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Evaluation of Aquablok on Contaminated Sediment to Reduce Mortality of Foraging Waterfowl

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INTRODUCTION

The U.S. Army has used Eagle River Flats (ERF), Fort Richardson, Alaska, since 1945 as an impact area for artillery shells, mortar rounds, rockets, grenades, illumination flares, and Army/Air Force Door Gunnery Exercises. In August 1981, hunters discovered large numbers of duck carcasses in ERF. Since that time, the Army and other federal and state agencies have been involved in identifying the cause of the waterfowl mortality. On February 8, 1990, the Army temporarily suspended firing into Eagle River Flats due to the suspected correlation between explosives and duck deaths (Quirk 1991). In July 1990, a sediment sample collected from ERF was suspected of containing white phosphorus (WP). By February 1991, it was concluded that WP in ERF was the cause of waterfowl mortality (CRREL 1991).

Waterfowl populations, overall, have been decreasing continent-wide (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1989). Many factors effect

their numbers such as the availability of breeding, loafing and feeding habitat. ERF is an important spring (April to May) and fall (August to October) waterfowl feeding and staging area. Contamination of waterfowl feeding areas in ERF with WP represents a serious hazard. During fall migration, August to September 1993, movement, distribution, turnover rate and site specific exposure of waterfowl species most susceptible to white phosphorus poisoning was determined at Eagle River Flats, Fort Richardson, Alaska (Cummings et al. 1994). Sixty-two ducks of five species were captured mainly in areas C, C/D, and Bread Truck with mist nets and swim-in traps. Of those, radio transmitters were attached to 12 mallards, 11 pintails, and 11 green-winged teal. Tracking data indicated that during August (pre-hazing) telemetry species ranged over the entire Flats. Mallards tended to concentrate in areas A and B, Racine Island and the C/D transition area. Pintails used area C and bread truck. Green-winged teal used the C/D transition area and shallow pools in areas A and C. Post-hazing, most waterfowl concentrated in areas B and the C/D transition area. The average daily turnover rate of waterfowl species using the Flats during August and September was about 3%. Using this turnover rate and the data from ERF aerial waterfowl surveys, it is estimated that about 5,400 ducks used the Flats during fall migration (August to October). Waterfowl most susceptible to white phosphorus represent about 3,900. Eight telemetry ducks were found dead (23%) on ERF: Racine Island (1), area A (3), area C (2) and the C/D transition area (2).

During spring migration, April-May 1994, 34 ducks, 20 dowitchers and 10 bald eagles were captured on ERF using various capture techniques. All birds were

fitted with radio transmitters. This included 27 mallards, 4 green-winged teal and 1 northern pintail. Of the 10 eagles, 3 were fitted with satellite transmitters. All eagles transmitters are expected to last 2 years. Tracking data indicated that mallards and teal averaged 6.8 days (range 1-17 days) on the Flats. Average daily turnover for waterfowl was about 5%. Waterfowl mortality during the spring migration period was about 12%. Waterfowl, mallards and teal tended to concentrate in areas C, C/D and D. Waterfowl spent more time in areas B and D, and off the Flats post-hazing. Bald eagles spent an average of 2.9 days on the Flats. Most of the telemetry contacts with eagles were in the wooded areas bordering ERF. Transmitters from three scavaged ducks were found in trees surrounding ERF and at an eagle nest site on the Flats. Eagles fitted with satellite transmitters moved to Kodiak Island and Cordova, Alaska, in late November. No eagle mortality has been documented as of March 1995. Dowitchers spent an average of 6.8 days on the Flats and mainly foraged in highly contaminated areas without any mortality (Cummings et al. 1995).

In 1995, we continued to focus on issues outlined under the CERCLA process for ERF. In the conceptional site model, waterfowl and bald eagles are listed as receptors to the exposure and effects of white phosphorus. On ERF, bald eagles are considered the top avian scavengers of waterfowl poisoned by white phosphorus. In this case, both waterfowl and bald eagles are considered to be prime species in the ERF food chain that would have direct exposure to white phosphorus and be a significant part of the Ecological Risk Assessment. The

objectives, as outlined below, of this study are designed to contribute to remedial decisions concerning ERF. Objectives:

1. *Determine the daily and seasonal movements and distribution, turnover and mortality rates of waterfowl most susceptible to white phosphorus poisoning at ERF;*
2. *Determine the hazards that waterfowl poisoned by white phosphorus pose to bald eagles at ERF; and*
3. *Establish baseline data for waterfowl and bald eagles with respect to proposed remediation actions.*

METHODS

Beginning August 1, 1995, we captured ducks on Eagle River Flats with swim-in traps, mist nets, or net-guns. Bald eagles were captured with cannon nets, padded leg-hold traps, or net-guns. Ducks and eagles were individually banded with U.S. Fish and Wildlife Service bands. We color-marked ducks on the right wing with a 2.5- x 7.5-cm patagial tag except for green-winged teal, which were marked with a 1.25- x 7.5-cm tag, made from coated nylon fabric (Armorlite, Codey, Inc., Pawtucket, RI). We used pink for mallards, white for northern pintails, and blue for green-winged teal. Eagles were marked with a 10-cm diameter dumbbell-shaped patagial tag of either white, red, orange, blue, pink, yellow or a double-colored tag combination. The capture and release locations and

date, band number, weight, age and sex and other pertinent measurements were recorded for each bird. In addition, all birds were fitted with radio transmitters. Transmitters for mallards and northern pintails weighed 9.1 g; green-winged teal, 3.6 g; and bald eagles, 88 g (satellite). Satellite transmitters had a standard transmitter (16 g) attached so that daily movement data could be collected and birds could be located if satellite transmitters indicated a problem. Eagle transmitters are expected to last for up to 24 months. Waterfowl transmitters were programmed to be active during August, September and October and again during April, May and June 1996. Each transmitter was positioned on the upper back of each bird. Transmitters were attached with a teflon ribbon harness (Cummings et al. 1993).

Birds (eagles from both 1994 and 1995) were tracked from fixed telemetry towers located on opposite sides of ERF. Each tracking tower was equipped with a notebook containing radio tracking forms, a directional yagi antenna, a compass for determining telemetry bearings, and a two-way radio for communications. Birds were located simultaneously from two fixed tracking towers and/or one mobile unit. The birds were assumed to be near the point where the bearings crossed, and each bearing location was entered onto a radio tracking form. Birds were also tracked on foot, from hovercraft or National Guard helicopter, to determine their status. Towers could receive radioed birds up to 25 km from the Flats. Helicopters were used to track birds up to 90 km from the Flats in areas such as the Susitna Flats, Palmer Hay Flats, and Chickaloon Flats.

Following capture and release of eagles (April) and ducks (August), a location for standard radio transmitters was determined daily between 0700 to 1000 and 1500 to 1800 and 2000 to 2200 h during April and May, and August, September and October. Birds that could not be detected as moving or did not move more than 10° in 2-3 days were visually located to determine their status. Dead birds were recovered, or remains were collected to determine the cause of death.

Data from eagles fitted with satellite transmitters was compiled by the Argos Data Collection system which is a cooperative venture between CNES, the French Space Agency, NASA, and NOAA. The Argos data collection receiver is simultaneously carried on two TIROS Family, NOAA satellites, which are in 85 km circular orbits. The eagle satellite transmitters or Platform Transmitter Terminals (PPT) are programmed to turn on for 8 hr every 96 hr and will send a message every 60 s. The PTTs differentiated from each other by a unique code built in by the manufacturer. The received messages are recorded and retransmitted to ground stations at Fairbanks, AK; Wallops Island, VA; and Lannion, France. The messages are relayed to Suitland, MD, processed and the data made available to users (DWRC).

In 1993, ERF was divided into seven areas representing sites that waterfowl used for foraging and loafing. Since that time, telemetry data has been plotted and analyzed based on these seven areas. The areas were synonymous with areas used by the U.S. Army to identify specific areas on ERF. The seven areas are A, B, RI (Racine Island), C, C/D, D, and BT (bread truck). Areas A, RI, C, and BT have

documented high levels of white phosphorus. The activity on different areas of ERF was determined by counting the number of telemetry locations within an area, divided by the total number of telemetry locations for that bird and expressing it as a percentage. These data from radio-instrumented birds were used to address concerns about the relative risk to respective species and to establish baseline data with respect to proposed remediation actions. In addition, these data were used to evaluate the effects of hazing on birds using ERF. Waterfowl movements and distribution in hazed and non-hazed areas was compared pre- and post-hazing.

The daily turnover rate of instrumented birds on ERF was determined by dividing the number of radio-instrumented ducks that departed ERF each day by the total (by species) instrumented. The daily turnover rate was used to determine the relative WP risk to birds using ERF.

Daily activity budgets for radio-instrumented bald eagles nesting on the periphery of ERF were documented. In addition, nesting success of bald eagles nesting on the periphery of ERF was compared to that of bald eagles nesting at Susitna and Chickaloon Flats.

RESULTS

Waterfowl

From August 1-17, 1995, 96 ducks were captured, banded and released. Of those, 17 mallards, 16 northern pintails, and 21 green-winged teal were each

fitted with backpack transmitters (Table 1). The movement of instrumented ducks following release indicated that transmitters did not appear to inhibit movements or activities. Observations indicated that the behavior of instrumented ducks did not differ from that of other ducks in its associated flock. On some occasions, instrumented birds were observed leading flights of ducks. However, about 10% of the instrumented ducks were in various stages of molt when captured. These ducks were noted to remain in the capture/release areas longer than the same species that had completed molt.

Duck movements and distribution on ERF during the fall varied by species. Mallards (n = 17) spent the majority of their time from August 1 to September 5 (pre-hazing) in areas B, A and D (Fig. 1). Use of these areas represented about 60% of the time mallards spent on ERF. Several mallards were documented moving to various locations near ERF, such as the Palmer Hay Flats and Susitina Flats. They spent about 32% of their time off-site (Fig. 2). Mallard use of most contaminated areas on ERF decreased uniformly following the start of the hazing program (September 5) except for RI where use increased substantially (Fig. 1). As hazing continued, the time mallards spent off ERF increased about 18% over pre-hazing levels (Fig. 2).

Northern pintails (n = 16) use patterns were different than mallards (Fig. 3). Pintails spent about 87% of their time in areas A, C/D and D and about 20% of their time off the Flats prior to hazing. The use of areas B, BT and RI represented about 5% of pintails' time on ERF (Fig. 3). When hazing began (September 5) on

ERF, use of area A and C by pintails decreased as much as 50% and the amount of time doubled that they spent off ERF (Fig. 4).

