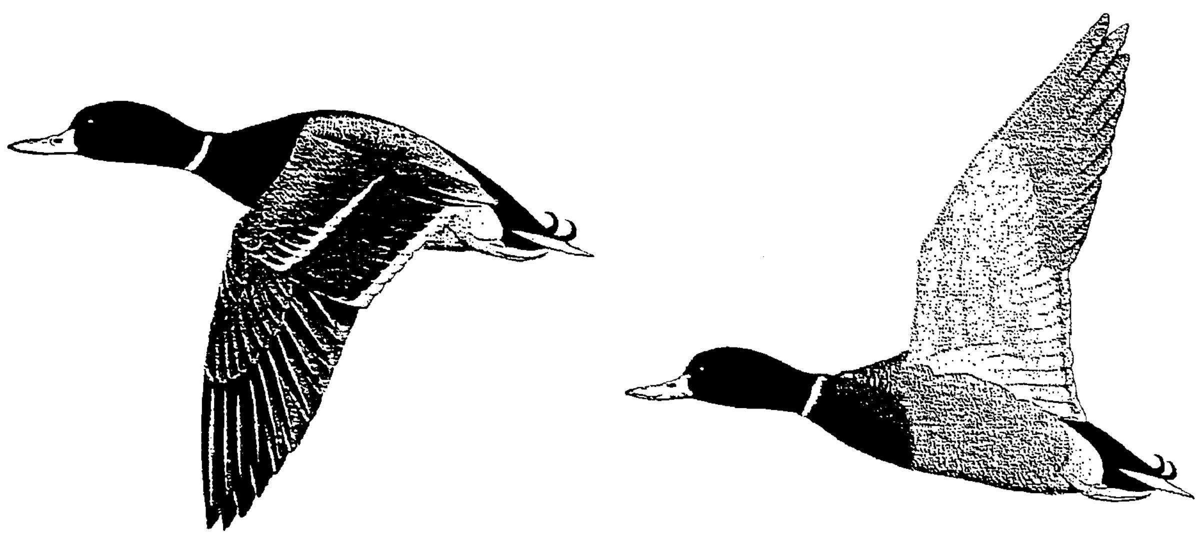
U.S. Army
Fort Richardson, Alaska

Interim Waterfowl Mortality Monitoring Report Operable Unit C—Eagle River Flats Impact Area Fort Richardson, Alaska



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EXECUTIVE SUMMARY

This document presents the results of the Waterfowl Mortality Monitoring study conducted from 1996 through 2002, excluding 2000, for Operable Unit C (OU-C)—Eagle River Flats on Fort Richardson, Alaska. The purpose of the waterfowl monitoring at ERF is to support the confirmation that the short and long-term remedial action objectives (RAOs) are being achieved.

The remedial action objectives (RAOs) for the ERF are designed to accomplish the following:

- Within 5 years of the CERCLA Record of Decision (ROD) being signed (1998), reduce the dabbling duck mortality rate attributable to white phosphorus to 50 percent of the 1996 mortality rate (35%) attributable to white phosphorus. Model data from radio telemetry and aerial surveys suggest that about 1,000 birds died from white phosphorus during spring and fall migration at ERF in 1996. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 500.
- Within 20 years of the ROD being signed (1998), reduce the mortality attributable to white phosphorus to no more than 1 percent of the total annual fall population of dabbling ERF ducks. Population estimates based on model data indicate a 1996 fall dabbling duck population of approximately 5,000. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 50. This long-term goal could be adjusted based on future population studies conducted during the monitoring program.

These objectives will be achieved by reducing the area of white phosphorus-contaminated media and reducing the exposure to white phosphorus. Reducing the exposure will reduce the availability of white phosphorus to ducks, which in turn will reduce duck deaths.

Monitoring at ERF will be conducted to verify that RAOs are achieved. The following are goals of waterfowl mortality monitoring:

- To verify that an exposure pathway does not exist between waterfowl and white phosphorus-contaminated sediment.
- To determine the number of waterfowl using ERF.
- To determine the number of waterfowl dying as a result of feeding in white phosphorus-contaminated sediment.
- To determine whether remedial action is effective or need modification.

In addition, a dabbling duck mortality model was developed to evaluate the specific remedial action objective (RAO) of reducing dabbling duck mortality. This RAO addresses the single most important issue associated with white phosphorous contamination of areas on ERF. Because dabbling ducks have been the most affected, their mortality was assessed specifically in support of the achievement of this objective. Mallards were chosen as the indicator species.

Aerial surveys to monitor waterfowl use of ERF were conducted during the spring, summer and fall from 1996 through 2002. A complete count was conducted of the number of waterbirds, specifically dabbling ducks, by species, and classified by location on ERF using standardized study areas and survey techniques. Survey data of dabbling ducks from the fall period was incorporated into the dabbling duck mortality model developed for ERF.

Since 1996, excluding 2000, 648 mallards were captured from random locations on ERF using primarily a net-gun from a Bell 212 helicopter. On average, 31 hours of helicopter time each year was used to capture mallards. Each mallard was radio-marked with a 9.1 gram backpack transmitter, held for 12-36 hours to assess its condition and released at its capture site. All mallards were fitted with standard/mortality transmitters that emit about 60 pulses per minute when the duck is alive and 120 pulses per minute when the duck dies.

Movement and distribution of radio-marked mallards on ERF during the fall migration period from 1996 through 2002, excluding 2000, indicate that mallards spent the majority of their time in areas A, B, C, and C/D from August through October. Use of these areas represented about 84 percent of the time mallards spent on ERF. During remedial actions, mallards redistributed to areas on ERF that had minimal disturbances.

Overall, the average number of days radio-marked mallards spent on ERF from 1996 through 2002, excluding 2000 was 40 days. The range was from 1 to 77 days. The greatest turnover from 1996 through 2002, excluding 2000, occurred during August 2-20 and September 14-28.

From 1996 through 2002, excluding 2000, 201 radio-marked mallards that used ERF August through October died. Of those mallards, 131 (65%) mortalities were attributed to white phosphorous. The remaining majority of the mortalities were attributed to hunting (25%). Mortalities from predators, attachment method and unknown causes were minor (10%). Of the 131 radio-marked mallard mortalities attributed to white phosphorous, 40 (31%) were found in area C/D, 31 (24%) were found in area C and 29 (22%) were found in area A. These three areas represented 77% of radio-marked mortalities.

Of 49 radio-marked mallard carcasses recovered from ERF, from 1996 through 2002, excluding 2000, 44 (90%) tested positive for white phosphorous. Residue levels of white phosphorous in these mallards ranged from 0.09 μg/g to 3,210 μg/g. Analysis of 41 unmarked waterfowl recovered from ERF had white phosphorous residue levels that ranged from 0.004 μg/g to 1,170 μg/g. Of the 41 waterfowl, 26 were mallards, 10 were northern pintails, 2 were green-winged teal, 2 were tundra swans, and 1 was an American wigeon.

The dabbling duck mortality model estimated the fall dabbling duck mortality for 1996 through 2002, excluding 2000. It used data from waterfowl aerial surveys and turnover and mortality data from radio-marked mallards that used ERF from August through mid-October from 1996 through 2002 to estimate the number of dabbler mortalities attributed to white phosphorous. The model also estimated the peak number of dabblers and the total number of dabblers using ERF during the same period. In 1996, which was considered the base year for the mortality model, it was estimated that 5,146 individual dabblers used ERF from August 3 to October 16. Dabblers peaked at 2,382 individuals during September 13-16. The estimated overall mortality that occurred on ERF was 692. From 1997 through 2002, excluding 2000, the number of individual dabblers that used ERF ranged from 1,230 to 4,630. Dabblers peaked at between 731 and 3,496 individuals. The estimated mortality was 108 dabblers in 1997, 317 dabblers in 1998, 179 dabblers in 1999, 91 dabblers in 2001 and 192 dabblers in 2002.

The number of radio-marked mallard mortalities attributed to white phosphorous has decreased from 38 in 1996 to 8 in 2002. The dabbling duck mortality model for ERF indicates that the dabbling duck mortality rate (%) has decreased from 35 percent in 1996 to 12 percent in 2002 and the number of estimated mortalities has decreased from 692 in 1996 to 192 in 2002. The mortality model indicates that the 5-year goal outlined in the CERCLA Record of Decision for Operation Unit C, Fort Richardson, Anchorage, Alaska (September 1998) to reduce the dabbler mortality rate attributed to white phosphorous to less than 50 percent of the 1996 mortality rate (35%) or reduce the number of dabbler mortalities attributed to white phosphorous to less than 500 has been met.

ACRONYM LIST

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
BT	Bread Truck
CE	Coastal East
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act
CRREL	Cold Regions Research and Engineering Laboratory
CW	Coastal West
ERF	Eagle River Flats
EOD	Explosive ordnance disposal
FFA	Federal Facility Agreement
FP	Field Procedure
GIS	Geographical Information System
GPS	Global Positioning System
HE	High Explosives
IWMMR	Interim Waterfowl Mortality Monitoring Report
KHz	Kilohertz
LD_{50}	Lethal dose
LOEL	Lowest Observed Effect Level
m	Meter
MHz	Megahertz
MLOD	Minimum Level of Detection
NCP	National Contingency Plan
NPL	National Priorities List
NWRC	National Wildlife Research Center
OB/OD	Open Burn/Open Detonation
OU	Operable Unit
RA	Remedial Action
RAO	Remedial Action Objective(s)
RAT	Remedial Action Team
RCRA	Resource Conservation and Recovery Act
RI	Racine Island
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SOPs	Standard Operating Procedures
USARAK	U.S. Army Alaska
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
WMM	Waterfowl Mortality Monitoring
WP	White phosphorus

1.0 INTRODUCTION

The U.S. Army has used Eagle River Flats (ERF), Fort Richardson, Alaska since 1949 as an impact area for artillery training (Figure 1). Various artillery shells, mortar rounds, rockets, grenades, and illumination flares have been fired at targets in ERF. In 1980, Army biologists noticed an unusually high number of waterfowl carcasses, including several dead swans, in the ERF marshes. Subsequent, random searches by the U.S. Army, U.S. Fish and Wildlife Service (USFWS), and Alaska Department of Fish and Game (ADFG) discovered abnormally high numbers of dead waterfowl, indicating a serious problem. Ground searches conducted in September 1983 found 368 waterfowl carcasses, including about 35 fresh carcasses. In August and September 1984, about 175 carcasses were discovered. At that time, the U.S. Army estimated the number of waterfowl deaths to be between 1,500 and 2,000 per year. In a later study, a series of aerial and ground surveys in 1988 documented more than 900 waterfowl carcasses and feather piles in one area of ERF.

Census data for 1988 and 1989 indicated that dabbling ducks comprised the majority of the affected waterfowl and the ducks were continuing to die. The focus of the 1990 field season was to find the cause of mortality based on the assumptions that the contaminant(s) resided in sediment, were distributed heterogeneously at ERF, and were slow to degrade.

In 1990, field and laboratory studies provided evidence that white phosphorus was the likely cause of the mortality. In addition, because white phosphorus persists (does not sublimate and oxidize) when wet or submerged, the water and sediment conditions at ERF are conducive to long-term retention of white phosphorus in the sediments. The evidence indicated that ingestion of white phosphorous particles by ducks and swans was the cause of most of the elevated waterfowl mortality in ERF. White phosphorous has been identified at elevated levels in the sediment of the following areas on ERF: Area A, C, C/D, Bread Truck, and Racine Island (Figure 2).

In June 1994, the U.S. Environmental Protection Agency (USEPA) listed Fort Richardson, Alaska, on the National Priorities List (NPL). This listing designated the post as a Federal Superfund Site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Following inclusion of Fort Richardson on the NPL, the U.S. Army Alaska (USARAK), USEPA, and the Alaska Department of Environmental Conservation (ADEC) negotiated the Federal Facility Agreement (FFA) for Fort Richardson. All three parties signed the FFA on December 5, 1994. Under the terms of the FFA, all remedial response activities will be conducted to protect public health and welfare and the environment in accordance with CERCLA, the National Contingency Plan (NCP), the Resource Conservation and Recovery Act (RCRA), and applicable state law.

1.1 Fort Richardson

Fort Richardson was established in 1940 as a military staging and supply center during World War II. It now occupies approximately 62,000 acres bounded to the north by Knik Arm, to the west by Elmendorf Air Force Base, and to the south by the Municipality of Anchorage (Figure 1). The current mission of Fort Richardson is to support the rapid deployment of U.S. Army forces from Alaska to the Pacific Theater.

The FFA divided Fort Richardson into four Operable Units (OUs, named with letters A through D) to represent the potential source areas for hazardous substances. The OUs were created based on the amount of existing information, the similarity of contamination, and the level of effort required to complete a Remedial Investigation (RI). In 2000, an additional Operable Unit, OU-E, was added. This Interim Waterfowl Mortality Monitoring Report focuses on OU-C.

1.1 Operable Unit C

OU-C consists of a 2,160-acre salt marsh that makes up ERF and an 8-acre gravel open burn/open detonation (OB/OD) ordnance disposal pad on the eastern edge of ERF.

1.2 Eagle River Flats

ERF is a 2,160-acre cornucopia-shaped, estuarine salt marsh at the mouth of the Eagle River. It is surrounded by forested uplands on the west, south, and east sides, and bounded by the Knik Arm on the north. The Eagle River flows through ERF from southeast to northwest, ultimately discharging into Knik Arm. Two creeks, Clunie and Otter, also drain in to ERF (Figure 1).

ERF is the only impact area for heavy artillery and mortars on Fort Richardson. Approximately 25 derelict cars and trucks have been placed individually or in groups as targets around ERF. U.S. Army personnel practice firing at the targets from more than 25 points, at distances of up to 6 miles. ERF has been used for military training since 1949, creating thousands of craters in the wetlands and associated mud flats and leaving an estimated 10,000 unexploded mortar and artillery shells buried in the shallow subsurface. Four types of munitions have been fired into ERF: high explosives (HEs), white phosphorus smokes, illumination flares, and hexachloroethane-zinc mixture.

Although ERF is an active impact area, it remains a productive wetland, serving as an important staging ground for migrating waterfowl during the spring and fall migrations. ERF also supports local populations of fish, birds, mammals, and macro invertebrates. A series of ponds distributed throughout ERF provides excellent habitat for dabbling ducks and other waterfowl.

1.3 Purpose and Objectives

This document presents the Interim Waterfowl Mortality Monitoring Report (IWMMR) for the U.S. Army at Eagle River Flats, Operable Unit C, Fort Richardson, Alaska. Eagle River Flats is one of two OU-C source areas. The purpose of the waterfowl monitoring at ERF is to support the confirmation that the short and long-term remedial action objectives (RAOs) are being achieved.

The remedial action objectives (RAOs) for the ERF are designed to accomplish the following:

- Within 5 years of the CERCLA Record of Decision (ROD) being signed (1998), reduce the dabbling duck mortality rate attributable to white phosphorus to 50 percent of the 1996 mortality rate (35%) attributable to white phosphorus. Model data from radio telemetry and aerial surveys suggest that about 1,000 birds died from white phosphorus during spring and fall migration at ERF in 1996. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 500.

- Within 20 years of the ROD being signed (1998), reduce the mortality attributable to white phosphorus to no more than 1 percent of the total annual fall population of dabbling ERF ducks. Population estimates based on model data indicate a 1996 fall dabbling duck population of approximately 5,000. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 50. This long-term goal could be adjusted based on future population studies conducted during the monitoring program.

These objectives will be achieved by reducing the area of white phosphorus-contaminated media and reducing the exposure to white phosphorus. Reducing the exposure will reduce the availability of white phosphorus to ducks, which in turn will reduce duck deaths.

Monitoring at ERF will be conducted to verify that RAOs are achieved. The following are goals of waterfowl mortality monitoring:

- To verify that an exposure pathway does not exist between waterfowl and white phosphorus-contaminated sediment.
- To determine the number of waterfowl using ERF.
- To determine the number of waterfowl dying as a result of feeding in white phosphorus-contaminated sediment.

- To determine whether remedial action is effective or need modification.

2.0 MONITORING DESIGN

As part of CERCLA documents for ERF, waterfowl radio-telemetry and aerial waterfowl population surveys were selected as monitoring strategies to verify that RAOs were achieved. The use of radio telemetry:

- Is considered a standard method for projects of this type (Fite et al. 1998, reference EPA monitoring).
- Identifies individuals.
- Creates a unique sub-sample of the population.
- Generates data on mallard distribution, movements, turnover and mortality.
- Has very little impact on the behavior of radio-marked mallards.
- Reduces human exposure to unexploded ordinances (UXO's).
- Supports measuring the assessment endpoints with relatively good confidence limits.

These two techniques conducted in concert were extremely useful in identifying potential white-phosphorous contaminated sites, evaluating the selected remedial action: pumping, determining the number of waterfowl, especially mallards, using ERF, and determining waterfowl mortality, especially mallards, as a result of feeding in white phosphorous contaminated sites.

2.1 Selection of Indicator Species

Of all bird species observed at ERF, three species of dabbling ducks: mallard, northern pintail, and green-winged teal, account for nearly 97 percent of all waterfowl censused in aerial surveys and all waterfowl mortality. These three species are considered to be primary ecological receptors on ERF. The mallard was selected as the primary indicator species for ERF because they are present on ERF from the start of the fall migration period (August) until freeze-up (later part of October), they represent about 60% of the dabbler population observed on ERF (Eldridge 1996, 1997, 1998, 1999, 2000, 2001, 2002) and they are sensitive to white phosphorous. In addition, their foraging behavior and foraging sites with respect to ERF are very similar to the other two dabbler duck species. Data from pilot telemetry studies in 1993, 1994 and 1995 (Cummings, J.L. et al. 1994, 1995, 1996) and carcass searches indicate that mallards, northern pintails and green-winged teal all use similar foraging areas on ERF. In 1996, recovery of carcasses of these three species in similar areas i.e. Racine Island, supports the use of the mallard as a representative species for dabblers on ERF.

These three species have the greatest exposure to white phosphorous because of their feeding behavior which is sift-feeding in pond sediment where white phosphorous particles are encountered and their use of areas on ERF that have been identified as contaminated with white phosphorous. The mean lethal dose for 50 percent of a sample population (LD_{50}) for a mallard is 5.20 mg/kg body weight with a range of 4.05 to 6.40 mg/kg bodyweight. The lowest observed effect level (LOEL) based on mortality was estimated for particles of white phosphorous to be between 3.00 and 4.00 mg/kg bodyweight per day, and a LOEL based on sub-lethal effects (liver, kidney, and heart tissue damage) would be less than 2.00 mg/kg bodyweight per day.

2.2 Aerial Surveys

All ERF surveys were conducted by fixed-wing aircraft. The majority of surveys were flown with a Cessna 172, but occasionally a Cessna 206 or Piper Cub was used. The objective of the survey was to obtain a complete count of visible waterbirds on ERF which was accomplished using a transect design (Figure 3). The parallel transects generally run in a north/south direction from tree line on the south side to the coast of Knik Arm on the north. Water conditions, lighting conditions, and numbers of birds vary considerably on ERF transects thus endpoints are not fixed points and may vary depending on conditions. For each aerial survey, 10 transects were flown twice, in opposite directions, during each survey. The controlling factor was complete coverage of suitable habitat for waterbirds in ERF with good visibility under existing conditions at the time of the survey.

2.2.1 Transect Technique: Aerial Survey

The survey is modeled after standard Department of Interior aerial survey techniques (Appendix 1). The survey was conducted at a maximum altitude of 75 m and a speed of 100-150 km/hour. The survey was started on the coast of the west side of the Coastal West area with 3 short transects, moving east with each transect until longer transects could be flown that ran the entire north/south length of ERF (Figure 3). A side transect was made bisecting Area B to the west to obtain complete coverage of that area, then the north/south transects are resumed across ERF to the lobe of Area D. That lobe was also bisected with an east/west transect to obtain complete coverage.

The observer sat on the right side of the airplane and counted all waterbirds on his side out to a maximum of 200 m, but generally less. When flying from the coast inland the pilot would start the transect at a distance from the tree line indicated by the observer, not to exceed 200 meters. At the end of each transect, the pilot would turn and fly the same transect in the opposite direction, allowing the observer to count in the opposite direction. The observer would not count more than 200 m in that direction, and may use less depending on conditions, but he would use visual landmarks to mark the outside edge of that transect. The pilot initiated the next transect at a distance not to exceed 200 m on the opposite side of the visual landmarks identified by the pilot, and would proceed inland. The observer counted birds on that side to his visual landmarks. The pilot would then fly the next transect in the opposite direction, permitting the observer to count on the other side of the transect, and establish new visual landmarks for the next transect.

2.2.2 Data Collection: Aerial Surveys

The observer used a tape recorder to record all observations of waterbirds and carried a map of ERF that delineated each area and permanent pond with standard numbers from the ERF Cold Region Research Environment Laboratory (CRREL) pond data base. The observer identified and counted birds and noted the area for all observations, and pond number when possible. All geese and ducks were identified to species when possible or labeled "unidentified dabbler or unidentified diver" when identification was not possible. Gulls were recorded as large or small, and shorebirds were recorded but not classified by species. Bald eagles were recorded in trees bordering ERF and on ERF, as adults or immature. Sandhill cranes, ravens, and raptors were recorded when observed. Beluga whales in the river or along the shoreline, moose, brown and black bears, and wolves were noted. All species were counted when possible, and when in flocks, flock size was estimated.

2.2.3 Data Analysis: Aerial Surveys

Data was transcribed from tapes and entered in a standard data base for analysis. Numbers of waterbirds were recorded by survey date, standard ERF study area, and pond number. Densities of duck species by study area was based on the area of permanent water bodies within each of the standard study areas, using the CRREL pond data base.

2.2.4 Survey Timing: Aerial Surveys

Surveys were not conducted before 0900 or after 1900 to maximize lighting conditions. Surveys were not conducted in rain or when winds in any direction were greater than 33 km/h. It was not possible to standardize survey timing to tide levels or time of day due to restrictions placed by the U.S. Army on air space availability over ERF.

2.2.5 Observer Training: Aerial Surveys

Observers used for this survey were trained by USFWS wildlife biologists from the Division of Migratory Bird Management. Each observer had extensive experience in aerial waterfowl surveys in Alaska.

2.3 Waterfowl Radio Telemetry

Radio-tracking techniques are used when bird movement patterns and activity patterns limit the use of conventional methods such as direct observations or mark-recapture (or re-sight) techniques. The reasons radio telemetry was selected for use at ERF to monitor mallards is stated in section 2.0. Consideration was given to other techniques such as, general observations, visual marks, and mass marking. However, with these alternative techniques the appropriate data could not be collected. Radio telemetry was the most reliable technique to address the RAO's.

2.3.1 Waterfowl Capture Period and Techniques

Starting in 1996 and continuing through 2002, excluding 2000, the primary goal was to capture between 100 and 150 mallards from random locations on ERF during the fall migration period, August 2-23, between about 0800 and 1600. Capture techniques consisted of a netgun from a helicopter, swim-in decoy trap and mist nets. A netgun from a Bell 212 helicopter was the primary capture tool used. It accounted for 582 of 648 mallards captured. The remaining mallards were captured with either a swim-in decoy trap or mist net. The netgun from a helicopter was used because it is more efficient and less stressful on mallards.

Prior to each capture mission, Range Control was notified with a flight plan, number of personnel and intended capture area. A helicopter flight safety briefing was conducted before leaving the ground. Radio communication with Range Control, netgun equipment and safety harnesses were also checked.

The netgun used at ERF for capturing mallards was the Coda Netgun® (Appendix 2). It is a hand held net launching assembly that uses expanding gases from a blank cartridge to propel four weights attached to a 3 m x 3 m x 5 cm mesh size net weighing 1.5 kg. Prior to firing the net gun, a net canister is loaded by first laying the net out flat and then gathering the weights in a clockwise or counter-clockwise direction allowing the net to hang straight down from the weights. The net is then loaded into the canister, starting with the end farthest from the weights until all of the net is in the canister, it is important not to twist the net. Two strips of masking tape are placed over the top of the canister to prevent the net from falling out of the canister prior to shooting. In preparation for field capture of mallards, nets were preloaded into canisters placing the weights into each of the four respective corners of the canister. One loaded canister was placed between the barrels and each of the four weights inserted into the barrels until the net end of each weight is flush with the mouth end of each barrel. When the netgun is fired, propelled weights pull the net from the netgun's net canister and carry it out over the target bird (Appendix 2).

Birds were captured from a UH1 (U.S. Army) helicopter in 1996, 1997, and 1998 and a Bell 212 in 1999, 2001, and 2002. Procedure for using the netgun from the air was as follows: A three man crew was required, a pilot, spotter and net gunner. Each followed safety guidelines outlined in the WS aviation safety manual for flying in a helicopter at less than 170 m (Appendix 3). Each crew member was equipped with the following personal protective equipment: helmet, NOMEX® flight suit, harness, gloves, boots, and neo-preen waders. The net gunner and spotter sat on the bench seat in back of the pilot's seat. The net gunner was tethered by a body harness to the aircraft directly behind the pilot and fired from the left side of the helicopter. The net gunner and spotter stayed in contact with the pilot to direct him to capture sites and away from obstacles while flying low. The spotter recorded the capture location and time, acted as relief gunner, and helped collect netted birds. Communication between pilot and gunner was imperative to conduct a safe capture. The pilot made the gunner aware of obstacles, alterations in the flight path, and any ground conditions that may affect the gunner's shooting. Shots were taken when mallards were at the helicopter's side, midway between pilot and gunner, 45 degrees above the skid (45 degrees below the horizontal), and 7 to 10 m from the helicopter. By shooting at a 45 degree angle, the gunner would avoid deploying the net into the main rotor or onto the skid. Once a mallard was captured, it was retrieved and placed in a labeled carrying cage by capture location. After each helicopter mission, mallards were returned to base, processed and placed in a holding cage by capture location.

After each flight mission (1.5 to 2.0 hours) all equipment was checked. This included cleaning and checking the barrels of the netgun for debris, checking the nets for holes, checking the weights to see if they are still securely fastened to the nets and reloading canisters with nets for the next mission.

The capture period for each year was as follows:

1996: August 3-23

1997: August 2-12

1998: August 4-13

1999: August 4-10

2000: No Project-helicopter unavailable

2001: August 2-10

2002: August 15-20 – helicopter unavailable until this time

2.3.2 Processing Mallards for Telemetry

Following each daily net gun sessions, each mallard was individually banded with a USFWS numbered band and fitted with a radio transmitter weighing 9.1 g. The transmitter represented less than 2% of the mallards' body weight. Each transmitter was positioned on the upper back of the duck and attached with a Teflon® ribbon harness (Cummings et al. 1993) (Appendix 4). The capture and release location, date, band number, age and sex were recorded for each mallard.

Each transmitter had a distinct frequency between 166 and 168 MHz, were separated by 10 KHz, and had a life of 180 days. The average ground to ground range was about 8 km, by air over 32 km. Each transmitter emitted 60 pulses (beeps) per minute when the mallard was active and 120 pulses per minute when mallard activity ceased (mortality). There was a five minute delay before the micro-switch in the transmitter would activate and place the transmitter in mortality mode. Transmitter provided daily movements, distribution and mortality data.

In 1996, 1997, and 1998, two types of transmitters were used to address the objectives of the study. During each year about half of the mallards captured were fitted with a standard transmitter which was active throughout the study period and provided daily mallard movements and distribution data and would pulse at a higher rate when in mortality mode. The remaining mallards were fitted with a mortality transmitter which only activated if the mallard movements stopped for over five minutes (resting or mortality). It was assumed that the two transmitter groups of mallards had the same turnover. Starting in 1999, all mallards were fitted with a standard transmitter (except for 12 mortality used in 1999) so that if needed a larger sample of mallards could be radio-tracked for movement and distribution data. During 1996 and 1997, mallards were held from 12 to 15 hours in holding pens (3 m x 2 m x 2 m) to allow them to acclimate to the transmitters before being released back at their capture site. From 1998 through 2002, all mallards were held between 24 to 36 hours to acclimate to the transmitters. The longer acclimation period reduced their pre-occupation with the transmitter in the wild which was assumed to have reduced mortality from predators.

2.3.3 Radio Telemetry Tracking

Mallards were tracked from three fixed telemetry towers that were strategically located on ERF (Figure 4). 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 communication. A yagi antenna has more sensitivity in the forward direction then most other types of antennas and is usually the antenna of choice in open or semi-open terrain and at frequencies above 140 MHz.

Prior to the start of radio tracking some initial steps were undertaken (Appendix 5). The fixed telemetry towers were positioned at the right distances around ERF in order to be both close enough and far enough away to get accurate telemetry readings on each mallard. The yagi antennas were properly matched, mounted and coupled out-of-phase, and oriented with regard to a reference transmitter.

A schedule was agreed upon to synchronize data taking. Starting with the lowest frequency transmitter and proceeding through the highest frequency transmitter, mallards were located simultaneously from each tracking tower. The mallard was assumed to be near the point where the bearings crossed and each bearing location was entered on its respective tower radio tracking form. In addition, the Cole Point tower tracker entered all telemetry locations for each mallard from the other two tracking towers into a master notebook and immediately into the computer program LOCATE II (Pacer, Truro, Nova Scotia, Canada).

LOCATE II tracking program is a DOS program that runs on any PC-compatible computer with at least 220 K free memory and a VGA-compatible video adapter. The program imports radio telemetry readings from each telemetry tower, triangulates the location of the mallard, and calculates 95% error ellipses using Lenth Maximum Likelihood Estimators.

The median and average error polygon for mallards on ERF from 1996 through 2002, excluding 2000, was between 14,706 m^2 and 25,832 m^2. The data set for each year was transferred from LOCATE II to Excel and mapped using the U.S. Army GIS ARC/INFO and ARC/VIEW.

Mallards that were not able to be located or were thought to be in mortality were tracked on foot, from hovercraft, or from helicopters to determine their status. The procedure for tracking on foot is much the same as a fixed position antenna, but uses a hand-held antenna. The first step was to get to a point on ERF that was open. This minimized problems with signal "bounce", where the signal can be reflected. The antenna is held 90 degrees to the trackers body. The receiver is set on the frequency to be located. Once a signal was detected, the tracker would slowly rotate in a complete circle. This would determine the maximum and minimum signal strength in order to determine the direction in which the signal is originating. This process was repeated along with reducing the volume of the receiver as the tracker approached the transmitter until the transmitter was located. The same procedure was followed when used in a hovercraft or helicopter.

Receivers at telemetry towers could receive radio-marked mallards up to 8 km from the Flats. Helicopters were used to track birds up to 32 km from the Flats in areas such as the Susitna Flats, Palmer Hay Flats, and Chickaloon Flats.

During 1996, 1997, and 1998, telemetry locations were determined daily between 0700 to 1000 and 1500 to 2000 during August, September, and October. However, during 1999, 2001, and 2002, mallards were tracked for movement/mortality data Monday through Friday. On weekends and holidays, mallards were tracked from 0700 to 0900 for their presence or absence from ERF or to determine if a transmitter was in mortality mode. Birds that could not be detected as moving or did not move more than 10 degrees in 1 to 3 days were visually located to determine their status. Mortality transmitters were recovered once they activated. Dead birds were recovered to determine the cause of death and the location of each was recorded with a Global Positioning System (GPS) recorder.

2.3.4 Mallard Movements and Distribution on ERF

Telemetry data points for each radio marked mallard from 1996 through 2002, excluding 2000, were entered into Excel and mapped using the U.S. Army GIS ARC/INFO and ARC/VIEW. A GIS map was generated for each mallard showing its movement patterns, distribution, and mortality location on ERF. Over 640 maps are available.

In 1995, ERF was divided into the following ten areas representing sites that waterfowl used for foraging and loafing: A, B, RI (Racine Island), C, C/D, D, BT (bread truck), EOD, Coastal West, and Coastal East (Figure 2). The areas were synonymous with areas used by the U.S. Army to identify specific areas on ERF. Areas A, RI, C, C/D, and BT were documented as having high levels of white phosphorous. Since 1996, RI (Racine Island) and portions of BT (bread truck) have been drained as a remediation action to eliminate waterfowl use of these areas and reduce white phosphorous concentrations.

In an effort to identify the relative risk of these areas and evaluate on going remediation actions, mallard use of these areas was documented. The use of each area was determined by counting the number of telemetry locations within an area, dividing that number by the total number of telemetry locations, and expressing it as a percentage.

2.3.5 Mallard Turnover on ERF

Mallard turnover on ERF is defined as the point that a radio-marked mallard leaves ERF after being released or died on ERF. Any radio-marked mallard that leaves ERF or died was excluded from the radio-marked mallard population at that point. The daily turnover rate of mallards on ERF was determined by dividing the number of radio-marked mallards that departed ERF or died each day by the total number of mallards radio-marked. The daily turnover rate was used to adjust the aerial dabbling duck census number to the estimated number of dabblers using ERF by census period.

2.3.6 Mallard Mortality on ERF

Mallard mortality and the location of that mortality on ERF were determined by telemetry. Procedures for searching, locating and determining if a radio-marked mallard died of white phosphorous poisoning are covered in NWRC SOP FP 004.0 (Appendix 6). Procedures for labeling and recovering radio-marked mallards are covered in NWRC SOP FP 007.0 (Appendix 7).

Radio-marked mallards that transmitted mortality signals, or remained within 10 degrees of their location for 1 to 3 days, were located visually to determine their status. Most radio-marked mallards that were in mortality mode were visually located at the end of each day, except on weekends and holidays in 1999, 2001, and 2002. In some cases this presented a problem. Radio-marked mallards affected from ingesting white phosphorous go through a number of convulsions prior to death. This attracts the attention of predators, especially bald eagles. During each year of the study, there were cases of radio-marked mallards that died from ingesting white phosphorous that radio trackers could not get to before bald eagles either consumed the bird on site or removed the bird from ERF. For these birds, procedures outlined in NWRC SOP FP 004.0 (Appendix 6) were used to determine the cause of death. The possible causes of death were either identified as white phosphorous poisoning, predation, hunting, exposure, attachment method or unknown. The experience of radio trackers have been that waterfowl found dead on ERF have been due to ingesting white phosphorous. Of 81 whole mallards recovered by NWRC personnel from ERF, 1996 through 2002, 76 or 94% were confirmed white phosphorous mortality (NWRC, unpubl. data) suggesting that most waterfowl found dead on ERF can be attributed to white phosphorous.

Each mallard that was recovered from ERF was processed according to NWRC SOP FP 007.0 (Appendix 7) and analyzed for white phosphorous using NWRC Method 82A (Appendix 8). The date, time, species, sex, band number; radio transmitter number, condition of the bird; surrounding habitat, possible cause of death and location (GPS) were recorded. The mortality rate was determined by dividing the number of radio-marked mallard mortalities by the total number of mallards captured and radio-marked.

2.4 Waterfowl Mortality Model for ERF

Statistical techniques available to estimate mortality rate from telemetry data range from a simple calculation of the proportion of animals that die during an interval of time to sophisticated methods that allow comparison of actual mortality/survival curves or test for the effects of time-specific covariates on mortality. A mortality model was developed for ERF to estimate the total number of individual dabblers using ERF, the peak number of dabblers using ERF and the total number of duck mortalities caused by white phosphorus on ERF during the fall migration period. The following assumptions for the model were met to assure correct mortality estimates:

1. The radio-marked mallards are representative of the dabbler population at ERF and are a random sample of the population.
2. Radio-marked mallards represent independent samples.
3. Radio-marking did not influence mortality. Mallards captured and fitted with radio transmitters provided an unbiased estimate of the mortality rate.
4. Mallards that departed ERF or died were excluded from the analyses for time periods following their departures or death.
5. The time of white phosphorus mallard mortalities was known.

The model approach was designed to estimate the mortality of dabbler ducks at specific time intervals between August and mid-October. The time intervals were based on waterfowl censuses conducted on ERF during this period (Eldridge 1996, 1997, 1998, 1999, 2000, 2001, 2002). This approach required the following data which radio telemetry provided: the number of radio-marked mallards present at the start of each survey interval, the number of radio-marked mallards that departed ERF during each time interval, the number of radio-marked mallards that died during each time interval and the cause of each death. The following are definitions of terms used in the mortality model or to describe the results:

1. **Survey period**---the time period (days) interval between waterfowl surveys conducted during August-October (Eldridge 1996, 1997, 1998, 1999, 2000, 2001, 2002).
2. **Radio-marked mallard**---a randomly captured mallard from a random location on ERF, fitted with a 9-gram backpack-transmitter, held for 12-36 hours and released at its capture site.
3. **Turnover**---a radio-marked mallard that left ERF after being released or died from various causes on ERF. Any radio-marked mallard that left ERF or died from any cause including white phosphorous is censored/excluded from the analyses for time periods following their departures.
4. **Mortality**---radio-marked mallards that died on ERF from white phosphorous. As it pertains to the mortality model, mortality is part of the number of turnovers.
5. **Identified dabblers**---the number of waterfowl counted on ERF from a fixed-wing aircraft at specific time intervals. For the mortality model, only dabbler duck numbers were used from the aerial surveys.
6. **Unidentified dabblers**---dabblers not specifically identified during the aerial survey. Dabblers represent 95% of the unidentified waterfowl in each aerial survey (Eldridge, W., pers. commun. 1997).

7. **Total dabblers**---the summation of dabblers surveyed from aerial surveys that include both identified and unidentified dabblers. As it pertains to the mortality model, "dabblers" are calculated by survey time period.
8. **Adjusted for turnover**---the number of dabblers using ERF during a particular time period. As it pertains to the mortality calculations, this number represents the estimated number of dabblers using ERF during specific survey periods.
9. **Total dabblers using ERF by survey period**---the total number of dabblers using ERF. "Total dabblers" and the "Adjusted for turnover column" added together equals the total dabblers using ERF.
10. **Projected mortality**---the number of dabblers that died during specific time periods from ingesting white phosphorus based on a dabbler population adjusted for turnover.

The mortality calculations adjust for turnover and estimate the number of dabblers using ERF by duck survey period. The total number of individual dabblers using ERF is calculated by totaling the positive increases in dabblers by survey period, i.e. period 1 = 370 dabblers, period 2 = 650 dabblers, and period 3 = 363 dabblers. The total for these periods would be 370 + 280 + 0 = 650. The peak number of dabblers on ERF is determined from the period having the greatest number of dabblers. The estimated mortality (%) of dabblers is calculated by survey period, by dividing the number of mallard mortalities during the census period by the number of radioed mallards present during the census period. The projected number of dabbler mortalities by survey period is estimated by multiplying the total dabblers adjusted for turnover by the percent mortality. The number of dabbler mortalities during the study period is the sum of all mortalities that occurred in each survey period. The calculation required for the i^{th} survey period were i = 1, 2, 3…final survey period.

The model formula is:

$$\hat{T}_i = \frac{A_i}{1 - (D_i/R_i)} \qquad \hat{M}_i = \frac{T_i\,(M_i)}{R_i}$$

$\hat{T}_i$ = Estimated number of dabblers using ERF.

A_i = Number of dabblers visually estimated from aerial surveys during the i^{th} survey period.

D_i = Number of radio-marked mallards departing ERF during the i^{th} survey period.

$\hat{M}_i$ = Estimated number of dabbler mortalities on ERF during the i^{th} survey period.

M_i = Number of radio-marked mallard mortalities during the i^{th} survey period.

R_i = Number of radio-marked mallards available during the i^{th} survey period.

The R_i, and R_1 in particular, are the only investigation-controlled variables in the equations. The magnitude of R_i is primarily determined by resources and logistics. The magnitude of R_i determines the precision of the mortality estimates, with increasing R_i providing more precise estimates. R_i also determines the fidelity of mortality estimates, with larger R_i allowing mortality estimates on a finer scale. For example, $R_i = 20$ would allow mortalities to be estimated to the nearest 5% whereas $R_i = 100$ allows estimates to the nearest 1%.

3.0 CHRONOLOGY OF EVENTS

3.1 Summary of Events: Interim Waterfowl Mortality Monitoring at OU-C-ERF

DATE	EVENT
June 1995	Final 1995 Work Plan signed
July-October 1996	Waterfowl Mortality Monitoring (WMM) Base Year
July 1997	CRREL/NWRC 1996 Final Report
July-October 1997	WMM First Year Post Base Year
July-October 1998	WMM Second Year Post Base Year
August 1998	CRREL/NWRC 1997 Final Report
September 30, 1998	ROD for OU-C signed
July-October 1999	WMM Third Year Post Base Year
July 1999	CRREL/NWRC 1998 Final Report
July-October 2000	No WMM—No helicopters*
July 2000	CRREL/NWRC 1999 Final Report
July-October 2001	WMM Fourth Year Post Base Year
August 2001	CRREL/NWRC 2000 Final Report
April 2002	CRREL/NWRC 2001 Final Report
July-October 2002	WMM Fifth Year Post Base Year
July 2003	CRREL/NWRC 2002 Final Report
January 2004	Meet short term WMM Goals
2008	Conduct WMM
2018	Conduct WMM
2018	Meet Long-term WMM Goals

*No helicopters available to do work because of Alaskan wild fires.

4.0 RESULTS

4.1 Waterfowl Aerial Survey

Aerial surveys of waterfowl conducted from 1996 through 2002 censused avian species using ERF from April through October. Aerial surveys of waterfowl indicate that dabbling ducks comprise 97 percent of the ducks counted by air and 95 percent by ground. For the purpose of this report, data analysis was based on census results that coincided with radio telemetry from August until mid-October for each year and for dabbler species that were most susceptible to white phosphorous: mallard, northern pintail, and green-winged teal. For this survey period, 1996 through 2002, mallards, northern pintail and green winged teal represented an average of 60, 17, and 23 percent of the dabbler population, respectively (Tables 1-7).

4.2 Movement, Distribution and Turnover of Radio-marked Mallards

4.2.1 Movement, Distribution and Turnover 1996-Base Year

From August 3 to 23, 1996, 107 mallards were captured, banded, and released on ERF. Of the mallards, 87 were captured with the net gun/helicopter, 14 in swim-in decoy traps, and 6 in a mist net (Table 8). Twenty-five hours of helicopter time were used to capture 87 mallards; however 9 of those hours were used to capture only 2 mallards due to inexperience of pilots. Of the 107 mallards, 53 were fitted with standard transmitters. In addition, 54 mallards were fitted with mortality transmitters (Tables 9, 10). Mallards were held 12 to 15 hours to let them acclimate to the radio transmitter and then released at their capture site. 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 U.S. Army GIS system produced two types of maps for mallards fitted with a standard transmitter. The first map showed individual mallard movement locations from telemetry. There were 53 maps showing movements of each radio-marked mallard. These maps were generated by the U.S. Army GIS system. Figure 5 depicts an actual example of this type of map. The second map depicts the last 5-10 telemetry locations of mallards that died on ERF. These maps (n = 15) were useful in determining the location that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. An exact location where the duck might have ingested the white phosphorous depended if the whole carcass was recovered. If so, the mallard was assumed to ingest white phosphorous at or near that location. Missing telemetry points because of lack of a good cross, telemetry personnel not working on the weekends or the carcass being scavenged made it difficult to determine the exact location of mallard mortalities.

Mallard (n = 53) movements and distribution on ERF during the fall migration period indicate that they spent the majority of their time from August 3 to October 16 in Areas A, B, C, and C/D (Figure 7). Use of these areas represented about 91% of the time mallards spent on ERF (Figure 7). 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 (Figure 7).

The average number of days spent on ERF by mallards (n = 53) was 43, and ranged from 1 to 71 days. At the conclusion of the study, October 16, 4 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 2.4%. The greatest turnover for mallards occurred from October 5 to 16, where 40% of the mallards departed ERF (Figure 8). Over 32% of the mallards departed between August 3 and 27 (Figure 8).

4.2.2 Movements, Distribution and Turnover 1997

From August 2 to 12, 1997, 136 mallards were randomly captured on ERF using a net gun from a Bell UH1 helicopter (Table 8). Forty-one hours of helicopter time were used to capture mallards. Of the 136 mallards, 54 were fitted with standard transmitters and 82 mallards were fitted with mortality transmitters (Tables 9, 11). Mallards were held 12 to 15 hours to allow them to acclimate to the transmitter. The movement of instrumented mallards following release indicated that transmitters did not appear to inhibit movement or activities. Observations indicated that the behavior of instrumented mallards did not differ from that of other ducks in its associated flock. On some occasions, instrumented birds were observed leading flights of ducks. However, 7% of the instrumented mallards were in the 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.

The GIS system produced two types of maps for mallards fitted with a standard transmitter. The first map showed individual mallard movement locations from radio telemetry. There were 54 maps showing movements of each radio-marked mallard. These maps were generated by the U.S. Army GIS system. Figure 5 depicts an actual example of this type of map. The second map depicts the last 5-10 telemetry locations of mallards that died on ERF. These maps (n=8) were useful in determining a general area that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. Missing telemetry points because of lack of a good cross, telemetry personnel not working on the weekends or the carcass being scavenged made it difficult to determine the exact location of mallard mortalities.

Mallard (n=54) movements and distribution on ERF during the fall indicate that they spent the majority (88%) of their time from August 2 to October 22 in Areas A, B, C, C/D (Figure 7). In addition, mallards spent about 69% of their time in areas which are areas that are considered to be contaminated A, BT, C, C/D, and RI (Figure 7). However, mallards were only located 6 of 144 times in the actual Racine pond and 2 of 21 times in the actual Bread Truck pond. Several mallards were documented moving to various locations near ERF, such as Gwen, Otter, and Six Mile Lakes, Palmer Hay Flats, Susitna Flats, and the Anchorage Bowl.

The average and median number of days mallards (n=54) spent on ERF was 46 and 59, respectively. The range was from 1 to 74 days. At the conclusion of the study, October 22, 5 mallards remained on ERF. These birds were confined to using the Eagle River and some open water in Area B because all other areas on ERF were covered with snow and/or ice. The average daily turnover rate for mallards was about 2.3%. The greatest turnover of mallards occurred from October 1 to 22, whereas 64 (48%) of the mallards departed ERF during this time period (Figure 9). In addition, 21% of the mallards departed between August 4 and 18 (Figure 9).

4.2.3 Movements, Distribution and Turnover 1998

From August 4 to 13, 1998, 96 mallards were randomly captured on ERF using a net gun from a Bell UH1 helicopter, 13 mallards were captured in a swim-in decoy trap (Table 8). Twenty-seven hours of helicopter time were used to capture mallards. All 109 mallards were fitted with standard transmitters but only 60 were continuously monitored for movement and distribution data. The remaining 49 mallards were monitored for mortality only (Tables 9, 12). Mallards were held 24-36 hours to allow them to acclimate to the transmitters. The behavior of instrumented mallards following release indicated that the transmitters did not inhibit movements or activities. Observations indicated that the behavior of instrumented mallards 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 4% of the instrumented mallards were in final stages of molt when captured. These ducks remained in the capture-release areas longer than the same species that had completed molt.

The GIS system produced two types of maps for mallards fitted with a standard transmitter. The first map showed individual mallard movement locations from radio telemetry. There were 60 maps showing movements of each radio-marked mallard. These maps were generated by the U.S. Army GIS system.

Figure 5 depicts an actual example of this type of map. The second map depicts the last 5-10 telemetry locations of mallards that died on ERF. These maps (n=23) were useful in determining a general area that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. Missing telemetry points because of lack of a good cross, telemetry personnel not working on the weekends or the carcass being scavenged made it difficult to determine the exact location of mallard mortalities.

Mallard (n=60) movements and distribution on ERF during the fall migration period indicate that they spent the majority (75%) of their time from August 4 to October 21 in Areas A, B, C, and C/D (Figure 7). In addition, mallards spent about 65% of their time in areas A, BT, C, C/D, and RI which are areas that are considered to be contaminated (Figure 7). Of the 2,758 telemetry locations, 276 were in the Racine quadrant, 653 were in the A quadrant, 14 were in the BT quadrant, 404 were in the C quadrant, and 399 in the C/D quadrant. Mallards were only located 6 of 276 times in the actual Racine Pond and 2 of 14 times in the actual Bread Truck pond. Several mallards were documented moving to various locations near ERF, such as Gwen, Otter, and Six Mile Lakes, Palmer Hay Flats, Susitna Flats, and the Anchorage Bowl.

The average and median number of days mallards (n=60) spent on ERF were 39 and 43, respectively. The range was from 1-72 days. At the conclusion of the study, October 21, 49 mallards remained on ERF. These birds were using the Eagle River and some open water in Areas B, C/D, and D. In previous years, the ponded areas on ERF were completely frozen, which caused most ducks to leave the area. The average daily turnover rate was about 1.0%. The greatest turnover of mallards occurred from August 4 to 19, where 24 (22%) of the mallards departed ERF during this period (Figure 9).

4.2.4 Movements, Distribution and Turnover 1999

From 4-18 August 1999, 92 mallards were captured from random locations on ERF using a net gun from a Bell 212 helicopter, and 24 mallards captured in a swim-in decoy trap (Table 8). Thirty-six hours of helicopter time were used to capture the mallards. All 116 mallards were fitted with standard/mortality transmitters that emit about 60 pulses per minute when the duck is alive and 120 pulses per minute when the duck dies (Table 9, 13). Mallards were held for 24 to 36 hours to allow them to acclimate to the transmitter. The movement of instrumented mallards following release indicated that transmitters did not appear to inhibit movements or activities. Observations indicated that the behavior of instrumented mallards did not differ form that of other ducks in its associated flock. On some occasions, instrumented birds were observed leading flights of ducks.

The GIS system produced two types of maps for each mallard. The first map (n=104) showed individual mallard movement locations from radio telemetry from August 4 to October 20. These maps are generated by the U.S. Army GIS system. Figure 5 depicts an actual example of this type of map. The second map depicts the last 5 to 10 telemetry locations of mallards that died on ERF. These maps (n=24) were useful in determining the location that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. Missing telemetry points because of lack of a good cross, telemetry personnel not working on the weekends or the carcass being scavenged made it difficult to determine the exact location of mallard mortalities.

Mallard (n=104) movements and distribution on ERF during the fall migration period indicated that they spent the majority (82%) of their time from August 4 to October 20 in Areas A, B, C, and C/D (Figure 7). In addition, mallards spent about 61% of their time in areas A, BT, C, C/D, and RI which are areas that are considered to be contaminated (Figure 7). Of the 4,848 telemetry locations, 182 were in the Racine quadrant, 1,544 were in the A quadrant, 77 were in the BT quadrant, 418 were in the C quadrant, and 715 in the C/D quadrant. Mallards were only located 14 of 182 times in the actual Racine pond and 17 of 77 times in the Bread Truck pond. Several mallards were documented moving to various locations near ERF, such as Gwen, Otter, and Six Mile Lakes, Palmer Hay Flats, Susitna Flats and the Anchorage Bowl.

Mallards use of Area A decreased about 30% from 1996 to 1999 (Table 10). The use of Areas B and C/D by mallards increased 15% and 6%, respectively, during the same period. Use of all other areas on ERF remained about the same from 1996 to 1999 (Figure 7).

The average and median number of days mallards (n=104) spent on ERF was 35. The range was from 1-72 days. At the conclusion of the study, October 20, 16 mallards remained on ERF. These birds were using the Eagle River and some open water in Areas B, C/D, and D. The average daily turnover rate for mallards was about 2.4%. The greatest turnover of mallards occurred from

August 4 to 20, August 25 to 30, and September 21 to 28, where 47 (41%) of the mallards departed ERF during these time periods (Figure 10).

4.2.5 Movements, Distribution and Turnover 2000

No telemetry conducted.

4.2.6 Movements, Distribution and Turnover 2001

From August 2-10, 2001, 108 mallards were captured from random locations on ERF using a net gun from a Bell 212 helicopter and 4 mallards were captured in a swim-in decoy trap (Table 8). Thirty-three hours of helicopter time were used to capture the mallards. All 112 mallards were fitted with standard/mortality transmitters that emit about 60 pulses per minute when the duck is alive and 120 pulses per minute when the duck dies (Tables 9, 14). Mallards were held for 24 to 36 hours to assess their condition and acclimation to the transmitter and released at its capture site. The movement of instrumented mallards following release indicated that transmitters did not appear to inhibit movements or activities. Observations indicated that the behavior of instrumented mallards did not differ from that of other ducks in its associated flock. On some occasions, instrumented birds were observed leading flights of ducks.

The GIS system produced two types of maps for each mallard. The first map (n=112) showed individual mallard movement locations from radio telemetry from August 2 to October 16. These maps were generated by the U.S. Army GIS system. Figure 5 depicts an actual example of this type of map. The second map depicts the last 5 to 10 telemetry locations of mallards that died on ERF. These maps (n=11) were useful in determining a general area that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. Exact locations were documented when ducks were recovered.

Mallard (n=112) movements and distribution on ERF during the fall migration period indicated that they spent the majority (40%) of their time from August 2 to October 16 in area C/D and about 24% of their time in area A (Figure 7). In addition, mallards spent about 86% of their time in areas A, B, C, and C/D, which are areas that are considered to be contaminated (Figure 7). Of the 5,076 telemetry locations, 152 were in the Racine quadrant, 1,218 were in the A quadrant, 50 were in the BT quadrant, 507 were in the C quadrant, and 2,030 in the C/D quadrant. Helicopter time was restricted to ERF, thus there were no chances to document mallard movements to other locations near ERF, such as Gwen, Otter, and Six Mile Lakes, Palmer Hay Flats, or Susitna Flats.

Mallard use of area A decreased about 61% from 1996 to 2001 (Figure 7). The use of areas C/D and D by mallards both increased 400% during this same period. Use of all other areas on ERF remained about the same from 1996 to 2001 (Figure 7).

The average and median number of days mallards (n=112) spent on ERF was 37 and 35, respectively. The range was from 1-77 days. At the conclusion of the study, October 16, 5 mallards remained on ERF. These birds were using the Eagle River. The average daily turnover rate for mallards was about 3.3%. The greatest turnover of mallards occurred from August 2-9, August 25-29, and

September 28 to October 2, where 44 (39%) of the mallards departed ERF during these time periods (Figure 12).

4.2.7 Movements, Distribution and Turnover 2002

From August 15-20, 2002, 66 mallards were captured from random locations on ERF using a net gun from a Bell 212 helicopter, 1 mallard was captured in a swim-in decoy trap and 1 mallard was captured in a mist net (Table 8). Twenty-two hours of helicopter time were used to capture the mallards. All 68 mallards were fitted with standard/mortality transmitters that emit about 60 pulses per minute when the duck is alive and 120 pulses per minute when the duck dies (Tables 9, 15). Mallards were held 24 to 36 hours to assess their condition and acclimation to the transmitters and released at its capture site. The movement of instrumented mallards following release indicated that transmitters did not appear to inhibit movements or activities. Observations indicated that the behavior of instrumented mallards did not differ from that of other ducks in its associated flock. On some occasions, instrumented birds were observed leading flights of ducks.

The GIS system produced two types of maps for each mallard. The first map (n=68) showed individual mallard movement locations from radio telemetry from August 15 to October 18. These maps were generated by the U.S. Army GIS system. Figure 5 depicts an actual example of this type of map. The second map depicts the last 5 to 10 telemetry locations of mallards that died on ERF. These maps (n=11) were useful in determining a general area that mallards could have been exposed to white phosphorous. Figure 6 depicts an actual example of this type of map. Exact locations were documented when ducks were recovered.

Mallard (n=68) movements and distribution on ERF during the fall migration period indicated that they spent the majority (32%) of their time from August 15 to October 18 in areas A and about 23% of their time in area C/D (Figure 7). In addition, mallards spent about 80% of their time in areas A, B, C, and C/D, which area areas that are considered to be contaminated (Figure 7). Of their 2,278 telemetry locations, 78 were in the Racine quadrant, 859 were in the A quadrant, 36 were in the BT quadrant, 207 were in the C quadrant, 553 were in the C/D quadrant and 369 were in the B quadrant. Helicopter time was restricted to ERF, thus there were no chances to document mallard movements to other locations near ERF, such as Gwen, Otter, and Six Mile Lakes, Palmer Hay flats or Susitna Flats.

Mallard use of all areas on ERF except areas B and C/D have decreased from 1996 levels (Figure 7). The use of areas B and C/D by mallards increased due to remediation actions in other areas on ERF (Figure 7). The fluctuation in use of all areas on ERF will continue until remediation actions are concluded.

The average and median number of days mallards (n=68) spent on ERF were 27 and 28, respectively. The range was from 1-64 days. At the conclusion of the study, October 18, 6 mallards remained on ERF. These birds were using the Eagle River. The average daily turnover rate for mallards was about 3.9%. The greatest turnover of mallards occurred during August 15-24 and September

14-18, where 13 (19%) and 23 (34%) of the mallards departed ERF during these time periods, respectively (Figure 13).

4.3 MALLARD MORTALITY ON EAGLE RIVER FLATS

4.3.1 Mallard Mortality 1996: Base Year

Of the radio-marked mallards that used ERF between August 3 and October 15, 43 died. (Table 16). Of those radio-marked mallard deaths, 38 were attributed to white phosphorous, 2 were shot by hunters and 3 taken by mink (Table 17). Mallards found dead during this period were on ERF from 4 to 69 days. The average exposure before mortality due to white phosphorous was 28 days. The greatest mortality that was attributed to white phosphorous occurred in Area C, 13 of 38 (34%); A, 8 of 38 (21%); and C/D and RI accounted for 7 (18%) and 6 (16%), respectively (Table 18). Overall, these areas accounted for 89% of the mallard mortality on ERF attributed to white phosphorous. The three mallard deaths that were attributed to mink had carcasses and transmitters recovered from mink burrows. No mallard mortality was noted from capture, handling or the transmitter. Eight whole mallard carcasses were recovered from the 38 mallard mortalities attributed to white phosphorous.

4.3.2 Mallard Mortality 1997

Of the radio-marked mallards that used ERF between August 3 to October 22, 37 died (Table 16). Of those radio-marked mallard deaths, 21 were attributed to white phosphorous, 13 were shot by hunters, 1 was caught by a falcon and 2 taken by mink (Table 17). Mallards found dead during this period were on ERF from 1 to 67 days. The average exposure before mortality due to white phosphorous was 30 days. The greatest mortality that was attributed to white phosphorous occurred in Areas BT, 5 of 21 (24%); A, 5 of 21 (24%); and C/D and C, 7 of 21 (33%) (Table 18). Overall, these areas accounted for 81% of the mallard mortality on ERF attributed to white phosphorous. No mallards died in Bread Truck or Racine Island ponds. The carcasses and transmitter of suspected mink kills were recovered from mink burrows, but there were not enough remains to warrant analysis for white phosphorous. No mallard mortality was noted from capture, handling or the transmitter. Fifteen whole duck carcasses were recovered from the 21 mallard mortalities attributed to white phosphorous.

4.3.3 Mallard Mortality 1998

Of the radio-marked mallards that used ERF between August 2 and October 22, 36 died (Table 16). Of those, 29 were attributed to white phosphorous, 6 were shot by hunters, and 1 was caught by a falcon (Table 17). Mallards found dead during this period were on ERF from 5 to 67 days. The average exposure before mortality was 28 days. Mallard mortalities attributed to white phosphorous occurred in the following areas: Area C/D, 12 of 29 (41%); Area A, 5 of 29 (17%); Area C, 5 of 29 (17%); Area RI, 4 of 29 (14%); and Area B, 3 of 29 (10%) (Table 18). These areas accounted for all mallard mortalities on ERF attributed to white phosphorous. No mallards died in Bread Truck pond, but three died in the ponded areas on Racine Island. No mallard mortality was noted from capture, handling, or the transmitter. Thirteen whole mallard carcasses were recovered from the 29 mallard mortalities attributed to white phosphorous.

4.3.4 Mallard Mortality 1999

Of the radio-marked mallards that used ERF between August 4 and October 14, 37 died (Table 16). Of those mallards, 24 (71%) were attributed to white phosphorous, 6 were shot by hunters, 1 was tangled in its harness, 3 were predated, and 3 were unknown mortalities (Table 17). Mallards found dead during this period were on ERF from 5 to 56 days. The average exposure before mortality was 32 days. Mallard mortality attributed to white phosphorous occurred in the following areas: C/D, 6 of 24 (25%); A, 9 of 24 (38%); C, 6 of 24 (25%); BT, 1 of 24 (4%); and B, 2 of 24 (4%) (Table 18). Additional dead ducks not instrumented with a radio transmitter were also recovered from these areas. No mallards were found dead in the drained portion of Racine Island. No mallard mortality was noted from capture or handling but one mallard got its leg tangled in its transmitter harness. Fifteen whole mallard carcasses were recovered from the 24 mallard mortalities attributed to white phosphorous.

4.3.5 Mallard Mortality 2000

No telemetry conducted.

4.3.6 Mallard Mortality 2001

Of the radio-marked mallards that used ERF between August 2 to October 17, 29 died (Table 16). Of those mallards, 11 (38%) were attributed to white phosphorous, 16 were shot by hunters, 1 was tangled in its harness, and 1 was an unknown mortality (Table 17). Mallards found dead during this period were on ERF from 3 to 70 days. The average exposure before mortality was 35 days.

Mallard mortalities attributed to white phosphorous occurred in areas A, 1 of 11 (9%); B, 1 of 11 (9%); C, 3 of 11 (27%); and C/D, 6 of 11 (55%) (Table 18). Additional dead ducks not instrumented with a radio transmitter were also recovered from these areas. No mallards were found dead in the drained portion of Racine Island. No mallard mortality was noted from capture or handling but one mallard got its leg tangled in its transmitter harness. Seven whole mallard carcasses were recovered from the 11 mallard mortalities attributed to white phosphorous.

4.3.7 Mallard Mortality 2002

Of the radio-marked mallards that used ERF between August 15 and October 18, 19 died (Table 16). Of those mallards, 8 (42%) were attributed to white phosphorous, 7 were shot by hunters, 1 was taken by a predator and 3 were unknown mortalities (Table 17). Mallards found dead during this period were on ERF from 1 to 60 days. The average exposure before mortality was 26 days. Mallard mortalities attributed to white phosphorous occurred in areas A, 1 of 8 (13%) and C and C/D, 7 of 8 (87%) (Table 18). Additional dead ducks not instrumented with a radio transmitter were also recovered from these areas. No mallards were found dead in the drained portion of Racine Island. No mallard mortality was noted from capture or handling but one mallard got its wing tangled in its transmitter harness. Three whole mallard bodies were recovered from 8 mallard mortalities attributed to white phosphorous.

4.4 White Phosphorous Residues in Recovered Radio-marked Mallards and Unmarked Waterfowl.

4.4.1 1996: Base Year—White Phosphorous Residues in Recovered Waterfowl

Eight radio-marked mallard whole carcasses were recovered from 38 mallard mortalities attributed to white phosphorous. Analysis showed that 8 of 8 were positive for white phosphorous (Table 19, Appendix 9). Residue levels of white phosphorous in radio-marked mallards ranged from 0.094 μg/g to 473.0 μg/g.

Analysis of one un-marked green-winged teal recovered from an unknown area had 1.17 μg/g of white phosphorous.

4.4.2 1997: White Phosphorous Residues in Recovered Waterfowl

Fifteen radio-marked mallard whole carcasses were recovered from 21 mallard mortalities attributed to white phosphorous. Analysis showed that 8 of 10 were positive for white phosphorous (Table 19, Appendix 9). The remaining five mallards were not analyzed by CRREL for unknown reasons. Residue levels of white phosphorous in radio-marked mallards ranged from 0.152 μg/g to 1,220.0 μg/g. The remaining two mallards were below the MLOD, 0.003 μg/g and 0.013 μg/g, respectively. These two mallards were analyzed at separate times. A MLOD was calculated for each analysis.

Analysis of one unmarked mallard recovered from an unknown area had 2.49 μg/g of white phosphorous.

4.4.3 1998: White Phosphorous Residues in Recovered Waterfowl

Thirteen radio-marked mallard whole carcasses were recovered from 29 mallard mortalities attributed to white phosphorous. Analysis showed that 10 of 13 were positive for white phosphorous (Table 19, Appendix 9). Residue levels of white phosphorous in radio-marked mallards ranged from 0.121 μg/g to 833.0 μg/g. The remaining 3 mallards were below the MLOD of 0.014 μg/g.

White phosphorous residues of 12 unmarked waterfowl recovered from ERF, that included 4 mallards, 4 northern pintails, 2 green-winged teal, 1 American wigeon, and 1 tundra swan were all positive for white phosphorous. White phosphorous levels in these waterfowl by area as follows: 3 mallards, 3 northern pintails, 1 American wigeon, and 1 green-winged teal collected from Area A averaged 28.5 μg/g (range 0.05 to 72.8 μg/g); 1 mallard collected from Area C had 0.41 μg/g; 1 northern pintail collected from Area C/D had less than the MLOD (0.014 μg/g); 1 green-winged teal collected from Area RI had 0.46 μg/g; and one tundra swan from Area D had 95.9 μg/g.

4.4.4 1999: White Phosphorous Residues in Recovered Waterfowl

Fifteen radio-marked mallard whole carcasses were recovered from 24 mallard mortalities attributed to white phosphorous. Analysis showed that 15 of 15 were positive for white phosphorous (Table 19, Appendix 9). Residue levels of white phosphorous in radio-marked mallards ranged from 0.116 μg/g to 3,210 μg/g.

White phosphorous residues of 9 unmarked mallards recovered from ERF, ranged from 0.350 μg/g to 1,170 μg/g.

4.4.5 2000: No telemetry study was conducted.

4.4.6 2001: White Phosphorous Residues in Recovered Waterfowl

Seven radio-marked mallard whole carcasses were recovered from 11 mallard mortalities attributed to white phosphorous. Analysis showed that 7 of 7 were positive for white phosphorous (Table 19, Appendix 9). Residue levels of white phosphorous in radio-marked mallards ranged from 0.02 µg/g to 771 µg/g.

White phosphorous residues of 16 unmarked waterfowl recovered from ERF which included 12 mallards, 4 northern pintails, and 1 tundra swan ranged from 0.004 µg/g to 430.0 µg/g.

4.4.7 2002: White Phosphorous Residues in Recovered Waterfowl

Three radio-marked mallard whole carcasses were recovered from 8 mallard mortalities attributed to white phosphorous. Analysis showed that 3 of 3 were positive for white phosphorous (Table 19, Appendix 9). Residue levels of white phosphorous in radio-marked mallards ranged from 2.49 µg/g to 12.9 µg/g. Analysis of 2 unmarked northern pintails recovered from ERF showed white phosphorous residue levels ranging from 2.98 µg/g to 6.69 µg/g.

4.5 Dabbling Duck Mortality Model for ERF

The model estimated the annual dabbler duck mortality for 1996 through 2002. It used the data from waterfowl aerial surveys (Eldridge et al. 1996, 1997, 1998, 1999, 2001, 2002) and turnover and mortality data from radio-marked mallards that used ERF from August through mid-October from 1996 through

2002 to estimate the number of dabbler mortalities attributed to white phosphorous. The model also estimates the peak number of dabblers and the total number of dabblers using ERF during the same period. From 1996 through 2002, except for 2000, mallards were fitted with the same type and weight transmitter each year, captured about the same time period each year with the same type of capture equipment and same personnel, and processed and radio tracked by the same tracking crew, with few exceptions. These factors contributed to estimation of the dabbler duck mortality that occurred from white phosphorous on ERF without observer bias.

In 1996, it is estimated that 5,146 individual dabblers used ERF from August 3 to October 16 (Figure 14). Dabblers peaked at 2,382 individuals during September 13-16 (Table 20, Figure 14). The estimated overall mortality that occurred on ERF was 692 dabblers (Table 20, Figures 15-16).

In 1997, an estimated 4,630 individual dabblers used ERF from August 2 to October 22 (Figure 14). Dabblers peaked at 3,496 individuals during September 9-10 (Table 21, Figure 14). The estimated overall mortality that occurred on ERF was 108 dabblers (Table 21, Figures 15-16).

In 1998, an estimated 3,656 individual dabblers used ERF from August 4 to October 22 (Figure 14). Dabblers peaked at 1,647 individuals during August 27 and September 2 (Table 22, Figure 14). The estimated overall mortality that occurred on ERF was 317 dabblers (Table 22, Figures 15-16).

In 1999, it is estimated that 1,230 individual dabblers used ERF From August 4 to October 14 (Figure 14). There were two small peaks of dabblers on

ERF 619 and 731 between August 21-24 and September 21-28, respectively (Table 23, Figures 14). The estimated overall mortality that occurred on ERF was 179 dabblers (Table 23, Figures 15-16).

In 2000, no work was conducted.

In 2001, an estimated 3,028 individual dabblers used ERF from August 2 to October 17 (Figure 14). Dabblers peaked at 1,726 between September 22-25 (Table 24, Figures 14). The overall estimated mortality that occurred on ERF was 91 dabblers (Table 24, Figures 15-16).

In 2002, 3,028 individual dabblers used ERF from August 15 to October 18 (Figure 14). Dabblers peaked at 2,022 dabblers between September 17-18 (Table 25, Figure 14). The overall projected mortality that occurred on ERF was estimated at 192 dabblers (Table 25, Figure 15-16).

In 1996, the model estimated 692 dabbler mortalities and a 35% mortality rate attributed to white phosphorous for dabbler ducks during the fall migration period. In 2002, the model estimated 192 dabbler mortalities and a 12% mortality rate attributed to white phosphorous for dabbler ducks (Tables 20-25 and Figure 16). This represents a 72% reduction in dabbler duck mortalities attributed to white phosphorous and a 66% reduction in the mortality rate (Figures 15, 16). The 2002 estimates are below the 5-year goal outlined in the CERCLA Record of Decision for Operation Unit C, Fort Richardson Alaska (September 1998) to reduce the dabbler mortality rate attributed to white phosphorous to less than 50 percent of the 1996 mortality rate (35%) or reduce the number of dabbler mortalities to white phosphorous to less than 500. The decrease is attributed to remediation actions on ERF.

5.0 DISCUSSION

The weight of evidence indicates that ingestion of white phosphorous particles by dabbler ducks, specifically mallards, northern pintails, and green-winged teal is the cause of the elevated waterfowl mortality on ERF. White phosphorous has been identified at elevated levels in several areas used extensively by dabbler ducks, i.e. areas A, BT, C, C/D, and RI. In addition, the recovery of marked and unmarked waterfowl from various areas also indicates greater than 94% mortality attributed to white phosphorous.

5.1 Aerial Waterfowl Surveys

Aerial surveys of waterfowl indicate that dabbling ducks comprise 99 percent of the ducks counted by air and 95 percent by ground through the season. Ponds were the most important habitat type used by dabblers. Ponds in areas A, C, C/D, and D generally had the highest densities of dabbling ducks. The number of aerial counts conducted 1996 through 2002 varied slightly because of weather or flight restrictions on ERF. The number of dabbling ducks recorded each year during the fall migration period on ERF varied depending on water conditions, on-going remediation actions and available habitat. At the peak of remediation (pumping and drying) the number of dabblers using ERF decreased or re-distributed to other areas on ERF. In some cases, concentrating dabblers in areas that were considered contaminated with white phosphorous.

