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Movement, Distribution and Relative Risk of Mallards and Bald Eagles Using Eagle River Flats: 1996.

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U.S. Army Eagle River Flats: Protecting Waterfowl from Ingesting White Phosphorus

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MOVEMENTS, DISTRIBUTION AND RELATIVE RISK OF WATERFOWL AND BALD EAGLES USING EAGLE RIVER FLATS: 1996

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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 scavenged 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 December 1996. 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, daily waterfowl movements during August, September, and October indicated that all species moved among areas quite readily. However, each species showed 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. Teal preferred ponds that were shallow (< 8 cm) or areas that had extensive mudflats. Distribution data indicated that ducks as in previous years used a larger portion of ERF in August than in September. This was 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. Mortality during 1995 (n=5) was 9% or about half the number of ducks that died during fall migration in 1993. Finally, the turnover rate (3.8%) for 1995 was lower than 1993 or 1994. The average number of days spent on ERF by mallards was 40 days; pintails, 46 days; and teal, 27 days.

In 1996, 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. Cn ERF, mallards have been selected as the indicator species to evaluate the effects of WP on waterfowl. Bald eagles are considered the top avian scavengers of waterfowl poisoned by white phosphorus. In this case, both mallards 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. The objectives were:

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

METHODS

Beginning August 3, 1996, we captured ducks, specifically mallards on ERF with swim-in traps, mist nets, or net-guns. Swim-in traps were placed in traditional locations, 1 in area B, 3 in area A, 1 in area C/D, and 1 in area D (Fig. 1). Mist nets were used in the area surrounding the EOD pad (Fig. 1). Ducks captures with the net-gun were at random from all areas on ERF. Ducks 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 orange patagial tag (Armorlite, Codey, Inc., Pawtucket, RI). The capture and release locations and date, band number, age and sex were recorded for each bird. In addition, all ducks were fitted with radio transmitters (standard or mortality) weighing 9.1 g. The first 50 mallards captured were fitted with standard transmitters which provided daily movement and distribution data. The remaining mallards and pintails were fitted with mortality transmitters which only activated when the duck died. These transmitters were used to determine only mortality. Each transmitter was positioned on the upper back of each bird and attached with a teflon ribbon harness (Cummings et al. 1993).

Bald eagles were captured, marked, and radioed in 1994 and 1995 (Cummings et al. 1994, 1995). The satellite transmitters were expected to last about 18-24 months or until about January 1997.

Mallards and bald eagles 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.

Telemetry locations were determined daily between 0700 to 1000 and 1500 to 2000 h during 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. Mortality radios were recovered once they activated. Dead birds were recovered, or remains were collected to determine the cause of death and a location recorded.

Data from mallards was compiled using Locate II (Pacer, Truro, Nova Scotia, Canada) and mapped using GIS ARC/INFO and/or ARC/VIEW. 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 1995, ERF was divided into ten areas representing sites that waterfowl used for foraging and loafing (Fig. 1). Since that time, telemetry data has been plotted and analyzed based on these ten areas. The areas were synonymous with areas used by the U.S. Army to identify specific areas on ERF. The ten areas are A, B, RI (Racine Island), C, C/D, D, BT (bread truck), EOD, Coastal West, and Coastal East. Areas A, RI, C, and BT have documented high levels of white phosphorus. In 1996, 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.

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

Mallard mortality and the location of that mortality was determined by telemetry. The mortality rate was determined by dividing the number of mallard mortalities by the total number of mallards captured and radioed.

RESULTS

Waterfowl

From August 3-23, 1996, 107 mallards and 51 pintails were captured, banded and released on ERF (Table 1). Of the mallards, 2 were captured with the mist nets, 8 with swim-in traps, and 97 with the net gun/helicopter. We used 25 hours of helicopter time to capture 97 mallards, 9 of those hours we only captured 2 mallards due to the inexperience of pilots. The best capture was 21 mallards in 2 hours. All pintails were captured in area A with swim-in traps. Of the 107 mallards, 53 were fitted with standard transmitters. In addition, 54 mallards and 29 pintails were fitted with mortality transmitters (Table 2). 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 12% of the instrumented mallards were in final 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. Of the 13 mallards in molt, 7 were captured on Racine Island.