Green-winged teal (n = 21) use patterns of ERF were similar to pintails (Fig. 5). Teal spent about 63% of their time in areas A and D prior to hazing (Fig. 6). Teal spent <1% of their time in areas B and RI. When hazing began, slight increases were noted in the used areas C/D and D. Also, it should be noted that even though use patterns in areas A, D, and BT changed only slightly between pre- and post-hazing, that teal were using shallow mudflats and ponds in these areas that are not considered contaminated and are not hazed.

The average number of days spent on ERF by mallards (n = 17) was 40, range 1-78; pintails (n = 16) was 46, range 6-72; and teal (n = 21) was 27, range 1-51 (Table 2). At the conclusion of the study, October 17, 7 mallards, 6 pintails and no teal remained on ERF (Table 3). These birds were observed using small areas of open water in areas B and D, the Eagle River and several of its drainages. The average daily turnover rate for waterfowl (mallards, pintails and teal) was about 3.8%. Teal had the greatest average daily turnover of 4.7% (Fig. 7), mallards 3.7% (Fig. 8) and pintails 3.1% (Fig. 9). The greatest turnover of waterfowl occurred prior to September 5 where 47% mallards, 37% pintails and 43% teal departed ERF (Table 4).

The mortality of instrumented ducks using ERF from August 1 to October 17 was five ducks or about 9% (Table 5). The four mallards found dead during this period were on the Flats between 1 and 28 days, whereas the green-winged teal was on the Flats for 48 days. In addition, two other ducks, one teal and one

pintail were shot by hunters on the Susitna Flat on September 10 and 30, respectively (Table 6). Also, one mallard captured August 18, 1993 was found dead in area C/D August 26, 1995, and one pintail captured August 9, 1995, was found dead August 31 in area C. Both birds were collected and frozen for residue analysis.

Bald Eagles

From April 24-31, 1995, 14 bald eagles (13 adults and one 2-3 year old) were captured on ERF and each fitted with backpack transmitters (Table 1). Of the 14, 8 adult eagles were fitted with a satellite transmitter coupled with a standard transmitter. Two of those were breeding adults from two nest sites surrounding ERF. Telemetry and observational data of instrumented eagles, excluding the two nesting birds, indicated that eagles spent an average of 1.2 days (range 1-25) on the Flats during the spring (Table 7) an average of 0.2 days (range 1-50) on the Flats during the fall (Table 8). Instrumented eagles were only located in areas A, C, and C/D during the spring (Fig. 10) and areas A and C/D during the fall (Fig. 11). Most of the time was spent in the wooded areas surrounding ERF (Figs. 12-13). Eagles (satellite) that did not nest in the woods surrounding ERF were located with 300 km radius of the Flats.

In addition, nesting success of eagles on ERF did not differ significantly from eagles nesting on Susitna or Chickaloon Flats. Eagles on ERF (nest = 3) produced

an average of 1.3 eggs and fledged an average of 0.33 eaglets. Eagles on Susitna Flats (nest = 10) produced an average of 1.6 eggs and fledged an average of 0.6 eaglets. Eagles on Chickaloon Flats (nest = 7) produced an average of 1.0 eggs and fledged an average of 0.28 eaglets.

No eagle mortality occurred during their use of the Flats or within the 268 km contact area. To date, eagles are enroute to wintering areas near Prince William Sound, Washington. Eagles will continue to be monitored until spring of 1997, which is the life expectancy of the transmitters.

DISCUSSION

Daily waterfowl movements indicate that all species moved among areas quite readily. However, each species show a preference for certain areas on ERF. Mallards preferred area B; pintails, area C; and teal, area D. All species had in common area A. However, we found that species segregated into specific areas within Area A. Teal preferred ponds that were shallow (< 8 cm) or had extensive mudflats. On several occasions, teal were observed foraging in mudflats after a high tide. Waterfowl distribution data from 1995 was similar to 1993 and 1994. The only exception was that teal used pools in area D in 1995 more extensively than in 1993 or 1994. We attribute this to variations in tide cycles and below normal water levels on the Flats in these years.

Distribution data indicates that ducks as in previous years used a larger portion of ERF in August than in September. This can be attributed to the start of

the hazing program on September 5. However, pintail use patterns post-hazing indicated an increase in the use of area C. We attribute this to the restrictive hazing guidelines of which hazing was not started until 0800 each day and was limited when dredging operations were initiated.

Mortality during 1995 (n = 5) was 9% or about half of the number of ducks that died during fall migration in 1993. The difference could be attributed to a number of factors, such as more efficient hazing, re-distribution of waterfowl into uncontaminated areas and higher water levels which dispersed foraging waterfowl into areas that were probably void of WP. In 1995, waterfowl were located in portions of areas A and D that had not been used in past years.

Turnover rates for waterfowl in 1995 was lower than in 1993 or 1994. We suggest that the lower turnover rate for 1995 might be an effect of our trapping effort. In 1995, all waterfowl were captured and instrumented within 13 days, which allowed for a longer exposure time on ERF. In previous years, trapping covered about 40 days. Because of the extended trapping period, we probably unintentionally reduced the average time waterfowl spend on the Flats.

In conclusion, we feel that the movements of waterfowl on ERF were influenced by hazing, to a lesser degree, the presence of researchers, or initially obstructions in certain areas, i.e., dredge or equipment. The turnover rate during the fall on ERF is low, which makes ducks at a greater risk to WP poisoning. However, the combination of the estimated turnover rate, mortality, and population number wil give a much clearer picture of the number of waterfowl lost during August, September and October.

RECOMMENDATIONS

Assessment Endpoints

The biological assessment endpoint for ERF is the reduction in waterfowl mortality. To measure this endpoint, we suggest that monitoring susceptible waterfowl (mallards, pintails and/or teal) with the use of telemetry can give a realistic waterfowl mortality rate that occurs across the entire ERF. By increasing the number of transmitters from 54 (1995) to 150 the standard deviation is reduce from 4 to 2%. In addition, there could be a greater reduction in the SD or confidence limits if mortality is actually >9%.

Of importance, is being able to determine if remediation actions reduce mortality. Because waterfowl use the entire ERF, remediation of one area doesn't necessarily mean that mortality will decrease. Waterfowl might redistribute themselfs to other sites. Telemetry can account for this whereas transects being tied to a specific ponded site can not. Transects can not relate to the entire ERF.

The use of telemetry:

.reduces human exposure to UXO's.

.supports measuring the assessment endpoints with relatively good confidence limits.

.generates excellent data on waterfowl distribution, movements, turnover and mortality which are all factors effecting remediation.

.costs are <$80,000 per year if 150 transmitters are used.

.has no impact on the behavior of radioed birds or other birds using ERF. In addition, it is considered a standard method for projects of this type.

SUMMARY

We determined spatial distribution, movements, turnover rate and mortality of waterfowl and bald eagles using Eagle River Flats, Fort Richardson, Alaska, during fall migration, August 1 to October 17, 1995. Eighty-two ducks and 14 bald eagles were captured on ERF using various capture techniques. Of the waterfowl, 17 mallards, 16 northern pintails and 21 green-winged teal were fitted with radio transmitters. Of the 14 eagles, 8 were fitted with satellite transmitters, the others with standard transmitters. Waterfowl transmitters were programmed to be on from August to November 1995, and again from April to June 1996. Eagle transmitters are expected to last 24 months. Tracking data indicated that transmitters did not appear to inhibit movements or activities of either ducks or bald eagles. Daily waterfowl movements indicate that all species moved among areas quite readily. Mallards spent about 60% of their time in areas B and A; pintails spent about 87% of their time in areas A, C/D and D; and teal spent about 63% of their time in areas A and D. After the hazing program was started, waterfowl use patterns changed on ERF. The average number of days spent on ERF by mallards, pintails and teal was 40, 46 and 27 days, respectively. The average daily turnover rate for waterfowl was about 3.8%. The greatest turnover of waterfowl occurred prior to September 5 where 47% mallards, 37% pintails and

43% teal departed ERF. Mortality of instrumented ducks using ERF from August 1 to October 17 was five ducks or about 9%. Most of the telemetry contacts with eagles, excluding the two nesting birds, indicated that eagles spent an average of 1.4 days on the Flats. Instrumented eagles were only observed in areas A, C, and C/D during the spring and A and C/D during the fall. Nesting success of eagles on ERF did not differ significantly from eagles nesting on Susitna or Chickaloon Flats. Eagles on ERF produced an average of 1.3 eggs and fledged an average of 0.33 eaglets. No adult eagle mortality has been documented from instrumented birds, even though eagles scavenge dead ducks (which has included instrumented ducks).

ACKNOWLEDGEMENTS

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Use Committee during this study. Also, a Section 7-Rare and Endangered Species Consultation was completed prior to the start of the study.

It is recommended that telemetry data be integrated into the risk assessment process, that future remediation actions be assessed with telemetry birds, that mortality on ERF be assessed by instrumenting > 100 waterfowl with mortality transmitters and that eagles fitted with satellite transmitters will continue to be monitored.

REFERENCES

Cummings, J.L. 1993. U.S. Army Eagle River Flats: Protecting waterfowl from ingesting white phosphorus. Den. Wildl. Res. Ctr. Final Report 94-1. 78pp.

Cummings, J.L. 1994. U.S. Army Eagle River Flats: Protecting waterfowl from ingesting white phosphorus. Den. Wildl. Res. Ctr. Final Report 94-2. 69pp.

Table 1. Waterfowl, dowitchers, and bald eagles captured at Eagle River Flats, Fort Richardson, Alaska in 1993, 1994 and 1995.

Waterfowl, dowitchers, and bald eagles instrumented with radio transmitters on Eagle River Flats, Fort Richardson, Alaska.

	1993	*1994*	*1995*
Mallards	12	27	17
Pintails	11	1	16
Green-winged teal	11	4	21
Bald eagles	0	10	14
Dowitchers	0	20	0
Banded only	28	2	28
TOTAL	**62**	**64**	**96**

Grand total 222

Fall waterfowl use of ERF August 1 to October 17, 1995

	Mallard	*Pintail*	*Green-winged teal*
Birds (no.)	17	16	21
Avg. days on ERF (no.)	39.9	45.9	26.9
Range (no. days)	1-78	6-72	1-51

Table 3. Captured waterfowl and the number remaining on Eagle River Flats through October 17, 1995.

Waterfowl captured and the number remaining on Eagle River Flats through October 17, 1995

	Mallards		*Pintails*		*Green-winged teal*	
Period captured	*Captured*	*On ERF*	*Captured*	*On ERF*	*Captured*	*On ERF*
August 1-7	14	5	8	2	6	0
August 8-17	3	2	8	4	15	0

Table 4. Waterfowl mortality on Eagle River Flats and the number of waterfowl remaining on the Flats pre- and post hazing from August 1 to October 17, 1995.

