--
60	Greens Cr.	F	26	163	6-28-87	h	transmitting
59[e]	Greens Cr.	M	3	80	9-21-81	h	--
59[e]	King Salmon	M	5	113[d]	5- 1-83	h	mortality
58	Eagle Peak	M	4	180	9-21-81	h	--
58	Hawk Inlet	M	5	194	8- 8-82	s	last sighted 9-84
36	Mansfield	F	14	230	9-26-81	h	radio lost 5-82
50	Greens Cr.	M	3	120	9-26-81	h	--
50	Greens Cr.	M	5	146[d]	6-17-83	h	radio lost 5-85
14	Greens Cr.	F	7	120	9-26-81	h	--
14	Greens Cr.	F	8	90	7- 2-82	h	--
14	Greens Cr.	F	11	95[d]	7- 8-85	h	bear kill 8-88
B-14	King Salmon	F	2	100	9-26-81	h	mortality
43	King Salmon	F	15	250	9-27-81	h	--
43	Greens Cr.	F	20	114	7- 3-86	h	transmitting
6	King Salmon	F	8	150[d]	9-27-81	h	--
6	Wheeler Cr.	F	10	153	6-14-83	h	radio lost 5-86
62	Young Bay	F	14	150	6-16-82	s	last located 9-86
10	Greens Cr.	M	11	280[d]	7- 2-82	h	--
10	Greens Cr.	M	13	288[d]	7- 6-84	h	--
10	Hawk Inlet	M	15	315	6- 9-86	s	radio lost 5-87
38	Greens Cr.	F	23	280	7- 2-82	h	--
38	Greens Cr.	F	26	180[d]	7- 8-85	h	found dead 5-86
99	Greens Cr.	F	17	200	7- 8-82	h	--
99	Greens Cr.	F	19	158	6-21-84	h	radio lost 9-85

- Continued -

Table 1. Continued.

Bear No.	Location	Sex	Age[a]	Capture (recapture) Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1987)
95	Mansfield	F	8	170	7- 8-82	h	--
95	Mansfield	F	14	200	9-16-88	h	transmitting
72	Eagle Peak	M	6	200	7- 8-82	h	last located 9-86
34	Mansfield	F	2	70	7- 8-82	h	hunter kill 9-83
63	Greens Cr.	F	17	160	7- 8-82	h	last loc. 10-84
20	Greens Cr.	M	5	100	7-30-82	s	--
20	King Salmon	M	6	135	5- 1-83	h	mortality
56	Greens Cr.	F	13	170	7-30-82	s	--
56	Greens Cr.	F	16	158[d]	7- 8-85	h	transmitting
48	Greens Cr.	M	adult	300	8- 3-82	s	radio lost 6-83
39	Mansfield	F	9	270	8- 7-82	s	--
39	Mansfield	F	12	171[d]	7- 9-85	h	transmitting
37	Mansfield	F	10	270	8- 3-82	s	hunter kill 10-83
67	Greens Cr.	F	2	60	8- 2-82	s	no radio
7	Pack Cr.	F	11	150	8-26-82	d	no radio
11	Pack Cr.	M	4	120	8-28-82	t	hunter kill 5-83
8	Pack Cr.	F	10	150	8-26-82	t	--
8	Pack Cr.	F	16	120	7-19-88	d	removed radio
9[f]	Pack Cr.	F	1	54	8-26-82	d	no radio
91	Pack Cr.	F	19	162[d]	6-21-83	h	?
92	Pack Cr.	F	16	158[d]	6-21-83	h	radio lost 5-86
93	Pack Cr.	M	5	158[d]	6-21-83	h	--
93	Pack Cr.	M	10	170	6-27-88	h	removed radio
94	Pack Cr.	F	10	156[d]	7-13-83	t	--
94	Pack Cr.	F	15	114	7-19-88	d	removed radio
40	Greens Cr.	M	10	180	6-21-83	h	last located 8-85
13	Greens Cr.	M	15	284[d]	6-14-83	h	--
13	Greens Cr.	M	16	270[d]	7- 6-84	h	--
13	Hawk Inlet	M	18	270	6-11-86	s	hunter kill 5-88

- Continued -

Table 1. Continued.

Bear No.	Location	Sex	Age[a]	Capture (recapture) Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1987)
55	Greens Cr.	F	7	124	6-21-83	h	--
55	Greens Cr.	F	10	155[d]	7-10-86	h	--
55	Greens Cr.	F	11	113	6-26-87	h	transmiting
35	Wheeler Cr.	F	8	135[d]	6-17-83	h	mortality
18	Greens Cr.	M	6	214[d]	6-17-83	h	last located 8-85
16	Greens Cr.	F	4	90[d]	6-16-83	h	--
16	Wheeler Mt.	F	8	170[d]	6-28-87	h	transmitting
66	Greens Cr.	M	4	180[d]	6-22-83	h	last located 8-85
64	Eagle Peak	F	14	190[d]	6-24-83	h	--
57	Greens Cr.	F	11	203[d]	9-28-83	h	last located 7-85
68	Greens Cr.	F	5	146[d]	9-28-83	h	radio lost 1986
4	Greens Cr.	F	6	214[d]	9-29-83	h	hunter kill 9-87
19	King Salmon	F	13	191	9-29-83	h	mortality
41	Mansfield	M	2	135	6-21-84	h	hunter kill 9-86
49	Mansfield	M	3	100	6-16-84	h	no radio
81	Mansfield	F	14	200	6-21-84	h	last located 9-85
29	Wheeler Mt.	F	12	158	7- 5-84	h	last loc. 11-84
69[g]	Eagle Peak	M	2	59	7- 9-85	h	radio lost 5-86
79	Hawk Inlet	F	5	124	6-11-86	s	hunter kill 9-87
27[h]	Greens Creek	M	2	77	6-11-86	s	--
27[h]	Greens Creek	M	3	154[d]	6-28-87	h	--
27[h]	L. Florence	M	5	159	7- 6 88	h	removed radio
28	Greens Creek	M	13	260	6-11-86	s	--
28	Wheeler Mt.	M	13	260	7-10-86	h	hunter kill 5-87
61	Hawk Inlet	M	10	215	6-12-86	s	--
61	Hawk Inlet	M	12	215	6-27-88	h	transmitting
77	Greens Cr.	M	3	115	6-26-86	h	hunter kill 5-88
46	Greens Cr.	M	11	248[d]	6- 2-86	h	transmitting
52	Greens Cr.	M	5	190	6-26-86	h	transmitting

- Continued -

Table 1. Continued.

