DISTRIBUTION AND STATUS OF GREAT GRAY OWLS (*STRIX NEBULOSA*) ON THE TARGHEE NATIONAL FOREST, 1989

by

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ABSTRACT

Surveys for great gray owls were conducted from April through July 1989 on the Island Park, Ashton, and Teton Basin Ranger Districts (RD) of the Targhee National Forest (NF). Surveys consisted of nocturnal playback of recorded great gray owl calls in areas on these ranger districts where owls had historically been heard or seen. Daytime searches for nests were conducted in areas where owls were heard in nocturnal surveys or in areas where great gray owls were sighted. Although we were unable to confirm any successful nests on the Targhee NF in 1989, we did locate two new suspected great gray owl nests on the Island Park RD and one on the Teton Basin RD. We also compiled records of great gray owls which we heard or sighted during our 1989 surveys. In addition, we summarized knowledge of historic nests sites and areas where young birds have been sighted in the past on these ranger districts. Lastly, we have made several recommendations for future studies and management of great gray owls on the Targhee NF.

INTRODUCTION

The great gray owl (Strix nebulosa) inhabits the boreal climatic zones of North America and Eurasia (Johnsgard 1988). In North America, this large forest owl is distributed from Alaska and northern Canada south through the Cascades and Sierra Nevadas to central California; in the Rockies to northern Idaho, western Montana, and northwestern Wyoming; and east across Canada to south-central Ontario and northern Minnesota (Figure 1). The focus of this report is a nesting population which occurs on the Targhee NF (Franklin 1987, 1988) in southeastern Idaho, on the southern edge of the great gray owl's breeding range.

From 1980-1983, Franklin (1987) studied aspects of the breeding biology of great gray owls in southeastern Idaho and northwestern Wyoming. He located seven nests and six "breeding territories" (based on finding fledged birds) in the Idaho portion of his study area. He also modified 16 snags experimentally on the Targhee NF in an attempt to improve nesting habitat for great grays (Franklin 1982). Although there has been a limited effort to locate great gray nests since Franklin's study, biologists on the Targhee NF have reported very few nests (G. Worden and D. Welch, pers. comm.). In addition, a local wildlife photographer with considerable experience in looking for and photographing great gray owls, has reported seeing fewer owls in recent years (M. Quinton, pers. comm.).

Because of its rarity and lack of information regarding its status, the great gray owl is classified as a Species of Special Concern in Idaho by the Department of Fish and Game (IDFG). Given this classification and concerns, the Natural Heritage Section of IDFG and the Targhee NF initiated surveys in 1989 to determine the nesting status of great gray owls.

BACKGROUND INFORMATION

The purpose of this background section is to provide information on the biology of great gray owls most pertinent to the population occurring on the Targhee NF. A more complete review of the biology of great gray owls (Johnsgard 1988) is provided in Appendix A. Appendix B contains a reprint of Franklin's (1988) paper on his great gray owl study in the Greater Yellowstone Area which included the Targhee NF.

Great gray owls are the largest owls in North America in terms of body size (Johnsgard 1988). In a display of reverse sexual dimorphism common to many raptor species, females weigh approximately 30% more than males. Great grays are easily recognized by their large and "earless" heads with yellow eyes surrounded by a series of dark concentric rings. The body plumage is generally dark save for a white "moustache" which appears to have a black bow tie attached to it.

A series of low-pitched hoots which gradually drop in frequency and decelerate toward the end of the series constitute the usual call of the great gray owl (Johnsgard 1988). On the

Targhee NF, great gray owls begin territorial calling some time between the end of March and the beginning of April (A. Franklin, pers. comm.). Mean date of egg laying was 5 May during Franklin's (1988) study. This date was significantly correlated with snow depth at the onset of the breeding season (defined as 1 April). Eggs were laid as early as 19 April and as late as 23 May. The incubation period lasted approximately 30 days, and young left the nest at a mean age of 28.5 days.

Franklin (1988) reported on 15 great gray owl nests in his study area on the Targhee NF and in the adjacent Bridger-Teton NF, Yellowstone National Park, and Grand Teton National Park. Of these 15 nests, 40% were in old raptor stick nests whereas 60% were in depressions on the tops of broken-top snags. Most nests were in the lodgepole pine (Pinus contorta)/Douglas-fir (Pseudotsuga menziesii)/quaking aspen (Populus tremuloides) zone.

The average clutch size in the Greater Yellowstone study was 3.3 (Franklin 1988). Seventy-one percent of the nesting attempts were successful. Young owls moved at a constant rate in a constant direction away from the nest as they grew older. The height at which these fledglings roosted above the ground was positively correlated with their age.

Northern pocket gophers (Thomomys talpoides) were the most frequent item in the great gray owl's diet followed by voles (Microtus spp.) (Franklin 1988). The frequency of pocket gophers in the diet was directly proportional to the amount of clearcut surrounding the nest.

Although Franklin's (1987, 1988) study did not address home range, movements, or mortality, some information is available on these aspects of the great gray owl's life history from a study conducted by Evelyn Bull and her colleagues in northeastern Oregon (Bull et al. 1988, 1989). During 1983 - 1986, they found that the maximum distance great gray owls moved from their nest sites was 13.4 km. Home ranges of adults averaged 67.3 km^2 whereas home ranges for juvenile birds averaged 157 km^2. The larger value for juvenile birds was a reflection of their dispersal from natal sites. There was considerable variation in movements and home range among birds and between years for the same bird.

By following 19 radio-tagged 1-year old owls and three 2-year old owls, Bull et al. (1989) concluded that great gray owls rarely breed at age one, sometimes at two years, and more commonly at three years. They found annual probabilities of survival to be 0.91 and 0.84 for adult males and females, respectively. Probabilities of juveniles surviving the first 12, 18, and 24 months were 0.53, 0.39, and 0.31, respectively. Great-horned owls (Bubo virginianus) and northern goshawks (Accipiter gentilis) appeared to be the single greatest source of juvenile mortality. On the Targhee NF great gray owls most commonly nested in mid- to late-successional stages of Douglas-fir forests (Franklin 1987). The terrain was usually flat with varying amounts of herbaceous cover; all of the nests had some amount of clearcuts or natural meadows associated with them.

In their study in eastern Oregon, Bull et al. (1988a) found that the majority of great gray owl nests occurred in mature Douglas-fir/grand fir (Abies grandis) forest types on north-facing slopes. In two study areas they found minimum nesting densities ranging from 0.7 to 1.7 pr/km^2. Males foraged in mature open stands of Ponderosa pine (Pinus ponderosa) and Douglas-fir from perches close to the ground.

METHODS

From April through July 1989, we surveyed selected areas on the Island Park, Ashton, and Teton Basin Ranger Districts for great gray owls. Areas selected for surveys were based upon information provided to the Idaho Natural Heritage database by Alan Franklin, data records on great gray owl observations in the files of the three ranger districts, and personal observations by U. S. Forest Service (USFS) wildlife biologists. Surveys were conducted by playing tape-recorded vocalizations of calling great gray owls and listening for an elicited response. Tapes were played on a portable cassette tape recorder wired to a Portapage Megaphone or from a Johnny Stewart Bird and Animal Caller. Tapes were usually played approximately every 0.5 mile, although this distance varied with habitat and topography. Surveys were initiated at dusk and usually lasted until 2400 hr, although a few surveys were extended to 0100 hr of the following morning. Surveys were conducted via 4-wd truck, cross-country skis, or snowmobiles.

We prepared a poster which described great gray owls and solicited information on any sightings (Appendix C). This poster was widely circulated among USFS and IDFG offices and staff. In addition, it was posted in restaurants, grocery stores, post offices, etc. in all towns within or adjacent to the study area.

When owls were heard on nocturnal surveys, the area was marked with orange flagging and later searched during the day for a nest. We also searched numerous other locales for nests based

on sightings information generated by the poster. Table 1 summarizes the nocturnal survey areas; Table 2 summarizes areas where daytime searches for nests were conducted.

Table 1. Areas surveyed for great gray owls on the Targhee NF by nocturnal tape playback, April - August 1989.

Date	Site	TRS From	TRS To
Island Park Ranger District			
4-21-89	Sawtell Peak Rd.	T14NR42ES12	T14NR43ES15
4-21-89	Harriman State Park	T12NR42ES35	
4-25-89	Kilgore Rd.	T13NR43ES13	T13NR42ES11
4-25-89	Island Park RD Nest	T13NR43ES34	
5-22-89	Stamp Meadows Rd.	T14NR43ES22	T13NR43ES7
5-22-89	Red Rocks Rd.	T15NR43ES34	T15NR43ES30
5-22-89	Garner Canyon Rd.	T15NR44ES31	T15NR44ES28
6-21-89	Stamp Meadows	T14NR43ES22	T13NR43ES7
6-29-89	Meadow Creek Rd. Two Top Rd.		
Ashton Ranger District			
4-20-89	Mesa Falls Rd. Hatchery Butte Rd.	T10NR44ES32	T11NR43ES11
4-22-89	N. Antelope Flat Rd.	T11NR42ES14	T11NR42ES7
4-22-89	Little Butte Rd.	T11NR42ES23	T11NR42ES20
4-22-89	Cave Falls Rd.	T9NR44ES23	T9NR45ES19
4-22-89	Sawmill Creek Rd.	T9NR45ES17	T9NR45ES5
4-22-89	Fish Creek Rd.	T9NR44ES7	T9NR44ES3
4-22-89	Bear Gulch Ski Area	T10NR44ES32	
4-22-89	Anderson Mill Rd.	T10NR43ES30	T10NR43ES28
4-22-89	Fall River Ridge Rd.	T9NR44ES26	T9NR44ES25
4-22-89	Lower Jackass Loop Rd.	T8NR44ES1	T8NR45ES12
5-21-89	Flagg Ranch Rd.	T48NR118WS35	T47NR118WS5

Table 1 (continued)

Date	Site	TRS From	To
Teton Basin Ranger District			
4-18-89	Dry Ridge Rd.	T6NR46ES19	T45NR118WS20
4-19-89	Horseshoe Loop Rd.	T5NR45ES30	
4-27-89	Relay Ridge Rd.	T5NR43ES17	T5NR43ES5
5-89	Dry Creek/Tepee Cr. Ridge	T7NR45ES14	
5-17-89	Jack Pine Loop Rd.	T46NR118WS28 T7NR46ES7	T7NR46ES25 T7NR45ES10
5-25-89	Dry Ridge Rd.	T45NR118WS20	

Table 2. Areas surveyed for great gray owl nests on the Targhee National Forest via diurnal walking transects, April - August, 1989.

Date	Site	TRS
Island Park Ranger District		
4-25-89	Island Park Nest	T13NR43ES34
5-16-89	" "	"
6-22-89	Stamp Meadows	T14NR43ES15,22,23
6-28-89	Mill Creek	T13NR43ES7
6-29-89	Moose Meadows	T15NR44ES15,16
6-30-89	Sawtell Rd.	T14NR43ES15
6-30-89	Coyote Gulch	T12NR42ES12,13,23
7-4-89	Two Top Rd.	T15NR43ES25
7-4-89	Targhee Creek	T16NR43ES23,24
7-12-89	Garner Canyon	T15NR44ES31
7-13-89	Tyler Creek	T14NR43ES28,29
7-14-89	Howard Creek	T14NR40ES24,25,26
7-20-89	West End Campground	T12NR41ES10,11,14
Ashton Ranger District		
5-22-89	Anderson Mill Canyon	T10NR43ES27,28
5-22-89	Huckleberry Ridge	T9NR44ES1,2
7-5-89	Porcupine Guard Station	T9NR44ES23
7-20-89	N. Antelope Flat Rd.	T11NR42ES14,15
7-20-89	Little Butte Rd.	T11NR42ES20,21
7-26-89	Flagg Ranch Rd.	T47NR118WS5,8
7-26-89	Chain Lakes	T8NR45ES12
8-2-89	Anderson Mill Canyon	T10NR43ES27,28

Table 2 (continued)

Date	Site	TRS
1989***	Fall River Ridge	T9NR44ES25,26
1989***	Porcupine Guard Station	T9NR44ES23
1989***	Little Butte	T11NR42ES20,21
1989***	Anderson Mill	T10NR43ES22,27,28
1989***	Road 704	T11NR43ES29
1989***	Huckleberry Ridge	T9NR45ES4,5,7,8,9
Teton Basin Ranger District		
7-17-89	Dry Ridge Rd.	T6NR46ES17
7-18-89	Grouse Creek	T45NR118WS20,21
7-18-89	Hovermale Ridge	T45NR118WS3,4
7-19-89	Badger Creek	T6NR45ES9
7-25-89	Jackpine Loop Rd.	T7NR45ES11

*** Denotes areas surveyed by USFS personnel.

RESULTS

Island Park Ranger District

Historical Distribution and Status:

Although four nests have been found on the Island Park RD, only two of these are confirmed great gray owl nests (Table 3 and Figure 2). The first, referred to as the Island Park Nest is a Douglas-fir snag which was modified by photographer Michael Quinton to make it more acceptable for nesting by great grays. Although the nest has been used successfully by great grays for about 10 years (M. Quinton, pers. comm.), no accurate records on occupancy or productivity have been maintained. The second nest, referred to as the Tomar nest, was located close to the Island Park nest, but apparently blew down (A. Franklin, pers. comm.) in the early 1980s. Again, no records are available on occupancy or productivity of this nest. A third nest was reportedly found by a USFS crew in 1987 in the vicinity of Bootjack Pass, although the exact location remains unknown. Alan Franklin reported seeing juvenile great grays in this area in 1980. Similarly, a fourth nest was reported by a USFS crew near Twin Creek in 1987 or 1988 (L. Wilson, pers. comm.).

Sightings of young (< 1 yr) birds are another indication of an occupied breeding territory. Over the last three years, young great gray owls have been sighted in at least five different locales on the Island Park RD (Table 3 and Figure 2).

1989 Survey Results:

The Island Park Nest was not occupied in 1989, although birds did call from its vicinity in April (Table 4). We were unable to relocate the Bootjack Pass or Twin Creek nests. However, three new owl nests were located on the Island Park RD in 1989. The Taylor Creek nest was located in a Douglas-fir snag. Although owl feathers were found at the base of the nest tree, we could not confirm that this nest was successful in 1989. Despite an intensive search of the area, no young birds were located. The second nest (Zehntner Nest) was occupied by a pair of long-eared owls (Asio otus), who fledged three young which were photographed on low branches of trees near the nest by C. Groves on 7-12-89. This nest was also located in a Douglas-fir snag. The third nest was located near the Christensen's property off the Yale-Kilgore Road. Although a nest with great gray owl feathers at the base of the tree was found, we could not confirm that this nest was successful in 1989 because no owls were observed. The Christensens noted that they had seen great grays in the area each of the last three summers.

Great gray owls were sighted or heard in several locales on the Island Park RD in 1989 (Table 4 and Figure 2). Most of the sightings were of single adult birds. No observations of young birds were made.

Ashton Ranger District

Historical Distribution and Status:

Seven great gray owl nests have been found on the Ashton RD (Table 5 and Figure 3) (G. Worden, USFS - unpublished data and pers. comm.). With the exception of 1984, the Anderson Mill nest (Douglas-fir snag) was occupied from 1981 until 1987 when it blew down. Some data are available on productivity of this nest during that time period. The Antelope Flat nest consisted of an abandoned goshawk nest in a lodgepole pine. It has not been used since 1982. The Snow Creek nest was discovered in 1982 when the nesting tree was cut down during a logging operation; three young were taken into captivity at the time. Records are insufficient to locate or determine the historical or current status of the Osborne Butte nest. The Hatchery Butte nest was located in a 25"-diameter lodgepole pine snag; it was occupied only in 1984. The Huckleberry Ridge nest was a Douglas-fir snag which was modified for great gray use in 1982 (Franklin 1982). It was occupied in 1986, and two young fledged from this nest in 1987. The Firewood nest was occupied only in 1985.