Status of waterfowl on Eagle River Flats from August 1 to October 17, 1995

	Number of ducks					
	Mortality					
Species	*Radioed*	*On ERF*	*Off ERF*	*Remaining on ERF through September 5*	*Remaining on ERF through October 17*	*Observed off ERF*
Mallard	17	4	0	9	7	11
Pintail	16	0	1	10	6	11
Green-winged teal	21	1	1	12	0	14
Total	**54**	**5**	**1**	**31**	**13**	**36**

Table 5. Waterfowl mortality on Eagle River Flats and the average days these waterfowl spent on the Flats August 1 to October 17, 1995.

Fall waterfowl mortality on Eagle River Flats, Fort Richardson, Alaska
August 1 to October 17, 1995

	Mallard	*Pintail*[1]	*Green-winged teal*[1]
Mortality (no.)	4	0	1
Avg. days (no.)	15.75	0	48
Range (no. days)	1-28	0	48

[1] 1 pintail and 1 green-winged teal were recovered off ERF (shot by hunters)

Table 6. Recovery locations of waterfowl using Eagle River Flats August 1 to October 17, 1995.

Mortality of waterfowl using ERF in 1995

			Mortality	
Species	*Capture date*	*Cause of mortality*	*Location*	*Date*
Mallard	8-5-95	white phosphorus	area B	8-7-95
Mallard	8-1-95	white phosphorus	area A by tower	8-9-95
Mallard	8-2-95	white phosphorus	woods behind EOD pad	9-2-95
Mallard	8-3-95	white phosphorus	area C/D	9-7-95
Green-winged teal	8-2-95	hunters	mouth of Big Susitna River	9-10-95
Green-winged teal	8-9-95	white phosphorus	near Eagle's Nest Point	9-26-95
Pintail	8-8-95	hunters	Susitna Flats	9-30-95

Table 7. Bald eagle use of and mortality on Eagle River Flats during spring migration May 1-25, 1995.

Bald eagle use of and mortality on Eagle River Flats, Fort Richardson, Alaska
May 1 to May 25, 1995

	Eagles captured in 1995	*Eagles captured in 1994*
Eagles (no.)	14	7
Capture period	April 24-30	May 1-19
Avg. days on ERF (no.)	1.2[1]	4
Range (no. days)	1-4	1-4
Mortality (no.)	0	0
Observed off ERF (no.)	8	1

[1]The two eagles nesting on Eagle River Flats were not used in calculating the average or the range.

Table 8. Bald eagle use of and mortality on Eagle River Flats during fall migration August 1 to October 17, 1995.

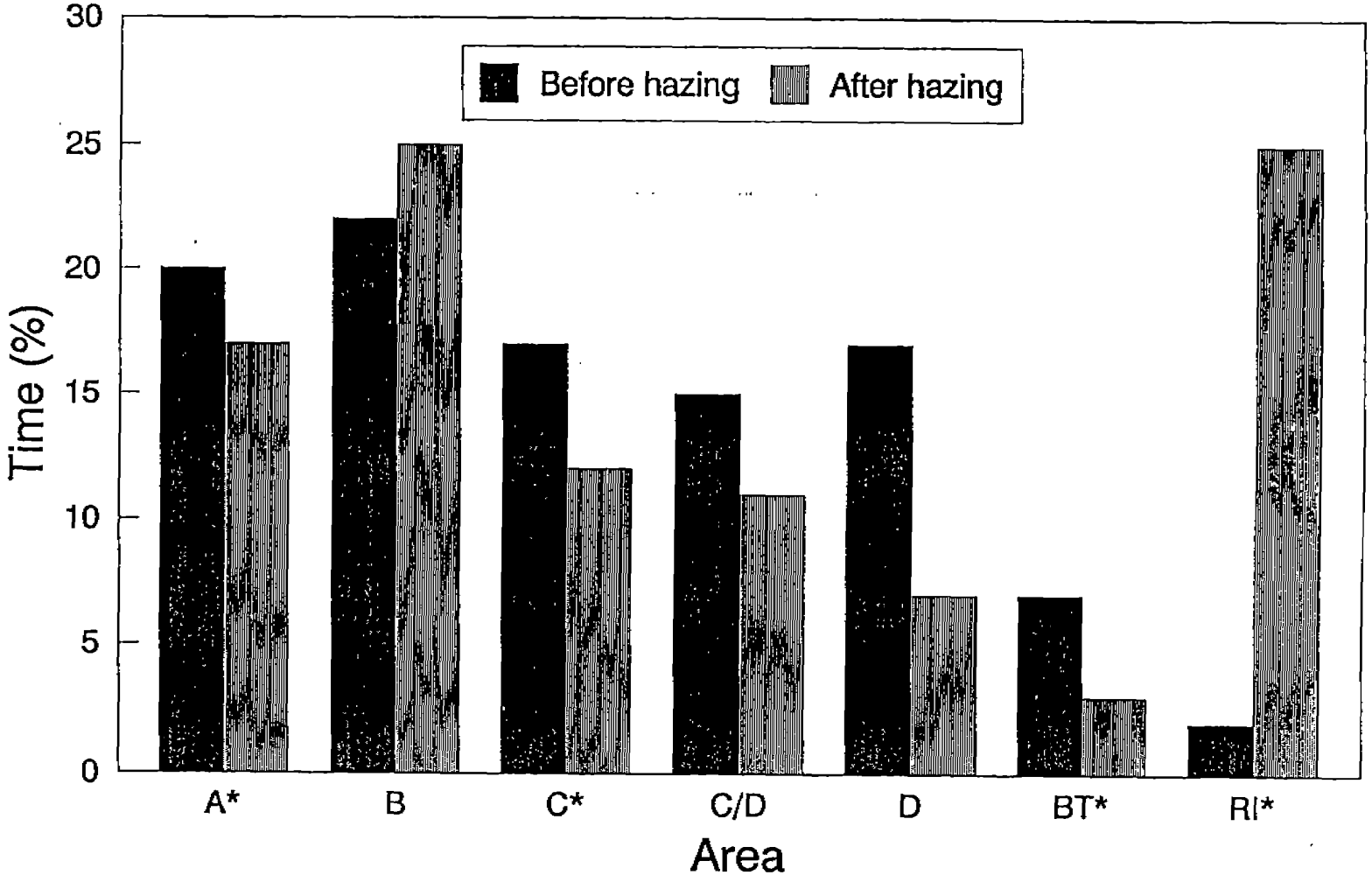
Bald eagle use of and mortality on Eagle River Flats, Fort Richardson, Alaska
August 1 to October 17, 1995

	Eagles captured in 1995	*Eagles captured in 1994*
Eagles (no.)	14	7
Capture period	April 24-30	May 1-19
Avg. days on ERF (no.)	0.2[1]	0
Range (no. days)	1	0
Mortality (no.)	0	0
Observed off ERF (no.)	11	1

[1]The two eagles nesting on Eagle River Flats were not used in calculating the average or the range.

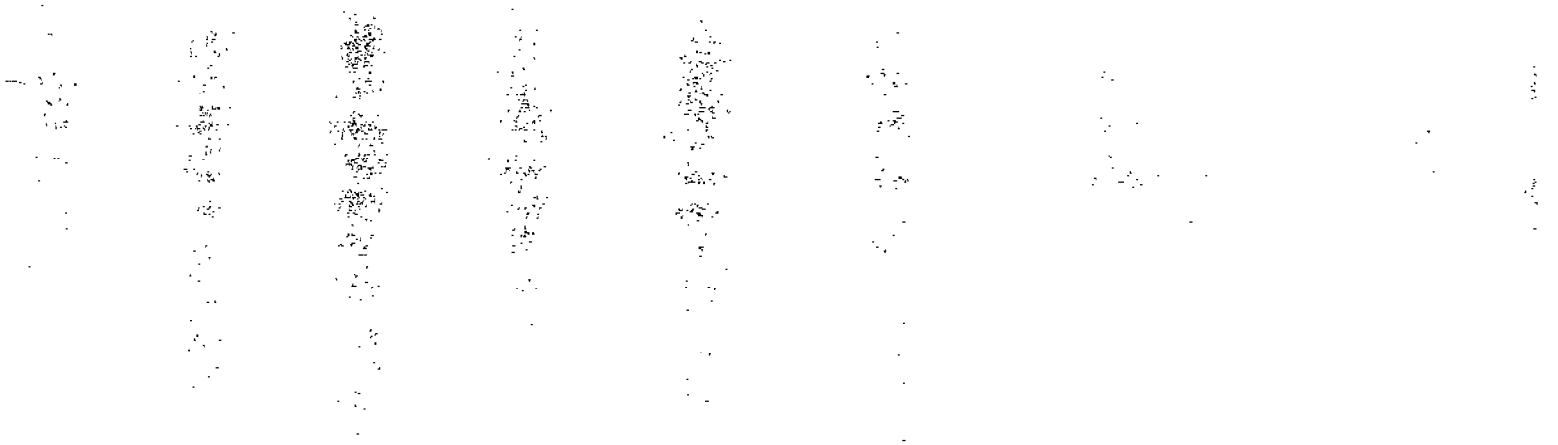
Figure 1. Distribution of mallards on Eagle River Flats from August 1 to October17, 1995.

DISTRIBUTION OF MALLARDS ON EAGLE RIVER FLATS
FALL 1995



* Denotes areas of high white phosphorus concentrations. Attempts were made to haze ducks from these areas.

Figure 2. Time mallards spent on and off Eagle River Flats from August 1 to October17, 1995.