The GIS system produced two types of maps for each mallard. The first map showed mallard telemetry points pre- and post September 5 (Fig. 2-actual example). This division is based on previous hazing start-up dates. These data will be used to compare 1996 with previous years. The second map depicts the last 5 to 10 telemetry locations before the mallard died (Fig. 3-actual example). These maps (n=16) was useful in determining a general area that mallards could have been exposed to WP. Exact locations and on occasions even the general location of where the duck might have ingested the WP was difficult to discern because telemetry data points were missing. Missing telemetry points were attributed to lack of a good cross from each telemetry tower or because telemetry personnel did not work on the weekends.

Mallard (n=53) movements and distribution on ERF during the fall indicate that they spent the majority of their time from August 3 to October 15 in areas A, B, C and

C/D (Table 3). Use of these areas represented about 91% of the time mallards spent on ERF (Table 3). Several mallards were documented moving to various locations near ERF, such as Gwen, Otter, and Six Mile lakes, Palmer Hay Flats and Susitna Flats. Mallards spent about 83% of their time in areas A, BT, C, C/D, EOD, and RI, which are areas that are considered contaminated (Table 3).

In order to evaluate the effects of hazing on mallards, we compared mallard movements and distribution from 1996 (non-hazed year) to 1995 (hazed year). During 1995 hazing began on September 5. In that year mallards (n=17) spent the majority of their time from August 1 to September 5 (non-hazing period) in areas A, B, and D. Use of these areas represented about 60% of the time mallards spent on ERF (Fig. 4). In areas that were actively hazed, area A, C, C/D and BT, mallards spent about 31% of their time in these areas during the non-hazed period and 21% of their time during the hazed period (Fig. 4). In 1996, mallards spent 33% of their time in areas A, C, C/D, and BT prior to September 5 and 46% of their time in the same areas after September 5.

The average number of days spent on ERF by mallards (n = 53) was 47, range 1-71. At the conclusion of the study, October 15, 3 mallards remained on ERF. These birds were using the Eagle River because all other areas on ERF were covered with snow and/or ice. The average daily turnover rate for mallards was about 1.4%. The greatest turnover for mallards occurred from October 1 to 15, where 62% of the mallards departed ERF (Fig. 5). Over 20% of the mallards departed between August 16 to 31 (Fig. 5). Turnover prior to September 5 of 1995 and 1996 for mallards was 47% and 26%, respectively.

The mortality of mallards using ERF from August 3 to October 15 was 37 (C.L. 26-44) or about 35% (Table 4). Mallards found dead during this period were on the Flats from 4 to 68 days. The average exposure before mortality was 29 days. The greatest mortality occurred in areas C, 13 of 37 (35%); A, 8 of 37 (22%); and C/D and RI both accounted for 6 of 37, (16%). Overall, these areas accounted for 89% of the mallard mortality on ERF (Table 5). Three other mallards found dead were attributed to mink. The carcasses and transmitter of each bird was recovered from mink burrows. No mallard mortality was noted from capture, handling or the transmitter. Carcasses were collected and frozen for residue analysis.

Bald Eagles

During 1994 and 1995, 10 and 14 bald eagles were captured on ERF and each fitted with backpack transmitters, respectively. In 1995, two of those were breeding adults from two nest sites surrounding ERF. Telemetry and observational data (see Cummings et al., 1995 ERF report) 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 and an average of 0.2 days (range 1-50) on the Flats during the fall. Instrumented eagles were only located in areas A, C, and C/D during the spring and areas A and C/D during the fall. Most of the time was spent in the wooded areas surrounding ERF. Eagles (satellite) that did not nest in the woods surrounding ERF were located with 300 km radius of the Flats.

As of December 1996, only one satellite transmitter remained active. That eagle is near Cordova, Alaska. During the study no eagle mortality occurred.