Sightings of young birds have been made in several areas on the Ashton RD (Table 5 and Figure 3). Most of these sightings were from Alan Franklin's study period (1979-1981); only one observation of young birds has been made since Franklin's study. Four of the eight sightings of young birds have been along the Jackass Loop Road.

1989 Survey Results:

Several individual birds were observed and great grays were heard in four locales during calling surveys on the Ashton RD. However, no nests were located and no young birds were seen during the 1989 surveys. The artificial nest which had been occupied in 1987 and 1988 was not occupied during 1989.

Teton Basin Ranger District

Historical Distribution and Status:

Four nests are known from the Teton Basin RD (Table 7 and Figure 4), although information on the type of nesting tree, occupancy, and productivity is sketchy. The McRenolds Reservoir nest was occupied from 1981 through 1985 (K. Nielsen, pers. comm.). The Dry Creek nest was occupied in 1981 and 1986 (L. Becker - USFS records), but its status in the intervening years is unknown. Similarly, we know nothing about the occupancy of the Badger Creek and Grouse Creek nests, other than they were last occupied in 1986. There are no historical observations of young birds on the Teton Basin RD.

1989 Survey Results:

The Hovermale nest was discovered by USFS personnel in June 1989 (Table 8 and Figure 4). A great gray owl was reported to have flown from the nest at that time. When E. Zehntner visited the nest on 7-17-89, she found no evidence of use by owls, nor could any owls be located in the vicinity. Although C. Groves heard a great gray owl in the vicinity of the Dry Creek nest, we were unable to relocate the Dry Creek, Badger Creek, or Grouse

Creek nests. E. Zehntner checked the McRenolds Reservoir nest on 7-25-90 and found it unoccupied. Young birds were observed in two different locales on the district. Of particular interest was the sighting of young birds in Kirkham Hol, which apparently represents the first known successful nesting of great gray owls in the Big Hole Mountains.

Table 3. Locations of nests and sightings of young great gray owls on the Island Park Ranger District, Targhee National Forest, prior to 1989 surveys.

Site	TRS	Last Observed	Source
Tomar Nest	T13NR43ES35SW1/4	?	A. Franklin
Island Park Nest	T13NR43ES34NE1/4	1988	M. Quinton
Bootjack Pass Nest	T15NR43ES28,29	1987	D. Welch
Twin Creek Nest	T14NR40ES35SE1/4	1987 or 1988	L. Wilson
Tom Creek (young)	T14NR42ES31	1980s	M. Quinton
Sheridan Creek (young)	T13NR40ES1	1986	D. Welch
Garner Canyon (young)	T15NR44ES28,32	1987	D. Welch
Sawtell Creek (young)	T14NR43ES10	1987	D. Welch
Stamp Meadows (young)	T14NR43ES22,23	1988	M. Quinton

Table 4. Locations of nests and sightings (or callings) of great gray owls on the Island Park Ranger District, Targhee National Forest, during 1989 surveys.

Site	TRS	Date	Source
Taylor Creek Nest	T14NR41ES29NE1/4	6-14-89	T. Gilette
Zehntner Nest (Long-eared owl nest)	T15NR43ES25NE1/4	7-4-89	E. Zehntner
Christensen's Nest	T13NR42ES1	7-89	E. Zehntner
Sawtell Peak Rd.(1 adult) (pair)	T14NR43ES10 "	4-14-89 6-18-89	J. Trotter USFS
Island Park Nest(calling)	T13NR43ES34	4-25-89	C. Groves
Kilgore Road (calling)	T13NR43ES7	4-25-89	C. Groves
Stamp Meadows (1 adult)	T14NR43ES28	5-22-89	C. Groves
Kilgore Road (1 adult)	T14NR41ES35	6-21-89	G. Hardin
Enget Creek (calling)	T14NR44ES3	6-23-89	S. Patla
West Dry Creek (1 adult)	T13NR40ES__	6-28-89	USFS
Highway 20 (1 adult)	T15NR43ES35	6-29-89	E. Zehntner
Highway 20 (1 adult)	T15NR43ES36	6-29-89	E. Zehntner
Lakeside Lodge Campground (1 adult)	T13NR42ES24	7-1-89	Bennet
Bishop Lake (pair)	T12NR41ES10	7-20-89	E. Zehntner
Chick Creek Rd. (1 adult)	_____	7-24-89	USFS
Moose Creek Plateau (1 adult)	T14NR45ES20	7-26-89	Smith
Targhee Creek (1 adult)	T16NR43ES24	1989	B. George
Moose Creek Rd. (1 adult)	T13NR44ES11	1989	J. Winder

Table 5. Locations of nests and sightings of young great gray owls on the Ashton Ranger District, Targhee National Forest, prior to our 1989 surveys.

Site	TRS	Last Observed	Source
Anderson Mill Nest (.001)	T10NR43ES21NE1/4	1987	G. Worden
Antelope Flat Nest	T11NR42ES14NW1/4	1982	A. Franklin
Snow Creek Nest	T11NR43ES18NW1/4	1982	A. Franklin
Osborne Butte Nest	T11NR43ES4SW1/4	?	A. Franklin
Hatchery Butte Nest	T11NR43ES10SE1/4	1984	G. Worden
Firewood Nest	T11NR43ES5SE1/4	1985	G. Worden
Huckleberry Ridge Artificial Nest	T9NR45ES5	1988	G. Worden
Hale Canyon (young)	T9NR43ES3	1979	A. Franklin
Upper Mesa Falls (young)	T10NR43ES12	1979	A. Franklin
Jackass Loop Rd. (young)	T8NR45ES11	1980	A. Franklin
Jackass Loop Rd. (young)	T47NR118WS12	1980	M. Maj
Chain Lakes (young)	T8NR45ES12	1980	A. Franklin
Bear Gulch Ski Area (young)	T10NR44ES32	1981	A. Franklin
Warm River Spring (young)	T10NR44ES15	1981	A. Franklin
Ernest Lake (young)	T47NR118WS5	1988	B. Heath

Table 6. Locations of nests and sightings (or callings) of great gray owls on the Ashton Ranger District, Targhee National Forest, during 1989 surveys.

Site	TRS	Date	Source
Little Butte Rd.(calling)	T11NR42ES20	4-22-89	H. Black
Anderson Mill Rd. (calling, sighting - pair)	T10NR43ES28	4-22-89	Finklenburg
Fall River Ridge Rd. (calling)	T9NR44ES26	4-22-89	B. Leed
FS Road 764 (1 adult)	T11NR43ES30E1/2	5-10-89	USFS
Gibson Meadows (calling, sighting - 1)	T48NR118WS35	5-21-89	C. Groves
Porcupine Guard Station (calling, sighting - pair)	T9NR44ES23	7-89	USFS
Conant Creek (pair)	T47NR118WS22	7-31-89	USFS
July Creek (1 adult)	T11NR41ES36	8-10-89	D. Aslett
Road 736 (1 adult)	T10NR43ES1,2	8-24-89	USFS
Chain Lakes (1 adult)	T8NR45RES12	9-6-89	B. Heath
Pole Bridge (1 adult)	T11NR44ES20	9-25-89	USFS
Jackass Loop Rd (1 adult)	T8NR45ES9	9-27-89	USFS
Jackass Meadows (1 adult)	T47NR118WS15	10-1-89	USFS
Horseshoe Lake (1 adult)	T10NR45ES26	10-2-89	USFS
Highway 20 (1 adult)	T11NR42ES13	1989	D. Hayes
Mesa Falls Rd. (1 adult)	T11NR43ES29	1989	D. Wood
Hatchery Butte (1 adult)	T11NR43ES22	1989	G. Worden

Table 7. Locations of nests and sightings of young great gray owls on the Teton Basin Ranger District, Targhee National Forest, prior to 1989 surveys.

Site	TRS	Last Observed	Source
McRenolds Reservoir Nest	T8NR46ES32SW1/4	1985	K. Nielsen
Badger Creek Nest	T7NR45ES36SE1/4	1986	A. Franklin
Dry Creek Nest	T7NR45ES14NW1/4	1986	L. Becker
Grouse Creek Nest	T45NR118WS20SE1/4	1986	L. Becker

Table 8. Locations of nests and sightings (or callings) of great gray owls on the Teton Basin Ranger District, Targhee National Forest, during 1989 surveys.

Site	TRS	Last Observed	Source
Hovermale Nest	T45NR118WS4SE1/4	7-19-89	E. Zehntner
Dry Ridge Road (calling)	T6NR46ES20	4-18-89	C. Groves
Jack Pine Loop Rd. (calling)	T7NR45ES10	5-17-89	C. Groves
Roads 806/807 junction (1 young)	T7NR45ES13	8-15-89	S. Patla
Kirkham Hol (3 young)	T5NR43ES31	9-31-89	S. Patla
Road 383/806 junction (1 adult)	T7NR46ES19	10-11-89	G. Short

DISCUSSION

We were unable to locate and confirm any successful great gray owl nests on the Island Park, Ashton, and Teton Basin RDs in 1989. However, we know from sightings of two separate groups of young birds that there were occupied and successful nesting territories on at least the Teton Basin RD. Although it is tempting to conclude from our findings that the great gray owl population on the Targhee NF has declined since Alan Franklin's study in the early 1980s, such a conclusion would be premature and cannot be substantiated by any quantitative data.

Nevertheless, three different lines of reasoning suggest that the owl population may have declined or be in a decline. First, USFS wildlife biologists and others have reported that they have seen fewer owls in recent years. Second, traditionally occupied nests such as Island Park, the artificial nest on Huckleberry Ridge, and the McRenolds Reservoir nest were vacant in 1989. Third, despite several hundred hours of searching for nests, we and USFS personnel were unable to locate even one nest.

It is obvious from the positive responses elicited by taped great gray owl calls that there are still owls attempting to nest on all three ranger districts. Why we were unable to locate any nests is not clear. There are several possible explanations. First, our inexperience with great grays and underestimation of the personnel needed to reasonably conduct surveys over such a large area is likely part of the reason for not finding nests.

Second, some owl species are known to call territorially but either not attempt nesting or suffer nearly complete nest failure in years of low prey abundance (Hayward 1989). Unfortunately, there are no prey data for the Targhee NF in 1989 or prior years to support or reject this notion. Third, the relatively large amounts of timber clearcut in the last 15 years on the Targhee NF in response to problems with pine bark beetles may have reduced the amount of nesting habitat available to great gray owls. Bull et al. (1988a) noted that although partially logged stands in eastern Oregon did not appear detrimental to hunting by great gray owls, the majority of nests occurred in unlogged stands. Because most of the timber harvest on the Targhee NF has been in the form of clearcuts (as opposed to selective cuts), it is possible that timber harvest has reduced the amount of nesting habitat. This hypothesis needs to be addressed in future studies.

Given what we've learned from these surveys and Franklin's study, the following interaction of timber harvest and great gray owls on the Targhee NF could be hypothesized. Clearcut harvest of lodgepole pine in relation to pine bark beetle infestations began on the Targhee NF around 1974 (H. Gibbs, pers. comm.) At that time, much of the Island Park and Ashton Ranger Districts consisted of uniform stands of lodgepole pine which were 100 - 120 years old. Thus, foraging habitat and prey may have been limiting to the great gray owl population then. By the time of Franklin's study (1980-1983), a number of new forest openings

(i.e., clearcuts) had appeared, and these presumably increased foraging habitat and prey (i.e., pocket gophers) availability for great grays. This increase in foraging habitat and prey may have led to an increase in the great gray owl population. Since Franklin's study, the additional timber harvest which has taken place may have continued to increase foraging habitat but also decreased nesting habitat. This decrease in nesting habitat may have resulted in a decrease in the great gray owl population from that observed on the forest in the early 80s. Other unknown factors in this timber harvest-great gray owl equation are 1) what effects timber harvest has had on other raptors such as red-tailed hawks (Buteo jamaicensis) and northern goshawks, both of which build stick nests that great gray owls utilize, and 2) how timber harvest has affected the populations of predators to great gray owl nests such as ravens (Corvus corax) and great horned owls.

MANAGEMENT RECOMMENDATIONS

I. Alan Franklin's study provided us with information on breeding chronology, productivity, nesting success, and nesting habitat. There is a lack of information on home range, movements, foraging habitat, population mortality, and nesting densities of great gray owls on the Targhee NF. Future studies on the Targhee NF need to address these areas of great gray owl biology.

II. Of particular concern is discerning what impacts, if any, timber harvest via clearcuts or selective logging for large diameter trees has had on great gray owl foraging and nesting habitat. This concern could be addressed through a radiotelemetry study which focuses on movements, home range, and hunting behavior of owls in different age class stands. Such information could be combined with data on small mammal densities and biomass in different aged stands as well as data on nesting habitat requirements from Franklin's study and others to develop a model which would help explain what impacts changes in the forest (due to timber harvest) may have had on great gray owl populations. Such a model might also be useful in suggesting management practices which could benefit great gray owls in the future. Because of the manner and extent to which timber has been harvested on the Targhee NF and the habitat needs of great grays owls (i.e., open areas for hunting), the Targhee NF provides a unique natural laboratory for examining the effects of timber harvest on a large forest owl. A geographical information

system (GIS) would be an ideal tool for developing a model to analyze how timber harvest on the Targhee NF may have affected the great gray owl population over time.

III. Great gray owls may be a species that can only persist on timber-harvested lands by specifically managing for them. Important points to consider for managing great gray owls and their habitat are as follows (E. Bull, USFS - Oregon, pers. comm.): 1) protection of nest sites, 2) erection of artificial nesting platforms, 3) retention or creation of hunting perches for adults and juveniles, 4) reduced or no activity during the nesting period, and 5) maintenance or enhancement of prey availability.

In areas where nesting sites are limited, artificial platforms (Appendix D) can be erected. These platforms should be erected in pairs, placed at least 15 m high on trees, and be situated within stands adjacent to a clearcut or meadow. Perches from which adult great gray owls can hunt are an important habitat component. Poles or trees 2-5 m tall should remain in harvested areas or artificial perches should be erected in clearcuts or meadows. Suitable roost and perch sites for juveniles should also be maintained. These would include low stumps, downed trees, leaning trees ("leaners"), and trees with low branches. The presence of leaners is critical to the survival of young great gray owls during the pre-flight period of their development (Franklin 1987, E. Bull, pers. comm.).

IV. Efforts should be made to standardize data collection and data record keeping for great gray owls at the ranger district level. With a couple exceptions, records kept since Franklin's study have been scant and inconsistent. When nests are located, data should be recorded on the exact location, date, type of nesting structure, habitat surrounding nest, weather conditions, and state of birds in nest (incubating, # eggs, # chicks, etc). Nests should be monitored through the nesting season to determine how many birds are successfully fledged. A sample data sheet which might be used is provided in Appendix E. The Raptor Management Techniques Manual published by the National Wildlife Federation (Pendleton et al. 1987) has several excellent chapters on measuring and sampling habitat, assessing reproductive success and productivity, and managing raptor habitat.

V. Several USFS personnel have inquired about the feasibilty of using great gray owl responses to taped calls as a means to monitor population trends by establishing systematic calling transects. Although this is potentially a cost and time-effective approach, there are several problems with it. First, there are likely several reasons for which great gray owls call (mate attraction, strengthening of pair bond, defense of nest territory). Thus, the rate and periodocity of calls may vary with individual owls depending upon the purpose of the call. Second, the rate, timing, and periodocity of calls may vary with such extrinsic factors as climate and prey availability. For

example, Franklin (1987) demonstrated that the initiation of great gray owl nesting on the Targhee NF was corrleated with the depth of snow pack. Hayward (1989), in a study of boreal owls in central Idaho, showed that in a year of poor prey abundance, most owls did not call or attempt breeding. Finally, the low density of great gray owls makes it difficult to get a sufficient sample size of calls to statistically use them as an index for monitoring what the population is doing. Presently, the only valid way to monitor great gray owl populations is to locate nesting territories and monitor these each year. Because great gray owls do show fidelity to a site (Bull et al. 1988a) they can be expected to return to the same territory annually provided that the nesting structure remains intact. Thus, by monitoring the occupancy and productivity of nesting territories, population trends can be ascertained. However, this approach initially requires an intensive and extensive surveying effort to locate nesting territories. Though not imperative to finding nesting territories, the radiotelemetry study outlined above would aid in finding these territories.