TIME UTILIZATION FOR MALLARDS
FALL 1995

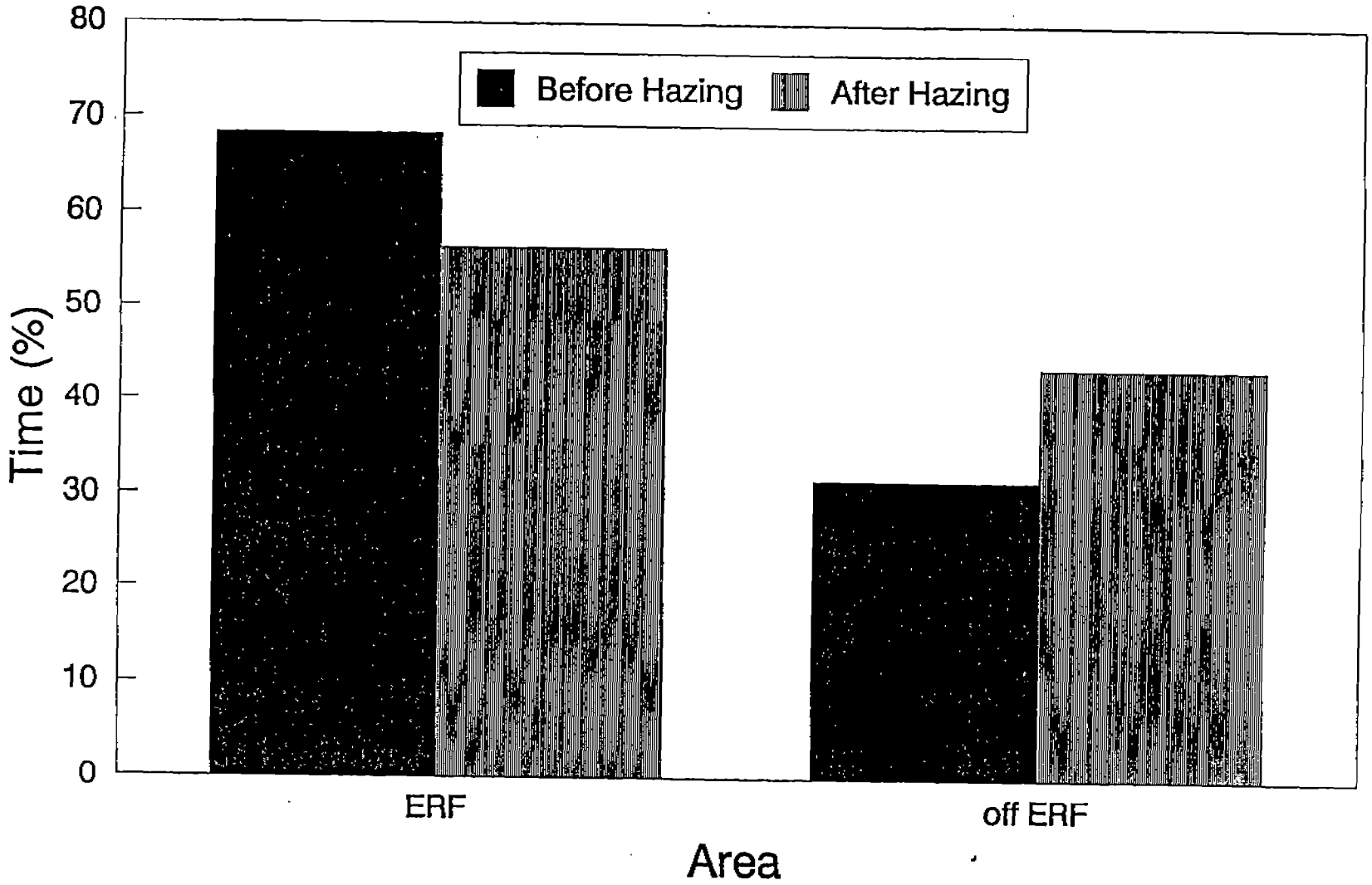
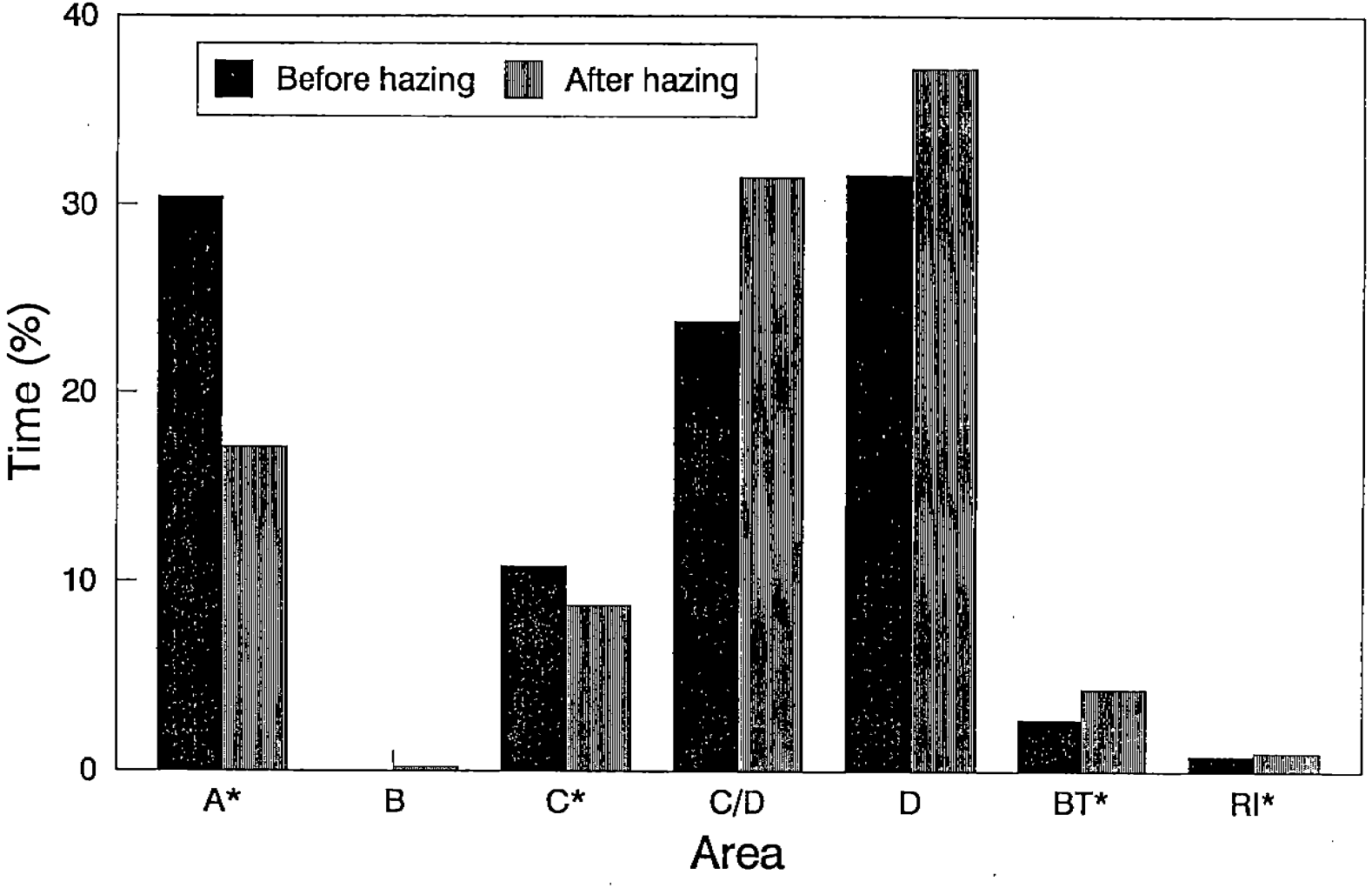


Figure 3. Distribution of northern pintails on Eagle River Flats from August 1 to October 17, 1995.

DISTRIBUTION OF PINTAILS ON EAGLE RIVER FLATS
FALL 1995



* Denotes areas of high white phosphorus concentrations. Attempts were made to haze ducks from these areas.

Figure 4. Time northern pintails spent on and off Eagle River Flats from August 1 to October 17, 1995.