Aerial surveys were an important component of the ERF mortality model. The aerial surveys were considered a complete count of the number of dabbling ducks using ERF.

5.2 Mallard Radio Telemetry

Mallards were selected as the indicator species to represent dabbling duck use of ERF. They were used to measure the effects of the remedial action selected for ERF which involved pumping permanent ponds dry to allow for the sublimation and oxidation of the white phosphorous present in the pond. The sample sizes of radio-marked mallards used each year from 1996 through 2002, excluding 2000, were large enough to establish a baseline that future changes in mallard movements, distribution, turnover, and mortality could be detected with confidence. As ERF is remediated, the dabbling duck mortality from white phosphorous will decrease. Using a sample size of 100 mallards, the confidence limits on the 20 year goal (2018) of 1% mortality of the base would be 0 to 2.9%.

5.3 Movements and Distribution of Radio-marked Mallards

Since 1996, the movements and distribution of radio-marked mallards on ERF have varied among some areas such as area A, B, C/D and RI, but have remained relatively unchanged in areas BT, C, CE, CW, D, and EOD. The on-going remediation in selected areas on ERF has affected the number of dabbling ducks, their movements and distribution. In 1996, dabbling ducks preferred areas A, B, C, and C/D as foraging and loafing areas. However, as pumping was initiated in areas A, C, C/D and EOD and the main ponded areas in RI and BT were drained dabblers redistributed into other areas. Increases were noted in area B and parts of areas C and C/D that were not affected pumping. The redistribution of dabblers has a bias effect on mortality by concentrating dabblers into areas that were considered contaminated with white phosphorous.

The average number of days mallards spent on ERF has decreased only slightly from 47 in 1996 to 39 in 2002 which was adjusted for a 14 day delay in starting the project. Weather and remedial actions are factors that affect the length of time mallards spend on ERF.

5.4 Dabbler Duck Mortality Model for ERF

The number of radio-marked mallard mortalities has decreased from 38 in 1996 to 8 in 2002. The mortality model for ERF indicates that the dabbling duck mortality rate (%) has decreased from 35% in 1996 to 12% in 2002 and the number of estimated mortalities has decreased from 692 in 1996 to 192 in 2002. The mortality model indicates that the 5-year goal outlined in the CERCLA Record of Decision for Operation Unit C, Fort Richardson, Anchorage, Alaska (September 1998) has been met.

6.0 LESSONS LEARNED AND DEVIATIONS FROM INITIAL MONITORING DESIGN

6.1 Successes

6.1.1 Mallard Capture Technique

The use of a netgun from a helicopter to capture mallards for this project has been very successful. The number of helicopter hours used each year varied from 21 to 36 total hours. It has been shown that using other capture techniques was not feasible on ERF and the sample size needed to detect changes in remedial actions could not be obtained. The overall cost to capture individual ducks was about $1,000 per bird, which is less than previous costs when only swim-in decoy traps, mist nets and spot-lighting were used to capture half the number over a 60 day period. In addition, the use of the netgun/helicopter reduces human exposure to UXO's.

6.1.2 Radio Telemetry

Radio telemetry has been successful in addressing the RAO's. Mallards are a good representative dabbling duck species and should continue to be used as the indicator species for ERF. Showing the effects of remedial actions will depend on having a sample size of at least 100 radio-marked mallards that are captured in a relatively short period of time during the first part of August. Of importance, is being consistent with capture and telemetry activities from year to year.

It has been shown that telemetry can account for factors affecting mortality whereas transects which are tied to a specific pond site or area can not. In addition, the advantage of radio-marked mallards can identify general and specific areas of white phosphorous contamination for sampling and remediation.

6.1.3 Mortality Model

The mortality model developed for ERF has been successfully used to estimate the dabbling duck mortalities attributed to white phosphorous. As ERF is remediated and the associated dabbling duck mortalities decrease over time so will the variance and the need for large sample sizes. The model can detect a 1% mortality rate if more than 100 mallards are fitted with transmitters. The model is a more accurate estimation of the actual number of dabblers that die from ingesting white phosphorous because the model combines all data from radio-marked mallards, including numbers, mortality, turnover, and the aerial survey to estimate the actual number of ducks that die from white phosphorous. The model can estimate the dabbler mortality on a daily, weekly, or monthly basis.

6.1.4 Aerial Survey of Waterfowl

Aerial surveys were successfully conducted on ERF at time intervals allowed by U.S. Army Range Control and weather.

6.2 Problems Encountered and Solutions

6.2.1 Helicopters

In 2000, contracting problems were encountered in procuring a helicopter to provide support for the waterfowl mortality monitoring. Magnifying the problem was a very limited availability of helicopters during the season due to a high instance of forest fires. Also, pilots that are competent and experiences in netgun waterfowl capture work are in short supply. Due to the contracting issue and availability problem of helicopter and pilot, the waterfowl telemetry work was not performed in 2000. Contracting issues have been resolved; however, availability of helicopters and pilots could continue to be a problem. Evergreen Helicopters is working with the ERF Remedial Action Team (RAT) to ensure experienced pilots and helicopter are available for performing this work as required.

6.2.2 Mallard Capture and Aerial Surveys

Conducting helicopter captures of mallards and aerial surveys of waterfowl on ERF has been affected by U.S. Army Range Control operations. Their operations require a complete shut-down of any aerial operation on ERF. These delays can be for hours and in some cases for days. Better aerial access to ERF would insure a complete capture sample and a more consistent aerial survey period. Aerial surveys need and should be conducted at 3 day intervals.

6.2.3 ERF Activities

In order to obtain an unbiased sample of mallards from areas on ERF for radio telemetry all activities other than the netgun/helicopter operations should be delayed during the mallard capture period.

6.2.4 Recovery of Radio-marked Mallards

Each year, some radio-marked mallards that died on ERF were not recovered before they were either scavenged or removed by predators: bald eagles or mink. Increasing the monitoring period to seven days a week, quick access to ERF, and man-power to search for mortalities would increase the recovery rate. However, costs to conduct this activity would increase by 30 to 40 percent. Indications are that 94 percent of the waterfowl recovered from ERF are positive for white phosphorous and the remaining percentage were under the MLOD.

7.0 SUMMARY

Aerial surveys to monitor waterfowl use of ERF were conducted during the spring, summer and fall from 1996 through 2002. A complete count was conducted of the number of waterbirds, specifically dabbling ducks, by species, and classified by location on ERF using standardized study areas and survey techniques. Survey data of dabbling ducks from the fall period was incorporated into the dabbling duck mortality model developed for ERF.

Since 1996, excluding 2000, 648 mallards were captured from random locations on ERF using primarily a net-gun from a Bell 212 helicopter. On average, 31 hours of helicopter time each year was used to capture mallards. Each mallard was radio-marked with a 9.1 gram backpack transmitter, held for 12-36 hours to assess its condition and released at its capture site. All mallards were fitted with standard/mortality transmitters that emit about 60 pulses per minute when the duck is alive and 120 pulses per minute when the duck dies.

Movement and distribution of radio-marked mallards on ERF during the fall migration period from 1996 through 2002, excluding 2000, indicate that mallards spent the majority of their time in areas A, B, C, and C/D from August through October. Use of these areas represented about 84 percent of the time mallards spent on ERF. During remedial actions, mallards redistributed to areas on ERF that had minimal disturbances.

Overall, the average number of days radio-marked mallards spent on ERF from 1996 through 2002, excluding 2000 was 40 days. The range was from 1 to

77 days. The greatest turnover from 1996 through 2002, excluding 2000, occurred during August 2-20 and September 14-28.

From 1996 through 2002, excluding 2000, 201 radio-marked mallards that used ERF August through October died. Of those mallards, 131 (65%) mortalities were attributed to white phosphorous. The remaining majority of the mortalities were attributed to hunting (25%). Mortalities from predators, attachment method and unknown causes were minor (10%). Of the 131 radio-marked mallard mortalities attributed to white phosphorous, 40 (31%) were found in area C/D, 31 (24%) were found in area C and 29 (22%) were found in area A. These three areas represented 77% of radio-marked mortalities.

Of 49 radio-marked mallard carcasses recovered from ERF, from 1996 through 2002, excluding 2000, 44 (90%) tested positive for white phosphorous. Residue levels of white phosphorous in these mallards ranged from 0.09 μg/g to 3,210 μg/g. Analysis of 41 unmarked waterfowl recovered from ERF had white phosphorous residue levels that ranged from 0.004 μg/g to 1,170 μg/g. Of the 41 waterfowl, 26 were mallards, 10 were northern pintails, 2 were green-winged teal, 2 were tundra swans, and 1 was an American wigeon.

The dabbling duck mortality model estimated the fall dabbling duck mortality for 1996 through 2002, excluding 2000. It used data from waterfowl aerial surveys and turnover and mortality data from radio-marked mallards that used ERF from August through mid-October from 1996 through 2002 to estimate the number of dabbler mortalities attributed to white phosphorous. The model also estimated the peak number of dabblers and the total number of dabblers using

ERF during the same period. In 1996, which was considered the base year for the mortality model, it was estimated that 5,146 individual dabblers used ERF from August 3 to October 16. Dabblers peaked at 2,382 individuals during September 13-16. The estimated overall mortality that occurred on ERF was 692. From 1997 through 2002, excluding 2000, the number of individual dabblers that used ERF ranged from 1,230 to 4,630. Dabblers peaked at between 731 and 3,496 individuals. The estimated mortality was 108 dabblers in 1997, 317 dabblers in 1998, 179 dabblers in 1999, 91 dabblers in 2001 and 192 dabblers in 2002.

The number of radio-marked mallard mortalities attributed to white phosphorous has decreased from 38 in 1996 to 8 in 2002. The dabbling duck mortality model for ERF indicates that the dabbling duck mortality rate (%) has decreased from 35 percent in 1996 to 12 percent in 2002 and the number of estimated mortalities has decreased from 692 in 1996 to 192 in 2002. The mortality model indicates that the 5-year goal outlined in the CERCLA Record of Decision for Operation Unit C, Fort Richardson, Anchorage, Alaska (September 1998) to reduce the dabbler mortality rate attributed to white phosphorous to less than 50 percent of the 1996 mortality rate (35%) or reduce the number of dabbler mortalities attributed to white phosphorous to less than 500 has been met.

8.0 WATERFOWL MORTALITY MONITORING CONTACT INFORMATION AND REFERENCES CITED

8.1 Contacts

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Table 1. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 30-October 16, 1996.

	7/30	8/06	8/20	8/27	8/31	9/03	9/06	9/09	9/12	9/16	9/19	9/23	9/26	9/30	10/04	10/08	10/11	10/16	TOTAL
Mallard	17	54	267	352	635	125	87	100	420	289	328	67	47	214	944	239	593	5	4,783
Northern Pintail	27	262	197	330	560	0	50	4	130	0	65	12	0	10	55	33	8	0	1,743
Green-winged Teal	18	80	248	198	62	20	66	385	420	343	271	0	75	121	45	28	49	9	2,438
95% of Un-identified dabblers	20	0	201	1,026	855	627	1,451	697	760	1,594	1,492	675	537	52	0	198	48	0	10,233
TOTAL	82	396	913	1,906	2,112	772	1,654	1,186	1,730	2,226	2,156	754	659	397	1,044	498	698	14	19,196

Table 2. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 30-October 22, 1997.

	7/30	8/04	8/18	8/21	8/26	8/28	9/02	9/03	9/08	9/10	9/16	9/18	9/23	9/25	9/30	10/02	10/06	10/09	10/16	10/22	TOTAL
Mallard	66	145	177	60	305	163	265	148	647	240	72	6	243	238	25	650	90	157	18	6	3,721
Northern Pintail	0	33	34	31	120	5	20	75	233	90	0	5	23	20	0	0	0	0	0	0	689
Green-winged Teal	86	55	52	32	150	53	170	245	255	155	31	16	10	66	5	88	85	6	0	0	1,560
95% of Un-identified dabblers	55	0	71	172	114	439	371	622	896	3,011	192	348	281	266	1,110	390	278	177	0	0	8,791
TOTAL	207	233	334	295	689	660	826	1,090	2,031	3,496	295	375	557	590	1,140	1,128	453	340	18	6	14,321

Table 3. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 26-October 21, 1998.

	7/26	8/04	8/11	8/19	8/26	9/02	9/04	9/07	9/10	9/15	9/18	9/22	9/24	9/28	10/02	10/07	10/12	10/16	10/21	TOTAL
Mallard	34	208	68	57	142	110	260	119	419	373	556	135	212	819	178	436	426	174	63	4,789
Northern Pintail	0	0	5	155	19	91	395	199	154	90	24	131	81	176	0	0	0	0	0	1,529
Green-winged Teal	2	13	42	58	80	118	10	108	265	18	25	36	222	153	3	52	55	50	77	1,387
95% of Un-identified dabblers	0	56	125	585	618	1,199	589	10	0	0	0	1	38	190	45	0	69	0	0	3,525
TOTAL	36	277	240	855	859	1,518	436	436	838	490	605	303	553	1,338	226	488	550	224	140	11,230

Table 4. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 28-October 20, 1999.

	7/28	8/16	8/20	8/24	8/30	9/03	9/08	9/14	9/16	9/20	9/28	10/04	10/07	10/13	10/20	TOTAL
Mallard	2	166	184	197	142	182	45	117	105	67	432	188	158	123	29	2,137
Northern Pintail	0	65	27	95	45	51	15	5	20	13	10	24	11	0	0	381
Green-winged Teal	11	73	40	143	66	56	57	84	52	65	55	38	87	97	8	932
95% of Un-identified dabblers	24	68	43	158	52	0	26	82	95	233	60	147	32	0	0	1,020
TOTAL	37	372	294	593	305	289	143	288	272	378	557	397	288	220	37	4,470

Table 5. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 26-October 17, 2000.

	7/26	8/10	8/17	8/23	8/30	9/05	9/12	9/18	9/21	9/26	10/02	10/09	10/17	TOTAL
Mallard	127	161	79	191	156	81	45	175	214	281	396	221	144	2,271
Northern Pintail	37	55	41	41	117	91	0	91	85	156	0	2	0	716
Green-winged Teal	22	205	65	27	76	30	44	31	79	67	14	7	4	671
Unidentified dabblers	0	0	23	0	0	182	900	58	61	175	6	0	0	1,405
TOTAL	186	421	208	259	349	384	989	355	439	679	416	230	148	5,063

Table 6. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 23-October 16, 2001.

	7/23	8/01	8/09	8/16	8/24	8/29	9/03	9/09	9/14	9/19	9/21	9/25	9/27	10/02	10/05	10/09	10/11	10/16	TOTAL
Mallard	50	71	151	347	36	189	192	201	176	323	335	584	547	151	515	333	222	40	4,463
Northern Pintail	39	35	65	60	152	48	59	27	20	70	42	670	245	0	53	0	0	0	1,585
Green-winged Teal	39	52	116	217	65	98	116	12	12	35	49	309	5	5	18	33	31	5	1,217
95% of Un-identified dabblers	0	0	124	167	126	231	314	166	154	216	114	163	52	62	0	0	0	0	1,888
TOTAL	128	158	456	791	379	566	681	406	362	643	540	1,726	849	218	586	366	253	45	9,153

Table 7. Aerial survey of ERF during the fall for dabbler ducks: mallards, northern pintail, and green-winged teal, July 23-October 18, 2002.

	7/23	8/13	8/24	8/27	8/30	9/04	9/06	9/13	9/16	9/18	9/20	9/23	9/27	10/02	10/09	10/18	TOTAL
Mallard	0	219	204	176	410	462	76	395	244	510	567	225	161	216	111	85	4,061
Northern Pintail	19	47	52	23	30	76	35	2	56	60	215	21	44	105	100	0	885
Green-winged Teal	0	40	186	13	36	18	60	250	124	0	118	26	31	4	0	0	906
95% of Un-identified dabblers	39	43	0	62	119	95	499	0	304	755	38	34	0	76	0	0	2,064
TOTAL	58	349	442	274	595	651	670	647	728	1,325	938	306	236	401	211	85	7,916

Table 8. Mallards fitted with radio transmitters since 1996 on Eagle River Flats, Fort Richardson, Alaska.

Year	Netgun	Swim-in	Mist Net	Total
1996	87	14	6	107
1997	136	0	0	136
1998	96	13	0	109
1999	92	24	0	116
2000[1]	NA	NA	NA	NA
2001	108	4	0	112
2002[2]	66	1	1	68[1]
TOTAL	582	56	7	648

[1] No telemetry was conducted in 2000.

[2] Capture period was reduced because of the availability of a helicopter due to Alaskan wild fires.

Table 9. Numbers of standard and mortality transmitters placed on radio-marked ducks by year.

Year	Standard Transmitter (no.)	Mortality Transmitter (no.)	TOTAL
1996	53	54	107
1997	55	81	136
1998	60	49	109
1999	104	12	116
2000	NA	NA	NA
2001	112	0	112
2002	68	0	68
TOTAL	452	196	648

Table 10. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1996.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	1477-73416	Mallard	F	164.432	S	08/08/96	RI	10/09/96	RI	Scavenged	09/09/96	B	WP	No	No gizzard
2	1477-73417	Mallard	M	164.440	S	08/03/96	RI			NC 10/7					
3	1477-73418	Mallard	F	164.466	S	08/03/96	RI			NC 10/8					
4	1477-73419	Mallard	M	164.490	S	08/03/96	B			NC 10/14					
5	1477-73420	Mallard	F	164.513	S	08/03/96	B			NC 10/14					
6	1477-73421	Mallard	F	164.532	S	08/03/96	B			NC 10/14					
7	1477-73422	Mallard	F	164.539	S	08/03/96	A	08/21/96	RI	Scavenged	08/12/96	RI	WP	No	No gizzard
8	1477-73423	Mallard	F	164.552	S	08/03/96	A	08/18/96	C/D	Scavenged	08/15/96	C/D	WP	No	No gizzard
9	1477-73424	Mallard	M	164.565	S	08/03/96	A			NC 10/14					
10	1477-73425	Mallard	UNK	164.570	S	08/03/96	A			NC 10/14					
11	1477-73426	Mallard	F	164.671	S	08/05/96	B	10/07/96	B	Trans only	09/30/96	B	WP	No	No gizzard
12	1477-73427	Mallard	M	164.666	S	08/05/96	B	10/09/96	C	Scavenged	10/08/96	C/D	WP	No	No gizzard
13	1477-73428	Mallard	M	164.640	S	08/05/96	B			NC 10/14					
14	1477-73429	Mallard	F	164.581	S	08/05/96	RI			NC 10/14					
15	1477-73430	Mallard	M	164.589	S	08/05/96	RI			NC 10/14					
16	1477-73431	Mallard	M	164.592	S	08/05/96	RI	08/21/96	B	Scavenged	08/20/96		mink		
17	1477-73432	Mallard	M	164.613	S	08/05/96	RI	09/24/96	A	not recov.	09/04/96		WP	No	No gizzard
18	1477-73433	Mallard	F	164.681	S	08/05/96	RI			NC 10/14					
19	1477-73434	Mallard	UNK	166.815	S	08/05/96	RI	10/07/96	CE	Scavenged	09/16/96	C	WP	No	No gizzard
20	1477-73435	Mallard	UNK	166.790	S	08/05/96	B			ERF 10/14					
21	1477-73436	Mallard	M	166.765	S	08/05/96	B			NC 10/11					
22	1477-73437	Mallard	M	166.740	S	08/05/96	RI			NC 10/14					
23	1477-73438	Mallard	F	164.689	S	08/06/96	B			NC 10/14					
24	1477-73439	Mallard	M	164.712	S	08/06/96	RI			NC 10/14					
25	1477-73440	Mallard	M	166.839	S	08/06/96	RI	08/21/96	RI	Scavenged	08/12/96	RI	WP	No	No gizzard
26	1477-73441	Mallard	M	166.915	S	08/06/96	C/D			NC 10/14					

Table 10 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1996.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
27	1477-73442	Mallard	M	164.514	S	08/06/96	C/D	08/20/96	C/D	Scavenged	08/20/96	C/D	WP	Yes	0.0944(a)
28	1477-73443	Mallard	M	167.065	S	08/06/96	C/D	08/18/96	BT	Scavenged	08/12/96	BT	WP	No	No gizzard
29	1477-73444	Mallard	M	164.465	S	08/06/96	C/D	08/18/96	C	Scavenged	08/12/96	C	WP	No	No gizzard
30	1477-73445	Mallard	F	167.004	S	08/06/96	C/D			NC 10/14					
31	1477-73446	Mallard	M	166.987	S	08/06/96	C/D			NC 8/12					
32	1477-73447	Mallard	M	167.039	S	08/06/96	C/D			NC 10/14					
33	1477-73448	Mallard	M	166.890	S	08/06/96	C/D			NC 8/16					
34	1477-73449	Mallard	M	167.090	S	08/06/96	C/D			NC 8/23					
35	1477-73450	Mallard	M	166.790	S	08/06/96	A	08/15/96	RI	Scavenged	08/12/96	RI	WP	No	No gizzard
36	1477-73451	Mallard	F	167.166	S	08/06/96	A			ERF 10/14					
37	1477-73452	Mallard	F	166.866	S	08/06/96	A	10/14/96	A	Scavenged	UNK	A	WP	No	No gizzard
38	1477-73453	Mallard	F	166.965	S	08/06/96	A			NC 10/14					
39	1477-73454	Mallard	UNK	167.150	S	08/06/96	A			ERF 10/14					
40	1477-73455	Mallard	UNK	167.126	S	08/06/96	A	08/23/96	A		08/12/96		Slipped*		
41	1477-73456	Mallard	UNK	167.015	S	08/06/96	A			NC 10/14					
42	1477-73457	Mallard	M	167.023	S	08/07/96	RI			NC 10/11					
43	1477-73458	Mallard	M	167.115	S	08/07/96	RI	09/25/96	Susitna	Carcass			Shot		
44	1477-73459	Mallard	F	166.941	S	08/07/96	B			NC 9/20					
45	1477-73460	Mallard	M	167.000	S	08/07/96	B	08/21/96	RI	Scavenged	08/15/96	RI	WP	No	No gizzard
46	1477-73461	Mallard	M	167.101	S	08/08/96	A	10/14/96	A	Scavenged	UNK	A	WP	No	No gizzard
47	1477-73462	Mallard	F	167.016	S	08/08/96	A			NC 10/11					
48	1477-73463	Mallard	M	166.940	S	08/08/96	A			NC 10/8					
49	1477-73464	Mallard	M	167.051	S	08/08/96	A			NC 10/11					
50	1477-73465	Mallard	F	167.139	S	08/08/96	A			ERF 10/14					
51	1477-73466	Mallard	M	164.561	M	08/08/96	A								
52	1477-73467	Mallard	M	164.440	M	08/08/96	C/D								

Table 10 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1996.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
53	1477-73468	Mallard	M	164.465	M	08/08/96	A	~12/1/1996	SR, AK	Carcass			Shot		
54	1477-73469	Mallard	M	164.511	M	08/09/96	B								
55	1477-73470	Mallard	F	164.489	M	08/09/96	B								
56	1477-73471	Mallard	UNK	164.712	M	08/09/96	C/D	8/23 trans	C	Carcass	09/20/96	C	WP	Yes	0.0950(a)
57	1477-73472	Mallard	UNK	164.689	M	08/09/96	C/D	08/21/96	C/D	Scavenged	08/20/96	C/D	WP	No	No gizzard
58	1477-73473	Mallard	M	164.664	M	08/09/96	B								
59	1477-73474	Mallard	F	167.038	M	08/09/96	B								
60	1477-73475	Mallard	M	164.590	M	08/09/96	C/D								
61	1477-73476	Mallard	M	164.611	M	08/09/96	B								
62	1477-73477	Mallard	M	164.638	M	08/09/96	B								
63	1477-73479	Mallard	F	164.538	M	08/10/96	A	10/08/96	C	Scavenged	09/23/96	C	WP	No	No gizzard
64	1477-73484	Mallard	M	166.964	M	08/10/96	RI								
65	1477-73485	Mallard	M	167.014	M	08/12/96	A								
66	1477-73486	Mallard	M	166.740	M	08/12/96	A	10/14/96	Off EOD	In snow	UNK	C/D	WP	No	No gizzard
67	1477-73487	Mallard	M	166.838	M	08/12/96	A	08/21/96	C	Scavenged	08/19/96	A	WP	No	No gizzard
68	1477-73488	Mallard	M	166.790	M	08/12/96	A	09/03/96	C	Carcass	09/03/96	C	WP	Yes	367.0(a)
69	1477-73489	Mallard	M	166.862	M	08/12/96	C/D	10/09/96	A	Scavenged	10/09/96	A	WP	No	No gizzard
70	1477-73490	Mallard	M	166.888	M	08/12/96	B	10/07/96	C	Scavenged	10/07/96	C	WP	No	No gizzard
71	1477-73491	Mallard	M	166.914	M	08/12/96	C/D	10/09/96	RI	Scavenged	09/17/96	RI	WP	No	No gizzard
72	1477-73492	Mallard	M	166.938	M	08/13/96	A								
73	1477-73493	Mallard	M	166.811	M	08/13/96	C/D	09/17/96	Off EOD	Scavenged	08/23/96	A	WP	No	No gizzard
74	1477-73494	Mallard	F	166.989	M	08/13/96	A								
75	1477-73495	Mallard	F	166.763	M	08/13/96	C/D	10/09/96	6 mi lake	Scavenged	09/17/96		mink		
76	1477-73496	Mallard	F	164.638	M	08/13/96	C								
77	1477-73497	Mallard	F	164.713	M	08/13/96	B								
78	1477-73498	Mallard	M	164.664	M	08/13/96	A	08/23/96	C	Carcass	08/23/96	C	WP	Yes	148.0(a)

Table 10 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1996.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
79	1477-73499	Mallard	M	166.811	M	08/13/96	A	08/12/98	A	Carcass	08/12/98	A	WP	Yes	0.125(b)
80	1477-73500	Mallard	F	166.787	M	08/13/96	B	08/23/96	C	Scavenged	08/23/96		mink		
81	1477-73589	Mallard	M	164.464	M	08/23/96	A	09/09/96	C	Carcass	09/09/96	C	WP	Yes	12.1(a)
82	1477-73601	Mallard	M	164.689	M	08/14/96	B	10/14/96	A	Under ice	09/26/96	A	WP	No	No gizzard
83	1477-73602	Mallard	M	166.914	M	08/14/96	C/D								
84	1477-73612	Mallard	M	166.840	M	08/17/96	C								
85	1477-73613	Mallard	F	164.588	M	08/17/96	C	08/23/96	C	Scavenged	08/23/96	C	WP	No	No gizzard
86	1477-73614	Mallard	M	164.612	M	08/17/96	C	08/26/96	C	Carcass	08/23/96	C	WP	Yes	473.0(a)
87	1477-73615	Mallard	M	164.465	S	08/20/96	D			ERF 10/14					
88	1477-73616	Mallard	F	164.552	S	08/20/96	A			NC 9/13					
89	1477-73617	Mallard	F	167.065	S	08/20/96	A			NC 10/14					
90	1477-73618	Mallard	M	167.038	M	08/20/96	A								
91	1477-73619	Mallard	M	167.115	M	08/20/96	C/D								
92	1477-73620	Mallard	M	167.066	M	08/20/96	C/D								
93	1477-73621	Mallard	M	167.089	M	08/20/96	B	10/08/96	BT	Decayed	09/18/96	BT	WP	No	No gizzard
94	1477-73628	Mallard	M	166.839	M	08/21/96	B								
95	1477-73629	Mallard	F	166.764	M	08/21/96	B	10/07/96	B	Scavenged	09/12/96	A	WP	No	No gizzard
96	1477-73630	Mallard	F	166.739	M	08/21/96	A								
97	1477-73631	Mallard	F	167.014	M	08/21/96	A								
98	1477-73632	Mallard	F	167.066	M	08/21/96	A	09/03/96	C	Scavenged	08/26/96	C	WP	No	No gizzard
99	1477-73633	Mallard	F	167.088	M	08/21/96	A	09/17/96	C/D	Scavenged	09/16/96	C/D	WP	No	No gizzard
100	1477-73634	Mallard	M	164.438	M	08/23/96	A								
101	1477-73635	Mallard	M	167.162	M	08/23/96	A	10/08/96	C	Scavenged	09/20/96	C	WP	No	No gizzard
102	1477-73636	Mallard	F	167.138	M	08/23/96	C	08/30/96	C	Scavenged	08/27/96	C	WP	No	No gizzard
103	1477-73639	Mallard	M	166.888	M	08/23/96	B	09/23/96	RI	Carcass	09/23/96	RI	WP	Yes	0.100(a)
104	NB	Mallard	M	166.783	M	08/13/96	A								

Table 10 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1996.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
105	NB	Mallard	F	166.764	M	08/13/96	B	08/21/96	C/D	Scavenged	08/20/96	C/D	WP	No	No gizzard
106	NB	Mallard	M	166.864	M	08/14/96	C/D								
107	NB	Mallard	M	166.888	M	08/14/96	C/D								
	(a) 8/13/98 WP Analysis, MLOD = 0.003 ug/g														
	(b) 1/7/99 WP Analysis, MLOD = 0.014 ug														
	* Transmitter came untied														
	SR, AK = Sher. River, Alaska														

Table 11. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	1477-73430	Mallard	M	167.782	M	08/09/97	B								
2	1477-73645	Mallard	F	166.303	S	08/02/97	C/D	09/02/97	Birchwood	Carcass			Shot	Yes	<MLOD(b)
3	1477-73646	Mallard	M	166.368	S	08/02/97	C/D								
4	1477-73647	Mallard	M	166.329	S	08/02/97	C/D								
5	1477-73648	Mallard	F	166.39	S	08/02/97	C/D								
6	1477-73649	Mallard	M	166.233	S	08/02/97	C/D	08/19/97	C/D	Carcass	08/18/97	C/D	WP	Yes	159.0(a)
7	1477-73650	Mallard	M	166.362	S	08/02/97	C/D								
8	1477-73651	Mallard	F	166.43	S	08/02/97	C/D								
9	1477-73652	Mallard	U	166.246	S	08/02/97	C/D								
10	1477-73653	Mallard	M	166.462	S	08/02/97	C/D								
11	1477-73654	Mallard	F	166.282	S	08/02/97	C/D								
12	1477-73655	Mallard	M	166.216	S	08/12/97	C/D	09/04/97	PHF	Carcass			Shot		
13	1477-73656	Mallard	M	166.383	S	08/02/97	C/D	09/03/97	Anchorage	Carcass			Shot		
14	1477-73657	Mallard	F	166.47	S	08/02/97	C/D	10/08/97	Palmer	Carcass			Shot		
15	1477-73658	Mallard	M	166.419	S	08/02/97	C/D								
16	1477-73659	Mallard	M	166.253	S	08/02/97	B								
17	1477-73660	Mallard	M	166.317	S	08/02/97	B								
18	1477-73661	Mallard	UNK	166.803	S	08/02/97	B								
19	1477-73662	Mallard	M	166.342	S	08/02/97	B								
20	1477-73663	Mallard	M	166.405	S	08/02/97	B								
21	1477-73664	Mallard	M	166.657	S	08/05/97	A	10/28/97	Anchorage	Carcass			Falcon		
22	1477-73666	Mallard	F	166.666	S	08/05/97	A	11/22/97	Lk Otis, AK	Carcass			Shot		
23	1477-73667	Mallard	F	166.795	S	08/05/97	A								
24	1477-73668	Mallard	M	166.778	S	08/05/97	A	09/22/97	river RI	Scavenged	09/17/97	RI	WP	No	No gizzard
25	1477-73669	Mallard	M	166.77	S	08/05/97	A	10/06/97	C/D	Scavenged	10/03/97	C/D	WP	No	No gizzard
26	1477-73670	Mallard	M	166.444	S	08/05/97	A	10/15/97	Palmer	Carcass			Shot		

Table 11 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Number	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Location	Status	Morality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
27	1477-73671	Mallard	M	166.54	S	08/05/97	A	10/29/97	Wasilla	Carcass			Shot		
28	1477-73672	Mallard	M	166.606	S	08/05/97	A	09/15/97	BT	Scavenged	09/13/97	BT	WP	No	No gizzard
29	1477-73673	Mallard	UNK	166.903	S	08/05/97	A								
30	1477-73674	Mallard	M	166.586	S	08/05/97	A								
31	1477-73675	Mallard	M	166.721	S	08/05/97	A								
32	1477-73676	Mallard	F	166.593	S	08/05/97	A								
33	1477-73677	Mallard	M	166.616	S	08/05/97	A								
34	1477-73678	Mallard	M	166.637	S	08/05/97	A	08/14/97	A	Carcass	08/13/97	A	WP	Yes	538.0(a)
35	1477-73679	Mallard	M	166.646	S	08/05/97	A								
36	1477-73680	Mallard	M	166.692	S	08/05/97	A								
37	1477-73681	Mallard	M	166.684	S	08/05/97	A								
38	1477-73682	Mallard	F	166.727	S	08/05/97	A								
39	1477-73683	Mallard	F	166.892	S	08/05/97	A	08/19/97	A	Alive			Slipped*		
40	1477-73684	Mallard	M	166.839	S	08/05/97	A	08/14/97	A	UNK	08/13/97	A	WP	No	No gizzard
41	1477-73685	Mallard	M	166.487	S	08/05/97	A								
42	1477-73686	Mallard	F	166.921	S	08/05/97	A								
43	1477-73687	Mallard	F	166.704	S	08/05/97	A								
44	1477-73688	Mallard	F	166.572	S	08/05/97	A								
45	1477-73689	Mallard	M	166.554	S	08/05/97	A								
46	1477-73690	Mallard	M	166.859	S	08/05/97	A								
47	1477-73691	Mallard	M	166.868	S	08/06/97	B								
48	1477-73692	Mallard	M	166.878	S	08/06/97	B								
49	1477-73693	Mallard	M	166.271	S	08/06/97	B	08/12/97	B	Scavenged			Mink		
50	1477-73694	Mallard	M	166.535	S	08/06/97	B								
51	1477-73695	Mallard	M	166.479	S	08/06/97	B								

Table 11 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Number	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Location	Status	Morality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
52	1477-73696	Mallard	M	166.522	S	08/06/97	B								
53	1477-73697	Mallard	M	166.507	S	08/06/97	B	08/12/97	B	Carcass			Mink		
54	1477-73698	Mallard	M	164.687	M	08/07/97	C/D								
55	1477-73699	Mallard	F	164.713	M	08/07/97	C/D								
56	1477-73700	Mallard	F	164.638	M	08/07/97	C/D	09/22/97	BT	Scavenged	09/19/97	BT	WP	No	No gizzard
57	2387-80901	Mallard	M	164.613	M	08/07/97	C/D	10/04/97	PHF	Carcass			Shot		
58	2387-80902	Mallard	M	166.937	M	08/07/97	C/D	08/14/97	C	Scavenged	08/08/97	C	WP	No	No gizzard
59	2387-80903	Mallard	F	166.989	M	08/07/97	C/D								
60	2387-80904	Mallard	F	164.564	M	08/08/97	C/D								
61	2387-80905	Mallard	F	167.162	M	08/08/97	C/D	08/14/97	C/D	Carcass	08/13/97	C/D	WP	Yes	<MLOD(a)
62	2387-80906	Mallard	F	167.037	M	08/08/97	C/D	10/09/97	BT	not rec.	10/09/97	BT	WP		No gizzard
63	2387-80907	Mallard	M	167.013	M	08/07/97	C/D								
64	2387-80908	Mallard	M	167.114	M	08/07/97	C/D								
65	2387-80909	Mallard	M	166.964	M	08/07/97	C/D	10/06/97	C/D	Scavenged	10/03/97	C/D	WP	No	No gizzard
66	2387-80910	Mallard	M	167.065	M	08/07/97	C/D								
67	2387-80911	Mallard	F	167.138	M	08/07/97	C/D								
68	2387-80912	Mallard	M	167.716	M	08/08/97	C/D								
69	2387-80913	Mallard	F	167.763	M	08/08/97	C/D								
70	2387-80914	Mallard	F	167.681	M	08/08/97	C/D	01/02/98	WA1	Carcass			Shot		
71	2387-80915	Mallard	M	167.855	M	08/08/97	C/D								
72	2387-80916	Mallard	M	167.886	M	08/08/97	C/D								
73	2387-80917	Mallard	F	167.766	M	08/08/97	A	11/15/97	Anchorage	Carcass			Shot		
74	2387-80918	Mallard	M	166.802	S	08/08/97	A								
75	2387-80919	Mallard	F	167.965	M	08/08/97	A								
76	2387-80920	Mallard	F	167.831	M	08/08/97	A								
77	2387-80921	Mallard	M	167.737	M	08/08/97	A								

Table 11 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Number	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Location	Status	Morality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
78	2387-80922	Mallard	M	167.782	M	08/08/97	A								
79	2387-80923	Mallard	F	167.787	M	08/08/97	A								
80	2387-80924	Mallard	M	167.791	M	08/08/97	A								
81	2387-80925	Mallard	M	167.955	M	08/08/97	A	09/02/97	A	Carcass	09/02/97	A	WP	Yes	315.0(b)
82	2387-80926	Mallard	M	167.985	M	08/08/97	A								
83	2387-80927	Mallard	M	167.914	M	08/08/97	A								
84	2387-80928	Mallard	M	167.739	M	08/08/97	A								
85	2387-80929	Mallard	M	167.896	M	08/08/97	A								
86	2387-80930	Mallard	M	167.821	M	08/08/97	C/D								
87	2387-80931	Mallard	M	167.682	M	08/08/97	C/D								
88	2387-80932	Mallard	M	167.936	M	08/08/97	C/D								
89	2387-80933	Mallard	M	167.934	M	08/09/97	C/D	11/09/97	CN1	Carcass			Shot		
90	2387-80934	Mallard	F	167.807	M	08/09/97	C/D								
91	2387-80935	Mallard	M	167.793	M	08/09/97	B	09/26/97	river RI	Scavenged	09/22/97	RI	WP	No	No gizzard
92	2387-80936	Mallard	M	167.807	M	08/09/97	B	10/22/97	Palmer	Carcass			Shot		
93	2387-80937	Mallard	M	167.885	M	08/09/97	B								
94	2387-80938	Mallard	F	167.715	M	08/09/97	B	09/18/97	B	Scavenged	09/17/97	B	WP	No	No gizzard
95	2387-80939	Mallard	M	167.841	M	08/09/97	B								
96	2387-80940	Mallard	M	167.956	M	08/09/97	B								
97	2387-80941	Mallard	F	167.808	M	08/09/97	B								
98	2387-80942	Mallard	F	167.737	M	08/09/97	B								
99	2387-80943	Mallard	F	167.682	M	08/09/97	A								
100	2387-80944	Mallard	M	167.831	M	08/09/97	A								
101	2387-80945	Mallard	F	167.914	M	08/09/97	A								
102	2387-80946	Mallard	F	167.857	M	08/09/97	C/D								
103	2387-80947	Mallard	F	167.986	M	08/09/97	C/D	09/18/97	C	Carcass	09/15/97	C	WP	Yes	0.152(a)

Table 11 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Number	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Location	Status	Morality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
104	2387-80948	Mallard	F	167.765	M	08/09/97	C/D								
105	2387-80949	Mallard	F	167.718	M	08/09/97	C/D								
106	2387-80950	Mallard	F	167.841	M	08/09/97	C/D	11/08/97	WA2	Carcass			Shot		
107	2387-80951	Mallard	F	167.867	M	08/09/97	C/D								
108	2387-80952	Mallard	M	167.945	M	08/09/97	C/D								
109	2387-80953	Mallard	M	167.867	M	08/09/97	B								
110	2387-80968	Mallard	F	167.842	M	08/12/97	C/D								
111	2387-80969	Mallard	M	167.806	M	08/12/97	C/D								
112	2387-80970	Mallard	U	164.662	S	08/12/97	C/D								
113	2387-80971	Mallard	M	167.892	M	08/12/97	C/D								
114	2387-80972	Mallard	M	167.795	M	08/12/97	C/D								
115	2387-80973	Mallard	M	164.69	S	08/12/97	C/D	35685	BT	Carcass	09/12/97	BT	WP	Yes	110.0(b)
116	2387-80974	Mallard	F	167.984	M	08/12/97	C/D	08/29/97	BT	Carcass	08/28/97	BT	WP	Yes	1220.0(b)
117	2387-80975	Mallard	M	167.856	M	08/12/97	C/D								
118	2387-80976	Mallard	F	167.986	M	08/12/97	C/D								
119	2387-80977	Mallard	M	167.819	M	08/12/97	C/D	08/20/97	C	Carcass	08/20/97	C	WP	Yes	7.74(a)
120	2387-80978	Mallard	F	167.944	M	08/12/97	C/D	08/14/97	C/D	Alive			Slipped*		
121	2387-80979	Mallard	M	167.955	M	08/12/97	C/D								
122	2387-80980	Mallard	M	167.944	M	08/12/97	A								
123	2387-80981	Mallard	M	167.934	M	08/12/97	A								
124	2387-80982	Mallard	M	167.913	M	08/12/97	A								
125	2387-80983	Mallard	F	167.966	M	08/12/97	A								
126	2387-80984	Mallard	U	167.831	M	08/12/97	A								
127	2387-80985	Mallard	M	167.856	M	08/12/97	A	10/10/97	B	Scavenged	10/07/97	B	WP	No	No gizzard
128	2387-80986	Mallard	M	167.884	M	08/12/97	A	08/19/97	B	Alive			Slipped*		
129	2387-80987	Mallard	M	167.896	M	08/12/97	A								

Table 11 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1997.

#	Band Number	Species	Sex	Trans-mitter Number	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Location	Status	Morality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
130	2387-80988	Mallard	F	167.893	M	08/12/97	A								
131	2387-80989	Mallard	M	167.837	M	08/12/97	A								
132	2387-80990	Mallard	M	167.945	M	08/12/97	A								
133	2387-80991	Mallard	M	167.885	M	08/12/97	A	08/26/97	A	Carcass	08/25/97	A	WP	Yes	2.38(a)
134	2387-80992	Mallard	M	167.841	M	08/12/97	A								
135	2387-80993	Mallard	M	167.933	M	08/12/97	A	08/19/97	A	Carcass	08/19/97	A	WP	Yes	<MLOD(a)
136	2387-80994	Mallard	M	167.914	M	08/12/97	A								
WA1	Skaggit R. Delta														
WA2	N River		(a)	8/13/98	WP	Analysis	MLOD=	0.003 ug/g							
CN1	Sayward, BC		(b)	10/29/99	WP	Analysis	MLOD=	0.013 ug/g							
WA	Washington														
CN	Canada														
PHF	Palmer Hay Flats														
*	Transmitter came	Untied													

Table 12. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1998.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Area	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	2387-80995	Mallard	M	165.483	S	08/10/98	C/D								
2	2387-80996	Mallard	M	165.496	M	08/05/98	D								
3	2387-80997	Mallard	M	165.506	S	08/05/98	D								
4	2387-80998	Mallard	M	165.522	S	08/05/98	D	08/18/98	C/D	Scavenged	08/12/98	C	WP	No	No gizzard
5	2387-80999	Mallard	F	165.536	M	08/06/98	A								
6	2387-81000	Mallard	M	165.545	S	08/06/98	A								
7	2387-81101	Mallard	M	165.403	S	08/05/98	D								
8	2387-81102	Mallard	M	165.417	M	08/05/98	D	09/09/98	So. PHF	Scavenged			Shot		
9	2387-81103	Mallard	F	165.43	S	08/05/98	D	09/21/98	D	Carcass	09/21/98	C/D	WP	Yes	833.0
10	2387-81104	Mallard	M	165.443	M	08/05/98	D								
11	2387-81105	Mallard	M	165.457	S	08/10/98	C/D	09/26/98	GBM	Carcass			Shot		
12	2387-81106	Mallard	M	165.464	M	08/05/98	D	09/04/98	C/D	Carcass	09/03/98	C/D	WP	Yes	<MLOD
13	2387-81107	Mallard	F	165.557	M	08/06/98	A								
14	2387-81108	Mallard	M	165.566	S	08/06/98	A								
15	2387-81109	Mallard	M	165.587	M	08/06/98	A								
16	2387-81110	Mallard	M	165.594	S	08/06/98	A	09/25/98	CBM	Carcass			Shot		
17	2387-81111	Mallard	M	165.605	S	08/06/98	A	08/14/98	A	Carcass	08/12/98	A	WP	Yes	40.70
18	2387-81112	Mallard	F	165.623	M	08/06/98	A								
19	2387-81113	Mallard	M	165.632	S	08/06/98	A	10/15/98	A	Scavenged	08/13/98	A	WP	No	No gizzard
20	2387-81114	Mallard	M	165.645	M	08/10/98	D								
21	2387-81115	Mallard	M	165.664	S	08/06/98	A								
22	2387-81116	Mallard	M	165.685	M	08/06/98	A								
23	2387-81117	Mallard	F	165.699	S	08/06/98	B	08/24/98	C	Carcass	08/24/98	C	WP	Yes	69.10
24	2387-81118	Mallard	F	165.706	M	08/06/98	B								
25	2387-81119	Mallard	F	165.716	S	08/06/98	B	09/30/98	C/D	Scavenged	09/30/98	C/D	WP	No	No gizzard
26	2387-81120	Mallard	F	165.732	S	08/06/98	B	08/19/98	RI	Scavenged	08/17/98	Unknown	WP	Yes	<MLOD

Table 12 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1998.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Area	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
27	2387-81121	Mallard	M	165.741	S	08/06/98	B	08/19/98	RI	Carcass	08/17/98	RI	WP	Yes	1.410
28	2387-81122	Mallard	M	165.755	M	08/10/98	D								
29	2387-81123	Mallard	F	165.767	S	08/06/98	B	08/18/98	C/D	Scavenged	08/13/98	C/D	WP	No	No gizzard
30	2387-81124	Mallard	M	165.781	S	08/06/98	C/D								
31	2387-81125	Mallard	F	165.799	M	08/06/98	C/D								
32	2387-81126	Mallard	F	165.806	S	08/06/98	C/D								
33	2387-81127	Mallard	F	165.814	M	08/06/98	C/D	09/09/98	S BRD Aport	Scavenged			Shot		
34	2387-81128	Mallard	M	165.835	S	08/06/98	C/D								
35	2387-81129	Mallard	F	165.845	M	08/06/98	B								
36	2387-81130	Mallard	M	165.857	S	08/06/98	B								
37	2387-81131	Mallard	M	165.864	M	08/06/98	D								
38	2387-81132	Mallard	F	165.886	S	08/06/98	D								
39	2387-81133	Mallard	F	165.895	M	08/07/98	B	09/25/98	RI	only transmitter	09/21/98	RI	WP	No	No gizzard
40	2387-81134	Mallard	M	165.906	S	08/07/98	B								
41	2387-81135	Mallard	F	165.914	M	08/07/98	B								
42	2387-81136	Mallard	M	165.934	S	08/07/98	B								
43	2387-81137	Mallard	F	165.946	S	08/07/98	B	08/18/98	CW	Scavenged	08/19/98	C/D	WP	No	No gizzard
44	2387-81138	Mallard	M	165.956	S	08/10/98	D	08/20/98	C	Carcass	08/19/98	C	WP	Yes	89.10
45	2387-81139	Mallard	M	165.965	S	08/07/98	B	09/04/98	C/D	Carcass	09/03/98	C/D	WP	Yes	120.0
46	2387-81140	Mallard	M	165.981	M	08/07/98	A								
47	2387-81141	Mallard	F	165.995	S	08/07/98	A	09/04/98	B	Carcass	09/03/98	B	WP	Yes	<MLOD
48	2387-81142	Mallard	M	166.004	M	08/07/98	A	10/06/98	B	under H2O	10/06/98	B	WP	No	No gizzard
49	2387-81143	Mallard	F	166.017	S	08/07/98	A	10/13/98	BT	Scavenged	10/13/98	C/D	WP	No	No gizzard
50	2387-81144	Mallard	M	166.035	M	08/07/98	A								
51	2387-81145	Mallard	F	166.046	S	08/07/98	A								
52	2387-81146	Mallard	M	166.083	M	08/07/98	C/D								

Table 12 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1998.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Area	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
53	2387-81147	Mallard	M	166.093	S	08/10/98	RI								
54	2387-81148	Mallard	M	166.118	S	08/07/98	RI								
55	2387-81149	Mallard	M	166.13	M	08/07/98	RI								
56	2387-81150	Mallard	M	166.143	S	08/07/98	C/D								
57	2387-81151	Mallard	M	166.106	M	08/07/98	C/D								
58	2387-81152	Mallard	M	166.065	S	08/07/98	B								
59	2387-81153	Mallard	M	166.061	M	08/07/98	B								
60	2387-81154	Mallard	M	166.162	M	08/07/98	B								
61	2387-81155	Mallard	F	166.171	S	08/07/98	B	08/19/98	B	Scavenged	08/12/98	B	WP	No	No gizzard
62	2387-81156	Mallard	M	166.185	M	08/07/98	B								
63	2387-81157	Mallard	M	166.946	S	08/10/98	D								
64	2387-81158	Mallard	M	166.955	M	08/10/98	B								
65	2387-81159	Mallard	M	166.971	S	08/10/98	B								
66	2387-81160	Mallard	M	166.982	M	08/10/98	B	11/10/98	Cordova, AK	Carcass			Shot		
67	2387-81161	Mallard	M	166.996	S	08/10/98	B	09/28/98	A	Scavenged	09/18/98	A	WP	No	No gizzard
68	2387-81162	Mallard	F	167.007	S	08/10/98	C/D	08/18/98	C	Carcass	08/18/98	C	WP	Yes	294.0
69	2387-81163	Mallard	F	167.022	M	08/10/98	C/D								
70	2387-81164	Mallard	F	167.03	S	08/10/98	C/D								
71	2387-81165	Mallard	M	167.046	M	08/10/98	C/D								
72	2387-81166	Mallard	M	167.056	S	08/10/98	A								
73	2387-81167	Mallard	M	167.072	M	08/10/98	A	10/19/98	Anchorage	Carcass			Falcon		
74	2387-81168	Mallard	M	167.078	S	08/10/98	A								
75	2387-81169	Mallard	F	167.096	M	08/10/98	A								
76	2387-81170	Mallard	F	167.106	S	08/10/98	A	08/27/98	C/D	Scavenged	08/26/98	C/D	WP	No	No gizzard
77	2387-81171	Mallard	F	167.121	M	08/10/98	A								
78	2387-81172	Mallard	M	167.132	S	08/10/98	A								

Table 12 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1998.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Area	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
79	2387-81173	Mallard	F	167.146	M	08/11/98	A								
80	2387-81187	Mallard	M	167.155	S	08/11/98	B								
81	2387-81188	Mallard	M	167.168	M	08/11/98	B								
82	2387-81189	Mallard	M	167.178	S	08/11/98	B								
83	2387-81194	Mallard	M	167.19	M	08/11/98	A								
84	2387-81195	Mallard	F	167.210	S	08/11/98	A	10/01/98	C/D	under H2O	09/28/98	C/D	WP	No	No gizzard
85	2387-81196	Mallard	M	167.221	M	08/11/98	B								
86	2387-81197	Mallard	M	167.234	S	08/11/98	B								
87	2387-81198	Mallard	M	167.241	M	08/11/98	B								
88	2387-81199	Mallard	F	167.261	S	08/11/98	B								
89	2387-81200	Mallard	M	167.27	M	08/12/98	A								
90	2387-81201	Mallard	M	167.281	S	08/12/98	A								
91	2387-81202	Mallard	M	167.289	M	08/12/98	A	09/09/98	A	under H2O	08/31/98	A	WP	No	No gizzard
92	2387-81203	Mallard	M	167.31	S	08/12/98	B								
93	2387-81204	Mallard	F	167.32	M	08/12/98	B								
94	2387-81205	Mallard	M	167.336	S	08/12/98	D	08/26/98	C/D	Carcass	08/24/98	C/D	WP	Yes	0.1210
95	2387-81206	Mallard	M	167.347	M	08/12/98	D								
96	2387-81207	Mallard	M	167.354	S	08/12/98	A								
97	2387-81208	Mallard	M	167.369	M	08/12/98	A	09/01/98	GBM	Carcass			Shot		
98	2387-81209	Mallard	F	167.384	S	08/12/98	A	09/28/98	B	Scavenged	09/28/98	RI	WP	No	No gizzard
99	2387-81210	Mallard	M	167.399	M	08/12/98	A								
100	2387-81211	Mallard	F	167.405	S	08/12/98	B								
101	2387-81212	Mallard	F	167.413	M	08/12/98	B	10/05/98	C/D	Scavenged	10/05/98	C/D	WP	No	No gizzard
102	2387-81213	Mallard	M	167.435	S	08/12/98	B								
103	2387-81214	Mallard	M	167.445	M	08/12/98	B								
104	2387-81215	Mallard	M	167.455	S	08/12/98	B								

Table 12 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1998.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Area	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
105	2387-81216	Mallard	M	167.468	M	08/13/98	D								
106	2387-81217	Mallard	M	167.485	S	08/13/98	D	09/18/98	D	Carcass	09/17/98	C/D	WP	Yes	367.0
107	2387-81219	Mallard	M	167.497	M	08/13/98	A	10/15/98	A	Scavenged	10/14/98	A	WP	No	No gizzard
108	2387-81220	Mallard	M	167.506	S	08/13/98	B								
109	2387-81221	Mallard	M	167.517	S	08/13/98	B	08/20/98	C	Scavenged	08/19/98	C	WP	Yes	228.0

1/7/99 WP Analysis, MLOD = 0.014 ug

Table 13. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1999.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	1477-73701	Mallard	M	165.804	S	08/17/99	A	10/23/99	Jim Creek (1)	Recovered			Shot		
2	1477-73702	Mallard	M	165.781	M	08/17/99	A								
3	1477-73703	Mallard	M	165.755	S	08/17/99	A	09/02/99	A	Scavenged	08/30/99	A	WP	No	No gizzard
4	1477-73704	Mallard	M	165.742	M	08/17/99	A								
5	1477-73705	Mallard	M	165.731	S	08/17/99	A	12/11/99	Comox, BC, CN	Recovered			Shot		
6	1477-73706	Mallard	M	165.722	S	08/17/99	A								
7	1477-73707	Mallard	M	165.693	S	08/17/99	B								
8	1477-73708	Mallard	F	165.655	M	08/17/99	A	09/21/99	A	Recovered	09/20/99	A	WP	Yes	0.633
9	1477-73709	Mallard	M	165.682	M	08/17/99	D trap								
10	1477-73710	Mallard	M	165.668	S	08/17/99	D trap								
11	1477-73711	Mallard	M	165.548	M	08/17/99	D trap								
12	1477-73712	Mallard	M	165.642	S	08/17/99	D trap								
13	1477-73713	Mallard	M	165.605	M	08/17/99	D trap	09/01/99	Birchwood	Recovered			Shot		
14	1477-73714	Mallard	M	165.521	S	08/17/99	D trap								
15	1477-73715	Mallard	M	165.630	M	08/17/99	D trap	09/16/99	C/D	Recovered	09/16/99	C/D	WP	Yes	155.0
16	1477-73716	Mallard	M	165.622	S	08/17/99	D trap								
17	1477-73717	Mallard	M	165.571	S	08/17/99	D trap								
18	1477-73718	Mallard	M	165.554	M	08/18/99	B	none	b/w B & ER	Unrecovered	09/30/99	Unknown	Unknown	No	No gizzard
19	1477-73719	Mallard	M	165.532	M	08/18/99	A	09/21/99	C/D	Recovered	09/21/99	C/D	WP	Yes	0.116
20	1477-73720	Mallard	M	165.507	S	08/18/99	A								
21	1477-73721	Mallard	M	165.494	M	08/18/99	C/D	none	Inlet	Unrecovered	08/23/99	Unknown	Unknown	No	No gizzard
22	2387-80944	Mallard	M	167.167	S	08/09/99	B								
23	2387-81001	Mallard	F	167.995	S	08/04/99	B								
24	2387-81002	Mallard	M	167.978	S	08/04/99	B								
25	2387-81003	Mallard	F	167.969	S	08/04/99	B								
26	2387-81004	Mallard	F	167.952	S	08/04/99	B								

Table 13 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1999.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
27	2387-81005	Mallard	F	167.941	S	08/04/99	B								
28	2387-81006	Mallard	M	167.933	S	08/04/99	B								
29	2387-81007	Mallard	F	167.917	S	08/04/99	B	10/30/99	Portage Val. AK	Recovered			Shot		
30	2387-81008	Mallard	M	167.905	S	08/04/99	B								
31	2387-81009	Mallard	F	167.897	S	08/04/99	B								
32	2387-81010	Mallard	F	167.880	S	08/04/99	B								
33	2387-81011	Mallard	F	167.868	S	08/04/99	B								
34	2387-81012	Mallard	M	167.857	S	08/04/99	B								
35	2387-81013	Mallard	F	167.841	S	08/04/99	B	09/15/99	A	Scavenged	09/15/99	A	WP	No	No gizzard
36	2387-81015	Mallard	M	167.818	S	08/04/99	B								
37	2387-81016	Mallard	F	167.805	S	08/04/99	B	08/11/99	B	Predated	08/10/99		Predation		
38	2387-81017	Mallard	F	167.794	S	08/04/99	B								
39	2387-81019	Mallard	M	167.553	S	08/04/99	C/D	10/16/99	GBM	Recovered			Shot		
40	2387-81020	Mallard	M	167.453	S	08/04/99	C/D	09/24/99	C	Recovered	09/24/99	C	WP	Yes	505.0
41	2387-81021	Mallard	M	167.505	S	08/04/99	C/D								
42	2387-81022	Mallard	M	165.704	M	08/17/99	C/D								
43	2387-81023	Mallard	F	167.779	S	08/04/99	B	09/02/99	B	Recovered	09/02/99	B	WP	Yes	0.0013
44	2387-81024	Mallard	F	167.770	S	08/04/99	B	09/07/99	RI river	Scavenged	09/01/99	C	WP	No	No gizzard
45	2387-81025	Mallard		167.753	S	08/04/99	B	08/08/99	B	Recovered	08/07/99	B	Attachment	Yes	ND
46	2387-81026	Mallard	F	167.745	S	08/04/99	B								
47	2387-81027	Mallard	M	167.730	S	08/04/99	B	09/03/99	B	Recovered	09/03/99	B	Unknown	Yes	ND
48	2387-81028	Mallard	M	167.719	S	08/04/99	B	09/21/99	A trees	Unrecovered	09/17/99	C	WP	No	No gizzard
49	2387-81029	Mallard	F	167.705	S	08/04/99	B								
50	2387-81030	Mallard	F	167.696	S	08/04/99	B	09/14/99	A	Scavenged	09/10/99	A	WP	No	No gizzard
51	2387-81031	Mallard	F	167.681	S	08/04/99	B								

Table 13 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1999.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
52	2387-81032	Mallard	M	167.541	S	08/04/99	C/D	09/14/99	A	Scavenged	09/07/99	A	WP	No	No gizzard
53	2387-81033	Mallard	M	167.671	S	08/04/99	B	10/01/99	RI river	Unrecovered	09/27/99	B	WP	No	No gizzard
54	2387-81034	Mallard	M	167.433	S	08/04/99	B								
55	2387-81035	Mallard	M	167.468	S	08/04/99	B								
56	2387-81036	Mallard	M	167.418	S	08/04/99	B								
57	2387-81037	Mallard	F	167.403	S	08/04/99	B	08/11/99	B	Predated	08/10/99		Predation		
58	2387-81038	Mallard	M	167.653	S	08/04/99	B	08/13/99	C	Recovered	08/13/99	C	WP	Yes	0.228
59	2387-81039	Mallard	F	167.642	S	08/04/99	B	08/30/99	A	Scavenged	08/27/99	A	WP	No	No gizzard
60	2387-81041	Mallard	F	167.624	S	08/06/99	A								
61	2387-81042	Mallard	F	167.607	S	08/06/99	A								
62	2387-81043	Mallard	M	167.596	S	08/06/99	A								
63	2387-81044	Mallard	F	167.582	S	08/06/99	A								
64	2387-81045	Mallard	M	167.567	S	08/06/99	A	09/14/99	A	Scavenged	09/07/99	A	WP	No	No gizzard
65	2387-81046	Mallard	F	167.532	S	08/06/99	A	08/30/99	A	Scavenged	08/23/99	A	WP	No	No gizzard
66	2387-81047	Mallard	M	167.494	S	08/06/99	A								
67	2387-81048	Mallard	F	167.481	S	08/06/99	A								
68	2387-81049	Mallard	F	167.443	S	08/06/99	A								
69	2387-81050	Mallard	F	167.518	S	08/06/99	A								
70	2387-81051	Mallard	M	167.352	S	08/06/99	A	09/13/99	BT	Recovered	09/13/99	C	WP	Yes	13.50
71	2387-81052	Mallard	M	167.396	S	08/06/99	B								
72	2387-81053	Mallard	F	167.381	S	08/06/99	B								
73	2387-81054	Mallard	F	167.369	S	08/06/99	B	10/04/99	A	Scavenged	10/01/99	A	WP	No	No gizzard
74	2387-81055	Mallard	F	167.343	S	08/06/99	A								
75	2387-81056	Mallard	F	167.332	S	08/06/99	C/D								
76	2387-81057	Mallard	M	167.315	S	08/06/99	C/D								
77	2387-81058	Mallard	F	167.304	S	08/06/99	C/D								

Table 13 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1999.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
78	2387-81059	Mallard	M	167.753	S	08/09/99	D trap								
79	2387-81060	Mallard	F	167.832	S	08/09/99	D trap	10/07/99	PHF	Scavenged	10/01/99		Shot		
80	2387-81061	Mallard	M	167.292	S	08/09/99	D trap								
81	2387-81062	Mallard	F	167.279	S	08/09/99	D trap								
82	2387-81063	Mallard	M	167.266	S	08/09/99	D trap								
83	2387-81064	Mallard	M	167.254	S	08/09/99	D trap	09/22/99	C/D	Scavenged	09/21/99	C/D	WP	No	No gizzard
84	2387-81065	Mallard	M	167.244	S	08/09/99	D trap	08/13/99	C/D	Predated	08/13/99	C/D	Predation	Yes	ND
85	2387-81066	Mallard	M	167.232	S	08/09/99	D trap								
86	2387-81067	Mallard	F	167.219	S	08/09/99	D trap	08/27/99	C	Recovered	08/25/99	C	WP	Yes	38.0
87	2387-81068	Mallard	M	167.204	S	08/09/99	B								
88	2387-81069	Mallard	M	167.193	S	08/09/99	B								
89	2387-81070	Mallard	F	167.152	S	08/09/99	B								
90	2387-81071	Mallard	M	167.145	S	08/09/99	B								
91	2387-81072	Mallard	F	167.130	S	08/10/99	C/D								
92	2387-81073	Mallard	M	167.118	S	08/10/99	B								
93	2387-81074	Mallard	M	167.105	S	08/10/99	B								
94	2387-81075	Mallard	F	167.096	S	08/10/99	B								
95	2387-81076	Mallard	M	167.179	S	08/10/99	B								
96	2387-81077	Mallard	M	167.805	S	08/11/99	B								
97	2387-81078	Mallard	F	167.080	S	08/11/99	C/D								
98	2387-81079	Mallard	F	167.054	S	08/11/99	C/D								
99	2387-81080	Mallard	M	167.403	S	08/11/99	B								
100	2387-81081	Mallard	M	167.631	S	08/11/99	D trap								
101	2387-81082	Mallard	F	167.006	S	08/11/99	D trap	08/30/99	C/D	Recovered	08/30/99	C/D	WP	Yes	3,210.0
102	2387-81083	Mallard	F	167.028	S	08/11/99	D trap								
103	2387-81084	Mallard	M	167.045	S	08/11/99	D trap								

Table 13 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 1999.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard
104	2387-81085	Mallard	F	166.994	S	08/13/99	A							
105	2387-81086	Mallard	M	166.979	S	08/13/99	A							
106	2387-81087	Mallard	M	166.951	S	08/13/99	A							
107	2387-81088	Mallard	F	166.968	S	08/13/99	A							
108	2387-81089	Mallard	M	166.943	S	08/13/99	A	08/25/99	Eagle Nest	Unrecovered	08/20/99	BT	WP	No
109	2387-81090	Mallard	F	166.931	S	08/14/99	A	08/30/99	C/D	Scavenged	08/27/99	C/D	WP	Yes
110	2387-81091	Mallard	F	165.929	S	08/14/99	A							
111	2387-81092	Mallard	F	165.921	S	08/14/99	A							
112	2387-81093	Mallard	M	165.895	S	08/14/99	A							
113	2387-81094	Mallard	F	165.882	S	08/14/99	A							
114	2387-81095	Mallard	M	165.868	S	08/14/99	D trap	09/21/99	C/D	Recovered	09/20/99	C/D	WP	Yes
115	2387-81096	Mallard	M	165.854	S	08/14/99	D trap							
116	2387-81100	Mallard	F	165.820	M	08/17/99	B							
	10/29/99 WP Analysis, MLOD = 0.013 ug													
	ND = no peak was >3X the baseline noise of the instrument													
	(1) Jim Creek is 10 mi E Palmer													

Table 14. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2001.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	2387-81401	Mallard	M	165.403	S	08/02/01	B								
2	2387-81402	Mallard	M	165.419	S	08/02/01	B								
3	2387-81403	Mallard	M	165.440	S	08/02/01	B								
4	2387-81404	Mallard	F	165.453	S	08/02/01	B								
5	2387-81406	Mallard	M	165.480	S	08/02/01	B								
6	2387-81407	Mallard	M	165.492	S	08/02/01	B								
7	2387-81408	Mallard	F	165.506	S	08/02/01	B	08/09/01	B	Recov	08/09/01	B	Unknown	Yes	ND
8	2387-81409	Mallard	M	165.517	S	08/02/01	B								
9	2387-81410	Mallard	M	165.530	S	08/02/01	C/D								
10	2387-81411	Mallard	UNK	165.431	S	08/02/01	C/D								
11	2387-81412	Mallard	M	165.545	S	08/02/01	C/D								
12	2387-81413	Mallard	M	165.556	S	08/02/01	C/D								
13	2387-81414	Mallard	UNK	165.568	S	08/02/01	C/D				09/26/01	EAFB	Shot	No	No gizzard
14	2387-81415	Mallard	F	165.581	S	08/02/01	C/D								
15	2387-81416	Mallard	F	165.592	S	08/02/01	C/D								
16	2387-81417	Mallard	M	165.604	S	08/02/01	C/D				04/30/03	CAN	Shot	No	No gizzard
17	2387-81418	Mallard	M	165.618	S	08/02/01	C/D								
18	2387-81419	Mallard	M	165.628	S	08/02/01	C/D	09/04/01	C	Recov	9/2-4/01	C	WP	Yes	19.0
19	2387-81420	Mallard	F	165.644	S	08/02/01	C/D	10/12/01	C/D	Recov	10/11-12/01	C/D	WP	No	No gizzard
20	2387-81421	Mallard	M	165.654	S	08/02/01	C/D								
21	2387-81422	Mallard	M	165.668	S	08/02/01	C/D				10/09/01	ANC	Shot	No	No gizzard
22	2387-81423	Mallard	F	165.683	S	08/02/01	C/D				10/03/01	PHF	Shot	No	No gizzard
23	2387-81424	Mallard	F	165.692	S	08/02/01	C/D								
24	2387-81425	Mallard	F	165.705	S	08/02/01	C/D								
25	2387-81426	Mallard	M	165.717	S	08/02/01	C/D								
26	2387-81427	Mallard	M	165.731	S	08/02/01	C/D								

Table 14 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2001.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard
27	2387-81428	Mallard	F	165.743	S	08/02/01	C/D							
28	2387-81429	Mallard	M	165.754	S	08/03/01	C/D							
29	2387-81430	Mallard	M	165.780	S	08/03/01	C/D							
30	2387-81431	Mallard	M	165.791	S	08/03/01	A							
31	2387-81432	Mallard	F	165.805	S	08/03/01	A				10/04/01	PHF	Shot	No
32	2387-81434	Mallard	M	165.843	S	08/03/01	C/D							
33	2387-81435	Mallard	UNK	165.856	S	08/03/01	C/D				09/06/01	PHF	Shot	No
34	2387-81436	Mallard	M	165.869	S	08/03/01	C/D				10/06/01	GBM	Shot	No
35	2387-81437	Mallard	M	165.877	S	08/03/01	C/D							
36	2387-81438	Mallard	M	165.904	S	08/03/01	D				10/14/01	PHF	Shot	No
37	2387-81440	Mallard	M	165.927	S	08/03/01	C/D							
38	2387-81441	Mallard	F	165.944	S	08/03/01	C/D							
39	2387-81442	Mallard	F	166.944	S	08/03/01	C/D	08/07/01	C/D	Recov	08/06/01	C/D	WP	Partial
40	2387-81443	Mallard	F	166.972	S	08/03/01	C/D				09/01/01	Knik Riv	Shot	No
41	2387-81444	Mallard	F	165.468	S	08/05/01	A							
42	2387-81445	Mallard	F	166.980	S	08/05/01	A				10/21/01	Wasilla	Shot	No
43	2387-81446	Mallard	M	166.993	S	08/05/01	C/D				10/12/01	EAFB	Shot	Yes
44	2387-81447	Mallard	M	167.004	S	08/05/01	C/D							
45	2387-81448	Mallard	F	167.017	S	08/05/01	C/D							
46	2387-81449	Mallard	F	167.032	S	08/05/01	C/D							
47	2387-81450	Mallard	M	167.046	S	08/05/01	C/D							
48	2387-81451	Mallard	M	167.055	S	08/05/01	C/D							
49	2387-81452	Mallard	F	167.068	S	08/05/01	C/D							
50	2387-81453	Mallard	M	167.079	S	08/05/01	C/D							
51	2387-81454	Mallard	M	167.094	S	08/05/01	C/D							
52	2387-81455	Mallard	M	167.108	S	08/05/01	C/D							

Table 14 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2001.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
53	2387-81456	Mallard	F	167.120	S	08/05/01	C/D								
54	2387-81457	Mallard	M	167.133	S	08/05/01	C/D	10/17/01	Riv. Chan.	Unrec	10/12-17/01	C/D	WP	No	No gizzard
55	2387-81458	Mallard	M	167.143	S	08/05/01	C/D								
56	2387-81459	Mallard	F	167.153	S	08/06/01	C/D								
57	2387-81460	Mallard	M	165.829	S	08/06/01	C/D								
58	2387-81461	Mallard	M	167.167	S	08/06/01	C/D								
59	2387-81462	Mallard	F	167.179	S	08/06/01	C/D								
60	2387-81463	Mallard	F	167.193	S	08/06/01	C/D	09/11/01	A	Recov	09/11/01	A	WP	Yes	21.1
61	2387-81464	Mallard	M	167.220	S	08/06/01	C/D								
62	2387-81465	Mallard	M	167.231	S	08/06/01	C/D								
63	2387-81466	Mallard	M	167.241	S	08/06/01	C/D								
64	2387-81467	Mallard	M	167.254	S	08/06/01	C/D								
65	2387-81468	Mallard	M	167.270	S	08/06/01	C/D								
66	2387-81469	Mallard	F	167.481	S	08/07/01	B								
67	2387-81470	Mallard	M	167.469	S	08/07/01	B								
68	2387-81472	Mallard	M	167.445	S	08/07/01	B								
69	2387-81473	Mallard	M	167.282	S	08/07/01	D								
70	2387-81474	Mallard	M	167.291	S	08/07/01	D								
71	2387-81475	Mallard	M	167.305	S	08/07/01	D								
72	2387-81476	Mallard	M	167.317	S	08/07/01	D								
73	2387-81477	Mallard	F	167.345	S	08/07/01	D								
74	2387-81478	Mallard	M	167.355	S	08/07/01	D								
75	2387-81479	Mallard	F	167.368	S	08/07/01	D								
76	2387-81480	Mallard	F	167.380	S	08/07/01	D				10/12/01	ANC	Shot	No	No gizzard
77	2387-81482	Mallard	M	167.397	S	08/08/01	B				09/09/01	Swan Lk	Shot	No	No gizzard
78	2387-81483	Mallard	M	167.421	S	08/08/01	A								

Table 14 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2001.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
79	2387-81484	Mallard	M	167.581	S	08/08/01	A								
80	2387-81485	Mallard	M	167.569	S	08/08/01	A				10/13/01	Wasilla	Shot	No	No gizzard
81	2387-81486	Mallard	M	167.595	S	08/08/01	C/D								
82	2387-81487	Mallard	M	167.494	S	08/08/01	C/D								
83	2387-81488	Mallard	M	167.606	S	08/08/01	C/D								
84	2387-81489	Mallard	F	167.516	S	08/08/01	C/D								
85	2387-81490	Mallard	F	167.541	S	08/08/01	C/D	08/18/01	B	Recov	08/18/01	B	WP	Yes	771.0
86	2387-81491	Mallard	M	167.531	S	08/08/01	D								
87	2387-81492	Mallard	F	167.617	S	08/08/01	D								
88	2387-81493	Mallard	M	167.552	S	08/08/01	D								
89	2387-81494	Mallard	M	167.629	S	08/08/01	D								
90	2387-81495	Mallard	M	167.656	S	08/08/01	D	08/12/01	C/D	Recov	08/12/01	C/D	WP	Yes	2.92
91	2387-81496	Mallard	M	165.921	S	08/08/01	D								
92	2387-81497	Mallard	M	167.672	S	08/09/01	A								
93	2387-81498	Mallard	UNK	167.642	S	08/09/01	A				10/15/01	ANC	Alive		
94	2387-81499	Mallard	M	167.680	S	08/09/01	B								
95	2387-81500	Mallard	M	167.730	S	08/09/01	B	08/26/01	B	Recov	08/26/01	B	Attachment	Yes	ND
96	2387-82001	Mallard	M	167.721	S	08/09/01	B	09/29/01	C/D	Recov	9/28-29/01	C/D	WP	No	No gizzard
97	2387-82002	Mallard	F	167.752	S	08/09/01	B								
98	2387-82003	Mallard	M	167.744	S	08/09/01	C/D	09/08/01	C/D	Recov	09/08/01	C/D	WP	Yes	142.0
99	2387-82004	Mallard	F	167.695	S	08/09/01	C/D								
100	2387-82005	Mallard	F	167.843	S	08/09/01	C/D								
101	2387-82006	Mallard	M	167.878	S	08/09/01	C/D								
102	2387-82007	Mallard	M	167.953	S	08/10/01	C/D								
103	2387-82008	Mallard	F	167.897	S	08/10/01	C/D								
104	2387-82009	Mallard	M	167.793	S	08/10/01	C/D	09/30/01	C	Recov	09/30/01	C	WP	Yes	1.18

Table 14 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2001.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
105	2387-82010	Mallard	F	167.994	S	08/10/01	C/D								
106	2387-82011	Mallard	M	167.978	S	08/10/01	C/D								
107	2387-82012	Mallard	F	167.771	S	08/10/01	C/D	09/04/01	C	Recov	9/2-4/01	C	WP	No	No gizzard
108	2387-82013	Mallard	M	167.968	S	08/10/01	C/D				01/08/03	Br. Col. CN	Shot	No	No gizzard
109	2387-82026	Mallard	M	167.904	S	08/15/01	D								
110	2387-82027	Mallard	F	167.920	S	08/15/01	D								
111	2387-82028	Mallard	M	167.930	S	08/15/01	D								
112	2387-82029	Mallard	M	167.947	S	08/15/01	D				10/20/01	PHF	Shot	No	No gizzard
	MLOD = 0.015ug														
	ND = not detected														
	Br. Col. CN = British Columbia, Canada														

Table 15. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2002.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
1	2387-82023	Mallard	M	165.657	S	08/15/02	C/D								
2	2387-82030	Mallard	M	165.703	S	08/15/02	C/D								
3	2387-82031	Mallard	F	165.695	S	08/15/02	C/D								
4	2387-82032	Mallard	M	165.644	S	08/15/02	C/D	09/04/02	near EOD	Trans	08/31/02	C	WP	No	No gizzard
5	2387-82033	Mallard	M	165.636	S	08/15/02	C/D								
6	2387-82034	Mallard	M	165.622	S	08/15/02	C/D								
7	2387-82035	Mallard	M	165.608	S	08/15/02	C/D								
8	2387-82036	Mallard	UNK	165.596	S	08/15/02	C/D								
9	2387-82037	Mallard	F	165.582	S	08/16/02	B								
10	2387-82038	Mallard	F	165.518	S	08/16/02	D	08/29/02	C/D	Trans	08/29/02	C/D	WP	No	No gizzard
11	2387-82039	Mallard	M	165.496	S	08/16/02	D								
12	2387-82040	Mallard	M	165.506	S	08/16/02	C/D								
13	2387-82041	Mallard	F	165.546	S	08/16/02	B	10/15/02	C/D	Recov	10/15/02	C/D	WP	Yes	3.9
14	2387-82042	Mallard	M	165.556	S	08/16/02	B				10/27/02	Eklutna	Shot	No	No gizzard
15	2387-82043	Mallard	M	165.531	S	08/16/02	B								
16	2387-82044	Mallard	M	165.405	S	08/16/02	B								
17	2387-82045	Mallard	F	165.568	S	08/16/02	A								
18	2387-82046	Mallard	M	165.420	S	08/16/02	B				10/09/02	Wasilla	Shot	No	No gizzard
19	2387-82047	Mallard	F	165.447	S	08/16/02	C/D								
20	2387-82048	Mallard	M	165.484	S	08/16/02	C/D								
21	2387-82049	Mallard	M	165.471	S	08/16/02	C/D								
22	2387-82050	Mallard	M	165.457	S	08/16/02	C/D	10/02/02	near EOD	Recov	08/31/02	C/D	WP	No	No gizzard
23	2387-82051	Mallard	M	167.665	S	08/16/02	C/D								No gizzard
24	2387-82052	Mallard	M	167.682	S	08/16/02	C/D				12/17/02	ANC	Shot	No	No gizzard
25	2387-82056	Mallard	M	167.695	S	08/17/02	C/D								
26	2387-82058	Mallard	M	167.730	S	08/17/02	C/D								

Table 15 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2002.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
27	2387-82060	Mallard	M	167.705	S	08/17/02	C/D								
28	2387-82061	Mallard	M	167.748	S	08/17/02	C/D								
29	2387-82063	Mallard	M	167.767	S	08/17/02	C/D				09/02/02	PHF	Shot	No	No gizzard
30	2387-82064	Mallard	F	167.782	S	08/17/02	C/D								
31	2387-82065	Mallard	M	167.969	S	08/18/02	B				11/01/02	GBM	Shot	No	No gizzard
32	2387-82067	Mallard	F	167.955	S	08/17/02	C/D	08/22/02	B	Recov	08/20/02	B	Unk	Yes	ND
33	2387-82068	Mallard	M	167.946	S	08/17/02	B								
34	2387-82069	Mallard	M	167.931	S	08/17/02	B								
35	2387-82070	Mallard	F	167.917	S	08/17/02	B								
36	2387-82071	Mallard	F	167.908	S	08/17/02	B								
37	2387-82072	Mallard	M	167.793	S	08/17/02	C/D				09/20/02	PHF	Shot	No	No gizzard
38	2387-82073	Mallard	M	167.878	S	08/17/02	C/D								
39	2387-82074	Mallard	M	167.868	S	08/17/02	C/D								
40	2387-82075	Mallard	M	167.854	S	08/17/02	C/D								
41	2387-82076	Mallard	M	167.840	S	08/17/02	A								
42	2387-82077	Mallard	M	167.829	S	08/17/02	A	09/15/02	C/D-C	Recov	09/15/02	C/D-C	WP	No	No gizzard
43	2387-82078	Mallard	M	167.819	S	08/17/02	A								
44	2387-82079	Mallard	M	167.807	S	08/17/02	A								
45	2387-82080	Mallard	F	167.180	S	08/18/02	A								
46	2387-82081	Mallard	M	167.193	S	08/18/02	B								
47	2387-82082	Mallard	M	167.219	S	08/18/02	B								
48	2387-82083	Mallard	M	167.205	S	08/18/02	B								
49	2387-82084	Mallard	M	167.230	S	08/18/02	C/D								
50	2387-82085	Mallard	M	167.241	S	08/18/02	C/D								
51	2387-82086	Mallard	M	167.254	S	08/18/02	C/D								
52	2387-82092	Mallard	M	167.282	S	08/19/02	C/D	09/03/02	near UCP	Trans	08/31/02	A	WP	No	No gizzard

Table 15 cont. Summary and status of radio-marked mallards from Eagle River Flats, Fort Richardson, Alaska, 2002.