ACKNOWLEDGMENTS

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APPENDIX A

Great Gray Owl Chapter from Johnsgard (1988)

Great Gray Owl *Strix nebulosa* Forster 1772

Other Vernacular Names:
cinereous owl, Lapland Owl, sooty owl, speckled owl, spectral owl.

North American Range (Adapted from AOU, 1983.)

Breeds in North America from central Alaska, northern Yukon, northwestern and central Mackenzie, northern Manitoba, and northern Ontario south locally in the interior along the Cascades and Sierra Nevadas to central California; in the Rockies from northern Idaho and Montana to western Wyoming; and to central Alberta, central Saskatchewan, southern Manitoba, northern Minnesota, and south-central Ontario (rarely to northern Wisconsin and northern Michigan). Winters generally through the breeding range, but wanders south irregularly to southern Montana, North Dakota, southern Minnesota, southern Wisconsin, central Michigan, southern Ontario, and central New York, casually as far as southern Idaho, Nebraska, Iowa, Indiana, Ohio, and from southern and eastern Quebec, New Brunswick, and Nova Scotia south to Pennsylvania and New Jersey. Also distributed widely in northern Eurasia. (See Figure 40.)

North American Subspecies (Adapted from AOU, 1957.)

S. n. nebulosa Forster. Range in North America as described above.

Measurements

Wing (of *nebulosa*), males 410–447 mm (ave. of 5, 433), females 430–465 mm (ave. of 7, 446); tail, males 300–323 mm (ave. of 5, 313.6), females 310–347 mm (ave. of 7, 323.3) (Ridgway, 1914). The eggs of *nebulosa* average 54.2 × 43.4 mm (Bent, 1938).

Weights

Earhart and Johnson (1970) reported that 7 males averaged 935 g (range 790–1030), and that 6 females averaged 1296 g (range 1144–1454). Craighaed and Craighead (1956) noted that 7 females averaged 1084 g. Mikkola (1983) stated that 24 males and 31 females of the Eurasian population averaged 871 and 1242 g respectively. The estimated egg weight is 53 g.

Description (of *nebulosa*)

Adults. Sexes alike, but females often appearing darker than males. General color of upperparts dusky grayish brown or sooty, broken by transverse mottlings of grayish white, the uniformly sooty median portions of the feathers producing an effect of irregular dusky stripes, most conspicuous on back and scapulars; outer webs of wing coverts variegated by whitish mottlings; alulae and primary coverts with very indistinct bands of paler brown; secondaries crossed by about nine bands of pale grayish brown, fading into paler on edges of outer webs; primaries crossed by nine transverse series of pale brownish gray spots; proximal secondaries and middle rectrices with coarse mottling or marbling of dusky brown or sooty and grayish white, the markings tending to form irregular, broken bars; rest of tail dusky crossed by about nine paler bands; ground color of underparts grayish white, each feather of neck, chest, breast, and abdomen with a broad median blackish stripe; sides, flanks, vent region, and under tail coverts narrowly banded or barred with sooty brown and grayish white, the legs with narrower, more irregular bars; superciliary "eyebrows," lores, and chin grayish white, with a dusky area immediately in front of eye; face disk grayish white with distinct concentric semicircular bars of dusky brown; facial disk circled by dark brown and becoming white on foreneck, where interrupted by a spot of brownish black on throat. Bill light dull yellow to bright yellow or pale olive green; iris lemon yellow; claws blackish.

Young. Newly hatched birds have grayish down dorsally and white down below, with yellowish legs and yellowish gray iris color. Juveniles are olive-brown, darkly barred and spotted with white above, barred below, with broad black facial markings. The wings and tail (if present) are as in the adult plumage, which is attained in less than five months (Mikkola, 1983), but first-year birds have gray-tipped flight feathers. These remiges are also shorter and narrower than in adults. Some first-year remiges may be retained for several years (Robert Nero, personal communication).

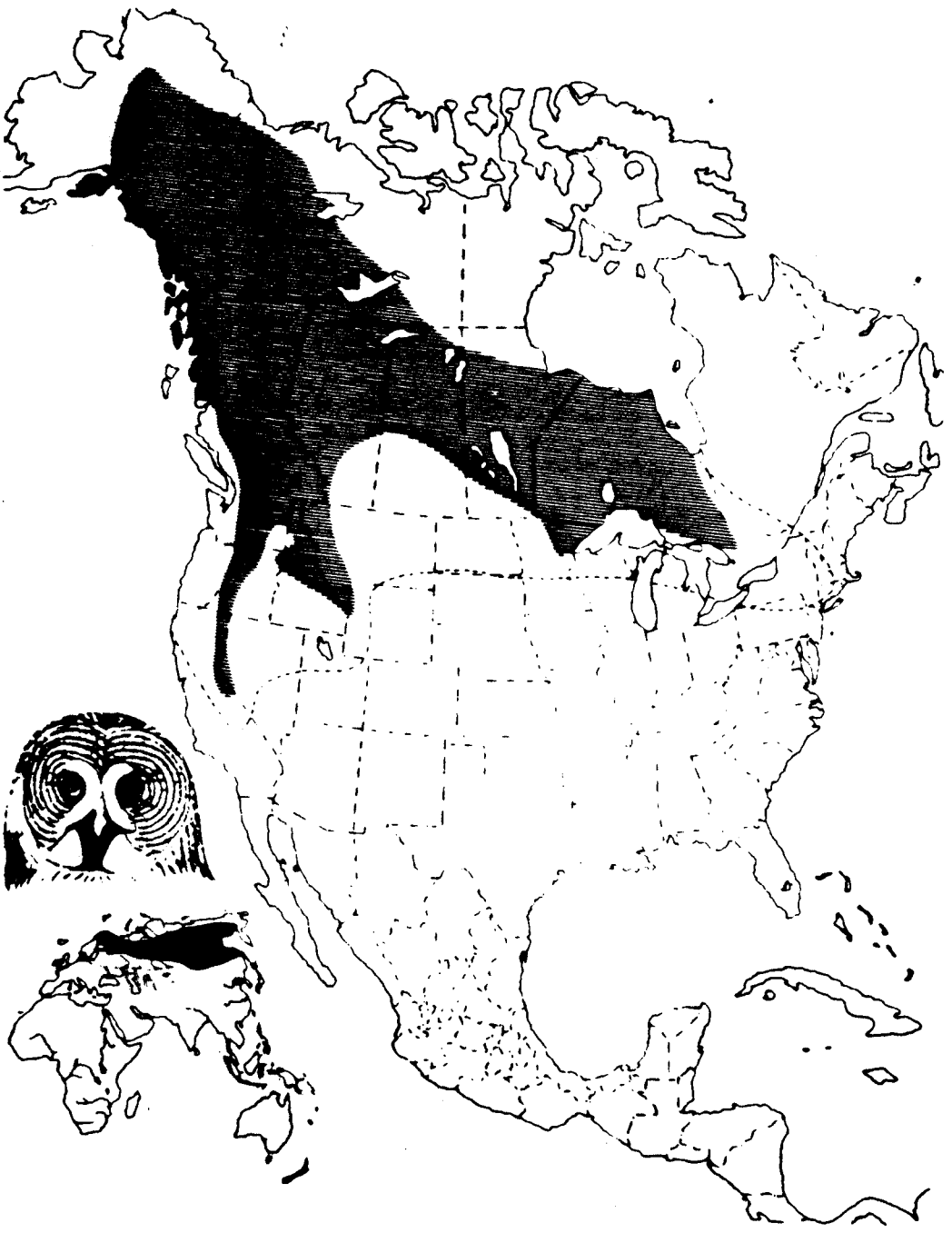

Figure 40. North American breeding distribution of the Great Gray Owl. The dashed line indicates usual limits of wintering vagrants. Extralimital distribution shown in inset.

Identification

In the field. This enormous owl is almost instantly recognizable by its very large and "earless" head, and by a generally dark body plumage except for a white "moustache" that is variably broken in the middle by a black "bow tie." The usual call is a deliberate series of soft and low-pitched single- or double-syllable hoots that gradually drop in frequency and decelerate toward the end of the series.

In the hand. The large size (wing over 410 mm) and large but "earless" head, with yellow eyes that are surrounded by a series of dark concentric rings in a distinct and circular facial disk, instantly identify this species. The wing is broad, with the sixth primary the longest, and the inner webs of the outer five primaries emarginated. The tarsus and heavily feathered toes are both relatively short, but the claws are long and slender.

Vocalizations

The vocalizations of this species have only been carefully studied in Europe (Berggren and Wahlstedt, 1977), but there is no reason to believe that these findings are not applicable to the North American race, which to some degree has been described by Oeming (1955). In Scandinavia, the males begin their territorial calling in January or February, often during the first period of mild weather, with a peak in calling activity during the nesting period. Territorial calling there may also be heard late in the breeding season, during June or July, and again sometimes in autumn (Mikkola, 1983).

In the Sierra Nevadas of California the birds are vocal throughout the year, responding to tape-recorded calls at virtually any time, but primarily uttering territorial calls between March and mid-May. Typically there the calling begins late in the evening after sundown, with a premidnight peak, followed by a sharp decline around midnight but a second peak shortly thereafter, and then gradually declining. Each call phrase lasts 6–8 seconds, the individual soft hooting notes uttered at the rate of about 3 per 2 seconds, and with an average interval of 33 seconds between calls (Winter, 1981). Under ideal conditions the call can be heard for up to 800 meters, but it often carries only about 500 meters (Mikkola, 1983).

Although the female sometimes also utters the territorial call prior to the egg-laying period in spring, her most common note is a single soft and mellow hoot, described by Nero (1980) as a *whoop* and by Oeming (1955) as a soft and dovelike *ooh-ah*. A similar hoot that can be heard for up to about 300 meters is used by the male at the nest. A double, excited *ooh-uh* is uttered by the female when the male is arriving with food. As a defensive or warning cry both sexes produce an extended series of double notes, uttered in groups of up to 100 in sequence and at the rate of up to 3 notes per second. The female's typical alarm call is a deep growling, together with bill snapping. During intense alarm, as when performing nest-distraction or injury-feigning displays, she may produce a series of wails, squeaks, and hoots, climaxed by a loud heronlike squack or bark. Prior to and during copulation the female produces a call reminiscent of the begging calls of chicks and juveniles, the latter rapid, chattering *sher-richt* notes. The chicks also produce bill-snapping sounds when being handled or otherwise disturbed (Nero, 1980; Mikkola, 1983).

Habitats and Ecology

In North America the broad range of the great gray owl encompasses a variety of vegetational types, ranging from subalpine coniferous forests through dense boreal and montane coniferous forests to stunted forests transitional to arctic tundra. Nesting is commonly done in stands of mature poplars (*Populus* spp.) adjacent to muskegs. Islands of poplars or aspens amid stands of spruce or pines are common breeding locations, as are similar groves or marginal strips of often-stunted tamaracks (*Larix laricina*) in wetter sites (Nero, 1980). In the Sierra Nevadas of California the birds breed in mixed-conifer forests and red fir (*Abies magnifica*) forests (at about 900–1800 meters and 1800–2700 meters elevation respectively), especially in dense forest stands bordering meadows. During late summer and fall the birds are prone to move higher into lodgepole pines (*Pinus contorta*) forests, but they also use lower-altitude ponderosa pine (*Pinus ponderosa*) forests during fall and winter (Verner and Boss, 1980; Winter, 1986). In winter the birds often move out of the forest to hunt in open fields having scattered trees, scrub patches, weedy areas, and fencerows (Brenton and Pittaway, 1971).

In the western Palearctic the great gray owl is mainly associated with dense and mature lowland or sometimes montane coniferous forests that are dominated by pines, spruces, and firs, these sometimes interspersed with birches (*Betula*) (Cramp, 1985). Most hunting is not done in such forests, but rather in adjacent open habitats, including marshes and cleared

forests (Mikkola, 1983). Probably a combination of abundant small (up to about 100 grams) rodents occurring in semiopen habitats such as meadows or muskegs where they can be readily captured, plus proximity to dense coniferous forests offering both roosting and nesting sites, are primary aspects of breeding habitats.

In Manitoba the birds favor tamarack during summer, apparently avoiding jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), open treeless areas, and habitats with a dense shrub layer. Factors affecting habitat selection include relative availability of microtine prey, suitable perches, and shrub density (Servos, 1987). Most Saskatchewan breedings have been in tamarack–black spruce forested wetlands, with 25 of 27 suspected nestings within 500 meters of such habitats (Harris, 1984). Although within areas of tamarack forests, 14 nest sites in Minnesota were associated with black ash (*Fraxinus nigra*) and basswood (*Tilia americana*), the forks of which provide better nest sites for raptors than the surrounding scrub tamaracks (Spreyer, 1987). Preferred winter habitat in Alaska consists of the ecotone between grassland meadows and tall willows, balsam poplars (*Populus balsamea*), and white spruce (*Picea alba*) (Osborne, 1987).

Population density estimates for North America are few, but Bull and Henjum (1987) found 5 nesting pairs in one 290 hectare study area, and 7 in an area of 937 hectares. Spreyer (1987) noted that in Minnesota as many as 8 nests in a single year occurred within a 52 square kilometer area. In Sweden variations in breeding density of from 7 pairs in 20 square kilometers to 9 pairs in 100 square kilometers (0.09–0.35 pairs per square kilometer) have been noted, and in one location 7 pairs occupied an area about 3 kilometers in diameter (Cramp, 1985). A nesting season home range of approximately 260 hectares, with a maximum diameter of about 2.3 kilometers, was estimated for great gray owls in the Grand Teton area of Wyoming by Craighead and Craighead (1956), based on sight records of unmarked birds. A winter home range of 45 hectares (maintained by one bird over an 11-day period) was estimated by Brenton and Pittaway (1971) in Quebec.

Movements

It is well known that great gray owls are irregularly irruptive or migratory, with periodic invasions into various northern states and southern Canadian provinces (Eckert, 1984; Nero, 1969). In the winter of 1983–84 more than 400 birds were seen in southern Ontario alone, the numbers peaking in January (*American Birds* 38:312). Nero (1980) thought that these winter invasions might often be the result of a combination of years of good reproductive success followed by prey declines, or perhaps the birds may be forced out of breeding areas because of deep snow accumulations or icy crusts that affect hunting success. There is some evidence that winter incursions may to a large degree be made up of immature birds; Nero and Copland (1981) noted that 20 of 24 birds banded during winter along the Trans-Canada Highway in southern Manitoba were immatures. Nero also noted (1980) that two females that bred successfully one year were repeatedly seen the following winter within a mile or two of their nest sites.

Postfledging movements of juvenile birds are sometimes quite extensive, judging from European banding data. Thus, in Finland 11 juveniles moved up to 226 kilometers, and in Sweden 16 juveniles moved up to 490 kilometers from the nest. At least the Swedish movements were not correlated with rodent population levels, but instead the dispersal pattern was random. A few long-distance movements of adults, including two females that moved 110 and 430 kilometers over periods of 2–4 years, have also been reported (Cramp, 1985). One long-distance movement of an immature was mentioned by Nero (1980), the bird being a nestling banded near Winnipeg and recovered the following winter about 753 kilometers southeast in extreme southern Minnesota. In an Oregon study, 11 radio-tagged juveniles traveled 8.8–31.4 kilometers from their nests in one year, while 11 adults moved 3.1–42.9 kilometers during the same period, suggesting that little if any age difference in mobility occurred there (Bull and Henjum, 1985).