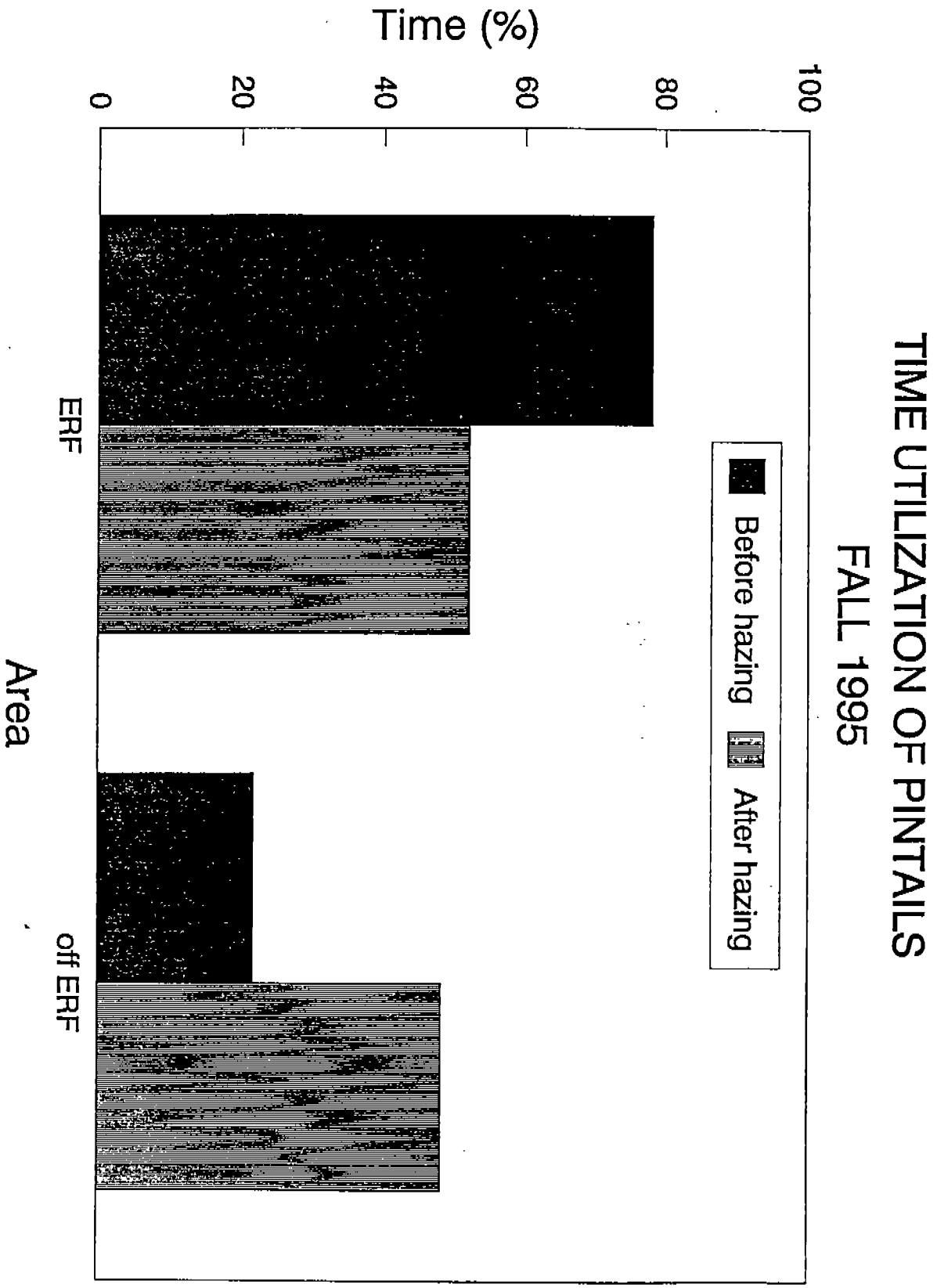
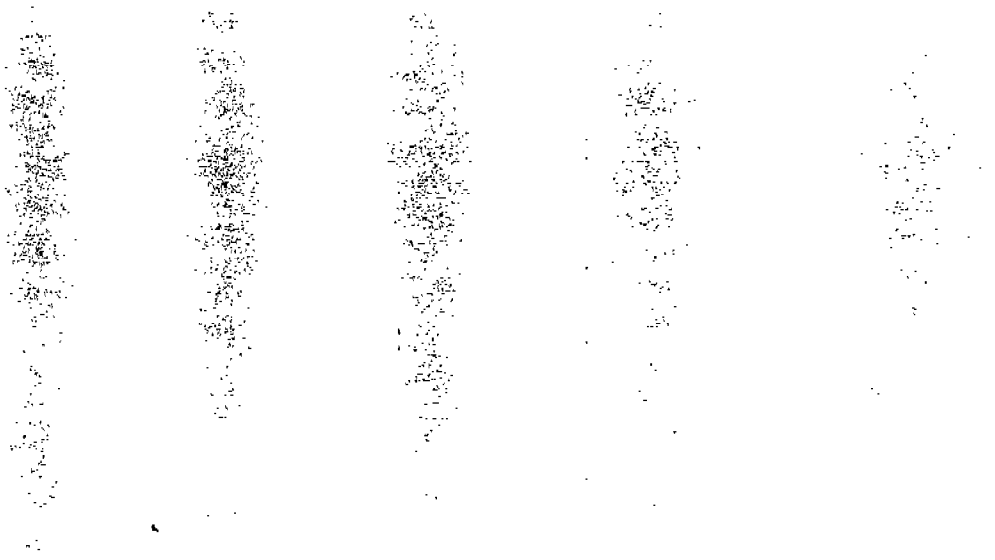
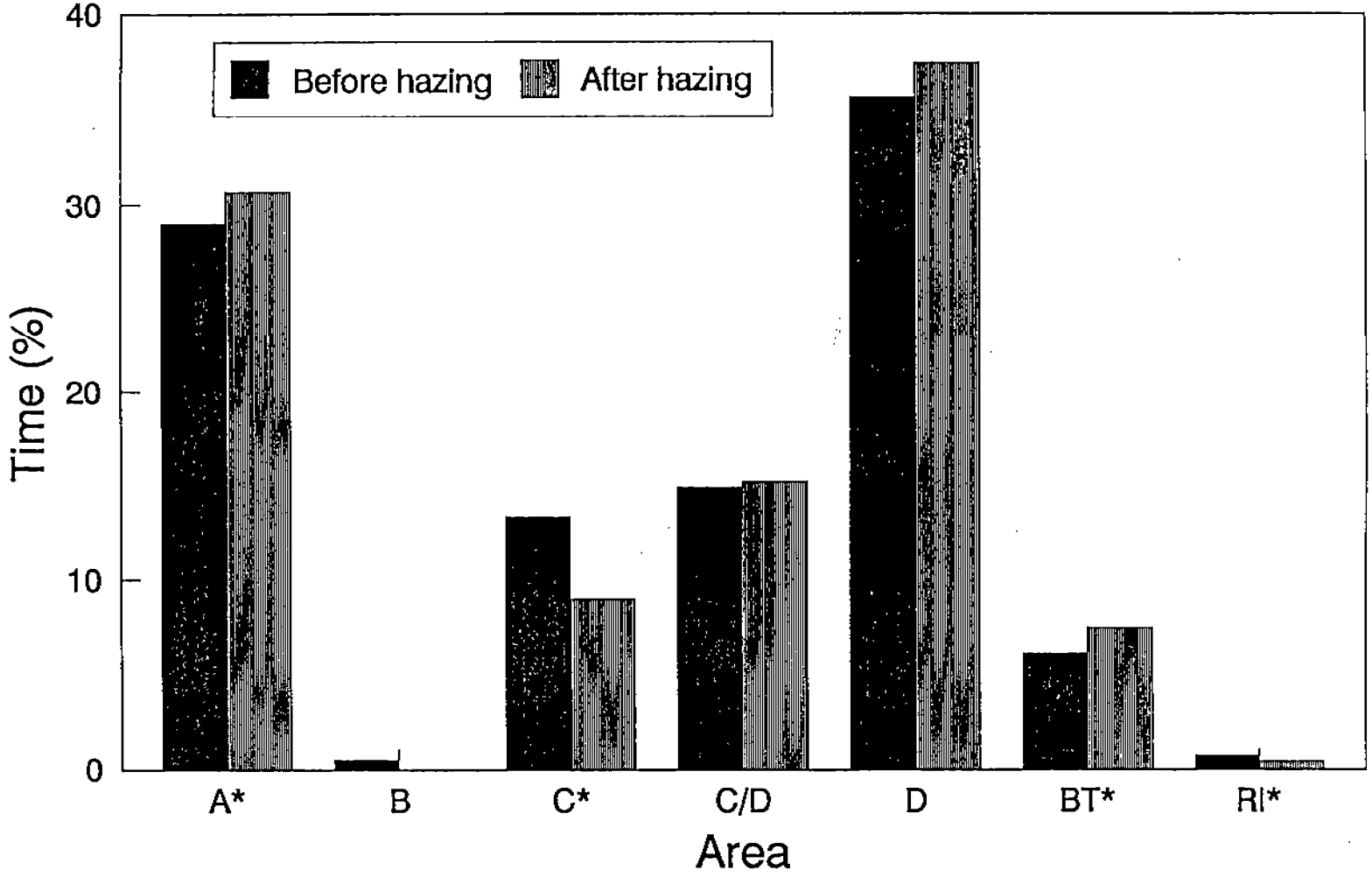

TIME UTILIZATION OF PINTAILS
FALL 1995
Time (%)
0
20
40
60
80
100
Before hazing
After hazing
ERF
off ERF
Area

Figure 5. Distribution of green-winged teal on Eagle River Flats from August 1 to October 17, 1995.



DISTRIBUTION OF GREEN-WINGED TEAL ON EAGLE RIVER FLATS FALL 1995



* Denotes areas of high white phosphorus concentrations. Attempts were made to haze ducks from these areas.

Figure 6. Time green-winged teal spent on and off Eagle River Flats from August 1 to October 17, 1995.

TIME UTILIZATION OF GREEN-WINGED TEAL
FALL 1995

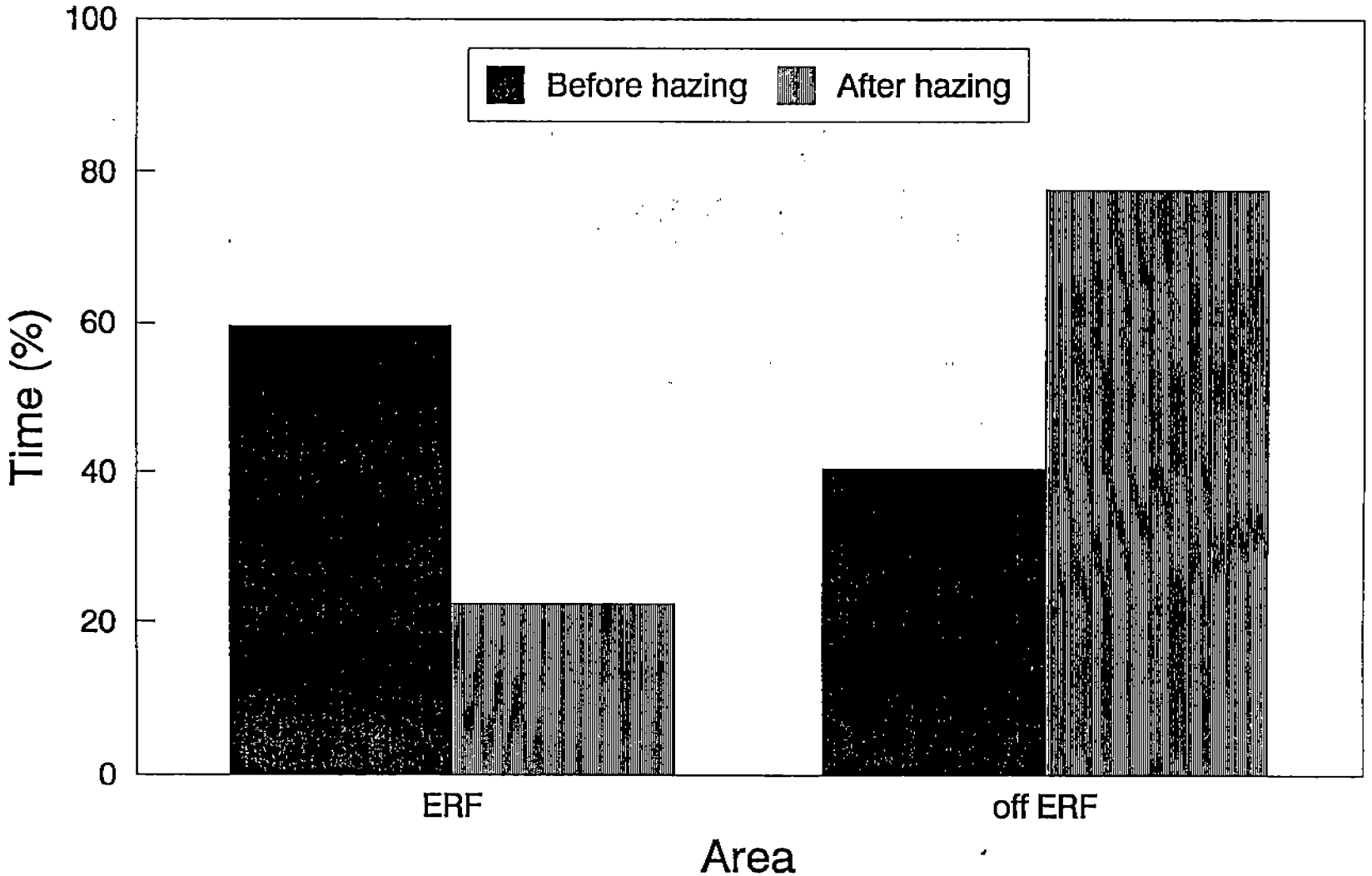
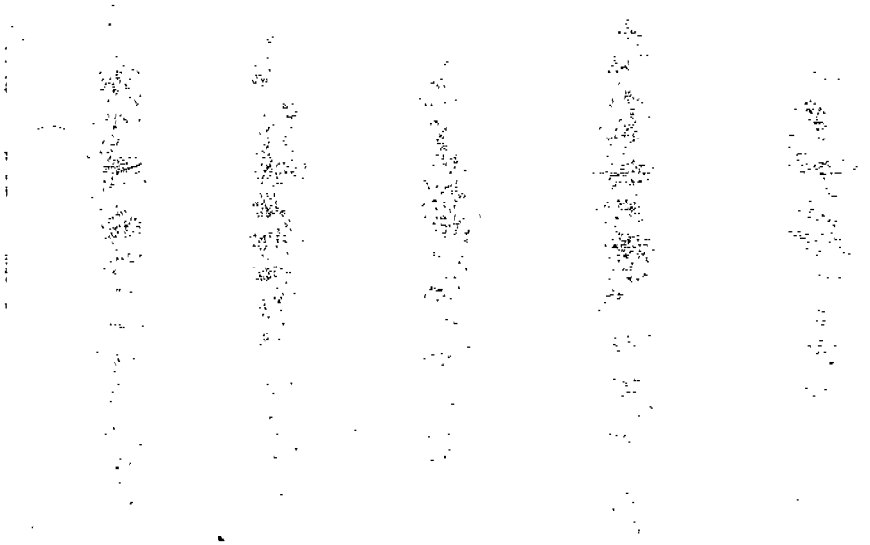