Bear No.	Location	Sex	Age[a]	Capture (recapture) Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1987)
98	Greens Cr.	M	19	315[d]	6-26-86	h	transmitting
96	Mansfield	F	7	148	6- 3-86	h	last loc. 10-87
89	Eagle Peak	M	15	150[d]	7- 9-86	h	DLP 8-87[i]
84	Wheeler Mt.	F	11	213[d]	7- 9-86	h	transmitting
97	Greens Cr.	M	11	293[d]	7-10-86	h	transmitting
76[j]	Greens Cr.	M	2	130[d]	7-10-86	h	--
76[j]	L. Florence	M	3	168	7- 6-88	h	transmitting
78	Greens Cr.	F	(3)	91	7-10-86	h	mortality 8-86
85	Wheeler Mt.	F	11	150	7-11-86	h	transmitting
25[k]	Greens Cr.	M	2	68	6-26-87	h	transmitting
71	Wheeler Mt.	F	3	148	6-29-87	h	lost radio 8-87
54[l]	Eagle Peak	M	3	73	6-26-87	h	lost radio 1988
70[m]	Greens Cr.	F	4	118	9-16-88	h	transmitting

[a] Age determined by tooth sectioning or (estimated).
[b] Weight estimated.
[c] h = helicopter, s = snare, t = trap, d = darted free ranging.
[d] Actual weight.
[e] #60's offspring.
[f] #9's offspring; Pack Cr. problem bear called "Pest".
[g] #99's offspring.
[h] #76's sibbling, probably #56's offspring.
[i] DLP = defense of life property.
[j] #27's sibbling, probably #56's offspring.
[k] #55's offspring.
[l] #64's offspring.
[m] #60's offspring.

Table 2. Summary and status of brown bears captured on Chichagof Island, summer 1983 through 30 June 1988.

Bear No.	Location	Capture (recapture) Sex	Age[a]	Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1988)
23	Kadashan	M	5	158[d]	6-23-83	h	last located 10-30
21	Corner Bay	F	adult	168[d]	6-23-83	h	radio lost 6-85
88	Kadashan	M	5	167[d](190)	6-23-83(7-18-85)	h	DLP mortality[e]
24	Corner Bay	F	16	225[d]	6-23-83	h	radio lost 9-84
12	Kook Lake	F	3	100	6-24-83	h	radio lost 8-84
30	Kadashan	M	3	126[d](136)	6-24-83(9-16-83)	h/s	DLP 11-86[e]
2	Crab Bay	M	6	216[d]	6-24-83	h	last located 7-84
73	Kadashan	F	11	158(181)[d]	8-8-83(7-12-84)	s	last located 1987
18	Kadashan	M	19	215	9-16-83	s	hunter kill 55-84
44	Kadashan	F	adult	272	9-17-83	s	found dead 9-84
90	Corner Bay	M	4	135	9-22-83	d	radio lost, sighted 5-84 Portage
32	Kadashan	F	5	136	7-10-84	s	transmitting
11[f]	Kadashan	F	2(3)	118(100)[d]	7-10-84(6-20-85)	s/h	last located 1987
82	Kadashan	F	4	145[d](158)[d]	7-11-84(7-15-85)	s	transmitting
53	Kadashan	F	16	215	7-12-84	s	last located 1987
65[g]	Corner Bay	F	2	79	7-19-84	s	lost radio, last sighted 6-85 Corner Bay
33[g]	Corner Bay	F	3	79	7-19-84	s	not transmitting, sighted 7-85 Kadashan wier
26	Kadashan	F	18	200[d](180)	7-21-84(8-1-85)	s	lost radio 5-86
9	Kadashan	F	adult	154[d]	7-21-84	s	radio lost 8-84, sighted 7-85 Kadashan
3	Kook Lake	M	3	136[d](167)[d]	10-2-84(7-18-85)	s	last located 4-86 Lisianski River
22	Kook Lake	F	3	91	10-8-84	s	last located 1987
17	Crab Bay	M	4	200[d]	6-18-85	h	last located 1987

- Continued -

Table 2. Continued.

Bear No.	Location	Sex	Age[a]	Weight (kg)[b]	Date	Capture techniques[c]	Current status (30 June 1987)
		Capture (recapture)					
5	Crab Bay	F	4	118[d]	6-18-85	h	last located 1987
70	Kadashan	M	4	163[d]	6-18-85	h	last located 7-86
15	Corner Bay	F	5	113[d]	6-18-85	h	lost located 1987
25	Crab Bay	F	15	159[d]	6-20-85	h	last located 8-86
7	Kadashan	F	17	160	7-19-8	s	last located 1987

[a] Age determined by tooth sectioning or (estimated).
[b] Weight estimated.
[c] h = helicopter
s = snare
t = trap
d - darted, free ranging
[d] Actual weight.
[e] DLP = defense of life property.
[f] #73's offspring.
[g] Probably #24's offspring; #11 and #65 are sibblings. We received an unconfirmed report that one of these bears was killed at Corner Bay and the collar destroyed.

Table 3. Seasonal habitat use of radio-collared brown bears[a] on Admiralty Island, Southeast Alaska, 1982 through 1988.

Habitat Type	Habitat Use (%)				
	Spring	Summer Early	Summer Late	Fall	Annual
Old-growth forest					
Upland forest	55.9	28.2	24.5	30.6	28.4
Riparian forest	8.7	11.0	53.6	18.8	33.3
Beach fringe	6.8	4.9	2.0	1.5	3.1
Subalpine forest	3.7	14.0	5.2	10.3	8.4
Nonforest					
Avalanche slopes	12.4	15.7	5.5	23.2	11.3
Alpine	3.7	18.9	2.8	7.6	8.4
Estuary	3.8	4.5	5.3	0.6	4.3
Other	5.0	2.8	1.1	7.4	2.8
n relocations =	161	772	1285	340	2558

[a] Interior bears are not included.

Table 4. Mark-recapture[a] density estimate for brown bears on northern Admiralty Island[b], 1987.