Foods and Foraging Behavior

In spite of its large size, the great gray owl subsists almost entirely on relatively small rodents. Mikkola (1983) determined that of nearly 5200 prey items from the breeding season, 87.7 percent were of prey species averaging from 10 to 49.9 grams as adults, and only about 10 percent were of species averaging more than 100 grams. Studies at 61 nest sites in Finland and Scandinavia indicated that about 94 percent of the prey items were of rodents, and *Microtus* species alone comprised nearly 75 percent, with *Clethrionomys* the second most important genus, adding about 10 percent. Birds contributed

only about 1 percent. When breeding-season data are analyzed on a biomass basis, small microtine voles are responsible for 86.5 percent of the total, larger mammals (mostly of *Arvicola* voles) about 9 percent, and birds about 2 percent. Outside the breeding season the biomass representation of small voles declined somewhat, the latter two prey categories totaling about 20 percent of the estimated biomass consumption (Cramp, 1985).

Although North American studies are far less extensive, a similar rodent-based dietary picture emerges. Winter (1986, 1987) estimated the average weight of 662 prey items in California as about 75 grams, with pocket gophers (*Thomomys bottae*) contributing about 57 percent of the prey items and nearly 80 percent of the prey biomass. *Microtus* voles were of secondary importance, comprising 33 percent of the prey items and an estimated 17 percent of the total biomass. In Oregon, breeding-season prey consisted of about 58 percent *Microtus* voles and 34 percent pocket gophers (*Thomomys talpoides*) (Bull and Henjum, 1985). In the Grand Teton National Park area these two prey types likewise constituted 93 percent of the prey identified in a recent study (Franklin, 1985). The use of pocket gophers as summer prey has also been observed in Montana (Tryon, 1943). Limited observations in Quebec (Brenton and Pittaway, 1971) suggest that there the birds subsist almost exclusively on *Microtus* voles during winter, and *Microtus xanthognathus* comprised 66 percent of a sample of more than 200 pellets from Alaska, with other microtines contributing 28 percent and miscellaneous mammals and birds the remainder. Oeming (1955) similarly reported a concentration of *Microtus* voles in Alberta. Both Bent (1938) and Nero (1980) suggested that other mammalian species such as squirrels, moles, rats, young rabbits and hares, and weasels are also taken, as well as birds, usually quite small but sometimes as large as ducks and grouse.

Great gray owls prefer to hunt in relatively open country where scattered trees or forest margins provide for suitable vantage points for visual searching. Winter (1987) found that about 90 percent of monitored birds' time was spent within 124 meters of an open meadow. In the winter the birds hunt primarily in early morning and again from late afternoon to dusk, with little or no nocturnal activity, judging from Brenton and Pittaway's (1971) observations. Oeming (1955) also reported that, prior to the nesting season, most hunting is done in late afternoon, but while feeding young both daytime and nocturnal hunting may be done. Similar observations during winter in Finland suggest that the birds prefer to hunt at dusk, but modify their crepuscular tendencies to include daytime during midwinter, when the day is very short, and especially during dull, overcast days. On the other hand, during the short nights of summer at high latitudes the birds concentrate their foraging around midnight, although the great need for food during the nestling period may force the male to be active throughout the daylight hours (Mikkola, 1983).

There is good evidence that the great gray owl has remarkable visual acuity and is able to see small rodent prey running across the snow at distances of up to about 200 meters. Additionally they are able to locate and capture live prey from deep beneath the snow by acoustic clues alone (Nero, 1980). This is done by dropping down from a perch or a nearly motionless hovering position above the invisible prey, reaching down with their legs and crashing through the snow to depths of about 30 centimeters. Tryon (1943) also saw an owl crash through the roof of a feeding runway of a pocket gopher's burrow to get at the animal below.

Social Behavior

As a seminomadic species, it is not to be expected that great gray owls would have permanent pair bonds or strong nesting-site tenacity, and this generally appears to be the case. If food is locally abundant over a period of years the females may return to nest at the same sites, with records of a nest used for as long as five years, but at other times they may move elsewhere. Similarly, some young birds return to breed near their natal areas, while others may breed as far as 100 kilometers away (Cramp, 1985; Mikkola, 1983). Judging from limited data, both hand-raised and wild females can sometimes breed at a year of age, but two years might be the normal age of initial breeding. The pair bond is apparently monogamous but of unknown duration, and it is not maintained outside of the breeding season (Glutz and Bauer, 1980).

When perched, the birds typically remain almost motionless while standing close to the main bole of the tree, where their barlike plumage pattern allows them to blend into their surroundings remarkably well. When aware of approach by humans, they assume an upright, sleeked posture with the eyes remaining open and the breast rather than the wing directed toward the intruder (Figure 41, right). On the

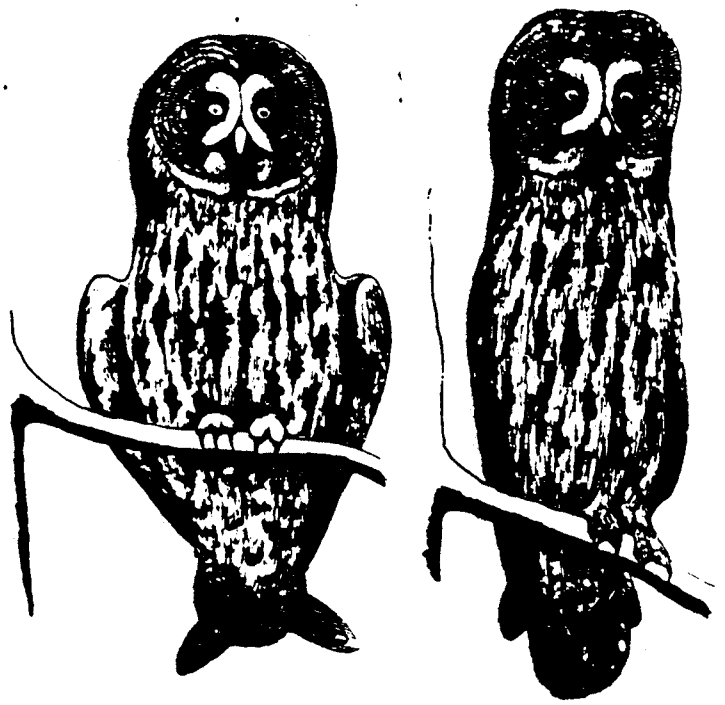

Figure 41. Postures of the Great Gray Owl, including *(left)* preattack posture and *(right)* concealment posture. After drawings in Mikkola (1983).

other hand, when about to attack an intruder the bill is snapped, the head feathers are fluffed, and the wings are spread slightly and drooped somewhat prior to takeoff (Figure 41, left).

The two most evident aspects of courtship behavior in great gray owls are courtship feeding and mutual preening. Nero (1980) regarded the latter as one of the most significant aspects of pair-bonding behavior and found that it could be easily elicited from adults of both sexes as well as from subadults. Even badly injured owls would respond to his tilting the top of his head toward them by running their beaks through his hair, gently nibbling on the scalp and often pulling on a few hairs. Similarly, Oeming (1955) observed mutual preening in captive birds. The birds would first stand with breasts touching and face to face as the male rubbed his beak over the female while uttering a humming sound; he would then circle her in a similar manner. Males have also been observed "combing" the breast feathers of the female with their talons, and although males apparently initiate mutual grooming the female may actually groom her mate more than the male (Katherine McKeever, quoted in Nero, 1980).

Courtship feeding begins in midwinter (lasting from January to mid-April in Manitoba), the female beginning to hoot softly and shifting her weight from leg to leg when she sees her mate carrying a prey animal. Stimulated by the female, the male flies to perch beside her, closes his eyes as he leans toward her, and holds out the prey for her to receive. The female seizes it with closed eyes and a slight mewing sound, thereby helping to form or reestablish the pair bond (Nero, 1980). Duncan (1987) reported seeing an immature male feeding a mated female at the nest, apparently representing the first record of possible nest helping among owls, although the possibility of this has been suggested for long-eared owls.

Nero (1980) described one attempted copulation that occurred in late February. The male flew into a tree where he was shortly joined by the female, who perched on the same branch some ten feet higher up. The male then flew and, cupping his wings, braked and dropped momentarily on the female's back. They then separated and flew away. In another incomplete observation the male was observed vigorously flapping his wings during copulation, while one or both birds uttered a peculiar

rasping screech. Shortly after that the male flew away and the female resumed hunting.

Nest visits may begin as early as mid-February in Manitoba, with the male uttering a nest-showing or advertisement call, while the female calls in response. When she visits the nest site she often sits and makes scraping movements. The male may then fly off, followed by the female. He may thus show her several possible nesting sites, the final choice presumably being made by the female. Selection of a nest site may in part be influenced by the relative local prey population, and this factor may also affect the timing of initial egg laying (Nero, 1980; Cramp, 1985; Mikkola, 1983).

Breeding Biology

Egg records in North America are rather limited, but 15 records from Alberta are from March 23 to May 15, with 8 occurring between April 9 and May 1. Three records from Alaska and arctic Canada are from May 15 to July 19 (Bent, 1938). In Alberta most nests have complete clutches by April 15, with the earliest record of a complete clutch being March 23 (Oeming, 1955). In Ontario eggs have been reported between April 29 and June 5 (Peck and James, 1983), and in the Sierra Nevadas of California breeding occurs from late February to mid-June, with a peak from mid-April to late May (Verner and Boss, 1980; Winter, 1986). Early April was reported as the earliest laying time by the Craigheads (1956) for the Grand Teton area, and Nero (1980) stated that laying may begin as early as mid-March, presumably referring to the area around Winnipeg.

Of 185 nests found in Finland (Mikkola, 1983), about 83 percent were twig nests originally built by raptors or corvids, 13 percent were on stumps, and the remainder in miscellaneous locations. Of 106 nests, 45 percent were in "damp heath" coniferous forests, 35 percent were in spruce bogs, 11 percent in "dry heath" coniferous forests, and the remaining 9 percent in pine peat bogs or herb-rich forests. About half of the nests had marsh areas located within 1,000 meters, and nearly half had an area cleared by felling within 500 meters. The majority of the stick nests had originally been made by goshawks (*Accipiter gentilis*), while those of buzzards (*Buteo buteo*) comprised the next most common category.

Franklin (1985) noted that 9 of 15 nest sites in the Grand Teton area were in broken-top snags, and almost 80 percent of the active nest sites were reused at least once. Of 52 nests in Oregon, half were in old raptor nests, 21 percent on artificial platforms, 19 percent on broken-top snags, and 10 percent in mistletoe clumps (Bull and Henjum, 1985). All of five California nests were located on the tops of large snags (Winter, 1980). Of 32 Canadian (apparently mostly Manitoban) nests mentioned by Nero (1980), 16 were in man-made structures, 10 were in completely artificial nests, and 6 were in rebuilt natural nests (Nero, 1980). Oeming (1955) stated that in Alberta favored nesting areas are among poplar woods, which often are lightly mixed with conifers and usually are close to areas of muskeg that are used for hunting. Among 23 sites from Alberta, 15 were in aspens (*Populus tremuloides*), 3 were in balsam poplars (*P. balsamifera*), 3 in black spruces (*Picea mariana*), and 2 in tamaracks (*Larix laricina*). They were typically in old, unmodified raptor or crow nests averaging 13 meters above ground (Oeming, 1955). In spite of early statements to the contrary, there is no good evidence that the owls enlarge, line, or otherwise modify their nest sites in any way except to deepen the cup of the nest.

Females lay eggs at a rate of about one per day, although longer intervals may sometimes elapse, especially for the eggs laid later in a clutch. Among 241 European clutches the

range of clutch size was 1–9 eggs, with an average of 4.4 (Mikkola, 1983). Twenty-three Alberta nests ranged from 2 to 5 eggs, with an average of 3.2 (Oeming, 1955). Evidently European clutch sizes increase from south to north, and they are also apparently influenced by local food conditions. Replacement clutches have been reported, with renesting usually occurring 15–30 days after the loss of the first nest (Bull and Henjum, 1987). There are reports that in good vole years as many as three clutches may be laid, although of course only one brood per year is raised (Mikkola, 1983).

The female does all the incubation, which normally requires 28–29 days, while the male performs all the hunting duties, often in open areas only a few hundred meters from the nest. The female receives the prey from her mate with the bill and consumes it herself or, after the young have hatched, passes it on to them, after first tearing it to bits if the owlets are very small.

Hatching of the eggs typically occurs at intervals of from one to three days, with the young weighing about 37–38 grams at hatching. Within 5 days after hatching they will normally almost have doubled their hatching weights, and by two weeks old will have attained a weight of about 500 grams, which attests to the importance of an abundance of food at this time. There are cases of young increasing in weight from 40 to 225 grams in a single week. The owlets normally leave the nest at 20–29 days, when weighing 425–630 grams. By then they are surprisingly agile at climbing trees, even though they are incapable of flight. Actual fledging probably occurs before they are 55 days old, but even after this they are likely to remain near the nest. They stay within the nesting territory for some months, watched over by the female. They probably become independent and begin dispersing at about 4–5 months (Cramp, 1985; Mikkola, 1983). Great horned owls are apparently serious predators on young birds (Bull and Henjum, 1987). There is seemingly a high mortality rate of young birds; Nero and Copland (1981) noted that 88 percent of 50 great gray owls found dead one winter in Manitoba were young of the year. Among 193 owls found dead over a 15-year period, 157 were killed by collision with motor vehicles, 26 had been shot, and 10 died from miscellaneous causes (Nero, Copland, and Mezibroski, 1984).

Although adult great gray owls may consume about 150–200 grams of feed per day on average, during a 50-day study period a young male and female averaged 76.4 and 80.6 grams of food respectively. This provides some idea of the enormous weight and number of prey that must be provided by a pair of birds (and primarily the male) if they are to raise a brood successfully (Mikkola, 1983).

Among a sample of 42 Finnish nests whose clutch sizes were known, 80.5 percent of the eggs hatched, and 72.1 percent of the chicks left the nest, for an overall reproductive success rate of 58 percent. The average number of fledged young per successful nest was 2.4, with humans being responsible for the largest number of egg and chick losses (Mikkola, 1983). Among a sample of 69 nesting attempts in Oregon, 75 percent of first nestings were successful, with northern ravens a major cause of egg losses. The average mortality of radio-tagged juveniles was 46 percent during their first year, as compared with 8–29 percent for adults (range of 3 years) (Bull and Henjum, 1987). Franklin (1987) reported a 71 percent

nesting success rate for 17 breeding attempts in the Grand Teton area, with an average of 2.5 fledged young per nest.

Evolutionary Relationships and Conservation Status

The great gray owl is a quite distinct form, and frequently has been given monotypic generic status by taxonomists. However, more recent classifications have placed it within the rather large genus *Strix*, albeit with no obvious close relatives. It seems possible that the Ural owl (*Strix uralensis*), and its southern counterpart the tawny owl, are the nearest living relatives to the great gray owl; the great gray and Ural owls are widely sympatric in Eurasia.

The status of the great gray owl in North America is difficult to judge, but Nero (1980) made an educated guess that the total population may be in the neighborhood of 50,000 birds, most of which are certainly found in Canada. There have been recent reviews of the species's status in Manitoba (Nero, Copland, and Mezibroski, 1984) and Saskatchewan (Harris, 1984), as well as a California survey (Winter, 1980). Recent studies by Franklin (1985) have shown the species to be fairly common in northwestern Wyoming and adjacent Idaho, where he found evidence of 67 territories, while in Oregon Bull and Henjum (1985) located over 50 nests in three years. Breeding almost certainly occurs in Washington, but its occurrence in that state is virtually undocumented. There are several breeding records for Minnesota, one for northern Wisconsin (where a brood was seen in 1978), and one from Michigan, on Neebish Island, Chippewa County (Jensen, Robinson, and Heitman, 1982).