Figure 7. Daily turnover of green-winged teal on Eagle River Flats from August 1 to October 17, 1995.



DAILY TURNOVER OF GREEN-WINGED TEAL USING EAGLE RIVER FLATS

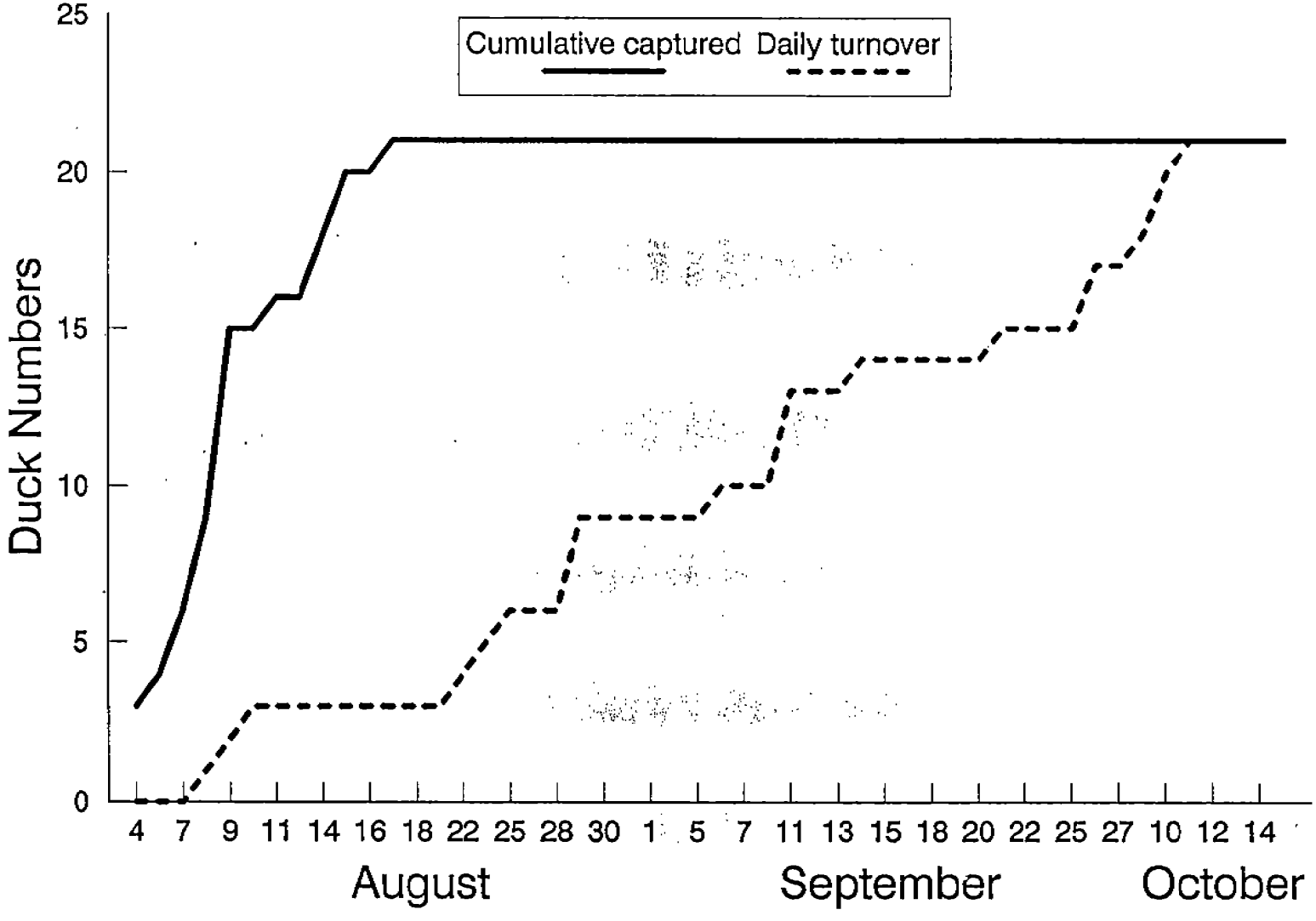
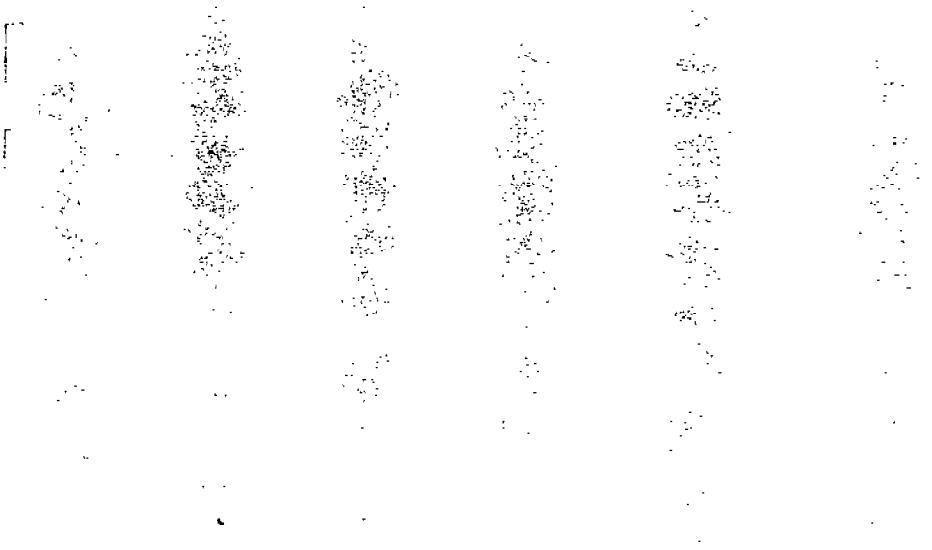


Figure 8. Daily turnover of mallards on Eagle River Flats from August 1 to October 17, 1995.



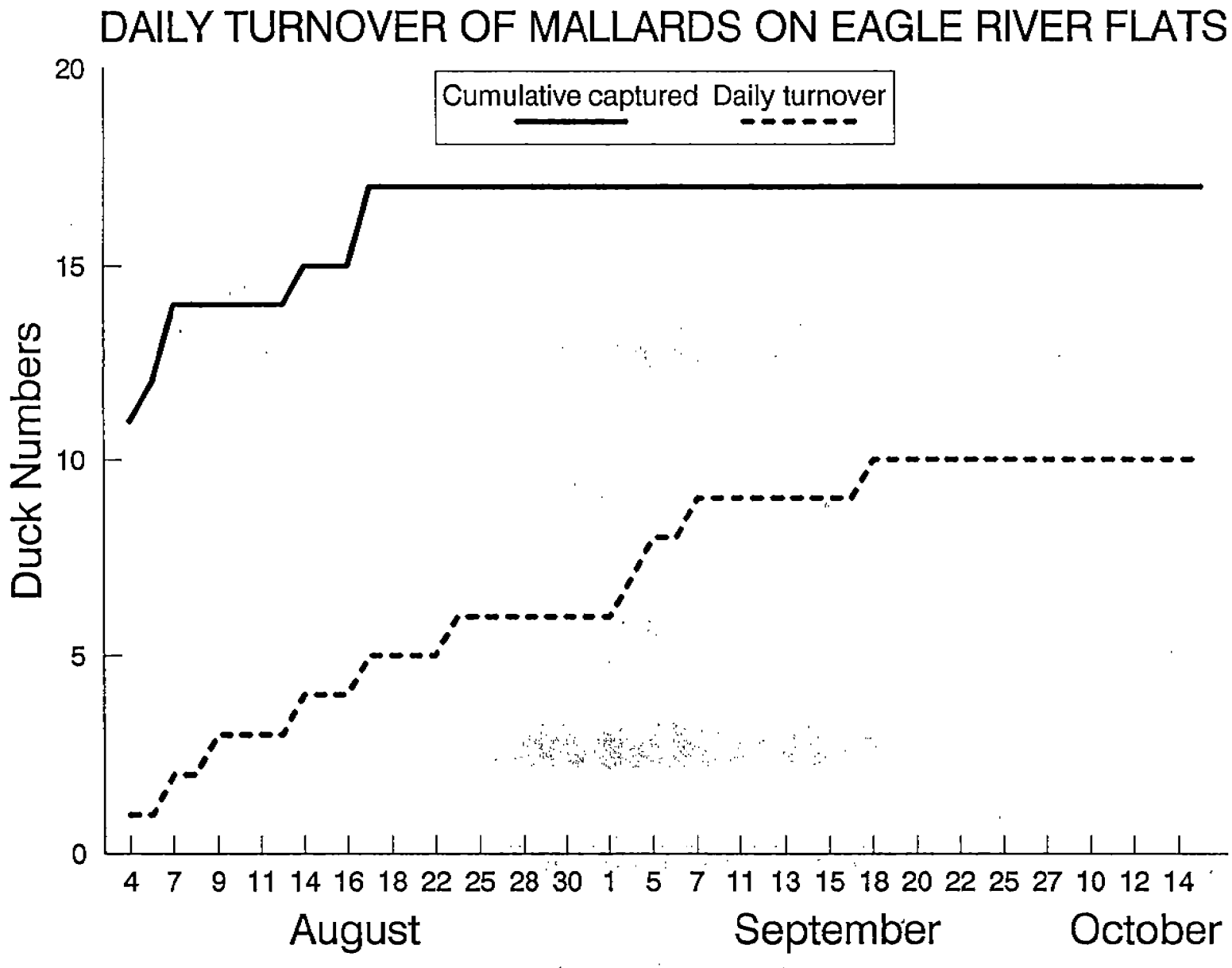

DAILY TURNOVER OF MALLARDS ON EAGLE RIVER FLATS
Cumulative captured
Daily turnover
Duck Numbers
0
5
10
15
20
4 7 9 11 14 16 18 22 25 28 30 1 5 7 11 13 15 18 20 22 25 27 10 12 14
August
September
October

Figure 9. Daily turnover of northern pintails on Eagle River Flats from August 1 to October 17, 1995.