#	Band Number	Species	Sex	Trans-mitter Frequency	Trans-mitter Type	Capture Date	Capture Location	Recovery Date	Recovery Area	Status	Mortality Date	Mortality Area	Cause of Mortality	Gizzard	WP (µg/g)
53	2387-82094	Mallard	F	167.294	S	08/19/02	B								
54	2387-82095	Mallard	F	167.305	S	08/19/02	A	10/11/02	RI	Recov	10/11/02	RI	Predated	Yes	ND
55	2387-82096	Mallard	F	167.756	S	08/20/02	C/D								
56	2387-82097	Mallard	M	167.719	S	08/20/02	C/D								
57	2387-82098	Mallard	F	167.319	S	08/20/02	C/D								
58	2387-82100	Mallard	UNK	167.108	S	08/20/02	C/D								
59	2387-81501	Mallard	F	167.117	S	08/20/02	C/D								
60	2387-81502	Mallard	F	167.133	S	08/20/02	C/D	09/19/02	C/D	Recov	09/19/02	C/D	WP	Yes	2.49
61	2387-81503	Mallard	F	167.146	S	08/20/02	C/D	09/16/02	BT	Recov	09/16/02	BT	WP	Yes	12.9
62	2387-81504	Mallard	F	167.155	S	08/20/02	B								
63	2387-81505	Mallard	F	167.168	S	08/20/02	B	09/03/02	B	UnRec	08/31/02	B	Unk	No	No gizzard
64	2387-81506	Mallard	F	167.033	S	08/20/02	B								
65	2387-81507	Mallard	F	167.045	S	08/20/02	B	08/29/02	near UCP	UnRec	08/27/02	B	Unk	No	No gizzard
66	2387-81508	Mallard	F	167.056	S	08/21/02	C/D								
67	2387-81509	Mallard	F	167.080	S	08/21/02	B				10/26/02	Swan Lk	Shot	No	No gizzard
68	2387-81510	Mallard	M	167.095	S	08/21/02	B								
	MLOD =														
	ND = not detected														

Table 16. Mortality of radio-marked mallards from white phosphorus (WP) during August, September and October from 1996 to 2002 on Eagle River Flats, Fort Richardson, Alaska.

Year	Captured (no.)	Mortalities (no.)	WP Mortalities (no.)
1996	107	43	38
1997	136	37	21
1998	109	36	29
1999	116	37	24
2000*	NA	NA	NA
2001	112	29	11
2002	68	19	8

*No telemetry was conducted in 2000.

Table 17. Mortality of radio-marked mallards from other causes than white phosphorus from 1996 to 2002, Eagle River Flats, Fort Richardson, Alaska.

Year	Hunting	Predation	Attachment Method	Unknown
1996	2	3	0	0
1997	13	3	0	0
1998	6	1	0	0
1999	6	3	1	3
2000*	NA	NA	NA	NA
2001	16	0	1	1
2002	7	1	0	3
TOTAL	50	11	2	7

*No telemetry conducted in 2000.

Table 18. Mortality locations of radio-marked mallard deaths attributed to white phosphorous using Eagle River Flats, Fort Richardson, Alaska in 1996-2002.

		Area								
Year	*Transmitter*	*A*	*B*	*C*	*D*	*BT*	*C/D*	*RI*	*CE/CW*	*Total*
1996	Standard	3	2	2	0	1	3	4	0	15
	Mortality	5	0	11	0	1	4	2	0	23
	Total	8	2	13	0	2	7	6	0	38
1997	Standard	2	0	0	0	2	2	1	0	7
	Mortality	3	2	3	0	3	2	1	0	14
	Total	5	2	3	0	5	4	2	0	21
1998	Standard	3	2	5	0	0	10	3	0	23
	Mortality	2	1	0	0	0	2	1	0	6
	Total	5	3	5	0	0	12	4	0	29
1999	Standard	8	2	6	0	1	4	0	0	21
	Mortality	1	0	0	0	0	2	0	0	3
	Total	9	2	6	0	1	6	0	0	24
2001	Standard	1	1	3	0	0	6	0	0	11
	Mortality	0	0	0	0	0	0	0	0	0
	Total	1	1	3	0	0	6	0	0	11
2002	Standard	1	0	1	0	1	5	0	0	8
	Mortality	0	0	0	0	0	0	0	0	0
	Total	1	0	1	0	1	5	0	0	8
TOTAL		29	10	31	0	9	40	12	0	131

Table 19. Presence of white phosphorus in radio-marked mallards recovered from Eagle River Flats, Fort Richardson, Alaska from 1996 to 2002.

Year	Mallard Mortalities	WP Mortalities	Mallards Recovered	Mallards Tested	WP Positive
1996	43	38	8	8	8
1997	37	21	15	7	5
1998	36	29	13	13	10
1999	37	24	11	11	11
2000[1]	NA	NA	NA	NA	NA
2001	29	11	7	7	7
2002	19	8	3	3	3

[1] No telemetry was conducted in 2000.

Table 20. Mortality Model for Eagle River Flats, Fort Richardson, Alaska, August 3 to October 16, 1996.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	WP Mortality (no.)	Identified Dabblers (no.)	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for Turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/3-8/20	107	27	11	712	201	913	308	1,221	126
8/21-8/27	80	8	6	880	1,026	1,906	212	2,118	159
8/28-8/31	72	0	0	1,257	855	2,112	0	2,112	0
9/1-9/3	72	1	1	145	627	772	11	783	11
9/4-9/6	71	3	1	203	1,451	1,654	73	1,727	24
9/7-9/9	68	2	2	489	697	1,186	36	1,222	36
9/10-9/12	66	5	1	970	760	1,730	142	1,872	28
9/13-9/16	61	4	2	632	1,594	2,226	156	2,382	78
9/17-9/19	57	4	2	664	1,492	2,156	163	2,319	81
9/20-9/23	53	4	4	79	675	754	62	816	62
9/24-9/26	49	1	1	122	537	659	14	673	14
9/27-9/30	48	1	1	345	52	397	8	405	8
10/1-10/4	47	0	0	1044	0	1,044	0	1,044	0
10/5-10/8	47	2	2	300	198	498	22	520	22
10/9-10/11	45	6	2	650	48	698	107	805	36
10/12-10/16	39	35	2	14	0	14	123	137	7
Total	107	103	38	--	--	--	--	--	692

*Unidentified ducks are 95% dabblers

Table 21. Mortality model for Eagle River Flats, Fort Richardson, Alaska, August 4 to October 22, 1997.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	Mortality (no.)	Identified Dabblers (no.)	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/4-8/18	136	28	5	263	71	334	87	421	15
8/19-8/21	108	5	2	123	172	295	14	309	6
8/22-8/26	103	3	1	575	114	689	21	710	7
8/27-8/28	100	1	1	221	439	660	7	667	7
8/29-9/2	99	6	1	455	371	826	53	879	9
9/3	93	0	0	468	622	1,090	0	1,090	0
9/4-9/8	93	0	0	1,135	896	2,031	0	2,031	0
9/9-9/10	93	0	0	485	3,011	3,496	0	3,496	0
9/11-9/16	93	6	3	103	192	295	20	315	10
9/17-9/18	87	2	2	27	348	375	9	384	9
9/19-9/23	85	2	2	276	281	557	13	570	13
9/24-9/25	83	5	0	324	266	590	38	628	0
9/26-9/30	78	7	0	30	1,110	1,140	112	1252	0
10/1-10/2	71	5	0	738	390	1,128	85	1213	0
10/3-10/6	66	5	2	175	278	453	37	490	15
10/7-10/9	61	22	2	163	177	340	192	532	17
10/10-10/16	39	32	0	18	0	18	82	100	0
10/17-10/22	7	0	0	6	0	6	0	6	0
Total	136	129	21	--	--	--	--	--	108

*Unidentified ducks are 95% dabblers

Table 22. Mortality model for Eagle River Flats, Fort Richardson, Alaska, August 4 to October 21, 1998.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	Mortality (no.)	Identified Dabblers	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for Turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/04-8/19	109	24	11	270	585	855	237	1,092	110
8/20-8/26	85	3	3	241	618	859	31	890	31
8/27-9/2	82	6	1	319	1,199	1,518	129	1,647	20
9/3-9/4	76	5	3	665	589	1,254	85	1,339	53
9/5-9/7	71	0	0	426	10	436	0	436	0
9/8-9/10	71	2	0	838	0	838	22	860	0
9/11-9/15	69	0	0	490	0	490	0	490	0
9/16-9/18	69	2	2	605	0	605	18	623	18
9/19-9/22	67	2	2	302	1	303	9	312	9
9/23-9/24	65	0	0	515	38	553	0	553	0
9/25-9/28	65	6	2	1,148	190	1,338	126	1,464	45
9/29-10/2	60	1	1	181	45	226	4	230	4
10/3-10/7	59	4	2	488	0	488	34	522	18
10/8-10/12	55	2	0	481	69	550	19	569	0
10/12-10/16	53	4	2	224	0	224	17	241	9
10/17-10/21	49	0	0	140	0	140	0	140	0
Total	109	60	29	--	--	--	--	--	317

*Unidentified ducks are 95% dabblers

Table 23. Mortality model for Eagle River Flats, Fort Richardson, Alaska, August 4 to October 20, 1999.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	Mortality (no.)	Identified Dabblers (no.)	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for Turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/4-8/20	116	22	2	251	43	294	69	363	6
8/21-8/24	94	4	1	435	158	593	26	619	7
8/25-8/30	90	15	5	253	52	305	61	366	20
8/31-9/3	75	8	2	289	0	289	35	324	9
9/4-9/8	67	6	2	117	26	143	14	157	5
9/9-9/14	61	7	2	206	82	288	37	325	11
9/15-9/16	54	3	2	177	95	272	16	288	11
9/17-9/20	51	9	3	145	233	378	81	459	27
9/21-9/28	42	10	4	497	60	557	174	731	70
9/29-10/4	32	4	1	250	147	397	57	454	14
10/5-10/7	28	1	0	256	32	288	11	299	0
10/8-10/13	27	6	0	220	0	220	63	283	0
10/14-10/20	21	5	0	37	0	37	12	49	0
Total	116	100	24	--	--	--	--	--	179

*Unidentified ducks are 95% dabblers

Table 24. Mortality model for Eagle River Flats, Fort Richardson, Alaska, August 2 to October 16, 2001.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	Mortality (no.)	Identified Dabblers (no.)	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for Turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/2-8/9	112	12	1	332	124	456	55	511	5
8/10-8/16	100	6	1	624	167	791	50	841	8
8/17-8/24	94	9	1	253	126	379	40	419	4
8/25-8/29	85	15	0	335	231	566	121	687	0
8/30-9/3	70	6	2	367	314	681	64	745	21
9/4-9/9	64	10	1	240	166	406	75	481	8
9/10-9/14	54	2	1	208	154	362	14	376	7
9/15-9/19	52	5	0	428	215	643	68	711	0
9/20-9/21	47	0	0	426	114	540	0	540	0
9/22-9/25	47	0	0	1,563	163	1,726	0	1,726	0
9/26-9/27	47	1	0	797	52	849	18	867	0
9/28-10/2	46	17	2	156	62	218	128	346	15
10/3-10/5	29	4	0	586	0	586	94	680	0
10/6-10/9	25	2	0	366	0	366	32	398	0
10/10-10/11	23	4	1	253	0	253	53	306	13
10/12-10/16	19	14	1	45	0	45	126	171	9
Total	112	107	11	--	--	--	--	--	91

*Unidentified ducks are 95% dabbler

Table 25. Mortality model for Eagle River Flats, Fort Richardson, Alaska, August 15 to October 18, 2002.

	Telemetry			Aerial Counts					
Date	Radioed Mallards (no.)	Turnover (no.)	Mortality (no.)	Identified Dabblers (no.)	Unidentified Dabblers* (no.)	Total Dabblers (no.)	Adjusted for Turnover (no.)	Total Dabblers using ERF by survey period	Estimated Mortality (no.)
8/15-8/24	68	13	0	442	0	442	104	546	0
8/25-8/27	55	2	0	212	62	274	10	284	0
8/28-8/30	53	5	1	476	119	595	62	657	12
8/31-9/4	48	5	3	556	95	651	76	727	45
9/5-9/6	43	0	0	171	499	670	0	670	0
9/7-9/13	43	1	0	647	0	647	15	662	0
9/14-9/16	42	13	2	424	304	728	326	1,054	50
9/17-9/18	29	10	1	570	755	1,325	697	2,022	70
9/19-9/20	19	1	0	900	38	938	52	990	0
9/21-9/23	18	1	0	272	34	306	18	324	0
9/24-9/27	17	1	0	236	0	236	15	251	0
9/28-10/2	16	3	0	325	76	401	93	494	0
10/3-10/9	13	4	0	211	0	211	94	305	0
10/10-10/18	9	3	1	85	0	85	43	128	14
Total	68	62	8	--	--	--	--	--	192

*Unidentified ducks are 95% dabblers

Figure 1: Map showing location of Operable Unit C—Eagle River Flats, Fort Richardson, Anchorage, Alaska.

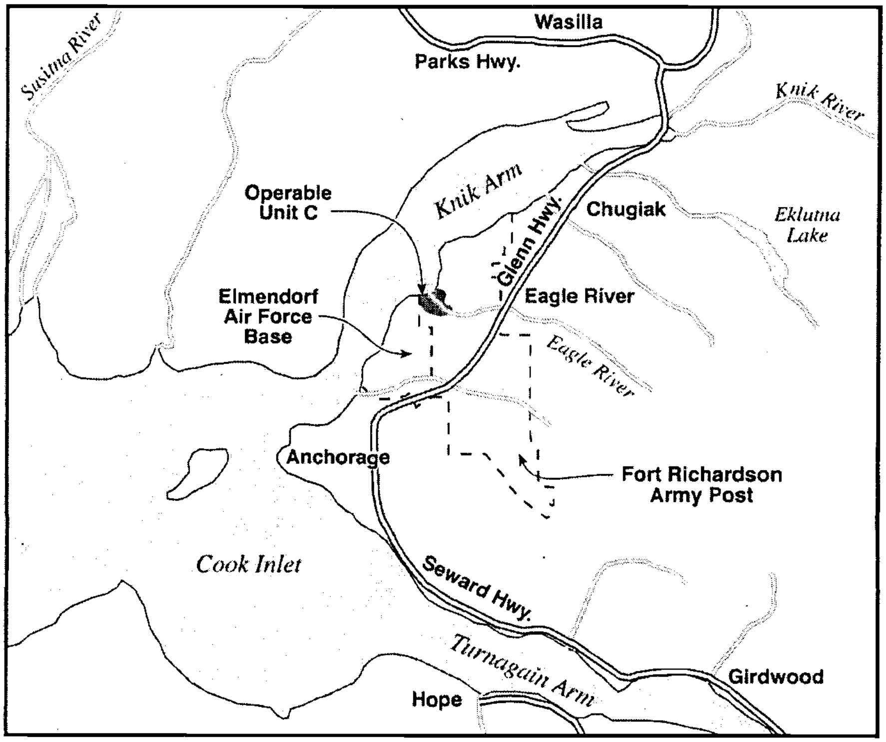


Figure 2: Map of Eagle River Flats, Fort Richardson, Alaska showing the ten areas that waterfowl use for foraging and loafing. Areas A, RI (Racine Island), C, C/D, and BT (Bread Truck) were documented as having high levels of white phosphorous.

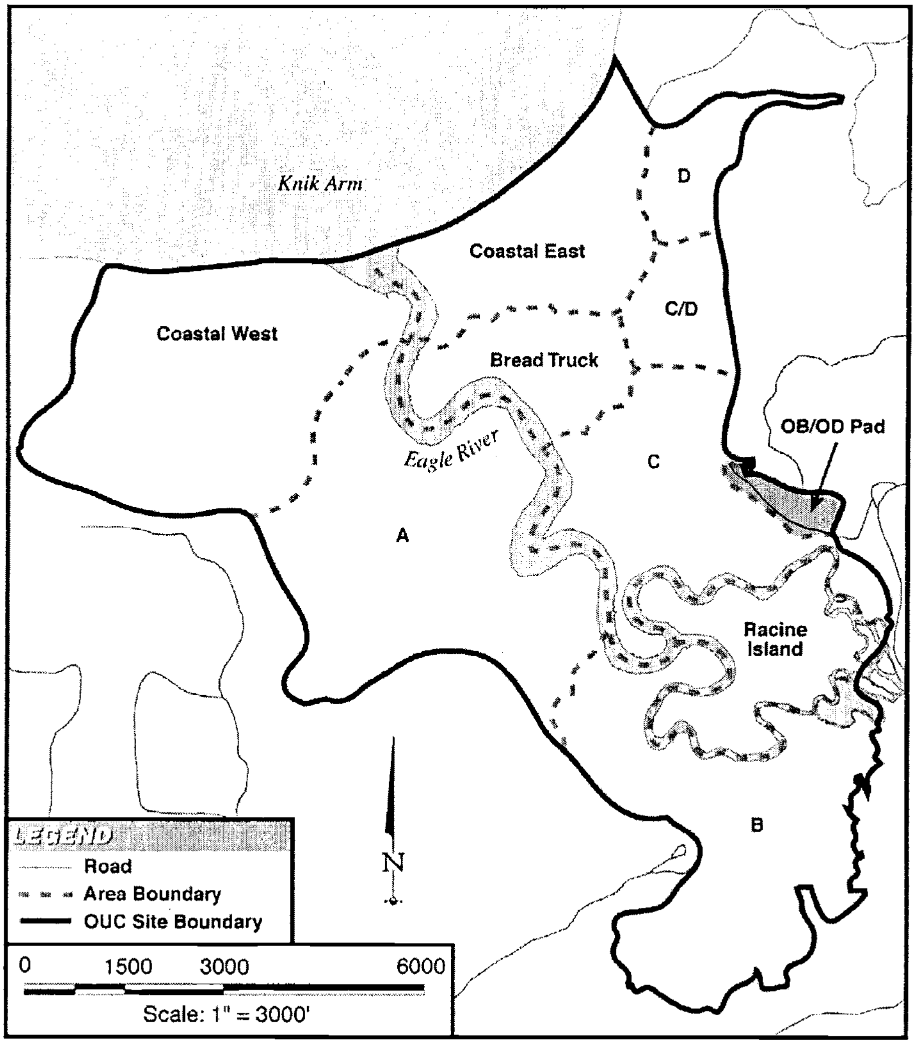


Figure 3. Aerial survey transects used to conduct a complete count of waterbirds on Eagle River Flats, Fort Richardson, Alaska.

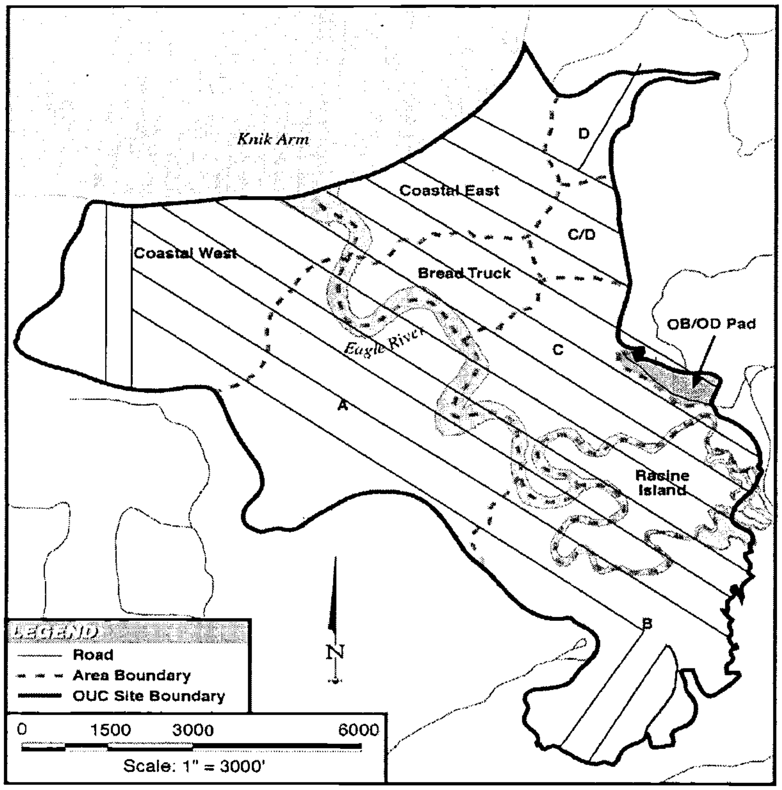
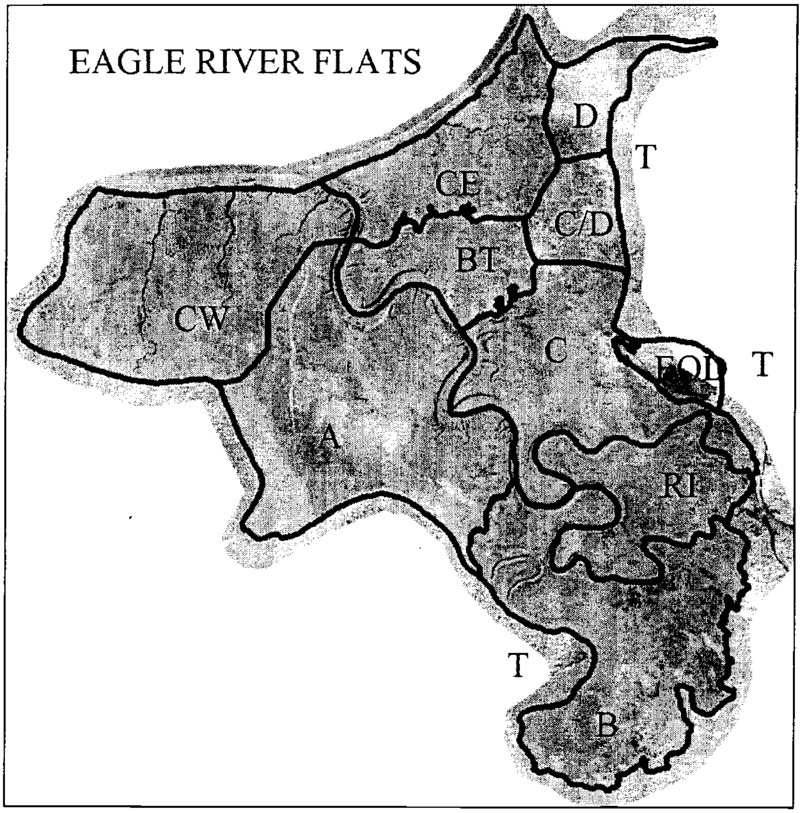


Figure 4: Eagle River Flats, showing the locations of the radio-telemetry towers



T = Telemetry Tower

Figure 5: Example of a GIS map of radio telemetry results on Eagle River Flats, Fort Richardson, Alaska showing all 2,278 telemetry points from mallard movement patterns from 15 August to 18 October 2002. One dot can represent several telemetry locations.

All 69 Mallards Movement Locations 2002

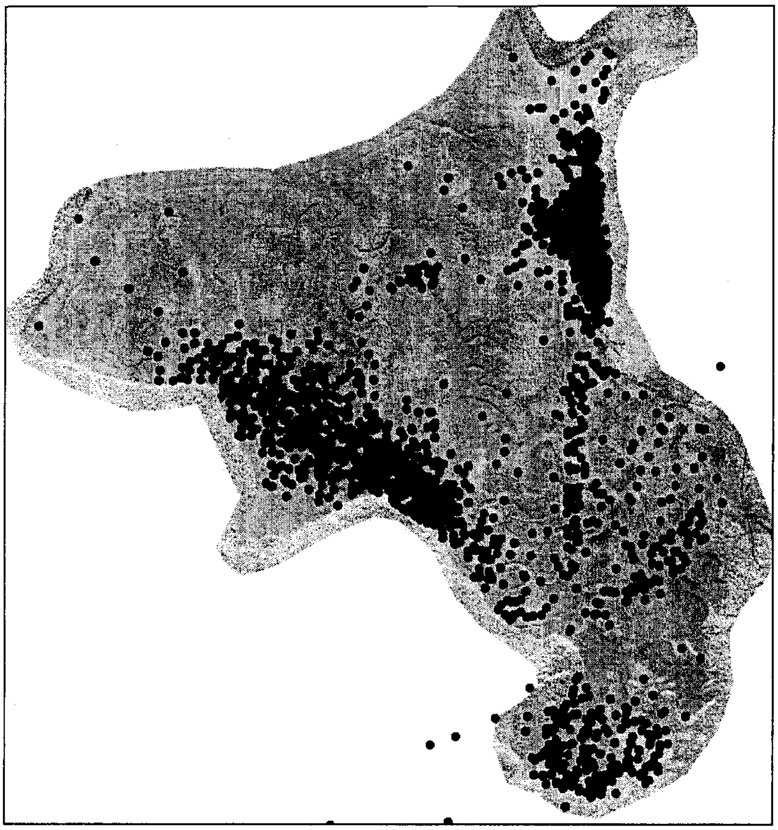


Figure 6: Example of a GIS map of Eagle River Flats, Fort Richardson, Alaska depicting radio telemetry results of a mallard that died from ingesting white phosphorus. This map shows the last five to ten locations before death. C is the capture location, F is the location at which the transmitter went into mortality mode, and R is where the carcass was recovered.

2002 WP Mortality 81502

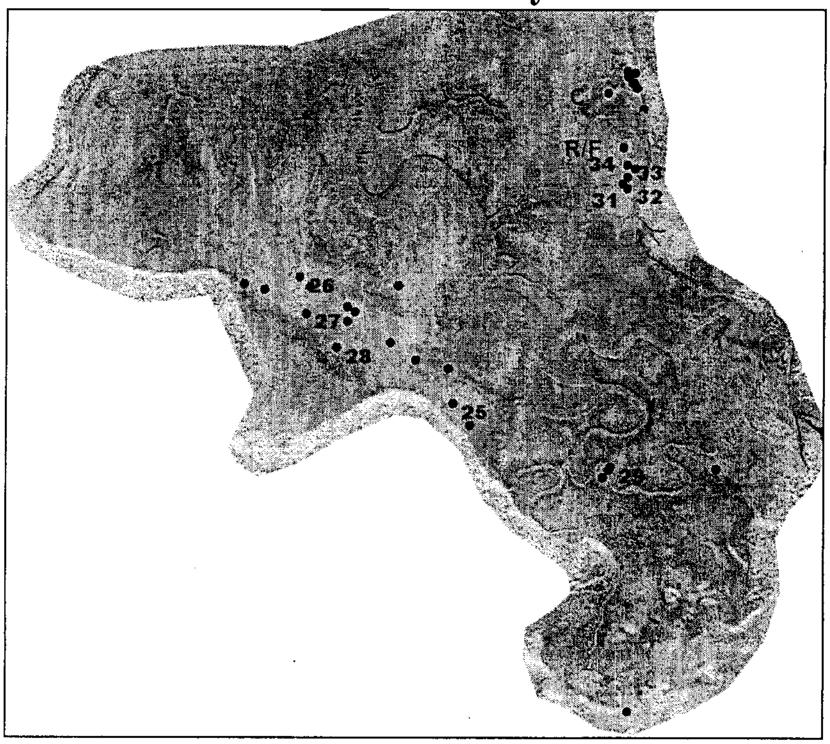


Figure 7: Distribution of radioed mallards on Eagle River Flats, Fort Richardson, Alaska during August, September and October from 1996 to 2002.

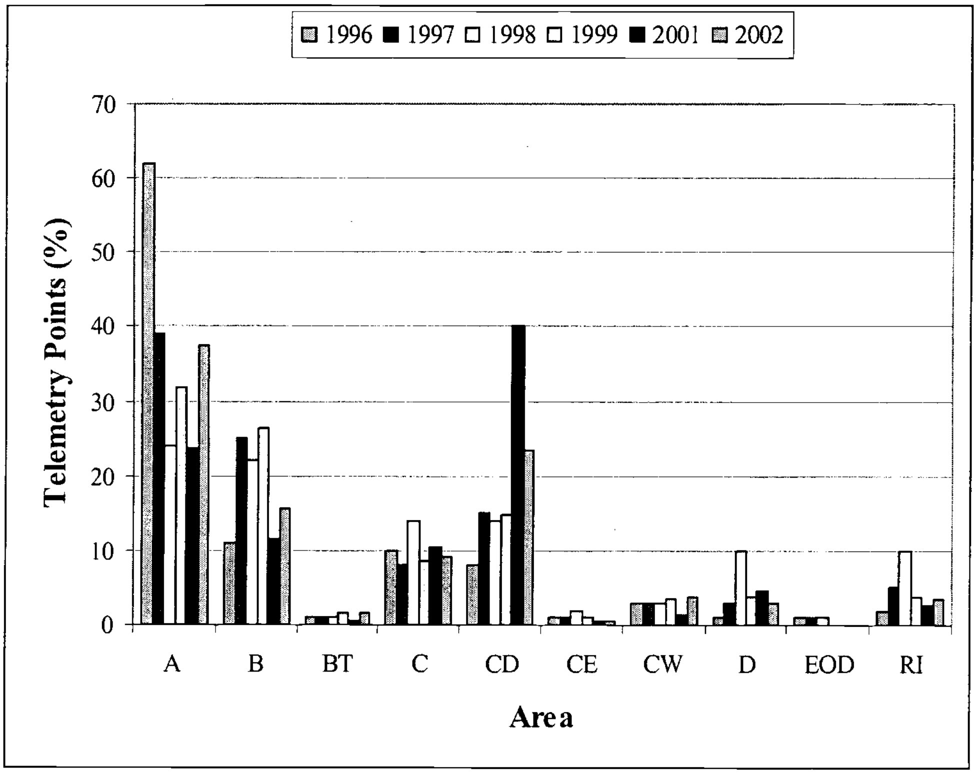


Figure 8. Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 3 to October 16, 1996.

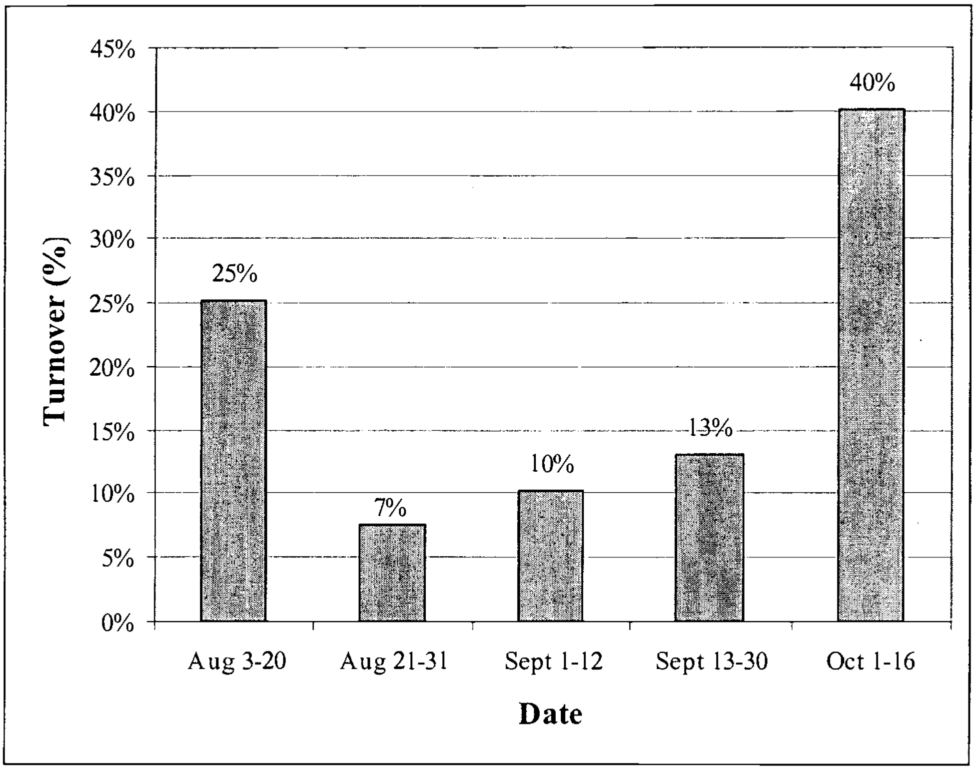


Figure 9: Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 4 to October 22, 1997.

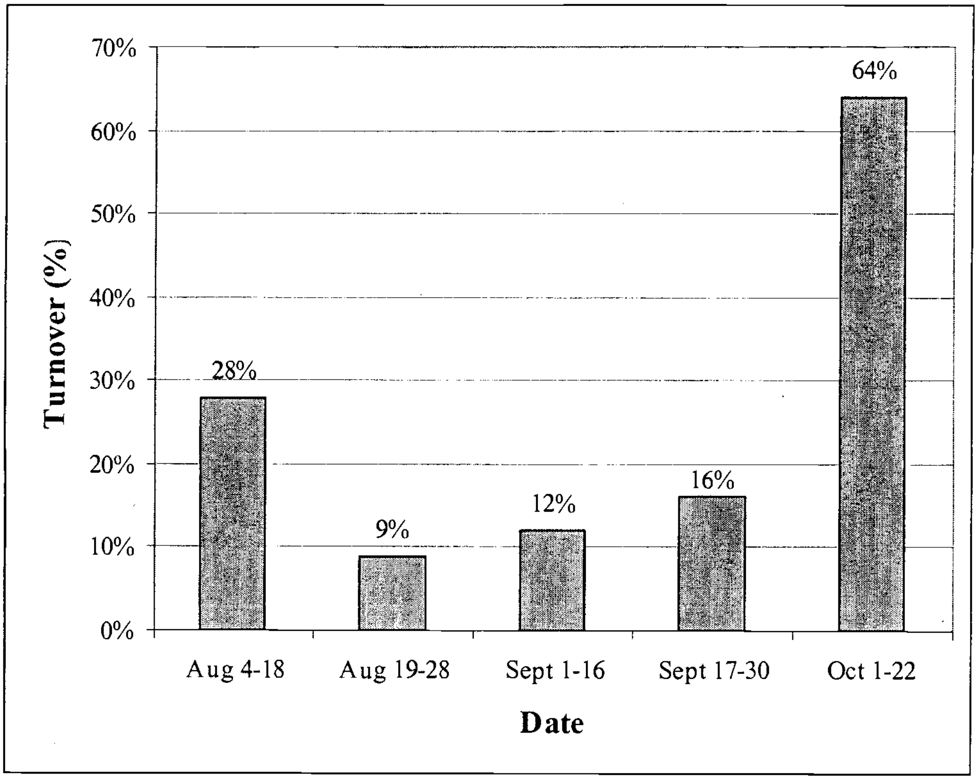


Figure 10: Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 4 to October 21, 1998.

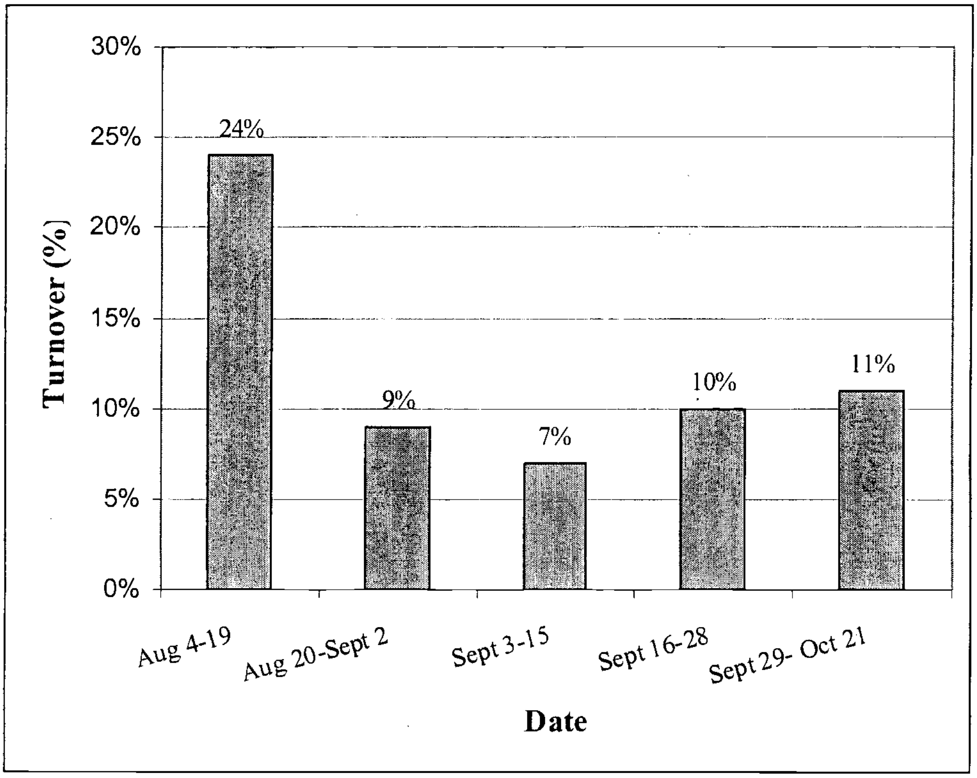


Figure 11: Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 4 to October 20, 1999.

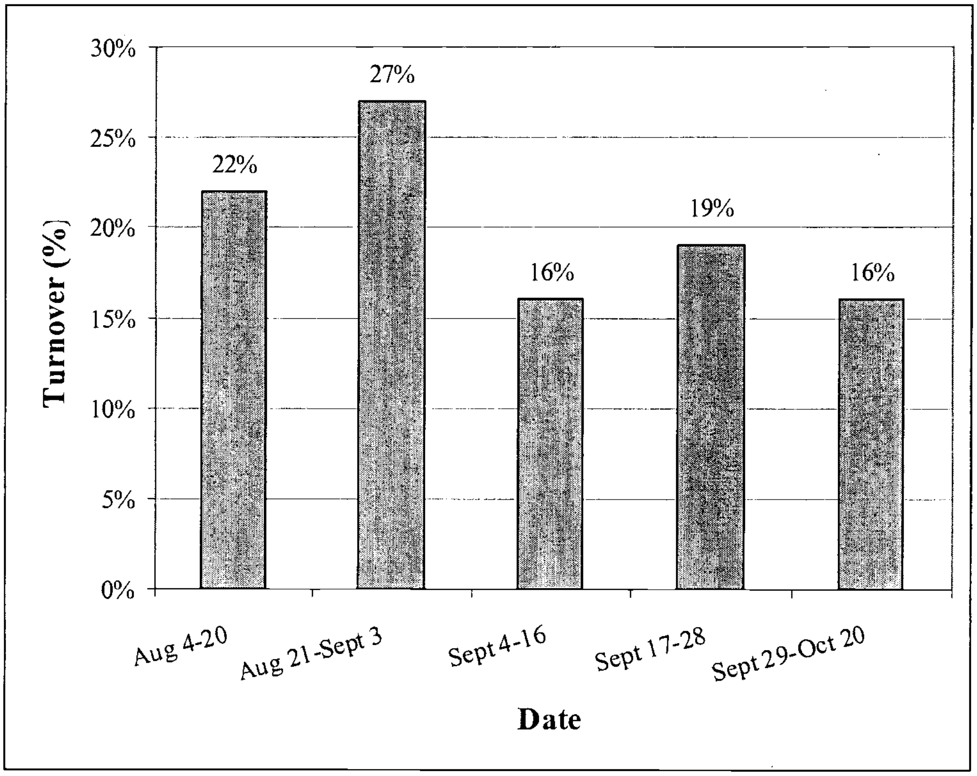


Figure 12: Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 2 to October 16, 2001.

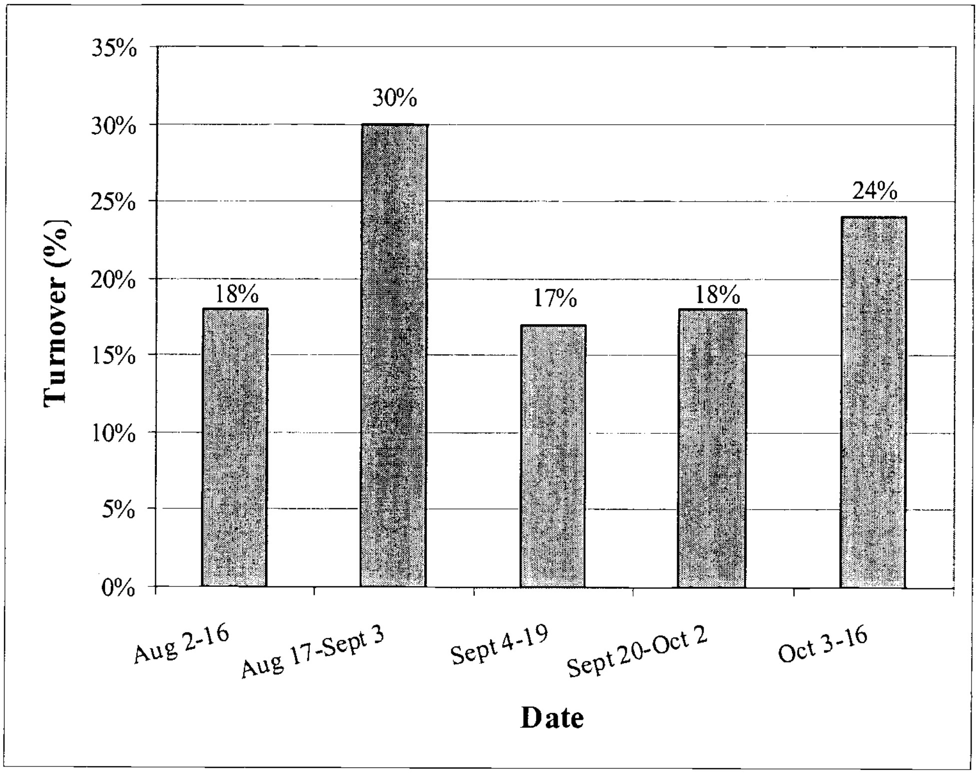


Figure 13: Turnover of mallards on Eagle River Flats, Fort Richardson, Alaska from August 2 to October 16, 2002.

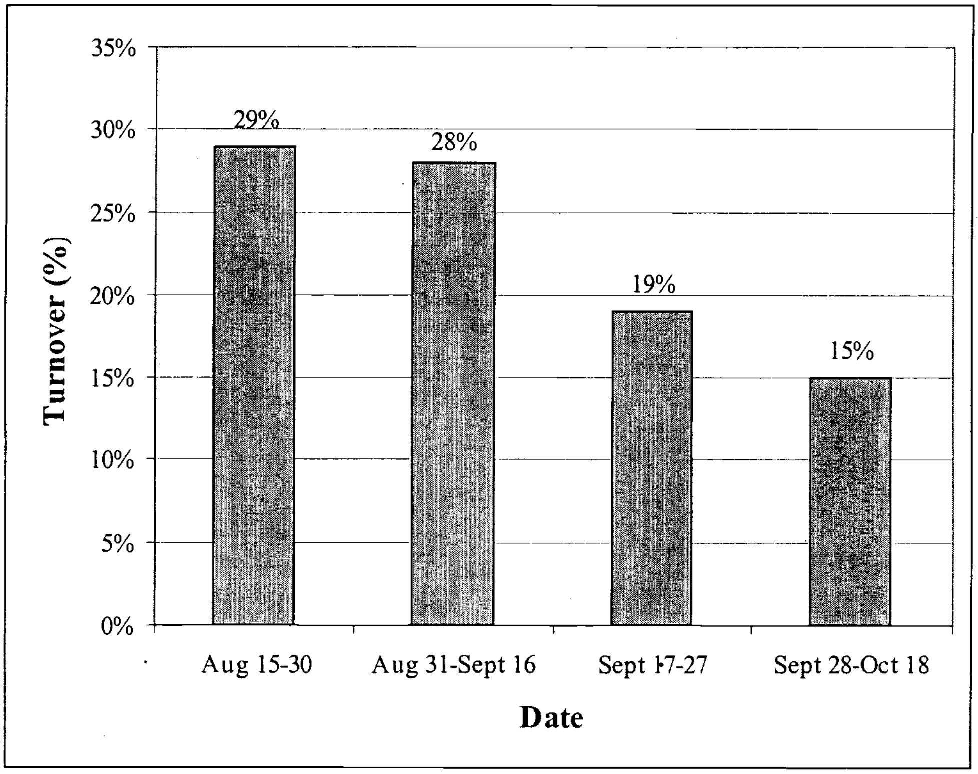


Figure 14: Total dabblers, peak number of dabblers and estimated dabbler mortality from the ERF mortality model, Eagle River, Flats, Fort Richardson, Alaska, 1996-2002.

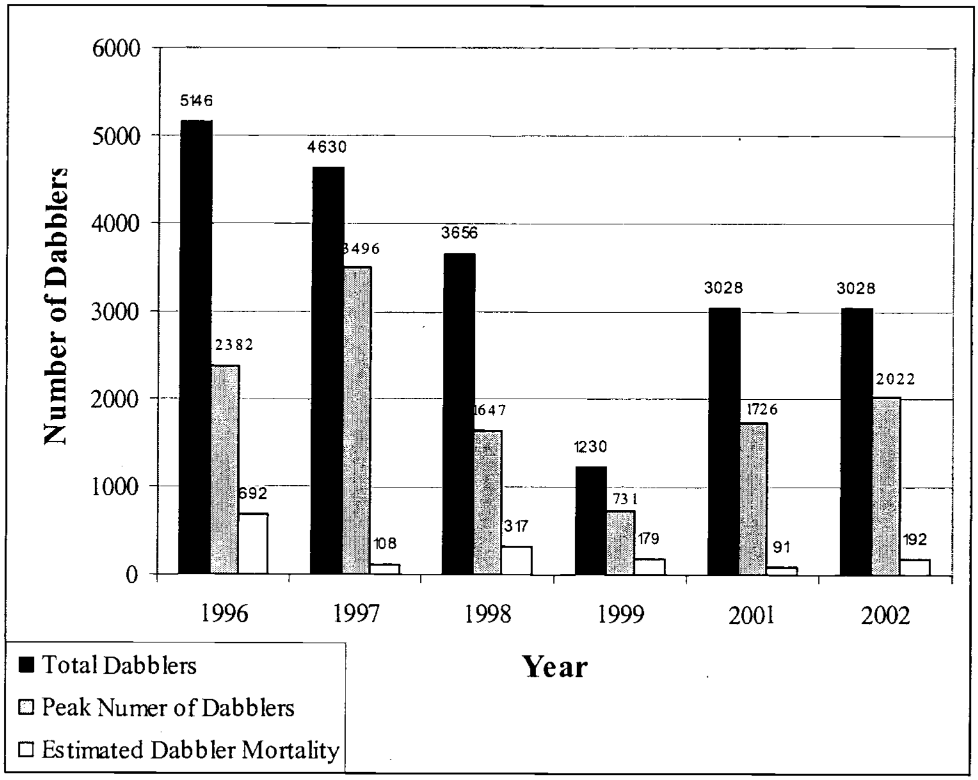


Figure 15. Estimated dabbler mortality from the ERF mortality model, Eagle River Flats, Fort Richardson, Alaska, 1996-2002.

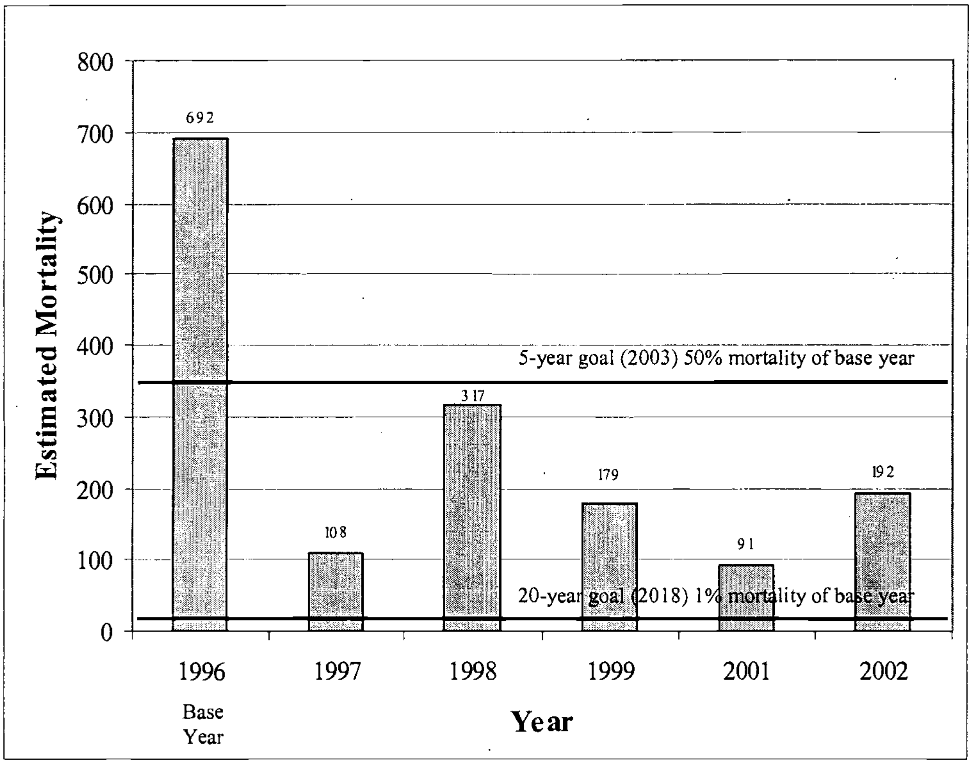
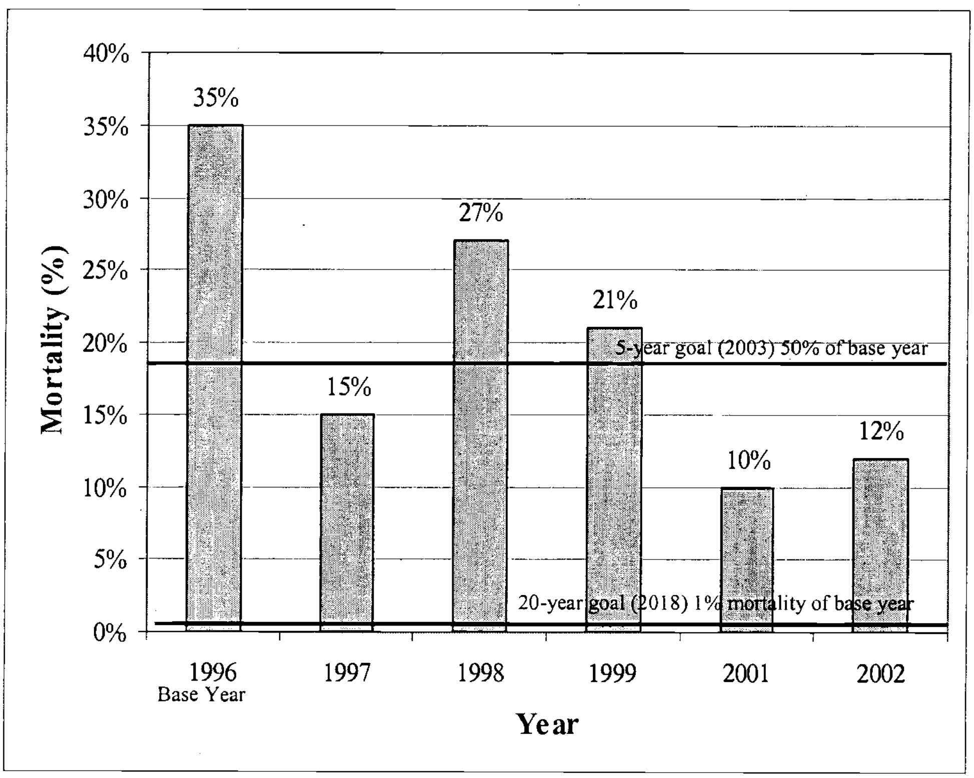


Figure 16. Mortality rate (%) of radio-marked mallards attributed to white phosphorous, Eagle River Flats, Fort Richardson, Alaska, 1996-2002.

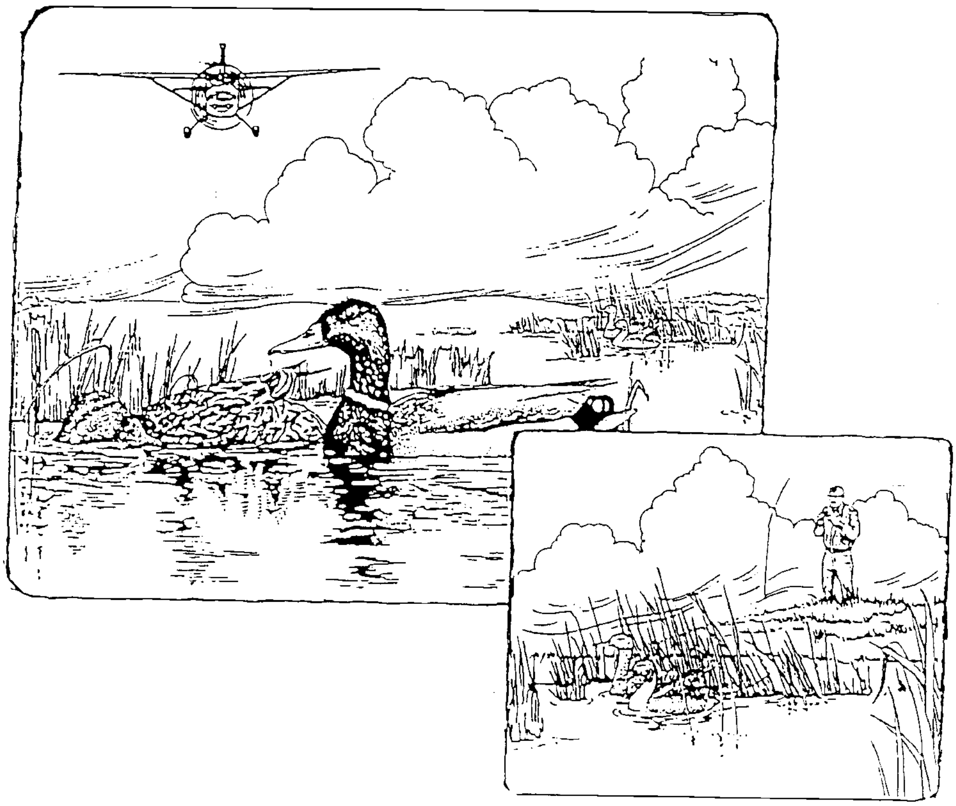


Appendix 1: Standard Operating Procedures for Conducting Aerial Surveys.

Standard Operating Procedures

for

AERIAL WATERFOWL BREEDING GROUND POPULATION AND HABITAT SURVEYS IN NORTH AMERICA



U.S. Department of the Interior
Fish and Wildlife Service

Environment Canada
Canadian Wildlife Service

April 1987

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SECTION I: INTRODUCTION

The Migratory Bird Treaty Act of 1918 (as amended) implements treaties between the United States of America and Great Britain (Canada, 1916), the United Mexican States (1936 as amended in 1972), Japan (1972 as amended in 1974), and the Soviet Union (1978). Under this Act, the Secretary of the Interior (United States) and the Minister of Environment (Canada) are responsible for the protection of migratory bird species.

In facilitating this task, an essential element has been the monitoring of various species population levels. In the late 1940's, the U.S. Fish and Wildlife Service developed aerial waterfowl breeding population and production surveys. These surveys were designed to provide annual breeding population and production indices covering changes over a major portion of the duck breeding range in North America. Today, these surveys continue to provide a basis for the management of most duck species on this continent.

The aerial Waterfowl Breeding Population and Habitat Survey was initiated experimentally in 1947 but was not fully operational until 1955. Similarly, the aerial Waterfowl Production and Habitat Survey was established experimentally in 1950 and became operational in 1956. Since their inception, these surveys have been conducted annually and without interruption. In 1959, air-ground comparison segments were started throughout most of the prairie crew areas to provide visibility correction factors for each species. The correction factors are applied to data obtained on the Waterfowl Breeding Population and Habitat Survey. These air-ground segments did not become operational until 1961. An attempt at developing air-ground comparison segments for the Waterfowl Production and Habitat Survey was initiated in 1950 but, because of many inherent problems, this work was discontinued in 1967. Consequently, the Waterfowl Production and Habitat Survey results are not adjusted for visibility bias.

Currently, the federal- and state-conducted surveys (utilizing the techniques outlined in this manual) monitor waterfowl population and habitat changes over nearly 1.4 million square miles (3.6 million km^2) of breeding habitat within portions of Alaska, the Yukon and Northwest territories, 5 western Canadian provinces, and 5 north-central states (Fig. 1). This area has been divided geographically into 9 federal and 2 state crew areas, each of which is surveyed by independent crews. Due to their general cover types, federal crew areas encompassing survey

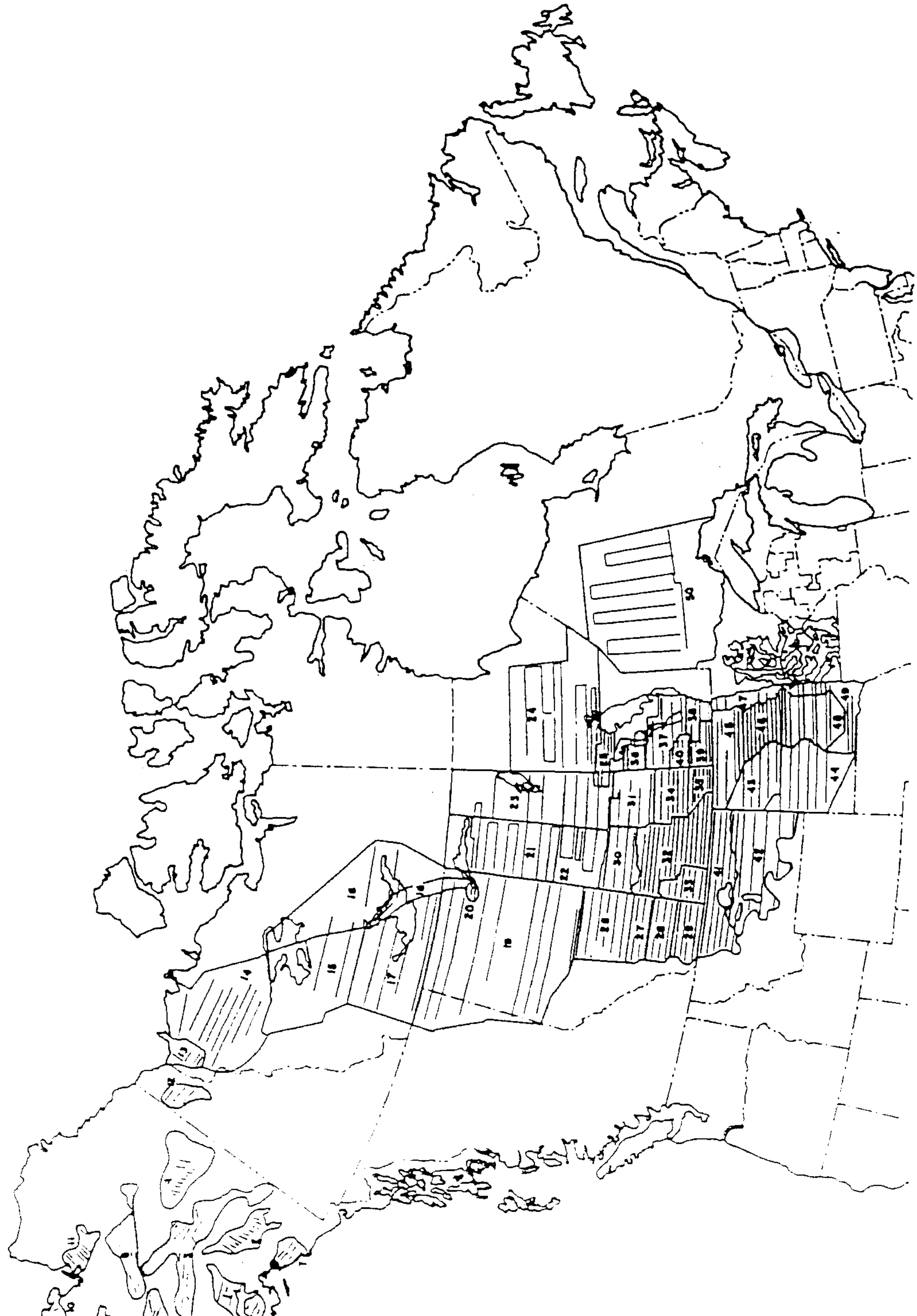


Figure 1. Survey strata and transects for principal areas of Waterfowl Breeding Population and Habitat Surveys in North America.

strata 1 through 25 and stratum 50 have been termed "bush" crew areas, whereas those encompassing strata 26 through 49 have been termed "prairie" crew areas. About 44,200 miles (71,100 km) of transects are covered during the Waterfowl Breeding Population and Habitat Survey which provides about a 1 percent sample of the combined strata areas. The Waterfowl Production and Habitat Survey covers roughly 30,700 miles (49,400 km) of transects to provide about a 0.5 percent sample of 0.8 million square miles (2.1 million km^2) covered by this survey (Fig. 2).

The breeding ground surveys in Canada are a cooperative effort between the U.S. Fish and Wildlife Service and the Canadian Wildlife Service with the assistance of various other federal, state, provincial, and territorial resource management agencies. The standard operating procedures presented herein represent the latest refinement of survey methodology (Bowden 1973). Earlier contributors to these procedures are listed in the Bibliography. First-time readers of this document are cautioned to be aware that although there are great similarities between the Waterfowl Breeding Population and Habitat Survey and the Waterfowl Production and Habitat Survey, the methods and reporting procedures are described completely and separately without reference to each other.