APPENDIX B

Reprint of: Franklin, A. B. 1988. Breeding biology of the great gray owl in southeastern Idaho and northwestern Wyoming. Condor 90:689-696.

The Condor 90:689–696

BREEDING BIOLOGY OF THE GREAT GRAY OWL IN SOUTHEASTERN IDAHO AND NORTHWESTERN WYOMING[1]

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Abstract. In this study, I documented the existence of a breeding population of Great Gray Owls (*Strix nebulosa*) in southeastern Idaho and northwestern Wyoming and recorded aspects of this species' breeding biology between 1980 and 1983. Thirty-eight pairs were found; 25 fledged young at least once. Fifteen nests were documented; 40% in old stick nests and 60% on tops of broken-top snags. Nests were frequently reused. Mean date of egg laying was 5 May. Onset of egg laying appeared to be delayed during years of higher snow depth. Mean clutch and brood sizes were 3.3 and 3.0, respectively. Seventy-one percent of the nest attempts were successful. Fledged young moved at a constant rate and direction away from the nest before they were able to fly. Northern pocket gophers (*Thomomys talpoides*) and voles (*Microtus* spp.) constituted 57.9% and 34.1% frequency of the diet, respectively. Great Gray Owls nesting near clearcuts had higher percentages of pocket gophers in their diet while those nesting near natural meadows had higher percentages of voles.

Key words: *Great Gray Owl; Idaho; Wyoming; breeding biology; food habits;* Strix nebulosa.

INTRODUCTION

The Great Gray Owl (*Strix nebulosa*) is found in the boreal climatic zones of North America and Eurasia (Mikkola 1983). The breeding range in North America is from central Alaska and Canada, south to central California, the northern Rocky Mountains, extreme northwestern Minnesota and south-central Ontario (Collins 1980, Nero 1980). Idaho and Wyoming were included in the breeding range of this species based on four records of young (Hand 1941, Johnson 1974, Collins 1980) and one nest (Craighead and Craighead 1969) observed between 1931 and 1975. In addition, 17 specimens and 12 sight records collected between 1906 and 1974 provided additional, if limited, information on the occurrence of Great Gray Owls in Idaho and Wyoming (Kemsies 1935, Bent 1938, Long 1941, Test 1941, Scott 1970, Collins 1980).

The breeding biology of Great Gray Owls has been summarized by Collins (1980) and Nero (1980) for Canada, and by Mikkola (1983) for Eurasia. However, few studies have been conducted on Great Gray Owls in the southern portion of their range in the continental United States (Winter 1979, 1981, 1982a, 1982b; Evelyn Bull, pers. comm.).

In this study, I documented a breeding population of Great Gray Owls in southeastern Idaho and northwestern Wyoming and recorded aspects of this species' breeding biology between 1980 and 1983.

METHODS

The study area encompassed about 24,000 km^2 in northwestern Wyoming and southeastern Idaho and included the Targhee National Forest (TNF), the Teton portion of the Bridger-Teton National Forest (BTNF), Grand Teton National Park (GTNP), and Yellowstone National Park (YNP) (Fig. 1). The study area was described in more detail by Franklin (1987).

Locations of Great Gray Owls within the study area were initially collected from unpublished records from the TNF, BTNF, YNP, and GTNP. Between April and August of 1980 through 1982, areas of historic observations were searched during the day for nests and surveyed during the night using broadcasted territorial calls from an 8-W cassette tape player. A limited amount of data was collected in August 1983. Surveys were used only to locate nesting pairs within the study area. The study area was not systematically censused to obtain estimates of abundance or density.

Monthly snow depths for January through May were obtained annually from 40 snow course stations (U.S. Dep. Agric. Soil Conserv. Serv.) distributed at different elevations throughout the study area.

[1] Received 20 January 1988. Final acceptance 12 April 1988.

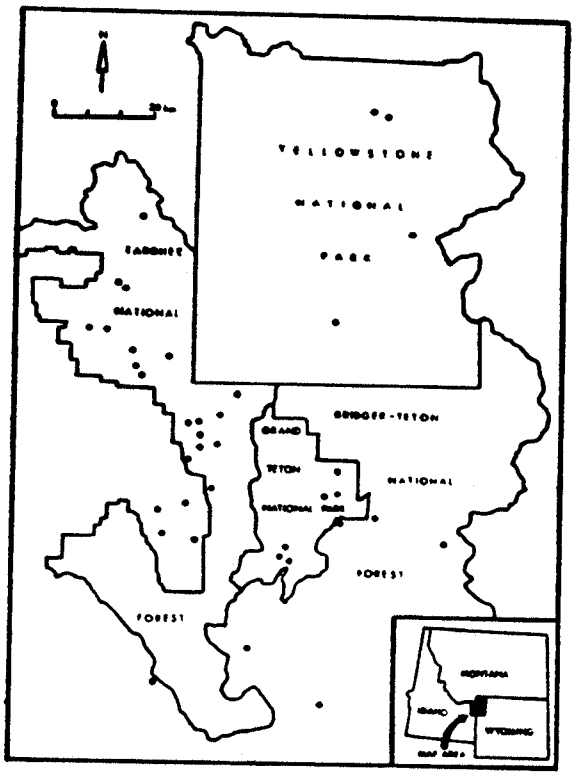

FIGURE 1. Map of the study area in southeastern Idaho and northwestern Wyoming showing locations of Great Gray Owl pairs (dots).

Time-lapse cameras were installed at three nests in 1981 and five nests in 1982 to record nesting chronology. Time-lapse cameras consisted of Minolta Autopack D6 movie cameras housed in waterproof aluminum cases. Telonics TIC-2 intervalometers were used to expose one frame of Ektachrome 160 Super 8 mm movie film every 3 min during the day. Cameras were installed above the nest in trees about 15 to 20 m from the nest. All nests were checked every 3 to 5 days by climbing trees adjacent to the nest to count eggs and young in the nests. Females usually left the nests and perched nearby during these climbs but returned to the nest within 5 min. No mortality of eggs or young was attributed to nest-site visits.

Movements from the nest and roost locations of young were documented every 3 to 5 days by searching the area surrounding the nest. At each roost location used by young, I measured the distance and direction from the nest with a compass and tape measure and the height of the young above the ground with a clinometer. Fifty-eight directions from nests to roosts of young were pooled for each nest and analyzed using circular statistics (Batschelet 1981).

Nest trees were measured after the young left the nest. At each nest tree, I measured the following variables: (1) nest height, with a clinometer, (2) diameter at breast height (DBH) of the nest tree, with a diameter tape, and (3) the surface area available for nesting, by two taped measurements across the nest surface and using the formula for computing the area of either a circle or an ellipse.

Meadow and clearcut cover-types within a 2.59-km^2 circle centered around nests were considered potential foraging habitat (Winter 1982a, Mikkola 1983). A 2.59-km^2 circle approximated the home range for Great Gray Owls (Craighead and Craighead 1969, Winter 1982a). Cover-types within the circle were outlined on aerial photographs (scale = 1:15,840) and their areas measured with a polar planimeter. Clearcuts were defined as logged areas, and meadows as natural openings. I computed a clearcut index, expressed as a percentage, by dividing the area of clearcut within the potential foraging habitat around each nest by the total area of clearcut and meadow within the potential foraging habitat.

I determined the composition of prey taken by Great Gray Owls by collecting regurgitated pellets around nests and under roost sites of young and adults. Each nest was considered a separate sampling location. Prey items were identified to species using skull characteristics (Glass 1973, Larrison and Johnson 1981). Biomass was approximated for each prey species using mean weights in Burt and Grossenheider (1964), Forsman (1975), and Weaver (1977). Skulls of northern pocket gophers (*Thomomys talpoides*) were classified as juveniles or adults based on lengths of upper and lower incisor bevels and molariform rows using criteria in Weaver (1977) and Franklin (1987). At each nest where pellets were collected, I computed a *Thomomys* index, expressed as a percentage, by dividing the frequency of *Thomomys* in the diet by the total frequency of *Thomomys* and *Microtus* in the diet.

Nonparametric tests were used for pairwise comparisons and bivariate associations (Daniel 1978, Sokal and Rohlf 1981). Tests of independence and homogeneity were evaluated using chi-square (Sokal and Rohlf 1981).

RESULTS

DISTRIBUTION AND ABUNDANCE

I recorded 255 sightings of Great Gray Owls within the study area. Most (67.5%) of the sight-

TABLE 1. Measurements of nests and nest trees of Great Gray Owls in southeastern Idaho and northwestern Wyoming. Data are $\bar{x} \pm$ SD with n in parentheses.

Nest type[a]	Height of nest aboveground (m)	DBH[b] of nest tree (cm)	Nesting surface area (cm²)
LPP snag	4.0 ± 0.3 (3)	50.8 ± 6.7 (3)	808 ± 217 (3)
DF/ES snag	7.5 ± 1.1 (4)	71.8 ± 13.8 (4)	1,172 ± 381 (3)
All snag	6.0 ± 2.0 (7)	62.8 ± 15.3 (7)	990 ± 342 (6)
Stick	11.1 ± 2.7 (5)	38.6 ± 17.5 (5)	2,445 ± 281 (5)
Overall	8.1 ± 3.4 (12)	52.7 ± 19.9 (12)	1,651 ± 817 (11)

[a] LPP = lodgepole pine, DF/ES = Douglas-fir/Engelmann spruce.
[b] Diameter at breast height.

ings were from 1980 to 1983 with 94.1% occurring after 1960. Sightings were recorded between 1,524 and 3,000 m elevation. The mean elevation where active nests and fledged young were observed was 2,078 m (SD = 241, n = 41). Over 90% of the sightings were in the lodgepole pine (*Pinus contorta*)/Douglas-fir (*Pseudotsuga menziesii*)/aspen (*Populus tremuloides*) zone which included the lower half of the forested slopes in the area.

Thirty-eight pairs were found within the study area between 1980 and 1983 (Fig. 1). Twenty-five of the pairs were reproductively active, fledging young at least once during the 4-year study period. Twenty-four areas (defined by 2.59-km² circles) were known to be occupied by pairs for a mean of 7.2 years (SD = 8.4). One area in GTNP had been sporadically occupied between 1947 and 1983 (36 years) with young fledged in 1947 and 1981.

NEST SITES

Fifteen nests have been found in the study area; one in 1947 (Craighead and Craighead 1969), one in 1973 (D. Taylor, pers. comm.), three in 1977 (C. Youmans, pers. comm.; E. Bowman, pers. comm.), one in 1979 (T. Weaver, pers. comm.), and nine during this study.

Nine (60%) of the nests were in shallow depressions on the tops of broken-top snags. Five of these were in lodgepole pine snags, three in Douglas-fir snags and one in an Engelmann spruce (*Picea engelmannii*) snag. All of the snags were in advanced stages of decay (sensu Cline et al. 1980). Six (40%) of the nests were in old stick nests; four were in lodgepole pines, one in an aspen, and one in a Douglas-fir snag.

Nests in lodgepole pine snags were lower to the ground and had the smallest surface area (Table 1). Stick nests were the highest and had the largest surface area. Nests in snags (all tree species combined) were significantly closer to the ground (Mann-Whitney U-test, $U = 33$, $P < 0.05$), in trees of larger DBH ($U = 30$, $P < 0.05$), and had smaller surface areas ($U = 30$, $P < 0.01$) than stick nests.

Nest destruction over 2 years appeared greatest in lodgepole pine snags followed by stick nests. Two lodgepole pine snags used for nesting were felled during a windstorm while a third was depredated. Two stick nests were destroyed by wind. I observed no loss of nests in Douglas-fir/Engelmann spruce snags.

Five nests observed over a 2-year period (one nest in 1947–1948, F. Craighead, pers. comm.; two nests in 1977–1978, C. Youmans, pers. comm.; two nests in 1981–1982, this study) were occupied each year and were reproductively successful. A sixth nest was used for four consecutive years (1980 to 1984), producing two to three young each year. A seventh nest was active in 1980, 1981, and 1983, but not in 1982. In 1982, time-lapse films recorded an adult on this nest

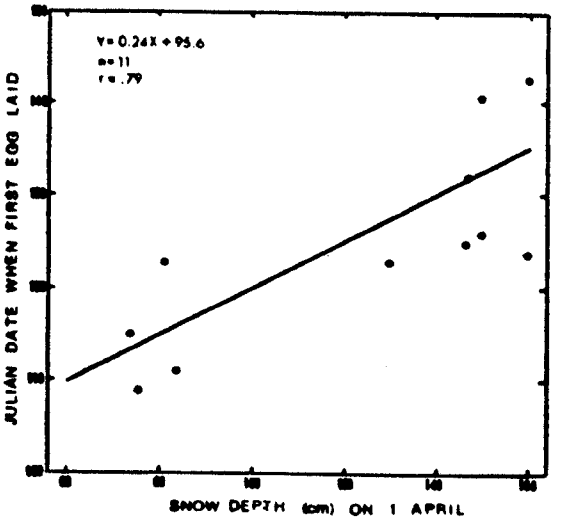

FIGURE 2. Julian date of first egg laid in relation to snow depth on 1 April at Great Gray Owl nests in southeastern Idaho and northwestern Wyoming. Spearman's rank correlation coefficient is significant at $P < 0.01$.

TABLE 2. Reproductive output of Great Gray Owls in southeastern Idaho and northwestern Wyoming.

	Observed frequency of n individuals						
	1	2	3	4	$\bar{x}$	SD	n
Clutch size	0	2	2	4	3.3	0.3	8
Brood size	1	2	6	4	3.0	0.3	13
Size of fledgling groups[a]	1	0	4	2	3.0	0.4	7
Size of fledgling groups able to fly	1	3	1	0	2.0	0.3	5

[a] n = number of eggs for clutch size and number of young for the other three variables.
[b] Not yet capable of flight.

for 15 to 20 min on 27 April and 1 May with no other activity recorded for the rest of the year.

NESTING CHRONOLOGY

Before egg laying, adults were frequently recorded at the nest. Time-lapse photography at two nests revealed that adults repeatedly visited the nests 17 to 25 days before the females settled on the nest. One or both of the owls made at least one to four trips daily to the nest ($\bar{x}$ = 2.3, SD = 1.0, n = 19) each or every other day and spent 3 to 75 min at the nest ($\bar{x}$ = 15, SD = 16, n = 42) during daylight visits.

The mean date when the first egg was laid was 5 May (SD = 9.9 days, n = 11). The date when the first egg was laid was significantly correlated with snow depth at the onset of the breeding season (defined as 1 April) (Fig. 2). Eggs were laid as early as 19 April under conditions of relatively shallow snow and as late as 23 May when snow was deeper.

Incubation period (from the laying of the first egg to the hatching of the last egg) averaged 29.7 days (SD = 1.6, n = 3 clutches). Young left their nests at a mean age of 28.5 days (SD = 1.5, n = 6). At this stage, the young were considered fledged even though they were incapable of flight. Young were capable of sustained gliding flight an average of 14.2 days (SD = 1.1, n = 5) after leaving the nest.

REPRODUCTIVE OUTPUT

The most common clutch was three to four eggs (75.0%) and the most common brood was three to four young (76.9%) (Table 2). Annual clutch size ranged from a mean of 3.0 (n = 4) in 1981 to 3.3 (n = 4) in 1982. Clutch sizes in this study were not statistically different (Mann-Whitney U-test, U = 110–149, $P > 0.50$) from clutch sizes from two other studies in North America (Oeming 1955 [n = 23 clutches], Collins 1980 [n = 11]). However, comparison of the pooled data from North America with data from four studies (n = 21, 28, 30, and 66 clutches) in Finland and Sweden (Hildén and Helo 1981), which also were not significantly different (Mann-Whitney U-test, U = 380–898, $P > 0.12$), revealed that clutch sizes in North America ($\bar{x}$ = 3.2, n = 34) were significantly smaller (Mann-Whitney U-test, U = 3,709, $P < 0.001$) than clutch sizes in Scandinavia ($\bar{x}$ = 4.3, n = 145).