Date	n_1[c]	m_2[d]	n_2[e]	Sightability	Est. cumul. bear days	Avg.# bears $\underline{N}$	95% CI(+/-) (normal)	Bear density bear/km^2(mi^2)
All bears								
7/3	36	8	22	0.22	93.6	94	39.8	0.27 (0.67)
7/6	37	14	56	0.38	253.2	127	35.5	0.37 (0.90)
7/7	37	15	56	0.41	384.6	128	27.6	0.37 (0.91)
7/9	39	20	65	0.51	508.5	127	21.4	0.37 (0.90)
7/10	38	15	67	0.40	678.9	136	20.6	0.40 (0.96)
Bears > 2 years of age								
7/3	19	4	14	0.21	59.0	59	33.9	0.17 (0.42)
7/6	20	7	33	0.35	159.0	80	31.5	0.23 (0.57)
7/7	20	7	36	0.35	264.3	88	28.2	0.26 (0.62)
7/9	22	10	44	0.46	360.9	90	22.9	0.26 (0.64)
7/10	21	8	42	0.38	472.2	94	21.3	0.27 (0.67)

[a] $\underline{N} = \frac{(n_1 + 1)\ (n_2 + 1)}{m_2 + 1} - 1$

[b] The study site is 344 km^2 (141 mi^2).

[c] n_1 = # of marked bears observed.

[d] m_2 = # of marked bears in population.

[e] n_2 = total # of bears observed.

Reproduction

During the spring of 1988 we monitored 15 different family groups on Admiralty Island. Intensive field work was discontinued on Chichagof Island, so our data there are incomplete. From data collected on marked females over an 8-year period (Tables 5 and 6), it is apparent that cub mortality is high (about 40%) during the 1st year of life. Age at first breeding is variable, but it generally exceeds 5 years. During the winter of 1987-88, 2 females denned with 2-year-old cubs and 1 female denned with a 3-year-old cub. There continues to be much variability in maternal behavior and frequency of litter production in brown bears from Southeast Alaska.

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LITERATURE CITED

Miller, S.D., W.B. Ballard and E.F. Becker. 1987. Density and structure of black and brown-grizzly bear populations in Alaska estimated using modified capture-recapture techniques. Int. Conf. Bear Res. and Manage. 7: in press.

Schoen, J. W. 1982. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed Aid in Wildl. Rest. Prog. Rep. Proj. W-22-1. Juneau. 44pp.

__________, 1986. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Unpublished Study Plan. Juneau. 17pp.

__________, and L. R. Beier. 1983. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed Aid in Wildl. Rest. Prog. Rep. Proj. W-22-2. Juneau. 39pp.

__________, and __________. 1985. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-3. 83pp.

Table 5. Reproductive history of radio-collared female brown bears on Admiralty Island, 1981-88.

Bear No.	Age at capture (yrs)	Offspring[a] by year							
		1981	1982	1983	1984	1985	1986	1987	1988
60	20	1 2-yr	0	2 Coy[b]	1 Coy	1 1-yr	1 2-yr	1 3-yr	1 4-yr[e]
36	14	2 Coy	--	--	--	--	--	--	--
14	7	0	0	0	2 Coy	0[c]	0	2 Coy	2 1-yr
43	15	0	2 Coy	2 1-yr	--	--	--	2 Coy	2 1-yr
6	8	0	0	1 Coy[d]	0	0	--	--	--
62	14	--	0	0	0	0	0	--	--
38	23	--	0	0	0	0	0	--	--
99	17	--	2 3-yr	2 Coy	2 1-yr	1 2-yr[d]	--	--	--
63	17	--	2 cubs	0	0	2 Coy	--	--	--
95	8	--	2 1-yr	2 2-yr	0	2 Coy	2 1-yr	--	2 Coy
34	2	--	0	0	--	--	--	--	--
56	13	--	2 2-yr	2 3-yr	2 Coy	2 1-yr	2 2-yr[e]	1 Coy	0[d]
67	2	--	0	--	--	--	--	--	--
37	10	--	0	1 Coy	--	--	--	--	--
39	9	--	0	0	2 Coy	0[d]	1 Coy	?	?
7	11	--	1 Coy	1 1-yr	1 2-yr	--	--	--	--
8	10	--	0	0	2 Coy	2 1-yr	2 2yr	2 3-yr[e]	1 Coy
9	1	--	0	0	0	0	0	0[g]	0
35	8	--	0	--	--	--	--	--	0
16	4	--	0	0	--	--	0	0	0
91	19	--	0	--	--	--	--	--	--
92	16	--	0	2 Coy	--	--	--	--	--
55	7	--	0	--	--	--	1 1-yr	1 2-yr	1 3-yr[e]
64	14	--	--	1 yr	1 2yr[e]	2 Coy	1 2-yr	2 2-yr	1 3-yr[e]
94	10	--	--	0	2 Coy	2 1-yr	2 2-yr[e]	2 2Coy	2 1-yr
57	11	--	--	2 2-yr	2 3-yr	2 Coy	--	--	--
68	5	--	--	0	0	0	0	?	0
4	6	--	--	0	2 Coy	2 1-yr	--	--	--

- Continued -

Table 5. Continued.

Bear No.	Age at capture (yrs)	Offspring[a] by year							
		1981	1982	1983	1984	1985	1986	1987	1988
19	13	--	--	1 2-yr	--	--	--	--	--
81	14	--	--	--	0	0	--	--	--
29	12	--	--	--	3 1-yr[f]	0	--	--	--
79	4	--	--	--	--	--	0	0[g]	--[i]
84	10	--	--	--	--	--	2 Coy	2 1-yr	2 2-yr
85	7	--	--	--	--	--	1 Coy	1 1-yr	1 2-yr[e]
89	10	--	--	--	--	--	2 Coy	2 1-yr[h]	--
96	7	--	--	--	--	--	3 Coy[f]	2 1-yr	--
78	3	--	--	--	--	--	--	0	--
71	6	--	--	--	--	--	--	0	--
70[j]	3	--	--	--	--	--	--	0	0

[a] Coy = cub of year
1-yr = yearling
2-yr = 2-year-old
cub = cub older than COY
0 = no cubs observed.
[b] Male killed cubs in June.
[c] Female ate cubs in den.
[d] Cubs disappeared over winter.
[e] Cubs left over summer.
[f] One cub disappeared over summer.
[g] Observed breeding.
[h] Female killed DLP 8-87
[i] Killed by hunter 9-87
[j] #60's offspring.

Table 6. Reproductive history of radio-collared female brown bears on Chichagof Island, 1983-88.