The following Standard Operating Procedures Manual (henceforth referred to as the Waterfowl Breeding Ground Surveys Manual) has been prepared to standardize the procedures used in conducting these surveys. Involving more than 40 aerial and ground crew members in the federal survey units, these surveys require complex coordination effort. Although the procedures described here were formulated and finalized prior to 1955, minor revisions have become necessary with subsequent improvements in equipment and capabilities, organizational name changes, updating of long-term visibility rates, changes in survey coverage, etc. Therefore, this manual has been set up in loose-leaf form to facilitate periodic updates.

This revision supersedes the Standard Operating Procedures for Waterfowl Breeding Ground Population and Habitat Surveys, 1977. Copies of this edition are available on request from the Department of the Interior, U.S. Fish and Wildlife Service, Migratory Bird Management Office, Patuxent Wildlife Research Center, Laurel, Maryland 20708, and the Department of the Environment, Canadian Wildlife Service, Prairie Migratory Bird Research Centre, University of Saskatchewan, Saskatoon, Saskatchewan S7N OX4.

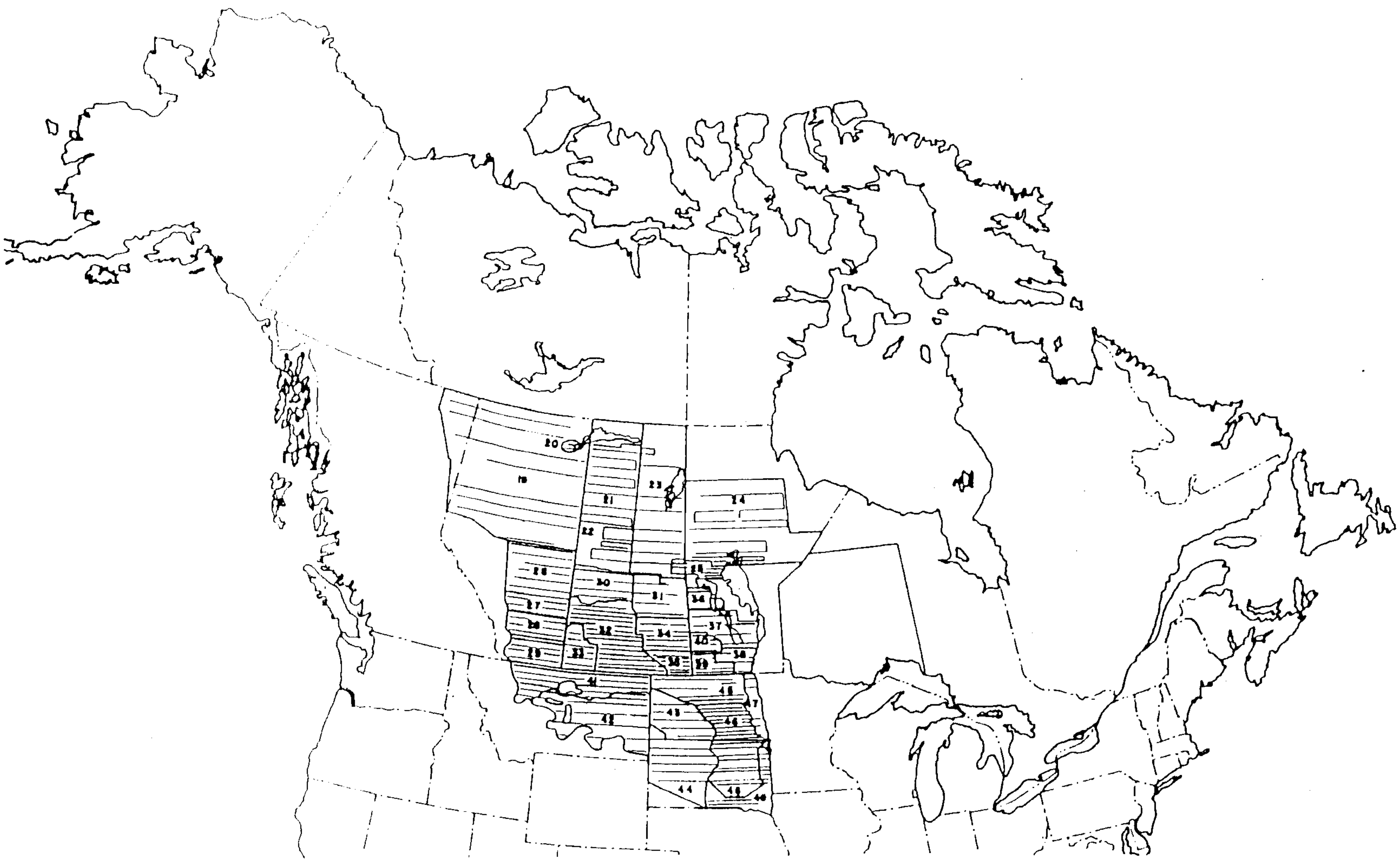


Figure 2. Survey strata and transects for principal areas of Waterfowl Production and Habitat Survey in North America.

SECTION II: RESPONSIBILITIES OF SURVEY PARTICIPANTS

A. U.S. Fish and Wildlife Service

1. Branch Chief-Surveys: The Branch Chief, Surveys, Migratory Bird Management Office (MBMO), United States Fish and Wildlife Service (FWS) is responsible for the compilation of survey data from all reporting units. This includes preparing the final waterfowl breeding population and production indices for the survey areas. These data become major components in the annual Fall Flight Forecast and Waterfowl Status Reports prepared by the FWS.

2. Section Chief - Waterfowl Population Surveys: The Section Chief-Waterfowl Population Surveys (WPS) is responsible for coordination of U.S. and Canadian personnel and insures the orderly conduct of the program in Canada and the United States. The Section Chief supervises all FWS personnel working on air and ground surveys in both the United States and Canada, and represents the FWS in all matters relating to the Canadian Wildlife Service (CWS), other Canadian officials, the Canadian public, and similar United States entities. The Section Chief is ultimately responsible to the Branch Chief-Surveys, FWS in reporting survey data.

3. Flyway Biologist: The Flyway Biologist is responsible to the Section Chief-WPS for the actual conduct of the waterfowl breeding ground population and habitat surveys in the assigned crew area. In this assigned crew area, the Flyway Biologist is in charge of the aerial and ground survey crews and coordinates the timing and sequence of ground surveys. The Flyway Biologist is the pilot-observer in the survey aircraft. Upon arrival in the assigned crew area, the Flyway Biologist contacts the appropriate state, provincial or territorial wildlife management agencies to inform them of planned activities and to offer an exchange of information. The Flyway Biologist, in cooperation with the Population Management Biologist (CWS) within the prairie provinces of Canada, compiles and analyzes the breeding population and habitat estimates to be included in the Waterfowl Breeding Population and Habitat Survey Report. The Flyway Biologist prepares and distributes the following reports to reach the addressees listed in the appendix by the established dates.

a. Waterfowl Breeding Population and Habitat Survey Report

b. Mid-May Habitat Conditions Report (submit only to Branch Chief-Surveys, FWS)

c. Waterfowl Production and Habitat Survey Report

d. Mid-July Habitat Conditions Report (submit only to Branch Chief-Surveys, FWS).

Flyway Biologists conduct surveys in specified portions of the Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Montana, North Dakota, and South Dakota.

4. Waterfowl Biologist-Waterfowl Investigations: The Waterfowl Biologist-Waterfowl Investigations stationed in Alaska conducts the surveys in specified portions of Alaska and the Yukon Territory. This individual performs the same duties outlined for Flyway Biologists and provides survey results (including photography) to the Assistant Branch Chief-Surveys, FWS by the required due dates.

B. Canadian Wildlife Service

1. Head-Population Management Section: The Head-Population Management Section (PMS), Western and Northern Region, is responsible for the coordination of activities between the 3 Canadian air-ground comparison survey crews (i.e. participation requirements, consistency of ground crew participants, procedural discrepancies, etc.), and the orderly conduct of the ground crew activities in Canada.

2. Population Management Biologist: The Population Management Biologist is responsible to the Head-PMS, for coordination of activities of the air-ground comparison survey crew, consistency in the adherence to survey procedures, and the compilation and analysis of ground survey data in the assigned area. In cooperation with the Flyway Biologist, FWS, this individual assists in the analysis of breeding population and habitat estimates to be included in the Waterfowl Breeding Population and Habitat Survey Report. The Population Management Biologist prepares and submits the Provincial Waterfowl Status Report in sufficient time to reach the Head-PMS by June 10.

C. State Wildlife Management Agencies

Waterfowl Biologist: The states of Minnesota and Wisconsin have participated in these cooperative surveys using comparable procedures since 1964 and 1973, respectively. Waterfowl Biologists for these states are responsible for surveys in specified portions of their respective states. These individuals perform the same duties as outlined for Flyway Biologists and provide survey results and appropriately labeled color slides as indicated to the Assistant Branch Chief-Surveys, FWS by the required due dates.

SECTION III: WATERFOWL BREEDING POPULATION AND HABITAT SURVEY

A. Methods

1. Survey Dates: The survey is performed in the prairie crew areas during the approximate period of 1 to 25 May. Differences exist in the chronology of the breeding season among years. In some years, most waterfowl en route farther north have departed the southern prairies by 1 May, and late-arriving waterfowl (e.g. blue-winged teal) have arrived and are occupying breeding territories. In other years, transient waterfowl in the southern prairies (e.g. scaup and certain other divers) may still be present in large mixed aggregations and blue-winged teal may not have arrived by 10 May. Therefore, to obtain the most representative breeding population information for the greatest number of duck species, the Breeding Population and Habitat Survey should not begin until the majority of more northern breeding species have moved through, and the bulk of late-nesting species have arrived and are dispersed into breeding territories. The survey should be initiated before early-nesting mallard and pintail drakes are commonly observed in post-breeding flocks of 3 and 4. In prairie Canada, the aerial crews coordinate closely with the CWS ground personnel to determine roughly when to plan crew arrival. Reconnaissance flights in each prairie crew area are conducted to determine the survey starting time.

The Breeding Population and Habitat Survey in the bush crew areas is performed during the approximate period 12 May to 12 June. Primary criteria used in bush crew areas for initiation of this survey are spring breakup, the build-up of representative waterfowl in traditional breeding areas, and the dispersal of paired waterfowl into breeding territories. As in the prairies, reconnaissance flights are made to determine the appropriate time for beginning the survey. The survey in Alaska begins about 18 May, depending entirely upon spring breakup.

2. Survey Flight Time: Daily survey flights begin no later than 1 hour after sunrise in prairie habitat and no later than 2 hours after sunrise in the parkland and southern bush habitats. The later start in parkland and bush areas allows for better light penetration into dense woodlands to improve visibility. In northern bush

habitats, survey flights are conducted during the mid-day period due to the extended daylight in northern latitudes at this time of year. Transect flying is completed by 12:00 noon (local standard time) each day in the prairies. Because of extended daylight and logistical problems associated with subarctic conditions, the completion time for bush operations is somewhat later in the day.

3. Survey Flight Conditions: Aerial surveys are not initiated when winds consistently exceed 15 mph (13 kts), if adverse weather conditions exist (i.e. snow, moderate to heavy rain, excessively rough air), or if visibility is poor for other reasons. Surveys are discontinued when winds exceed 25 mph (22 kts), turbulence is excessive, or if other adverse weather develops which is unsafe for flight or may compromise survey results.

4. Survey Flight Speed and Altitude: Transects are flown at ground speeds of 90-105 mph (78-90 kts). A stop watch is used to monitor aircraft ground speed and to aid in locating segment end points. Aircraft are normally flown at 100-150 feet (30-50 m) above ground level (AGL) to ensure accurate identification of waterfowl species under average light conditions and to assure safe obstacle clearance. Established known-width sample transects are flown at regular intervals to maintain consistency and accuracy of the aerial crew's transect width. Reference marks are applied to the aircraft's wing struts as guides for both pilot-observer and observer to indicate the approximate transect boundaries from the appropriate altitude.

5. Survey Flight Path: Transects are centered on section lines in the prairies and along degree lines of latitude or longitude in the bush. In Alaska, transects are oriented generally perpendicular to river valleys and coastlines. The transects are located as depicted in Fig. 1. The flight path is altered only to avoid flying directly over towns, game farms, poultry, livestock, or persons. The aircraft's flight path is not altered to facilitate identification of waterfowl. Transects are flown in the same direction each year as much as practical to minimize variance associated with changes between years.

6. Survey Sample: A segment is an 18-mile (29-km) sampling unit, 16-mile (26-km) in the Alaska crew area, having a total width of 1/4 mile (400 m), i.e. 1/8 mile (200 m) on each side of the aircraft for the waterfowl

sample, and a width of 1/8 mile (200 m) on the observer's side of the aircraft for the pond sample (Fig. 3). The pilot-observer in the left front seat counts all identifiable ducks, geese, and coots within 660 feet (200 m) on that side of the aircraft while the observer in the right front seat counts all identifiable ducks, geese, and coots within 660 feet (200 m) on that side of the aircraft. The observer also counts specified types of water areas (ponds) within 660 feet (200 m) on that side of the aircraft. All waterfowl and pond data are recorded for each individual segment.

A transect is a continuous series of segments. Most transects in this survey are oriented in an east-west direction and are parallel to the other transects at regular intervals within any given stratum. The survey employs a systematic random sampling of potential transect locations. The transect is the sampling unit.

A stratum is a specific geographic unit encompassing areas of similar waterfowl densities and is generally of a specific habitat type. The transects usually extend from one side of a stratum to the other. Beginning near the southern boundary of a stratum, the transects extend to or near the northern boundary. Spacing between transects varies depending upon waterfowl densities. Transect spacing within strata 1 through 50 varies between 14 miles (23 km) and 60 miles (97 km).

7. Reporting Units and Survey Crew Areas: Because it is desirable to report the data on a political unit basis and to maintain historical continuity in the various survey units, the survey data are compiled and analyzed by reporting unit (Fig. 4). Survey crew areas have been geographically organized on the basis of alignment with political boundaries, similarity in habitat, and equitable distribution of work load or flight time required to conduct the survey (Fig. 5). The strata surveyed and the strata reported on by each aerial survey crew for the Waterfowl Breeding Population and Habitat Survey are provided in Table 1.

For those instances where one aerial crew conducts the survey in a specified area and another crew reports on that area, it is the responsibility of the Flyway Biologist collecting the data to summarize the information and transmit it to the Flyway Biologist responsible for the report. The original and one copy of each Field Data Form, Field Data Form (stratum

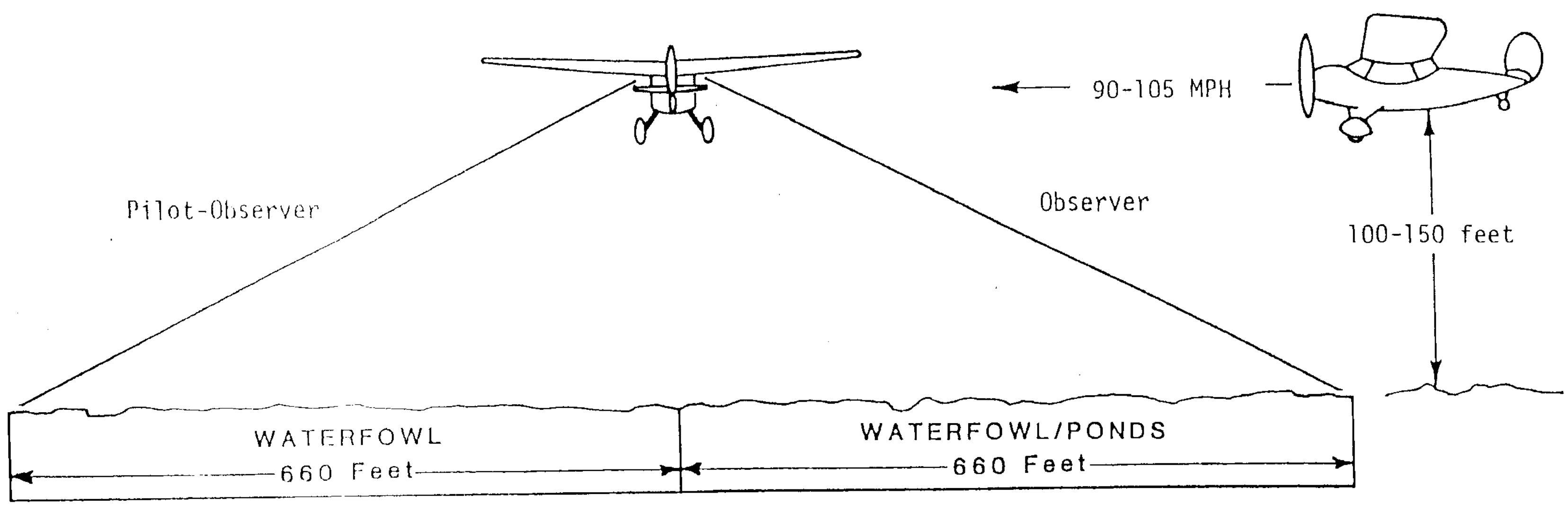


Figure 3. Survey sample for Waterfowl Breeding Population and Habitat Survey.

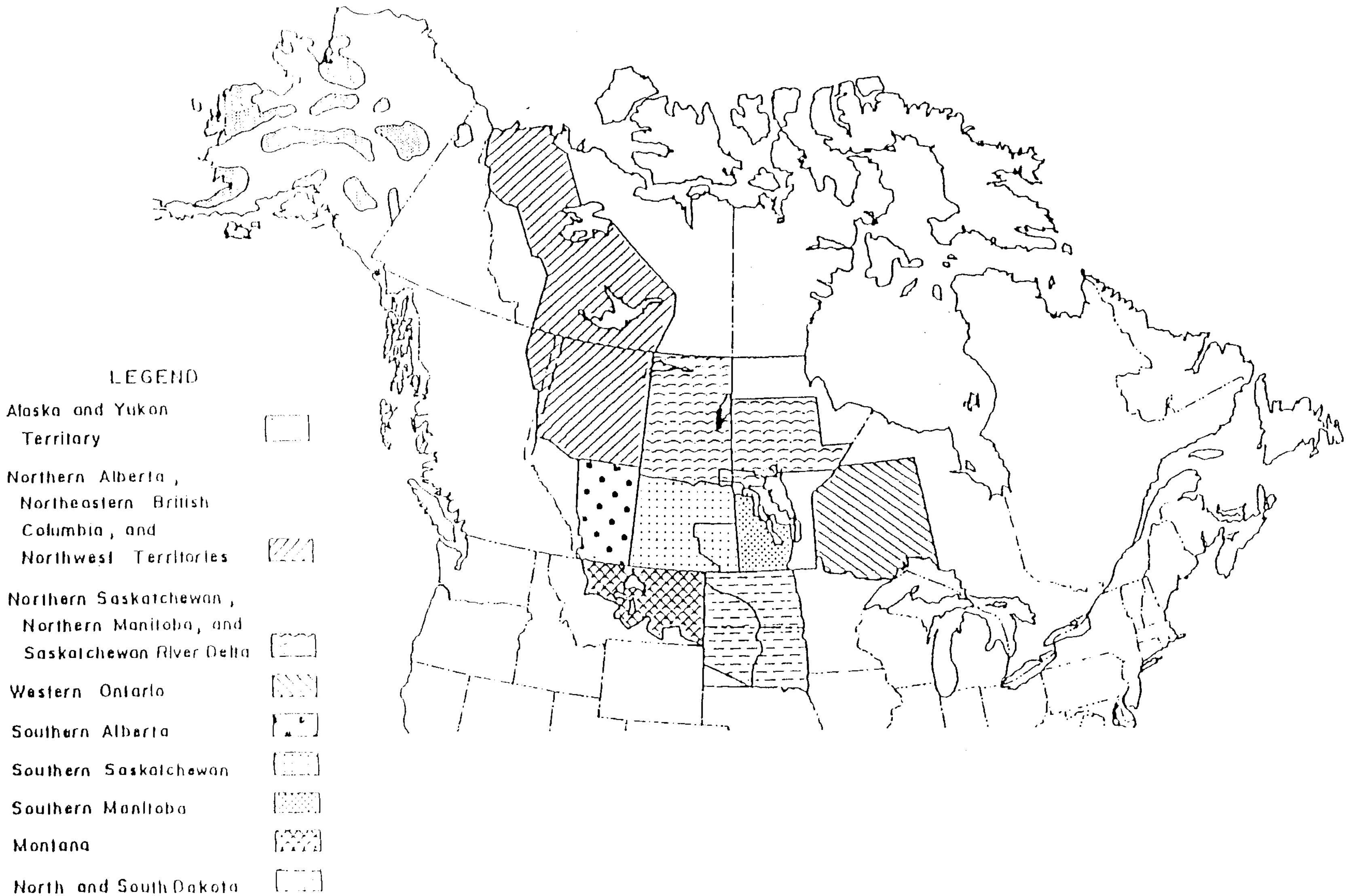


Figure 4. Reporting units for the federal aerial waterfowl breeding ground surveys.

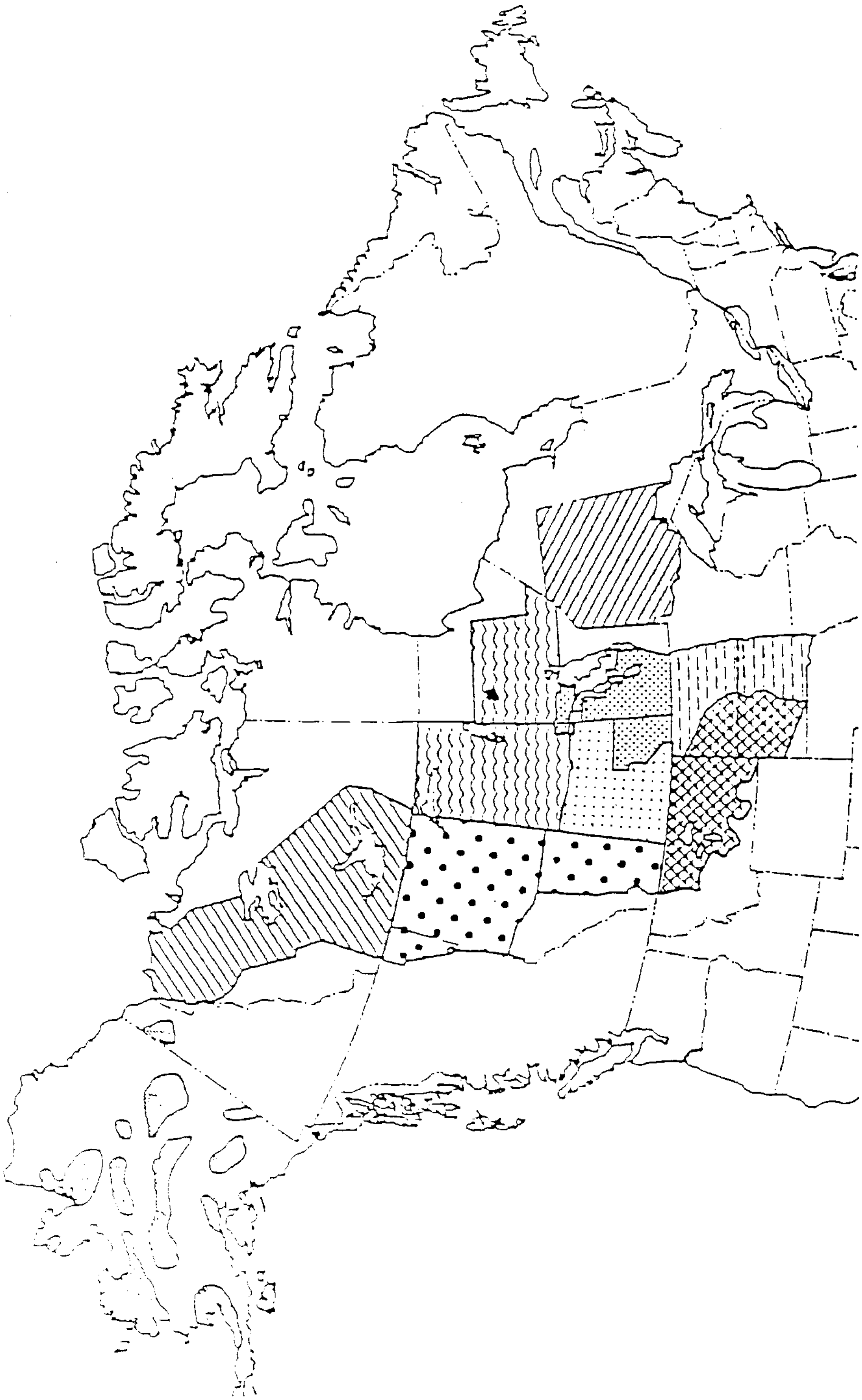


Figure 5. Crew areas for the federal aerial waterfowl breeding ground surveys.

Survey area	Crew Area Strata	Crew Area Area (Sq. mi.)	Crew Area Sample (Sq. mi.)	Crew Area Linear miles	Reporting Unit Strata	Reporting Unit Area (Sq. mi.)	Reporting Unit Sample (Sq. mi.)
FEDERAL							
Bush							
Alaska and Yukon Territory	1-12	81,770	912.0	3,648.0	1-12	81,770	912.0
Northern Alberta, Northeastern British Columbia, and Northwest Territories	13-18	273,201	927.0	3,708.0	13-20	438,687	1,669.5
Northern Saskatchewan, Northern Manitoba, and the Saskatchewan River Delta	21-24	217,314	1,417.5	5,670.0	21-25	224,130	1,534.5
Western Ontario	50	176,609	607.5	2,430.0	50	176,609	607.5
Bush subtotal		748,894	3,864.0	15,456.0		921,196	4,723.5
Prairies							
Southern Alberta	19,20,26-29	229,783	2,056.5	8,226.0	26-29	64,297	1,314.0
Southern Saskatchewan	30-33	88,912	967.5	3,870.0	30-35	111,120	1,269.0
Southern Manitoba	25,34-40	67,752	850.5	3,402.0	36-40	38,728	432.0
Montana	41-44	120,791	1,260.0	5,040.0	41-42	73,657	868.5
North and South Dakota	45-49	89,101	1,111.5	4,446.0	43-49	136,235	1,503.0
Prairie subtotal		596,339	6,246.0	24,984.0		424,037	5,386.5
FEDERAL total		1,345,233	10,110.0	40,440.0		1,345,233	10,110.0
STATE							
Minnesota		33,899	527.3	2,109.2		33,899	527.3
Wisconsin		43,359	412.5	1,650.0		43,359	412.5
STATE total		77,258	939.8	3,759.2		77,258	939.8
GRAND TOTAL (Federal and State)		1,422,491	11,049.8	44,199.2		1,422,491	11,049.8

Table 1. Waterfowl Breeding Population and Habitat Survey - crew area and reporting unit constants.

summary), and the original Segment Data Form are delivered to the Flyway Biologist responsible for that reporting unit as soon as possible following survey completion. Copies of the Field Data Forms and Field Data Form (stratum summaries) are retained by the aerial survey crew (aerial data) and the CWS ground crew leader (ground data) for referral should questions arise.

B. Data Collection

1. General: The following instructions are generally applicable to both the aerial and ground crews.

a. Strict adherence to the instructions and procedures set forth in this manual is required unless changes are approved by the Section Chief-WPS prior to the initiation of the surveys.

b. Survey data are recorded daily on the appropriate Field Data Forms.

c. Field Data Forms must be prepared in duplicate. It is not necessary to prepare duplicates of the Segment Data Forms (discussed later in this section). Copies are stored and mailed separately to reduce the chance of losing any field data.

d. The original field records are prepared neatly and legibly to facilitate auditing, duplication, and data transfer. Black ink or dark pencil (#2 or darker) is used on all forms.

e. Survey records are double-checked by the survey crew to ensure that transcriptions and mathematical calculations are accurate.

f. Instructions for completing the various forms are printed on the back side of each form and should be strictly followed.

g. The Segment Data Forms and originals of all aerial and ground Field Data Forms as well as stratum summaries are submitted directly to the Assistant Branch Chief-Surveys at the conclusion of the survey. Express Mail is used for this purpose whenever possible.

h. Color slides are useful in depicting habitat changes through the years, particularly as they relate to availability of surface water and specific land-use activities detrimental to waterfowl. It is the responsibility of the ground crew leader to obtain and send photo material representating habitat change to the crew area Flyway Biologist; this material includes the unprocessed slides and a photo log with appropriate labels. These slides are then processed and labeled by the Flyway Biologist. It is the responsibility of the Flyway Biologist to obtain and appropriately label aerial color slides. These are forwarded with the ground crew slides to the Assistant Branch Chief-Surveys as soon as possible following survey completion, via Express Mail if available.

2. Waterfowl Data: Within the transect boundaries, all ducks (except lone hens) that can be identified by the aerial crews are recorded by segment on a tape recorder. When water areas occur on the boundary of a transect, only those waterfowl judged to be within 1/8 mile boundary on each side of the aircraft are counted. A separate recorder is used by each aerial crew member. These data are then transcribed to Field Data Forms each afternoon following the survey flights. (Exhibit 8-prairie crews and Exhibit 9-bush crews). The data are then summarized by stratum using the same forms (Exhibit 10-prairie crews and Exhibit 11-bush crews). It is emphasized that only those ducks within the transect boundaries on water bodies cut by the transect boundary are recorded. Unidentified ducks should not be recorded. Identified ducks in flight are recorded only if their flight originates or terminates within the transect boundary. For all species of ducks observed and identified, the number in each of the following categories is recorded. Instructions appear on the reverse of the Field Data Form.

a. Lone drake--single isolated drake without a visible associated hen. (Lone hens are not recorded by the aerial crew.)

b. Flocked drakes--2 or more drakes in close association (for the purposes of this manual, flocked drakes recorded on the Field Data Form are limited to groupings of 2 to 4 drakes).

c. Pair--male and female in close association.

d. Group--3 or more of a mixed-sex grouping of the same species in close association which cannot be separated into singles and pairs (for the purposes of this manual, a hen and 2 drakes are recorded as a pair and a lone drake, and 5 or more flocked drakes are recorded as a group).

Coots are recorded as a total number for each observation. Geese observed on transect are recorded in the same manner as ducks.

It is emphasized that this is a breeding population survey and not a true breeding pair survey. The estimates derived include not only indicated pairs but also grouped birds, some of which are undoubtedly non-breeders and transient birds.

Table 1 (Exhibit 1) of the survey unit report contains a long-term trend in adjusted waterfowl breeding population estimates by species for the current year and all previous years of record. Table 2 (Exhibit 2) contains the current year's adjusted waterfowl breeding population estimates by species and stratum, showing comparisons of the current year with the previous year, the previous 10-year mean, and the long-term mean.

3. Water Data: Water data are collected only in the prairie and parkland habitats. The aerial observer records the number of individual water areas within 660 feet (200 m) on that side of the aircraft for each segment. The pilot-observer does not count ponds for reason of flight safety. Water areas intersected by the transect boundary are counted. A tape recorder is used for this purpose as is done for the waterfowl data. Two mechanical counters are often used to assist the observer in this task, particularly in high density pond areas. The number of natural water areas (e.g. ponds, lakes, rivers, streams) is recorded on one counter, while the number of artificial water areas (e.g. reservoirs, stock dams, dugouts, and large irrigation ditches) likely to contain water into mid-summer is recorded on the other. Natural and artificial water areas are identified as such to monitor human effects on natural wetlands over the history of the surveys. The number of ponds for each segment is the sum of the counter totals. Table 4 (Exhibit 4) contains the long-term trend in adjusted pond estimates by stratum, comparing the current year with the previous year, previous 10-year mean, and the long-term mean. Table 4 (Exhibit 4) represents types III, IV, and V wetlands (Shaw and Fredine 1956),

artificial areas, and streams only. Type I wetlands are tallied only on the ground crew field data and summary forms.

Natural water areas to be counted from the air include Type III, IV, and V wetlands, rivers, and streams. Type III ponds (seasonal wetlands) refer to hay meadows or basins containing natural aquatics which normally are dry by midsummer but are expected without additional precipitation to retain water for at least 3 weeks following the observation. These wetlands normally have a uniform vegetative cover and contain at least 6 inches (15 cm) of water. Under dry fall conditions, many ponds are plowed but refill with water in the spring. In these instances, no vegetation is present, but these wetlands should be counted if they have sufficient water depth and lasting qualities. To minimize subjectivity, it is stressed that water depth is the primary criterion. Type IV ponds (semi-permanent wetlands) have sufficient water depth that they will likely persist through the brood season but may become dry during late August or September. These wetlands usually contain water during at least 7 out of 10 years, and the vegetation is normally clumped, covering all but the center of the wetland. Type V ponds (permanent wetlands) are deep marshes or lakes having sufficient water depth to persist throughout the summer and fall. These wetlands normally are characterized by a peripheral rim of aquatic vegetation bordering an open body of water. Streams and rivers that meander through the transect are counted as separate water bodies each time they occur within the transect boundary. Dugouts that are inundated by a natural wetland are not recorded as artificial water areas, but if the dugout can be identified as a water area separately from the surrounding natural water area, both the dugout and the natural water area are counted.

The following water areas are not recorded by the aerial crew:

a. Type I ponds (temporary wetlands) refer to temporary water, sheet water, small wet areas in stubble or plowed fields, and wet depressions that have less than 6 inches (15 cm) of water depth and can be expected to last less than 3 weeks.

b. Roadside or borrow ditches where the water is confined entirely to the ditch and small ditches used for local irrigation.

c. Muskeg areas where water may glisten under a dense growth of grass. Open areas of water within muskeg are not counted.

4. Air-Ground Comparison Data: Aerial and ground crews conduct surveys of selected segments in each stratum to provide correction factors for visibility biases (waterfowl and ponds present but not observed by the aerial crew). Visibility biases are known to exist for all aerial observers. These biases change between years as a result of varying conditions (i.e. vegetative cover, cloud cover, light, wind, aircraft design and noise level, observer fatigue, observer experience, etc). These biases are not necessarily consistent between individual observers given the same set of circumstances. To minimize the effect of these factors, as many variables as possible are made consistent between years. Some variables cannot be controlled and must be dealt with annually. In the prairies, visibility rates for major species of ducks may vary significantly. Therefore, visibility rates are determined on an annual basis in each of the prairie crew areas. Although it is suspected that visibility rates for bush crews vary to a lesser degree, species visibility correction factors developed in prairie crew areas are applied to bush transects. (See Exhibit 12 for these visibility rates.) To develop more precise visibility correction factors applicable to bush crew areas, air-ground comparison segments are being established using helicopters.

a. Aerial Crew: The aerial crew covers each air-ground comparison segment in the same manner as other segments. Each air-ground segment is flown within a day of the time the immediately adjacent transects are flown (preferably on the same day). The aerial crew flies air-ground segments in early, mid-, and late-morning to obtain an even distrubtion of sampling effort. Likewise, the aerial crew distributes the number of eastbound and westbound air-ground segment flights proportionately to the transect flights flown within that stratum. The data are recorded on the Aerial Crew Field Data Form in the same manner that other segment data are recorded, but is prepared on a separate Field Data Form (Exhibit 13) from the operational transect data.

b. Ground Crew: The ground crew consists of no less than 2 and no more than 4 individuals. The ground crew initiates segment coverage within 1-1/2 to 2 hours of sunrise. Every effort is made to complete the ground segment by 12:00 noon (local standard time). However, coverage will be completed within one day. Ground coverage of all air-ground segments is from east to west to minimize visibility problems associated with sun glare. The ground crew covers each segment on the same day or within 2 days following aerial coverage. Every effort is made to begin the segment on the morning of the day immediately following aerial coverage. Ground coverage is not initiated until at least 1/2 hour after aerial coverage has been completed if conducted the same day. Ground coverage is not initiated or continued when winds are in excess of 25 mph (40 kph) or if other adverse weather conditions exist (e.g. moderate to heavy snow, heavy rain, thick smoke, heavy fog). If the ground crew cannot complete coverage within the 3-day specified period, a second aerial count is required. The ground coverage, as before, is completed on the same day or within 2 days following aerial coverage. Landowners are contacted whenever possible prior to entry upon their land.

It is emphasized that the primary objective of the ground work is to get a <u>complete count</u> of all waterfowl present on the air-ground comparison segment. Whenever there is any doubt regarding the ground crew member's ability to see the entire surface of a water body and all waterfowl that might be resting on its shore, the ground crew member walks around the pothole to the extent necessary to ensure sighting and identifying all waterfowl. In instances where there are large potholes with open shorelines and large numbers of waterfowl, the ground crew member refrains from flushing the waterfowl since this may result in counting error due to "roll-up" (counting the same waterfowl at 2 or more locations) or inability to identify all the birds in flight due to poor positioning or dealing with too many birds at one time (mass flights). Waterfowl that are flushed will be recorded and watched to the extent necessary to rule out duplicate counting further along the segment.

When a pothole falls on the boundary of a segment only those waterfowl are counted that are judged to be within the segment at the time the ground crew arrives at the wetland. Waterfowl in flight over the segment are counted only when they are obviously associated with the segment. Waterfowl are recorded in the same manner as by the aerial crew. However, all waterfowl present on the segment must be identified and included in the count. Unlike the aerial crew, the ground crew records certain lone hen data. Lone hen redhead, scaup, ring-necked duck, and ruddy duck are recorded. Lone hens of other species are not recorded (Bowden 1973). This is explained in the Data Adjustment Section to follow. To minimize "roll-up" and inability of the ground crew to identify all waterfowl during mass flights, firecrackers, shellcrackers, uncontrolled dogs, and other scare devices are not used.

All-terrain vehicle use is minimized for the same reason. However, limited use may be warranted in situations where access would not otherwise be possible. Direct inspection of ponds while on these vehicles is avoided. The noise produced by these vehicles masks the ability of ground crew members from cuing to ducks by sound. For reason of safety, all crews using all-terrain vehicles strictly adhere to prescribed operating guidelines.

The ground crew tabulates and classifies all water areas within the entire segment width of 1/4 mile (400 m). In addition to the kinds of water areas counted by the aerial crew, Type I wetlands are recorded by the ground crew. These temporary wetlands are sheet water, small wet areas in stubble or plowed fields, and wet depressions that are less than 6 inches (15 cm) deep and can be expected to last less than 3 weeks under normal conditions. Type I ponds are important to the ground survey for the purpose of monitoring specific habitat condition changes that cannot be readily measured by the aerial crew. In cases where ponds join because of high water levels, the ponds are recorded as one pond and are noted as such on the data forms.

Additionally, pond water level data can be gathered in a qualitative manner by the ground crew. A system for doing this was developed by Millar in 1980. For this system he defined a basin as the total physical depression capable of holding water and a wetland as the portion of the basin which contains any wetland vegetation. He further defined specific water level as follows:

Stage 1 — DRY- surface water has disappeared completely due to seepage, evaporation, or drainage.

Stage 2 — VESTIGIAL - water occurs only as small pools or puddles within the central vegetative zone of the wetland and can be expected to dry up within a matter of days.

Stage 3 — RECESSIONAL - water levels have receded within the central zone but still cover a fairly extensive area. In Open Water type of wetlands there is a drawdown mudflat between the water edge and the emergent vegetation. In Emergent Deep marshes and Shallow marshes, a fairly wide band of the central zone is DRY.

Stage 4 — INTERMEDIATE - in Open Deep marshes and Shallow Open Water wetlands, the central open water zone is completely flooded and the water extends into the inner edge of the emergent vegetation. In Emergent Deep marshes and Shallow marshes, the water extends throughout most of the central zone.

Stage 5 — FULL - the wetland is filled to the outer limit of the wet meadow zone.

Stage 6 — FLOODED - water has spilled out of the wetland proper and floods the upland vegetative communities in the basin.

Stage 7 — OVERFLOWING - water is at full supply level (FSL) of the basin and is spilling over. FSL can vary greatly from basin to basin. In some basins it is at the level of the outer edge of the wet meadow zone and in others FSL is so high that it will never be attained (e.g. terminal wetlands).

Stage 8 — DUGOUT-RECESSIONAL - water has receded well below the rim of the dugout.

Stage 9 DUGOUT-FULL - water level is at or close to the rim of the dugout.

Pond and waterfowl data collected by the ground crew for each water area include the following:

(1) pond number--designated from potential basins when the transects were established.

(2) pond type (Shaw and Fredine 1956).

(3) water level (Millar 1980).

(4) margin width--the area extending up to 33 feet (10 m) beyond the outer edge of the wet meadow zone.

(5) type and percentage of impaction to wetland basin (burned - autumn or spring, cultivated, drained, filled, grazed, hayed, or impacted by construction)--the basin is defined as that area from the center of the wetland to the outer edge of the wet meadow zone.

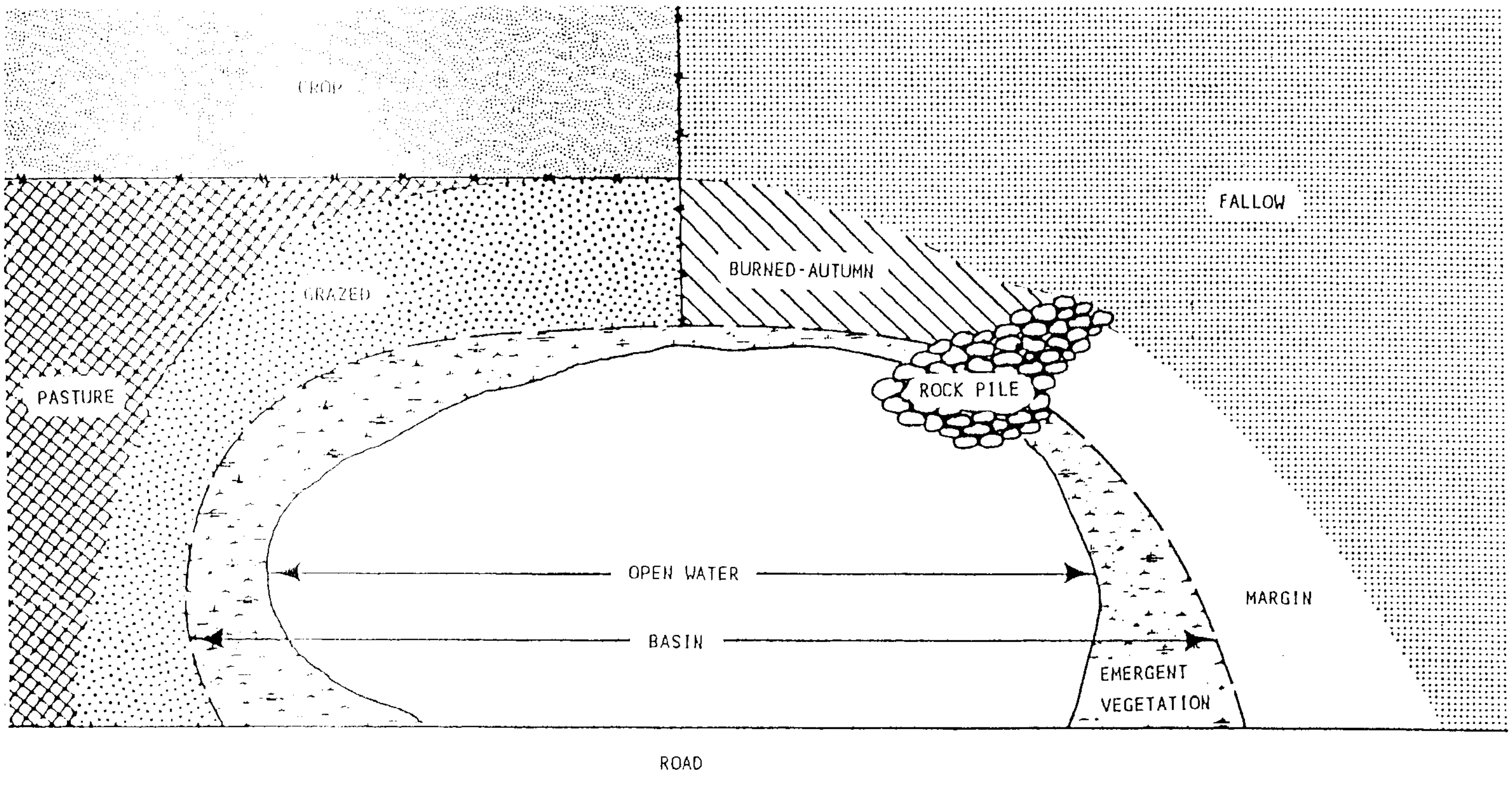
(6) type and percentage of impaction to wetland margin (burned - autumn or spring, cultivated, cleared, grazed, hayed, or impacted by construction).

(7) type and percentage of impaction to the uplands (crop, fallow, grassland, hayland, pasture, stubble, or woodland)--the upland is defined as the area contiguous with the margin.

Note: Fig. 6 provides a sample diagram of various types of wetland impacts as discussed in items 5, 6, and 7 above.

(8) the number of lone drakes, certain lone hens (redhead, scaups, ring-necked duck, and ruddy duck), flocked drakes, pairs, and grouped waterfowl of each species observed.

The starting and finishing time and certain weather data are recorded for each segment. These data are entered on the Air-Ground Comparison Segment--Ground Crew Field Data Form and the Ground Crew Summary Form (Exhibits 14 and 15).



Wetlands						
Pond No.	Pond Type	Water Level	Margin Width	Impaction (%/type)		
				Basin	Margin	Uplands
1	5	3	8	5F 20I	50G 20BA	40P 10C 50F

Figure 6. Wetland impaction diagram.

The original Field Data Forms and Summary Forms are delivered to the Flyway Biologist in charge of the reporting unit at the completion of the ground survey. These data become part of the Waterfowl Breeding Population and Habitat Survey Report for that reporting unit.

C. Data Adjustment

1. Prairies: Data collected by the ground and aerial survey crews are entered on the Air-Ground Visibility Rate Calculation Form (Exhibit 5) to calculate the visibility rate for each species. It is necessary to combine air-ground segment data from all strata within a crew area to develop reliable visibility rates for each specific crew area. This pooling of data is necessary to reduce the variance associated with small sample sizes. The following table lists all prairie crew areas and strata in the first and second columns and strata used for adjustment purposes in the third column:

Table 2. Strata used for adjustment of data by crew area on air-ground segments.

Crew areas	For stratum	Combine air-ground data from strata
Prairie		
Southern Alberta	26	26-29
	27	26-29
	28	26-29
	29	26-29
Southern Saskatchewan	30	30-33
	31	30-33
	32	30-33
	33	30-33
Southern Manitoba	34	34-40
	35	34-40
	36	34-40
	37	34-40
	38	34-40
	39	34-40
	40	34-40
Montana	41	41-44
	42	41-44
	43	41-44
	44	41-44
North and South Dakota	45	45-49
	46	45-49
	47	45-49
	48	45-49
	49	45-49

When the current year's calculated visibility rate for a particular species falls within the specified range (Exhibit 12), the current year's rate is used; when the current year's calculated visibility rate for a particular species falls outside the specified range (Exhibit 12), the long-term average crew area visibility rate is used in calculating the species index. In such cases, the substituted visibility rate is entered on the Air-Ground Visibility Rate Calculation Form as well as the Stratum Summary Form with appropriate footnotes. The long-term average species visibility correction factors developed in the combined prairie crew areas are always used for American black duck, goldeneyes, bufflehead, oldsquaw, eiders, scoters, and mergansers, as these species are rarely sampled in sufficient numbers during any given survey. Table 5 (Exhibit 5) of the survey unit report is the Air-Ground Visibility Rate Calculation Form and contains the current year's air-ground data along with any appropriately noted exceptions.

In preparing the Waterfowl Breeding Population and Habitat Stratum Summary Forms and the Air-Ground Comparison Segment--Ground Crew Summary Forms, lone and flocked drake redheads, scaups, ring-necked ducks, and ruddy ducks are multiplied by 1 to determine total indicated birds, rather than by doubling as is done for all other species. This procedure is used because these species are known to be late nesters and have significant disproportionate sex ratios leaning heavily towards males. Similarly, lone hens of these species observed by the ground crew are multiplied by 1 on the Ground Crew Summary Form.

In strata 34 through 40, ground crews have demonstrated that an positive relationship exists between mallard visibility rates and pond densities. To correct for this phenomenon, an adjusted mallard visibility rate is used in these strata. The method of calculating this rate was derived from work done by Bowden (1973) and is presented in Exhibit 16. This phenomenon has not been consistently demonstrated for any other species or in any other crew area.

2. <u>Bush</u>: As previously indicated, the average species visibility correction factors developed in the prairie crew areas over the history of the survey are applied in the bush crew areas. Work is continuing to develop more appropriate visibility rates in all bush units.

D. Data Analysis

Field Data Forms designed for the prairie crew areas and bush crew areas are used to tabulate waterfowl and water data for each segment, transect, and stratum. Data collected for each stratum are summarized on the Waterfowl Breeding Population and Habitat Survey Stratum Summary Form (Exhibit 17). Each stratum expansion factor is determined by dividing the total area (mi^2) in the stratum design by the total (mi^2) sampled within the stratum (current year). This factor is then used as a multiplier in obtaining the expanded waterfowl and pond indices. Waterfowl and pond visibility rates obtained from the Air-Ground Visibility Rate Calculation Form (Exhibit 5) are an integral part of the calculation on the Stratum Summary Form to obtain the adjusted waterfowl population and pond estimates. A copy of the Stratum Summary Form for each stratum becomes a part of the survey report and follows Table 7 (Exhibit 7).

In the prairies, a lone drake index (LDI) is used as a relative measure of the nesting season progress at the time of the survey. The survey is conducted at the most appropriate time when the LDI is highest for a given breeding season. A low LDI would indicate an early or late survey or even a poor nesting effort regardless of survey timing. A low LDI in conjunction with a detectable bird movement would suggest the survey was early. In contrast, a low LDI in conjunction with an unusually large number of post-breeding drake aggregations consisting of 4 or more birds would suggest the survey was late. Irregular weather patterns may complicate the interpretation. There are several species which do not exhibit synchronous nesting, regardless of the season; therefore, only certain species are used in deriving this index. Since the mallard, northern pintail, and canvasback normally begin to nest in early May and their numbers are comparatively high, the determination of the LDI is based on these species only. The method used to calculate lone drake indices is presented in Exhibit 18. Table 3 (Exhibit 3) of the survey unit report contains these data for the current and all previous years of record. These data are not tabulated for the bush units.

Flyway Biologists conducting surveys in Canada cooperatively analyze and interpret the field survey data with the Population Management Biologist, CWS, and provide copies of all pertinent data before leaving Canada. The data are made available to the CWS as soon as possible after survey completion because of the importance of these data for the development of annual Canadian waterfowl regulations in early June.

E. Segment Data Form

The Waterfowl Breeding Population and Habitat Survey-Segment Data Form (Exhibit 19) is used to provide data for entry in the FWS primary computer. The form is completed following the tabulation of the data for each day's flight. Transcribing errors are greatly reduced by the observer and the pilot-observer auditing each other's work.

F. Survey Design

The survey design and the coverage of the current year's survey is presented in Table 7 (Exhibit 7). The first set of data presents the survey as it was designed by stratum including the area (mi^2) in each stratum, the area (mi^2) in the sample (both waterfowl and ponds), the number of linear miles in the sample, the number of transects in the sample, the number of segments in the sample, and the expansion factor. The second set of data is the current year's survey coverage. If the current survey is incomplete or has been modified, the second set of data will reflect these changes. The narrative section of the report explains the reasons for any omissions or changes.

G. Reports

1. Mid-May Habitat Conditions Report: During mid-survey, the Flyway Biologist in charge of each crew area contacts the Assistant Branch Chief-Surveys, by telephone, and provides a report regarding general habitat conditions including spring weather, and other events that "set the stage" for the survey since the previous summer (i.e. climatological, land-use changes), surface water abundance and relative water levels, soil moisture, timing of snow and ice disappearance, quality and timing of run-off, relative availability and quality of both upland and overwater nesting cover, phenology of vegetation, impact of agricultural practices, nesting chronology, overall production potential, and other pertinent information. This report is due on 15 May for prairie units and 25

one-page report reflecting these observations is mailed at the time this information is called in. Attached to this is a roughed-out map of the survey unit including pertinent notes based on reconnaissance flights and survey observations made prior to the mid-survey reporting date. Express Mail is used for this purpose whenever possible.

2. Waterfowl Breeding Population and Habitat Survey Report: The Waterfowl Breeding Population and Habitat Survey Report is prepared using the following outline and suggested minimum text material.

COVER SHEET: The following statement is used--"The data presented in this report are preliminary and subject to further auditing. Final estimates will be available from the U.S. Fish and Wildlife Service, Migratory Bird Management Office, Patuxent Wildlife Research Center, Laurel, Maryland 20708."

TITLE: Waterfowl Breeding Population and Habitat Survey for (insert unit title)

STRATA SURVEYED: (insert strata numbers)

DATES: __-__ May 19__

DATA SUPPLIED BY: United States Fish and Wildlife Service and Canadian Wildlife Service (include CWS only for surveys conducted in southern Alberta, southern Saskatachewan, and southern Manitoba).

Air Crew
- Pilot-Observer (insert name, affiliation, and title)
- Observer (insert name, affiliation, and title)

Ground Crew
- Crew Leader (insert name, affiliation, and title)
- Assistants (insert names, affiliations, and titles)

ABSTRACT: A concise summary of weather and habitat conditions, the May pond estimates, lone drake indices, and breeding population estimates for the more numerous and important species is presented showing changes from the previous year, the previous 10-year mean, and the long-term mean. A brief statement is provided on the overall waterfowl status in the reporting unit compared to previous years.

METHODS: A statement similar to the following begins this section of the report: "The procedures followed in conducting this survey are contained in the Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America, Section III, revised 1987." Any deviation from these procedures or changes in aerial or ground coverage is explained in detail.

WEATHER AND HABITAT CONDITIONS: This section of the report expands on the Mid-May Habitat Conditions Report and updates these comments. Reference is made to Table 6 (Exhibit 6) which contains weather data from representative weather stations within the reporting unit from the previous summer through the survey period. The results of the adjusted pond counts compared to the previous year, the previous 10-year mean, and the long-term mean as presented in Table 4 (Exhibit 4) are also discussed in this section of the prairie unit reports.

BREEDING POPULATION ESTIMATES: Waterfowl breeding population status based upon the estimates contained in Tables 1 and 2 (Exhibits 1 and 2) is discussed in detail, and comparisons are made between the current year and the previous year, the previous 10-year mean, and the long-term mean estimates. Suspected reasons for any changes are discussed.

LONE DRAKE INDEX: The current year's figures, as well as all previous years of record, are presented in Table 3 (Exhibit 3) and their implications in interpreting the nesting season chronology and survey timing are discussed in the prairie unit reports.

CONCLUSIONS: Based on weather, habitat conditions, breeding population estimates, and other available information, the anticipated recruitment within the reporting unit is discussed.

TABLES: The following titles are used for the tables included in each survey unit report. The bush unit reports do not include tables on the lone-drake index, May ponds, and air-ground visibility rates.

1. Table 1. Long-term trend in waterfowl breeding population estimates by species in (reporting unit), 19__-__. (Exhibit 1)

2. Table 2. Status of waterfowl breeding population estimates by species and stratum in (reporting unit), comparing 19__ with 19__ , the 19__-19__ previous 10-year mean, and the 19__-19__ long-term mean. (Exhibit 2)

3. Table 3. Lone drake index: long-term trend expressed as a percentage of total drakes in (reporting unit), 19__-19__. (Exhibit 3)

4. Table 4. Long-term trend in May pond estimates by stratum in (reporting unit), comparing 19__ with 19__, the 19__-19__ previous 10-year mean, and the 19__-19__ long-term mean. (Exhibit 4)

5. Table 5. Air-ground visibility rate calculation for ducks, coots, and ponds for (reporting unit) in strata __-__, May 19__. (Exhibit 5)

6. Table 6. Precipitation summaries for selected reporting stations in (reporting unit), September 19__ through May 19__. (Exhibit 6)

7. Table 7. Survey design for (reporting unit), May 19__. (Exhibit 7)

One copy of the Waterfowl Breeding Population and Habitat Survey - Stratum Summary Form (Exhibit 17) for each stratum becomes a part of the survey unit report and will follow Table 7.

The Segment Data Forms and originals of all supporting Field Data Forms, Field Data Form (stratum summaries), Ground Crew Field Data Forms and Air-Ground Comparison Segment--Ground Crew Summary Forms are submitted directly to the Assistant Branch Chief-Surveys, immediately upon return of the Flyway Biologist to the field station after the survey is completed. Express Mail is used for this purpose whenever possible. Reference is made to the appendix for report addressees and distribution. This report and all supporting data are due on 10 June for prairie units and 20 June for bush units.

Table 1. Long-term trend in waterfowl breeding population estimates by species in Southern Duckland, 1955-85 (estimates in thousands)[a]

Species	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Ducks											
Dabblers											
Mallard	2,443.1	3,026.5	2,866.8	1,911.3	2,237.1	2,138.8	1,504.6	1,944.4	1,713.7	1,412.1	1,334.7
Am. black duck	1.1	.0	.0	.0	.7	.0	.0	.0	.0	.0	.0
Gadwall	753.5	721.9	600.8	532.9	695.5	474.5	409.5	619.7	573.2	460.4	588.4
Am. wigeon	817.5	664.6	460.6	641.5	812.8	610.4	332.2	594.5	675.0	366.7	453.4
Green-winged teal	311.0	321.9	222.3	302.1	463.7	276.6	185.3	269.8	255.8	131.4	273.4
Blue-winged teal	2,622.8	1,799.6	1,631.3	902.4	1,482.8	1,307.2	1,110.0	818.2	963.1	874.9	1,293.6
N. shoveler	730.3	823.0	422.7	426.6	692.4	494.8	333.8	699.1	792.8	352.7	669.3
N. pintail	2,050.3	2,549.5	672.5	961.7	1,580.0	897.5	526.2	1,222.1	1,029.3	542.1	521.7
Subtotal	9,729.6	9,907.0	6,877.0	5,678.5	7,965.0	6,199.8	4,401.6	6,167.8	6,002.9	4,140.3	5,134.5
Divers											
Redhead	288.6	270.5	227.6	184.1	227.9	323.0	213.3	123.9	233.4	306.9	323.4
Canvasback	305.7	283.3	253.5	128.9	280.9	221.0	111.1	181.1	212.7	166.6	118.8
Scaups	622.1	495.0	702.2	526.1	796.5	629.0	277.1	498.2	844.8	549.2	326.4
Ring-necked duck	62.1	49.1	45.0	51.8	54.0	63.9	47.2	80.4	25.1	48.0	24.7
Goldeneyes	18.4	18.0	73.1	15.8	40.2	33.1	22.7	23.4	18.3	17.1	30.5
Bufflehead	62.0	33.4	52.5	58.1	61.8	34.8	40.0	33.5	52.2	38.5	36.9
Ruddy duck	114.8	97.3	122.7	68.1	134.5	77.1	76.6	301.2	149.9	88.5	163.7
Subtotal	1,473.7	1,246.6	1,476.6	1,032.9	1,595.8	1,381.9	788.0	1,241.7	1,536.4	1,214.8	1,024.4
Miscellaneous											
Oldsquaw	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Eiders	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Scoters	8.6	1.3	5.1	3.2	15.1	2.1	.6	4.0	3.0	3.7	3.2
Mergansers	4.7	3.4	2.1	4.1	8.2	4.3	9.2	2.2	3.7	11.2	1.2
Subtotal	13.3	4.7	7.2	7.3	23.3	6.4	9.8	6.2	6.7	14.9	4.4
Total ducks	11,216.6	11,158.3	8,360.8	6,718.7	9,584.1	7,588.1	5,199.4	7,415.7	7,546.0	5,370.0	6,163.3
Canada goose	8.7	12.9	9.3	12.6	15.3	15.9	21.5	22.6	30.7	33.0	32.7
Am. coot	1,177.4	1,513.0	440.0	433.6	1,309.1	634.3	395.1	282.8	673.4	566.7	530.7

[a]Adjusted for visibility bias.

Table 1 (continued). Long-term trend in waterfowl breeding population estimates by species in Southern Duckland, 1955-85 (estimates in thousands)[a]

Species	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Ducks										
Dabblers										
Mallard	1,104.1	1,965.6	2,015.8	2,119.9	2,164.1	2,938.3	3,401.5	2,670.9	2,367.0	2,079.5
Am. black duck	.0	.0	.0	.0	.0	.0	.7	.0	.0	.0
Gadwall	506.6	677.9	469.1	689.7	557.0	524.4	637.2	573.0	334.0	626.9
Am. wigeon	774.8	845.1	690.1	584.5	787.1	812.1	914.3	673.1	1,050.6	751.3
Green-winged teal	126.6	273.1	373.6	215.6	521.1	439.2	390.0	243.9	313.0	303.7
Blue-winged teal	1,070.0	1,496.7	1,395.7	862.4	1,034.0	2,160.4	1,917.8	1,819.7	1,842.8	1,520.7
N. shoveler	308.1	843.6	793.6	485.9	750.4	760.8	907.7	922.0	538.4	705.2
N. pintail	716.6	1,595.4	1,671.0	774.4	1,956.1	2,417.2	2,222.2	2,261.6	1,006.3	2,186.1
Subtotal	4,606.8	7,697.4	7,408.9	5,732.4	7,769.8	10,052.4	10,391.4	9,164.2	7,452.1	8,173.4
Divers										
Redhead	90.5	149.5	213.1	69.2	210.6	189.3	279.6	138.1	179.3	179.0
Canvasback	111.5	112.9	148.7	91.1	197.0	255.4	191.8	137.7	229.0	181.7
Scaups	155.2	185.6	316.4	189.4	306.5	322.9	221.7	239.3	223.0	377.9
Ring-necked duck	26.7	18.4	12.0	1.7	7.5	16.1	8.3	9.8	9.6	49.1
Goldeneyes	9.9	11.8	16.2	25.4	9.8	17.6	16.0	5.1	23.3	15.7
Bufflehead	33.3	20.0	25.9	43.7	56.1	28.9	18.4	48.1	25.3	26.9
Ruddy duck	48.4	83.3	77.7	87.2	58.5	52.1	76.0	97.8	153.4	131.1
Subtotal	475.5	581.5	810.0	507.7	846.0	882.3	811.8	675.9	842.9	961.4
Miscellaneous										
Oldsquaw	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Eiders	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Scoters	10.0	3.1	2.4	7.5	4.4	.6	6.2	3.0	5.7	2.7
Mergansers	5.5	.0	.0	.6	.9	5.5	.8	.0	1.4	.3
Subtotal	15.5	3.1	2.4	8.1	5.3	6.1	7.0	3.0	7.1	3.0
Total ducks	5,095.4	8,282.0	8,221.3	6,248.2	8,621.1	10,940.8	11,210.2	9,843.1	8,302.1	9,137.8
Canada goose	2.5	3.2	1.6	1.0	5.3	4.1	8.8	10.0	6.5	8.7
Am. coot	254.4	333.3	358.0	450.7	407.5	900.7	963.0	569.8	931.9	1,088.6

[a]Adjusted for visibility bias.

Table 1 (continued). Long-term trend in waterfowl breeding population estimates by species in Southern Duckland, 1955-85 (estimates in thousands)[a]

Species	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Ducks										
Dabblers										
Mallard	3,948.4	5,339.8	4,518.6	5,066.4	2,192.1	3,287.7	1,650.4	1,133.6	1,552.5	1,379.1
Am. black duck	.8	.0	1.9	.0	.0	.0	.0	.0	.0	.0
Gadwall	366.8	436.9	390.9	144.6	185.0	237.1	717.8	632.2	307.4	408.7
Am. wigeon	997.7	1,460.4	859.4	1,113.4	572.0	598.2	453.8	760.0	505.9	488.2
Green-winged teal	430.1	574.4	316.4	238.0	142.4	245.6	412.3	199.1	207.8	201.7
Blue-winged teal	2,758.0	3,428.6	2,528.0	1,891.8	1,247.8	1,337.3	1,223.2	674.5	459.9	1,022.1
N. shoveler	809.3	1,037.3	757.4	396.9	302.2	720.6	482.5	426.8	199.2	375.3
N. pintail	4,113.3	5,105.7	2,700.5	1,557.0	645.2	1,418.7	846.6	596.7	835.2	853.4
Subtotal	13,424.4	17,383.1	12,073.1	10,408.1	5,286.7	7,845.2	5,786.6	4,422.9	4,067.9	4,728.5
Divers										
Redhead	225.8	470.9	280.2	150.9	115.1	140.3	57.2	157.6	36.3	84.5
Canvasback	240.7	362.2	330.5	234.2	76.0	107.7	99.9	166.9	87.2	121.6
Scaups	723.9	1,074.1	757.0	440.0	577.3	409.1	673.2	324.3	153.6	133.5
Ring-necked duck	31.5	19.5	12.6	13.4	31.8	15.9	9.6	.0	24.0	11.2
Goldeneyes	13.3	23.9	19.9	11.0	15.0	24.1	11.9	8.7	4.4	2.9
Bufflehead	11.1	13.4	22.2	10.1	13.7	19.4	12.4	2.9	17.4	19.3
Ruddy duck	155.8	330.2	158.1	72.4	269.3	133.1	80.9	67.3	40.3	37.5
Subtotal	1,402.1	2,294.2	1,580.5	932.0	1,098.2	849.6	945.1	727.7	363.2	410.5
Miscellaneous										
Oldsquaw	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Eiders	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Scoters	6.5	16.2	1.0	12.0	5.9	6.6	3.1	.0	4.6	7.1
Mergansers	.3	.0	.0	.0	.3	7.2	1.7	.0	6.0	1.5
Subtotal	6.8	16.2	1.0	12.0	6.2	13.8	4.8	.0	10.6	8.6
Total ducks	14,833.3	19,693.5	13,654.6	11,352.1	6,391.1	8,708.6	6,736.5	5,150.6	4,441.7	5,147.6
Canada goose		-	-	-	1.8	2.6	2.5	2.5	3.6	3.2
Am. coot	1,265.3	2,104.6	1,503.2	448.2	489.4	383.5	211.0	252.5	109.4	201.9

[a] Adjusted for visibility bias.

Table 2. Status of waterfowl breeding population estimates by species and stratum in Southern Duckland, comparing 1985 with 1984, the 1975-1984 previous 10-year mean, and the 1955-1984 long-term mean (estimates in thousands).[a]

Species	Stratum (1985) 30	31	32	33	34	35	1985 Total	1984 Total	10-Year Mean	Long-Term Mean	Percent Change from 1984	10-Year Mean	Long-Term Mean
Ducks													
Dabblers													
Mallard	275.5	243.0	311.1	56.2	327.9	121.0	1,334.7	1,412.1	2,119.8	2,469.8	- 5	- 37	- 46
Am. black duck	.0	.0	.0	.0	.0	.0	.0	.0	.2	.2	-	-	-100
Gadwall	119.2	76.7	287.5	23.1	60.2	21.7	588.4	460.4	584.2	508.8	+ 28	+ 1	+ 16
Am. wigeon	132.1	75.6	159.6	21.2	45.1	19.8	453.4	366.7	397.6	722.3	+ 24	- 24	- 37
Green-winged teal	51.0	40.9	29.5	2.2	114.1	35.7	273.4	131.4	274.0	296.9	+108	NC	- 8
Blue-winged teal	310.6	309.7	320.0	6.8	226.0	120.5	1,293.6	874.9	1,351.2	1,506.8	+ 48	- 4	- 14
N. shoveler	164.0	149.3	224.3	16.5	91.6	23.6	669.3	352.7	576.8	609.7	+ 90	+ 16	+ 10
N. pintail	91.1	82.4	200.3	40.6	71.9	35.4	521.7	542.1	1,203.1	1,583.7	- 4	- 57	- 67
Subtotal	1,143.5	977.6	1,532.3	166.6	936.8	377.7	5.134.5	4.140.3	6,706.9	7,698.2	+ 24	- 23	- 33
Divers													
Redhead	132.6	95.8	63.8	11.5	16.7	3.2	323.4	306.9	239.9	193.9	+ 5	+ 35	+ 67
Canvasback	37.0	28.5	18.0	2.1	28.5	4.7	118.8	166.6	214.5	187.6	- 29	- 45	- 37
Scaups	133.6	67.7	76.1	2.8	35.5	10.7	326.4	549.2	594.0	458.1	- 41	- 45	- 29
Ring-necked duck	6.3	9.2	6.3	.0	.7	2.2	24.7	48.0	52.7	28.5	- 49	- 53	- 13
Goldeneyes	19.5	6.4	2.2	.0	.8	1.6	30.5	17.1	28.0	18.9	+ 78	+ 9	+ 61
Bufflehead	20.4	8.7	.4	.0	1.2	6.2	36.9	38.5	46.7	31.2	+ 4	- 21	+ 18
Ruddy duck	48.4	43.0	32.5	.0	35.2	4.6	163.7	88.5	123.1	114.7	+ 85	+ 33	+ 43
Subtotal	397.8	259.3	199.1	16.4	118.6	33.2	1,024.4	1,214.8	1,298.9	1,032.9	- 16	- 21	- 1
Miscellaneous													
Oldsquaw	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	-	-	NC
Eiders	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	-	-	NC
Scoters	3.0	.0	.0	.0	.0	.0	3.0	3.7	4.7	5.2	- 14	- 32	- 42
Mergansers	.0	1.2	.0	.0	.0	.0	1.2	11.2	5.3	2.8	- 89	- 77	- 57
Subtotal	3.0	1.2	.0	.0	.0	.0	4.2	14.9	10.0	8.0	- 72	- 58	- 47
Total ducks	1,544.3	1,238.1	1,731.4	183.0	1,055.4	410.9	6,163.1	5,370.4	8,015.8	8,739.1	+ 15	- 23	- 29
Canada goose	3.2	9.1	7.3	3.0	3.1	7.0	32.7	33.0	18.2	9.6	- 1	+ 80	+241
Am. coot	142.1	137.7	101.5	35.3	103.5	10.6	530.7	566.7	742.5	668.4	- 6	- 29	- 21

[a] Adjusted for visibility bias.