DISCUSSION

In 1996, mallards were selected as the indicator species to measure the effects of any treatability studies or remedation actions on ERF. The 1996 sample size of 107 radioed mallards was large enough to establish a baseline that future changes in mallard movements, distribution, turnover and mortality can be detected with confidence. Any comparison of data from 1996 with that of 1993 and 1995 must be carefully interpreted because of the small sample size of mallards captured in 1993 and 1995. Also, other activities on the Flats during 1993 and 1995, such as hazing, data collection and movement of personnel are all factors that may influence waterfowl behavior.

Mallards highly preferred area A in 1996, followed by areas B, C and C/D. Mallards distribution data collected during the fall migration period in 1993 and 1995 indicates that mallards preferred area B over other areas on ERF. The distribution of mallards in previous years showed a larger use of ERF in August than in September and October. Indications from 1996 data is that hazing is having a positive effect on redistributing waterfowl to uncontaminated areas. For example, mallards showed a significant redistribution from non-hazed periods to hazed periods. A comparison of 1995 to 1996 shows that mallards spent about equal time in areas A, C, C/D and BT prior to September 5. Following this period use of these areas decreased 32% in 1995 (hazing) while increasing 40% in 1996 (non-hazing). In addition, the average number of days mallards spent on ERF in 1995 was 40, whereas it was 47 in 1996. Also, the average daily turnover rate was 3.8% in 1995 and 1.4% in 1996. Both of these factors indicate that without hazing, mallards resided longer on ERF and departed the Flats at a slower rate.

Mallards mortality during 1996 (n=37) was 35%. In 1995 it was 23% (4 of 17) and 16% (2 of 12) in 1993. Mortality in 1996 probably increased because mallards use of contaminated areas increased.

In conclusion, we feel that the baseline data collected in 1996 can be used to measure the effects of future remedation actions. Showing a significant effect will depend on having a sample size that exceeds 100 mallards captured in a relatively short period of time.

RECOMMENDATIONS

Assessment Endpoints

The biological assessment endpoint for ERF is the reduction in waterfowl mortality. To measure this endpoint, we suggest that mallards continue to be used as the indicator species for ERF and telemetry be used to monitor their activities. Increasing the number of transmitters by 50 will only reduce the standard deviation about 2%. In addition, a mix of standard and mortality transmitters will allow a board evaluation of factors effected by remedation actions.

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. It has been shown that telemetry can account for factors effecting mortality whereas transects which are tied to a specific ponded site can not. 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.

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 <$90,000 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 mallards using Eagle River Flats, Fort Richardson, Alaska, during fall migration, August 3 to October 15, 1996. One hundred-fifty-eight ducks were captured on ERF using various capture techniques. Of these, 107 mallards and 29 northern pintails were fitted with radio transmitters. Tracking data indicated that transmitters did not appear to inhibit movements or activities of either ducks. Mallard movements and distribution indicate that they spent about 91% of their time in areas A, B, C and C/D.

In addition, mallards spent about 83% of their time in areas that are considered contaminated (A, BT, C, C/D, EOD and RI). The average number of days spent on ERF by mallards was 47. The average daily turnover rate for waterfowl was about 1.4%. The greatest turnover of waterfowl occurred from October 1 to October 15 where 62% of the mallards departed ERF. Mortality of instrumented mallards using ERF from August 3 to October 15 was 37 or about 35%. The greatest mortality occurred in area C (35%), area A (22%) and areas C/D and RI (16%, respectively). During 1994 and 1995, 10 and 14 bald eagles were fitted with satellite transmitters. As of December, 1996 only one transmitter remains active. That eagle is near Cordova, Alaska. No eagle mortality has been documented from instrumented birds, even though eagles scavenge dead ducks (which has included instrumented ducks). Indications from the 1996 data as compared to 1993 and 1995 mallard data, is that hazing is having a positive effect on the redistribution of waterfowl to uncontaminated areas on ERF.

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Table 1. Waterfowl, dowitchers and bald eagles fitted with radio transmitters on Eagle River Flats, Fort Richardson, Alaska.