Bear No.	Age at capture (yrs)	Offspring[a] by year					
		1983	1984	1985	1986	1987	1988
21	Adult	0	3 Coy	3 1-yr	--	--	--
24	16	0	2 Coy	--	--	--	--
12	3	0	0	0	--	--	--
73	11	0	2 2-yr	0	3 Coy	3 3-yr	--
44	Adult	0	3 Coy[b]	--	--	--	--
32	5	0	0	0	--	--	1 1-yr
11[c]	2	0	0[c]	0	0[f]	--	0
82	4	0	0	0	0	0[f]	0
53	16	--	0	2 Coy	2 1-yr	--	--
65	2	--	0	0	--	--	--
33	2	--	0	0	0	--	--
26	18	--	2 cubs[d]	1 2-yr[e]	--	--	--
9	5	--	0	0	--	--	--
22	3	--	0	0	0	--	--
5	4	--	--	0	0	--	--
15	4	--	--	0	0	--	--
25	11	--	--	2 1-yr	2 2-yr	--	--
7	17	--	--	2 1-yr	2 2-yr	--	--

[a] Coy = cub of year
1-yr = yearling
2-yr = 2-year-old
cub = cub older than Coy 0 = no cubs observed.
[b] Female found dead by midsummer.
[c] Offspring of No. 73.
[d] Cubs dirrerent sizes.
[e] Cub gone by 7-85.
[f] Observed breeding.

__________, and __________. 1986. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-4. 45pp.

__________, and __________. 1987. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-5. 48pp.

__________, and __________ 1988. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-6. 27pp.

__________, J. W. Lentfer, and L. R. Beier. 1986. Differential distribution of brown bears on Admiralty Island, southeast Alaska: a preliminary assessment. Int. Conf. Bear Res. and Manage. 6:1-5.

__________, L. R. Beier, J. W. Lentfer, and L. J. Johnson. 1987. Denning ecology of brown bears on Admiralty and Chichagof Islands. Int. Conf. Bear Res. and Manage. 7:293-304.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. 2nd. edition. Griffin. London. 645pp.

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APPENDIX A

HABITAT CAPABILITY MODEL FOR BROWN BEAR IN SOUTHEAST ALASKA

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INTRODUCTION

The brown bear (Ursus arctos horribilis)[1] has been recommended for use as a management indicator species (MIS) in the revision of the Tongass Land Management Plan (Sidle and Suring 1986). Habitat capability models are needed for each of the MIS selected for use in the plan revision. These models will also be useful for project level planning, and are necessary for providing information to evaluate the biological effects of proposed land managment activities on wildlife habitats and populations. This model evaluates quality of habitat for brown bears which is assumed to be related to long-term carrying capacity. Habitats are rated (using unpublished habitat preference data from Schoen and Beier) on the basis of their value to bears during late summer when they are most concentrated and vulnerable to human activities and land-use practices.

Cumulative effects analysis is a relatively new but important component of forest planning (Christensen 1986, Weaver et al. 1986) and provides an approach for predicting the long-term effects of land management activities on brown bear habitat and populations. This model provides wildlife-forest managers with a tool for assessing cumulative effects of habitat change and human activity on brown bears.

Once widely distributed across western North America, brown bears currently range over a significantly reduced portion of the continent and were declared threatened in the United States south of Canada in 1975 (LeFranc et al. 1987). Loss of habitat to human encroachment and resource development is a serious problem for bear management in the lower 48 States and elsewhere (Zager and Jonkel 1983, Contreras and Evans 1986, Schoen 1989).

In North America today, the largest population of brown bears occurs in Alaska (Peak et al. 1987) where there are an estimated 30,000-40,000 bears (Alaska Department of Fish and Game 1978). Brown bears are indigenous to southeast Alaska where they occur throughout the mainland coast and on the islands north of Frederick Sound. The northern islands of Admiralty, Baranof, and

[1] Although considered the same species, U. a. horribilis is referred to as brown bear in coastal Alaska and grizzly bear in interior areas and the remainder of North America.

bear/mi^2 (1.6 km^2) on northern Admiralty) in the world (Schoen and Beier 1988).

The decline in the range and numbers of brown/grizzly bears over the past century in the lower 48 states has heightened management concern for this species and prompted an increase in brown bear research, particularly habitat-related studies throughout remaining ranges. Most of the significant research on bear/forestry relationships has been conducted within the last decade (see review in LeFranc et al. 1986, Zager and Jonkel 1983, Contreras and Evans 1986, Weaver et al. 1986) and several investigations are currently underway in British Columbia and Alaska (e.g., McLellan 1986, Hamilton and Archibald 1986, Schoen and Beier 1988).

Brown bears are one of the unique features of the Tongass National Forest. Game Management Unit 4, which includes Admiralty, Baranof, and Chichagof islands, is one of the most important brown bear hunting regions in the state, ranking 3rd behind the Alaska Peninsula and Kodiak Archipelago with an average annual hunter harvest of 83 bears since 1980 (unpublished data, ADF&G). Tourism and outdoor recreation are growing industries in this area. Many visitors to southeast Alaska are interested in an opportunity to observe the brown bear which is considered a symbol of the American wilderness. Although much of southeast Alaska is still undeveloped, significant levels of logging and mining are scheduled to occur throughout the range of the brown bear. Managers must therefore carefully display and evaluate the effect of such activities on brown bears to ensure that effects are minimized and that viable populations are maintained throughout their range.

HABITAT RELATIONSHIPS

Odum (1971:234) described habitat as the organism's "address" or the place it inhabits in fulfilling its life needs (e.g., food, cover, water). Harris and Kangas (1988) proposed that the definition of primary habitat explicitly extends beyond the individual to include an area of sufficient size or configuration to support a population over time.

The habitat relationships of brown/grizzly bears vary considerably across the diverse array of ecosystems they inhabit from the eastern Rockies, through coastal rain forests, and up to the arctic. The Alaska Department of Fish and Game began brown bear investigations in southeast Alaska in 1981 with particular emphasis on habitat relationships and the influence of logging and mining activities on bear populations (see problem analysis and literature review in Schoen 1986).

From 1981 through 1988, 70 brown bears have been radio-collared on northern Admiralty Island and over 2,700 relocations collected (Schoen and Beier 1989). Habitat use by radio collared brown bears varied seasonally (Table 1), and is considered a response to seasonal differences in food quality and availability.

Brown bears begin emerging from high-elevation (> 1,000 ft [305 m]) dens during April, and emergence continues through May. After den emergence, many bears move to low-elevation old-growth forests, coastal sedge meadows, or south-facing avalanche slopes. Bears seek out the new growth of vegetation on these sites which are the first to green up in the spring. During early summer (mid June through mid July), most bears move up to forested slopes and alpine/subalpine meadows where they forage on newly-emergent vegetation.

Bears concentrate along low-elevation coastal salmon streams from mid July through early September. During this late summer season, 54% of all bear relocations occurred in riparian forest habitat or forested streams vegetated by a spruce-devil's club community (Picea sitchensis-Oplopanax horridum) bordering the stream banks (Schoen and Beier 1989). During this same period 66% of all bear relocations occurred within a 0.1 mi (161 m) band on either side of anadromous fish streams (Schoen and Beier unpublished data). Though this zone included a variety of habitats, it was dominated by the riparian spruce-devil's club community. Bears used this habitat for fishing along river banks, for foraging on succulent vegetation and berries, and for security and thermal cover.