Between 1980 and 1983, eggs were laid in 88.2% of 17 nesting attempts while young were fledged in 70.5% of the attempts. Nests in lodgepole pine snags, stick nests and fir/spruce snags averaged 1.0 (n = 4), 3.0 (n = 4), and 3.3 (n = 4) fledglings per nesting attempt, respectively. The annual number of fledglings per successful nest, or productivity, ranged from a mean of 2.7 (n = 3) in 1981 to 3.0 (n = 3) in 1982.

Survival probabilities for young were determined at eight nests where eggs and young were followed through most or all of the developmental stages. A young Great Gray Owl had a probability of 0.76 (n = 25) of surviving incubation as an egg, 0.89 of surviving as a nestling (n = 19), and 0.77 of surviving through the flightless stage after fledging (n = 13).

MOVEMENTS OF FLEDGLINGS

Eleven banded young, fledged from five nests, moved at a constant rate (Fig. 3) and in a constant direction (n = 58 directions measured) away from the nest as they grew older. Mean directions taken by family groups were roughly north (n = 2; 19° and 32°), south (n = 1; 176°), and southwest (n = 2; 224° and 250°). The r values for the mean directions were high (range = 0.83–0.96) and significantly directed (Rayleigh test, $P < 0.001$) indicating that each family group maintained a constant compass direction as they moved away from the nest.

The height which fledglings roosted above the ground was significantly correlated with the age of the fledglings (Fig. 4). The roost sites used by fledglings as they moved away from their nests,

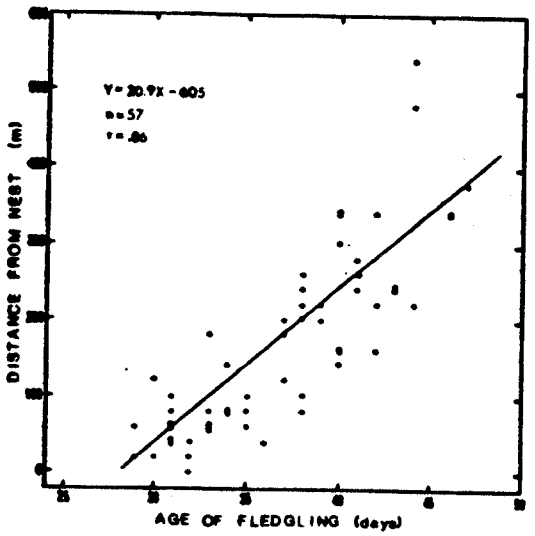

FIGURE 3. Distances moved from nests by fledgling Great Gray Owls in relation to their age in southeastern Idaho and northwestern Wyoming. Spearman's rank correlation coefficient is significant at $P < 0.001$.

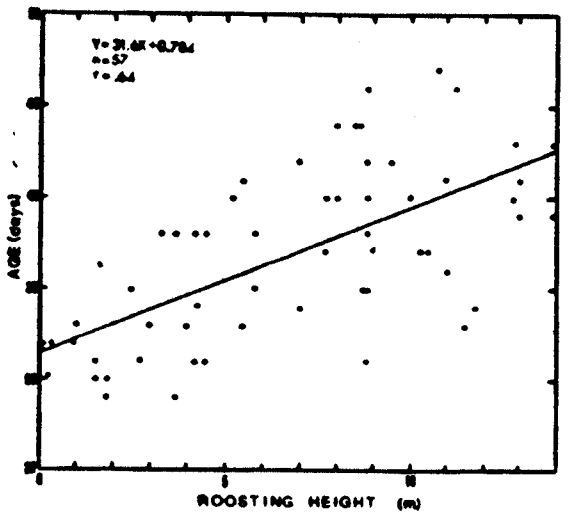

FIGURE 4. Height at which fledgling Great Gray Owls roosted in relation to their age in southeastern Idaho and northwestern Wyoming. Spearman's rank correlation coefficient is significant at $P < 0.001$.

but before they could fly, were assigned to three categories (Fig. 5); (1) most accessible to the young ($n = 8$), (2) moderately accessible ($n = 18$), and (3) least accessible ($n = 31$). Mean age of young using the three categories of roosts differed significantly (Mann-Whitney U-test, $U = 112$–433, $P < 0.05$). Accessibility was subjectively determined by the ease with which roosts could be reached by fledglings that could not fly. Vulnerability to mammalian predators was considered a direct function of accessibility.

FOOD HABITS

Northern pocket gophers and *Microtus* spp. constituted 92.0% (by frequency) and 92.9% (by biomass) of 435 prey items identified from pellets collected at eight nests (Table 3). Of 72 pocket gopher skulls aged, 76.4% were from juveniles; 65.8% from pellets collected in June ($n = 38$), 90.9% in July ($n = 22$), and 87.8% in August ($n = 8$).

Comparisons of the frequency of prey items placed in three categories (*Thomomys*, *Microtus*, and "Other" prey) resulted in three nest groups, containing nests not significantly different from each other. Nest group A ($\chi^2 = 13.0$, df = 8, $P > 0.10$) included five nests ($n = 199$ prey items) which fledged a mean of 2.9 young (SD = 1.1, $n = 7$), group B ($\chi^2 = 4.8$, df = 2, $P > 0.05$) included two nests ($n = 72$ prey) which fledged an average of 3.0 young ($n = 2$), and group C ($\chi^2 = 4.1$, df = 2, $P > 0.05$) included two nests ($n = 160$ prey) where the reproductive outcome was unknown. Differences in frequencies of *Thomomys* and *Microtus* among all three nest groups were significant ($\chi^2 = 4.3$–92.3, df = 1, $P < 0.05$) but not significant in the Other category ($\chi^2 = 0.1$–1.2, df = 1, $P > 0.25$). Percentages of *Thomomys* in the diet decreased, as *Microtus* increased, in groups A, B, and C, respectively (Fig. 6).

The differences in occurrence of prey may be partially explained by the types of foraging habitat around the nests. The amount of *Thomomys* in the diet appeared directly proportional to the amount of clearcut surrounding the nests (Fig. 7).

DISCUSSION

Productivity in this study was high with a mean of 3.0 young fledged per successful nest as com-

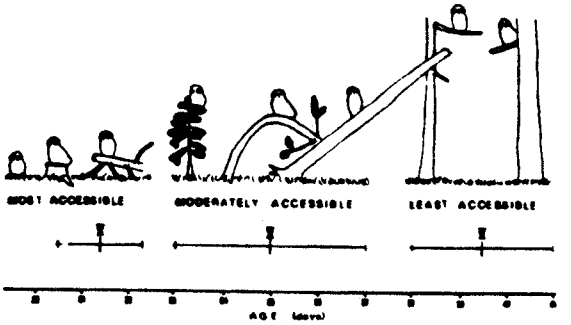

FIGURE 5. Mean age of fledgling Great Gray Owls using three categories of roosts in southeastern Idaho and northwestern Wyoming. Values represent means ± 95% confidence intervals around the mean.

TABLE 3. Prey items found in Great Gray Owl pellets in southeastern Idaho and northwestern Wyoming.

Prey species	n	Frequency (%)	Biomass (g)	Biomass (%)
Thomomys talpoides	252	57.9	17,415	69.4
Microtus montanus	139	32.0	5,560	22.1
Microtus agrestis	2	0.5	80	0.3
Microtus richardsoni	7	1.6	280	1.1
Peromyscus maniculatus	7	1.6	154	0.6
Sorex spp.	6	1.4	60	0.2
Tamiasciurus hudsonicus	3	0.7	600	2.4
Clethrionomys gapperi	3	0.7	75	0.3
Zapus princeps	3	0.7	90	0.4
Onychomys leucogaster	3	0.7	90	0.4
Unidentified bird	10	2.2	700	2.8
Total	435	100.0	25,104	100.0

pared to 2.3 in Oregon (Evelyn Bull, pers. comm.) and 2.7 to 3.9 in Finland and Sweden (Hildén and Helo 1981). Nesting success in this study was also high and similar to that observed in Oregon (75%, Evelyn Bull, pers. comm.). Despite larger clutches in Finland, the average number of fledglings per nest attempt ($\bar{x} = 2.4$, $n = 42$) in Finland (Mikkola 1981) was similar to that found in this study because of lower nestling survival in Finland than in this study (72% vs. 89%, respectively). Hatching rates were similar (81% in Finland and 76% in this study).

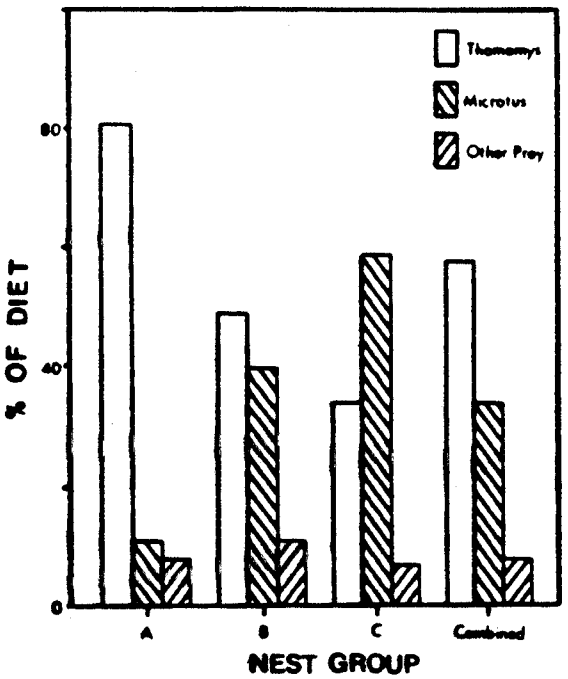

FIGURE 6. Percent of three prey categories in three groups of Great Gray Owl nests in southeastern Idaho and northwestern Wyoming. Prey categories and nest groups are explained in the text.

In this study, nests in fir/spruce snags were more productive and stable than nests in lodgepole pine snags and stick nests. Those in fir/spruce snags (1) had a larger nesting surface area, (2) were taller and, therefore, relatively inaccessible to predators, and (3) were more durable.

Great Gray Owls in North America use different proportions of stick nests and broken-top snags for nesting within different parts of their geographic range. In order of decreasing latitude, the ratio of snag to stick nests average 1:20 (n = 42) in Canada and Minnesota (Roberts 1936; Robinson 1954; Oeming 1955; Parmelee 1968; Nero 1970, 1984; Muir 1972; Kondla 1973; James 1977; Eckert 1979; Collins 1980; Houston and Wylie 1984), 1:2.5 (n = 41) in Oregon (Evelyn Bull, pers. comm.), 1:0.7 (n = 15) in this

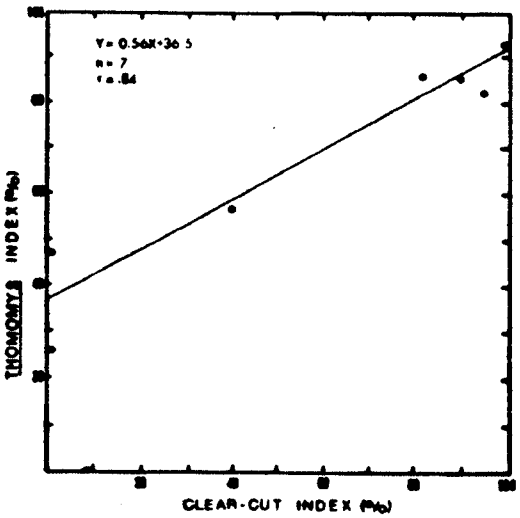

FIGURE 7. *Thomomys* index in relation to clearcut index at seven nests in southeastern Idaho and northwestern Wyoming. Spearman's rank correlation coefficient is significant at $P < 0.03$.

study and 1:0 ($n = 8$) in California (Winter 1980, 1982a). Use of snags for nests is almost three times more common in southern than in central and northern Finland (Mikkola 1983). The use of snags as nests may be related to nest-site availability within different proportions of this species' breeding range.

After leaving the nest, young climbed available perches near the nest probably to escape ground predators (Oeming 1955; Hoglund and Langsgren 1968; Nero 1970, 1984; Pulliainen and Loisa 1977; Follen 1979; Collins 1980). Survival of fledged young probably depends on: (1) the availability of roosts such as leaning and deformed trees which are accessible to them and which allows them to roost high enough to avoid ground predators and (2) the existence of forested habitat within a 500-m radius surrounding the nest. The reason for the unidirectional movements by family groups is unknown and appears to be unpredictable. However, Nero (1980) observed a female using vocalizations to lure young away from the nest indicating that movements by young may be controlled by their parents.

During the breeding season, over 90% of the prey in Great Gray Owl diets in Europe and Canada was in the family Microtidae (Oeming 1955; Hoglund and Langsgren 1968; Nero 1969; Mikkola and Sulkava 1970; Mikkola 1972, 1981; Pulliainen and Loisa 1977). However, pocket gophers (*Thomomys* spp.) constituted 34 to 58% of the diet of Great Gray Owls in the southern part of their range in North America (Evelyn Bull, pers. comm.; Winter 1982a; this study). Therefore, pocket gophers appear to be an important prey for Great Gray Owls in the southern portion of their North American range.

In this study, Great Gray Owls nesting near clearcuts may be utilizing the most abundant small mammal species available. Barnes (1973) and Teipner et al. (1983) reported higher densities of pocket gophers in clearcut areas than in other habitats. In addition, juvenile pocket gophers were present in the diet in higher percentages than were typically present in the age structure of northern pocket gopher populations. The proportion of juvenile gophers found in YNP by Youmans (1979) was 7% in June, 39% in July, and 78% in August as compared to 66%, 91%, and 88% juvenile gophers in the diet of Great Gray Owls in this study during those months, respectively. Great Gray Owls may be taking the most vulnerable age class of this prey since young pocket gophers often disperse aboveground (Chase et al. 1982). Winter (1982a) suggested that reduced microtine abundance could severely limit reproduction by Great Gray Owls. In this study, however, fledgling success was high at nests where high percentages of pocket gophers were present in the diet.

ACKNOWLEDGMENTS

I am particularly indebted to Jim and Alice Caulkins for their support throughout this project. Plastics Machinery Company, Society of Sigma XI, Snake River Audubon Society, Fremont County Audubon Society, Ed and Beth Hicks, and Jacqueline Koch kindly contributed funds through the National Audubon Society with the assistance of Bob Turner. John Weaver, Tracy Trent, Bob Oakleaf, Bob Wood, Lew Becker, Mary Maj, John McGee, Bruce Smith, Mike Whitfield, Gail Worden, Renee Askins, Franz Camenzind, Ann Chrisney, Tom Fieger, Jeff Foote, Barb Franklin, Ben Franklin, Bruce Hampton, Molly Hampton, Mary Langdon, Christine Aylesworth, and Pat Vitucci kindly provided their assistance during various phases of this project. Evelyn Bull, Rocky Gutiérrez, Carl Marti, Robert Nero, Pat Ward, and an anonymous reviewer critically reviewed earlier drafts of this manuscript. This project was done in partial fulfillment of the requirements for the Master of Science degree at Humboldt State University.

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APPENDIX C

Great Gray Owl Poster

GREAT GRAY OWL SIGHTINGS

WANTED

WE NEED YOUR HELP

The Idaho Department of Fish and Game is surveying national forests in Idaho for great gray owls—a Forest Service Sensitive Species and IDFG Species of Special Concern. We need your help in determining the status and distribution of these forest owls. Please turn in any sightings you make as soon as possible!