	1993	1994	1995	1996
Mallards	12	27	17	107
Northern Pintails	11	1	16	29
Green-winged teal	11	4	21	0
Bald Eagles	0	10	14	0
Dowitcher	0	20	0	0
Banded Only	28	2	28	22
Total	62	64	96	158

Table 2. Radio transmitters fitted to waterfowl on Eagle River Flats, Fort Richardson, Alaska, August 3 to October 15, 1996.

	Standard	Mortality	Banded Only
Mallards	53	54	0
Northern Pintails	0	29	22

Table 3. Distribution of mallards on Eagle River Flats (ERF), Fort Richardson, Alaska, August 3 to October 15, 1996.

ERF Area	Telemetry Points (no.)	Telemetry Points (%)	Mortality
A	1,215	62	8
B	213	11	2
C	204	10	13
C/D	167	8	6
CW	63	3	0
RI	40	2	6
CE	27	1	0
D	18	<1	0
EOD	16	<1	0
BT	13	<1	2
Total	1976	100	37

Table 4. Mallard mortality from white phosphorus on Eagle River Flats, Fort Richardson, Alaska.

	Captured (no.)	Mortalities (no.)	White Phosphorus Mortalities (%)
1996	107	37	35
1995	17	4	24
1994	27	5	19
1993	12	2	17

Table 5. Mortality of mallards on Eagle River Flats, Fort Richardson, Alaska, August 3 to October 15, 1996.

Transmitter	Area								Total
	A	B	C	D	BT	C/D	RI	CE/CW	
Standard	3	2	3	0	1	2	4	0	15
Mortality	5	0	10	0	1	4	2	0	22
Total	8	2	13	0	2	6	6	0	37

Figure 1. Geographic Information System map depicting Eagle River Flats.