Table 3. Lone drake index: long-term trend expressed as a percentage of total drakes in Southern Duckland, 1956-1985.[a]

Year	Mallard	Pintail	Canvasback	Total
1956	76.44	82.68	63.21	78.46
1957	83.49	85.97	75.44	83.83
1958	79.38	81.33	73.68	79.55
1959	74.58	69.44	46.39	72.96
1960	85.92	82.47	71.57	84.65
1961	73.90	69.94	44.97	71.90
1962	51.66	36.35	39.83	47.32
1963	82.81	82.92	77.77	82.59
1964	85.21	82.32	65.64	83.47
1965	82.11	83.69	68.02	81.77
1966	81.75	82.66	77.57	82.98
1967	86.80	82.13	56.50	83.80
1968	80.24	75.50	47.65	77.88
1969	88.37	85.10	64.14	85.92
1970	82.10	78.28	65.35	79.60
1971	79.33	76.58	64.68	77.62
1972	81.14	78.24	60.52	79.12
1973	78.85	74.25	42.26	75.02
1974	85.75	79.60	76.59	82.42
1975	83.06	74.88	72.78	79.08
1976	78.52	78.68	74.02	78.23
1977	69.62	62.99	41.93	65.54
1978	83.78	79.50	61.05	80.91
1979	81.30	77.87	63.50	78.85
1980	77.46	75.73	57.12	75.64
1981	75.68	71.78	46.04	73.37
1982	82.18	75.04	49.94	78.25
1983	75.04	73.90	65.77	73.97
1984	76.63	77.43	60.21	75.33
1985	78.04	73.44	78.30	77.03
10-year mean (1975-84)	78.33	74.77	59.24	75.91
Long-term mean (1956-84)	79.37	76.35	61.75	77.57

[a]Unadjusted for visibility bias.

Table 4. Long-term trend in May pond estimates by stratum in Southern Duckland, comparing 1985 with 1984, the 1975-1984 previous 10-year mean, and the 1961-1984 long-term mean (estimates in thousands).[a]

Year	Stratum 30	31	32	33	34	35	Total
1955[b]	525.7	884.7	958.5	213.4	1,198.8	733.1	4,474.2
1956[b]	315.9	414.9	729.4	103.2	746.9	452.6	2,762.8
1957[b]	164.1	399.3	344.2	72.9	636.2	299.4	1,916.1
1958[b]	210.0	319.0	367.8	108.2	466.8	344.1	1,815.9
1959[b]	57.5	218.7	159.9	79.4	169.0	77.4	761.9
1960[b]	166.2	692.6	394.8	90.0	487.4	270.3	2,101.4
1961	142.2	219.4	252.2	80.3	67.5	48.0	809.6
1962	176.8	422.8	343.1	49.8	291.3	64.8	1,348.6
1963	144.7	198.1	268.4	43.2	230.9	125.3	1,010.6
1964	203.3	369.1	333.1	66.8	493.7	403.7	1,869.7
1965	327.9	439.9	610.1	112.2	442.1	337.6	2,269.8
1966	350.8	587.3	595.1	133.0	593.7	404.9	2,664.8
1967	282.3	642.1	688.8	194.9	545.1	299.0	2,652.2
1968	219.5	312.6	383.4	61.8	123.5	58.5	1,159.3
1969	383.2	465.5	774.7	138.7	267.1	179.6	2,208.8
1970	289.6	628.7	763.8	106.8	721.3	518.1	3,028.3
1971	302.5	418.3	509.2	123.8	608.6	391.7	2,354.1
1972	356.5	659.8	364.7	64.5	552.2	306.2	2,303.9
1973	259.3	453.5	317.6	83.3	227.6	117.0	2,458.3
1974	465.6	910.9	822.0	133.8	945.4	462.1	3,739.8
1975	395.2	806.1	785.2	192.8	821.4	401.3	3,402.0
1976	201.9	398.9	553.3	96.9	657.1	671.5	2,579.6
1977	176.0	254.7	265.5	44.6	338.7	170.3	1,249.8
1978	274.0	393.5	566.1	161.7	545.4	280.7	2,221.4
1979	433.3	697.4	660.0	130.2	667.7	481.1	3,069.7
1980	265.5	311.3	358.2	48.1	273.3	137.2	1,393.6
1981	145.9	160.4	126.1	28.5	97.3	52.6	610.8
1982	284.0	630.6	705.3	119.3	251.5	213.8	2,204.5
1983	384.9	715.5	712.0	96.0	464.6	323.4	2,696.4
1984	283.1	548.4	267.0	35.2	250.6	127.0	1,511.3
1985	622.9	737.8	723.6	108.1	558.5	207.1	2,958.0
10-year mean	284.4	491.7	499.9	95.3	436.8	285.9	2,094.0
Long-term mean	281.2	485.2	501.0	97.8	436.6	274.0	2,117.4
Percent Change							
1985 from 1984	+120	+ 35	+171	+207	+123	+ 63	+ 96
1985 from the 10-year mean	+119	+ 50	+ 45	+ 13	+ 28	- 28	+ 41
1985 from the long-term mean[c]	+122	+ 52	+ 44	+ 11	+ 28	- 24	+ 40

[a] Adjusted for visibility bias.
[b] 1955-1960 unadjusted for visibility bias.
[c] Long-term mean utilizes only the years of comparable data (adjusted for visibility bias).

Table 5. Air-ground visibility rate calculation for ducks, coots, and ponds for Southern Duckland in strata 30-33 May 1985

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--AIR-GROUND VISIBILITY RATE CALCULATION FORM

Province/State: S. Duckland							Strata: 30-33				May 6-23, 1985				Sheet 4 of 4	
Segment	Kinistino		Ceylon		Goodwater		Dummer						30-33 Total		30-33 SOP	
Species	G/A	Rate	G/A	Rate	G/A	Rate	G/A	Rate	G/A	Rate	G/A	Rate	G/A	Rate	G/A	Rate
Mallard	76		22		22		50						772			
	42		4		20		24						414	1.8647		
Am. black duck																4.8000
Gadwall	14		32		6		56						344			
	6		2		2		16						90	3.8222		
Am. wigeon	18		14		2		16						228			
	2						4						38	6.0000		
G.W. teal	10		2										96			
	2												22	4.3636		
B.W. teal	56		14		10		34						768			
	14		3		4		6						142	6.4085		
N. shoveler	32		4		10		18						460			
	12		2				6						162	2.8395		
N. pintail	14		12		6		24						537			
	4		6		4		8						252	2.1310		
Redhead	13						28						175			
	1						12						23	7.6087		
Canvasback	8				4		18						89			
	6						10						70	1.2714		
Scaups	16		2		2		131						303			
	15						65						137	2.2117		
Ring-necked duck													8			
													2	4.0000		3.9363
Goldeneyes													0			
													0	--		5.5000
Bufflehead							2						16			
													2	8.0000		2.7000
Ruddy duck							17						102			
	1												19	5.3684		7.5382
Oldsquaw																6.5000
Eiders																6.0000
Scoters													0			
													0	--		1.3000
Mergansers													0			
													0	--		2.0000
TOTAL																
Am. coot	77				14		25						532			
	6				2		12						112	4.7500		
Ponds	21[illegible]		44		50		67						2,168			
	20[illegible]		44		48		62						2,098	1.0334		

Form 5

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Table 6. Precipitation summaries for selected reporting stations in Southern Duckland, September 1984 through May 1985.[a]

Station	9/1/84 to 10/31/84		11/1/84 to 3/31/85		4/1/85 to 5/22/85		9/1/84 to 5/22/85			
	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Diff-erence	Percent Change
N. Battleford	113.8	41.5	87.4	90.6	124.4	44.0	325.6	176.1	+149.5	+84.9
Saskatoon	116.8	49.1	65.8	87.9	113.6	45.1	296.2	182.1	+114.1	+62.7
Prince Albert	147.8	61.1	105.3	89.6	90.1	47.9	343.2	198.6	+144.6	+72.8
Hudson Bay	153.8	79.3	90.8	113.2	41.8	51.0	286.4	243.5	+ 42.9	+17.6
Wynyard	153.6	64.4	89.2	100.9	87.4	48.8	330.2	214.1	+116.1	+54.2
Kindersley	91.7	40.4	59.1	79.8	92.0	48.7	242.8	168.9	+ 73.9	+43.8
Swift Current	81.5	52.2	83.3	94.2	40.0	54.1	204.8	200.5	+ 4.3	+ 2.1
Moose Jaw	87.8	54.1	81.3	89.7	67.8	60.0	236.9	203.8	+ 33.1	+16.2
Yorkton	155.1	69.4	116.0	109.9	53.2	49.7	324.3	229.0	+ 95.3	+41.6
Regina	83.6	55.6	73.1	81.0	84.6	49.8	241.3	186.4	+ 54.9	+29.5
Broadview	146.0	75.5	80.9	76.8	43.2	66.5	270.1	218.8	+ 51.3	+23.4
Estevan	79.0	65.4	59.2	91.5	39.7	69.6	177.9	226.5	- 48.6	-21.5

[a] Data obtained from Environment Canada (all precipitation in millimeters).

Table 7. Survey design for Southern Duckland, May 1985.

	Stratum						
	30	31	32	33	34	35	Total
Survey design							
Square miles in stratum	18,570	21,086	37,911	11,345	13,164	9,044	111,120
Square miles in sample-waterfowl	162	144	571.5	90	175.5	126	1,269
Square miles in sample-ponds	81	72	285.75	45	87.75	63	634.5
Linear miles in sample	648	576	2,286	360	702	504	5,076
Number of transects in sample	4	5	14	6	5	6	40
Number of segments in sample	36	32	127	20	39	28	282
Expansion factor	114.630	146.431	66.336	126.056	75.009	71.778	87.565
Current year coverage							
Square miles in sample-waterfowl	162	144	571.5	90	175.5	126	1,269
Square miles in sample-ponds	81	72	285.75	45	87.75	63	634.5
Linear miles in sample	648	576	2,286	360	702	504	5,076
Number of transects in sample	4	5	14	6	5	6	40
Number of segments in sample	36	32	127	20	39	28	282
Expansion factor	114.630	146.431	66.336	126.056	75.009	71.778	87.565

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Province/State: S. Duckland | Stratum: 31 | Transect: 17 | Pilot-Observer: J. Mallard | Observer: M. Pintail | Sheet 1 of 1

May 20, 1939 | Wind: SE | Speed: 10 | Sky: ϕ

Notes	Time & Segment	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL		Coot		CG	Water Nat	Water Art
48°F start-Tot. lost emerg. light	1308 3	14 2 5; PP 5		1; P	1; P	4 3; PPP	4 2; PP	1				1; P			3 1							26	10 5				85	4
S-15	1320 4	26 9 5; PPPPPPPPP 5		2; PP		1 1; P	1 2; PP	6 2; PP	7 3; PPP	4 1; P	3 3; PP	4; PPPP										48	27 5	9		3 1	130	8
ϕ	1332 5	8 7; PPPPPPP		2; PP			1 1; P	5 1 5; P 5	7 2; PP	1 2; PP	4 1 6; 6	3 5; PPPPP			1 1; P	4						31	21 11	8		2 1; P	125	2
SE-15	1344 6	4 4; PPPP		1; P	1		3 1; P	2 2; PP	4 1													14	8	1			75	1
	1356 7	12 6; PPPPPP					2 3; PPP	3 3; PPP	4 1; P	1; P	1 5; 5	1 5; PPPPP	1; P									22	20 5	7		1 2; PP	124	2
SE-10	1408 8 1420	16 7; PPPPPPP		2 4; PPPP	1 1; P		1 6; PPPPPP	2 2; PP	5	1 1	5 2; PP	8 5; PPPP				2 2; PP						44	29	19			166	1
	TOTAL	80 35 10		3 10	2 2	5 4	12 15	19 10 5	27 6	6 4	12 5 11	12 20	1		3 1	4 2						185	115 26	44		6 3	705	18

Form 1

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Instructions for completing form:

Record heading information as follows:

- Time: Use Universal Coordinated (Greenwich) Tme (1150, 1315, 1410, etc.)
- Wind: Use True direction from which wind is blowing (NW, E, SW, etc.)
- Speed: Provide in Statute miles per hour (5, 8, 15, etc.)
- Sky: Indicate cloud cover as clear ○ , scattered ⦶ , broken ⦷ , or overcast ⦶ .
- Water: For each segment, enter the natural water count in the left half of the block and the artificial water count in the right half of the block. (Note: Do not double these counts on this form.)

Record waterfowl data as follows:

- Lone drakes: ~~1111~~ 111 etc.
- Flocked drakes: (2) (4) (3) etc.
  (Note: Five or more drakes of all species are to be treated as a group.)
- Pairs: PPPPPPP etc.
- Groups: [7] [5] [9] etc.
  (Note: A hen and 2 drakes will be treated as a pair and a lone drake and a hen and 3 drakes will be treated as a pair and 2 lone drakes.)

Summarize waterfowl data for each segment and for the transect using a "fractional" system as follows:

TOTAL DRAKES (lone drakes + flocked drakes)	TOTAL PAIRS
	TOTAL IN GROUPS

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Province/State: N. Duckland	Stratum: 21	Transect: 1	Pilot-Observer: R. Scaup	Observer: G. Ringneck	Sheet 1 of 1
May 17, 1985	Wind: 2.0	Speed: 10	Sky: 0		

Waterfowl Species

Notes	Time & Segment	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL		Coot	CG	WF	Swn	Crn
Start 6:58	1258 9																					10	6 / 20					
Rec-I	1308 8																					3	3 / 40					
	1317 7																					14	9 / 140	1				
	1327 6																					4	14					1
	1337 5																					2	2					
	1346 4																					13	50 / 96					
	1356 3																					8	14 / 85					
	1406 2																					2						
	1416																											
	1425																											
	Tot	25 5			3 1	2 2	1				2 1 / 5	3 37 / 161	4 10	3 3	1 2				7	12 30 / 215		56	98 / 381	1				1

Form 2

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Instructions for completing form:

Record heading information as follows:

Time: Use Universal Coordinated (Greenwich) Time (1150, 1315, 1410, etc.)
Wind: Use True direction from which wind is blowing (NW, E, SW, etc.)
Speed: Provide in Statute miles per hour (5, 8, 15, etc.)
Sky: Indicate cloud cover as clear ○ , scattered ⌽ , broken ⦶ , or overcast ⌽ .

Record waterfowl data as follows:

Lone drakes: ~~1111~~ 111 etc.

Flocked drakes: (2) (4) (3) etc.
(Note: Five or more drakes of all species are to be treated as a group.)

Pairs: PPPPPPP etc.

Groups: [7] [5] [9] etc.
(Note: A hen and 2 drakes will be treated as a pair and a lone drake and a hen and 3 drakes will be treated as a pair and 2 lone drakes.)

Summarize waterfowl data for each segment and for the transect using a "fractional" system as follows:

TOTAL DRAKES (lone drakes + flocked drakes)	TOTAL PAIRS
	TOTAL IN GROUPS

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Province/State: S. Duckburg | Stratum: 31 | Transect: 16-20 | Pilot-Observer: J. Mallard | Observer: M. Pintail | Sheet 1 of 1

May 20-22, 19__ | Wind: — | Speed: — | Sky: —

Notes	Time & Segment	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL		Coot		CG	Water Nat	Water Art
	16	102/23/35		18/21/5	4/10	1/4	46/37/15	73/26	46/20/10	12/8/10	16/4/15	15/24/6	/1			8/2/7						39	180/103	99		5/8	605	30
	17	80/35/10		3/10	2/2	1/4	12/15	19/10/5	27/6	6/4	12/5/11	12/20	/1		3/1	4/2						185	115/26	44		6/3	705	18
	18	21/13		2/3	/5	8/2	15/5	9/1	4/	4/2	6/	9/13	2/3	/1	/6	2/						83	53	10		4/3	277	40
	19	79/21/11		1/6	7/1	2/1	17/13	17/7	10/2	7/7	11/2/13	11/8/11	/2	2/	1/	6/2				1/1		167	73/35	37		/1	496	19
	20	32/4/16		2/	6/1	1/1	13/15	10/5	10/2	1/2	1/	5/5		1/								85	37/10	8		/1	236	16
	Total	314/98/66		26/40/5	24/11	26/12	103/85/15	128/49/5	97/30/10	30/23/10	46/11/39	52/70/17	2/7	4/	4/7	20/6/7				1/1		871	458/174	198		16/15	2315	123

Form 1

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Province/State: N. Duckland | Stratum: 21 | Transect: 1-11 | Pilot-Observer: R. Scaup | Observer: G. Ringneck | Sheet 1 of 1

May 10 - Jun 3, 1985 | Wind: -- | Speed: — | Sky: —

Notes	Time & Segment	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL		Coot	CG	WF	Swn	Crn
		Waterfowl Species																										
	1	25|5			3|1	2|2	|1				2|1 / 5	3|37 / 161	4|10	3|3	1|2				|7	12|30 / 215		56	98 / 381	1				|1
	2	8|1			1|1		|1	|1				3|5 / 100	2|11 / 10		|2					7|6 / 116		21	31 / 220					
	3	12|1			1|1	|1	|1					1|6	1|7 / 5		4|1				3|2			22	20 / 5					
	4	2| / 6			2|1	|1						1|4 / 10	5|5		1|1				|2	|1		12	14 / 14		|1			
	5	7|1 / 9			1|	|1					1| / 6	2|	2|	3|1				|1	6|3 / 14		22	7 / 29		|1			
	6	8| / 12				|		|1				|1	4|1 / 7		3|4				|7	|4 / 8		16	18 / 27		3|			
	7	10|1				|1						1|8	13|4		2|3				4|8	6|		36	25		1|2 / 14			
	8	4|1			1|1	1|2						6|3 / 20	8|2	|1	|1				3|4			23	15 / 20		|2			|1
	9	2|			1|							9|1	1|1		|1				1|5			14	8		1|2			
	10	3|4				1|2						2|2	1|	1|					4|3	1|2		13	13		| / 4			
	11	3|			1|1	4|1						3|4 / 20	2|		1|				1|4	2|		20	9 / 20		2| / 6			
Form 2 TOTAL		84|11 / 27			11|8	9|11	1|2	|2			2|1 / 5	30|71 / 317	13|41 / 22	5|4	15|16				16|43	35|45 / 347		235	258 / 418	1	7|8 / 24	MBMO-WPS		1|1

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--CREW AREA VISIBILITY RATES

In the PRAIRIE UNITS: Use the current year's calculated visibility rate when it falls within the ranges indicated below (unless otherwise indicated).

	Strata 26-29	Strata 30-33	Strata 34-40	Strata 41-44	Strata 45-49
Mallard	**	**	**	**	**
Am. black duck	4.8000*	4.8000*	4.8000*	4.8000*	4.8000*
Gadwall	2.5 - 7.8	2.6 - 8.6	4.2 - 18.7	1.6 - 9.0	1.6 - 9.0
Am. wigeon	2.6 - 6.5	4.4 -15.9	3.6042*	**	15.7701*
Green-winged teal	2.2 -25.4	5.1 -37.3	14.6272*	9.5255*	8.2471*
Blue-winged teal	**	**	**	**	**
N. shoveler	2.2 - 4.0	2.7 - 6.0	2.2 - 7.0	3.3 - 8.1	3.3 - 8.1
N. pintail	**	**	**	**	**
Redhead	1.8 -10.1	2.8 -10.8	2.1 -13.4	5.3645*	3.1 -16.9
Canvasback	.8 - 4.2	1.4 - 3.6	1.5 - 3.8	2.4263*	1.4 - 4.0
Scaups	1.2 - 3.2	1.6 - 5.2	1.2 - 4.3	1.2 - 7.3	1.2 - 6.1
Ring-necked duck	1.0893*	3.9363*	4.4183*	3.9608*	23.1799*
Goldeneyes	5.5000*	5.5000*	5.5000*	5.5000*	5.5000*
Bufflehead	2.7000*	2.7000*	2.7000*	2.7000*	2.7000*
Ruddy duck	6.5846*	7.5382*	16.1736*	9.0339*	15.8491
Oldsquaw	6.5000*	6.5000*	6.5000*	6.5000*	6.5000*
Eiders	3.6000*	3.6000*	3.6000*	3.6000*	3.6000*
Scoters	1.3000*	1.3000*	1.3000*	1.3000*	1.3000*
Mergansers	2..0000*	2.0000*	2.0000*	2.0000*	2.0000*
Am. coot	1.8 -16.8	3.6 -10.1	3.1 - 9.0	5.4616*	2.8 -12.0
Canada goose	1.0000*	1.0000*	1.0000*	1.0000*	1.0000*

However, when the current year's calculated visibility rate falls outside the range indicated above, use the appropriate long-term average provided below. Use the current year's calculated visibility rate for any species not listed above.

	Strata 26-29	Strata 30-33	Strata 34-40	Strata 41-44	Strata 45-49
Gadwall	4.4964	4.8694	9.3101	4.7773	5.3770
Am. wigeon	4.5033	8.6823	3.6042*	**	15.7701*
Green-winged teal	10.1474	18.7305	14.6272*	9.5255*	8.2471*
N. shoveler	3.2494	3.8656	4.6615	3.8377	5.6642
Redhead	4.5530	6.1675	4.7040	5.3645*	7.1900
Canvasback	2.5336	2.5069	2.6341	2.4263*	2.4848
Scaups	2.3755	3.7688	2.4407	2.6882	2.9933
Am. coot	4.5281	7.4026	5.6839	5.4616*	6.7119

In the BUSH UNITS: Always use the following species visibility rates.

Mallard	[illegible]	N. pintail	[illegible]	Oldsquaw	6.5000
Am. black duck	4.8000	Redhead	5.3645	Eiders	3.6000
Gadwall	4.7773	Canvasback	2.4263	Scoters	1.3000
Am. wigeon	5.3988	Scaups	2.6882	Ruddy duck	9.0339
Green-winged teal	9.5255	Ring-necked duck	3.9608	Mergansers	2.0000
Blue-winged teal	10.4047	Goldeneyes	5.5000	Am. coot	5.4616
N. shoveler	3.8377	Bufflehead	2.7000	Canada goose	1.0000

* Always use these visibility rates
** Use whatever calculated

Note: This table will be updated at approximate 5-year intervals.

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Province/State: S. Duckland | Stratum: 31 | Transect: Kinistino | Pilot-Observer: J. Mallard | Observer: M. Pintail | Sheet 1 of 1

May 22, 1985 | Wind: 5 | Speed: 15 | Sky: ∅

Notes	Time & Segment	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL		Coot		CG	Water Nat	Water Art
Start 8:38 10← E dry	1438 G/A	III 4BB(2) (11+) PPPPPP		I (1+) P	(1+) P	I (1+)	III (3+4) PPIP	++++ (5+1) P	II (2+)	I (1+)	I (2) (3+)	II (2) (4+2/7) PP (7)				I (1+)						35	17 / 7	IIPII (6)			95	5

Form 1 MBMO-WPS 4/87

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, AIR-GROUND COMPARISON SEGMENT--GROUND CREW FIELD DATA FORM

Province/State: S. Duckland | Stratum: 31 | Transect: Kinistino | May 23, 1985 | Sheet 1 of 31

Crew Leader: W. Teal | Assistants: G. Ringneck & S. Coot

Wetlands							Waterfowl Species																							
				Impaction (%/type)																										
Pond No.	Pond Type	Water Level	Margin Width	Basin	Margin	Uplands	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL	GG		Coot
1	5	3	8	5F 20T	50CC 20BA	10P 10C 50F	(2)					[5]		1													3+5	1		2
1A	3	1	3	100C	100C	30F 70S																								
1B	1	1	0	100C	100C	100F																								
1C	3	1	5	100BA	50C 50BA	100F																								
2	DD	1	--	5F	100BS	100F																								
3	5	3	7		30C	100F				p																	+1			
3A	3	2	4	100BS	100BS	100BS						p															+1			
4	3	2	3		100C	100S																								
5	5	4	5		100A	100F	1 p							p													1+2			1
6	4	4	5		70C	30W 70S																								
6A	1	2	0	100C	100C	100S																								
7	5	4	8		100A	70C 30F	(2)		p			p															2+2	p		5
8	5	4	7		70A 30C	100C						p															+1			
9	Sh	5	5		100BS	50W 50C																			p		+1			
10	5	5	10		60C	90C 10F	1						p	(2)													3+1			
11	3	3	5		100C	100S																								
Dry 4	I 2	III 5	IV 1	V 6	Str. [illegible]	Art. 1	6+1		+1	+1		+3/5	+1	3+1											+1		9+9/5	1+1		9

Form 3

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, AIR-GROUND COMPARISON SEGMENT--GROUND CREW FIELD DATA FORM

Instructions for completing form:

Record wetland types as follows:

Natural:

Type 1 - TEMPORARY WETLANDS: Sheet water, small wet areas in stubble or plowed fields, and wet depressions having no moist soil vegetation which can be expected to last less than 3 weeks under normal conditions of temperature and precipitation with less than 6 inches (15 cm) of water depth. To minimize subjectivity it is stressed that water depth is the primary criterion.

Type 3 - SEASONAL WETLANDS: Hay meadows or basins containing natural aquatics which normally can be expected to be dry by mid-summer, but retain water for at least 3 weeks after observation. These wetlands normally have a uniform vegetative cover and are 6 inches (15 cm) or more in depth. It should be pointed out that under dry fall conditions, many such ponds are plowed and refill with water in the spring. In such cases, no vegetation will be present; however, these wetlands should be classed as Type 3 if they have sufficient depth and lasting qualities.

Type 4 - SEMI-PERMANENT WETLANDS: Ponds of sufficient depth having water that will likely persist through the brood season but may go dry during late August or early September. These wetlands will retain water during at least 7 out of 10 years. Their vegetative cover is normally clumped and may cover all but the center of the wetland.

Type 5 - PERMANENT WETLANDS: Ponds, deep marshes, or lakes of sufficient depth that water will persist throughout the summer and fall. These wetlands are characterized by a peripheral rim of aquatic vegetation bordering an open water body.

Stream/River: Wet = STR Dry = DST

Artificial:

Type	Wet	Dry	Type	Wet	Dry
Dugout	D	DD	Gravel Pit	GP	DGP
Flooded Dugout	FD	--	Reservoir	R	DR
Stock Dam	S	DS	Irrigation Canal	IC	DIC
Borrow Pit	BP	DBP			

Record wetland water level stage as follows:

For use with the following water level stages, a basin is the total physical depression capable of holding water, while a wetland is the portion of the basin which contains any wetland vegetation.

Stage 1 - DRY - surface water has disappeared completely due to seepage, evaporation, or drainage.

Stage 2 - VESTIGIAL - water occurs only as small pools or puddles within the central vegetative zone of the wetland and can be expected to dry up within a matter of days.

Stage 3 - RECESSIONAL - water levels have receded within the central zone but still cover a fairly extensive area. In Open Water type of wetlands there is a DRAWDOWN MUDFLAT between the water edge and the emergent vegetation. In Emergent Deep marshes and Shallow marshes, a fairly wide band of the central zone is DRY.

Stage 4 - INTERMEDIATE - in Open Deep marshes and Shallow Open Water wetlands, the central open water zone is COMPLETELY FLOODED and the water extends into the inner edge of the emergent vegetation. In Emergent Deep marshes and Shallow marshes, the water extends throughout most of the central zone.

Stage 5 - FULL - the wetland is filled to the outer limit of the wet meadow zone.

Stage 6 - FLOODED - water has spilled out of the wetland proper and floods the upland vegetative communities in the basin.

Stage 7 - OVERFLOWING - water is at full supply level (FSL) of the basin and is spilling over. FSL can vary greatly from basin to basin. In some basins it is at the level of the outer edge of the wet meadow zone and in others FSL is so high that it will never be attained. (Terminal wetlands are an example of this latter situation.)

Stage 8 - DUGOUT-RECESSIONAL - water has receded well below the rim of the dugout.

Stage 9 - DUGOUT-FULL - water level is at or close to the rim of the dugout.

Record wetland impactions and upland conditions and use as follows:

Impactions should be recorded in appropriate space on field form by letter code and percent of area affected. Uplands should be recorded by use and percentage of use contiguous with the margin.

Basin - center to outer edge of wet meadow zone:

B = burned (A = autumn or S = spring)	F = filled	H = Hayed
C = cultivated	G = grazed	I = impacted by construction
D = drained		

Margin - up to 33 feet (10 m) outward from outer edge of wet meadow zone:

B = burned (A = autumn or S = spring)	CL = cleared	H = hayed
C = cultivated	G = grazed	I = impacted by construction

Upland - area contiguous with margin:

C = crop	H = hayland	S = stubble
F = fallow	P = pasture	W = woodland
G = grassland		

Record waterfowl data as follows:

Waterfowl data will be recorded to the right of the pond on which they occur. Waterfowl in flight and otherwise not on a specific pond when observed will be recorded to the right of the pond most closely associated with that bird.

Lone drakes: ++++ ||| etc.

Lone hens: hhhhh etc.

Flocked drakes: (2)(4)(3) etc. (5 or more drakes of any species are recorded as a group)

Pairs: pppppp etc.

Groups: [7][5][9] etc. (a hen and 2 drakes will be recorded as a pair and a lone drake and a hen and 3 drakes will be recorded as a pair and 2 lone drakes)

Summarize waterfowl data for each pond and at the bottom of each page as follows:

LONE DRAKES/FLOCKED DRAKES / TOTAL LONE HENS	TOTAL PAIRS / TOTAL BIRDS IN GROUPS
(redhead, scaups, ring-necked duck and ruddy duck)	

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY, AIR-GROUND COMPARISON SEGMENT--GROUND CREW SUMMARY FORM

Province/State: S. Duck Land	Stratum: 31	Segment: Kinistino	May 23, 1985	Start Time: 7:05
Crew Leader: G. Teal	Assistants: B. Wigeon, A. Shoveler			End Time: 12:45
Wind Direction: N	Wind Speed: 10	Cloud Cover: 15%		Precipitation: None

Species	Lone Drakes	Lone Hens	Flocked Drakes	Pairs	Grouped Birds	Total Indicated Birds
Mallard	13		15	10		76
Am. black duck						
Gadwall				4	6	14
Am. wigeon				6	6	18
Green-winged teal				5		10
Blue-winged teal				20	16	56
N. shoveler	5		3	8		32
N. Pintail	1		3	3		14
Redhead [1]		1		6		13
Canvasback			2	2		8
Scaups [1]	1	1	2	3	6	16
Ring-necked duck [1]						
Goldeneyes						
Bufflehead						
Ruddy duck [1]						
Oldsquaw						
Eiders						
Scoters						
Mergansers						
TOTAL	39	2	48	134	34	257
Am. coot					77	77

Ponds (I) w/water	20
Ponds (III-V) w/water	204
Ponds (I,III-V)w/water	224
Artificial water areas	8
Streams/Rivers	2
Wetlands w/water	234
Dry ponds	42
Potential ponds	276
Linear miles	18
Square miles	4.5
Ponds (III-V)/mi²	45.3
Total ponds [2]	214

[1] In the case of redhead, scaups, ring-necked duck, and ruddy duck, lone and flocked drakes and lone hens are multipled by 1 (x1) in calculating total indicated birds.
[2] Total ponds = ponds (III-V) with water + artificial water areaas+ streams/rivers. Note that this figure is directly comparable to the aerial crew's water count (natureal + artifical (x2)) to derive a visibility factor for water areas.

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--AIR-GROUND COMPARISON SEGMENT - GROUND CREW SUMMARY FORM

<u>Instructions for completing form:</u>

<u>Wind Direction</u> - direction from which wind is blowing (NW, E, SW, etc.)

<u>Wind Speed</u> - provide speed in miles per hour (5, 8, 15, etc.)

<u>Cloud Cover</u> - indicate as percent of sky covered by cloud (5%, 15%, 90%, etc.)

<u>Precipitation</u> - indicate type (rain, snow, sleet, etc.) and relative severity (light, moderate, heavy, etc.)

<u>Lone drakes</u> - the total number of lone males observed.

<u>Lone hens</u> - the total number of lone hens observed (redhead, scaups, ring-necked duck, and ruddy duck only).

<u>Flocked drakes</u> - the total number of males observed with one or more other males (no females present). For the purpose of this form, flocked drakes of all species numbering 5 or more per grouping will be treated as a "group" (multiplied by 1 in calculating "total indicated birds").

<u>Pairs</u> - the total number of male and female groupings observed.

<u>Grouped birds</u> - the total number of individuals, both male and female, observed in company which cannot be separated into singles and pairs at the time of observation. All coots will be entered under this column.

<u>Total indicated birds</u> - the total number of birds observed on the air-ground transect with allowances for hens not observed with single and flocked drakes. Total indicated birds is calculated by multiplying lone drakes by 2, lone hens by 2, flocked drakes by 2, the number of pairs by 2, and grouped birds by 1. In the case of redhead, scaups, ring-necked duck, and ruddy duck, lone and flocked drakes and lone hens are multiplied by 1 in determining total indicated birds.

Note: Five or more drakes of all species are to be treated as a group (x1); 4 or less drakes of all species are to be treated as flocked drakes (x2).

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY - SOUTHERN MANITOBA CREW ARE ADJUSTED MALLARD VISIBILITY RATE CALCULATION

A general regression equation has been developed to express the positive relationship existing in strata 30 through 40 between the mallard visibility rates (mallards observed by the ground crew divided by mallards observed by the aerial crew) and pond densities as determined by ground counts.

The equation is $Y = a + 0.0236X$

where Y = the unadjusted mallard visibility rate for the combined strata in a given year.

and X = the pond density as measured by Type III-V ponds, streams and artificial water bodies counted by the ground crew on all air-ground transects within strata 34-40.

To determine the adjusted mallard visibility rates <u>by stratum</u>:

(1) Substitute these data in the above equation and solve for "a."

(2) Then rewrite the equation with the new value for "a."

(3) Substitute the appropriate stratum's adjusted pond density (Type III-V ponds, streams and artificial water bodies counted by the aerial crew times the pond visibility rate) in the resulting equation.

(4) Solve for Y (adjusted mallard visibility rate for that stratum).

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--STRATUM SUMMARY FORM

Stratum: 31 Dates: 5/20/85 thru 5/22/85

Species	Drakes	Pairs	Grouped Birds	Total Indicated Birds (T)	Visibility Rate (V)	Population Index (P)
Mallard	314	98	66	890	1.8647	243,014
Am. black duck						
Gadwall	26	40	5	137	3.8222	76,677
Am. wigeon	24	19		86	6.0000	75,558
Green-winged teal	20	12		64	4.3636	40,894
Blue-winged teal	103	85	15	391	5.4085	309,660
N. shoveler	128	49	5	359	2.8395	149,268
N. pintail	97	30	10	264	2.1310	82,379
Redhead [a]	30	23	10	86	7.6087	95,817
Canvasback	46	11	39	153	1.2714	28,484
Scaups [a]	52	70	17	209	2.2117	67,687
Ring-necked duck [a]	2	7		16	3.9363 [b]	9,222
Goldeneyes [a]	4			8	5.5000 [b]	6,443
Bufflehead	4	7		22	2.7000 [b]	8,648
Ruddy duck	20	6	7	39	7.5382 [b]	43,049
Oldsquaw						
Eiders						
Scoters						
Mergansers	1	1		4	2.0000 [b]	1,171
Canada goose	16	15		62	1.0000 [b]	9,079
Am. coot			198	198	4.7500	137,718

Computation of the Population Index
P = Population Index
A = Square miles in the stratum
T = Total Indicated Birds
S = Square miles in the sample
V = Visibility Ratio
P = A · T/S · V

Number of observed ponds (x2)	4,876
Pond Index (x 1.0334)	737,843
Square miles in the stratum (A)	21,086
Square miles in the sample (S)	144
Number of segments	32
Expansion Factor	146.431

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[a] Drakes not doubled in calculating total indicated birds (T).
[b] Long-term visibility rates from SOP used.

Form 6

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--STRATUM SUMMARY FORM

Instructions for completing form:

Drakes - the total number of lone and flocked males observed.

Pairs - the total number of male and female groupings observed.

Grouped birds - the total number of individuals, both male and female, observed in company which cannot be separated into singles and pairs at the time of observation. All coots will be entered under this column.

Total indicated birds - the total number of birds observed on the air-ground segment with allowances for hens not observed with single and flocked drakes. Total indicated birds is calculated by multiplying lone drakes by 2, lone hens by 2, flocked drakes by 2, the number of pairs by 2, and grouped birds by 1. In the case of redhead, scaups, ring-necked duck, and ruddy duck, lone and flocked drakes and lone hens are multiplied by 1 in determining total indicated birds.

Note: Five or more drakes of all species are to be treated as a group (x1); 4 or less drakes of all species are to be treated as flocked drakes (x2).

Visibility ratio - the ratio of total indicated birds found by the ground crew to the total indicated birds found by the aerial crew on all air-ground segments within the applicable strata.

LONE DRAKE INDEX CALCULATION

Stratum	A Total Drakes	B Total Pairs	C Pairs and Drakes	D % Lone Drakes	E Drake Index	F Lone Drake Index	G % Lone Drakes
Mallard							
30	493	110	603	.8176	93,214	76,212	
31	314	98	412	.7621	65,162	49,660	
32	89	31	120	.7417	7,960	5,904	
33	83	34	117	.7094	15,064	10,686	
34	538	157	695	.7741	52,919	40,965	
35	264	84	348	.7586	25,445	19,303	
Total					259,764	202,730	.7804
N. pintail							
30	139	45	184	.7554	26,973	20,375	
31	97	30	127	.7638	19,329	14,763	
32	44	12	56	.7857	3,715	2,919	
33	43	24	67	.6418	9,517	6,108	
34	169	77	246	.6870	18,452	12,677	
35	97	27	124	.7823	9,080	7,103	
Total					87,066	63,945	.7344
Canvasback							
30	91	19	110	.8273	18,368	15,196	
31	46	11	57	.8070	11,202	9,046	
32	1	0	1	1.0000	66	66	
33	1	3	4	.2500	819	205	
34	86	33	119	.7227	9,489	6,858	
35	16	6	22	.7273	1,579	1,148	
Total					41,523	32,513	.7830
Survey Area Total							
30	723	174	897	.8060	138,555	111,675	
31	457	139	596	.7668	95,693	73,377	
32	134	43	177	.7571	11,741	8,889	
33	127	61	188	.6755	25,400	17,158	
34	793	267	1,060	.7481	80,860	60,491	
35	377	117	494	.7632	36,104	27,555	
Total					388,353	299,145	.7703

Instructions for completing calculations: For each stratum and species, accomplish the following mathematical process and enter the results on the appropriate lines.

1. Take A and B directly from Stratum Summary Form
2. C = A + B
3. D = A ÷ C
4. E = Total indicated birds (from Stratum Summary Form) x stratum expansion factor ÷ 2.
5. F = D X E

For the Survey Area Totals, add the totals in column A for each stratum. Do the same for columns B and C. Then, do the following:

1. D = A ÷ C
2. E = the sum of the stratum indices from same column
3. F = the sum of the stratum indices from same column
4. G = F ÷ E

WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--

SEGMENT DATA FORM

U.S. FISH AND WILDLIFE SERVICE
OFFICE OF MIGRATORY BIRD MANAGEMENT

Pilot-Observer: J. Mallard

Observer: M. Pintail

Month (1-2)	Day (3-4)	Year (5-6)	Province (7-8)	Stratum (9-10)	Transect (11-12)
05	20	85	79	31	17

		Segment (13-14): 03	Time (15-16): 13		Segment (13-14): 04	Time (15-16): 13		Segment (13-14): 05	Time (15-16): 14		Segment (13-14): 06	Time (15-16): 14	
		Wind (17-18): 13	Vel. (19-20): 10	Sky (21-22): 04	Wind (17-18): 18	Vel. (19-20): 15	Sky (21-22): 04	Wind (17-18): 18	Vel. (19-20): 15	Sky (21-22): 03	Wind (17-18): 13	Vel. (19-20): 15	Sky (21-22): 03
SPECIES	AOU No. (23-26)	Singles (27-30)	Pairs (31-34)	Groups (35-38)	Singles (27-30)	Pairs (31-34)	Groups (35-38)	Singles (27-30)	Pairs (31-34)	Groups (35-38)	Singles (27-30)	Pairs (31-34)	Groups (35-38)
Mallard	1320	14	2	5	26	9	5	8	7		4	4	
Am. black duck	1330												
Gadwall	1350		1			2			2			1	
Am. wigeon	1370		1								1		
G.W. teal	1390	4	3		1	1							
B.W. teal	1400	4	2		1	2		1	1		3	1	
N. shoveler	1420	1			6	2		5	1	5	2	2	
N. pintail	1430				7	3		7	2		4		
Redhead	1460				4	1		1	2				
Canvasback	1470				3	3		4		6			
Scaups	1490		1			4		3	5				
Ringneck	1500												
Goldeneyes	1510												
Bufflehead	1530	3							1				
Ruddy duck	1670							2					
Oldsquaw	1540												
Eiders	1600												
Scoters	1630												
Mergansers	1290												
Whitefronts	1710												
Canada goose	1720				3			2	1				
Swans	1800												
Am. coot	2210	0			9			8			1		
Ponds (obs.x2)	9990	178			276			254			152		

Form 7

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WATERFOWL BREEDING POPULATION AND HABITAT SURVEY--SEGMENT DATA FORM

Instructions for completing form:

1. Record all data for each whole segment recorded on the field data sheet. Data from partial segment are not to be recorded on this form.

2. Use the following codes for recording indicated information:

Code No.	Month
04	April
05	May
06	June

Code No.	Day
01	Numerical
02	day
10	of
15	the
22	month
etc.	

Code No.	Year
67	1967
68	1968
69	1969
etc.	etc.

Code No.	Wind
	(Recorded on 8 points of the compass.)
36	North
18	South
09	East
27	West
04	Northeast
31	Northwest
13	Southeast
22	Southwest
00	No wind

Code No.	Velocity
00	Record in miles
10	per hour.
etc.	

Code No.	Sky Cover
01	Clear
02	Scattered
03	Broken
04	Overcast

Code No.	Province
03	Alaska
04	Alberta
11	British Columbia
40	Labrador
43	Mackenzie
45	Manitoba
50	Minnesota
53	Montana
56	New Brunswick
57	Newfoundland
64	North Dakota
76	Quebec
79	Saskatchewan
81	South Dakota
93	Yukon

Code No.	Stratum, transect, and segment
01	(Record actual stratum,
05	transect, and segment
20	number, using a
30	2-digit code
etc.	

TIME: Use a 2-digit code and record to the nearest hour using the 24-hour clock based on Universal Coordinated (Greenwich) Time (Note - 14:30 Z would be 14 Z and 14:31 Z would be 15 Z).

3. For each species, record the number of drakes without hens, the number of birds in groups in appropriate columns. Example: 2 lone drakes would be 2 in the "Singles" column; 10 pairs would be recorded as 10 in the "Pairs" column; 14 birds in a group would be recorded 14 in the "Groups" column.

4. Only totals will be recorded for coot. The number of ponds observed should be doubled and the figure entered in the "Singles" column.

Note: All data recorded on a single form must reflect the same month, day, year, province, stratum, and transect. If any of these items change, prepare a separate form.

SECTION IV: WATERFOWL PRODUCTION AND HABITAT SURVEY

A. Methods

1. Survey Dates: The survey is performed during the approximate period of 1 to 21 July in the prairie crew areas and 8 to 22 July in the bush crew areas. The starting dates vary slightly each year, but ideally the surveys begin when the majority of the broods have developed beyond the Class I stage (Gollop and Marshall 1954) and are completed before Class III broods have fledged. Reconnaissance flights and ground inspections are conducted to determine the appropriate time for beginning the survey. However, for the survey to be of value in developing regulations at the Waterfowl Status Meeting set for 25 July each year, it must begin early enough to allow sufficient time to (1) sample the entire survey area, (2) analyze the data, and (3) telephone the survey results to the Assistant Branch Chief-Surveys, prior to or on 22 July.

2. Survey Flight Time: Daily survey flights begin no later than 1 hour after sunrise in prairie habitat and no later than 2 hours after sunrise in the parkland and southern bush habitats. This allows better light penetration into dense woodlands to improve visibility. In northern bush habitats, survey flights are conducted during the mid-day period due to the extended daylight in northern latitudes at this time of year. Transect flying in the prairies is completed by 12:00 noon (local standard time) each day. Because of extended daylight and logistical problems associated with subarctic conditions, the completion time for bush operations is somewhat later in the day.

3. Survey Flight Conditions: Aerial surveys are not initiated when winds consistently exceed 15 mph (13 kts), if adverse weather conditions exist (i.e. moderate to heavy rain, excessively rough air), or if visibility is poor for other reasons. Surveys are discontinued when winds exceed 25 mph (22 kts), turbulence is excessive, or if other adverse weather develops which is unsafe for flight or may compromise survey results.

4. Survey Flight Speed and Altitude: Transects are flown at ground speeds of 90-105 mph (78-90 kts). A stop watch is used to monitor aircraft ground

speed and to aid in locating segment end points. Aircraft are normally flown at 100-150 feet (30-50 m) AGL to ensure accurate identification of waterfowl species under average light conditions and to assure safe obstacle clearance. Established known-width sample transects are flown at regular intervals to maintain consistency and accuracy of the aerial crew's transect width. Reference marks are applied to the aircraft's wing struts as guides for both pilot-observer and observer to indicate the approximate transect boundaries from the appropriate altitude.

5. <u>Survey Flight Path</u>: Transects are centered on section lines in the prairies and along degree lines of latitude or longitude in the bush. Transects are flown as depicted in Fig. 2. The aircraft's flight path is altered only to avoid flying directly over towns, game farms, poultry, livestock, or persons. The aircraft flight path is not altered to facilitate identification of waterfowl. Transects are flown in the same direction each year as much as practical to minimize variance associated with such changes between years.

6. <u>Survey Sample</u>: A <u>segment</u> is defined as an 18-mile (29-km) sampling unit having a width of 1/8 mile (200 m), i.e. 1/16 mile (100 m) on each side of the aircraft for the waterfowl sample and a width of 1/8 mile (200 m) on the observer's side of the aircraft for the pond sample (Fig. 7). The pilot-observer in the left front seat counts all duck and coot broods and late-nesting ducks within 330 feet (100 m) on that side of the aircraft, while the observer in the right front seat counts all duck and coot broods and late-nesting ducks within 330 feet (100 m) on that side of the aircraft. The observer also counts specified types of water area (ponds) within 660 feet (200 m) on that side of the aircraft as was done on the Waterfowl Breeding Population and Habitat Survey.

A <u>transect</u> is a continuous series of segments. Most transects in this survey are oriented in an east-west direction and are parallel to the other transects at regular intervals within any given stratum. The survey employs a systematic random sampling of potential transect locations. The transect is the sampling unit.

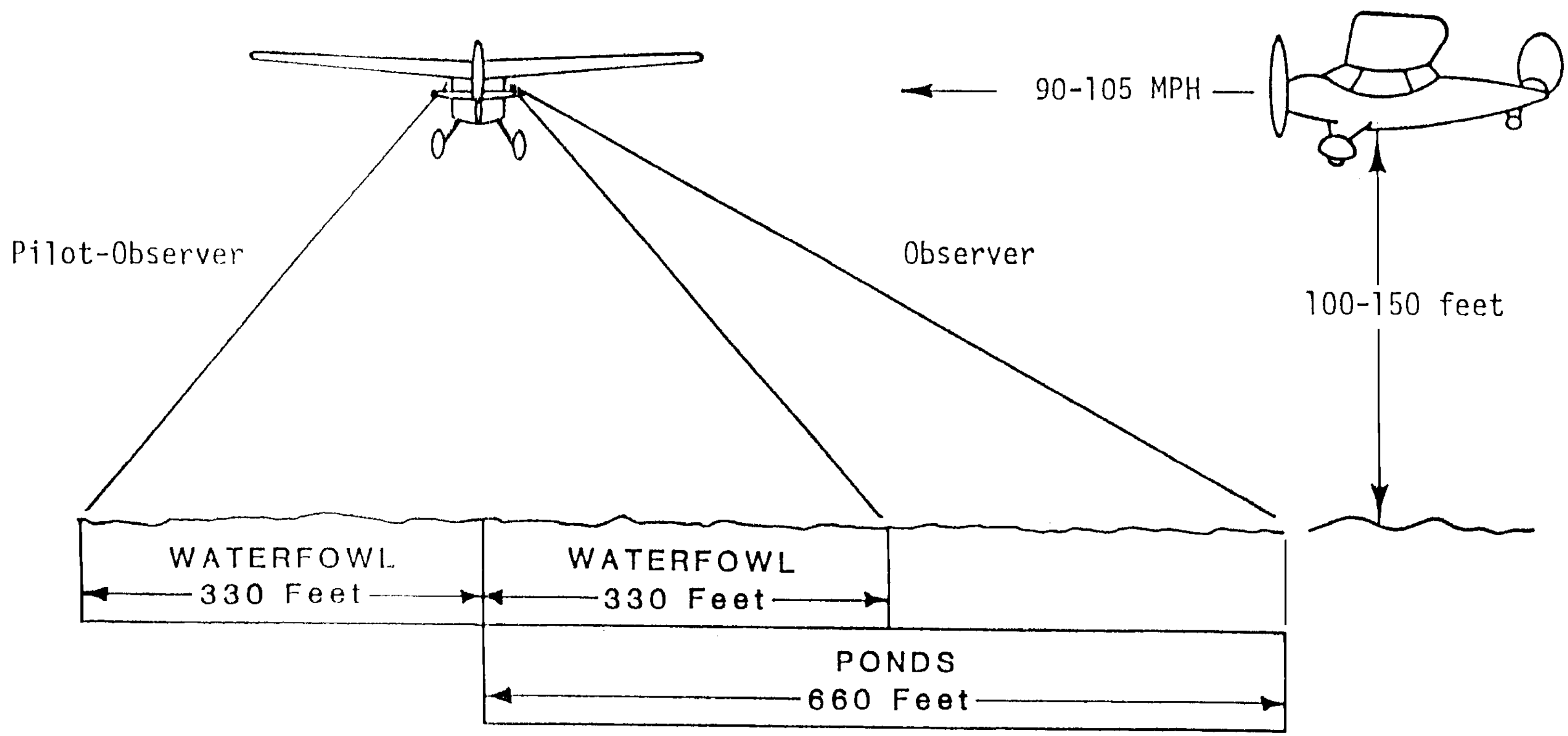

Figure 7. Survey sample for Waterfowl Production and Habitat Survey.

A stratum is a specific geographic unit encompassing areas of similar waterfowl densities and is generally of a specific habitat type. The transects usually extend from one side of a stratum to the other. Beginning near the southern boundary of a stratum, the transects extend to or near the northern boundary. Spacing between transects varies depending on waterfowl densities. Transect spacing within strata 1 through 50 varies between 14 and 60 miles (23 and 97 km).

Production surveys are not flown in Alaska, the Yukon and Northwest Territories, western Ontario, Minnesota, and Wisconsin. In the remaining 6 federal crew areas, the same transects flown during the Waterfowl Breeding Population and Habitat Survey are flown during this survey when possible. If sufficient time to cover all transects and meet the established deadline is unavailable, a representative sample of the remaining transects is selected and flown.

7. Reporting Units and Survey Crew Areas: Because it is desirable to report the data on a political unit basis and to maintain historical continuity in the various survey units, the survey data are compiled and analyzed by reporting unit (Fig. 4). Survey crew areas have been geographically organized on the basis of alignment with political boundaries, similarity in habitat, and equitable distribution of work load or flight time required to conduct the survey (Fig. 5). The strata surveyed and the strata reported on by each aerial survey crew are provided in Table 3.

For those instances where one aerial crew conducts the survey in a specified area and another crew reports on that area, it is the responsibility of the Flyway Biologist collecting the data to summarize the information and transmit it to the Flyway Biologist responsible for the report. The original and one copy of each Field Data Form and Field Data Form (stratum summary) are delivered to the Flyway Biologist responsible for that reporting unit as soon as possible following survey completion. Another copy of the Field Data Forms and Field Data Form (stratum summaries) is retained by that survey crew for referral should questions arise.

Survey area	Crew Area Strata	Crew Area Area (Sq. mi.)	Crew Area Sample (Sq. mi.)	Crew Area Linear miles	Reporting Unit Strata	Reporting Unit Area (Sq. mi.)	Reporting Unit Sample (Sq. mi.)
FEDERAL							
Bush							
Northern Saskatchewan, Northern Manitoba, and the Saskatchewan River Delta	21-24	217,314	1,417.5	5,670	21-25	224,130	1,534.5
Bush subtotal		217,314	1,417.5	5,670		224,130	1,534.5
Prairies							
Southern Alberta	19,20,26-29	229,783	2,056.5	8,226	26-29	64,297	1,314.0
Southern Saskatchewan	30-33	88,912	967.5	3,870	30-35	111,120	1,269.0
Southern Manitoba	25,34-40	67,752	850.5	3,402	36-40	38,728	432.0
Montana	41-44	120,791	1,260.0	5,040	41-42	73,657	868.5
North and South Dakota	45-49	89,101	1,111.5	4,446	43-49	136,235	1,503.0
Prairie subtotal		596,339	6,246.0	24,984		424,037	5,386.5
Grand total		816,653	3,832.75	30,654		648,167	

Table 3. Waterfowl Production and Habitat Survey - crew area and reporting unit constants.

B. Data Collection

1. General

a. Strict adherence to the instructions and procedures set forth in this manual is required unless changes are approved by the Section Chief-WPS prior to the initiation of the surveys.

b. Survey data are recorded daily on Field Data Forms.

c. Field Data Forms must be prepared in duplicate. Copies are stored and mailed separately to reduce the chance of losing any field data.

d. The original field records are prepared neatly and legibly to facilitate auditing, duplication, and data transfer. Black ink or dark pencil (#2 or darker) is used on all forms.

e. Survey records are double-checked by the survey crew to ensure that transcriptions and mathematical calculations are accurate.

f. Instructions for completing the various forms are printed on the back side of each form and these instructions are strictly followed.

g. Originals of all Field Data Forms and Field Data Form (stratum summaries) are submitted directly to the Assistant Branch Chief-Surveys at the conclusion of the survey. Express Mail is used for this purpose whenever possible.

h. Color slides are useful in depicting habitat changes through the years, particularly as they relate to availability of surface water and specific land-use activities detrimental to waterfowl. It is the Flyway Biologist's responsibility to obtain representative aerial shots for this purpose and provide developed slides, appropriately labeled, to the Assistant Branch Chief-Surveys, as soon as possible following survey completion, again utilizing Express Mail if available.

2. Waterfowl Data: This survey is conducted to gather data on numbers of duck broods by age class, average brood size, number of coot broods, and number

of single lone drakes and pairs. No attempt is made to identify broods by species, but lone drakes and pairs are identified if possible and recorded. Air-ground comparison segments are not conducted during the Waterfowl Production and Habitat Survey. As a result, lone drakes and pairs that cannot be identified are included in the counts but are designated as unidentified. Grouped waterfowl (3 or more birds of mixed sexes) and flocks of 2 or more drakes are not counted. These counts make up what is called the late-nesting index (LNI). A lone drake and a pair are each considered to be a potential brood in the derivation of the Fall Flight Forecast. The number of coot broods is recorded; however, adult coots are not recorded. It is emphasized that only those broods and LNI within the transect boundaries on water bodies cut by the transect boundary are recorded.

For each water area encountered on the transect:

a. First - Glance rapidly over the entire water area or that portion within the transect to determine what is there (number of broods and number of lone and paired adult ducks).

b. Second - Age the broods as Class I, II, or III, and determine the number of lone drakes and pairs (by species if possible).

c. Third - If there is sufficient time, count the number of ducklings in each Class II and III brood. Only complete Class II and III broods need be counted. If there is doubt as to whether the complete brood is visible, no record is made.

These data are recorded by segment on a tape recorder. A separate recorder is used by each aerial crew member. These data are then transcribed to Field Data Forms (Exhibit 25-prairie crews and Exhibit 26-bush crews) each afternoon following the survey flights. The data are then summarized by stratum using the same forms (Exhibit 27-prairie crews and Exhibit 28-bush crews). Table 1 (Exhibit 20) of the survey unit report presents the long-term trend in waterfowl brood and late-nesting indices for the current year and all previous years of record. Table 2 (Exhibit 21) presents the current year's waterfowl brood and late-nesting indices by stratum and compares the unit totals of the current year with the previous year, the previous 10-year mean, and the long-term mean.

3. Water Data: Water data are collected only in the prairie and parkland habitats. The aerial observer records the number of individual water areas within 660 feet (200 m) on that side of the aircraft for each segment. The pilot-observer does not count ponds for reason of flight safety. Water areas intersected by the transect boundary are counted. A tape recorder is used for this purpose as is done for the waterfowl data. Two mechanical counters are often used to assist the observer in this task, particularly in high pond density areas. The number of natural water areas (i.e. ponds, lakes, rivers, streams) is recorded on one counter, while the number of artificial water areas (i.e. reservoirs, stock dams, dugouts, and large irrigation ditches likely to contain water into mid-summer) is recorded on the other. Natural and artificial water areas are identified as such to monitor human effects on natural wetlands over the history of the surveys. The number of ponds for each segment is the sum of the counter totals. Table 3 (Exhibit 22) contains the long-term trend in unadjusted pond indices by stratum comparing the current year with the previous year, the previous 10-year mean, and the long-term mean.

Natural water areas to be counted from the air include types III, IV, and V wetlands (Shaw and Fredine 1956), rivers, and streams. Type III ponds (seasonal wetlands) refer to hay meadows or basins containing natural aquatics which normally are dry by midsummer but are expected without additional precipitation to retain water for at least 3 weeks following the observation. These wetlands normally have uniform vegetative cover and contain at least 6 inches (15 cm) of water. Under dry fall conditions, many ponds are plowed but refill with water in the spring. In these instances, only the current year's vegetation is present but these wetlands should be counted if they have sufficient water depth and lasting qualities. To minimize subjectivity, it is stressed that water depth is the primary criterion. Type IV ponds (semi-permanent wetlands) have sufficient water depth that they will likely persist through the brood season but may become dry during late August or September. These wetlands usually contain water during at least 7 out of 10 years, and the vegetation is normally clumped, covering all but the center of the wetland. Type V ponds (permanent wetlands) are deep marshes or lakes having sufficient water depth to persist throughout the summer and fall. These wetlands normally are characterized by a peripheral rim of aquatic vegetation bordering an open body of water. Streams and rivers that meander through the transect are counted as separate water bodies each time they occur within the transect boundary. Dugouts that are inundated by a natural wetland are not recorded as artificial water areas, but if the dugout can be identified as a water area separately from the surrounding natural water area, both the dugout and the natural water area are counted.

The following water areas are not recorded:

a. Type I ponds (temporary wetlands), refer to temporary water, sheet water, small wet areas in stubble or plowed fields, and wet depressions that have less than 6 inches (15 cm) of water depth and can be expected to last less than 3 weeks.

b. Roadside or borrow ditches where the water is confined entirely to the ditch and small ditches used for local irrigation.

c. Muskeg areas where water may glisten under a dense growth of grass. Open areas of water within muskeg are not counted.

C. Data Analysis

Field Data Forms designed for the prairie crew areas and bush crew areas are used to tabulate waterfowl and water data for each segment, transect, and stratum. Data collected for each stratum are summarized on the Waterfowl Production and Habitat Survey-Stratum Summary Form (Exhibit 29). Since we are interested in the numbers of late nests and not necessarily in the number of adult waterfowl observed, a pair and a lone drake are each given a value of one (1) in arriving at the LNI. The expanded species indices are obtained by multiplying each species total by the appropriate stratum expansion factor. Each stratum expansion factor is determined by dividing the total area (mi^2) in the stratum by the total area (mi^2) sampled within the stratum. A copy of the Stratum Summary Form for each stratum becomes part of the survey report and follows Table 5 (Exhibit 24).

The Flyway Biologist calls in the final data as soon as all the various report tables have been completed and double-checked. Specific information transmitted by phone includes general and unusual weather patterns since the spring survey, agricultural activities since the spring survey, relative abundance, quality and distribution of late-nesting and brood-rearing cover, overall production, and any other information pertinent to interpreting the fall flight potential.

D. Survey Design

The survey design and the coverage of the current year's survey are presented in Table 5 (Exhibit 24). The first set of data presents the survey as it was designed by stratum including the area (mi^2) in each stratum, the area (mi^2) in the sample (both waterfowl and ponds), the number of linear miles in the sample, the number of transects in the sample, the number of segments in the sample, and the expansion factor. The second set of data includes the current year's survey coverage. If the current survey is incomplete or has been modified, the second set of data will reflect these changes. The narrative section of the report explains the reasons for any omissions or changes.

E. Reports

1. Mid-July Habitat Conditions Report: During mid-survey, the Flyway Biologist in charge of each crew area contacts the Assistant Branch Chief-Surveys, by telephone, and provides a report regarding general habitat conditions including weather patterns occurring since the spring survey, crop development and outlook, quality and availability of late nesting cover and brood rearing cover, impact of agricultural practices on duck production since the spring survey, and other pertinent information. This verbal report is due no later than 15 July for both prairie and bush units. There is no written report.

2. Waterfowl Production and Habitat Survey Report: The Waterfowl Production and Habitat Survey Report is prepared using the following outline and suggested text material.

COVER SHEET: The following statement is used--"The data presented in this report are preliminary and subject to further auditing. Final indices will be available from the U.S. Fish and Wildlife Service, Migratory Bird Management Office, Patuxent Wildlife Research Center, Laurel, Maryland 20708."

TITLE: Waterfowl Production and Habitat Survey for (insert unit title)

STRATA SURVEYED: (insert strata numbers)

DATES: __-__ July 19__

DATA SUPPLIED BY: United States Fish and Wildlife Service

Air Crew
Pilot-Observer (insert name, affiliation, and title)
Observer (insert name, affiliation, and title)

ABSTRACT: A concise presentation of weather and habitat conditions, brood indices, late-nesting indices, pond indices, and a brief statement on overall waterfowl production in the reporting unit comparing the current year with the previous year, the previous 10-year mean, and the long-term mean.

METHODS: A statement similar to the following begins this section of the report: "The procedures followed in conducting this survey are contained in the Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America, Section IV, revised 1987." Any deviation from these procedures or changes in aerial coverage is explained in detail.

WEATHER AND HABITAT CONDITIONS: This section of the report expands on the Mid-July Habitat Conditions Report and updates those comments. Reference is made to Table 4 (Exhibit 23) which contains weather data from representative weather stations within the reporting unit since the Waterfowl Breeding Population and Habitat Survey completion. Results of the unadjusted pond estimates compared to the previous year, the previous 10-year mean, the long-term mean, and the adjusted May pond estimates are presented in Table 3 (Exhibit 22) and are discussed in this section of the prairie unit reports.

PRODUCTION INDICES: Waterfowl production based upon the indices contained in Tables 1 and 2 (Exhibits 20 and 21) is discussed in detail, and comparisons are made between the current year, the previous year, the previous 10-year mean, and the long-term mean indices. Suspected reasons for any changes are discussed.

LATE-NESTING INDICES: The current year's data as presented in Tables 1 and 2 (Exhibits 20 and 21) and

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DATES: __-__ July 19__

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LATE-NESTING INDICES: The current year's data as presented in Tables 1 and 2 (Exhibits 20 and 21) and their implications in interpreting the current year's anticipated production are discussed.

CONCLUSIONS: Based upon all available pertinent factors, both quantitative and qualitative, the anticipated fall flight from within the reporting unit is discussed and compared to the previous year, the previous 10-year mean, and the long-term mean.

TABLES: The following titles are used for the tables included in each survey report. The bush unit reports do not include a table on July ponds.

1. Table 1. Long-term trend in waterfowl brood and late-nesting indices by species in (reporting unit), 19__-19__. (Exhibit 20)

2. Table 2. Status of waterfowl brood and late-nesting indices in (reporting unit), comparing 19__ with 19__, the 19__-19__ previous 10-year mean, and the 19__-19__ long-term mean. (Exhibit 21)

3. Table 3. Long-term trend in July pond indices by stratum in (reporting unit), comparing 19__ with 19__, the 19__-19__ previous 10-year mean, the 19__-19__ long-term mean, and comparison of May with July ponds in 19__. (Exhibit 22)

4. Table 4. Precipitation summaries for selected reporting stations in (reporting unit), May through July 19__. (Exhibit 23)

5. Table 5. Survey design for (reporting unit), July 19__. (Exhibit 24)

One copy of the Waterfowl Production and Habitat Survey-Stratum Summary Form (Exhibit 29) for each stratum becomes a part of the survey unit report and will follow Table 5.

As indicated above, the results of the Waterfowl Production and Habitat Survey are relayed by telephone to the Assistant Branch Chief-Surveys, immediately following the completion of the survey but not later than noon (EDT) on 22 July (or as instructed). Flyway Biologists conducting surveys in Canada provide the Population Management Biologist, CWS, with copies of Tables 1, 2, 3, 4, 5, and all Stratum Summary Forms before leaving Canada.

The original of all Field Data Forms, Field Data Form (stratum summaries), and Stratum Summary Forms for each stratum are submitted directly to the Assistant Branch Chief-Surveys, immediately upon return of the Flyway Biologist to the field station after the survey is completed. Express Mail is used for this purpose whenever possible. Reference is made to the appendix for report addresses and distribution. This report and all supporting data are due on 30 July for both the prairie and bush units.

Table 1. Long-term trend in waterfowl brood and late-nesting indices by species in Southern Duckland, 1955-1985 (index in thousands).[a]

Species	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Broods											
Duck brood index	148.2	172.5	144.6	130.4	107.3	130.7	77.9	63.2	69.5	70.5	97.1
Average brood size[b]	4.7	4.5	5.3	4.7	5.3	4.6	4.2	4.8	4.5	4.6	5.3
Coot brood index	45.0	46.0	24.8	28.3	34.1	34.2	12.5	14.9	15.6	21.5	34.9
Late-nesting index[c]											
Ducks											
Dabblers											
Mallard											20.9
Am. black duck											.0
Gadwall											6.4
Am. wigeon											2.3
Green-winged teal											1.8
Blue-winged teal											7.7
N. shoveler											1.6
N. pintail											3.4
Subtotal											44.1
Divers											
Redhead											2.0
Canvasback											.7
Scaups											6.4
Ring-necked duck											1.0
Goldeneyes											.2
Bufflehead											.1
Ruddy duck											.7
Subtotal											17.4
Miscellaneous											
Oldsquaw											.0
Eiders											.0
Scoters											.0
Mergansers											.0
Subtotal											.0
Unidentified											20.9
Total ducks											82.4

(NOTE: This table provided for format only. Data will be supplied at a later date.)

[a] Unadjusted for visibility bias.
[b] From complete Class II and III broods observed.
[c] As indicated by observed adult pairs and singles.

Table 1 (continued). Long-term trend in waterfowl brood and late-nesting indices by species in Southern Duckland, 1955-1985 (index in thousands).[a]

Species	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Broods										
Duck brood index	244.1	382.0	414.5	269.5	104.5	121.7	71.8	35.6	46.1	67.5
Average brood size[b]	6.6	6.0	6.0	4.4	4.3	4.8	4.7	5.4	5.5	5.8
Coot brood index	-	70.5	217.7	21.9	6.0	15.3	4.9	.1	-	-
Late-nesting index[c]										
Ducks										
Dabblers										
Mallard										
Am. black duck										
Gadwall										
Am. wigeon										
Green-winged teal										
Blue-winged teal										
N. shoveler										
N. pintail										
Subtotal										
Divers										
Redhead										
Canvasback										
Scaups										
Ring-necked duck										
Goldeneyes										
Bufflehead										
Ruddy duck										
Subtotal										
Miscellaneous										
Oldsquaw										
Eiders										
Scoters										
Mergansers										
Subtotal										
Unidentified										
Total ducks										

(NOTE: This table provided for format only.
Data will be supplied at a later date.)

[a] Unadjusted for visibility bias.
[b] From complete Class II and III broods observed.
[c] As indicated by observed adult pairs and singles.

Table 1 (continued). Long-term trend in waterfowl brood and late-nesting indices by species in Southern Duckland, 1955-1985 (index in thousands).[a]

Species	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Broods										
Duck brood index	317.4	422.2	615.8	253.1	105.8	125.8	68.7	32.8	45.8	66.9
Average brood size[b]	6.0	5.6	6.0	4.3	3.7	3.8	4.4	4.9	5.4	5.7
Coot brood index	21.0	81.8	254.2	21.6	5.4	14.8	6.0	.1	5.2	9.2
Late-nesting index[c]										
Ducks										
Dabblers										
Mallard										
Am. black duck										
Gadwall										
Am. wigeon										
Green-winged teal										
Blue-winged teal										
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Eiders										
Scoters										
Mergansers										
Subtotal										
Unidentified										
Total ducks										

(NOTE: This table provided format only.
Data will be supplied at a later date.)

[a] Unadjusted for visibility bias.
[b] From complete Class II and III broods observed.
[c] As indicated by observed adult pairs and singles.

Table 2. Status of waterfowl brood and late-nesting indices by stratum in Southern Duckland, comparing 1985 with 1984, the 1975-1984 previous 10-year mean, and the 1955-1984 long-term mean (index in thousands).

Species	Stratum (1985) 30	31	32	33	34	35	1985 Total	1984 Total	10-Year Mean	Long-term Mean	Percent change from 1984	Percent change from 10-Year Mean	Percent change from Long-term Mean
Broods													
Duck brood index	29.6	19.6	23.0	.8	19.4	4.7	97.1	70.5	111.5		+ 38	- 13	
Average brood size[b]	5.9	4.5	5.3	6.0	5.1	5.5	5.3	4.6	4.7		+ 15	+ 13	
Coot brood index	11.7	15.8	2.3	.0	5.1	.0	34.9	21.5	27.7		+ 62	+ 26	
Late-nesting index[c]													
Ducks													
Dabblers													
Mallard	2.8	3.2	4.0	.3	7.4	3.2	20.9	21.8		(NOTE: Table 2 will be updated with complete data at a later date.)			
Am. black duck	.0	.0	.0	.0	.0	.0	.0	.0					
Gadwall	.9	.9	2.0	.0	2.5	.1	6.4	1.4					
Am. wigeon	.7	.5	.7	.0	.3	.3	2.3	1.5					
Green-winged teal	.9	.6	.1	.0	.2	.0	1.8	1.9					
Blue-winged teal	1.4	.6	2.1	.5	2.7	.4	7.7	15.8					
N. shoveler	.2	.0	.4	.0	.4	.6	1.6	.3					
N. pintail	.9	.3	.7	.0	1.2	.3	3.4	3.4					
Subtotal	7.8	5.9	10.0	.8	14.7	4.9	44.1	46.1					
Divers													
Redhead	.7	.3	.7	.0	.0	.3	2.0	.7					
Canvasback	.0	.3	.3	.0	.0	.1	.7	1.1					
Scaups	.9	.0	1.9	.0	2.2	1.4	6.4	11.2					
Ring-necked duck	.0	.5	.0	.0	.4	.0	1.0	.0					
Goldeneyes	.2	.0	.0	.0	.0	.0	.2	.0					
Bufflehead	.0	.0	.0	.0	.0	.1	.1	.0					
Ruddy duck	2.8	1.5	.4	.0	1.9	.4	7.0	4.9					
Subtotal	4.6	2.7	3.3	.0	4.5	2.3	17.4	17.9					
Miscellaneous													
Oldsquaw	.0	.0	.0	.0	.0	.0	.0	.0					
Eiders	.0	.0	.0	.0	.0	.0	.0	.0					
Scoters	.0	.0	.0	.0	.0	.0	.0	.0					
Mergansers	.0	.0	.0	.0	.0	.0	.0	.0					
Subtotal	.0	.0	.0	.0	.0	.0	.0	.0					
Unidentified	1.6	2.0	5.7	.5	7.8	3.3	20.9						
Total ducks	14.0	20.6	19.0	1.3	27.0	10.4	82.4	64.0					

[a] Unadjusted for visibility bias.
[b] From complete class II and III broods observed.
[c] As indicated by observed adult pairs and singles.