DAILY TURNOVER OF PINTAILS USING EAGLE RIVER FLATS

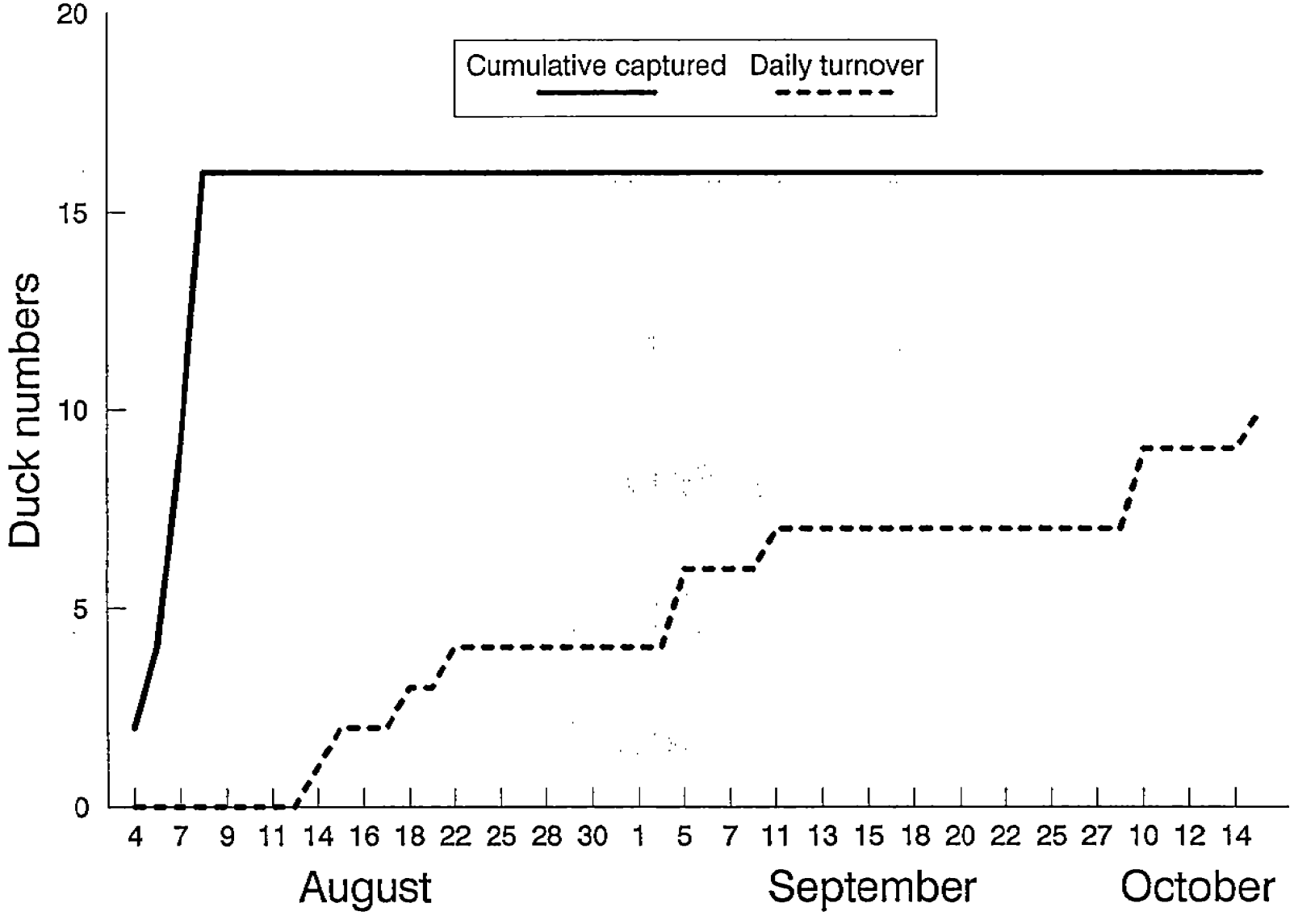
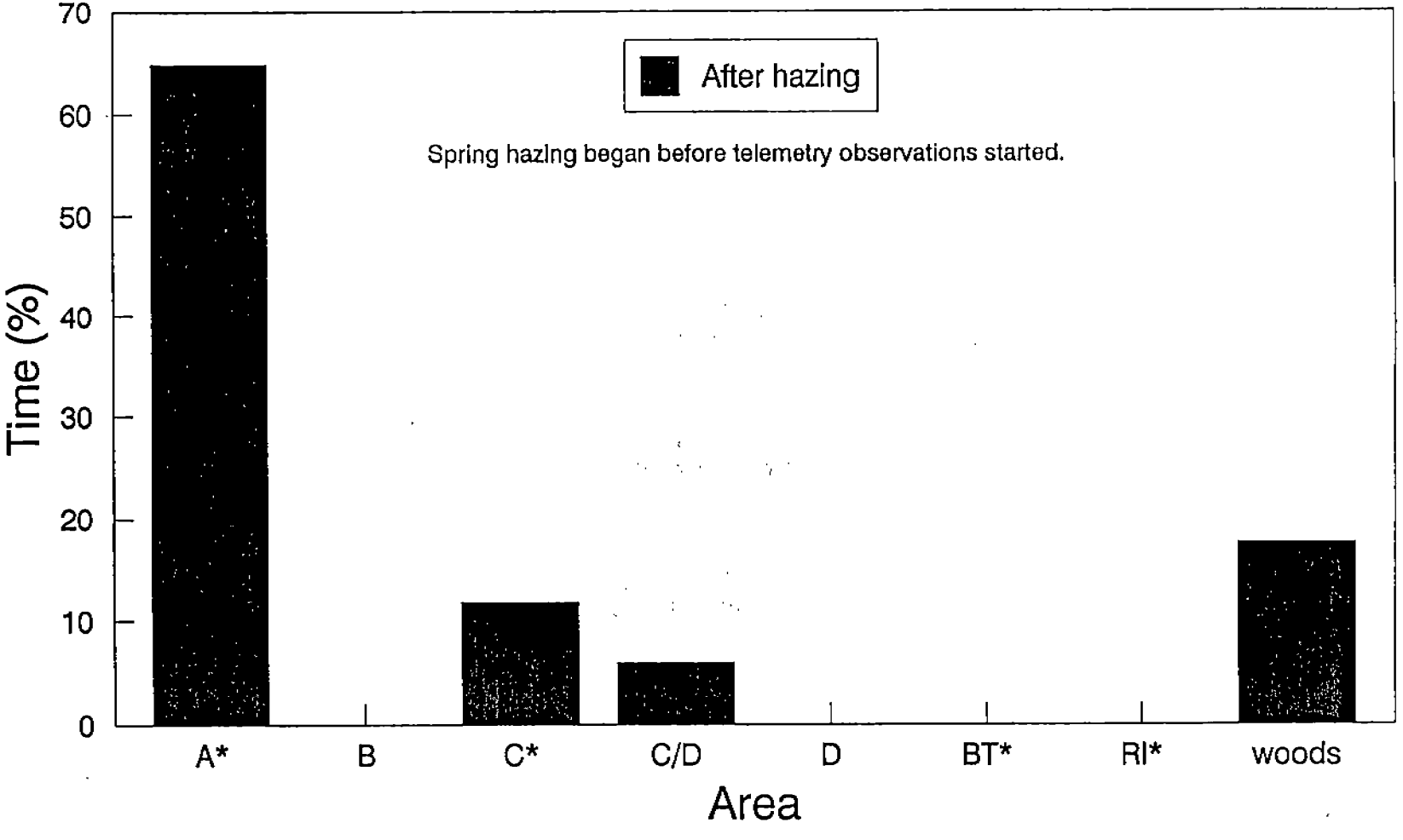