ERF RESEARCH AREAS

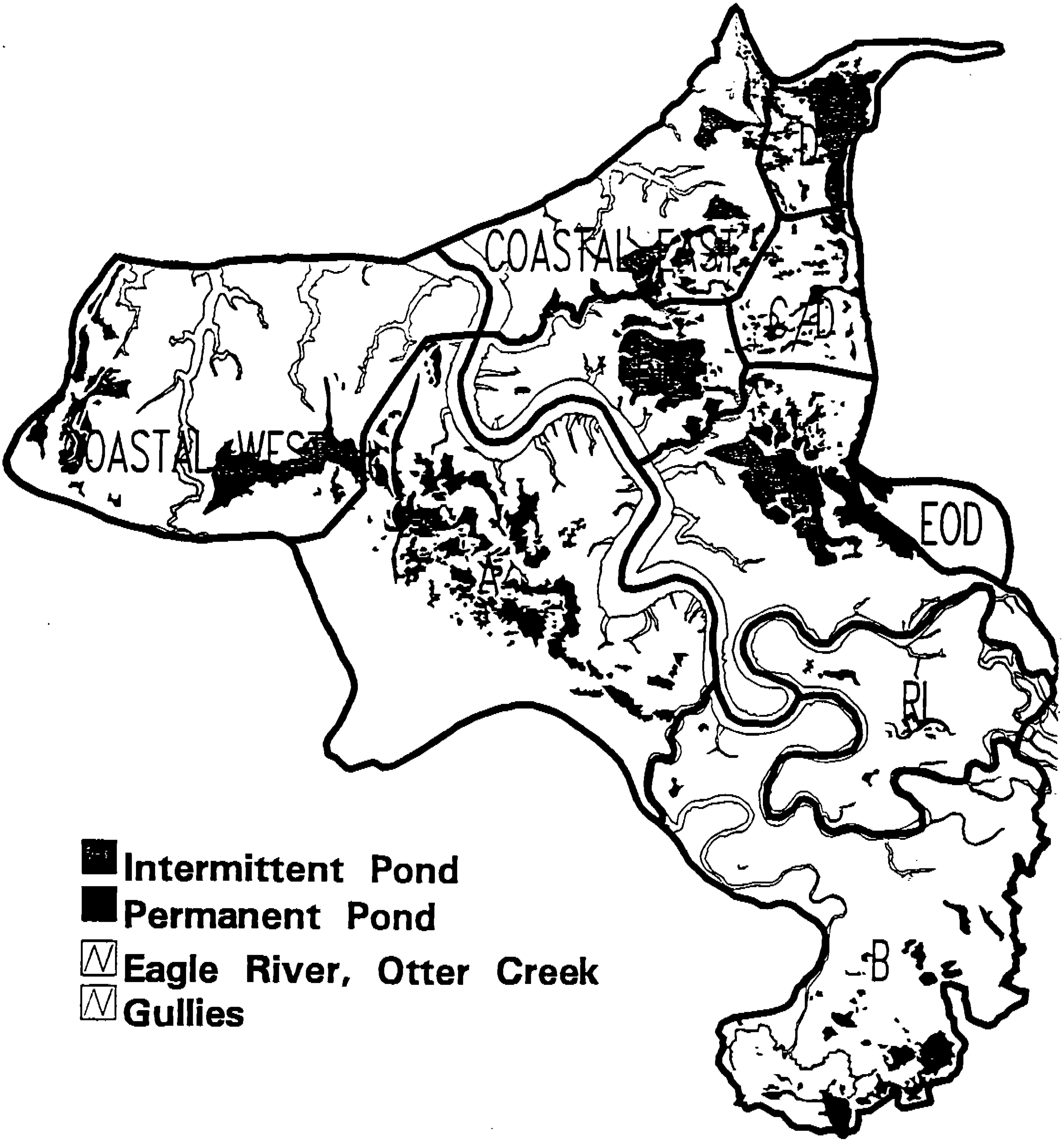


Figure 2. Example of radio-telemetry results on Eagle River Flats, Fort Richardson, Alaska. Movement patterns of a mallard from August 3 to October 15, 1996. Dark dots represent movements from August 3 to September 5 and light dots represent movements from September 6 to October 15. One dot may represent several telemetry locations.