Table 3. Long-term trend in July pond indices by stratum in Southern Duckland, comparing 1985 with 1984, the 1975-1984 previous 10-year mean, the 1955-1984 long-term mean, and comparison of May with July ponds in 1985 (estimates in thousands).[a]

Year	Stratum 30	31	32	33	34	35	Total
1955	138.6	332.1	374.5	120.5	668.5	449.0	2,083.2
1956	120.9	186.8	210.1	34.8	346.5	216.2	1,115.3
1957	59.0	136.8	127.6	18.9	260.8	77.4	680.5
1958	57.0	82.8	69.1	18.4	127.9	46.1	401.3
1959	40.1	95.9	123.0	31.5	155.6	74.1	520.2
1960	47.3	104.0	136.8	16.9	229.7	102.5	637.2
1961	41.0	35.6	51.1	10.3	32.8	22.4	193.2
1962	29.9	40.0	62.6	12.4	-	-	144.9[b]
1963	93.0	97.2	227.8	41.6	177.5	89.4	726.5
1964	33.5	82.5	99.2	13.1	141.9	144.3	514.5
1965	112.4	188.7	289.1	88.7	267.5	69.5	915.9
1966	149.0	320.8	239.9	72.9	164.3	105.2	1,052.1
1967	86.4	136.5	192.6	44.6	101.1	50.2	611.4
1968	66.3	96.2	88.5	15.9	41.1	20.2	328.2
1969	125.4	151.8	357.0	63.0	86.6	159.2	943.0
1970	278.3	365.8	568.2	70.1	219.3	209.6	1,711.3
1971	159.1	277.6	335.9	41.9	171.7	91.6	1,077.8
1972	116.5	189.7	154.8	25.2	108.0	107.4	701.6
1973	153.1	442.7	145.3	21.7	103.5	52.4	918.7
1974	262.5	309.9	455.3	57.5	252.5	175.0	1,512.7
1975	216.7	299.6	391.1	69.1	282.5	281.9	1,540.9
1976	165.1	254.5	414.2	55.2	266.7	211.5	1,367.3
1977	101.6	187.4	183.0	19.9	154.1	72.2	718.2
1978	82.1	177.8	240.1	50.4	165.3	135.7	851.4
1979	159.6	230.8	274.2	46.9	169.2	155.8	1,036.5
1980	77.3	109.8	90.3	21.9	63.0	32.7	395.0
1981	75.7	87.0	96.3	22.9	52.2	29.6	363.7
1982	130.9	197.1	372.5	122.0	86.0	55.4	963.9
1983	134.8	313.9	237.5	44.1	366.3	99.1	1,195.7
1984	126.8	218.8	140.1	21.7	103.4	41.9	652.7
1985	185.2	292.9	173.8	20.9	177.5	55.8	907.1
10-year mean	127.1	207.7	243.9	47.4	170.9	111.6	908.6
Long-term mean	114.7	191.7	224.9	43.1	181.6	116.5	862.5
Percent Change							
1985 from 1984	+ 47	+ 34	+ 24	- 4	+ 72	+ 33	+ 39
1985 from 10-year mean	+ 46	+ 41	- 29	- 56	+ 4	- 50	NC
1985 from long-term mean	+ 62	+ 53	- 23	- 52	- 2	- 52	+ 5
May ponds 1985 (adjusted)	622.9	737.8	723.6	108.1	558.5	207.2	2,958.0
Percent change							
May to July 1985	- 70	- 60	- 76	- 81	- 68	- 73	- 69

[a] July ponds are unadjusted for visibility bias.
[b] Incomplete coverage.

Table 4. Precipitation summaries for selected reporting stations in Southern Duckland, May through July 1985.[a]

	5/23/85 to 7/18/85				4/1/85 to 7/18/85			
Station	Actual	Normal	Difference	Percent Change	Actual	Normal	Difference	Percent Change
N. Battleford	72.7	110.0	- 37.3	- 34	197.1	154.0	+ 43.1	+ 28
Saskatoon	82.2	106.7	- 24.5	- 23	195.8	151.8	+ 44.0	+ 29
Prince Albert	138.0	121.1	+ 16.9	+ 14	228.1	169.0	+ 59.1	+ 35
Hudson Bay	135.6	126.4	+ 9.2	+ 7	177.4	177.4	.0	NC
Wynyard	115.4	127.5	- 12.1	- 9	202.8	176.3	+ 26.5	+ 15
Kindersley	39.8	91.5	- 51.7	- 57	131.8	140.2	- 8.4	- 6
Swift Current	76.1	116.6	- 40.5	- 35	116.1	170.7	- 54.6	- 32
Moose Jaw	75.1	108.1	- 33.0	- 31	142.9	168.1	- 25.2	- 15
Yorkton	144.8	122.5	+ 22.3	+ 18	198.0	172.2	+ 25.8	+ 15
Regina	68.0	129.7	- 61.7	- 48	152.6	179.5	- 26.9	- 15
Broadview	99.0	100.8	- 1.8	- 2	142.2	167.3	- 25.1	- 15
Estevan	79.3	132.1	- 52.8	- 40	119.0	201.7	- 82.7	- 41

[a]Data obtained from Environment Canada (all precipitation in millimeters).

Table 5. Survey design for Southern Duckland, July 1985.

	Stratum						
	30	31	32	33	34	35	Total
Survey design							
Square miles in stratum	18,570	21,086	37,911	11,345	13,164	9,044	111,120
Square miles in sample-waterfowl/ponds	81	72	285.75	45	87.75	63	634.5
Linear miles in sample	648	576	2,286	360	702	504	5,076
Number of transects in sample	4	5	14	6	5	6	40
Number of segments in sample	36	32	127	20	39	28	282
Expansion factor	229.259	292.861	132.672	252.111	150.017	143.556	175.130
Current year coverage							
Square miles in sample-waterfowl/ponds	81	72	285.75	45	87.75	63	634.5
Linear miles in sample	648	576	2,286	360	702	504	5,076
Number of transects in sample	4	5	14	6	5	6	40
Number of segments in sample	36	32	127	20	39	28	282
Expansion factor	229.259	292.861	132.672	252.111	150.017	143.556	175.130

WATERFOWL PRODUCTION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Province/State: S. Duckland | Stratum: 31 | Transect: 17 | Pilot-Observer: J. Mallard | Observer: M. Pintail | Sheet 1 of 1

July 17, 1985 | Wind: 0 | Speed: 0 | Sky: ⊕

		Duck Broods				Coot Broods	Late-Nesting Index																								Water	
		I	II	III	?		Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL	UNID		CG	Nat	Art
58°F Start 10:24	1624	1		1-5		1																										
	3																														26	3
w-5	1635	1		1-4		1111																					0					
	4								p																		1				46	7
	1646		1-4			1																						1				
	5																											p			22	3
NW-5	1657																															
	6																														7	3
N-5	1708	1	1-6, 1	1-4		1																										
	7																														26	4
NE-5	1719	11	1-3, 1-4			111												1			1						2					
	8											p									p						2				73	2
	1730																															
	To TA	5	5 / 4-17	3 / 3-13		13			0 / 1			0 / 1						1 / 0			1 / 1						2 / 3	2 / 1			200	22

Form 8

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WATERFOWL PRODUCTION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Instructions for completing form:

Record heading information as follows:

- Time: Use Universal Coordinated (Greenwich) Time (1150, 1315, 1410, etc.)
- Wind: Use True direction from which wind is blowing (NW, E, SW, etc.)
- Speed: Provide in Statute miles per hour (5, 8, 15, etc.)
- Sky: Indicate cloud cover as clear ○ , scattered ⦶ , broken ⦶⦶ , or overcast ⊕.
- Water: For each segment, enter the natural water count in the left half of the block and artificial water count in the right half of the block. (Note: Do not double these counts on this form.)

Record waterfowl data as follows:

- Duck broods: When the age class is known or unknown and the number of ducklings is unknown (~~1111~~ 111, etc.)
  When the age class is known and the complete number of ducklings is known (1-5, 1-7, 1-15, etc.)
  (the first number indicates a single brood and the second number indicates the number of ducklings in that brood)
  Note: Class 1 broods are recorded but the number of ducklings in age Class 1 broods are not recorded.
- Coot broods: Only the number of broods are recorded. Class and number per brood are not recorded (1111 111, etc.)
- Lone drakes: Isolated single drakes (~~1111~~ 11, etc.)
- Pairs: Isolated pair (PPPPPP, etc.)

Summarize brood data for each segment and for the transect using a "fractional" system as follows:

$$\frac{\text{TOTAL NUMBER OF BROODS IN A GIVEN AGE CLASS}}{\text{TOTAL BROODS FOR WHICH A COUNT OF DUCKLINGS WAS OBTAINED--TOTAL DUCKLINGS COUNTED IN ALL THOSE BROODS}} \left(\frac{15}{8\text{-}40}, \frac{6}{5\text{-}25}, \text{etc.}\right)$$

The top figure is the total number of broods in the age class being totaled. The lower figure is in two parts, the first being the total broods for which a good count of ducklings was obtained, the second part being the total ducklings counted in those defined broods. For example, if the observed Class II broods were ~~1111~~ 11, 1-5, 1-6, 1-4, the summary would be $\frac{10}{3\text{-}15}$.

Summarize late-nesting index data for each segment and for the transect using a "fractional" system as follows:

$$\frac{\text{TOTAL NUMBER OF LONE DRAKES OBSERVED}}{\text{TOTAL NUMBER OF PAIRS OBSERVED}} \left(\frac{3}{5}, \frac{2}{7}, \frac{1}{3}, \text{etc.}\right)$$

WATERFOWL PRODUCTION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Province/State: N. Duckland | Stratum: 21 | Transect: 1 | Pilot-Observer: R. Scaup | Observer: G. Ringneck | Sheet 1 of 1

July 11, 1935 | Wind: 5 | Speed: 5 | Sky: 0

Notes	Time & Segment	Duck Broods				Coot	Late-Nesting Index																								
		I	II	III	?	Broods	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL	UNID			CG
Start 8:15	1410																														
	9																														
BE-A	1420																														
	8																														
BE-A	1430										1														1		2				
	7																										0				
	1440	1	1-4,															1									1				
	6																										0				
BE-A	1450																														
	5																														
	1501		1-2,														1										1				
	4																										0				
	1511		1-8, 1-6																												
	3																														
	1522																														
	2																														
	1532																														
	1																														
	1542																														
	Total	1	4 / 4-20								1 / 0						1 / 0	1 / 0							1 / 0		4 / 0				

Form 9 MBMO-WPS 4/87

WATERFOWL PRODUCTION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Instructions for completing form:

Record heading information as follows:

Time: Use Universal Coordinated (Greenwich) Time (1150, 1315, 1410, etc.)

Wind: Use True direction from which wind is blowing (NW, E, SW, etc.)

Speed: Provide in Statute miles per hour (5, 8, 15, etc.)

Sky: Indicate cloud cover as clear ○ , scattered ⦶ , broken ⦷ , or overcast ⊕ .

Record waterfowl data as follows:

Duck broods: When the age class is known or unknown and the number of ducklings is unknown (~~1111~~ 111, etc.)
When the age class is known and the complete number of ducklings is known (1-5, 1-7, 1-15, etc.)
(the first number indicates a single brood and the second number indicates the number of ducklings in that brood)
Note: Class 1 broods are recorded but the number of ducklings in age Class 1 broods are not recorded.

Coot broods: Only the number of broods are recorded. Class and number per brood are not recorded (~~1111~~ 111, etc.)

Lone drakes: Isolated single drakes (~~1111~~ 11, etc.)

Pairs: Isolated pair (PPPPPP, etc.)

Summarize brood data for each segment and for the transect using a "fractional" system as follows:

$$\frac{\text{TOTAL NUMBER OF BROODS IN A GIVEN AGE CLASS}}{\text{TOTAL BROODS FOR WHICH A COUNT OF DUCKLINGS WAS OBTAINED--TOTAL DUCKLINGS COUNTED IN ALL THOSE BROODS}} \left(\frac{15}{8\text{-}40}, \frac{6}{5\text{-}25}, \text{etc.} \right)$$

The top figure is the total number of broods in the age class being totaled. The lower figure is in two parts, the first being the total broods for which a good count of ducklings was obtained, the second part being the total ducklings counted in those defined broods. For example, if the observed Class II broods were ~~1111~~ 11, 1-5, 1-6, 1-4, the summary would be $\frac{10}{3\text{-}15}$.

Summarize late-nesting index data for each segment and for the transect using a "fractional" system as follows:

$$\frac{\text{TOTAL NUMBER OF LONE DRAKES OBSERVED}}{\text{TOTAL NUMBER OF PAIRS OBSERVED}} \left(\frac{3}{5}, \frac{2}{7}, \frac{1}{3}, \text{etc.} \right)$$

WATERFOWL PRODUCTION AND HABITAT SURVEY, THE PRAIRIES--AERIAL CREW FIELD DATA FORM

Province/State: S. Duckland | Stratum: 31 | Transect: 16-20 | Pilot-Observer: J. Mallard | Observer: M. Pintail | Sheet 1 of 1

July 17-18, 19__ | Wind: — | Speed: — | Sky: —

Segment	Duck Broods I	Duck Broods II	Duck Broods III	?	Coot Broods	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL	UNID		CG	Water Nat	Water Art
16	6	16/9-38	3/3-13		13	4/1		0/1	1/0	1/0			1/0				1/0			2/0						10/2	2/0			184	44
17	5	5/4-17	3/3-13		13			0/1			0/1						1/0			1/1						2/3	2/1			200	22
18	6	5/4-17	1/1-8		3	3/0		1/0												1/0						5/0				112	51
19	5	4/2-8	4/1-7		16	1/2				1/0	0/1			1/0	1/0											4/3	0/1			202	28
20		2/1-6	2/2-7		4																						1/0			139	18
TOTAL	22	32/20-86	13/10-48		51	8/3		1/2	1/0	2/0	0/2		1/0	1/0	1/0		2/0			4/1						21/8	5/2			837	163

(Late-Nesting Index: Mal through Mer)

Form 8

MBMO-WPS 4/87

WATERFOWL PRODUCTION AND HABITAT SURVEY, THE BUSH--AERIAL CREW FIELD DATA FORM

Province/State: N. Duckland | Stratum: 21 | Transect: 1-11 | Pilot-Observer: R. Scaup | Observer: G. Ringneck | Sheet 1 of 1

July 11-20, 198[illegible] | Wind: — | Speed: — | Sky: —

Notes	Time & Segment	Duck Broods I	Duck Broods II	Duck Broods III	Duck Broods ?	Coot Broods	Mal	Blk	Gad	Wig	GWT	BWT	Shr	Pin	Red	Can	Scp	Rng	Gld	Buf	Rud	Old	Edr	Scr	Mer		TOTAL	UNID			CG
	1	1	4/4-20								1/0						1/0	1/0							1/0		4/0				
	2	1	3/3-14				2/0											1/1							3/0		6/1				
	3																														
	4	1	1/1-4	1/1-7			1/0										1/0										2/0				(II) 1/1-4
	5	1	2/2-10	1/1-4																1/0							1/0				
	6	2		1/1-4			1/0										0/1	2/0						1/1	1/0		5/2				
	7			1/1-4														0/1		2/0					1/0		3/1				(II) 1/1-5 (III) 2/2-8
	8	1		1/1-6							1/0						1/0			0/1							2/1				(III) 1/1-4
	9																1/0										1/0				
	10			2/2-4			1/0			1/0								2/1		1/0					1/0		6/1				
	11		2/2-11	1/1-8														0/1		1/0							1/1				(II) 3/3-12 (III) 4/4-19
Form 9	Total	7	12/12-59	8/8-47			5/0			1/0	2/0						4/1	6/4		5/1				1/1	7/0		31/7				(II) 5/7-31 (III) 3/7-31

M8MQ-WPS-4/87

WATERFOWL PRODUCTION AND HABITAT SURVEY--STRATUM SUMMARY FORM

Stratum: 31   Dates: 7/17/85 thru 7/18/85

BROODS

	Obs. Total	Index
Class I	22	6,443
Class II	32	9,372
Class III	13	3,807
Class ?	0	0
Total	67	19,622
Coots	54	15,814

Complete Class II and Class III Broods

	Obs. Total	Index	Average Brood Size
Broods	30	8,786	4.4665
Ducklings	134	39,243	

LATE-NESTING INDEX

Species	Drakes	Pairs		Total Indicated Pairs (T)		Late-Nesting Index (P)
Mallard	8	3		11		3,221
Am. black duck						
Gadwall	1	2		3		879
Am. wigeon	1			1		293
Green-winged teal	2			2		586
Blue-winged teal		2		2		586
N. shoveler						
N. Pintail	1			1		293
Redhead	1			1		293
Canvasback	1			1		293
Scaups						
Ring-necked duck	2			2		586
Goldeneyes						
Bufflehead						
Ruddy duck	4	1		5		1,464
Oldsquaw						
Eiders						
Scoters						
Mergansers						
Unidentified	5	2		7		2,050
Total	26	10		36		10,543

Computation of Late-Nesting Index:

P = Late-Nesting Index
T = Total Indicated Pairs
A = Square miles in the stratum
S = Square miles in the sample
P = T · A/S

Number of observed ponds	1,000
Pond Index	292,862
Square miles in the stratum (A)	21,086
Square miles in the sample (S)	72
Number of segments	32
Expansion Factor	292.861

Form 10   MBMO-WPS 4/87

WATERFOWL PRODUCTION AND HABITAT SURVEY--STRATUM SUMMARY FORM

Instructions for completing form:

Brood Indices - calculate by multiplying observed broods in each category by the stratum expansion factor.

Average Brood Size - calculate by multiplying the complete Class II and III broods observed (number of broods and number of ducklings) by the stratum expansion factor. Then divide this expanded duckling index by the expanded brood index to determine the average brood size. To calculate the reporting unit average brood size, add the brood and duckling indices for all strata and divide.

Lone drakes - the total lone drakes observed within the stratum.

Pairs - the total pairs observed within the stratum.

Total indicated pairs - the total number of lone drakes and pairs observed within the stratum. Total indicated pairs is calculated by multiplying lone drakes by 1 and pairs by 1 as each is indicative of an actively breeding pair. For the purposes of this survey each indicated pair is important as they potentially will produce a brood at some point in time after the survey is completed.

Unidentified - either lone drakes or pairs which cannot be identified for reasons of poor light, glare, etc. which contribute equally to the total indicated pairs (total LNI).

Late Nesting Index - total indicated pairs expanded by the stratum expansion factor (unadjusted for visibility bias).

APPENDIX. REPORT ADDRESSEES AND DISTRIBUTION

Addressees	Distribution
A. U.S. Fish and Wildlife Service	
Regional Director (and Migratory Bird Coordinator), 500 N.E. Multnomah, Suite 1692, Portland, Oregon 97232	2
Regional Director (and Migratory Bird Coordinator), P.O. Box 1306, Albuquerque, New Mexico 87103	2
Regional Director (and Migratory Bird Coordinator), Federal Building, Fort Snelling, Twin Cities, Minnesota 55111	2
Regional Director (and Migratory Bird Coordinator), 75 Spring Street, S.W., Atlanta, Georgia 30303	2
Regional Director (and Migratory Bird Coordinator), One Gateway Center, Suite 700, Newton Corner, Massachusetts 02158	2
Regional Director (and Migratory Bird Coordinator), P.O. Box 25486, Denver Federal Center, Denver, Colorado 80225	2
Regional Director (and Migratory Bird Coordinator), 1101 East Tudor Road, Anchorage, Alaska 99503	2
Chief, Migratory Bird Management Office, Matomic Building, Room 536, Washington, D.C. 20240	1
Director, Migratory Bird & Habitat Research Laboratory, Patuxent Wildlife Research Center, Laurel, Maryland 20708	1
Branch Chief-Surveys, Patuxent Wildlife Research Center, Laurel, Maryland 20708	3
Director, Northern Prairie Wildlife Research Center, P.O. Box 2096, Jamestown, North Dakota 58402	1
Section Chief-WPS, 500 N.E. Multnomah, Suite 1692, Portland, Oregon 97232	1

Atlantic Flyway Representative, Patuxent Wildlife Research Center, Laurel, Maryland 20708	1
Mississippi Flyway Representative, 700 Cherry Street, Suite D, Columbia, Missouri 65201	1
Central Flyway Representative, 730 Simms, Room 456, Golden, Colorado 80401	1
Pacific Flyway Representative, 500 N.E. Multnomah, Suite 1692, Portland, Oregon 97232	1
Flyway Biologist, P.O. Box 2096, Jamestown, North Dakota 58402	1
Flyway Biologist, Regional Airport, 210 John Glenn Road, Suite 21 & 22, Lafayette, Louisiana 70508	2
Flyway Biologist, Patuxent Wildlife Research Center, Laurel, Maryland 20708	2
Flyway Biologist, 730 Simms, Room 456, Golden, Colorado 80401	2
Waterfowl Biologist-Waterfowl Investigations, P.O. Box 1287, Juneau, Alaska 99802	1
Wildlife Biologist, P.O. Box 1287, Juneau, Alaska 99802	1
Waterfowl Biologist, Wetlands Management Assistance Office, 1500 Capitol Avenue, Bismarck, North Dakota 58501	1

B. Canadian Wildlife Service

Director General, Environment Canada Headquarters, Ottawa, Ontario K1A OE7 CANADA	2
Director, Western and Northern Region, 4999 - 98th Avenue, Edmonton, Alberta T6B 2X3 CANADA	2
Head, Population Management Section, Prairie Migratory Bird Research Centre, 115 Perimeter Road, Saskatoon, Saskatchewan S7N OX4 CANADA	1
Director, Eastern Region, Environment Canada, Ottawa, Ontario K1A OE7 CANADA	2

Librarian, Prairie Migratory Bird Research Centre, 115 Perimeter Road, Saskatoon, Saskatchewan S7N 0X4 CANADA — 1

Population Management Biologist, 4999-98th Avenue, Edmonton, Alberta T6B 2X3 CANADA — 1

Population Management Biologist, Prairie Migratory Bird Research Centre, 115 Perimeter Road, Saskatoon, Saskatchewan S7N 0X4 CANADA — 1

Population Management Biologist, 501 University Crescent, Winnipeg, Manitoba R3T 2N6 CANADA — 1

Population Management Biologist, P.O. Box 637, Yellowknife, Northwest Territories X1A 2N5 CANADA — 1

C. <u>State and Provincial Wildlife Management Agencies</u>

Commissioner, Alaska Department of Fish and Game, Box 3-2000, Juneau, Alaska 99801 — 1

Waterfowl Program Coordinator, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, Alaska 99502 — 1

Chief, Wildlife Management, Yukon Department of Renewable Resources, Box 2703, Whitehorse, Yukon Y1A 2L6 CANADA — 1

Senior Biologist, Small Game, Yukon Department of Renewable Resources, Box 2703, Whitehorse, Yukon Y1A 2L6 CANADA — 1

Waterfowl Ecologist, Northwest Territories Department of Renewable REsources, Box 1320, Yellowknife, Northwest Territories X1A 2L9 CANADA — 1

Director, British Columbia Wildlife Branch, Minister of Environment, Parliament Buildings, Victoria, British Columbia V8V 1X4 CANADA — 1

Bird and Endangered Species Specialist, British Columbia Wildlife Branch, Minister of Environment, Parliament Buildings, Victoria, British Columbia V8V 1X4 CANADA — 1

Director of Wildlife Branch, Fish and Wildlife Division, Department of Energy and Natural Resources, Main, North Petro Plaza, 9945-108 Street, Edmonton, Alberta T5K 2G6 CANADA 1

Provincial Wildlife Biologist, Department of Forestry, Lands and Wildlife, Petroleum Plaza, South Tower, 9945-108 Street, Edmonton, Alberta T5K 2C9 CANADA 1

Director, Wildlife Branch, Department of Parks, Recreation, and Culture, 3211 Albert Street, Regina, Saskatchewan S4S 5W6 CANADA 1

Provincial Waterfowl Biologist, Wildlife Branch, Department of Parks, Recreation and Culture, Box 3003, Prince Albert, Saskatchewan S6V 6G1 CANADA 1

Deputy Minister, Department of Natural Resources, 989 Century Street, Winnipeg, Manitoba R3H OW4 CANADA 1

Provincial Waterfowl Biologist, Department of Natural Resources, 989 Century Street, Winnipeg, Manitoba R3H OW4 CANADA 1

Director, Department of Fish, Wildlife and Parks, 1420 East Sixth Avenue, Helena, Montana 59601 1

Waterfowl Biologist, Department of Fish, Wildlife and Parks, 1125 Lake Elmo Drive, Billings, Montana 59105 1

Commissioner, Game and Fish Department, 100 North Bismarck Expressway, Bismarck, North Dakota 58501 1

Waterfowl Biologist, Game and Fish Department 100 North Bismarck Expressway, Bismarck, North Dakota 58501 1

Secretary, Department of Game, Fish and Parks, Anderson Building, Pierre, South Dakota 57501 1

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Director, Minnesota Department of Natural Resources, Division of Fish and Wildlife, 600 Lafayette Road, Box 7, St. Paul, Minnesota 55146 — 1

Waterfowl Populations Biologist, Minnesota Department of Natural Resources, Wetland Wildlife Populations and Research Group, 102 - 23rd Street, Bemiji, Minnesota 56601 — 1

Director, Bureau of Wildlife Management, Wisconsin Department of Natural Resources, GEF II, WM/4, Madison, Wisconsin 53701 — 1

Waterfowl Biologist, Wisconsin Department of Natural Resources, 1210 North Palmatory Street, Horicon, Wisconsin 53032 — 1

D. Ducks Unlimited

Chief Biologist, 1190 Waverley Street, Winnipeg, Manitoba R3T 2E2 CANADA — 1

Provincial Biologist, 10422-169 Street, Edmonton, Alberta T5P 3X6 CANADA — 1

Provincial Biologist, 1606-4th Avenue, Regina, Saskatchewan S4P 3W7 CANADA — 1

Provincial Biologist, #5, 1325 Markham Road, Winnipeg, Manitoba R3T 4J6 CANADA — 1

E. Other

Aerial crew observer — 1

Ground crew leader — 1

Requesting agencies/individuals — 1

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Appendix 2. Procedures for Using the Coda Netgun® from a Helicopter

CODA ENTERPRISES, Inc.

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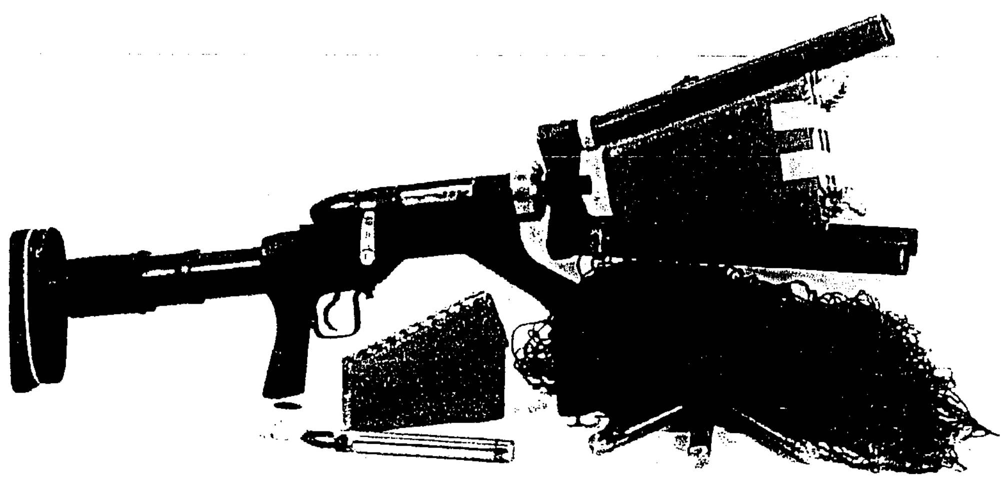

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STATEMENT OF LIABILITY

CODA ENTERPRISES INC.

1038 E. NORWOOD

MESA, ARIZONA 85203

The Coda Netgun is not classified as a firearm or dangerous weapon. It is sold by Coda Enterprises, Inc. with the express understanding that we assume no liability for its resale or safe handling under local laws and regulations. Coda Enterprises Inc. assumes no responsibility for physical injury or property damage resulting from either intentional or accidental discharge or for the functioning of this or any other Coda Enterprises Inc. net launching device subjected to influences beyond Coda's control. Coda Enterprises Inc. will honor no claim that may result from careless handling, unauthorized adjustments, defective or improper blank cartridges, corrosion, or neglect.

This statement of liability supersedes all previous statements of liability.

WARRANTY

Coda Enterprises Inc. warrants all products to be free of defects in material and workmanship and will, within 120 days of purchase by the original consumer, repair, replace, or adjust to its commercial standard, at Coda's option, any product or part thereof returned, prepaid, to the factory and found by Coda Enterprises Inc., to be defective in either material or workmanship. Such service will be made free of charge. Coda Enterprises Inc. will pay shipping costs from Coda Enterprises to owner.

The parties understand and agree that the buyers sole exclusive remedy against Coda Enterprises Inc., shall be for the repair or replacement of defective parts as provided herein.

This warranty shall NOT apply and is terminated when any product or component part therein, has been subjected to accidents, unauthorized alteration, abuse, misuse, or where incompatible parts are used, including the use of blank cartridges other than Coda Enterprises, Inc. issue, and/or damage caused through failure to provide reasonable and necessary maintenance.

If your Coda Netgun should require service outside the coverage of this warranty, it will be repaired for the then current charges for parts and labor, plus shipping costs to and from Coda Enterprises Inc.

Coda Enterprises Inc. shall not be deemed to be responsible or held liable for personal injuries or for any other damages whether direct or consequential.

This warranty supersedes all previous warranties and commitments and is not transferable.

Any representations or promises inconsistent with or in addition to the warranty are unauthorized and shall not be binding.

Terms of this warranty cannot be changed except in writing by an officer of Coda Enterprises Corporation.

Sept. 1993

TRAINING

CODA ENTERPRISES, INC., the designer, manufacturer, and distributor of the CODA NETGUN, CODA NET LAUNCHER and related equipment, offers you the opportunity to receive training in the effectual use of all equipment. Training is conducted, for a fee, by experienced personnel and includes "hands on" experience to provide a working knowledge of technique, safety, and maintenance.

Training insures proficiency in the use of the equipment and reduces your organization's costs in developing an effective and efficient capture team. The trial and error method of learning is expensive and hazardous: training pays.

Coda Enterprises, Inc. has pioneered the process for netting animals from helicopter in the United States. We have hundreds of hours of experience and have trained many individuals. Coda recommends that no one attempt capture from a helicopter unless that individual has received professional training.

CODA Enterprises Inc. conducts training on the clients premises and in the field: an actual capture project during training produces the most effective and complete learning experience.

We train as many people on your staff as you wish. Coda suggests, however, that a team of only two or three be trained and maintained. This practice helps maximize efficiency. We remain with your capture team until you feel they are adequately trained.

Please contact CODA ENTERPRISES INC. for additional information. We look forward to working with you.

CODA ENTERPRISES, INC.
1038 E. Norwood
Mesa, Arizona 85203
(480-964-0155)

Corrin (Corey) R. Gray President

THE CODA NETGUN

GENERAL INFORMATION

The CODA NETGUN represents years of development. Its design and production in the United States are per stringent guidelines maintained by the Bureau of Alcohol, Tobacco, and Firearms of the U. S. State Department. The ATF has classified the NETGUN as a "tool" rather than a "firearm". The Netgun has been subjected to rigorous proof-testing for sustained firing stress, and to extensive over-pressure chamber trials. It is manufactured as an experimental- research and animal-management tool to be utilized by professional personnel in the wildlife research and animal management fields.

The classification of the CODA NETGUN as a "tool" rather than a firearm allows inter-state transportation and shipping without restriction.

UNAUTHORIZED MODIFICATIONS TO NETGUN

Modifications, of any kind, made to the NETGUN may violate federal approval and may result in its classification as a firearm under the Gun Control Act of 1968. It would then become an illegal firearm, subject to confiscation by law enforcement agencies. Modifications performed on the NETGUN outside CODA ENTERPRISES' Service and Repair Center will void its warranty.

CAUTION

Although the CODA NETGUN is classified as a tool, it is capable of inflicting substantial damage to equipment and serious injury to personnel if used improperly. An individual should NEVER be permitted to fire the NETGUN without first studying the technical information thoroughly and then familiarizing himself/herself with the NETGUN. If the information in this instruction manual is not understood and/or not complete, please contact CODA ENTERPRISES before attempting to use the tool. Instruction provided by those already experienced in the use of the NETGUN is highly recommended as part of the training of inexperienced personnel. This instruction will help ensure safety and efficiency.

We strongly suggest that the instructions in this manual be photocopied and supplied to all personnel using the NETGUN during capture operations.

PLEASE READ ALL INFORMATION CAREFULLY PRIOR TO USING THE NETGUN!!
Pay particular attention to precautions and instructions.

CODA ENTERPRISES WILL PROVIDE TRAINING, FOR A FEE, IN THE SAFE AND EFFECTUAL USE OF THE NETGUN IN ANIMAL CAPTURE.

NETGUN DESCRIPTION

CODA'S NETGUN is designed to capture a variety of animals and birds for studying, examining, providing medical treatment, banding, tagging, or otherwise marking, attaching telemetric devices, transporting and/or relocating, etc. The NETGUN is a hand held net launching assembly, that uses expanding gases from a blank cartridge to propel an array of weights. When the NETGUN is fired, these propelled weights pull a net from the NETGUN'S net canister and carry it out over the animal.

The receiver is a .308 caliber unit.

The blank cartridges, formulated for the NETGUN, are supplied by the manufacturer. For safety reasons, do not use other blanks in the NETGUN. The use of any other blanks will void all warranties and may pose a serious threat to both the user and nearby personnel.

RECOIL STOCK (Figure #1)
The butt plate (2) of the recoil stock (4) rotates. This rotation provides comfortable and secure seating of the stock against the shooter's shoulder as he/she rotates the Netgun to improve their shooting advantage.

The built in shock absorbing feature of the stock and the recoil pad (1) reduces the recoil felt by the gunner.

RECEIVER: (Figure #1)
The receiver (5) is mounted to the fore stock (16) with bolts. A receiver recoil lug bedded into the stock adds strength and security to the mounting. The receiver is designed for extra strength.

WARNING: DO NOT ATTEMPT TO REMOVE STAINLESS STEEL CHAMBER FROM THE MOUTH OF THE RECEIVER. TO DO SO, WITHOUT CONSULTING CODA ENTERPRISES FIRST, MAY DAMAGE BOTH THE CHAMBER AND RECEIVER. CONTACT THE MANUFACTURER FOR HELP.

TRIGGER: (Figure #1)
The trigger is pre-adjusted for maximum pound trigger pull and length of trigger travel. Generally, the gunner is bounced around in the helicopter or in the back of a truck during the pursuit of an animal. This adjustment to the trigger helps prevent accidental firing of the NETGUN. Once the gunner has fired the NETGUN a couple of times, he/she easily

adapts to the firm and long trigger pull.

MANIFOLD: (Figure #1)
The manifold (8) is the gas distribution center that channels the gas from the chamber (7) to the barrels (11) of the NETGUN. Normally, the manifold is maintenance free; the high gas pressure in the manifold prevents buildup of gunpowder residue. The interior of the manifold may be cleaned by removing the set screws (9) located at the end of each manifold stem and using the small wire brush, provided in the tool kit, to brush away residue build-up in the manifold and stems. Replace the set screws after cleaning. Apply a thread lock material to the screws' threads before reassembly. LOKTITE is used by the manufacturer.

CANISTERS: (Figure #1 & #3)
Attach fiberglass canisters to the barrel assembly by placing the canister between the barrels with the canister's rubber strap facing up. Secure the canister in place by hooking its rubber strap onto the peg located on the top of the manifold.

Various canister sizes are available.

CODA NETGUN

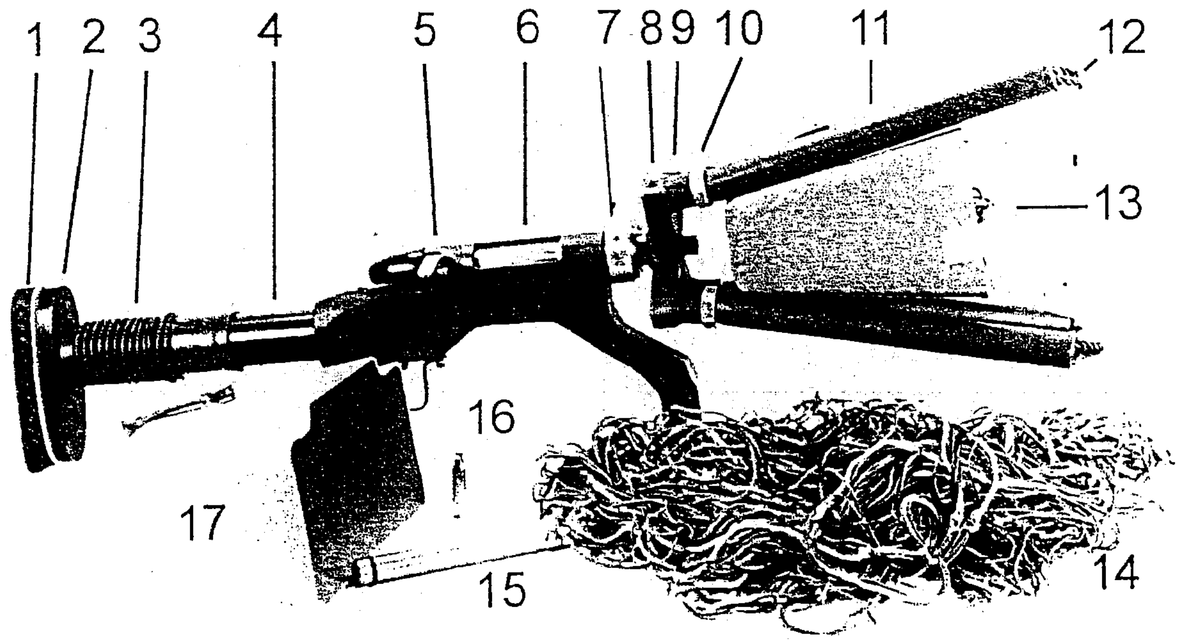


FIGURE #1

1. Recoil Pad
2. Butt Plate
3. Boot
4. Recoil Stock
5. Receiver
6. Bolt, Receiver
7. Chamber & Manifold Ring Nut
8. Set Screw, Manifold
9. Manifold
10. Barrel Lock (Jam) Nut
11. Barrel
12. Net Weight (inserted into barrel)
13. Net Canister & capture net
14. Capture Net
15. Net weight (projectile)
16. Blank Cartridge
17. Net Canister

NET CANISTERS

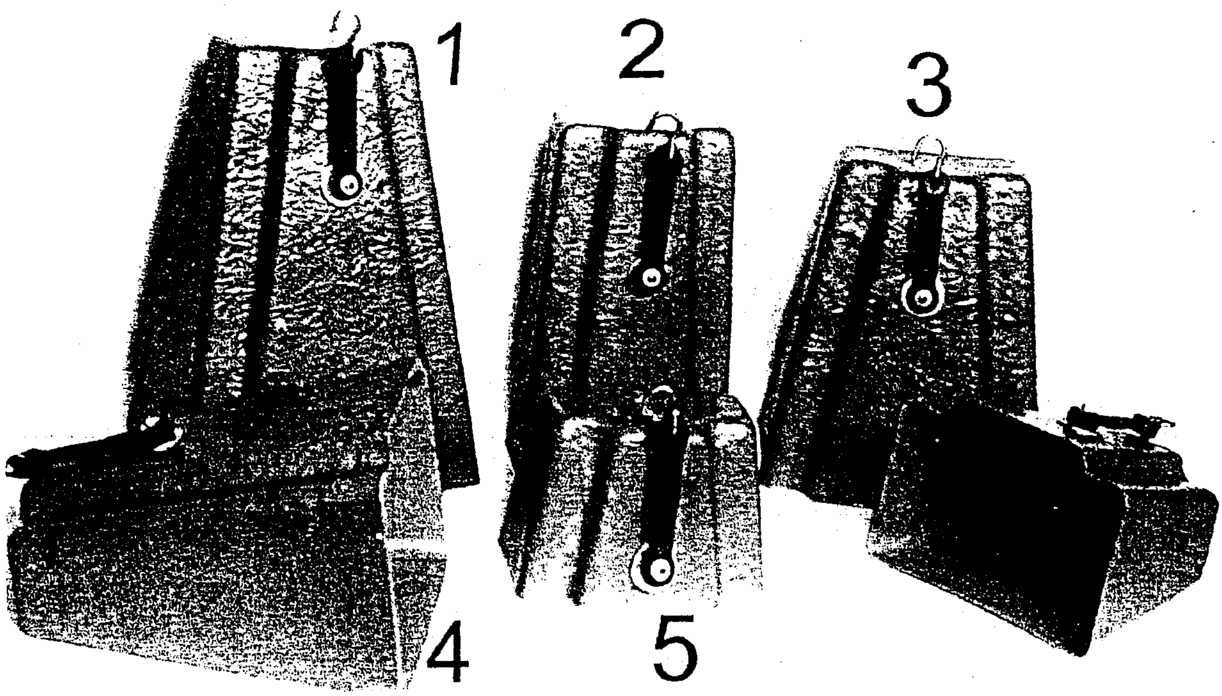


FIGURE #3

Canisters come in various sizes to accommodate a variety of nets. Pictured are samples of canisters that Coda offers.

1. Long canister: for large nets required on elk, moose, etc.
2. Narrow canister: primarily for bird capture. This canister is used with the barrels of the NETGUN adjusted to their most narrow position.
3. Standard canister: handles most of the nets used in capture work.
4. Short canister: used with small nets.
5. Wide-long canister: used on NETGUNS with extra wide angle barrels for quicker deployment of large nets.

Note: The hook and strap are used to attach the canister to the NETGUN.

HANDLING THE NETGUN

<u>NEVER LEND THE NETGUN TO ANYONE UNTIL HE OR SHE HAS BEEN THOROUGHLY SCHOOLED IN NETGUN USAGE AND SAFETY.</u> While the gunner has the NETGUN in hand, the gunner is part of a system over which he/she has complete control. The gunner is the only part of the system that can make the NETGUN safe—or unsafe. He/she is entirely responsible for his/her safety and the safety of others. Emphasis on the basics of safe gun handling and storage cannot be over-stressed. **<u>NETGUN SAFETY IS THE USERS RESPONSIBILITY.</u>**

<u>ALWAYS</u> consider the NETGUN loaded. <u>NEVER</u> point the NETGUN at anything you do not intend to capture.

<u>NEVER</u> hand a loaded NETGUN to another person.

<u>NEVER</u> clean, display, store, or transport a loaded NETGUN.

<u>ALWAYS</u> wear eye and ear protection when shooting the NETGUN.

<u>ENSURE</u> that all nuts and bolts are secure before firing the NETGUN. Double check receiver mounting bolts for tightness.

<u>ENSURE</u> that the gun barrels are free of any obstructions including mud, dirt, snow, excess grease, heavy oil, or foreign matter of any kind.

<u>FIRING THE NETGUN:</u> (Fig. #4 Pp. 2-9)

To fire the NETGUN: Press the butt of the recoil stock securely against the shoulder - but not so tightly that it collapses the recoil stock system - and grasp the grips firmly in both hands. Hold your head erect and away from the gun stock. <u>NEVER REST YOUR HEAD AGAINST THE NETGUN.</u> The recoil mechanism permits a rearward movement of the gun when fired. This movement could cause injury if the shooter were to rest his head against the stock as when firing a rifle or shotgun.

Lean forward, spread feet apart, and expect a recoil slightly greater than that of a 12 ga. shotgun.

Note: The stock butt plate rotates to permit secure seating against the shooter's shoulder - even while he turns the gun to compensate for movement of the animal during pursuit and capture.

DRY FIRING MAY DAMAGE THE FIRING PIN.

BLANK CARTRIDGES:

NEVER substitute other blank cartridges for those supplied by Coda Enterprises for use in the NETGUN. There are many kinds of blanks on the market that are intended for different purposes. Each kind has different characteristics and pressures. A substitution could damage the gun and/or injure the shooter. The blank cartridges supplied by Coda Enterprises are designed specifically for the CODA NETGUN. DO NOT EXPERIMENT!! The use of any other blanks will void Coda's NETGUN warranty.

TRIGGER SAFETY:

The bolt of the receiver is the NETGUN'S safety. When the bolt handle is in the raised position the NETGUN will not (cannot) fire. When the bolt lever is lowered into the locked position the NETGUN is ready to fire. A live blank should not be placed into the chamber until the gunner is about to shoot. Lock the bolt closed (armed) just seconds before pulling the trigger. The shooter's finger should not be on the trigger until the NETGUN is to be fired.

The CODA NETGUN does not have a mechanical safety for several reasons. Too often gun safety depends totally upon a gun's mechanical safety device. Some safeties do not have positive or totally safe "on" and "off" positions. It is possible for a gun to fire while the safety is "on." It is also possible for a gun to fire as the safety is released if the trigger had been pulled while the safety was engaged--without your touching the trigger again. Also, the gun may fire when the safety is positioned between "on" and "off." Shooters have been known to play with the safety switch, unconsciously, inadvertently leaving the safety off. Relying upon a mechanical safety is marginally safe at best.

The gunner's control of the receiver bolt's position provides more safety during the stress, excitement, and distractions of capture work than a mechanical safety device. It also makes the gunner more alert and conscious about extracting a blank should it not be fired during a capture effort. Again, a blank should not be in the chamber until the latter stages of pursuit, and the receiver bolt should not be locked until seconds before the net is to be deployed. Immediately extract the blank cartridge from the chamber if the pursuit is aborted. ACCIDENTS HAVE OCCURRED WHEN THIS PROCEDURE HAS BEEN IGNORED.

NETS:

Inspect webbing attaching the weights to the net. Look for wear that may weaken the webbing beyond safe use. Also check the cordage on the net where the weight attachment webbing joins the net. Replace worn cordage to prevent the weights from becoming detached upon deployment. A stray weight can be very dangerous. Any knots used in net repair can be further secured by applying glue to the knots.

INSERTING WEIGHTS INTO BARRELS:

Lightly lubricate the "O" rings on the weights before inserting the weights into the barrels. The grease lubricant shipped with the NETGUN will not cause the "O" rings to swell or otherwise deteriorate -- other lubricants may. Use a good grade of "O" ring lubricant.

Occasionally apply a small amount of "O" ring lubricant to the inside of the barrels with your finger.

Insert the weights of the net their full length into the barrels. DO NOT insert the weights all the way to the bottom of the barrels. Gas pressure developed in the manifold and barrels when the NETGUN is fired increases as the weights are inserted deeper into the barrels. As gas pressure increases the recoil felt by the gunner also increases. This additional pressure and the subsequent recoil increase may be sufficient to injure the gunner and will wear and stress to the NETGUN unnecessarily.

If more pressure is desired, insert the weights into the barrels a maximum of one inch beyond their full length.

WEIGHTS:

NEVER force the weights of the net into the barrels. An extra tight fit or restriction will increase pressure and may damage the gun or injure the shooter. The "O" rings on the weights provide proper gas seal and prevent the weights from sliding out of the barrels when the front of the gun is lowered.

To provide safe and efficient performance, the weight of the net weights is inter-related to the gas pressure produced by the blanks. Experimenting with different weights could be hazardous. Contact Coda Enterprises for more information.

Remove burrs from the weights. While capturing with the NETGUN, check the weights for burrs that may result from a weight hitting a rock. Remove burrs with the file provided in the tool kit.

CAUTION: WHEN USING PADDED WEIGHTS, A GUNNER MUST WEAR EYE PROTECTION (GLASSES AND/OR GOGGLES). THIS PROTECTION GUARDS AGAINST "BLOW BACK" CREATED WHEN THE PADDED WEIGHTS ARE PROJECTED FROM THE BARRELS AS NETGUN IS FIRED.

LOADING NET INTO CANISTER: (Figures #6,#7,#8. Pp. 2-10)

Before loading, spread the net and eliminate all tangles and debris. Moving either clockwise or counter clockwise around the net, gather the weights into one hand, keeping them in the same order they were collected. DO NOT cross the weights or twist the strands of netting. Each strand of the net, when the weights are held high, should trail down from the weights and not be twisted or tangled with other strands. If the position of the weights is switched around the net will be tangled when fired from its canister.

Hold the weights high above your head, permitting the net to trail down from the weights (Figure #6). Insert the portion of the net
furthest from the weights into the canister first and continue to feed the net into the canister, without twisting the net, until all of the net is in the canister. Continue to hold the weights in their respective positions (Figure #7) and insert them into the NETGUN'S empty barrels. (Figure #8). Note in Figures #7 & #8 the position of the weights (in the loader's hand) in relation to the barrels into which they are to be inserted. The mis-matching of weights and barrels will cause the net to tangle when fired from the canister. Fasten velcro tipped straps to contain the net; or, place masking tape across the mouth of the canister to prevent the net from falling out of the canister. Four strips of 1" masking tape are usually sufficient. (See Figure 5 on page 2-8).

When loading a net into a canister not attached to the Netgun, place weights in the corner (of the canister) corresponding to that weight's respective barrel.

Insert the weights into the barrels until the net-end of each weight is flush with the mouth-end of each barrel. Weights may be inserted deeper into the barrels to increase pressure and consequently to increase the net's projection (Figure #5); however, this adds to the recoil felt by the gunner. NEVER insert a weight deeper than one (1) inch below the mouth of a barrel. Under normal circumstances, weights should never require insertion deeper than flush with the mouth of each barrel. USE CAUTION.

SUMMARY:

1. Keep corresponding weights and barrels positioned respectively.
2. Do not switch the positions of the weights while loading the net or inserting the weights.
3. Do not twist the net while placing it into the canister.
4. Lubricate the "O" rings on the weights before inserting the weights into the barrels. Occasionally lubricate the inside of the barrels.
5. The Velcro tipped straps on the canister contain the net in its canister. Should a strap be lost or otherwise non-functional, masking tape may be used to contain the net.
   With the net properly loaded into the canister, place masking tape across the opening of the canister . The masking tape will tear away when the NETGUN is

fired and will not interfere with the net's deployment. Usually, four strips of 1" masking tape are sufficient. Apply 2 strips from one side to the other and 2 strips from the top to the bottom of the canister opening.

LUBRICATION AND CLEANING:

Clean and lubricate the NETGUN after each use. Give special attention to the cleanliness of the blank cartridge chamber, the gun receiver, and the bore of the barrels.

DO NOT ATTEMPT TO REMOVE THE CHAMBER FROM THE RECEIVER--TO DO SO WILL DAMAGE BOTH. CALL CODA ENTERPRISES FOR INSTRUCTIONS. THE MANIFOLD SHOULD NOT BE REMOVED FROM THE CHAMBER.

To completely clean and examine the barrel/gas distributor assembly, which is rarely required, remove all bolts from the manifold--except the canister mounting post. Visual inspection and subsequent cleaning are now possible. A flashlight greatly aides in the visual inspection of gun parts to be serviced. During reassembly, secure manifold "clean out plugs" with a liquid thread lock.

Before using the NETGUN, remove all oil from the outside of the receiver bolt and from the inside of the receiver. Dirt accumulation, mixed with the oil and grease on the receiver's action, will form a gummy residue that causes the bolt to work stiffly or not at all.

Usually, the NETGUN is subjected to more dirt and grime than a sporting rifle. This is especially true when the NETGUN is used around a helicopter. Landings and takeoffs subject the NETGUN to flying debris. This debris may become involved in the movements of the firing pin assembly in the bolt housing. The tolerances between the firing pin assembly and the bolt housing are tight; consequently, debris becomes a negative factor in the firing pin's functioning.

During extremely cold weather, oil on or in the bolt assembly may freeze or gel. This may prevent the bolt from sliding easily or the firing pin from functioning properly. A dry bolt during a capture operation will not shorten the life of the bolt assembly. During the capture day, frequently clean the bolt and receiver with a soft dry rag.

MISFIRES:

Should the blank cartridge fail to detonate, wait 30 seconds before removing the blank. Continue to hold the Netgun securely and keep the Netgun pointed in a safe direction until the blank is removed. Examine the primer of the blank cartridge. If the firing pin did not dimple the primer the normal amount, then suspect that the firing pin is frozen up due to cold temperature (20 degrees Fahrenheit or colder) or dirt is interfering with the movement of the firing pin. Thawing and/or thorough cleaning will be required to return the firing pin to its normal functioning condition.

Dip, soak, and stir the bolt in a solvent. If available, air from a pressurized air hose will facilitate cleaning dirt from inside the bolt assembly. A good, non-flammable solvent is carbo-chlor. It dries quickly and leaves no residue. This solvent may be purchased at a hardware or paint store. Helicopter fuel is a satisfactory solvent if other solvents are not available during capture in the field. Avoid flamable solvents.

DO NOT apply oil or grease to the firing pin assembly or to the interior of the bolt housing. These lubricants will act as dirt collecting media compounding the dirt problem.

DO NOT STORE THE NETGUN WITH THE TRIGGER "COCKED". STORING THE NETGUN IN THE COCKED MODE WILL WEAKEN THE FIRING PIN AND LEAD TO MISFIRES.

STORAGE:

When not using the NETGUN, store the cleaned UNLOADED NETGUN and blanks in a dry, clean, and locked area. Release tension on the firing pin spring by pulling the receiver bolt back, as if to load a blank cartridge, ensure that chamber is empty (no blank cartridge), pull trigger and hold it back, slide bolt forward and lock down, Release the trigger.

WARNING--WARNING--WARNING

READ AND FOLLOW ALL MANUALS, OPERATING INSTRUCTIONS, AND ALL MANUFACTURER SPECIFICATIONS, INSTRUCTIONS, ADVICE AND REQUIREMENTS FOR USE OF THE EQUIPMENT.

REQUEST AND RECEIVE TRAINING IN THE USE OF THE EQUIPMENT FROM CODA ENTERPRISES, INC. AND FOLLOW ALL TRAINING OR EXPERIENCE REQUIREMENTS AND RECOMMENDATIONS.

USE ONLY MANUFACTURER-RECOMMENDED, COMPATIBLE COMPONENTS.

EXAMINE EQUIPMENT AND REPLACE ANY DEFECTIVE, WORN, OR DETERIORATED COMPONENTS.

DO NOT EXCEED RECOMMENDED OR STATED FORCES OR OTHER FACTORS RELATED TO THE SAFE USE OF ALL EQUIPMENT.

NEVER LEND THE NETGUN TO ANYONE UNTIL HE OR SHE HAS BEEN THOROUGHLY SCHOOLED IN BOTH SAFETY AND USAGE.

ALWAYS CONSIDER THE NETGUN LOADED. NEVER POINT THE NETGUN TOWARDS ANYTHING YOU DO NOT INTEND TO CAPTURE.

NEVER HAND A LOADED NETGUN TO ANOTHER PERSON.

NEVER STAND IN FRONT OF THE NETGUN.

NEVER PERMIT ANYONE TO STAND IN FRONT OF THE NETGUN.

NEVER CLEAN, DISPLAY, STORE, OR TRANSPORT A LOADED NETGUN.

ALWAYS WEAR EYE AND EAR PROTECTION WHEN SHOOTING THE NETGUN.

ENSURE THAT ALL NUTS AND BOLTS ARE SECURE BEFORE FIRING THE NETGUN.

WHEN CAPTURING FROM A HELICOPTER, EXAMINE YOUR (THE GUNNER'S) SAFETY HARNESS, INCLUDING ALL FITTINGS, BUCKLES, SNAPS, AND OTHER FASTENERS BEFORE EACH USE. SECURE YOUR HARNESS AND TETHER YOURSELF; HAVE OTHERS DOUBLE CHECK THE HOOK-UP. REMEMBER, YOU HAVE MORE TO LOOSE THAN ANYONE ELSE IF THE HARNESS IS NOT SECURELY FASTENED. EXPERIENCE HAS PROVEN THAT YOU WILL ALWAYS BE MORE CONCERNED ABOUT THE SECURENESS OF THE HARNESS THAN ANY PERSON YOU MAY DELEGATE THIS RESPONSIBILITY TO.

PLEASE READ AND REREAD THESE INSTRUCTIONS – AND THEN FOLLOW THEM. YOUR SAFETY AND THE SAFETY OF OTHERS DEPEND ON IT.!!!!

SHOOTING POSITION

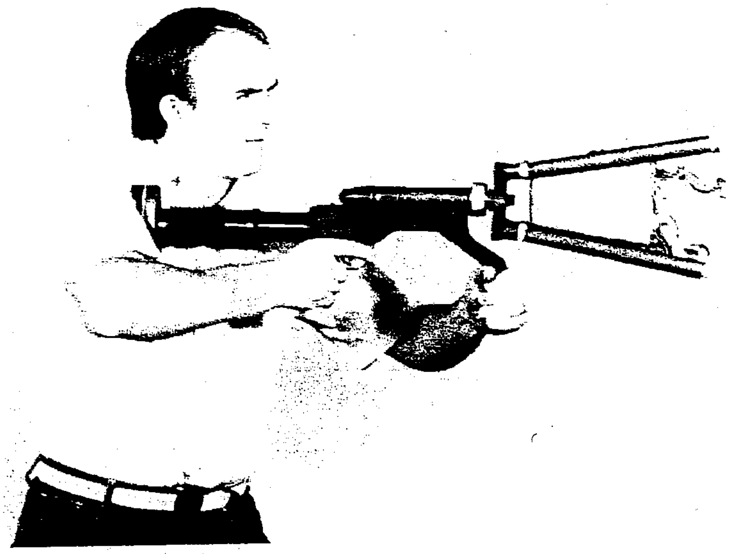


Figure #4

Do not rest your head on the gunstock. Keep your head erect to prevent the rearward movement of the NETGUN (via the recoil system) from hitting you in the face. Hold the NETGUN grips firmly. Position the gunstock securely to your shoulder. Lean forward, spread your feet for balance and bracing.

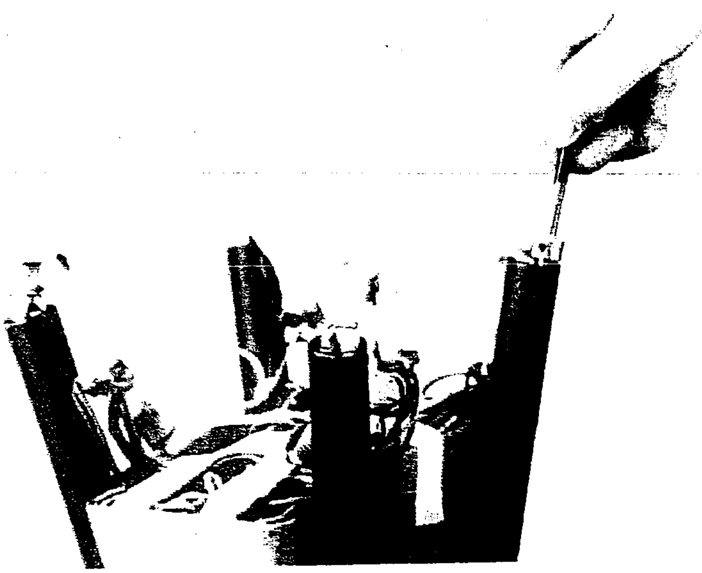


Figure #5

PLUNGING WEIGHTS DEEPER INTO BARRELS

LOADING NET INTO CANISTER

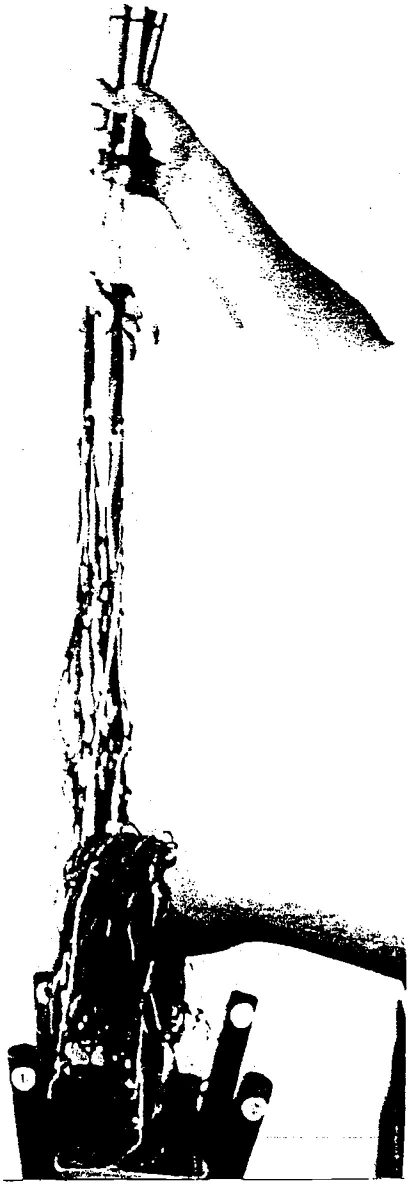


FIGURE #6

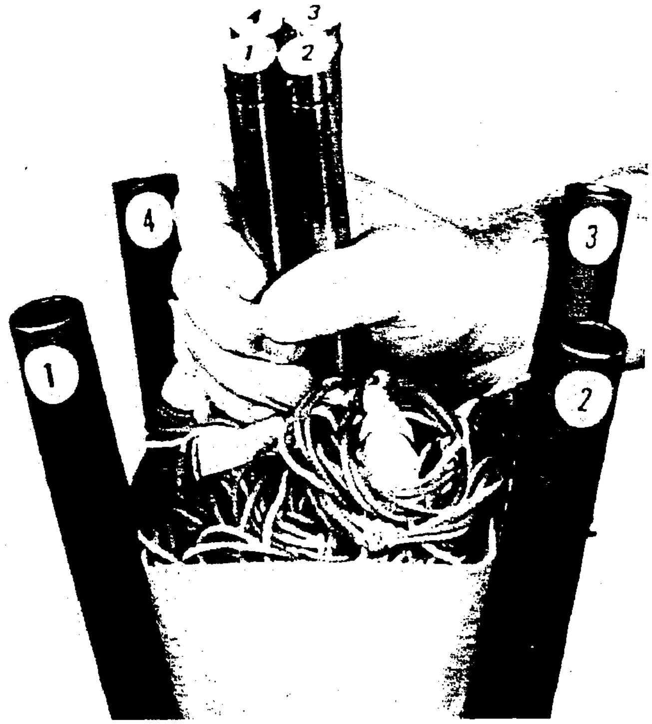


Figure #7

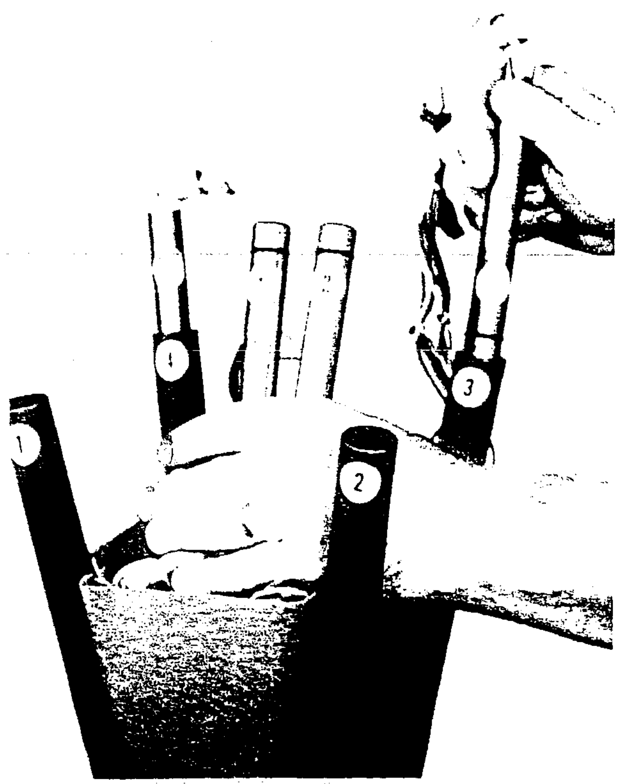


Figure #8

Hold net above canister. Load all of net into canister. Load net's trailing portion first. Hold weights in correct relationship to barrels.

Insert weights.

Do Not insert weights into non-corresponding barrels. Note numbering depicted on weights and barrels.

NET SELECTION GUIDE

To choose a net that is appropriate for a given species, one must consider the mesh size, cordage tensile strength, and the distance the net must be projected under capture conditions. Distance may vary with the method of capture used, that is, whether it is from a helicopter, ground vehicle, ground to ground, tree stand to ground, etc.

The following information is submitted as an aid in net selection.

NET SIZE FEET/SIDE	MESH SIZE INCHES	TENSILE STRENGTH	SPECIES
15	9	1800-S	ELK, MOOSE, BISON, HORSES, ETC.
17	8	1250-S	ELK, SMALL HORSES, BURROS, AND SMALLER MAMMALS
14	7	750-S	DEER, BIGHORN, PRONGHORN, MT. GOATS, ETC.
12	7	375	DEER, BIGHORN, PRONGHORN, MT. GOATS, ETC.
11	5	375	SMALL DEER (ANTLER-LESS)
11	4	500-S	WOLVES, COYOTES, ETC.
11	4	170	COYOTES, FAWNS, RAPTORS, CRANES, PELICANS, ETC.
11	3	170	SMALL MAMMALS, LARGE BIRDS, ETC.
9	1–2	125	BIRDS

NOTE: Field results have indicated effective capture of the listed species using the net size designated. However, this chart is simply a guide. The list is not all inclusive, nor does it imply restriction of a specific net size to a specific species. The fact that a species may vary in body size from one location to another indicates that net size requirements may vary. The final responsibility for net size selection to accomplish effective capture rests upon the user.

Note: S = spectra cordage.

EYE PROTECTION

SUCH AS SHOOTING GLASSES, PRESCRIPTION GLASSES, GOGGLES, AND/OR A FACE SHIELD, MUST BE WORN BY ANY PERSON SHOOTING NETGUN WITH PADDED WEIGHTS ON THE CAPTURE NET.

PADDED WEIGHTS CREATE "BLOW-BACK" THAT MAY CAUSE EYE INJURY TO UNPROTECTED EYES.

TRAINING

CODA ENTERPRISES, INC., the designer, manufacturer, and distributor of the CODA NETGUN, CODA NET LAUNCHER and related equipment, offers you the opportunity to receive training in the effectual use of all equipment. Training is conducted, for a fee, by experienced personnel and includes "hands on" experience to provide a working knowledge of technique, safety, and maintenance.

Training insures proficiency in the use of the equipment and reduces your organization's costs in developing an effective and efficient capture team. The trial and error method of learning is expensive and hazardous: training pays.

Coda Enterprises, Inc. has pioneered the process for netting animals from helicopter in the United States. We have hundreds of hours of experience and have trained many individuals. Coda recommends that no one attempt capture from a helicopter unless that individual has received professional training.

CODA Enterprises Inc. conducts training on the clients premises and in the field: an actual capture project during training produces the most effective and complete learning experience.

We train as many people on your staff as you wish. Coda suggests, however, that a team of only two or three be trained and maintained. This practice helps maximize efficiency. We remain with your capture team until you feel they are adequately trained.

Please contact CODA ENTERPRISES INC. for additional information. We look forward to working with you.

CODA ENTERPRISES, INC.
1038 E. Norwood
Mesa, Arizona 85203
(480-964-0155)

Corrin (Corey) R. Gray President

ANIMAL RESTRAINT & HANDLING

SELECTING A METHOD OF RESTRAINT: physical, chemical, or both.

Animals can injure a handler by kicking, biting, goring, butting, etc. Do not compromise your safety or the safety of others while handling an animal. Use quick and positive restraint methods.

Is the method of restraint safe for the handler?
Is the method of restraint safe for the animal?

What is the best animal restraint technique?
It may be physical, chemical, or a combination of both.

HANDLERS MUST CONSIDER:

1. Species to be restrained.
2. Condition of the animal.
3. Ambient temperature and weather.
4. Purpose of restraint.
5. Facilities available for handling.
6. Number of people in handling team.
7. Experience of team.
8. Potential restraint complications.
9. Compatibility of restraint method and purpose of handling.
10. Any predators in the area that may be a threat to a chemically restrained animal upon release.
11. Time of day--favorable working hours left.
12. Terrain.
13. Capture site: traffic, noise, other animals, observers, etc.

IF PHYSICAL RESTRAINT IS POSSIBLE, USE IT!!

Physical restraint is preferred over chemical restraint <u>if:</u>

1. There is minimal chance of injury to handlers
2. There is minimal chance of injury to the animal.
3. The animal will not be exhausted during process of handling. Prolonged handling time may require tranquilization or sedation.

REDUCE HANDLING TIME --> REDUCE STRESS.

.USUALLY, THE LEAST AMOUNT OF RESTRAINT POSSIBLE IS THE MOST DESIRABLE

RESTRAINT:

INITIAL STEPS AFTER NETTING:

Step One: Secure the head of a horned or antlered animal by first grasping, and therefore controlling, these potentially dangerous "handles", while "bull-dogging" the animal. Once the animal is down and lying on its side, lie on its neck from the backside (away from feet and legs) in a non-choking manner.

Blindfold the animal immediately. A blindfold helps to calm the animal and the reduce stress it experiences.

Step Two - Second Handler: Work from the backside of the animal to avoid being kicked. Force the hind legs forward and place your foot behind the animal's ham, thus reducing the chances of being kicked during the hobbling process.

Step Three: The animal hobbled, position its body so that the head faces uphill; this process reduces the animal's chances of regurgitation and subsequent complications also aids its breathing.

TEMPORARY RESTRAINT

If the animal is not to be restrained for a long period, simply attach a pigging string to the hind legs and stretch the animal out on the ground. This restraint is sufficient if another handler holds the head of the blindfolded animal.

MECHANICAL RESTRAINT:

1. Hobbles: A hobble is best constructed of material wide enough not to cut into the animal's skin as it binds. Wide material bindings also cause less tissue swelling.

A. Four tethers with buckles and center ring.
Disadvantages: Slack created where the ring and straps join will encourage an animal to struggle, testing the slackness for potential escape. These tethers are bulky, expensive, and are slow to attach to the animal. Release of the animal is also more difficult.

B. Two straps, 36" long or more, with buckles and a snap.
Leather is preferable to nylon strap.
Attachment: Secure the animal's hind legs with one strap. Secure its front legs with the other strap; then, join the two straps to each other by way of the snap swivel.
Disadvantages: Slack between the hardware and straps encourages the animal to continue struggling. Release can be awkward.

2. Pigging Strings: Usually, a pigging string is a flat nylon strap. This strap is compact, easily carried in pockets, and simple to apply, rendering quick and safe releases.