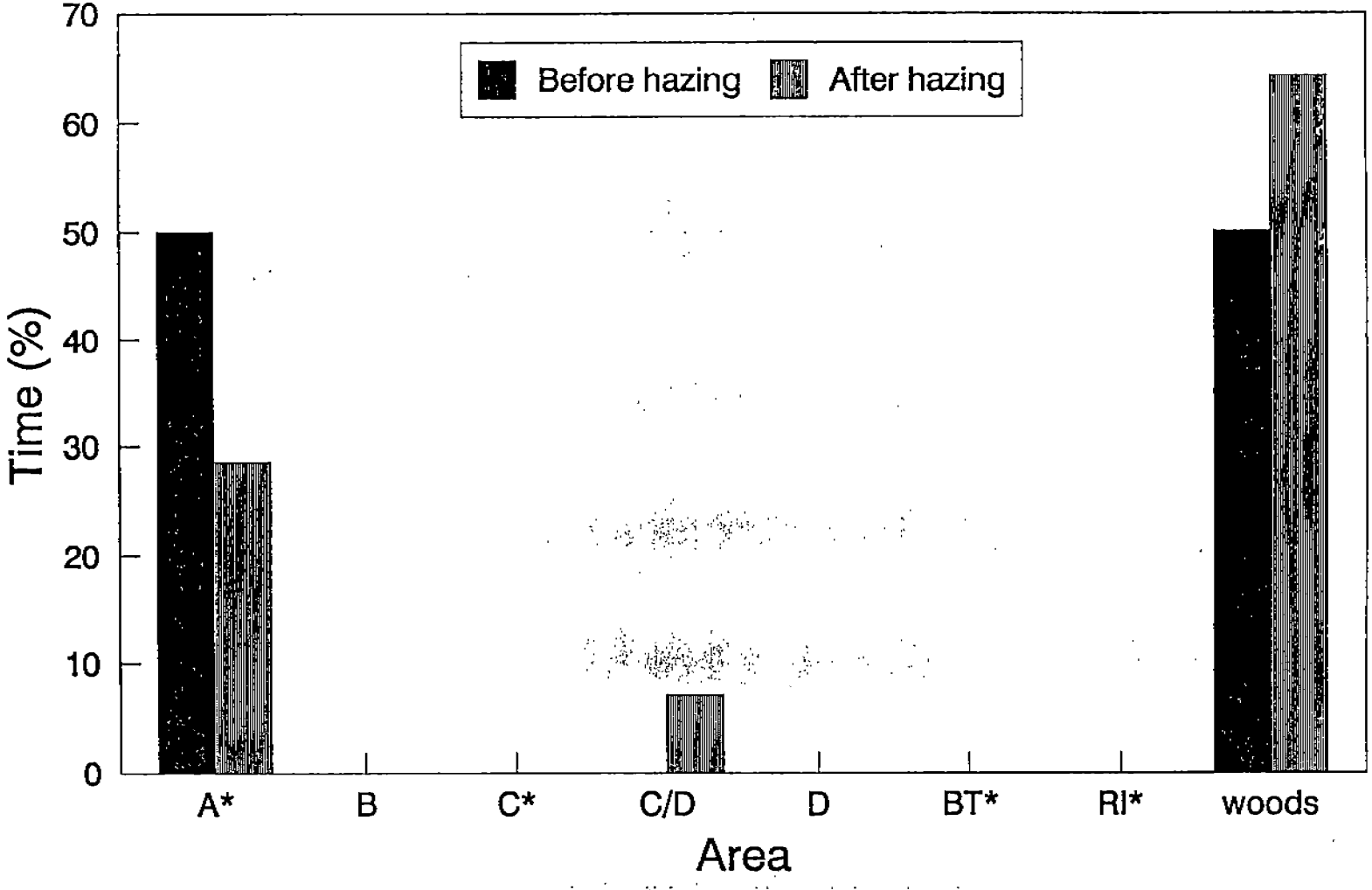
Figure 10. Distribution of bald eagles on Eagle River Flats during spring migration from April 25 to May 31, 1995.

DISTRIBUTION OF BALD EAGLES ON EAGLE RIVER FLATS SPRING 1995



* Denotes areas of high white phosphorus concentrations. Attemts were made to haze ducks from these areas.

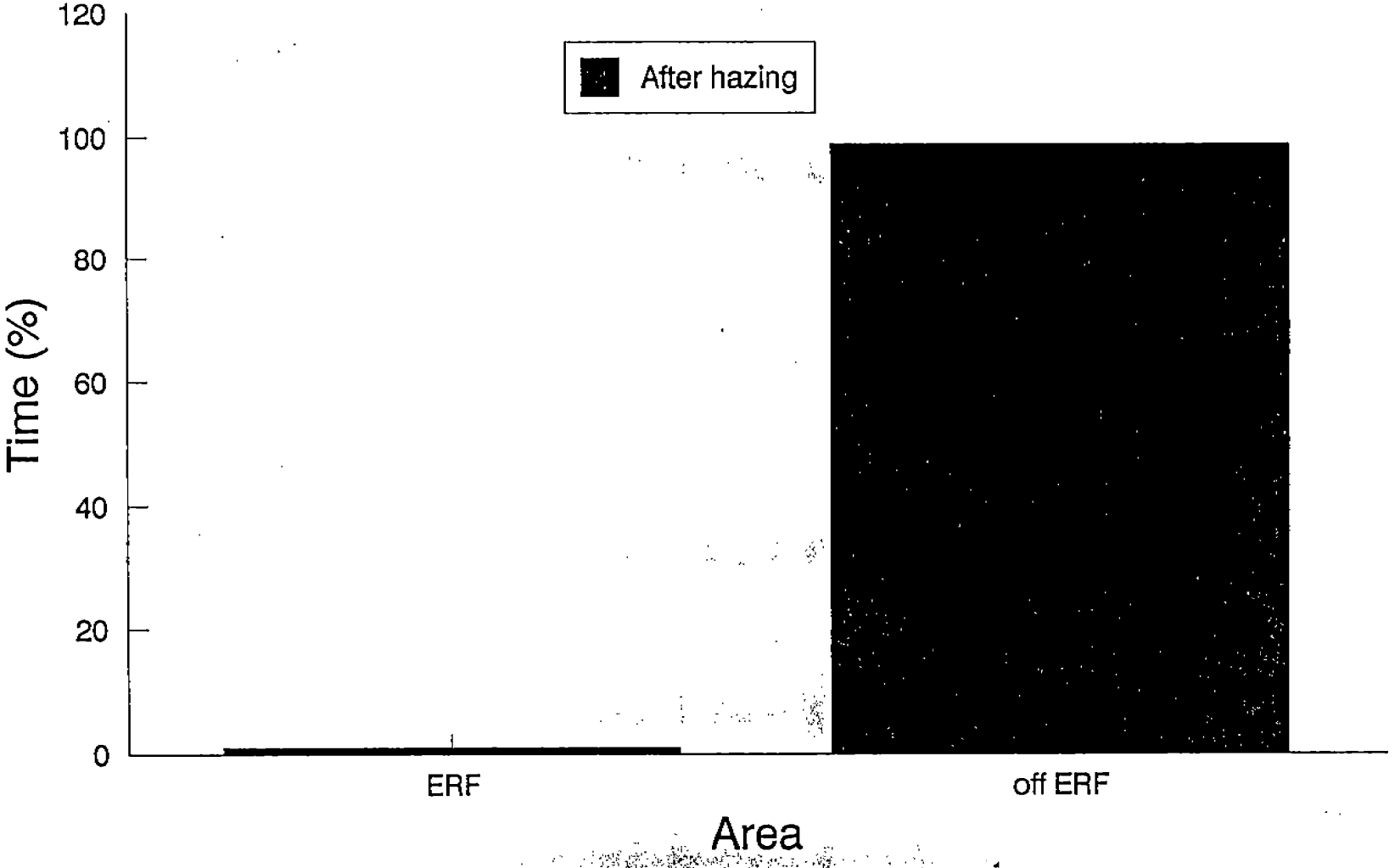
DISTRIBUTION OF BALD EAGLES ON EAGLE RIVER FLATS
FALL 1995



* Denotes areas of high white phosphorus concentrations. Attempts were made to haze ducks from these areas.

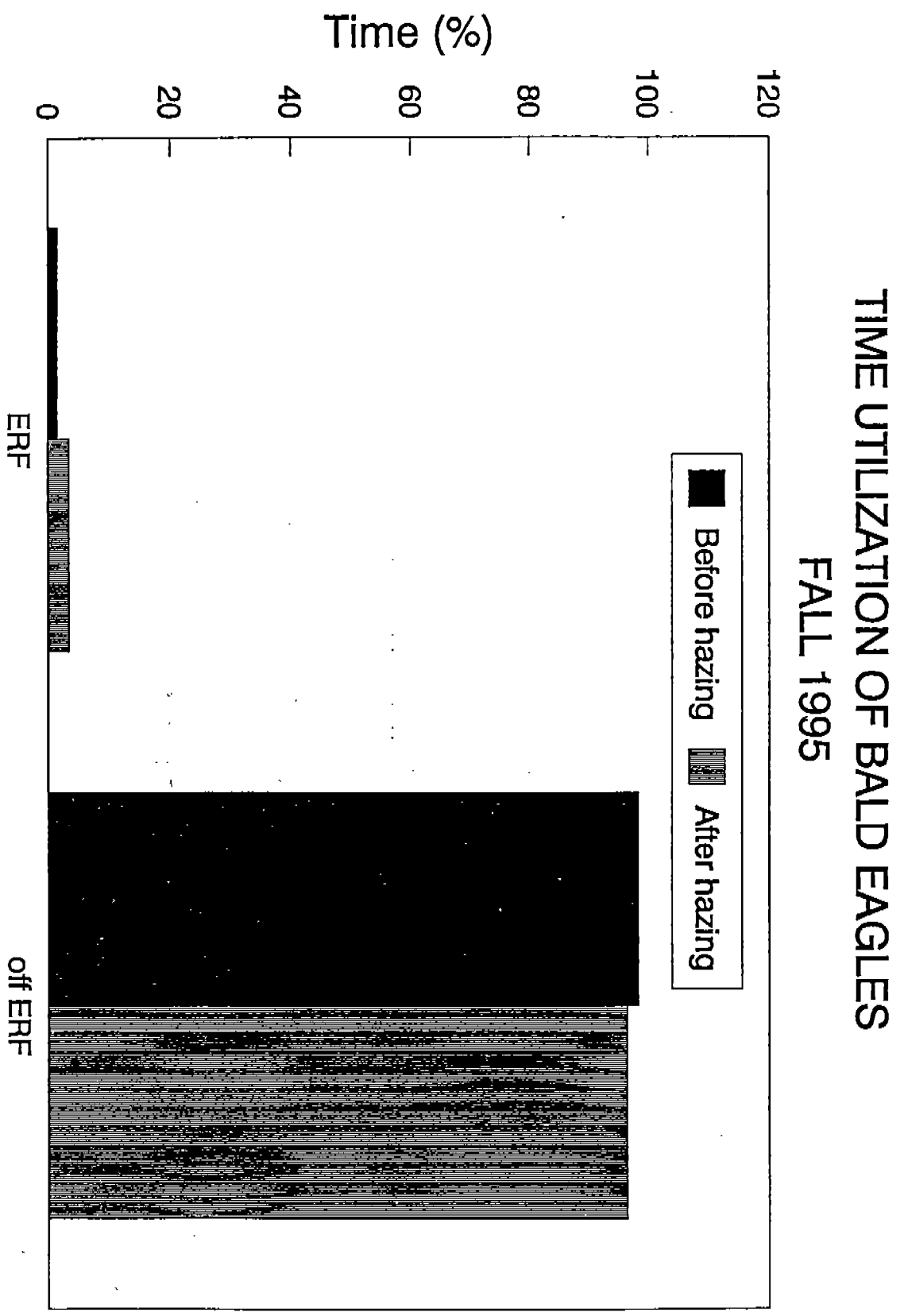
Figure 12. Time bald eagles spent on and off Eagle River Flats during spring migration from April 25 to May 31, 1995.

TIME UTILIZATION OF BALD EAGLES
SPRING 1995



Spring hazing began before telemetry observations started.

Figure 13. Time bald eagles spent on and off Eagle River Flats during fall migration from August 1 to October 17, 1995.


TIME UTILIZATION OF BALD EAGLES
FALL 1995
Time (%)
0
20
40
60
80
100
120
Before hazing
After hazing
ERF
off ERF
Area