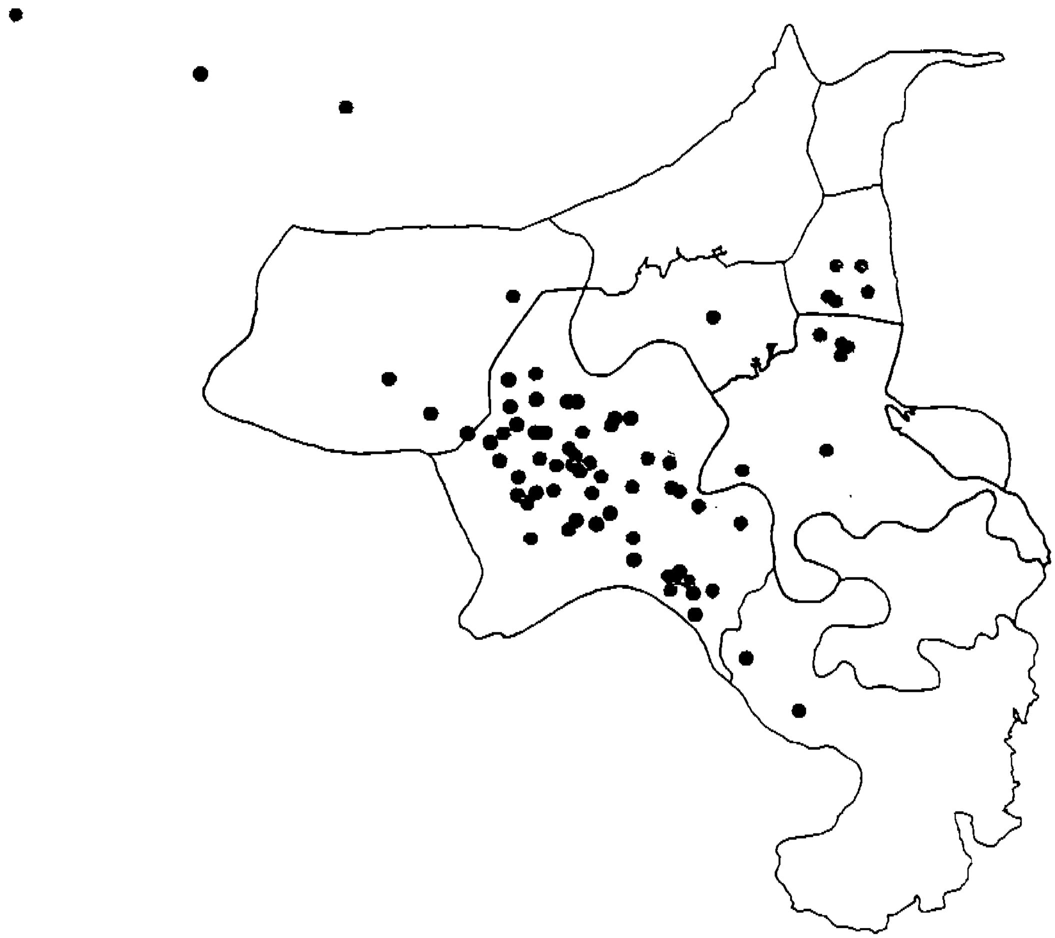


Figure 3. Example of a Geographic Information System map depicting a radio-telemetry result of a mallard that died from ingesting white phosphorus. Light dots show the last five days of movements prior to mortality.

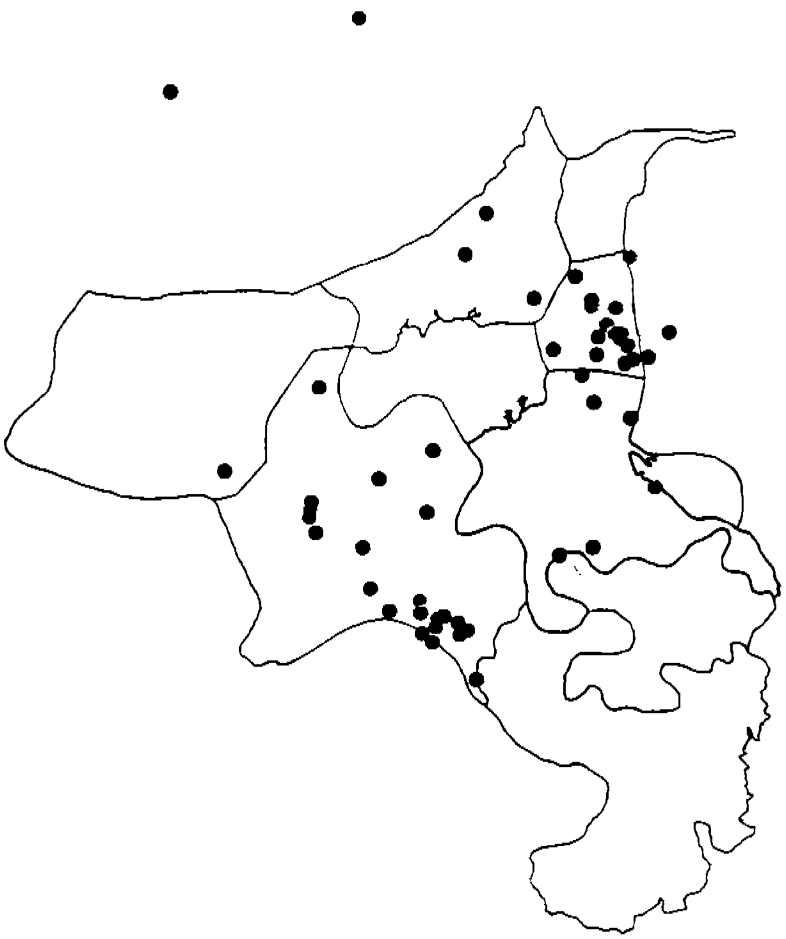


Figure 4. Distribution of mallards on Eagle River Flats pre and post September 5 in 1995 and 1996. Hazing was conducted during the post period in 1995.