Though most bears are associated with anadromous fish streams in late summer, some bears (primarily females) do not use coastal fish streams (Schoen et al. 1986). These bears (termed "interior" bears) remain in interior regions of the island thoughout the year, foraging primarily on vegetation and berries in subalpine and avalanche slope habitat. By mid September, most bears begin moving toward upper-elevation forests, avalanche slopes, and subalpine meadows where they feed on currant (Ribes spp.) and devil's club berries before denning.

Winter denning begins in October and November. Mean elevation and slope of 121 den sites of radio-collared bears from Admiralty and Chichagof islands were 2100 ft (640 m) and 35 degrees (Schoen et al. 1987a). Fifty-two percent of those dens occurred in old-growth forest habitat. Though cave denning was common on Admiralty Island, many dens were excavated under large-diameter old-growth trees or into the bases of large snags (Schoen et al. 1987a).

The seasonal food habits of Admiralty brown bears were described by McCarthy (1989). During spring, the diet of these bears is dominated by sedges (Carex spp.), other green vegetation, roots, and deer. Sedges and salmon (Oncorhynchus spp.) are the major food items consumed during summer, though skunk cabbage (Lysichitum americanum), devil's club berries, and other plants, berries, and roots are also used. During fall, salmon, devil's club berries, skunk cabbage, sedge, beach lovage roots

(Lisgusticum spp), and currants dominate the diet. The distribution of bears corresponded closely to the seasonal abundance and quality of the food items listed above. Because bears have relatively inefficient carnivore digestive systems (Bunnell and Hamilton 1983) and are active for only part of the year, they are forced to exploit the most productive feeding sites available.

In southeast Alaska, old-growth forest is used extensively throughout the year by brown bears for foraging, cover, and denning. Clearcut logging generally results in the production of an abundance of forage plants utilized by bears during early stages of forest succession (Mealy et al. 1977, Lindzey and Meslow 1977, Zager et al. 1983). Theoretically, these sites should provide good or adequate habitat for a generalist species like the brown bear. However, on Chichagof Island, clearcuts were avoided by bears; only 2% of 866 relocations of 27 radio-collared bears occurred in clearcuts (Schoen and Beier 1988). Although clearcuts only encompassed about 6% of the Chichagof study area, they made up a much larger proportion of low-elevation valleys adjacent to streams; the areas used used most extensively by bears in late summer. Brown bears possibly made limited use of clearcuts there because other sites (e.g., alpine/subalpine habitat, wetlands, riparian old growth, avalanche slopes) provided more nutritious foraging and better cover habitat than clearcuts (Schoen and Beier 1988). For example, devil's club berries, currants, and salmonberries, which are foraged on most extensively by bears (McCarthy 1989), are more abundant in riparian and avalanche slope habitat than in clearcuts. Because younger second-growth conifer stands (25-150 years-old) in Alaska produce minimal understory vegetation, second growth provides poor foraging habitat for herbivores (Wallmo and Schoen 1980, Alaback 1982, 1984).

HABITAT MODEL

This model assumes that habitat quality is related to brown bear preference for different habitats (e.g., alpine, riparian old growth, clearcuts, second growth). The ecological basis for infering habitat quality from preference data is found in habitat selection theory (Rosenzweig 1981, Fagen 1988). As stated by Ruggiero et al. (1988), "Habitat preferences are based on evolved behavior and thus relate directly to the probability of persistence. Therefore, habitat preferences must be viewed as reliable information about the environments needed for population persistence, and should be considered a valid basis for management decisions." While recognizing potential problems associated with populations dynamics and interpretation of habitat availability (Johnson 1980, Van Horne 1983, McLellan 1986), we have used habitat preference of radio-collared bears on Admiralty Island as our measure of habitat capability for brown bears in southeast Alaska.

Indices of habitat preference were calculated using a transformation of Ivlev's (1961) electivity coefficient as follows: $E_t = r_i/(r_i + p_i)$, where E_t = the transformed coefficient of electivity or habitat preference index, r_i = the proportion of observed use of category i (relocations of radio-collared bears), and p_i = the proportion of category i in the study area (availability).

Nine major habitat categories were identified for use in this model: old-growth forest, beach-fringe old growth, subalpine forest, second-growth forest, clearcuts, avalanche slopes, alpine, estuary, and other. Some of these were further subdivided relative to upland or riparian status, level of fish production, or age (Table 2).

Availability of habitats within the 141 mi^2 (365 km^2) Admiralty study area was estimated by extrapolation from a habitat data base derived for a 116 mi^2 (300 km^2) subsection of this study area. The original availability data (collected for a deer study) were determined from a random sample of 2495 points systematically overlaid on 1:12,000 scale aerial photographs. These were: old growth 75.6%, subalpine 8.1%, alpine 9.6%, and other 6.6% (Schoen and Kirchhoff unpublished data). In this study, we recognized a greater variety of habitat categories than in the original study. Old-growth forest was further subdivided into upland, beach fringe, and riparian, and the relative abundance of each habitat was estimated. We also estimated the relative abundance of avalanche slopes and estuaries.

To simplify our habitat capability model, we identified the late summer season as the most critical or limiting period. Brown bears are most concentrated along low-elevation valley bottoms and coastal salmon streams at this time. These are also the areas of highest human use and most intense resource development activities (e.g., logging and road building) resulting in the greatest vulnerability of the bears and their habitat to management activities. Late summer habitat use by radio-collared bears, habitat availability, index of habitat preference, and a habitat capability index (scaled from 0 to 1) are presented in Table 3. Habitat use determinations exluded "interior" bears because these bears represent a relatively small proportion of the population (approximately 10%), may be somewhat unique to Admiralty Island, and are relatively isolated from most forest management activities.

Several additional habitats are listed for which we did not have preference data from Admiralty Island. Although these habitats did not occur on the Admiralty study site or were not delineated, they are important because they are the result of forest management activities (e.g., clearcuts and second-growth forest) or are used extensively by bears and subject to a disproportionate amount of logging (e.g., riparian old growth). We ranked riparian habitats into 3 categories (streams with high, low, and no anadromous fish values) based on best professional judgement (Table 2).