Attachment: Place the animal's hind legs in the adjustable loop of the pigging string. Close the loop above the hooves. Lace the strap between the legs and hooves. Pull the hind legs forward and the front legs back. Tie front and rear legs together with the same strap. Do not permit slack in bindings between the front and rear legs; if there is no slack, the animal will struggle less. This elimination of slack is not possible with hobbles.

Release: Have one person secure the head of the animal. Untie its front legs and remove the strap from its hind legs except for initial loop. Stretch the animal out with the pigging string. Have person securing the head roll away from the animal. Immediately release your grip on the pigging string. The first step taken by the animal opens the loop of the string on its hind legs. The animal is free.

3. Tape:

A. Reinforced strapping tape

1. Attachment: Tape one of the animal's front legs, fold it back and run the tape over the animal's back to the other front leg. Fold that leg back; wrap it with tape and then tape the two front legs together, tape crossing the brisket. Bind the hind legs by pulling them forward.

This procedure positions the animal on its sternum (brisket) and lessens its chances of bloating during transfer. This method is for short term transport only. In all other cases, ship the animal by crates or in properly prepared trucks and trailers.

2. Tape may serve as a temporary restraint for collaring and tagging. Bind the animal's front legs together; bind its hind legs together; then, tape the front and hind legs together. To release: preferably, cut tape with blunt-ended scissors rather than a knife or sharp pointed scissors..

B. Masking Tape: Masking tape works well for binding the legs and wings of birds, however, do not use a tape with high adhesive qualities because it may stick too well to feathers, possibly breaking them when the tape is removed.

4. Rope: Cotton rope holds knots well and is softer than some nylon ropes. Beware of tissue swelling in the animal due to over-tight binding. Rope is not recommended.

5. Snare Pole: This device consists of an adjustable loop on the end of a pole. The

loop can be drawn tight around an animal's leg or another part of its body for partial restraint. Do not risk injury to the animal by placing the loop around the lower jaw only. Instead, place the loop over the animal's upper mandible and behind the canines so it cannot slip off. Use special care if you loop around an animal's neck.

SAFETY:

PERSONNEL SAFETY:

Wear clothing that is free of openings. Hooves or antlers in a pocket, under suspenders, or in a gaping jacket or shirt can cause injury.

Padded clothing and gloves can provide additional safety.

Avoid danger areas such as hooves, head, antlers, horns, and teeth.
Approach chemically or physically immobilized animals carefully. Determine that an animal is immobilized before handling it.

ANIMAL SAFETY DURING HANDLING:

1. Blindfold the animal to reduce the stress it experiences.
2. Do not sit on any animal while it is drugged or mechanically secured.
3. Hold the animal's head to prevent it from injuring itself.
4. Check the animal's vital signs.
5. Protect the animal from:
   - excessive heat.
   - excessive cold or loss of body heat.
   - dehydration.
   - damage to eyes (physical injury, sun, debris, etc.).
   - bloat (change its body position).
   - stress (unnecessary noise
   - unnecessary handling.
   - too many people.
   - foreign scents.
   - unnecessary testing, sampling.
   - prolonged handling.

WORK QUICKLY AND EFFECTIVELY
REDUCE STRESS TO THE ANIMAL
MINIMIZE HANDLING AND DOWN TIME.

TRANSPORT OF ANIMALS

PREPLANNING CONSIDERATIONS:

1. Species, approximate number, sex of animals, and the animal's physical condition.
2. Weather and temperatures.
3. Distance of transport -- minimum time.
4. Method of transport.
5. Road conditions.
6. Monitoring of animal during transport.
7. Contingency planning: "Plan B".

Equipment:
Equipment should be appropriate for the species transported. It should be maintained in sound condition and include back-up equipment.

TRANSPORT CONTAINERS:

1. Bags, cloth or burlap: snakes (non-venomous), lizards.
2. Boxes with secure lids: most birds, turtles, and animals that are not apt to claw or chew their way out of the box.
3. Wood, metal, or wire cages.
4. Wooden crates: single animals -- usually larger animals.
5. Trailers: (Compartmentalized) for groups of animals.
6. Trucks: (flatbed or enclosed) with crates, boxes, or compartments.

If a suitable transport container is not available, restrain the animal physically and/or chemically. If a chemical restraint is used, also hobble and blindfold the animal in case the drug wears off during transport. More than one bear has awakened in the cab of a pick-up truck during transport.

TRANSPORT HEALTH CONSIDERATIONS:

Ventilation: Provide the animal with fresh air, and protect it from dust; expel excess heat developed by ambient or body heat.

Urine produces ammonia vapors that may irritate the lining of the respiratory tract, leaving the throat and lungs susceptible to bacteria and virus infection. Place holes at the top and bottom of the transport container's side panels.

Overheating: Apply snow or ice as needed; watering down the animal helps.

Dehydration: Have water available when transport is stopped.
Watering down the animals helps if they are able to lick each other.

Stress:

Frequently monitor the animal(s) for stress during transport. Stress reduces the animal's ability to fight off disease.

If transport equipment and/or other conditions are not the best, sedating or tranquilizing the animal before transport may reduce the stress it experiences

Mechanically restrained animals may experience elevated stress levels that contribute to capture myopathy or injury during transport.

a. Visual Stress: Cover container openings. Blindfold the animal if necessary. Do not permit dogs in the area. (wildlife)
b. Auditory Stress: Converse in soft tones; avoid laughing and shouting; do not slam doors; eliminate mechanical noises.
c. Olfactory and Touch Stress: Do not smoke; do not pet animals (petting wild animals stresses them–it does not sooth them) avoid cologne. Work and camp down wind from contained animals.

Space: Provide enough space for the animal to stand, turn around, and lie down.

A TRANSPORT CONTAINER SHOULD:

1. Provide security, be escape proof, prevent other animals from entering, and discourage vandalism. Use the best materials available.
2. Protect from the elements (rain, snow, direct sun, drafts).
3. Protect from excess heat. Locate it in shade when possible.
4. Protect from excess cold. Auxiliary heat may be required.
5. Provide bedding that is deep and free of dust and mold.
   Bedding protects the animal from extreme cold and absorbs urine or spilled water.
6. Be clean and disinfected.
7. Provide access to observe animal's welfare.
8. Provide access to care for animal.
9. Provide secure footing. Wooden floors are best.

REDUCING CONTAINER-RELATED TRANSPORT INJURY:

1. Containers should have smooth interiors: remove or pad all sharp protrusions; remove splinters; eliminate or cover abrasive surfaces.

2. There should be no gaps in the container's walls or floor that could catch hooves, antlers, horns, etc.
3. Do not cage aggressive animals together.
4. Generally, load one animal per container.
5. Segregate animals by sex to prevent fighting among males in presence of females and young--especially during rut.
6. Separate animals that characteristically fight.
7. Wire cages will fray or break the feathers of birds.
8. Containers should be easy to grasp and move without dropping them.

ACCESS DURING TRANSPORT:

Visually check the animal's condition and note if it is:

1. Panting, shivering, wetness, huddling and suffocating.
2. Conscious or unconscious.
3. Properly positioned.
4. Safe from other animals.
5. Down and being stepped on by others.

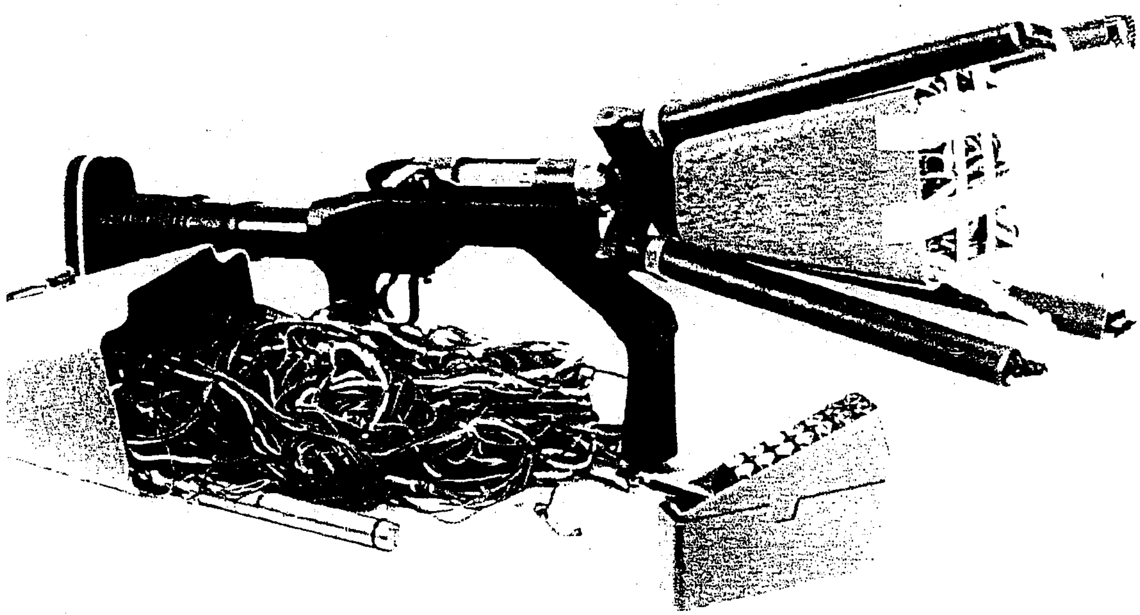
Provide means of access during transport that allow:

1. Administration of injections, anesthetics, reversals, or stimulants.
2. Care for other needs.

CODA NETGUN–STANDARD MODEL

82-2040 STANDARD FOUR BARREL SYSTEM: Includes NETGUN with four barrels that may be adjusted from wide angle to narrow angle; two net canisters; two nets and associated net weights; recoil system (in gunstock); recoil pad; tool kit; and 100 blank cartridges. The barrels are also removable and may be replaced with barrels of differing length and angle diversifying the NETGUN'S performance. The standard barrels shipped with the unit provide a system capable of capturing species ranging in size from birds to elk.

Price.....................$3395.00



STANDARD SQUARE NET SIZES: (other sizes available)

N-12-7-375	12' per side,	7" mesh,	375 lb. tensile strength
N-11-5-300	11' per side,	5" mesh,	300 lb. tensile strength
N-12-4-170	12' per side,	4" mesh,	170 lb. tensile strength
N-10-3-105	10' per side,	3" mesh,	105 lb. tensile strength
N-9-2-85	9' per side,	2" mesh,	85 lb. tensile strength
N-8-1-40	8' per side,	1" mesh,	40 lb. tensile strength

CODA SAFETY HARNESS

86-3000 SAFETY HARNESS:
The gunner's safety harness is made of nylon straps rated at 5000 pound tensile strength. It is adjustable, fits all sizes, and is comfortable when worn for long periods of time. The color of the harness is orange or yellow for high visibility.

The harness consists of two leg straps, a chest strap, shoulder straps, military spec hardware, and a five-foot-long tether strap with a static line snap. The detachable tether secures the gunner to the interior of a helicopter, to a tree stand etc.

Price: $139.95

HARNESS FITS ALL SIZES

CODA NETLAUNCHER

The Coda Netlauncher is a self-contained, net-launching unit designed to capture a variety of animals, including birds, for the purposes of studying, examining, administering medical treatment, banding, tagging or otherwise marking, attaching telemetric devices, relocating, and for animal control. The Netlauncher deploys a net over an animal that has been baited in with food or water or otherwise positioned, such as along trails, in the vicinity or zone of the launching unit.

One person, within five minutes, can easily set the Netlauncher into place and ready it for capture. Basic net size is 24' square. Other sizes are available. The Netlauncher functions somewhat like a rocket net.

The Netlauncher is fired by means of an electronic detonator triggered remotely by the gunner. Wireless (radio controlled) detonators are available. It is powered by a blank cartridge formulated for the Netlauncher. Blank cartridges are supplied by Coda Enterprises.

Baiting is the usual method for positioning the animal within the range of the net. Some species readily accept baits. For more wary species, concealment of the Netlauncher and/or pre-baiting the capture site may be necessary. The use of a "dummy" unit that is set into place prior to the capture effort is effective. After the animal has accepted the "dummy" unit, replace the "dummy" unit with the Netlauncher. Capture strategy is based on the species to be captured and what the animal is accustomed to in its environment.

The Netlauncher may be placed on the ground; mounted on platforms, vehicles, or other mountings that permit unobstructed deployment of the net.

The Net launcher is easily moved, transported, and stored.

CODA NETLAUNCHER

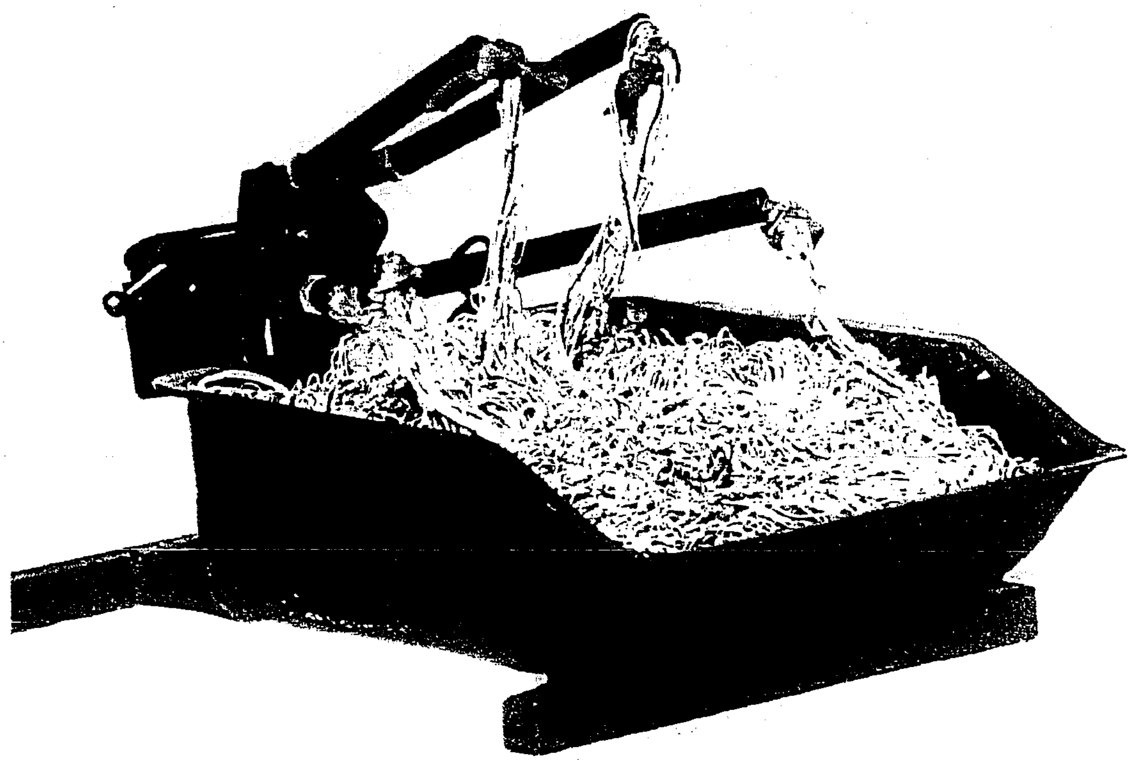
Includes self-contained, net-launching unit with net and weights, 100 blank cartridges (coded blue for identification), tools, tool box, and instruction manual.

86-6000 Netlauncher:
Netlauncher with hand-held remote detonator (wire).

Price..................$3395.00

86-7000 Netlauncher:
Netlauncher with radio controlled detonator (wireless).

Price..................$3895.00



Net prices may vary according to specs required.

A METHOD FOR NETTING ANIMALS FROM A HELICOPTER

CONCEPT:
A capture crew, in a helicopter, pursues an animal. When the animal is in proper position, relative to the helicopter, the gunner captures the pursued animal by "shooting" a net over it.

CAPTURE CREW:
Coda suggests that only three people, the pilot, the gunner, and the spotter (mugger), occupy a four place helicopter during capture work. This practice reduces the amount of weight in the helicopter thus increasing the craft's performance. The spotter sits next to the pilot and the gunner sits directly behind the pilot. The pilot and gunner will have the same view of the animal since they are seated on the same side of the helicopter.

When the gunner and the pilot sit on opposite sides of the helicopter, some pilots tend to tip the craft downward on the gunner's side, improving the pilot's view of the pursued animal but dipping the main rotor further into the gunner's shooting zone. Obviously, the main rotor should be as far from the gunner's shooting zone as possible.

After the animal is netted, land the helicopter near-by. The spotter and gunner restrain the animal by blindfolding and hobbling it. The capture team then completes the purpose of the capture.

With team practice the sequence of spotting, pursuing, netting, collaring and tagging, and releasing the animal requires relatively little time. In completing the total sequence, an experienced capture team may average 12 to 15 minutes per deer. Search time, of course, varies with the area and the population density.

Animal capture that includes net gunning from helicopter and/or low-level flying involves certain risks. Safety precautions, preparation and training, familiarization of personnel with equipment, and common sense all work together to reduce these risks.

COMMUNICATION ON BOARD:
Pilot - gunner communication is important. This interchange continues throughout the pursuit, coordinating the capture attempt as the pilot maneuvers the helicopter for position and the gunner launches the net at the proper moment. The pilot's commentary may include notations of ground conditions that could effect the gunner's shooting: oncoming obstacles, clearings in ground cover, and the pilot's need to change the course of the helicopter.

During pursuit, the spotter should remain silent except when alerting the pilot to obstacles in the helicopter's path.

BASE CAMP:
Radio base camp, to notifying them of the area being flown. Reporting every 30 minutes is good standard procedure. Preset plans should go into effect should the helicopter fail to report with-in an allotted time period.

PORTABLE RADIOS:
The capture team should have portable hand-held radios when left on the ground, while the helicopter returns to base camp for fuel, sling loads, transporting other personnel, etc.

PILOT:
The ideal pilot has many hours of experience in flying, capture, hazing, and animal handling. He should also know the habits and movements of pursued animals. The pilot should be carded for "special use" flight. Use the same qualified pilot(s) for all capture flights: constantly changing pilots decreases efficiency and safety.

Most Netgun shots are taken when the helicopter is flying 20 to 30 feet (6 to 9 meters) above ground level. As a result, the pilot must occasionally maneuver the craft below tree-top level. Low-level flight requires an experienced pilot and not just a helicopter driver.

GUNNER:
The gunner must be familiar with the NETGUN. He/she should fire the gun several times from the ground before attempting to shoot it from a helicopter. Ground training should include familiarization with the NETGUN and related equipment.

Remove the gunner's door from the helicopter before "take off". Also, removal of the pilot's door and the spotter's door facilitates entry and exit during capture.

All helicopter occupants wear seat belts. The gunner, however, in addition to the helicopter seat belt wears a gunner's safety harness that is secured to the interior of the craft. Should the seat belt disengage, the gunner's harness ensures his/hers safety. Together, harness, tether, and lap seat belt stabilize the gunner in shooting position.

Never completely rely upon another person to secure your harness or any other safety equipment. No one is as concerned for your safety as you. Check your equipment and hook-up and then check it again.

Adjust the tether strap on the harness to permit the gunner to lean out of the helicopter and attain the desired shooting position. The gunner should place his full weight against the harness each time he leans into the shooting position. Doing so consistently places him in the same shooting position and adds to his accuracy.

Get into shooting position by sitting sideways on the seat of the helicopter. Place both feet outside the craft and lean out of the helicopter. Rest your elbows on your knees or thighs while in this position. NEVER lift your elbows off your knees or thighs while shooting. Observing this rule keeps the net's path of deployment well below the main rotor blades -- regardless of the attitude of the helicopter during pursuit and netting.

WARNING: IF THE GUNNER, WHILE AIMING THE NETGUN, ELEVATES HIS ELBOWS SO THEY NO LONGER TOUCH HIS THIGHS OR KNEES, NET DEPLOYMENT WILL APPROACH OR ENTER INTO THE AREA OF THE MAIN ROTOR.

The gunner's head should be far enough out of the craft so as to be directly above the helicopter's skid. When the gunner is out this far, NETGUN held to shoulder, the muzzle of the NETGUN is well beyond the skid. The net, when deployed, will not become entangled on the skid. Should the gunner point the NETGUN towards the front of the craft, however, the skid will be in the net's projection- path. The shooting zone is to the side of the craft -- not to the front. (Figure #12 & #13)

Shots are taken when the animal is at the helicopter's side, midway between pilot and gunner, 45 degrees above the skid (45 degrees below the horizontal), and 20 to 30 feet (6 to 9 meters) from the helicopter.

By shooting the NETGUN 45 degrees above the skid (45 degrees below the horizontal) the gunner avoids deploying the net into the main rotor or onto the skid. If the skid is always directly below the gunner's head, if the animal appears 45 degrees out from the skid, and if the NETGUN is pointed at the animal when the trigger is pulled, then the net will not be deployed onto the skid or into the rotor blade zone. ALWAYS OBSERVE THE 45 DEGREE SHOOTING ZONE RULE.

DO NOT continuously point the NETGUN at the animal during pursuit. The animal will frequently change position in the shooting zone as it flees from the helicopter. If the gunner constantly aims at the target rather than maintaining shooting position, the NETGUN may become directed at the main rotor because the gunner, at times, views the animal through the arc of the main rotor. Hold the NETGUN constantly at 45 degrees above the skid, letting the animal position itself in front of the NETGUN. It will! Be patient! The shot will present itself. DO NOT attempt to create the shot by moving the NETGUN toward the animal!!

Repeat, should the gunner lift the NETGUN higher than 45 degrees above the skids, the path of the deployed net begins to approach the main rotor.

During search and early pursuit, NEVER have the NETGUN loaded and the bolt locked In the unlocked position (bolt handle up) the NETGUN will not fire; however, the safest practice is to never have a blank cartridge in the chamber while the NETGUN is in the helicopter and/or the gunner is not in his shooting position.

NEVER have a blank in the chamber while the gunner is not in the shooting position. During search, the gunner should rest the NETGUN on his lap with the muzzle pointing out the open door and in a downward position. The blank should be in the gunner's pocket or hand during search but NOT in the chamber. When the gunner leans out of the cabin to take the shooter's position it is NEVER necessary to have a blank in the chamber. Once in the shooter's position, he may then place the blank into the chamber and slide the receiver bolt forward. DO NOT LOCK THE BOLT DOWN AT THIS TIME. The gunner locks the receiver bolt, fully arming the NETGUN, only when he is about to shoot. Then and only then should the bolt be locked.

While being pursued, the animal may move out of the shooting zone. During this time, as the pilot maneuvers the helicopter for another try, the gunner should raise the receiver bolt to the unlocked (safety) position. When the animal is again in the shooting zone, return the receiver bolt to its locked position just seconds before firing. Repeat this procedure of locking and unlocking the bolt until the NETGUN has been fired or the pursuit canceled.

If the pursuit is canceled, the gunner should remove the blank from the chamber before abandoning his shooting position. After the blank is removed, the gunner may then return to the interior of the helicopter.

REPEAT:

*Lock receiver bolt ONLY seconds before firing.
*ALWAYS be in shooting position before locking the bolt.
*Should pursuit be canceled, REMOVE the blank from the chamber before abandoning shooting position.
*NEVER, whether or not the NETGUN is loaded, point the NETGUN upward toward the helicopters' main rotor blades.

Place your finger in the trigger guard only when you intend to fire. Resting a finger on the trigger is a dangerous habit: the helicopter's movement, the gunner's own body movement, or other unpredictable elements encountered could cause an accidental discharge of the NETGUN.

Be aware that the NETGUN'S top barrels slightly angle up and that the top of the net, when discharged, rises above the line of sight. Keep plenty of daylight between the NETGUN'S barrels and the helicopter's rotor blades.

Ensure that the net is securely contained in the canister to keep it from trailing out in the wind.

The gunner should be a person who can remain relatively calm during the exciting chase. With experience, the gunner will develop an automatic awareness of safety, terrain, the pursued animal, capture techniques, and surrounding "net hangers" (tree, brush, cactus, etc.) and still be prepared to "shoot" when appropriate.

Always have a backup net or two just in case the netted animal is still mobile. Never start a pursuit with only one net available to the gunner. Having at least six loaded nets on board at the flight's start reduces trips to the base camp for more loaded nets. Having base camp personnel reload nets rather than the helicopter team conserves capture time. On return trips, empty canisters and deployed nets may be dropped off at base camp. Have plenty of nets and canisters on hand.

Should the gunner miss his target and the pursuit continue, have the pilot record the location of the deployed net on the ship's Loran. This saves time searching for the net later.

SPOTTER:
The spotter helps look for the animal during the search stages of capture. During pursuit, he is to concentrate ONLY on alerting the pilot of any hazardous obstacles in the helicopter's path. He may also record information, operate telemetry receivers, and act as relief gunner. As spotter, his primary task is to ensure the crew's safety during pursuit.

When not in pursuit, the spotter should check the gunner's safety habits (visually and/or on the inter-com): is the Netgun unloaded (except during last stages of pursuit)? Is the blank cartridge out of the Netgun during search and transport? Is the gunner's safety harness secured to the interior of the ship? Is equipment secured so it will not fall or blow out of the ship.

This double checking of safety standards should not offend any safety-conscious crew member.

TEAM CONCEPT:
Train a team that will have the opportunity to work together, learn together, exchange ideas on capture work, and be permitted to function as a team over a long time period. Each capture coupled with an inexperienced gunner and a different pilot increases hazards. The capture methods efficiency decreases.

FATIGUE:
Capture work is fatigues the entire crew. Efficiency and safety decrease with fatigue. No number of captured animals is worth the risks associated with extending oneself beyond the realm of efficiency and safety. Often the supervisor on the ground must determine when to quit for the day. The capture crew works under the excitement associated with capture work and/or pressure to get the job done and are inclined to overextend the day's work.

Rotate trained gunners throughout the capture, keeping the team at its best.

TRAINING:
Only trained personnel should be directly involved in capture work. Limit the number of gunners so that each will stay in practice. Do not have a student net-gunner train another student. Coda Enterprises, Inc. provides in depth training in all facets of net-gunning. Refresher courses are necessary to maintain the capture team at its most efficient and safest performance level.

Do not fly with pilots who have not been trained for net-gunning. Pilots who have flown for dart gunning, shot-gunning, or hazing are not trained for net-gunning. For efficiency, economy, and safety, fly with a trained pilot.

AFTER THE CAPTURE:
Check equipment for damage. Clean, repair, and replace equipment.
Store equipment in a ready condition for the next capture.

WEATHER:
High winds make it difficult or impossible for the pilot to maintain a stable platform for the gunner. High winds may also cause a launched net to drift or float or otherwise deploy ineffectively.

Rain adds weight to a deployed net, and this weight negatively affects subsequent deployment of the net.

High ambient temperatures increase stress to the animal during pursuit and handling.

High ambient temperatures adversely affect the helicopter's performance.

High altitudes reduce the helicopter's level of performance.

THIS COMMENTARY DOES NOT INCLUDE ALL ASPECTS OF HELICOPTER-BASED NETGUNNING. IT IS SIMPLY AN INTRODUCTION. VARIATIONS IN METHOD MAY BE APPROPRIATE AND NECESSARY. ALWAYS HAVE THE PILOT GIVE ADDITIONAL SAFETY INSTRUCTIONS PRIOR TO FLIGHT.

SAFETY MUST ALWAYS BE THE PRIMARY

CONSIDERATION!!!

SHOOTING POSITION--HELICOPTER

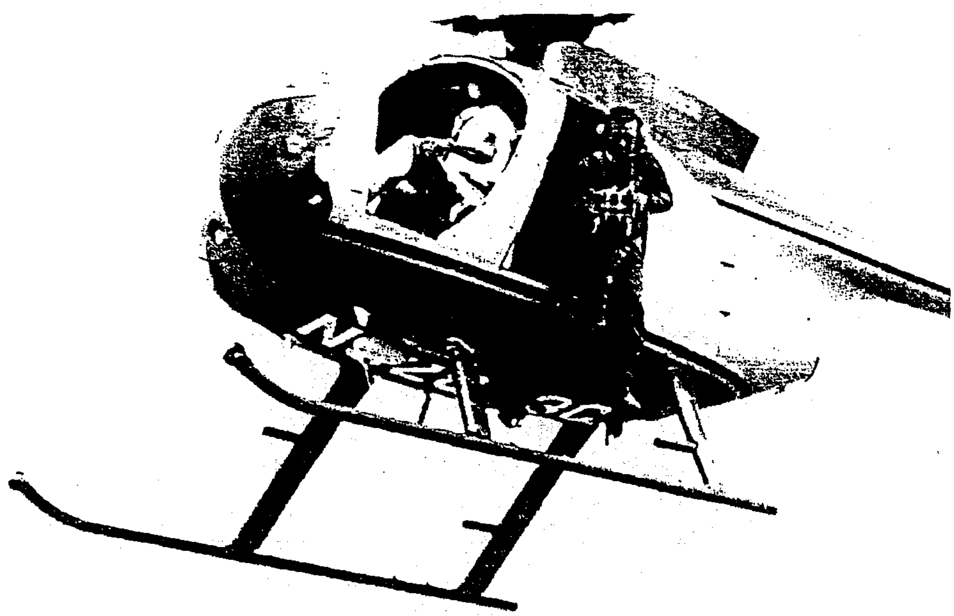


FIGURE #9

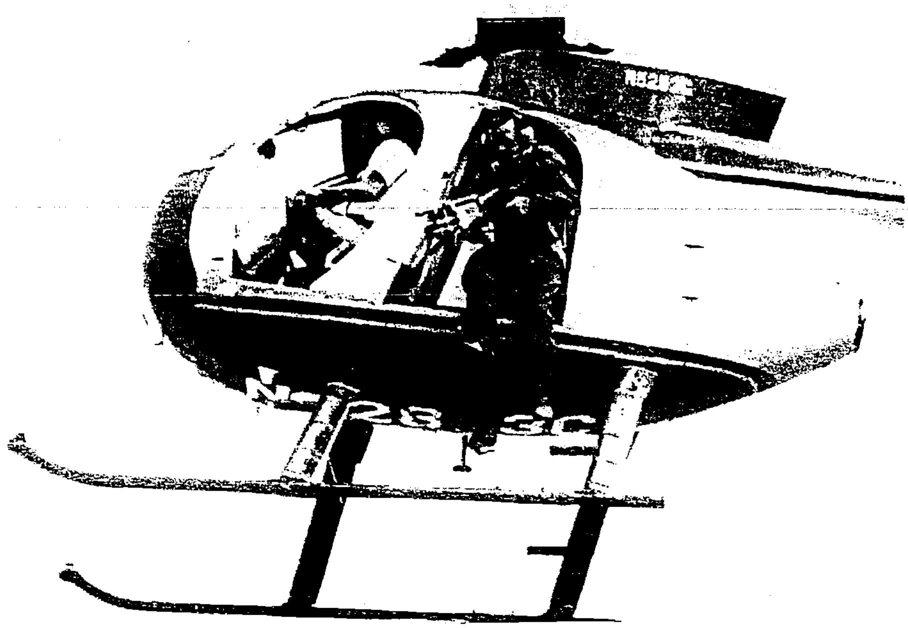


FIGURE #10

HELICOPTER SAFETY

PRE-FLIGHT:

Review with all team members:

1. Objectives of the operation.
2. Areas to be flown. Use topographic maps, marking these flight areas. Leave a of the map with the ground crew.
3. Weather forecasts.
4. Assigned duties:
   a. individual assignments.
   b. logistics coordination.
5. Flight-following procedures (page 5-13).
6. Regional "hazard map", noting and highlighting hazards such as power and telephone lines, etc.
7. Flight plans.
8. Helicopter safety.
9. Hand signals between helicopter and ground crews.
10. Use of equipment.
11. Locations of first-aid kits, survival equipment, ELT (emergency locator transmitter), and fire extinguishers. Check the availability of these items before flight day.
12. Emergency procedures.
13. Frequencies to be used between ship and base radios.

BRIEF THE FLIGHT TEAM ON:

1. Approaching an active helicopter
2. Proper procedures for entering and exiting a helicopter. In preparation for an emergency, the flight crew should be trained in and practice the procedures of embarking and disembarking from a helicopter at improved and unimproved landing sites. Training should include (but not be limited to): hover, one skid, and toe-in mounts and dismounts. Qualified personnel should teach these procedures.
3. Stowing of equipment.
4. Working around a helicopter.
5. Use of equipment (ELT, inter-comm, seat belts, headsets, etc.).
6. Leaving the area of an active helicopter.

APPROACHING AN ACTIVE HELICOPTER

Never move toward the landing area until the helicopter completes its landing, and the pilot indicates that it is safe to approach.

After establishing eye to eye contact with the pilot, use predetermined hand signals to indicate your intention to approach the helicopter. Do not approach the helicopter without the pilot's knowledge and approval.

Approach or depart on the helicopter's downhill side. Never approach or depart from the uphill side of the helicopter. Main rotors can reach below head-height even if the craft rests on moderately sloping terrain.

Never run to or from a helicopter.
Never approach from the rear of the helicopter.
Never depart towards the rear of the helicopter.
Never walk under the tail boom.
Secure headgear before approaching a helicopter.

LOADING EQUIPMENT:
Hold tools and equipment down low while carrying them to and from an active helicopter. Be especially careful with poles, antennas, snare poles, or other long equipment. Carry these and other tools horizontally and below the waist, never on the shoulder. Use caution; equipment can tip reaching rotor-blade height. A good "rule of thumb" is to never carry anything more than four feet long.

STORING AND HAULING EQUIPMENT IN A HELICOPTER:
Do not carry more equipment on board than is necessary for the mission.

Discuss with the pilot the equipment to be hauled on board.
Give him an accurate weight estimate.

Store equipment so as to equally distribute its weight throughout the helicopter.

Stow as much equipment as possible in the ship's storage compartment, maximizing cabin space.

Cargo loaded in external racks must be secure. Run tie-down cord through any handles on cargo. Do not leave loose items in cargo racks.

HAZARDOUS MATERIALS:
Transportation of explosives, flamable and other hazardous materials must comply with DOI's Aviation Transport of Hazardous Materials Handbook (351 DM) or HMR Part 175, CFR 49. The Department of Transportation can cite anyone disregarding these regulations.

ENTERING A HELICOPTER:
When you open a helicopter door, hold it securely so that rotor- wash or the wind will not slam it open or closed.

Do not use door's sliding windows or window air vents as handles to close the door.

Do not use the door to pull yourself into the helicopter or to support yourself during exit.

To enter, place one foot on the step and move your head and shoulders into the passenger compartment; then place your other foot inside.

ONCE ON BOARD:

Secure all loose items (maps, papers, etc.) -- especially if you are flying with the doors off.

Passengers and equipment must remain clear of all flight controls.

Upon entering a helicopter, put on a seatbelt. Keep it buckled until the pilot signals you to exit the craft. Before leaving the ship, re-buckle the formerly used seat belt behind you.

Never permit any seat belt to hang outside the door. Extensive damage will occur as the belt flaps against the helicopter during flight.

Do not throw anything from the helicopter during flight or on the landing pad, the rotors turning.

Do not smoke in the aircraft whether in flight or on the ground. Do not smoke within 100 feet of any fuel supply or a refueling operation.

GROUND CREW:

1. Keep the landing pad free of debris and equipment to prevent objects from becoming air-born (due to rotor down-wash) and striking the rotors.

2. Wear eye and ear protection.

3. Keep well away from the landing pad.

4. Face away from a landing or departing helicopter.

5. During take-off and landing, remain in group rather than scattered around pad area.

6. Do not smoke within 100 feet of a heliport, or during a refueling operation.

GENERAL SAFETY:

Helicopter operations should comply with safety and operations rules and practices prescribed by the agency in charge of the flight operation as well as federal, state, and OSHA guidelines.

Only trained personnel should participate in net-gunning operations.

The pilot and aircraft should be carded for net-gun operations.
(See Procurement of Aircraft Services, pp 5-16).

Train flight and ground personnel before permitting them to work in or around a helicopter.

The pilot should brief personnel on the hazards and limitations related to working around an active helicopter, throughly discussing safety precautions.

Permit necessary flights only. Do not carry more personnel than the operation requires. Keep "carry on" equipment at a minimum.

During hover hook-ups use trained personnel only.

Before take-off, brief crew on emergency procedures, signals, and work routines.

Do not permit heli-jumping during flight or hovering.

One-skid or toe-in landings are not to be used for loading or unloading passengers and/or equipment except in extreme emergencies and then only by trained personnel.

During flight and pursuit, routinely point out hazards in the flight area whether you think the pilot sees them or not.

Assist the pilot in watching tail-rotor clearance during field landings.

Never request a pilot to overextend his abilities or those of the ship's. Check pilot qualification card and the aircraft data card if in doubt. The pilot should approve all missions; his word is final.

Do not pressure the pilot to fly in adverse weather.

Only fly with a pilot who has had previous training and experience in the type of flying the mission involves.

Do not hesitate to cancel flights that present questionable flight conditions: weather, ship, pilot, crew, etc..

If the pilot supplied by the contractor is not qualified, do not hesitate to request a different pilot for the mission.

Use the best supervision possible. Maintain control of the operation.

Report all accidents and incidents to your supervisor.

FLIGHT-FOLLOWING PROCEDURES:

Flight-following is a check-in procedure where the person(s) performing the flight-following service routinely calls the aircraft at predetermined time intervals. Half-hour intervals are suggested. If the aircraft fails to respond to the flight-following service call within a half hour, the flight-following service will initiate a search and rescue operation. The flight-following service will notify (a) the county sheriff's office, (b) emergency medical service, and (c) the department's regional flight-safety officer.

Use a flight-following service for all low-level flights. This service may also be arranged through a local Forest Service, the Bureau of Land Management, or the flight contracting office (if it is close to the capture area and is staffed during flight hours).

FLIGHT PLAN:

File a flight plan with the flight-following service and give a copy to the field base camp. Include in the plan; areas to be flown, schedule of departure and return, location of base camp, alternate routes and areas, etc.

RADIO COMMUNICATIONS:

The aircraft shall have an on-board, VHF/FM-capable radio with state fish and game, U.S. Forest Service, and Bureau of Land Management (BLM) frequencies. Use this radio for flight-following services.

Portable radio: to be carried on all low-level flights. Each portable radio is to be programmable and repeater-capable and have a minimum of state game and fish, U.S. Forest Service, and BLM frequencies. Each portable radio will have spare alkaline batteries and be carried in a crush-proof container.

Emergency Locator Transmitters: Carry a functional personal locator transmitter (portable and voice capable) on each low altitude flight.

All aircraft will have on board a functional ELT.

Base, ship, and capture crews should have radios to facilitate communications. Often the capture crew will be left on the ground at the capture site while the helicopter is refueling, long-lining, or transporting other personnel.

FLIGHT-SAFETY COORDINATOR:

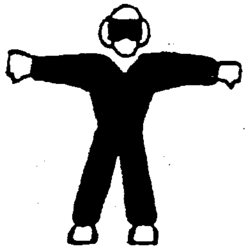
1. Coordinate aircraft safety program.
2. Monitor adherence to safety guidelines and procedures.
3. Coordinate training.
4. Liaison with flight-following services.
5. Develop and maintain aircraft hazard maps.
6. Act as a contact for aerial search and rescue operations.
7. Maintain equipment and control its use.

WEATHER:

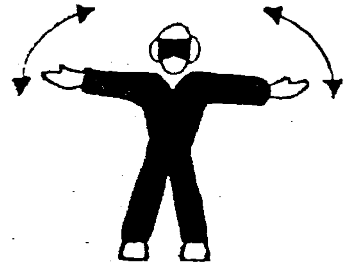
Obtain a weather briefing from the Federal Aviation Administration. Mountain and low-level flying require better weather than that designated by FAA for Visual Flight Rules (VFR).

Winds greatly increase the hazards of low-level and mountainous flights. Surface winds of 25 knots or greater should terminate the flight.

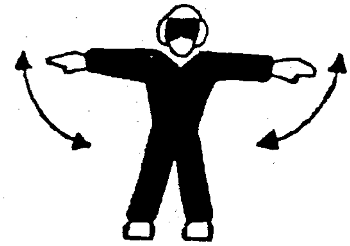
Helicopter Hand Signals



HOLD - HOVER:
Arms extended with fists clenched, thumbs down.



MOVE UPWARD:
Arms extended and sweeping upward repeatedly.

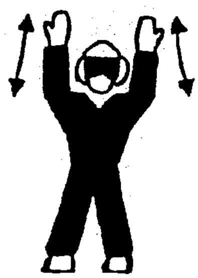


MOVE DOWNWARD:
Arms extended and sweeping downward repeatedly.

MOVE LEFT:
Right arm horizontal, left arm sweeps overhead.

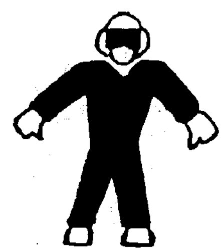
MOVE RIGHT:
Left Arm horizontal, right arm sweeps overhead.

MOVE TAIL ROTOR:
Rotate body with one arm extended.

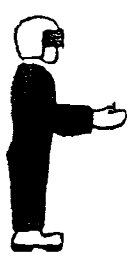


MOVE FORWARD:
Extend arms forward and wave helicopter towards you.

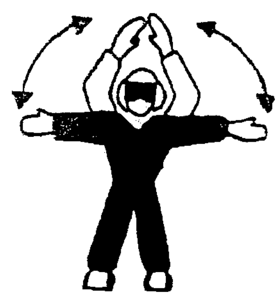
MOVE REARWARD:
Extend arms downward and to side and use shoving motion repeatedly.



HOLD ON GROUND:
Extend arms out at 45 degrees, thumbs pointing downward.



LAND HERE:
Extend arms toward landing area with wind at your back.



WAVE OFF=DO NOT LAND:
wave arms from horizontal to overhead repeatedly.

RELEASE SLING LOAD:
Contact left forearm with right hand.

PROCUREMENT OF AIRCRAFT SERVICES

Use the services of the U.S. Department of Interior, Office of Aircraft Services (OAS) to evaluate and certify aircraft service contractors. This program effectively increases safety standards when contracting aircraft services. The OAS, Coda Enterprises Inc., and state agencies who have used aircraft for net-gunning, hazing, drive netting, dart gunning, surveying, etc. have outlined the program. These procurement procedures are required by federal agencies and their employees. We recommend the program to non-federal agencies and private organizations.

This procurement procedure is superior to non-professionals attempting to evaluate an aircraft contractor and its pilots, aircraft, and maintenance program. It is most certainly superior to contracting with the lowest bidder, using price as the criterion for selection.

PROCUREMENT OF AIRCRAFT SERVICES: Helicopter or Fixed-wing Aircraft

1. Prospective aircraft service contractors are to be certified by the OAS before rental or charter contracts. This is an annual certification that includes the company, equipment, pilots, and maintenance practices.

2. All aircraft and pilots used must be carded by OAS to perform the flying requirement. The pilot shall upon request present his/her OAS pilot card that denotes certification for the planned use.

   A current Dept. of Interior aircraft data card (No. OAS-47 for general use or No. OAS-36 for special use) must be displayed in a conspicuous location in the aircraft.

3. The following categories are considered special-use activities by the OAS and have pilot and aircraft requirements exceeding those needed for general use:
   A. Flights with external loads.
   B. All flights less than 500 feet above ground level (AGL).
   C. Deep snow operations.
   D. Mountain flying.
   E. Mountainous terrain takeoffs and landings above 5,000 feet density altitude.
   F. Animal tagging and eradication.
   G. Net-gunning, dart gunning, drive netting.
   H. Aircraft operations requiring changes to the aircraft that invalidate the standard air worthiness certificate.

CERTIFICATION IS A POSITIVE STEP TOWARD SAFETY AND PERFORMANCE.

PERSONAL PROTECTIVE EQUIPMENT

Aviator's Protective Helmet: Helmet provides head, eye and hearing protection if fitted and worn properly. Motorcycle, football, rock climbing, and other non-aviation helmets are not acceptable. One of the best and most commonly used helmets, in a helicopter, is the SPH-4C helmet.

Fire-Retardant Clothing: Fire-retardant clothing greatly reduces the chances of receiving serious burns in the event of a fire---if it is worn correctly and fits properly. Clothing should fit loosely and it should cover all exposed skin- as much as possible. Sleeves should be long enough to reach first knuckle of the thumb, and should fit over the gloves worn. Wear with the collar up on shirt or jacket. Pants should be long enough to blouse when tightened over boot tops.
A Nomex flight suit is ideal protection. Do not use the short sleeved style. Use one that fits loosely over other clothing.
All clothing worn should be made of Nomex (or other fire retardant material), cotton, wool, or cotton/wool blends. Cotton, wool, and cotton-wool blends do not burn well. Avoid wearing synthetics since they promote burning.
All underclothes should be made of cotton, wool, or cotton/wool blends, or fire-retardant material.

Nomex information: Nomex I shrinks considerably when exposed to fire; Nomex II shrinks less; Nomex III shrinks the least. The hazard lies in the tendency of Nomex I and, to a lesser degree, Nomex II flight suits to pull apart at the elbows, knees, and other stress points when exposed to fire. Specify Nomex III when ordering.

Boots: Leather only. Boots should be high enough to cover ankles, and long enough for flight suit to hang over boot tops. Rubber boots, or boots made of nylon or other synthetics will burn or melt thus causing severe burns to the feet.

Gloves: Wear Nomex (or other fire retardant material), wool, cotton, or leather gloves during all flights.

Note: Protective clothing that has fuel and/or oil on it is no longer fire retardant. Keep clothing clean. Should your Nomex flight suit become drenched with fuel, take the suit off only while soaking in water. Static electricity created while removing the suit could start a fire.
MILITARY RECORDS SHOW THAT MANY DEATHS AND INJURIES ARE CAUSED BY IMPROPER WEARING OF THE PROTECTIVE CLOTHING PROVIDED. IT DOES NOT ALWAYS HAPPEN TO THE OTHER GUY.

TRAINING

CODA ENTERPRISES, INC., the designer, manufacturer, and distributor of the CODA NETGUN, CODA NET LAUNCHER and related equipment, offers you the opportunity to receive training in the effectual use of all equipment. Training is conducted, for a fee, by experienced personnel and includes "hands on" experience to provide a working knowledge of technique, safety, and maintenance.

Training insures proficiency in the use of the equipment and reduces your organization's costs in developing an effective and efficient capture team. The trial and error method of learning is expensive and hazardous: training pays.

Coda Enterprises, Inc. has pioneered the process for netting animals from helicopter in the United States. We have hundreds of hours of experience and have trained many individuals. Coda recommends that no one attempt capture from a helicopter unless that individual has received professional training.

CODA Enterprises Inc. conducts training on the clients premises and in the field: an actual capture project during training produces the most effective and complete learning experience.

We train as many people on your staff as you wish. Coda suggests, however, that a team of only two or three be trained and maintained. This practice helps maximize efficiency. We remain with your capture team until you feel they are adequately trained.

Please contact CODA ENTERPRISES INC. for additional information. We look forward to working with you.

CODA ENTERPRISES, INC.
1038 E. Norwood
Mesa, Arizona 85203
(480-964-0155)

Corrin (Corey) R. Gray President

Appendix 3. U.S. Department of Agriculture Wildlife Service Aviation Safety Manual

WILDLIFE SERVICES

AVIATION SAFETY MANUAL

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Appendix 4. Procedures for Attaching a Back-pack Transmitter

DENVER WILDLIFE RESEARCH CENTER
LAKEWOOD, COLORADO

Date Prepared: 04/22/90:cek

STANDARD OPERATING PROCEDURE

Title: A Teflon-ribbon body harness for back-pack transmitters on ravens.

I. Purpose: To describe the harness and its attachment to ravens for carrying back-pack transmitters.

II. Materials:

Harness: Two 18-in strands of 6.4 mm flat, non-elastic Teflon ribbon (Bally Ribbon Mills, Bally, PA).

Transmitters: Custom-built by the Electronics Unit, Section of Research Support, DWRC.

Ribbon closure clamp and pliers:
A 20 mm long by 9 mm wide J-shaped aluminum band and J-band pliers (Valentine Equipment Co., Hinsdale, IL)

Ribbon sealant:
Loctite Super Glue and Accelerator (Loctite Corp., Newington, CT).

III. Procedures:

This harness attachment is a modification of one described by Young and Engels (1988) and shown in Figures A-E from M. Kochert (1989, pers. comm.). The modification eliminates the box-stitch method of sowing the ends of the ribbons togther to close the harness (Figures D and E). The modification simplifies this process by using an aluminum band to crimp the ends of the ribbons together to close the harness once it is adjusted to fit. Loctite Super Glue is used to seal the ends of the ribbons after the excess has been removed. This attachment has been tested on a crow at the DWRC for at least 4 months and shows no signs of body abrasion where the ribbons go under the wings, nor does it appear to inhibit normal movements or activities of the test bird.

The base of each transmitter has two pairs of parallel slots through which the ribbons are threaded. Ribbons should be pulled through these slots to equal length and set in place with Loctite glue so the ribbons will not slip through the base, thus minimizing movement on the back of the bird.

To mount the transmitter, center it between the scapulae (Figure B) and hold in place with a finger of one hand. Thread the ribbons in front and behind each wing and bring them over the breast of the bird making sure the ribbons have no twists and lie against the skin under the feathers. Collect the loose ribbon ends together in a parallel bundle over the keel. At this point the bird may be inverted and held snuggly between the knees with the wings folded, exposing the ventral area. The J-band should be crimped loosely around the ribbon bundle with the J-band pliers. The transmitter position can be centered and adjusted by drawing each ribbon through the loose crimp until one index finger-width or about 1/2 in of space remains between the crimp and the keel of the bird. When satisfied the harness is in the proper position and the fit is appropriate, close the crimp with a vigorous squeeze of the pliers. Tug at each ribbon to ensure it does not move inside the crimp. If it does, tighten the crimp until no slippage occurs. To finish, cut the excess ribbon below the crimp and seal the ends at the crimp with copious amounts of Loctite and accelerator (to hasten the drying). This sealing process will also guard against future ribbon slippage in the crimp.

Right the bird and check the location of the transmitter and fit of the harness. If satisfactory, tune the telemetry receiver to the appropriate channel and record the fine-tune frequency and pulse rate. Place the bird on the ground for release.

If the initial check of the harness shows it to be too loose, crimp another J-band above the original to tighten the harness. If the harness is too tight and cannot be loosened, remove the entire device and start over with another harness. NEVER RELEASE AN INSTRUMENTED BIRD WITH AN IMPROPERLY FITTED HARNESS OR ONE THAT INHIBITS ITS MOVEMENTS.

Two individuals working together will expedite this procedure.

IV. References:

Young, L. S., and K. A. Engel. 1988. Implications of communal roosting by common ravens to operation and maintenance of Pacific Power and Light Company's Malin to Midpoint 500 kV transmission line. Environ. Serv. Dept., Pacific Power and Light Co., Portland, OR. 88 pp.

I have read this document and approve of its contents; I certify that it will be made available to all applicable personnel.

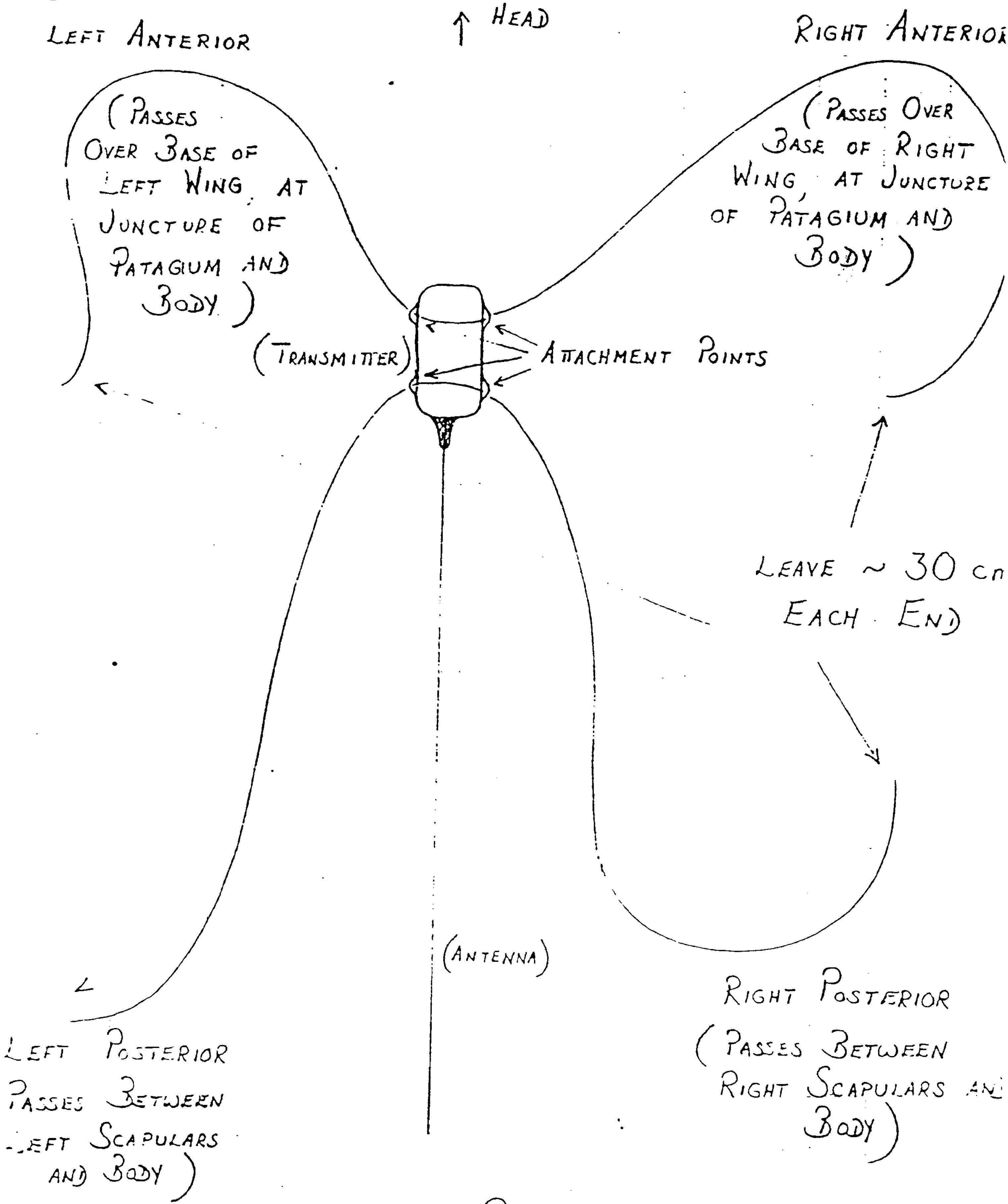
Kathleen A. Fagerstone
Section Chief

4/23/90
Date

M. Clay Mitchell
Quality Assurance Officer

4/23/90
Date

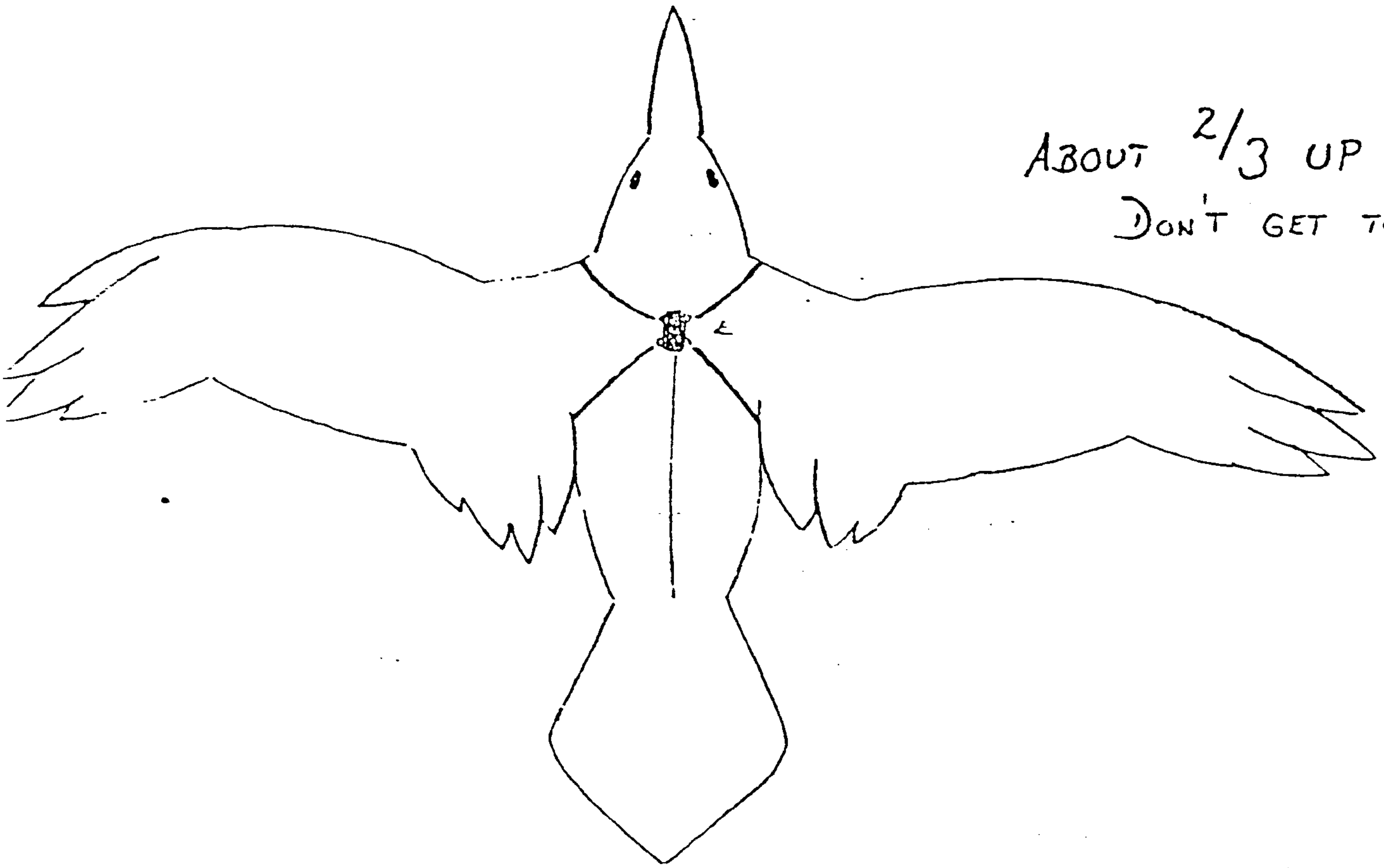
(A)



DORSAL PERSPECTIVE

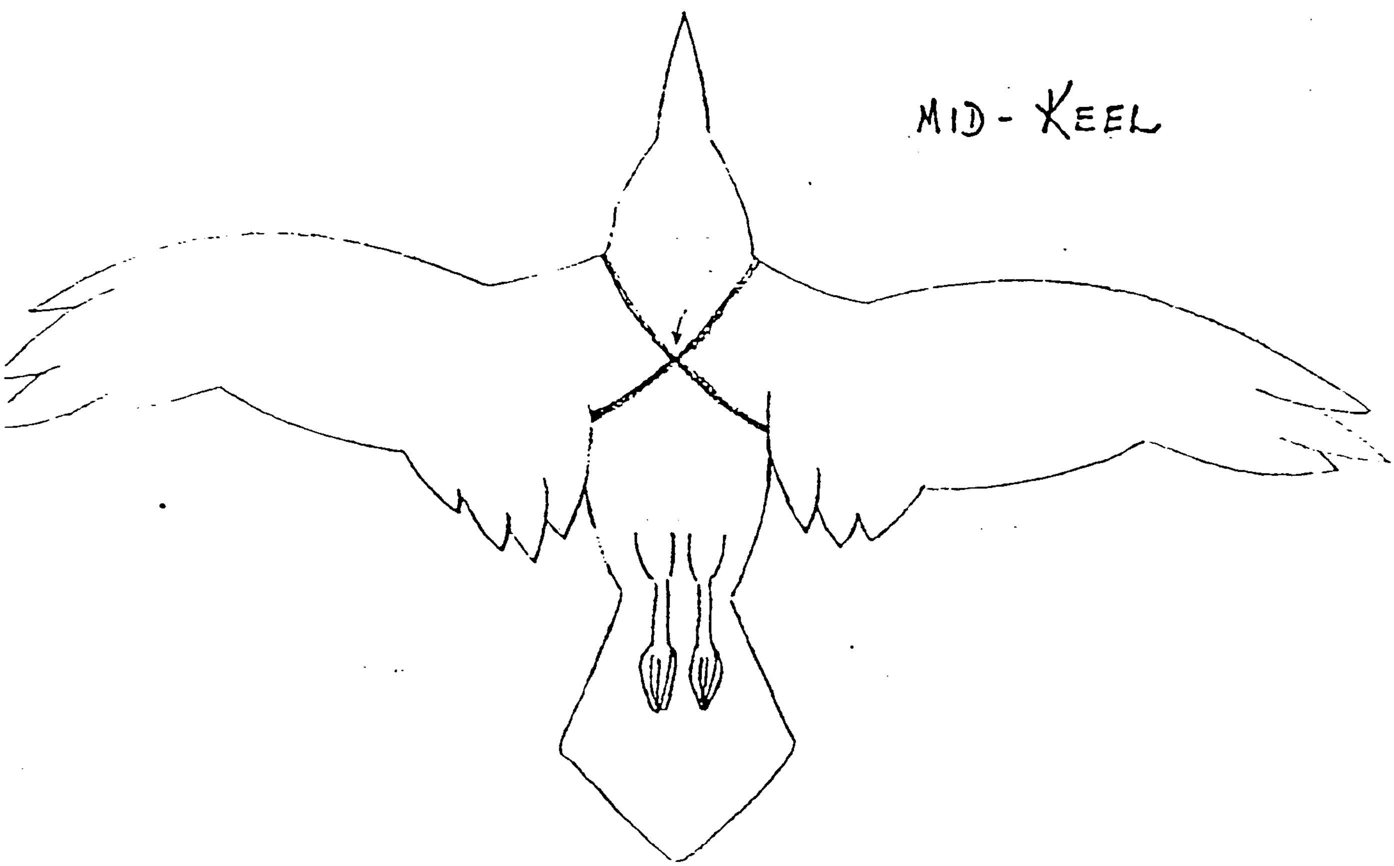
(3)

ABOUT 2/3 UP BAC
DON'T GET TOO HIC



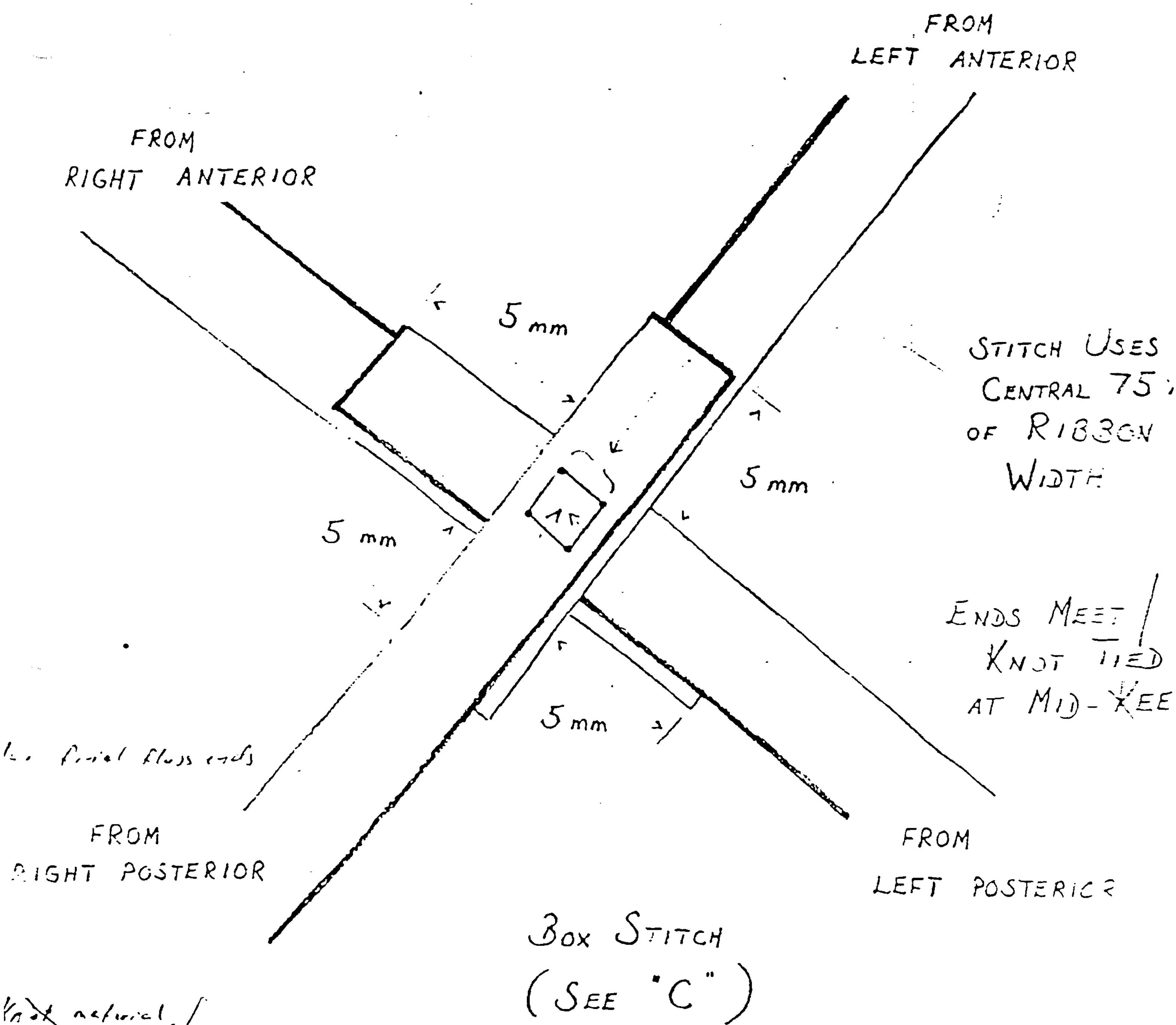
DORSAL PERSPECTIVE
(drawing of raven by Robert Bateman!)

(C)



VENTRAL PERSPECTIVE

(D)



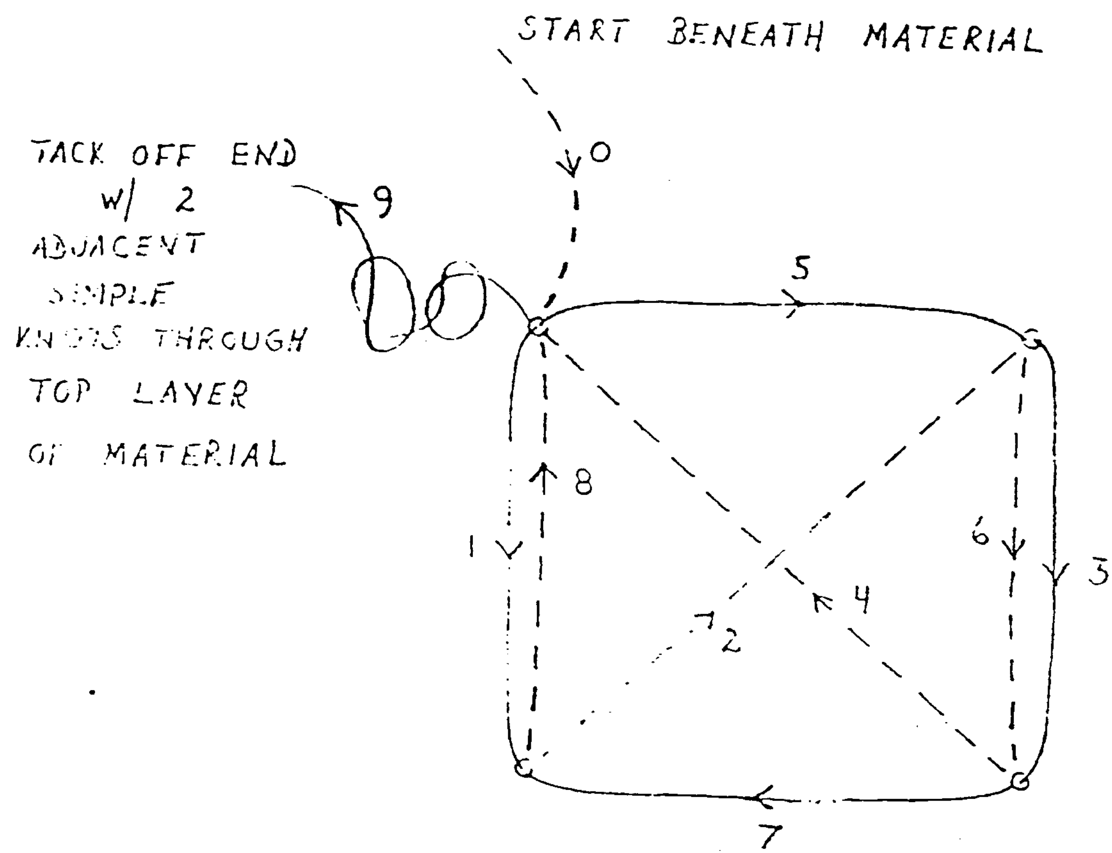
~~Knot natural.~~
~~- waxed dental floss~~
~~· Curved ... suture needle - diam. of dime~~
~~· held w/ hemostat~~
~~knot~~

VENTRAL PERSPECTIVE

length of ribbons about 18" ~~... (from ...)~~

space between keel & knot about 2 fingers widths - loose better than tight

BOX STITCH



—— SOLID LINE ABOVE

- - - DASHED LINE BENEATH

Appendix 5. Procedures for Conducting Radio-telemetry

USDA/APHIS/ADC

Denver Wildlife Research Center

Predator Studies Branch

Denver, Colorado

Date prepared: 08/07/87 ffk & lcs WRC-24

STANDARD OPERATING PROCEDURE

Locating radio transmitters using hand-held, fixed-station, and aircraft-mounted receiving equipment

---

Antenna-receiver hook-up and receiver tuning:

The following steps are the general procedure to follow for receiver and antenna use in hand-held, fixed station, and aircraft location of wildlife radio transmitters.

1. Start by attaching the terminal on the end of the antenna lead (coaxial cable) to the antenna input receptacle on the receiver (modified somewhat in aircraft applications, see appropriate section). In doing so, do not place any sharp kinks or heavy strains on the coaxial cable where it exits from the terminal connector. Lock the connector in place with an appropriate twist of the locking collar.

2. Decide whether you wish to use the speaker in the receiver or a headset. If you choose the latter, insert the plug (jack) on the end of the headset leads into the proper receptacle on the receiver panel. The primary advantage in using a headset is to reduce interference from the noises around you. When you start listening for very faint sounds, noises associated with wind blowing in your ears, chirps of birds, insect songs and a multitude of other environmental sources cause distractions and confusion. The large, soft ear cups on headsets can very effectively reduce interference from such sources.

3. Turn on the power switch, activating the receiver. If the gain (volume control) is separate from the power switch, make certain the gain control adjustment is at a very low level to avoid hurting or damaging your ears.