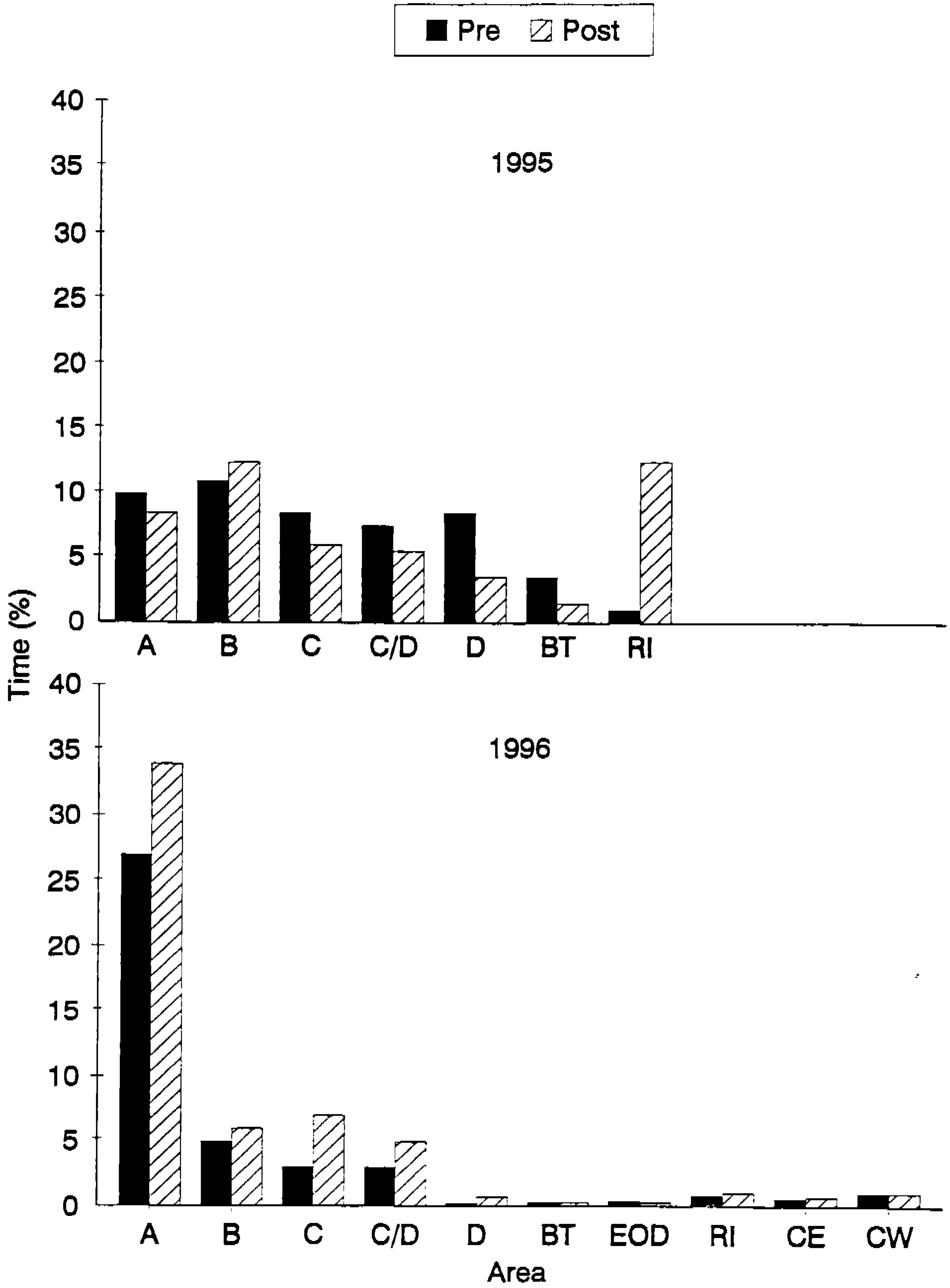
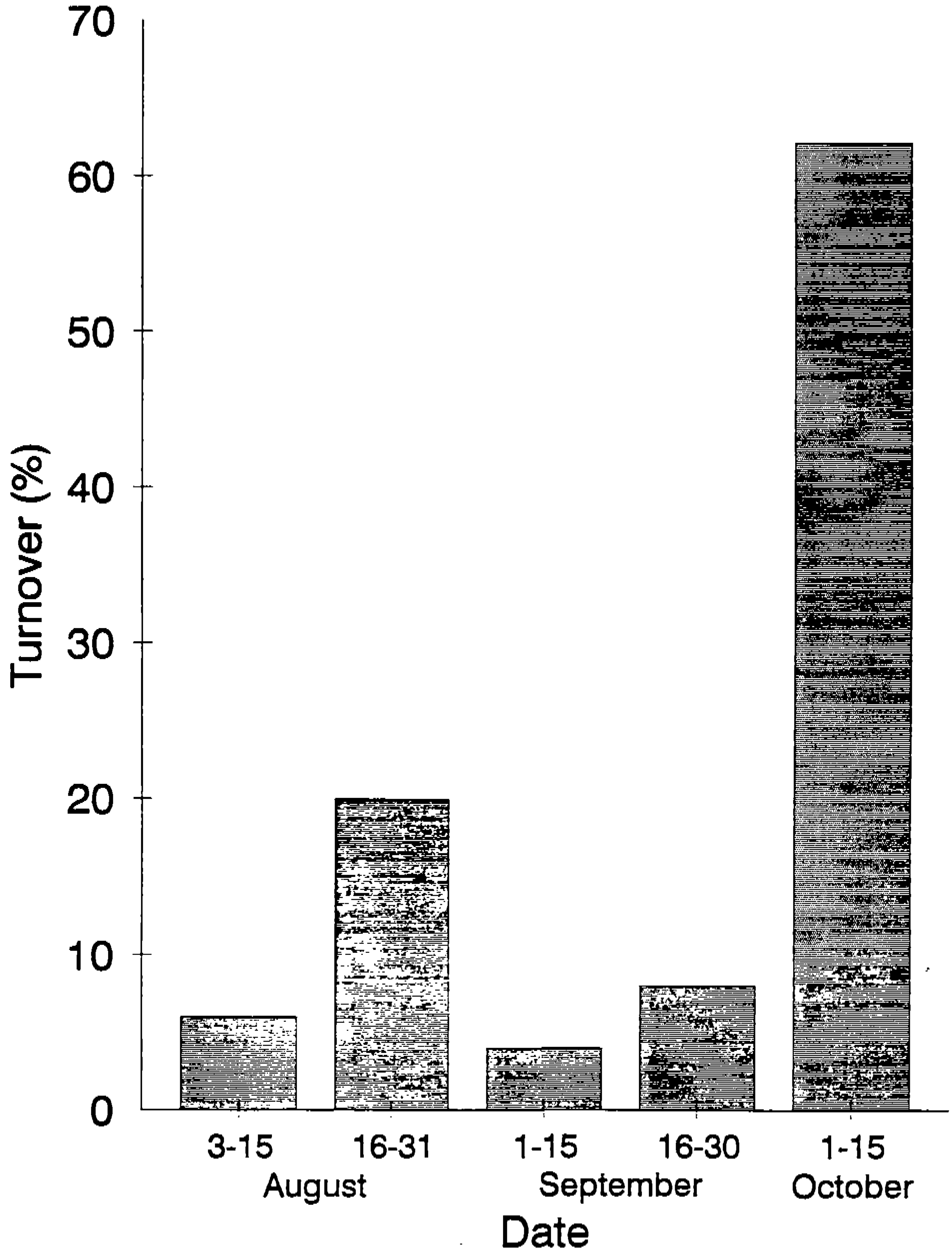

Pre
Post
1995
1996
Time (%)
0
5
10
15
20
25
30
35
40
A
B
C
C/D
D
BT
RI
EOD
CE
CW
Area

Figure 5. Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 3 to October 15, 1996.



70
60
50
40
30
20
10
0
Turnover (%)
3-15
16-31
1-15
16-30
1-15
August
September
October
Date