Because clearcuts (0-24 years) and second-growth forests (25-150 years) were not available within the Admiralty study area, their suitability was also ranked based on professional judgement (Table 2). The avoidance of clearcuts by radio-collared bears on Chichagof Island (Schoen and Beier 1988) and the minimal forage production of second growth (Wallmo and Schoen 1980, Alaback 1982) justify their low rankings. We distinguished an older category of second growth (151-300 year), however, with values intermediate between young second growth and old growth because of increasing availability of forage plants. Clearcuts and second growth in riparian sites with salmon streams were given higher value than upland sites because of the availability of spawning salmon.

Though availability of suitable den sites is an important component of brown bear habitat, we assume it is not limiting in most circumstances and is unlikely to be substantially impacted by forest management. However, to minimize loss of denning habitat as a consequence of logging, Schoen et al. (1987a) recommended avoiding logging on mid-volume (20-30 mbf/acre), hemlock-spruce stands on slopes greater than 20 degrees at elevations above 980 ft (300 m) in or adjacent to areas of brown bear concentrations.

HABITAT CAPABILITY

This model is designed to operate on a single- or multiple-watershed scale (e.g., ADF&G minor harvest areas). Each of the 23 habitats is assigned a habitat capability value based on habitat preference or best professional judgement (Table 3). The density of brown bears in the Admiralty study site was estimated at 1 bear/mi^2 (1/2.6 km^2)(Schoen and Beier 1988). We corrected this density to exclude the "interior" segment (10%) of the population. This resulted in a population of 127 bears within the 141 mi^2 (365 km^2) study area. This overall density and the composition of habitats on the Admiralty study area were used to estimate bear density in each habitat (Table 3).

As the mix of habitats is changed by forest management activities, we can estimate changes in bear numbers by totaling the amount of each habitat category and multiplying by the bear density for that habitat. Following estimation of habitat capability, the model then incorporates effects of human-induced disturbance and/or mortality.

HUMAN-INDUCED DISTURBANCE AND MORTALITY

Large carnivores, like brown bears which range over extensive areas (from 1,000 to 100,000 acres[400-40,000 ha]), should be considered creatures of landscapes rather than of specific habitat types per se (Harris and Kangas 1988, Schoen 1989).

Aside from habitat impacts, resource development (e.g., logging, mining, hydroelectric devlopment, tourism) must also be evaluated in terms of human/bear interactions (Peek et al. 1987, Mattson 1989, McLellan 1989, Schoen 1989). Resource development in brown bear habitat (generally wild, undeveloped areas) significantly improves human access and consequently increases disturbance as well as direct human-induced mortality of bears (Pearson 1977, Craighead et al. 1982, Schoen 1989). In general, roads are detrimental to bears because they increase opportunities for human-bear interactions (Elgmork 1978, Zager 1980, Archibald et al. 1987, Rogers 1987, Rogers and Allen 1987, McLellan and Shackleton 1988, Wilcove 1988, Schoen 1989). Although it is possible to manage legal hunting of bears, it is difficult to control illegal kills, wounding loss, and defense of life or property kills (Schoen et al. 1987b). Once an area is roaded for one development activity, it often results in additional developments which increase human-bear interactions, and ultimately reduces the area's capability for supporting viable bear populations (McLellan 1989).

The dense rain forest of southeast Alaska provides more security cover for bears than more open habitats in the Rocky Mountains or northern Alaska. Road building activities in the Greens Creek drainage of Admiralty Island displaced fewer bears than expected presumably because of the security cover provided by the dense forest (Schoen and Beier 1988). In southeast Alaska, limited displacement of bears away from human activity will likely result in increased bear-human interactions and ultimately greater bear mortality.

Another byproduct of development is waste disposal. Human garbage has been implicated as one of the major contributors to bear attacks on humans and ultimately the reason that many garbage habituated "problem" bears must be destroyed (Herrero 1985:52).

The combination of increased road access and bears becoming habituated to garbage dumps (and people) is a major concern of bear managers in the coastal forests of British Columbia and southeast Alaska (Archibald 1983, Archibald et al. 1986, Schoen 1989, Weaver et al. 1989). For example, the brown bear season on northeast Chichagof Island was closed under an emergency order of the Alaska Department of Fish and Game on 30 September 1988, because of high bear mortality resulting from increased road access and the inadequate garbage disposal policies of several small communities and logging camps. Clearly, the impacts of human activity and development on bears need to be incorporated into any analysis of the effects of land management activities on brown bears (Schoen 1989).

We subdivided the effects of human activity and development into different levels of impact. These relationships were estimated, based on best professional judgement, as reductions in habitat capability (or potential carrying capacity) within zones of human influence/disturbance (Table 4).

We estimated that larger communties would have greater impacts than smaller communites. For example, brown bears are rarely observed in or adjacent to major cities or towns in southeast Alaska, whereas they are much more frequently encountered near small villages. This indicates that suitable habitat is not used adjacent to these areas because the bears are killed or displaced. Even though the habitat may be suitable, it is not used and its value to bears decreases. We similarly estimated that permanent camp sites would have more impacts than temporary camps. We also assumed that camp sites frequented by transient workers (many with limited Alaska experience) would be less inclined to tolerate bears than long-term permanent residents.

Landfills without effective fuel-fired incineration attract bears from long distances. These bears become habituated to humans and human foods and are more prone to interact with humans, thus decreasing their probability for long-term survival.

Road access was considered detrimental to bears. Arterial and collector roads accessible to vehicles were estimated to have greater impacts on bears than local roads and roads closed to vehicular traffic. We believe that roads closed administratively (e.g., with gates or excavated pits) would still have some level of off-road vehicle traffic. Though less detrimental to bears than roads accessible to vehicles, roads closed administratively pose greater impacts than permanently closed roads (e.g., through bridge removal). We believe that all roads, regardless of closure, still have the potential for supporting additional human foot traffic which also influences bear populations.

MODEL VERIFICATION

This model has received interagency review by biologists from the Alaska Department of Fish and Game and the USDA Forest Service. The next stage in verification will be implementation in a pilot test of the GIS database currently being developed for southeast Alaska by the USDA Forest Service. This will allow biologists to game with the model to determine whether test results appear reasonable. Once the GIS is operational, the actual proportion of habitat types within the 141 mi^2 northern Admiralty Island study area can also be determined. After completion of the GIS data base, we will contrast model results between our study sites on Admiralty and Chichagof Islands where we have estimates of relative bear densities. Following these exercises, the model will be submitted for review to species experts who were not involved in model development.

LITERATURE CITED

Alaback, P. B. 1982. Dynamics of understory biomass in Sitka spruce-western hemlock forest of southeast Alaska. Ecology 63:1932-1948.