WHAT TO LOOK FOR

- largest owl in area
- 2-3 feet tall
- 4-5 foot wingspan
- distinct round facial ring
- gray coloration
- yellow eyes
- nests on top of snags or in old hawk nests

WHO TO CONTACT

Craig Groves – Nongame and Endangered Wildlife Program
Idaho Dept. of Fish and Game
Box 25
Boise ID 83707
(208) 334-3402

or

Wildlife Biologist
Targhee National Forest
Box 208
St.Anthony ID 83445
(208) 624-3151

Photo Courtesy of Michael Quinton

APPENDIX D

Nest Platform Plans (Bull et al. 1987)

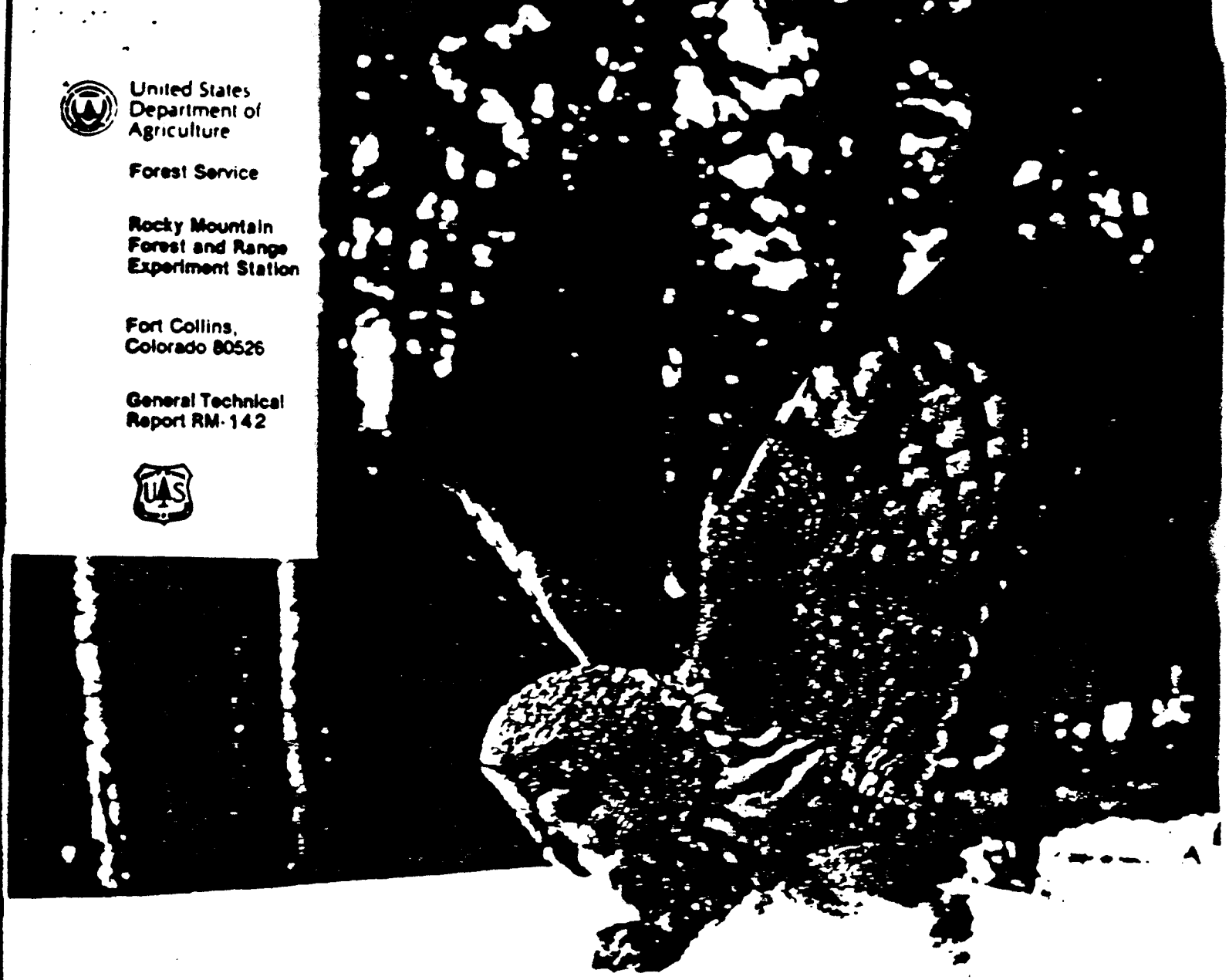
United States
Department of
Agriculture

Forest Service

Rocky Mountain
Forest and Range
Experiment Station

Fort Collins,
Colorado 80526

General Technical
Report RM-142



Biology and Conservation of Northern Forest Owls

Symposium Proceedings

February 3 - 7, 1987
Winnipeg, Manitoba

Nest Platforms for Great Gray Owls[1]

Evelyn L. Bull,[2] Mark G. Henjum,[3] and Ralph G. Anderson[4]

Abstract.--During 1983-1986, 12 great gray owl (Strix nebulosa) pairs nested on artificial platforms in northeastern Oregon. Platforms put up 15 m were preferred over those platforms put up 9 m. Nest platforms were preferred over nest boxes. Each platform cost $40 to construct and mount.

The loss of natural nest sites has encouraged use of artificial nest structures for owls (Strix spp.) in northern Europe (Stefansson 1978, Rauhala 1980, Hilden and Helo 1981, Mikkola 1983, Helo 1984), and Canada (Nero 1980). In the Pacific Northwest, great gray owls (S. nebulosa) frequently nest in vacated hawk nests or on the broken tops of dead trees. Intensified timber management has reduced the number of available nest sites because many large diameter dead and live trees have been harvested.

At least 5 types of nest structures have been constructed for and used by great gray owls. Helo (1984) described an open nest structure 40 x 30 cm with a height of 10 cm that great gray owls have used. Nest structures used in Canada and Minnesota include wire frames with sticks inside (Nero et al. 1974, Nero 1982), wire baskets with sticks inside (Bohm 1985), and nests constructed of sticks alone (R. W. Nero, pers. comm.). Quinton (1984) described nests created by cutting the tops off trees and making a shallow depression inside the bole.

Great gray owls readily use artificial structures (fig. 1); we wanted to determine if the owls had a preference for height of nest (placed at 9 m or 15 m above the ground), type of nest (wooden platforms or nest boxes), and distance of nest from a clearcut (adjacent to a clearcut or 100 to 200 m from the edge of a clearcut).

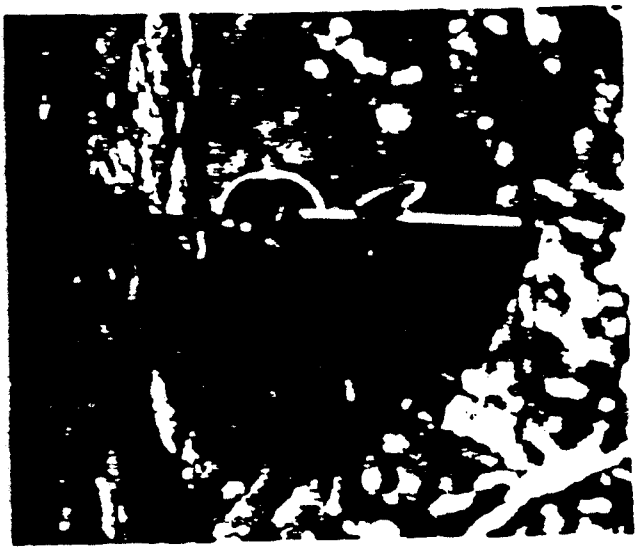


Figure 1. Female great gray owl nesting on wooden platform in northeastern Oregon, 1986.

METHODS

We established 3 study areas in the Blue and Wallowa Mountains in northeastern Oregon where mixed conifer forests were interspersed with openings. In study area A, we selected 26 sites and put 2 platforms (fig. 2) at each site, in separate trees but within 30 m of each other. One platform was 9 m and the other was 15 m above the ground.

In study area B, we selected 27 sites near clearcuts created 1 to 10 years ago. At each site, 1 platform was adjacent to the clearcut

[1] Paper presented at the Northern Forest Owl Symposium, Winnipeg, Manitoba, February 3-7, 1987.

[2] Research Wildlife Biologist, Forestry and Range Sciences Laboratory, La Grande, OR.

[3] Wildlife Biologist, Oregon Department of Fish and Wildlife, La Grande, OR.

[4] Biological Technician, Wallowa Valley Ranger Station, Joseph, OR.

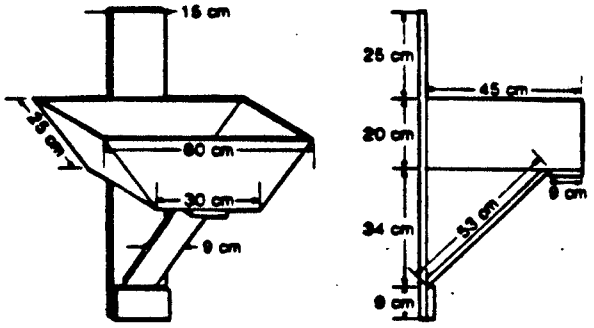


Figure 2.--Great gray owl nest platform constructed from 2-cm thick boards. Holes were drilled for 20-cm long ring-shank nails used with washers. Platforms were stained with 5 parts linseed oil and 1 part gray stain.

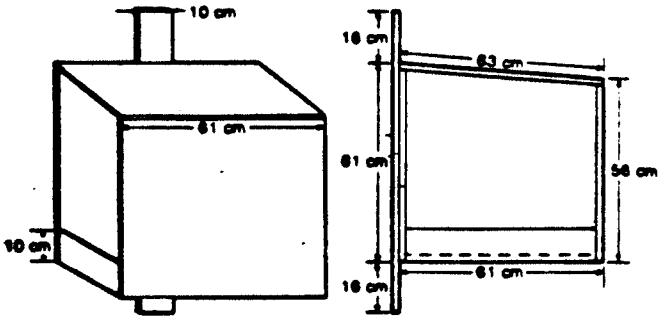


Figure 3.--Great gray owl nest box constructed of 1-cm thick plywood. The vertical support piece was a 2 x 10 cm board. Holes were drilled for 20-cm long ring-shank nails used with washers. Platforms were stained with 5 parts linseed oil and 1 part brown stain.

and 1 in a forest stand 100 to 200 m from the edge of the clearcut. Platforms were put 9 m above the ground.

In study area C, we selected 26 sites and put 1 wooden platform and 1 wooden nest box (fig. 3) at each site. Each platform was within 30 m of a box, and both were 9 m above the ground. An additional 28 wooden platforms were erected in study area C between 1975 and 1985 but were not part of this study. The platforms, 9 m above the ground in forested stands, were checked irregularly over the years.

Sites were at least 0.5 km apart--the minimum distance we found between active nests of great gray owls. Sites for platforms were selected based on historic use by great gray owls and the presence of mature trees.

Platforms were placed on the northeastern side of live trees _ 30 cm dbh (diameter at breast height) to reduce solar heat. Branches were removed along the bole from the ground to 1 m above the platform to allow access by the birds. An 8-cm layer of chips was placed in the bottom of platforms and boxes with twigs 1 cm in diameter placed on top. This chip layer permitted birds to dig depressions in which to lay eggs. Holes (1 cm in diameter) were drilled in the bottom of platforms and boxes for drainage.

The nest structures were put up in September 1984 in study areas A and B, and in summer 1982 in study area C. Each structure was checked annually in late April because great gray owls usually started incubating in late March. The female's tail was usually visible over the edge of the nest structure.

The cost of constructing and mounting the platforms was calculated using $5 for materials/platform, $7/hr for labor, and $0.10/km for vehicular travel. Eight platforms could be erected in a 10-hr day. To construct and mount, each platform cost $40.

RESULTS

From 1983 to 1986, 12 great gray owl pairs nested on these platforms (table 1). All 5 pairs that nested on platforms in study area A used the platforms 15 m above the ground. Two pairs nested in study area B, 1 on a platform adjacent to a clearcut and 1 on a platform 200 m from a clearcut. All 5 pairs that nested in study area C used wooden platforms. None used nest boxes. Ten of the 12 nesting pairs successfully fledged young. At least 5 of the additional 28 platforms in study area C were used by nesting great gray owls during 1980-1986.

Great horned owls (Bubo virginianus) nested on 1 platform in 1985 and on 5 platforms in 1986.

DISCUSSION

Great gray owls preferred the wooden platforms to the boxes and preferred the 15-m to the 9-m height, although the 9-m height was used when other suitable platforms were not available (as in study areas B and C). Platforms adjacent to and 200 m from a clearcut were used. Great gray owls sometimes used wooden platforms when natural nest sites were available nearby.

Table 1.--Number of artificial platforms used by great gray owls for nesting in northeastern Oregon, 1983-1986.

Study area	Year			
	1983	1984	1985	1985
A-Nest height (26 sites)				
9 m	NA[1]	NA	0	0
15 m	NA	NA	2	3
B-Proximity to clearcut (27 sites)				
Adjacent	NA	NA	0	1
100-200 m away	NA	NA	0	1
C-Nest structure type (27 sites)				
Platform	1	1	1	2
Box	0	0	0	0

[1]Platforms not put up until September 1984.

The number of pairs that fledged young was higher for those pairs that nested on wooden platforms (83%) than for pairs that nested on stick nests, mistletoe clumps, or broken-topped dead trees (70%) (unpublished data, E. L. Bull). This higher success was partly because the platforms are stable; eggs or nestlings sometimes fell through stick and mistletoe nests.

A potential problem exists with great horned owls using the platforms because great horned owls are a major predator of fledged great gray owls (Nero 1980). We did not anticipate this problem because the great horned owl nests we had observed before 1984 were in more concealed sites than the ones we offered. Because great horned owls nest 1 to 3 weeks earlier and are more aggressive, they could successfully compete with great gray owls for nest sites on platforms. The subsequent increase in great horned owls could take its toll on fledged great gray owls in the area.

Mikkola (1982, 1983) addressed a similar problem installing artificial nest structures for the tawny (S. aluco) and ural owls (S. uralensis) in Europe. The tawny and ural owls prey on smaller owls, and in areas where artificial nest structures were used by tawny or ural owls, the smaller owls disappeared (Schonn 1980).

Thus, nest platforms can provide nest sites for great gray owls, but caution is needed because platforms could also increase populations of great horned owls, which could be detrimental to great gray owls. Given the rarity of great gray owls and the attraction the species has to segments of the public, the cost of providing artificial nest platforms is justified.

ACKNOWLEDGMENTS

R. A. Grove, J. S. Henderson, J. E. Hohmann, and M. E. Walker helped design, construct, mount, and check platforms. A. Franklin, W. I. Haight, E. Mikkola, R. W. Nero, Oregon Department of Fish and Wildife, and personnel at the Wallowa Valley Ranger District provided additional assistance.