__________. 1984. Plant succession following logging in the Sitka spruce-western hemlock forests of southeast Alaska: implications for management. USDA For. Serv., Gen. Tech. Rep. PNW-173. 26pp.

Alaska Department of Fish and Game. 1978. Petition to remove the brown bear <u>Ursus arctos L.</u> in Alaska from Appendix II to the Convention on International Trade and Endangered Species of Wild Fauna and Flora. On file, Alaska Dep.Fish and Game, Juneau. 71pp.

Archibald, W. R. 1983. Problem analysis: grizzly bears and coastal development with particular reference to intensive forestry. Fish and Wildl. Bull. B-26. Wildl. Habitat Res. Publ. WHR-5. 24pp.

_________, R. Ellis and A. N. Hamilton. 1987. Responses of grizzly bears to logging truck traffic in the Kimsquit River Valley, British Columbia. Int. Conf. Bear Res. and Manage. 7:251 -257.

Bunnell, F. L. and T. Hamilton. 1983. Forage digestibility and fitness in grizzly bears. Int. Conf. Bear Res. and Manage. 5:179-185.

Christensen, A. G. 1986. Cumulative effects analysis: origins, acceptance, and value to grizzly bear management. Pages 213 -221. <u>In</u> G. P. Contreras and K.E. Evans eds. Proc.--grizzly Bear Habitat Symposium. USDA For. Serv., Gen. Tech. Rep. INT-207.

Contreras, G. P. and K. E. Evans eds. 1986. Proc.--grizzly Bear Habitat Symposium. USDA For. Serv., Gen. Tech. Rep. INT-207. 252pp.

Craighead, J. J., J. S. Sumner and G. B. Scaggs. 1982. A definitive system for analysis of grizzly bear habitat and other wilderness resources. Wildlife-Wildlands Institute Monograph No. 1. U of M Foundation, Univ. Montana, Missoula. 279pp.

Elgmork, K. 1978. Human impact on a brown bear population. Biol. Conserv. 13:81-103.

Fagen, R. 1988. Population effects of habitat change: a quantitative assessment. J. Wildl. Manage. 52:41-46.

Hamilton A. N. and W. R. Archibald 1986. Grizzly bear habitat in the Kimsquit River Valley, coastal British Columbia. Pages 50-58. In G. P. Contreras and K.E. Evans eds. Proc.--grizzly Bear Habitat Symposium. USDA For. Serv., Gen. Tech. Rep. INT-207.

Harris, L. D. and P. Kangas. 1988. Reconsideration of the habitat concept. Trans. North Am. Wildl. and Nat. Resour. Conf. 53:137-143.

Herrero, S. 1985. Bear attacks, their causes and avoidance. Winchester Press, Piscataway, N. J. 287pp.

Ivlev, V. S. 1961. Experimental Feeding of Fishes. Yale Univ. Press, New Haven, Conn. 302pp.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65-71.

LeFranc, M. N. Jr., M. B. Moss, K. A. Patnode, and W. C. Sugg, Editors. 1987. Grizzly Bear Compendium. Interagency Grizzly Bear Committee, Wash. D.C. 540pp.

Lindzey, F. G. and E. C. Meslow. 1977. Population characterisitics of black bears on an island in Washington. J. Wildl. Manage. 41:408-412.

Mattson, D. 1989. Human impacts on bear use of habitat. Int. Conf. Bear Res. and Manage. 8:In Press.

McCarthy, T. 1989. Food habits of brown bears on Admiralty Island, southeast Alaska. M.S. Thesis, Univ. of Alaska, Fairbanks. 84pp.

McLellan, B. 1986. Grizzly bear habitat use analysis and use of timber sites. Pages 163-166. In G. P. Contreras and K.E. Evans eds. Proc.--grizzly Bear Habitat Symposium. USDA For. Serv., Gen. Tech. Rep. INT-207.

__________. 1989. Relationships between human industrial activity and bears. Int. Conf. Bear Res. and Manage. 8:In Press.

__________ and D. M. Shakleton. 1988. Grizzly bears and resource extraction industries: effects of roads on behaviour, habitat use and demography. J. Appl. Ecol. 25:451-460.

Mealy, S. P., C. J. Jonkel and R. Demarchi. 1977. Habitat criteria for grizzly bear management. in T. Peterle ed. Proc. Int. Cong. Game Biol. 13:276-287.

Odum, E. 1971. Fundamentals of Ecology. W.B. Saunders Co. Philadelphia. Pa. 574pp.

Pearson, A. M. 1977. Habitat, management and the future of Canada's grizzly bears. Pages 33-40. In T. Mosquin and C Suchal eds. Proc. of the Symposium on Canada's threatened species and habitats. Ottawa. Ont.

Peek, J. M., M. R. Pelton, H. D. Picton, J. W. Schoen, and P. Zager. 1987. Grizzly bear conservation and management: a review. Wildl. Soc. Bull. 15:160-169.

Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and populations growth of black bears in northeastern Minnesota. Wildl. Monogr. 97. 72pp.

__________. and A. W. Allen. 1987. Habitat suitability index models: black bear, upper Great Lakes Region. USDI Fish & Wildl. Serv. Biol. Rep. 82(10.144). Wash. D.C. 54pp.

Rosenzweig, M. L. 1981. A theory of habitat selection. Ecology 62:327-335.

Ruggiero, L. F., R. S. Holthausen, B. G. Marcot, K. B. Aubry, J. W. Thomas, and E. C. Meslow. 1988. Ecological dependency: the concept and its implications for research and management. Trans. North Am. Wildl. and Nat. Resour. Conf. 53:115-126.

Schoen, J. 1986. Brown bear habitat preferences and brown bear logging and mining relationships in southeastern Alaska. Unpublished study plan on file. Alaska Dep. Fish and Game. Juneau.

__________. 1989. Bear habitat management: a review and future perspective. Int. Conf. Bear Res. and Manage. 8:In Press.

__________, and L. Beier. 1988. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-6. 27pp.

__________, and __________. 1989. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-7. In Press.

__________, J. W. Lentfer, and L. R. Beier. 1986. Differential distribution of brown bears on Admiralty Island, southeast Alaska: A preliminary assessment. Int. Conf. Bear Res. and Manage. 6:1-5.

__________, L. R. Beier, J. W. Lentfer, and L. J. Johnson. 1987a. Denning ecology of brown bears on Admiralty and Chichagof Islands, southeast Alaska and implications for management. Int. Conf. Bear Res. and Manage. 7:293-304.

__________, S. D. Miller, and H. R. Reynolds. 1987b. Last stronghold of the grizzly. Nat. Hist. 96:50-60.

Sidle, W. B. and L. H. Suring. 1986. Management indicator species for the National Forest lands in Alaska. USDA For. Serv., Alas. Reg., Tech. Publ. R10-TP-2. 62pp.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47:893-901.

Wallmo, O. C. and J. W. Schoen. 1980. Response of deer to secondary forest succession in southeast Alaska. For. Sci. 26:448-462.

Weaver, J., R. Escano, D. Mattson, and T. Puchlerz. 1986. A cumulative effects model for grizzly bear management in the Yellowstone ecosystem. Pages 234-246. In G. P. Contreras and K.E. Evans eds. Proc.--grizzly Bear Habitat Symposium. USDA For. Serv., Gen. Tech. Rep. INT-207.

__________, W. Archibald, and J. Schoen. 1989. Integrated management of grizzly bears and forests. In Proc. -- Habitat Futures Symposium. USDA For. Serv., B.C. Ministry of Environment. In Press.

Wilcove, D. S. 1988. National Forests Policies for the Future. Vol. 2. Protecting biological diversity. The Wilderness Soc., Wash., D.C.

Zager, P. E. 1980. The influence of logging and wildlfire on grizzly bear habitat in northwestern Montana. Ph.D. Thesis, Univ. Montana, Missoula. 131pp.

__________ and C. J. Jonkel. 1983. Managing grizzly bear habitat in the northern Rocky Mountains. J. For. 81:524-526.

__________, __________, and J. Habeck. 1983. Logging and wildfire influence on grizzly bear habitat in northwestern Montana. Int. Conf. Bear Res. and Manage. 5:124-132.

Table 1. Seasonal habitat use by radio-collared brown bears[a] on Admiralty Island, southeast Alaska, 1982-1988.[b]

Habitat Type	Percentage of Habitat Use				
	Spring	Summer		Fall	Annual
		Early	Late		
Old-growth forest					
Upland forest	55.9	28.2	24.5	30.6	28.4
Riparian forest	8.7	11.0	53.6	18.8	33.3
Beach fringe	6.8	4.9	2.0	1.5	3.1
Subalpine forest	3.7	14.0	5.2	10.3	8.4
Nonforest					
Avalanche slopes	12.4	15.7	5.5	23.2	11.3
Alpine	3.7	18.9	2.8	7.6	8.4
Estuary	3.8	4.5	5.3	0.6	4.3
Other	5.0	2.8	1.1	7.4	2.8
_n_ relocations =	161	772	1285	340	2558

[a] Interior bears were not included.
[b] Schoen and Beier (1989)

Table 2. Description of habitat categories used in the habitat capability model for coastal brown bears.

Habitat	Description
Physiographic categories	
Beach fringe	within 500 feet of mean high water
Estuary fringe	within 1000 feet of mean high water along an estuary
Riparian	the ecological riparian zone or within 0.1 mile of a stream, which ever is larger
Upland	the area between the beach and estuary fringes and the subalpine, excluding the riparian
Forest categories	
Old growth	unlogged stands greater than 300 years old
Subalpine	the ecological subalpine zone
Clearcut	stands 0-25 years old
Young second growth	stands 26 to 150 years old
Older second growth	stands 151 to 300 years old
Nonforest categories	
Avalanche slopes	recurrent slide zone
Alpine	ecological alpine community
Estuary	portion of an estuary below mean high water
Other	miscellaneous (e.g., muskeg, rock, roads)
Stream categories	
High fish	high availability of anadromous fish
Low fish	low availability of anadromous fish
No fish	no anadromous fish present

Table 3. Habitat capability for brown bear habitats during the late summer season in southeast Alaska.

Habitat	Use[a] (%)	Avail[b] (%)	Preference[c] index	HCI[d]	Density[e]
Upland forest					
old growth	24.5	55	0.31	0.34	0.83
subalpine	5.2	10	0.34	0.37	0.92
old 2nd growth	--	--	--	0.10[f]	0.25
young 2nd growth	--	--	--	0.00[g]	0.00
clearcut	--	--	--	0.10[g]	0.25
Riparian forest					
old growth	53.6	5	0.91	1.00	2.47
high fish	--	--	--	1.00[g]	2.47
low fish	--	--	--	0.70[g]	1.73
no fish	--	--	--	0.40[g]	0.99
old 2nd growth					
high fish	--	--	--	0.30[f]	0.74
low fish	--	--	--	0.20[f]	0.49
no fish	--	--	--	0.10[f]	0.25
young 2nd growth					
high fish	--	--	--	0.20[f]	0.49
low fish	--	--	--	0.10[f]	0.25
no fish	--	--	--	0.00[f]	0.00
clearcut					
high fish	--	--	--	0.50[f]	1.23
low fish	--	--	--	0.30[f]	0.26
no fish	--	--	--	0.20[f]	0.30
Beach-fringe forest	2.0	3	0.40	0.44	1.08
Estuary-fringe forest	--	--	--	0.60[f]	1.48
Avalanche slope	5.5	5	0.52	0.57	1.41
Alpine	2.8	10	0.22	0.24	0.59
Estuary	5.3	2	0.73	0.79	1.96
Other	1.1	10	0.10	0.11	0.27

[a] Habitat use by radio-collared brown bears on Admiralty Is.
[b] Availability of habitats on Admiralty Is. study site.
[c] Transformation of Ivlev's (1961) electivity coefficient (E_t).
[d] Habitat capability index = E_t scaled from 0-1.
[e] Bear density (per mi^2) by habitat from Admiralty study site.
[f] HSI determination based on best professional judgement.
[g] Extrapolated from Schoen and Beier (1988) and best professional judgement.

Table 4. Reductions in brown bear habitat capability within zones of human activity/disturbance in southeast Alaska.

Human activity/ landscape modification:	Habitat reduction factor[a] within zone of influence	
	< 1 mi	1-5 mi
Human Communities		
> 1,000 people	0.0	0.3
501-1,000	0.0	0.5
11-500	0.3	0.6
< 10	0.5	0.8
Landfill w/o effective incineration	0.0	0.5
FS cabin/developed camp ground	0.8	1.0
Permanent camp site	0.2	0.5
Temporary camp site	0.5	0.8
Access point (airstrip, dock, float plane lake)	0.8	1.0
Arterial and collector roads accessible to vehicles and connected to ferry access or town	0.4	0.7
Local roads accessible to vehicles	0.6	0.9
Roads closed administratively	0.8	1.0
Roads closed permanently	0.9	1.0

[a] Habitat capability multiplied by this factor equals bear potential within the specified zone. Derivation of reduction factors based on best professional judgement.

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