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Appendix E

Sample Data Sheet for Great Gray Owl Observations

GREAT GRAY OWL DATA SHEET

Territory Name:

Location: T_____ R_____ S_____
(attach map showing specific locale)

Directions to Nest: (detailed written directions)_____

_____

_____

Date Nest First Discovered: _____

Elevation:_____(feet) Aspect:_____

Land Ownership: _____

Type of Nest:_____

_____
(broken-top snag, old goshawk nest, etc. - give type of tree, tree height, height of nest, dbh)

Condition of Nest:_____

Description of Habitat Surrounding Nest:_____

_____

_____
(Describe dominant trees and age class of stand; provide distance to nearest meadow or clearcut)

Nest Surveys:

	Dates Checked	Findings
Occupancy	_____	_____
	_____	_____
Nestlings	_____	_____
	_____	_____
Fledglings	_____	_____
	_____	_____

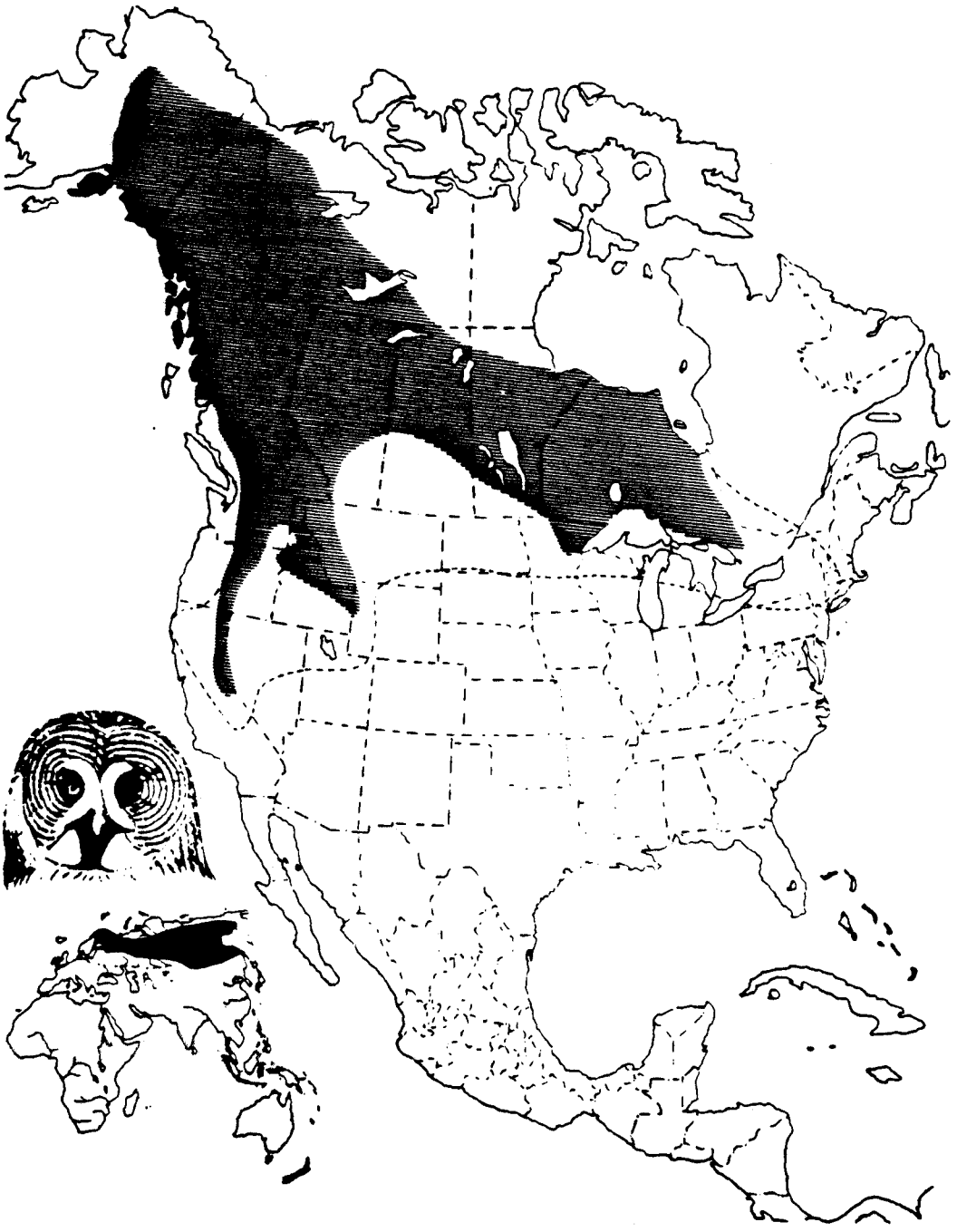


Figure 1. Distribution of great gray owls in North America (from Johnsgard 1988).

Figure 2. Locations of nests, young, and sightings of great gray owls on the Island Park RD, Targhee NF.

Figure 3. Locations of nests, young, and sightings of great gray owls on the Ashton RD, Targhee NF.

Figure 4. Locations of nests, young, and sighting of great gray owls on the Teton Basin RD, Targhee NF.

▲ = nests

● = young birds

✱ = sightings of adults

Roads, Trails, and Areas
Targhee National Forest

261.50(a) and (b), the following acts are prohibited on the
described in this order, all within the Targhee National

on roads when prohibited or restricted as shown on
CFR 261.54)

of vehicle on a trail when prohibited or restricted as
Map. (36 CFR 261.55)

a vehicle off Forest Development roads or trails when
as shown on the Travel Map. (36 CFR 261.56)

261.50(e), the following persons are exempt from this

permit or contract authorizing the otherwise prohibited

or local officer or member of an organized rescue or
performance of an official duty.

as described as open, restricted, or closed on the

6/1/89 — Date — District Ranger

punishable by fine of not more than $500 or imprisonment of not
USC 551).

16
Number

authorizes the Department of Fish and Game to enforce road
for the protection of wildlife resources.

AD LIGHTLY

TREAD LIGHTLY

a Travel Map from the Forest
ce, or regulations from other
land agencies. Learn the rules
follow them.

running over young trees,
s, and grasses—damaging or kill-
them.

off soft, wet roads and trails
y torn up by vehicles (particularly
g hunting seasons). Repairing the
ge is expensive.

around meadows, steep
des, or streambanks and
hores easily scarred by churning
s.

the urge to pioneer a new road
ll, or to cut across a switchback.

away from wild animals that are
ng young—or suffering from food
age. Stress can sap scarce
gy reserves.

gate closures and regulatory
Vandalism costs tax dollars.

out of Wildernesses. They're
ed to all vehicles. Know where the
ndaries are.

permission to travel across
te land. Respect landowner rights.

pportunities for exciting travel with
reation vehicle are in your hands,
AD LIGHTLY!

SE OF GATES ON MAIN ROADS

main access roads have gates
ll be closed during saturated con-
n the winter and spring. Travel on
d roads causes deep ruts. Water
wn the ruts instead of running
and off the road. This causes ero-
d gullies. Rutted roads require
ntly more maintenance and in-
funding needs.

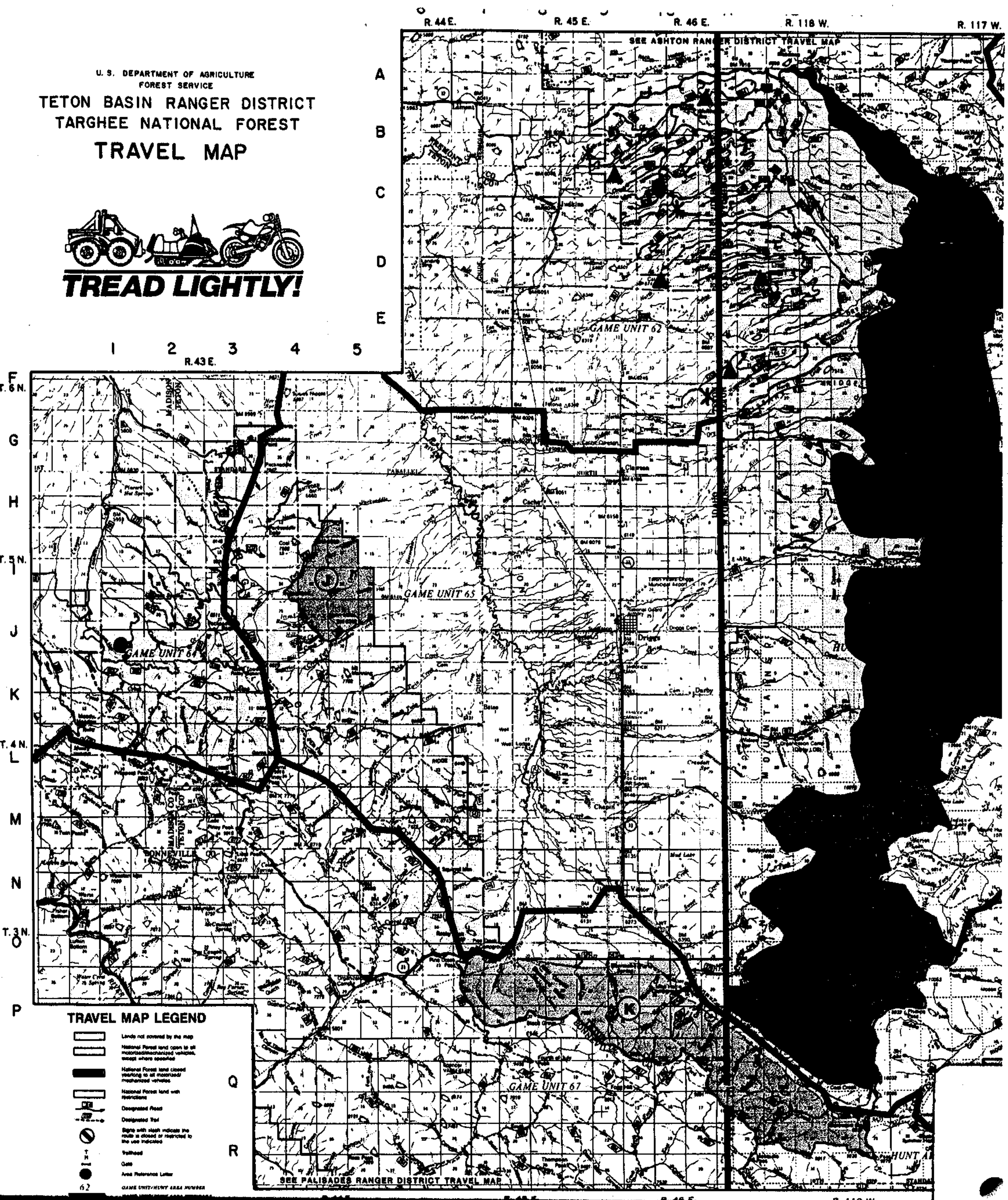
nership of vehicles driven on public
ate land comes the responsibility to
m with respect and care for the en-
nt, facilities, and other visitors.

ducate yourself by reading Travel
aps and regulations from public
gencies.
ravel only where motorized vehicles
re permitted. Comply with signs,
arriers, and ask owners' permission
o cross private property.
espect the rights of hikers, skiers,
ampers and others to enjoy their ac-
ivities undisturbed.
void streams which can be easily
olluted, and lakeshores, meadows,
muddy roads and trails, and steep
illsides which can be easily
amaged.
void wildlife. Snowmobilers and Off-
Road Vehicles may place unwanted
tress on wild animals that are in a
weakened condition (primarily during
he winter), or are rearing young.
Drive responsibly to protect the en-
vironment and preserve opportunities
o enjoy your vehicle on wild lands.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TETON BASIN RANGER DISTRICT
TARGHEE NATIONAL FOREST
TRAVEL MAP

TREAD LIGHTLY!



TRAVEL MAP LEGEND

- Lands not covered by the map
- National Forest land open to all motorized/mechanized vehicles, except where specified
- National Forest land closed yearlong to all motorized/mechanized vehicles
- National Forest land with restrictions
- Designated Road
- Designated Trail
- Signs with slash indicate the route is closed or restricted to the use indicated
- Trailhead
- Gate
- Area Reference Letter
- 62 GAME UNIT/HUNT AREA NUMBER

TARGHEE NATIONAL FOREST
ISLAND PARK RANGER DISTRICT

TRAVEL MAP

Special Order
Roads, Trails, and Areas
Targhee National Forest

Pursuant to 36 CFR 261.50(a) and (b), the following acts are prohibited on the roads, trails, and areas described in this order, all within the Targhee National Forest until further notice.

1. Use of any vehicle on roads when prohibited or restricted as shown on the Travel Map . (36 CFR 261.54)

2. Use of any type of vehicle on a trail when prohibited or restricted as shown on the Travel Map . (36 CFR 261.55)

3. Use or possess a vehicle off Forest Development roads or trails when prohibited or restricted as shown on the Travel Map . (36 CFR 261.56)

Pursuant to 36 CFR 261.50(e), the following persons are exempt from this order:

1. Persons with a permit or contract authorizing the otherwise prohibited act.

2. Any Federal, state, or local officer or member of an organized rescue or firefighting force in the performance of an official duty.

Area Described

Areas, roads, and trails as described as open, restricted, or closed on the attached Travel Map (Exhibit A).

Violations of this prohibition are punishable by a fine of not more than $500 or imprisonment of not more than 6 months or both (16 USC 551).

Forest Supervisor — Date — District Ranger

Order Number: 04 (Region) 16 (Forest Number)

Idaho Code Section 36-1004(b)10 authorizes the Department of Fish and Game to enforce road closures on National Forest lands for the protection of wildlife resources.

ASHTON RANGER DISTRICT
TARGHEE NATIONAL FOREST
TRAVEL MAP

Special Order
Roads, Trails, and Areas
Targhee National Forest

Pursuant to 36 CFR 261.50(a) and (b), the following acts are prohibited on the roads, trails, and areas described in this order, all within the Targhee National Forest until further notice.

1. Use of any vehicle on roads when prohibited or restricted as shown on the Travel Map . (36 CFR 261.54)

2. Use of any type of vehicle on a trail when prohibited or restricted as shown on the Travel Map . (36 CFR 261.55)

3. Use or possess a vehicle off Forest Development roads or trails when prohibited or restricted as shown on the Travel Map . (36 CFR 261.56)

Pursuant to 36 CFR 261.50(e), the following persons are exempt from this order:

1. Persons with a permit or contract authorizing the otherwise prohibited act.

2. Any Federal, state, or local officer or member of an organized rescue or firefighting force in the performance of an official duty.

Area Described

Areas, roads, and trails as described as open, restricted, or closed on the Travel Map.

Violations of this prohibition are punishable by a fine of not more than $500 or imprisonment of not more than 6 months or both (16 USC 551).

Forest Supervisor — 4/4/88 Date — Bruce B. Fox District Ranger

Order Number: 04 (Region) 15 (Forest Number)

Idaho Code Section 36-104(b)10 authorizes the Department of Fish and Game to enforce road closures on National Forest lands for the protection of wildlife resources.

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BETWEEN JANUARY 1
XCEPT SNOWMOBILES.

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RING AND

AREA CLOSURES

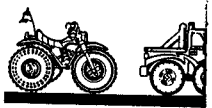
HENRY'S FORK
Closed to all motorized vehicles.
36 CFR 261.56

BIG BEND RIDGE
Seasonal closure area. Closed to all motorized vehicles from Nov. 1 to Jan. 1. From Jan. 2 to Oct. 31, open to public vehicle use including snowmobiles. Note year round road closures, shown below.
36 CFR 261.56 & 36 CFR 261.54(a)

WINEGAR HOLE & JEDEDIAH SMITH WILDERNESS AREAS
Closed to all motorized use and mechanical transport. 36 CFR 261.57(h)

LEGEND

- DISTRICT BOUNDARY
- SYSTEM ROAD
- TRAIL
- TRAIL HEAD
- DEVELOPED CAMPGROUND
- ROAD CLOSURE GATE, ROADS SHOWN ON MAP WITH THIS SYMBOL WILL HAVE PERIODIC USE RESTRICTIONS
- NATURAL ROAD CLOSURE, THESE ROADS ARE CLOSED INDEFINITELY
- NATIONAL FOREST LANDS OPEN TO MOTORIZED VEHICLES
- GAME UNIT BOUNDARY
- 62A GAME UNIT NUMBER



TREAD L

Submitted by:

Craig Groves

Craig Groves
Wildlife Staff Biologist

Approved by:

Wayne E. Melquist 2/7/90

Wayne E. Melquist
State Nongame Wildlife Manager

Tom Reinecker
Chief, Bureau of Wildlife

Jerry M. Conley
Director