4. Check the battery voltage to insure there is enough power to operate the receiver effectively.

5. Gradually advance the gain control until the "hissing" of the receiver (background noise) is audible, but not uncomfortable. Operating the receiver with the noise level too high (called over-driving the receiver) becomes obnoxious and uncomfortable and seldom improves the ability to discriminate weak signals.

6. Select the frequency range (channel) to be checked.

7. Rotate the fine tune adjustment very slowly while listening intently to the receiver output (presumably the antenna is in position). The pulsed signal from the transmitter will sound like a rhythmical beat, or beep superimposed on the hissing noise of the receiver. Move the fine tune adjustment back and forth slowly until a pitch or sound is heard that is comfortable and easy to listen to. Most receivers use two or three step-down stages to convert the incoming radio frequency to a much lower intermediate frequency. A beat frequency oscillator (BFO) is then used to convert the intermediate frequency to a frequency that is audible to human ears. This is done by comparing the intermediate frequency with a variable, but closely allied, frequency that is manipulated by the fine tune adjustment. The difference between the two frequencies is the sound that is heard. As a result, when the two frequencies are far apart, the difference is great and a very high pitch results. As the receiver is "tuned," the two frequencies become closer, the difference is less and the pitch decreases. When tuned directly on the frequency of the transmitter, there is no difference in the two frequencies and no "tone" is produced. As the BFO is adjusted beyond the frequency of the transmitter, the difference in the two frequencies becomes greater

again and the pitch increases until it vanishes in the realm beyond the detection of human hearing (Fig. 1). Some commercial receivers use an asymmetrical tuning process for the BFO which tends to blank out the signal on one side, resulting in the pitch change being much stronger on one side of the signal than the other.

8. After having completed the task with that channel, repeat steps 6 and 7 with other channels of interest.

9. When trying to approach a transmitter, the volume of the receiver output will increase as you get closer. If the receiver reaches the limits of its ability to respond, directional sensitivity of the antenna may be lost. This can be avoided by slowly turning the gain control counterclockwise to decrease the amplification the receiver is providing. Inexperienced personnel have a tendency to operate receivers at higher gain levels than needed and may be less effective than they could be.

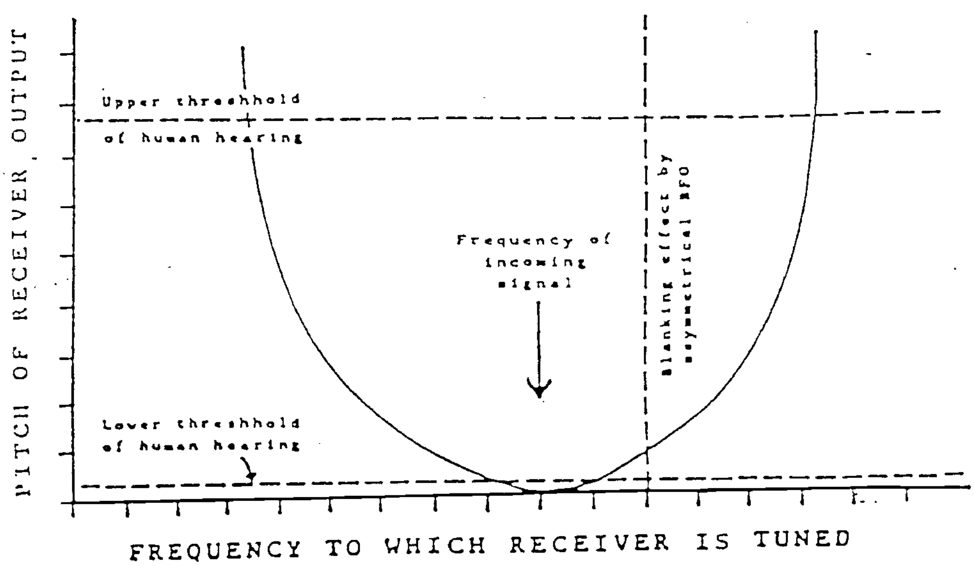


Fig. 1. Diagrammatic explanation for the change in pitch of a receiver output signal associated with adjustment of the fine tune knob (beat frequency oscillator).

10. After completing your work, turn the receiver power switch off and carefully disconnect earphones, antenna lead, etc., and store equipment properly.

One point that deserves additional comment is that on most commercially available receivers the range of the fine tune adjustment is greater than the separation of frequencies on the channel selector. As a result, if a transmitter is operating mid-way between two channels on the receiver, the same signals may be tuned on the high end of the fine tune adjustment on one channel and on the low end of the fine tune range on the next higher channel (see Fig. 2). This can be misleading even to experienced personnel if not kept in mind.

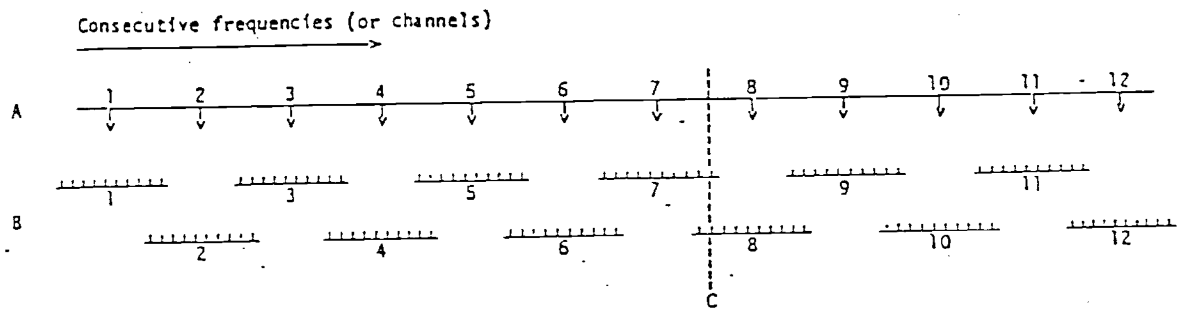


Fig. 2. Diagram of the functional relationship between frequency (channel) selector and fine tune adjustment in most commercial telemetry receivers. (A) Frequency, or channel selector, chooses one of a series of frequency ranges. (B) Fine tune adjustment shifts frequency tuning across a narrow range of frequencies in the immediate vicinity of the channel selected in A. (C) Usually the fine tuning range is greater than the separation between adjacent channels, sometimes causing confusion because a transmitter broadcasting midway beween channels (e.g. channels 7 and 8) can be tuned in on the high end of the fine tune range of one channel and on the low end of the fine tune range of the next higher channel.

Locating transmitters using hand-held equipment

Hand-held antennas:

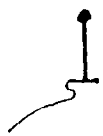
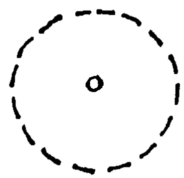
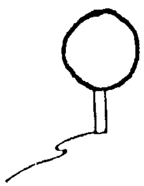
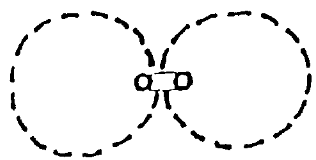
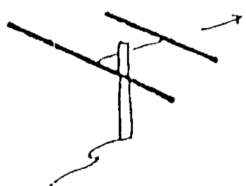
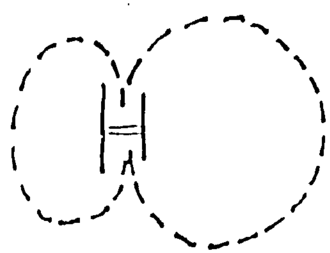
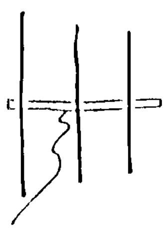
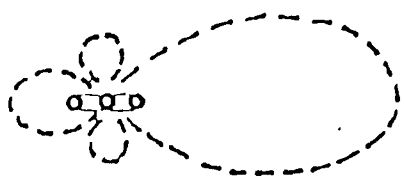
These are so-named because they are small enough to allow one person to use them as they are carried about. Four of the most commonly used types are depicted in Table 1. Each has advantages and disadvantages, and, depending on the circumstances, there are times and places where each might be the one of choice. Even using a metal paper clip as a tiny whip antenna may be preferred in some situations. Anything will work a little. It is helpful to constantly ask which specific antenna configuration might be most appropriate for the particular appplication involved.

A whip antenna is a single straight length of rod or spring steel that has been appropriately tuned and seldom useful for locating transmitters since it is equally sensitive in all directions. This type of antenna is useful in situations where transmitter location is not important but maintaining radio contact for monitoring purposes, such as determining activity periods or physiologic functions, is the primary objective. This type of antenna would not need attention (e.g., rotation) as long as it is sensitive enough to cover the area in which the animal is apt to roam.

Loop antennas are extremely handy because of their small size and directional properties. These advantages are offset by the fact they are seldom as sensitive as some other types of antennas and the pattern of sensitivity is ambiguous. The plane of the transmitter can be established, but from one location you cannot tell whether the signal is coming from in front or behind. Incidently, either the peak or the null (the antenna facets from which no signal is received) can be used to indicate the direction from which the signal is coming. The fastest and surest way to resolve the directional ambiguity is to move perpendicular to the plane established at the first location and establish a second plane from another location. Mentally extrapolating the intersection of the two planes will provide the direction to proceed to approach the source of the signal as well as some idea how far away it might be.

Yagi antennas are perhaps the most commonly used hand-held antennas. Since the "H" antenna is the first step in development of a yagi, these two antennas will be discussed together. As previously mentioned, a whip antenna is

Table 1. Comparison of characteristics of several types of hand-held antennas.

Antenna type	Physical configuration	Pattern of sensitivity (viewed from above)	Comments
Whip			Omni-directional. Convenient for monitoring where identification of direction to source is not important. If used for locating transmitters, must depend on relative signal strength to indicate relative proximity.
Loop			Signal pattern has two peaks and two nulls. Operator must resolve ambiguity to determine direction to signal source. Very convenient to use in confined situations or dense brush (e.g. bamboo thicket) but may be less sensitive than other antenna types.
"H"			Pattern has an obvious front and back lobe but does not provide a strong, narrow peak in the pattern. Relatively convenient to to carry and use, and is generally more sensitive than a loop antenna.
Yagi (3-element)			Pattern is very directional with a strong, and relatively narrow peak sensitivity. Should not confuse back and side lobes with front lobe of pattern. Has more sensitivity in forward direction than most other types of antennas. Probably the antenna of choice in open or semi-open terrain and at frequencies above 140 MHz.

omnidirectional, essentially having equal sensitivity in all directions. If another metal rod, or element, is placed in close proximity to such a whip, the electromagnetic waves are influenced and the pattern of sensitivity starts to be shaped, making the antenna more sensitive on the side opposite the added element. Such an element added behind the driven element is called a reflector. This essentially is the configuration of an "H" antenna. Needless to say, length and spacing of the extra element are important. The increased sensitivity, or gain, of such an antenna generally makes it more desirable as a direction-finding instrument. The lack of ambiguity permits directing your attention immediately in the direction of the transmitted signal.

If the addition of one element increases the sensitivity in one direction, what about adding more than one extra element? This essentially constitutes a yagi antenna. Any number of additional elements can be added (in a straight line); the more elements that are added, the more the pattern of sensitivity is shaped and the more directional the antenna. One point to remember is that after the addition of one reflector, all other elements are added in front of the driven element (even if they number 10 or more). Elements placed in front of the driven element of a yagi antenna are called directors. Every time the number of elements on an antenna is doubled, the sensitivity increases about 3 db (decibels) in the forward direction. This increased sensitivity toward the front comes at the expense of sensitivity to the sides and back. Remember, there are side lobes and a back lobe in the sensivity pattern of a yagi antenna, but they are much smaller than the forward lobe. This becomes quite important in fixed-station direction-finding work because frequently the antenna can not be seen (the operator can not tell in which direction the antenna is pointed) and there is no automatic correction should an error occur. Most yagi antennas used as hand-held devices have three or four elements. Additional elements become cumbersome and difficult to handle in the field. Even so, yagis can be quite unmanageable when working in brush or dense forest situations because the antenna is relatively large and elements frequently get caught on twigs and limbs. Normally there is a preference to use yagi antennas with the elements directed vertically because theoretically there is less attenuation (weakening) of the vertically polarized portion of the signal. There are occasions, however, when placing the elements horizontally works better. Experimenting may be the best way to resolve the situation.

Use of hand-held equipment:

When trying to locate transmitters in the field with hand-held antennas, the following procedures are recommended:

1. Seek a hilltop or other topographical prominence in the vicinity where the transmitter is expected to be. This may be in the vicinity where it was located previously or where it might be expected to be for other reasons. To the extent practical, try to stay in the open, as opposed to heavily forested hills, to minimize problems with signal "bounce" or penetration through foliage.

2. Follow steps 1-6 under antenna-receiver hookup and receiver tuning.

3. Hold the antenna aloft in one position and slowly rotate the fine-tune adjustment through the range of frequencies. If a signal is heard, immediately try to obtain the clearest signal possible through adjustment of the fine-tune knob without moving the antenna. Make a mental note of the fine-tune setting in case you lose the signal. Skip to step 6 (below).

4. If no signal is detected, rotate your body about 45 degrees so that the antenna is pointed in a new direction and repeat step 3. Continue this process until a signal is detected or the terrain commanded from that location has been covered.

5. If no signal is detected from that point, either wait 15-30 minutes and try again, hoping the animal has become active or moved within receiving range, or seek another topographically desirable location from which to search and repeat steps 2 and 3. If a signal is detected, proceed to step 6.

6. Slowly rotate your body to swing the antenna through a complete circle. Note the positions of maximum and minimum signal strength to determine the direction or plane (depending on antenna type) in which the signal is originating. Rotating your body is preferable to swinging the antenna because with any hand-held antenna you are part of the antenna and your body is influencing the antenna pattern. Consequently, try to keep your

relationship with the rest of the antenna as constant as practical.

7. Experience will help develop the ability to estimate how far away the transmitter is, based on the strength of the signal received. Consideration must be given to the relative strength of the transmitter, the amount of gain provided by the receiver (gain control setting plus battery voltage), the degree of topographic prominence, (especially elevation) associated with the specific monitoring location, physiographic features of the area where the transmitter might be (e.g., level plain, ridges and draws, hillside facing you, etc.), and perhaps other criteria.

8. Decide whether to approach the transmitter directly or obtain more information first. The decision may be influenced by how far away you think the transmitter is, whether it might be possible to get closer more easily by some other route, and whether you wish to approach the transmitter without being detected by the animal to which it is attached (e.g., if you wish to locate it to make behavioral observations).

9. If an indirect route is chosen, identify another prominent topographic feature from which to gain additional information by repeating the process described above. It is particularly helpful if a location not in a direct line with the transmitter and the initial point from which the signal was identified.

10. Gradually reduce the volume of the receiver output when approaching the transmitter if the direct approach is chosen. This will permit use of the most sensitive part of the antenna pattern and more closely identify the direction of the signal. Keep in mind that in descending from a hilltop, you may move out of line-of-sight reception, resulting in diminution of the signal (sometimes even resulting in loss of contact with the transmitter). This may not mean you are going in the wrong direction but rather that you are moving into a less favorable receiving situation. This is particularly common when working with a faint signal.

11. When getting very close to a transmitter, the regular antenna may become too sensitive and the signal may over-load the receiver even at the lowest gain settings. Loss of directionality of the antenna may occur under such conditions. One solution is to switch to a less sensitive antenna for more precise location of a transmitter that isn't readily evident. For example, one technique, used particularly when the transmitter is buried, is to unhook the regular antenna and insert a short piece of wire (e.g. a straightened metallic paper clip) into the "hot" lead portion of the antenna receptacle on the receiver. This creates a poorly tuned whip. Holding the receiver at arm's length and letting your body serve as a reflector essentially creates a directional antenna suitable for very close work. Another option useful in very dense brush or submerged habitats is to strip 1 to 2 inches of braid from the end of a piece of coaxial cable (which has an appropriate terminal on the other end to plug into the antenna receptacle of the receiver) and tape the coaxial cable along some kind of non-conducting stick. This creates a relatively insensitive whip antenna which can be used as a probe to pass into and around bushes or even under water. Relative signal strength can be used to discern whether the antenna (probe) is moving toward or away from the singal source, which will permit locating the transmitter.

Keep an open mind when using hand-held antennas and constantly be aware of the variety of explanations that could account for the electronic events you experience.

Locating transmitters with fixed station equipment

Fixed-station Antennas:

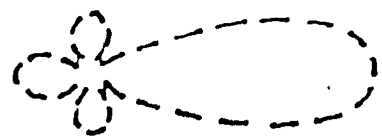
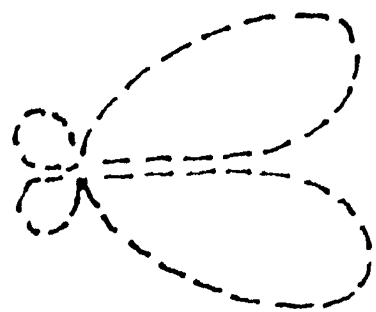
When it is desirable to intensively study the ways animals use space, or constant surveillence is desired, there are tremendous advantages in using fixed-station telemetry techniques. In general, these techniques use more sophisticated antenna technology to simultaneously determine the azimuth, or bearing, to a transmitter from two or more locations. Knowing the precise location of each receiving antenna and the direction (bearing) from which the radio signal was received at each antenna, it is possible to calculate and plot the location of the transmitter through use of trigonometric functions. The advantage of such techniques is that frequent relocations of one to many animals can be made without risk of disturbing the animals. The bigger antenna systems provide greater sensitivity and greater precision in estimating the direction from which the radio-signal originates.

Fixed stations are typically located on prominent hills or ridges and consist of larger, rotatable yagi antennas perched atop a tower or pole. The normal configuration is to use two yagis side-by-side (this is called horizontal stacking) and coupled together. There are several ways of coupling the antennas but the most dependable is to use a device called a "hybrid junction" or "hybrid tee." The antennas can be coupled in-phase, so that the signals arriving at each antenna reinforce each other and the two antennas work together to provide a slightly stronger signal. In this mode the pattern of sensitivity is similar to that of a single yagi (Table 2) except the pattern is shaped more and, because there are twice as many elements, the antenna provides 3 db more gain.

On the other hand, the antennas can be coupled out-of-phase, in which case the strength of the signal to the receiver represents the difference between what is sensed by the two antennas. A signal that originates equidistant from each antenna will be sensed equally and, since there is no difference, no signal is sent to the receiver. However, as the source moves away from being equidistant, the signals arrive at the two antennas at slightly different times which effectively shifts the signals received by the two antennas out-of-phase and the difference between the signals detected by the two antennas is transferred along the coaxial cable in the form of an electric current. If the signal is far enough toward one side, radio waves arriving simultaneously at the two antennas are completely out-of-phase resulting in a big difference between what the two antennas sense and a maximum signal is detected by the reciever (Table 2). The sharp null (lack of signal) between the two major lobes of the pattern can be measured quite accurately. Antennas coupled in this manner create one of the more powerful tools for studying movement patterns of wild animals.

Collection of high quality data depends on maintaining accuracy and precision in estimating the location of the transmitter. This means reducing the effects of systematic

Table 2. Comparison of characteristics of horizontally stacked yagi antennas coupled in-phase and out-of-phase.

Coupling mode	Pattern of sensitivity	Remarks
In-phase (sum mode)		Two antennas work together to provide a single large front lobe with 3 db more gain. There is relatively little improvement in the directivity.
Out-of-phase (difference mode)		The signal produced is related to the difference in the phase of the signal sensed by the two antennas. If the signal arrives simultaneously, there is no difference in the signals and a null (no signal) is produced. This occurs when the source is equidistant to the two antennas (e.g. directly ahead or behind). There are two large front lobes and two or more back lobes. Sensitivity between the two front lobes falls off very sharply permitting a very precise estimate of the bearing.

and random errors in the triangulation process as much as possible. Careful attention to the following can help: (1) location of monitoring stations (antenna towers) in relation to the area under surveillence; (2) proper selection and mounting of antennas as well as maintaining the proper orientation of them; (3) use of the most appropriate azimuth read-out mechanism; and (4) maintaining synchrony in readings from two or more locations.

There are two ideas to keep in mind when selecting locations for fixed station telemetry work. One is related to the average distance the tracking stations are from the instrumented animals and the other relates to the position of the stations relative to the animals. Both affect the accuracy and precision with which the locations of the transmitter-equipped animals can be determined. In the first instance, an error of one degree in azimuth from a tower equates to a lateral displacement of 15 meters at a distance of one kilometer; at a distance of 5 kilometers the same error would result in a lateral displacement of about 75 meters. The farther away a tower is, the greater the displacement associated with each degree of error. If you expect your study animals to utilize a large area, you will want the towers farther away than if you only expect them to use a small area. At the same time you have to recognize that there will be increasing loss of precision as the stations are set progressively farther apart. If you set the stations too far from animals that use only a very small area, you may not be able to detect any movement at all.

The second aspect with regard to precision results from differences in the amount of error associated with the position of the transmitter relative to the stations. The estimated location of the instrumented animal is derived from extending the azimuths obtained from each tower until they intersect. The most precise estimates are those in which the two azimuths are perpendicular at the point of intersection. These points correspond to the circumference of a circle whose diameter is the baseline between the two towers (Fig. 3). At the same time, errors associated with azimuths intersecting at angles less than 20 degreees or greater than 160 degrees become so large that the estimates become unreliable and meaningless. The practical application of this is to recognize that there is an area adjacent to the baseline (a line extended through the towers) which will provide very poor data, at best. Hence, given the choice, it is best to keep the baseline removed from the primary area the study animals may be using.

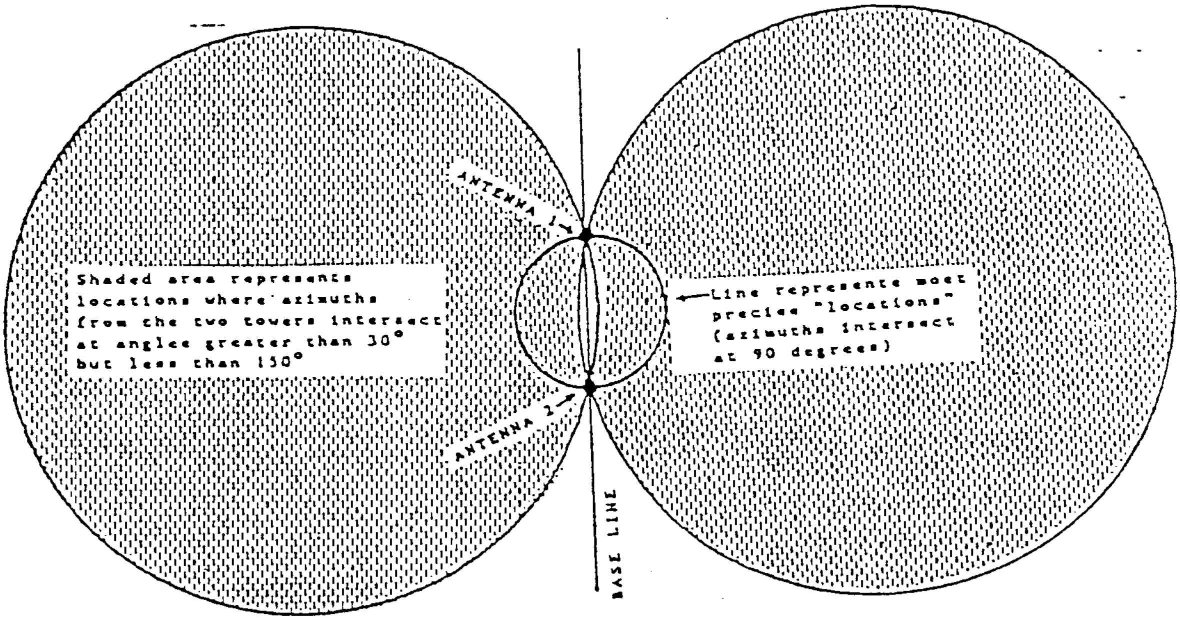


Fig. 3. Areas of good (shaded) and poor (clear) precision associated with triangulation from two locations.

In selecting yagi antennas to be used in a pair, select ones with as closely matched electrical properties (sensitivity) as possible. This should be determined by someone who is knowledgeable in antenna tuning procedures. Since the relative phase of the wave of incoming signals sensed by each antenna and transferred to the hybrid junction is critical (and distance equates with shifts in phase), it is essential that the coaxial cables connecting each antenna to the hybrid junction are the same length. The two antennas should be mounted parallel and spaced 3/4 of a wave length apart (actual dimensions will depend on the frequency involved). It is also preferable for the antenna array (the entire device at the top of the mast) to be balanced both physically and with regard to wind-loading to ease problems in turning the mast and holding it steady.

A precise mechanism to determine the direction the antenna is pointed is essential. This usually involves some sort of compass rose (a circular ring with 360 degree markings on it) and a pointer. Preferably, the rose should be attached to the antenna mást, so that it rotates with the mast, and the pointer should be stationary. This allows the operator

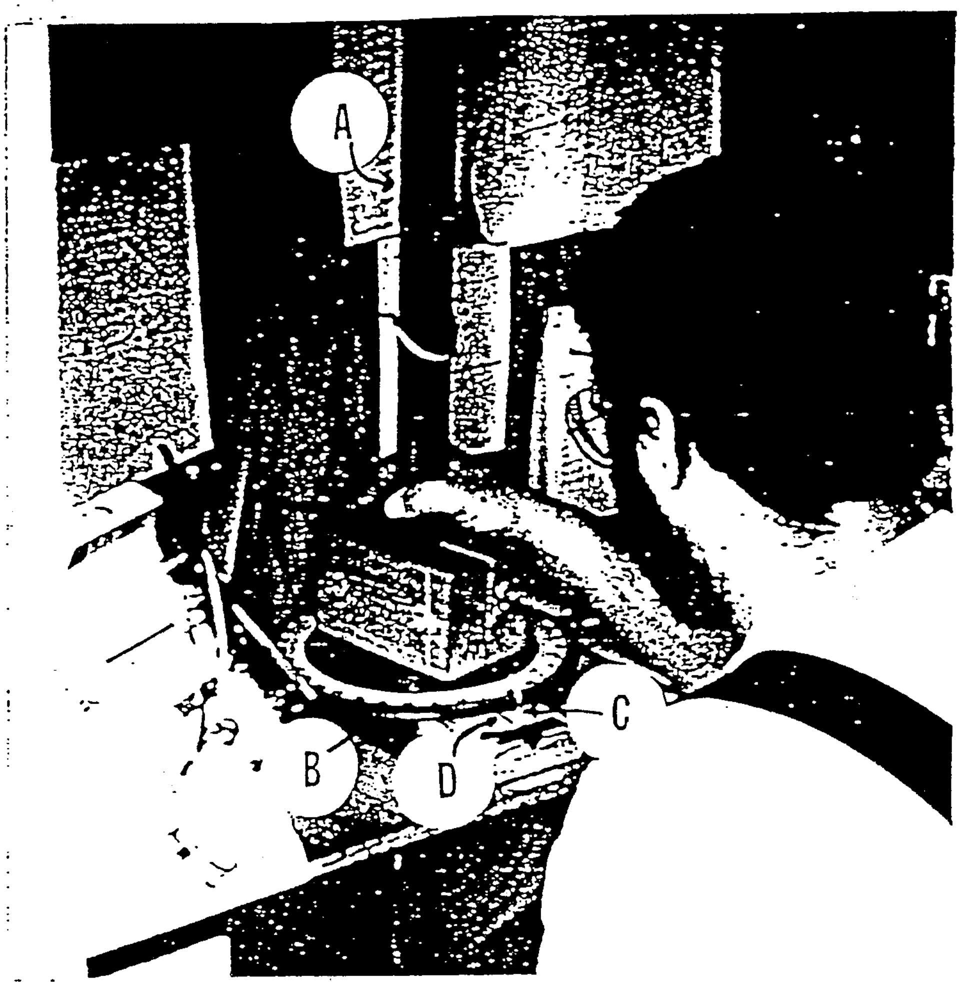


Fig. 4. Azimuth readout mechanism with the following parts identified: antenna mast (A); compass rose attached to mast (B); stationary pointer (C); and alignment mark to insure a common sighting plane for all readings (D).

to keep his eyes in the same relative position to the pointer and the rose, thus avoiding parallax problems caused by the rose and pointer being in different planes (Fig. 4).

Without correctly establishing and maintaining the orientation of the antenna system, the data collected may be of little value. Many people erroneously assume that the electrical pattern of an antenna, or antenna system, is aligned with the physical structure. To the contrary, it is not unusual for the electrical pattern to be skewed several degrees to the left or right of the physical pattern of the antenna. The best procedure for maintaining antenna orientation is to use a beacon transmitter as an electronic reference from which bearings are measured. The precise location of each antenna tower, as well as the location of the reference transmitter, should be established with a surveyor's transit (don't forget to also survey some known or measured distance to establish a scale for the map to be developed). This will provide a known azimuth (compass bearing) from each antenna tower to the reference transmitter. The position of the rose at each tower can then be adjusted so that when the reference signal is centered in the null of the antenna pattern, the correct compass azimuth is indicated. Thereafter, azimuths to the animal-mounted transmitters can be read directly. An alternative procedure does not require adjusting each rose but includes reading the azimuth to the reference transmitter just like all the other transmitters of interest. Subsequently all azimuths need to be recalculated based on a knowledge of the correct azimuth to the reference transmitter and the difference between azimuths to the reference and the animal-mounted transmitters. Such computations can become laborious and subject to error unless computer facilities are available. Even if the compass rose is adjusted to read correctly, the bearing to the reference transmitter should be checked at least once each hour of use to insure that the system is properly aligned.

The final source of error discussed here involves failure to obtain azimuths from each station at the same time. If an animal with a transmitter moves between the time the two azimuths are taken, appreciable errors can result, especially if the animal is relatively close to one of the stations. There are several means of maintaining synchrony in taking readings. The most convenient is to have two-way radio communcation between the two stations. Perhaps the simplest technique, however, is for the operators of the two stations to agree upon (1) a sequence for making readings and (2) a time schedule to be maintained throughout the monitoring period. This amounts to planning ahead and adhering to the plan.

Use of fixed-station equipment:

After (1) the receiving stations have been properly situated, (2) antennas are properly matched, mounted, coupled out-of-phase, and oriented with regard to a reference transmitter, (3) an accurate and trouble-free read-out mechanism is employed, and (4) a schedule has been agreed upon to synchronize data taking, it is essential to use a standard procedure for making readings. The recommended procedure is:

1. Connect the coaxial cable coming from the hybrid junction to the antenna receptacle on the receiver.

2. Orient the antenna so that the front of it is pointed in the general direction of the reference transmitter. It is best not to point it directly at the reference transmitter because that would place it in the null portion of the pattern.

3. Tune the receiver to the frequency of the beacon transmitter.

4. Reduce the receiver gain until the signal is of soft to moderate amplitude.

5. Rotate antenna 360 degrees to make certain you are working with the null between the two main lobes of the antenna pattern. Be aware that the coaxial cable may be wrapping around the antenna mast.

6. Very slowly rotate the antenna from one of the main lobes toward the frontal null. Note the exact reading (azimuth) where the signal can no longer be detected. Record that reading.

7. Without changing any settings on the radio receiver, rotate the antenna until the signal can be heard on the opposite side of the null.

8. Very slowly rotate the antenna in the opposite direction (back toward the null) and again note the exact reading where the signal can no longer be detected. Record that reading also. That completes the readings on the reference transmitter for that time. Always move from a good signal toward the null and read each side of the null. Do not use the point where the signal is reacquired because the human mind functions differently between losing and recognizing sounds. Ultimately the average (mean) of the two readings, one from each side of the null, will be calculated and used as the azimuth to the transmitter.

9. Search for other transmitters of interest using techniques outlined in steps 2-4 under hand-held antennas. When a signal is detected, repeat steps 5-8 above to determine the azimuth to that transmitter.

10. CAUTION! Do not leave your radio receiver connected to the coaxial cable coming from the antenna during an electrical storm. A direct hit from a lightning bolt on the antenna could destroy your receiver or may disable it simply by exposure to intense electrical fields even though an electrical discharge does not occur. For your own safety, move off the top of the hill to a safer location.

Locating transmitters using aircraft:

Aircraft antenna systems:

Occasionally radio-instrumented animals may move out of range of conventional ground-based receiving systems, and it is desirable to rapidly search extensive areas to locate the missing animal(s). In other instances, studies may only require sporadic checks of animals over rather extensive areas. In such cases, mounting receiving equipment on aircraft may be an expedient means of accomplishing the objectives because aircraft usually (1) provide a higher platform from which to search, with an attendant improvement in receiving capability, and (2) can rapidly cover extensive distances which might otherwise require hours or even days to cover with ground-based systems.

The manner in which the equipment is oriented and attached to the aircraft can substantially affect the effectiveness and efficiency with which transmitters can be detected and located. Theoretical considerations suggest that the primary concern should be to direct the most sensitive portion of the antenna pattern lateral to the flight of the aircraft so that as broad an area as possible can be covered as the flight proceeds. Normally it is not essential to have a strong antenna pattern in the direction the plane is going because eventually the plane will get there.

The most commonly used procedure is to attach a yagi antenna to each strut on a high-winged aircraft. The antennas are directed perpendicular to the fuselage with the front of the

7. Without changing receiver settings, switch back and forth between the two antennas. Tell the pilot to turn the aircraft in the direction of the antenna providing the loudest signal. The signal from that antenna should gradually diminish and the signal from the other antenna should increase. Continue doing this until the two signals are equal, the aircraft should be headed directly toward the transmitter. As the plane flies toward the transmitter, the signal should get progressively stronger (if the signal gradually becomes weaker, or even disappears, the plane may be moving away from the transmitter). Two cautionary notes: (1) don't compare signal strength from the two antennas while the airplane is banking; and (2) if working with a weak signal, the signal may be lost altogether when the plane turns because a less sensitive portion of the antenna pattern is pointed at the transmitter. If this happens, keep flying in the same direction and listening alternately to each antenna. Eventually the signal will be reacquired.

8. Reduce the gain level as the plane approaches the transmitter. When the plane passes directly over the transmitter, the signal will over-load the receiver even at the lowest gain settings and a very loud clapping sound will be heard instead of a beep.

9. If a more precise location is desired, have the pilot reduce altitude to 200-500 feet above terrain and approach the transmitter a second time, preferably from a different direction.

10. Resume search pattern for other transmitters of interest.

Aerial searching can be a very effective and efficient means of locating transmitters spread over extensive areas or ones that have moved beyond the capabilities of normal ground-based receiving equipment. Several cautionary comments: (1) attach all equipment securely to the aircraft without risk of damaging the plane; (2) the pilot has authority over what will or will not be done while the aircraft is in the air; (3) wind-drag from antennas can reduce air-speed and change flight characteristics of aircraft; (4) don't attempt aerial telemetry activities when flying conditions are marginal; and (5) proper planning can increase efficiency and minimize costs of aircraft rental.

Appendix 6. Standard Operating Procedures for Field Determination of White Phosphorous Mortality in Waterfowl at Eagle River Flats, Alaska.

National Wildlife Research Center

Standard Operating Procedure

Title: Field Determination of White Phosphorus Mortality in Waterfowl at Eagle River Flats, Alaska	Number: FP 004.00 Effective date: 8/15/99
	Replaces: n/a
Prepared by: Darryl York [signature] Date: 5/16/99	QAU: [signature] 08/09/99

1.0 PURPOSE

1.1 To provide guidelines for field personnel on the evaluation of white phosphorus (WP) mortality in waterfowl at Eagle River Flats (ERF), Fort Richardson, Alaska.

2.0 EQUIPMENT / MATERIALS / SUPPLIES NEEDED:

2.1 Notecards, 4×5 in.

2.2 Plastic bags

2.2.1 For duck Carcasses, 1-2 gallon (mallards generally require the larger size).

2.2.2 For notecards, sandwich size.

2.2.3 For large waterfowl (larger than mallards), trash can size (50 gal).

2.3 Sharpies or similar waterproof pens.

2.4 Geographic Positioning System (GPS) unit [Garmin GPSII or similar type (within 50 ft. accuracy)] or an accurate, detailed description that can be located on a map of ERF.

2.5 Additional equipment needed to locate radio-equipped ducks:

2.5.1 Telemetry receiver [such as ATS model R4000].

2.5.2 Yagi antenna with coaxial cable.

2.5.3 Headphones (required when working from helicopter and hovercraft)

3.0 TYPES OF SPECIMENS COLLECTED

3.1 All dead animals located in contaminated areas of ERF may be collected and analyzed for WP poisoning. The species primarily susceptible to WP poisoning are: mallards, northern pintails, green-winged teal, and swans (tundra and trumpeter). If an unusual carcass (i.e. bald eagle, dowitcher, mammal, etc.) is encountered or circumstances surrounding a carcass (i.e. several dead animals in one location known to be contaminated, etc.) are found, all such specimens may be picked up and analyzed for WP.

3.1.1 Waterfowl that are not being monitored by radio-telemetry have no history; therefore, these can only be determined as WP mortalities by analysis of gizzard contents and by other pertinent field observations.

3.1.2 Radio-equipped waterfowl which are stationary (remain within 10° of their location for 2-3 days or upon activation of the mortality mode of the transmitter) will be visually located to determine their status. These waterfowl/radios can be in several dispositions or functional states when located and analysis of the gizzard and best available data can be used to determine if they are WP mortalities.

3.1.2.1 A whole intact carcass (with gizzard) is located. These carcasses are analyzed in the laboratory for WP in the gizzard. If WP is found, it is considered a WP mortality. If WP is below the method limit of detection, it does not mean that the duck did not die of WP and best available data (see section 5.0) must be used to determine how it died.

3.1.2.2 Only part of a carcass is located. If a gizzard is found with the remains it is treated like a whole intact carcass. If a gizzard is not found with the remains, it is treated as a partial carcass and best available data must be used to determine cause of mortality. If any other dead animals are found near the carcass they will also recovered and analyzed for WP, if possible.

3.1.2.3 Only a radio transmitter is located. If the radio transmitter can be recovered, it is examined to determine if the harness is intact or if it gives any clues as to the status of the duck and the best available data are used to determine what happened to the duck. If the radio cannot be recovered, the best available data are still used to determine what happened to the duck.

4.0 PROCEDURES

4.1 Field personnel retrieving waterfowl carcasses will immediately package the remains in airtight plastic bags with a notecard indicating the species, time, date, location, USFWS band number (if any), and any comments. As much of a carcass as possible will be recovered.

4.2 The location of the carcass will be marked on a standardized map of ERF and UTM coordinates recorded from a hand-held Geographic Positioning System.

4.3 Carcasses will be placed in a designated freezer on Fort Richardson as soon as possible upon departure from ERF.

4.4 Carcasses containing intact gizzards will be analyzed for WP using NWRC Analytical Method 82A (follows USATHAMA KN01). Other tissues will not be analyzed because the gizzard is the first location of deposition where the highest concentration of WP is found. Presence of WP indicates a WP mortality. Absence of WP does not preclude WP mortality, and other factors, as indicated below, must also be considered.

5.0 ANALYSIS OF BEST AVAILABLE DATA

5.1 When results of analysis of the gizzard are below the method limit of detection or the carcass cannot be collected intact (with the gizzard), an evaluation to determine the cause of mortality will proceed on a case-by-case basis. Following are examples of the types of information that should be considered. Most situations will also include analysis of telemetry triangulation data from 3 towers 2-3 days prior to mortality to determine if the bird had visited areas known to be contaminated with WP within that time period.

5.1.1 Waterfowl carcasses with radio-transmitters in ERF will be carefully examined for signs indicating the possibility that the harness and/or transmitter restricted movements, which may leave radio-equipped waterfowl at increased risk of predation or susceptible to skin abrasions which may lead to infection. Past telemetry studies documented that the first 24-48 hrs after release are the most critical for capture-related mortalities and <1% of mortalities can be attributed to the radio-transmitter/harness after that time.

5.1.2 Field personnel will look at visual clues of the remaining carcass and habitat features where the carcass was located. Acute WP poisoning in waterfowl results in severe disorientation - affected birds may swim helplessly in circles. As dying birds swim about, their drooping wings and feet snag vegetative debris which weakened birds cannot dislodge and are plainly visible when mortalities are recovered. Even when only a partial carcass remains, a close examination of the wings or feet may show signs of vegetation accumulation on the bird.

5.1.3 Waterfowl suffering from WP poisoning may also seek protected areas near edges of ponds in high or dense vegetation and in coves. These areas will be closely examined to determine if raptor feeding perches are located nearby; if no such perches are obvious, it is highly probable the sick bird was seeking cover prior to death.

5.1.4 Antemortem movements and locations of waterfowl mortalities which are carried to feeding perches by raptors or to den locations by mammalian predators will be evaluated using telemetry triangulation data to determine if the bird in question had visited contaminated areas.

5.1.5 Antemortem locations of dead study birds will be analyzed to determine time spent in one location prior to initiation of the mortality signal from transmitters. Waterfowl which remain in a small area for lengthy periods may be showing signs of lethargy as a result of WP intoxication.

5.2 Analysis of all field data will take place upon first contact with the recovered carcass. Evaluation of telemetry triangulation data will take place after the carcass is recovered.

6.0 REFERENCES

6.1 NWRC Analytical Method 82A. 1998. White phosphorus residue determination in gizzard contents of ducks. July 15, 1998. 17 pp.

Appendix 7. Standard Operating Procedures for Labeling and Recovering Instrumented and Non-instrumented Waterfowl at Eagle River Flats, Alaska.

National Wildlife Research Center

Standard Operating Procedure

Title: Labeling and Recovering Radio Instrumented and Non-instrumented Waterfowl at Eagle River Flats, Alaska	***Number:*** FP 007.00 ***Effective date:*** 1 Feb 2000
	Replaces: n/a
Prepared by: Patricia A. Pochop [signature] ***Date:*** 1/19/00	***QAU:*** LA 19 Jan 2000

1.0 PURPOSE

1.1 To provide guidelines for field personnel on how to properly label radio instrumented and non-instrumented waterfowl carcasses collected on Eagle River Flats, Fort Richardson, Alaska.

2.0 EQUIPMENT / MATERIALS / SUPPLIES NEEDED

2.1 See SOP FP 004, Field determination of white phosphorus mortality in waterfowl at Eagle River Flats, Alaska.

2.2 A preprinted notecard (Section 4.0 in this SOP) will facilitate collection of appropriate information on recovered waterfowl carcasses and will be printed on 'write-in-the-rain' type paper.

2.3 A knife and/or scissors for removing the gizzard and/or other parts of the duck for closer examination.

3.0 TYPES OF SPECIMENS COLLECTED

3.1 A detailed explanation of the types of carcasses collected can be found in SOP FP 004. The most commonly encountered types of specimens are listed below.

3.1.1 Whole intact or some portion of a radio transmittered and banded duck(s) captured in the current year (i.e. band could be missing, carcass could be missing, radio could be missing, etc.).

3.1.2 Radio transmittered and/or banded duck(s) captured in previous years in various states (i.e. carcass and all equipment the duck carried could be intact, the band could be missing, radio could be missing, etc.).

3.1.3 Unbanded/unmarked carcass(es) will not be collected unless a whole gizzard can be extracted for analysis.

4.0 PREPRINTED NOTECARD

4.1 The following preprinted notecard will be filled out in the field to facilitate collection of information associated with radio instrumented and non-instrumented waterfowl on Eagle River Flats.

4.1.1 The top portion of the label is the information for the analytical laboratory to record in their log and for cross referencing data to the original specimen.

☐ Band No. ________________ Date Recovered ______________
Cross Reference No.
(to be filled out by Study Director only)
Notes for unbanded carcasses (i.e., Species, Sex, Age, Location, Condition, etc.)

Time Recovered ________ Frequency __________ Trans. No. __________

Species __________ GPS Location ____________________

Description of recovery location (i.e., 500 m W of the beaver dam in C/D) ________

Mortality (check one): ☐WP, ☐Predation, ☐Hunted, ☐Attachment method, ☐Exposure, ☐Unknown, Explain ____________________

Carcass condition (check one): ☐Whole, ☐Scavenged w/ gizzard, ☐Scavenged w/o gizzard ☐Decayed, ☐No carcass, ☐Other
Explain ____________________

Gizzard condition ____________________
Notes ____________________

Initials ________

4.1.2 The bottom portion is data for determining probable cause of mortality and the collection location of carcass on Eagle River Flats, Alaska. This is where pertinent field information is collected. Some of this information can no longer be accessed if it is not clearly and concisely written down before the carcass is removed from the field.

4.1.2.1 Cross Reference No. (to be filled out by the Study Director only) - This is a number that is used to cross reference data back to the appropriate specimen notes in a bound notebook. Only the Study

Director, or the person specifically chosen to act for the Study Director, should assign this number. This is the only portion of the notecard that should be left blank after collecting field data. The number is assigned prior to packing the gizzard for shipment to the analytical laboratory. This number is important when several unmarked specimens of the same type are collected within the same geographical area (i.e. Area A, Area B, etc.) of Eagle River Flats and it is necessary to be able to distinguish from which pond they were retrieved.

4.1.2.2 Band No. - The band number should be recorded if it is available. If the radioed bird does not have the leg band and the band cannot be located nearby, the data collector must determine and record the frequency number. This person will then reference their tower notebook to find and record the band number. If it is a bird that has been banded in a previous year, the band number must be determined and recorded prior to the specimen being shipped to the analytical laboratory. If the bird is not banded, '*no band*' should be recorded in this block.

4.1.2.3 Date Recovered - The date the specimen was recovered should always be recorded. If a researcher from a different project on Eagle River Flats recovers the specimen all attempts to collect all possible data on the preprinted notecard should be made by the person to whom the specimen was given. Insufficient data on the notecard reduces the value of that data to the study.

4.1.2.4 Notes for unbanded carcasses (i.e. Species, Sex, Age, Location, Condition, etc.) - As much data as possible should be collected for unbanded carcasses especially the species identification and location. If needed, notes may also be written on the back of the card. Sex and age data (if these can be determined) may help to distinguish unbanded carcasses from each other. Also, any conditions of the carcass that may be unique to that carcass should be recorded (i.e. a scar and the location on the body; an injury, its cause and location; etc.).

4.1.2.5 Time Recovered - The time the carcass was recovered should be noted. In the absence of a functional wristwatch the approximate time is sufficient.

4.1.2.6 Frequency - The frequency of each radio transmitter should be recorded. If the carcass is a bird that was marked in a prior year and no leg band is found, the frequency is the only piece of information available to determine the duck's identity, so that it can be reported as a mortality to the bird banding laboratory.

4.1.2.7 Trans. No. - Recording the transmitter number will be of value as a cross reference if the frequency is illegible either on the transmitter or on the notecard.

4.1.2.8 GPS Location - The actual location as determined using a geographical positioning system unit. GPS units are provided and have an accuracy of 50 feet. GPS locations will be recorded in UTM units. In the event that a carcass is recovered and there is no GPS unit available '*no GPS*' should be recorded in this block.

4.1.2.9 Description of recovery location - If a GPS coordinate is available, only a brief description of the recovery location is necessary. When unavailable, the location should be described in enough detail that anyone familiar with Eagle River Flats could relocate the spot the carcass was collected.

4.1.2.10 Mortality - Put an X next to the appropriate mortality type based on observations (refer to SOP FP 004). In the explanation space provided, write what it was about the carcass and/or location that made you come to your conclusion. Examples (not all inclusive):

4.1.2.10.1 WP mortality - Grass was wrapped around the legs, indicating that the bird probably went into convulsions. Others include; the head/neck was arched over the back, the carcass/other remain(s) were in locations known to be very hot, etc., see SOP FP 004 for additional information on defining WP mortalities.

4.1.2.10.2 Predation - The carcass was most likely taken alive and then killed and eaten. This would have a higher probability of occurrence in carcasses located within 1 - 2 days of capture and release. Also important signs include, signs of a struggle in or near the location the carcass was located, any wounds observed on the carcass during skin removal to check for wounds, etc.

4.1.2.10.3 Hunted - Wounds were visible, the carcass was collected off Eagle River Flats, etc. The skin should be removed to check for signs of wounds that might otherwise be missed by a surface check of the carcass.

4.1.2.10.4 Attachment method - The ribbon was wrapped around the leg/wing/neck, the ribbon was not sitting as it should on the carcass and there were no signs a predator tampered with it, the bird died within 1-2 days of capture and release, the glue was suspected to have failed (radio may be found with a thorough check of the recovery area), and the harness slipped off the bird, etc.

4.1.2.10.5 Exposure - Carcass was located within 1-2 days of capture and release, no other signs of mortality were present, and the capture/release crew suspected that possibly the bird could have been released in poor condition.

4.1.2.10.6 Unknown - no signs were present to explain the fate of the animal. This option is not meant to be a scape-goat option – examine the bird, area, and other pertinent field information. Then and only then consider this option if none of the other explanations fit.

4.1.2.11 Carcass condition - Put an X next to the appropriate carcass condition when recovered. When checking "no carcass" or "other", provide an explanation (i.e., only the transmitter was recovered, the transmitter was located in a tree and could not be recovered, transmitter could not be recovered because it was in the water, the carcass was observed being carried off by an eagle and could not be recovered, etc.).

4.1.2.12 Gizzard condition - This block is to be filled out when the gizzard is extracted. Explain if there were any pre-existing injuries to the gizzard (shot, partially scavenged, etc.) or if the gizzard was damaged during extraction from the carcass. NOTE: The gizzard is removed with 1-2 inches of esophagus and 1-2 inches of intestine taken with the gizzard for the analysis. Any other pertinent notes relating to the gizzard should be recorded (i.e. accidentally clipped the esophagus too close to the gizzard-some material may be lost from the sample, etc).

4.1.2.13 Notes - Any information that is pertinent or unusual that is not recorded elsewhere on the form should be recorded here. This space can also be used for additional notes.

4.1.2.14 Initials - The initials of the person recovering and recording the specimen data should be placed here. If there are any questions on any of the entries, the people who recovered the carcass can be contacted.

4.1.3 ALL POSSIBLE ATTEMPTS SHOULD BE MADE TO RECORD THE NOTECARDS CLEARLY, ACCURATELY, LEGIBLY, AND COMPLETELY.

4.1.4 When no pre-printed notecard is available, **ALL** the above data should be recorded on a blank notecard. **AS SOON AS POSSIBLE**, copies of preprinted notecards **WILL** be made or located and the data recorder will go back to the freezer with the preprinted notecard and completely and accurately transfer the original data to the preprinted notecard. The original notecard will then be given (ASAP) to the person in charge of the Master notebook and the original notecard will be placed in the Master notebook for safekeeping.

5.0 PROCEDURES

5.1 Personnel that will be conducting field research on Eagle River Flats will be sent a copy of this SOP and SOP FP 004.

5.2 Before proceeding onto Eagle River Flats, the recovery team (consisting of 2 persons of appropriate size to rescue each other) will make sure they have plastic bags, pre-printed notecards, pens, GPS unit, knife or scissors (for removing gizzard and field necropsy), antenna, receiver, headphones (for helicopter or hovercraft retrievals), and an army radio (for communicating with Range Control).

5.3 The recovery team will locate the carcass or determine the position of the transmitter to the best of their ability. One member of the recovery team will record the data as described above. Both members will note specifics of the carcass, the surroundings and determine to the best of their knowledge (using this SOP and guidelines in SOP FP 004) the appropriate data to record on the preprinted notecard.

5.3.1 The recovery team will determine whether to extract the gizzard in the field or to keep the carcass intact. It is preferred that whenever possible the gizzard be extracted in the field. However, time constraints will sometimes dictate that the carcass be recovered without extracting the gizzard.

Keep in mind that chemical analysis of gizzard contents may confirm or refute the cause of mortality initially written on the notecard. The purpose of the information on the card is to give the best description, as possible, of the field conditions and carcass/other remain(s) status at the time of retrieval.

5.4 The data recorder will double check all the information recorded on the notecard to make sure the notecard is accurate and complete. The notecard will then be placed into its own plastic bag and sealed before placing it into the bag with either the gizzard, the carcass, or other remains.

5.5 One member of the team or another person assigned to the project will take the carcass/gizzard/other remain(s) and place it/them in the designated freezer on Fort Richardson as soon as possible after exiting Eagle River Flats. However, the data recorder who helped recover the carcass is responsible for making sure the preprinted notecard is filled out as completely as possible. It is his/her responsibility to return to the freezer and fill in any missing information ASAP.

5.6 The person assigned to pack the gizzards for shipment to the analytical laboratory will double check that all the information (especially the cross reference number and the band number if one exists for the specimen) is on the cards for all the specimens. If any of the notecards are missing data the Study Director or the person assigned to act for the Study Director will be **IMMEDIATELY** notified. If the Study Director determines that the missing information is not important enough to delay shipment of the sample(s), the Study Director may allow the sample to be packed and sent. If the Study Director determines that critical information is missing, then the shipment of gizzards to the analytical laboratory will be delayed until that data is included on the notecard. The Study Director or the person assigned to act for the Study Director will notify the analytical laboratory of the delay and when to expect the samples.

5.7 Upon completion of the laboratory analysis for white phosphorus, the notecards will be returned to the Bird Project with the chemistry data for archiving. Notecards that are stored with recovered parts of birds/radios/or bands will be retrieved and placed in safe-keeping with the other project records. However, notecards stored with recovered whole carcasses or parts of ducks, radios, and/or bands should not be separated from its recovered 'whole or parts' until all the data in the notecard is accurately transcribed into a bound notebook and double checked for accuracy.

Appendix 8. Analytical Method 82A for Determining White Phosphorous Residues in Waterfowl.

USDA Analytical Method	United States Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services National Wildlife Research Center Research and Program Support Section Analytical Chemistry Project	Number: Method 82A Date Effective: 7/15/98 Supersedes: None Page: 1 of 17

White Phosphorous Residue Determination in Gizzard Contents of Ducks

I. Chemical Data

Common Name: White Phosphorous

Alternate Name: P_4, yellow phosphorous.

Formula: P_4

MW: 123.895 g/mole

MP: 44.1°C

Physical State: Colorless or white, transparent, crystalline solid; waxy appearance; darkens on exposure to light. Sometimes called yellow phosphorous; color due to impurities.

Solubility: One part per 300,000 in water. One gram dissolves in 400 mL absolute alcohol, 102 mL absolute ether, 40 mL chloroform, 35 mL benzene, 0.8 mL carbon disulfide, 80 mL olive oil, 60 mL oil of terpene, or 100 mL almond oil.

Stability: Ignites at about 30°C in moist air; the ignition temperature is higher when the air is dry. **Caution:** handle with forceps, keep under water or in oxygen-free environment. The fumes are poisonous, prepare and handle technical materials only in a fume hood. Tissue samples should be handled and prepared in a fume hood.

7/15/98 Developed By Date	7/15/98 Approved By Date
7/15/98 Validated By Date	7/15/98 QA/QC Specialist Date

II. Matrices Tested

This method was validated for the determination of white phosphorous residues in duck gizzard contents in amounts ranging from 0.03 to 3,000 μg.

III. Reagents

	Name	CAS RN
1)	Isooctane, HPLC grade	540-84-1
2)	Methanol, HPLC grade	67-56-1
3)	Tricaprylin	538-23-8
4)	Triethylphosphate, technical grade	78-40-0
5)	Triethylphosphate, 100 ppm certified solution	78-40-0
6)	Water, HPLC grade	7732-18-5

IV. Solutions

Water should be sparged with helium before coming into contact with white phosphorous to minimize oxidation.

V. Special Equipment

When possible, white phosphorous solutions which will be in contact with water should be prepared and stored in low actinic (red) glassware. When this is not possible, the containers used to store the solutions should be wrapped with aluminum foil to prevent exposure to light. Solutions of white phosphorous in isooctane are stable and do not need to be protected from the light. When using solutions of isooctane or methanol a fume exhaust hood should be employed to minimize exposure to these solvents.

1) Branson ultrasonic bath (Bransonic 32).

2) Centrific Centrifuge, Fisher model #225.

3) Eberbach mechanical shaker, 2 3/8" stroke

4) Fume exhaust hood.

5) Glove bag, purged with nitrogen.

VI. Standard Preparation

White Phosphorous Concentrated Standard Solution

Place a glove bag in a fume exhaust hood. Connect it to a cylinder of nitrogen. Place a plastic tray, tweezers, scalpel, beaker of deionized water, paper towels, and crimp-cap vial inside the glove bag. Place the bottle containing the white phosphorous technical material immersed in water in the glove bag. Purge the air from the bag with nitrogen and then seal the bag. Using tweezers, remove the white phosphorous technical material from the bottle and dry it on a paper towel to remove excess water. Using tweezers and a scalpel, remove any oxidized white phosphorous from the external surface of the block of technical material (the white phosphorous should have a slightly orange or yellowish translucent color to it) Cut several small pieces from the block of white phosphorous and place them in a 10-mL crimp cap vial. Place the block of technical material back in the bottle and seal it. Fill the crimp cap vial with water. Break the seal on the glove bag and remove the vial and bottle containing the white phosphorous technical material.

The following procedures should be conducted in a glove box or glove bag if available. Place the crimp cap vial in a water bath heated to approximately 60°C until the white phosphorous melts. Using an eppendorf pippetor, remove approximately 25 µL of molten white phosphorous from the vial. Immediately place the aliquot and pipette tip into a pre-weighed 100-mL volumetric flask containing approximately 50 mL of isooctane and re-weigh the flask. Dilute to approximately 90 mL with isooctane and mix. Place in a sonicating bath for 15 minutes, followed by immersion in a water bath at room temperature for 15 minutes. Remove the pipette tip and allow it to dry. Weigh the tip and subtract its weight from the weight of the flask plus white phosphorous determined above to determine the quantity of white phosphorous delivered. Bring the concentrated standard solution to volume with isooctane, yielding a solution with a concentration of about 400 µg/mL. Place a crimp cap on the vial containing the molten white phosphorous. Seal with a crimper and allow to cool to room temp in a dark place.

Place the white phosphorous solution in a 100-mL crimp-cap vial. To precipitate any suspended particulates, store in a refrigerator at about 4°C for three weeks. Filter the standard through a Whatman #1 filter paper and store in a clean crimp-cap vial. Store in a refrigerator at about 4°C.

If the concentration of the solution is found to be significantly different from 400 µg/mL, the aliquots taken from the stock should be adjusted to yield an appropriate amount of white phosphorous in all future work done with the stock.

Note:

Verification of the concentrations of the concentrated white phosphorous solutions will be performed on a gas chromatograph (GC) equipped with an atomic emission detector (AED). Quantification of gizzard residues will be accomplished using a GC equipped with a flame photometric detector (FPD).

White Phosphorous Verification Standard Solution (AED)

Transfer a 500 µL aliquot of the white phosphorous concentrated standard solution to a 10-mL volumetric flask. Dilute to volume with isooctane and mix. The concentration of the verification standard is about 20 µg/mL. This solution will be used to verify the concentration of the concentrated solution (See Section XI).

White Phosphorous Working Standard Solution (FPD)

Transfer a 100 µL aliquot of the white phosphorous concentrated standard solution to a 10-mL volumetric flask. Dilute to volume with isooctane and mix. The concentration of the working standard is about 4 µg/mL.

White Phosphorous Calibration Curve (FPD)
Using Hamilton syringes and 10-mL volumetric flasks, prepare a calibration curve in isooctane as follows:

Standard Level (µg/mL)	Aliquot Volume	Source
0.01	100 µL	1 µg/mL
0.003	30 µL	1 µg/mL
0.0015	150 µL	0.1 µg/mL

Triethylphosphate Concentrated Standard Solution

Accurately weigh about 10.000 mg of triethylphosphate reference material and quantitatively transfer to a 10-mL volumetric flask. Dilute to volume with methanol and mix, yielding a solution with a concentration of about 1,000 µg/mL.

Triethylphosphate Working Standard Solution (AED)

Transfer a 1.00 mL aliquot of the triethylphosphate concentrated standard solution to a 10-mL volumetric flask. Dilute to volume with methanol and mix. The concentration of the working standard is about 100 µg/mL.

Triethylphosphate Calibration Curve (AED)
Using Hamilton syringes and 10-mL volumetric flasks, prepare a calibration curve in methanol as follows:

Standard Conc. (µg/mL)	Aliquot Volume	Source
25	250 µL	Concentrated Stock
50	500 µL	Concentrated Stock
100	1 mL	Concentrated Stock
150	1.5 mL	Concentrated Stock
200	2 mL	Concentrated Stock

VII. Sample Preparation

Sample Preparation:

Samples should be prepared in a fume hood which has not been exposed to concentrated white phosphorous solutions. Remove the individually bagged, frozen gizzard from the freezer and place in a circulating water bath at room temperature for about an hour. Remove the gizzard from the plastic bag and place in a plastic weigh boat. Use a scalpel to cut open the gizzard by making an incision around the perimeter of the entire gizzard which will split it into two equal halves. Using a spatula and glass funnel, scrape the contents of the gizzard into a pre-weighed 50-mL glass test tube containing exactly 10.00 mL of isooctane. Re-weigh the tube to determine the weight of the gizzard contents. Rinse the gizzard and weigh boat with six 5 mL aliquots of helium sparged deionized water into the test tube containing the isooctane.

Sample Extraction:

Shake the samples horizontally on a mechanical shaker at low speed for 18 hours. The shaker should be placed in a dark room or the samples should be covered to prevent exposure to light. Centrifuge at high speed (approximately 2,700 rpm) for 5 minutes. Using a pasteur pipet, transfer some of the isooctane layer to an amber GC vial and cap it. Place the remainder of the isooctane in a 10-mL glass test tube and refrigerate.

Samples with expected white phosphorous residues in excess of 100 µg should be diluted with isooctane so that they fall within the linear range of the instrument. If the residue level from an unknown sample yields a response greater than the linear range of the instrument, aliquots of the sample's isooctane extract should be diluted with isooctane at a ratio sufficient to place the response within the linear range of the instrument.

VIII. Procedure

GC FPD:

Repeatedly inject 1 µL of the 4 µg/mL white phosphorous working standard to assess GC FPD system suitability. Inject 1 µL of each sample extract and record the white phosphorous peak response in each chromatogram.

GC/AED:
Repeatedly inject 1 μL of the 100 μg/mL triethylphosphate working standard to assess GC/AED system suitability. Inject 1 μL of each triethylphosphate and white phosphorous standard and record the phosphorous peak response in each chromatogram.

IX. System Suitability

System suitability is demonstrated when the relative standard deviation of the chromatographic peak area response is ≤ 2.0% for five consecutive injections of the working standard.

X. Typical GC Conditions (GC/FPD)

The instrument used during method validation was a Hewlett-Packard model 5890 Series II GC equipped with a flame photometric detector, a 7673A auto sampler tray, and a Hewlett-Packard work station.

Column:	Restek® DB-1, 12 m x 0.200 mm, or equivalent
Carrier:	Helium at 0.30 mL/min (EPC = 5.1 psi)
Injection Volume:	1 μL (Split less)
Split Vent:	20 mL/minute
Purge Vent:	On at 0.5 minutes Off at 2 minutes
Temperature Program:	hold @ 40°C for 4 minutes ramp to 150°C @ 60°C/minute hold @ 150°C for 0.3 minutes ramp to 40°C @ 70°C/min hold @ 40°C for 1.5 minutes
Detector:	Flame Photometric Detector Temperature: 200°C Auxiliary (Nitrogen): 120 mL/min Oxygen: 26 mL/min Hydrogen: 15 mL/min

The retention time of white phosphorous is approximately 5.7 minutes under the described conditions. Operating conditions and recording parameters should be adjusted to obtain optimum response and reproducibility.

Typical GC Conditions (GC/AED)

White Phosphorous:

Column: Restek® DB-XLB, 30m x 0.25mm, 0.25μm film thickness, or equivalent

Carrier: Helium at 0.7 mL/min (EPC = 9.5psi)

Injection Volume: 1 μL (Split less)

Injector Temp.: 250°C

Split Vent: 40 mL/minute

Purge Vent: On 3 minutes

Temperature Program:
hold @ 40°C for 7 minutes
ramp to 120°C @ 30°C/minute
hold @ 120°C for 6.33 minutes
ramp to 40°C @ 70°C/minute
hold @ 40°C for 0.1 minute

Detector:
Atomic Emission Detector (AED)
Transfer Line Temperature: 250°C
Cavity Temperature: 250°C
Hydrogen Pressure: 9.3 psi
Oxygen Pressure: 24.8 psi
Auxiliary Pressure: 34.0 psi
Cavity Pressure: 1.5 psi
Peak Width: 0.216 minutes
Solvent Vent: On @ 0.20 minutes
Off @ 12 minutes
Element Group: Xtended elements 1, non-metals
Elements: Carbon 193
Phosphorous 178
Phosphorous 186

Triethylphosphate:

Column:	Restek® DB-XLB, 30m x 0.25mm, 0.25µm film thickness, or equivalent
Carrier:	Helium at 0.7 mL/min (EPC = 10.2psi)
Injection Volume:	1 µL (Split less)
Injector Temp.:	250°C
Split Vent:	40 mL/minute
Purge Vent:	On @ 3 minutes
Temperature Program:	hold @ 60°C for 7 minutes ramp to 190°C @ 15°C/minute hold @ 190°C for 0.33 minutes ramp to 60°C @ 70°C/minute hold @ 60°C for 0.5 minute
Detector:	Atomic Emission Detector (AED) Transfer Line Temperature: 250°C Cavity Temperature: 250°C Hydrogen Pressure: 9.3 psi Oxygen Pressure: 24.8 psi Auxiliary Pressure: 34.0 psi Cavity Pressure: 1.5 psi Peak Width: 0.216 minutes Solvent Vent: On @ 0.01 minutes Off @ 7.5 minutes Element Group: Xtended elements 1, non-metals Elements: Carbon 193 Phosphorous 178 Phosphorous 186

XI. Data Analysis and Calculations

Calculation of Stock White Phosphorous Solution Concentration:

A certified standard will be used to calculate the concentration of the triethylphosphate working standards. The average percent recoveries of these standards will be used to apply a correction to standards in the triethylphosphate calibration curve.

The phosphorous concentration of the triethylphosphate standard will be calculated as follows:

Concentration of triethylphosphate concentrated standard solution:

$$\text{Elemental Conc. } (\mu g / mL) = \text{Triethylphosphate Concentration } (\mu g / mL) \times \frac{\text{Molecular Weight of Phosphorous}}{\text{Molecular Weight of Triethylphosphate}}$$

Sample calculation:

$$\text{Phosphorous Conc. } (\mu g / mL) = 99.7 \, (\mu g / mL) \times \frac{30.97 \text{ g / mole}}{182.16 \text{ g / mole}} = 17.0 \ \mu g / mL$$

The triethylphosphate response from the phosphorous 186nm emission line of the AED detector will be used to calculate the white phosphorous verification standard concentration in both the tricaprylin (see Section XII: Fortification Solutions) and isooctane solutions from their respective 186nm emission lines. A triethylphosphate calibration curve containing the standards outlined in Section VI will be injected in duplicate. A linear regression was performed on the log-transformed data. The log of response from the white phosphorous verification standards will be plotted on this curve and the log of phosphorous concentration calculated. The antilog of this value will be determined to yield the concentration of the white phosphorous in both the tricaprylin and isooctane stock solutions.

Five replicate dilutions from the each concentrated white phosphorous solution will be analyzed in this way and the arithmetic mean concentration will be calculated. This concentration will be extrapolated to determine the concentrations of the white phosphorous concentrated standard solutions. This concentration will in turn be used in calculating the white phosphorous concentration in the fortified samples.

$$\text{White Phosphorous Concentrated Standard } (\mu g / mL) = \text{Verification Standard Conc. } (\mu g / mL) \times \frac{\text{Dilution Volume (mL)}}{\text{Aliquot Volume (mL)}}$$

$$\text{White Phosphorous Concentrated Standard } (\mu g / mL) = 19.9\ \mu g / mL \times \frac{10.00 \text{ mL}}{0.500 \text{ mL}} = 398\ \mu g / mL$$

Calculation of White Phosphorous Recoveries from Gizzards:

Sample recoveries are calculated using the area of the white phosphorous peak from the FPD. The amount of white phosphorous in the sample is calculated using the equation:

$$\text{White Phosphorous Mass (mg)} = \frac{A_u}{A_{std}} \times C_{std} \times \text{Sample Volume (mL)}$$

where:

White Phosphorous Mass (μg) = the mass of white phosphorous in micrograms.

A_u and A_{std} = the white phosphorous chromatographic peak responses from the sample solution and working standard, respectively.

C_{std} = the white phosphorous working standard concentration in μg/mL (approximately 4 μg/ml).

sample volume = the volume of the isooctane extraction solvent plus the volume of any fortification solutions added in mL.

Calculation Example

A 8.69 g sample of gizzard contents was weighed out, fortified with 100 μL of a 5 μg/mL white phosphorous in isooctane solution, and extracted into 10.00 mL of isooctane as described by the procedures in this method. The white phosphorous chromatographic peak response from the sample solution was 32077 (arbitrary units). The concentration of the working standard was 3.66 μg/mL, and the corresponding chromatographic peak response for white phosphorous was 1800000. The mass of white phosphorous in the sample is calculated as follows:

$$\text{White Phosphorous Mass } (\mu g) = \frac{32077 \text{ AU}}{1800000 \text{ AU}} \times 3.66\ \mu g / mL \times 10.10 \text{ ml} = 0.659\ \mu g$$

XII. Method Validation

Concentrated Sample Fortification Solution:

Prepare a concentrated sample fortification solution by placing about 30 µL of molten white phosphorous technical grade material in approximately 20 mL of tricaprylin according to the procedures outlined in Section VI for the white phosphorous concentrated standard solution. Dilute the resulting solution to 25.00 mL using tricaprylin. The concentration of the resulting solution is about 2,000 µg/mL. The concentration of this standard solution will be verified on the GC/AED in the same manner as outlined for the white phosphorous standards in Section XI.

Dilute Fortification Solutions (FPD):

Prepare an intermediate sample fortification solution by diluting a 25.0 µL aliquot of concentrated sample fortification solution to volume with tricaprylin in a 10-mL volumetric flask. The concentration of the resulting solution is about 5 µg/mL.

Prepare a low level sample fortification solution by diluting a 600 µL aliquot of intermediate sample fortification solution to volume with tricaprylin in a 10-mL volumetric flask. The concentration of the resulting solution is about 0.3 µg/mL.

White Phosphorous Verification Standard Solution (AED):

Transfer a 100 µL aliquot of the concentrated sample fortification solution to a 10-mL volumetric flask. Dilute to volume with isooctane and mix. The concentration of the verification standard is about 20 µg/mL. This solution will be used to verify the concentration of the concentrated solution (See Section XI).

White Phosphorous Confirmation Standard Solution (FPD):

For each days analysis prepare three confirmation standards by placing 100 µL of the 5 µg/mL white phosphorous in tricaprylin intermediate sample fortification solution in a 10-mL volumetric flask and diluting to volume with isooctane. These standards will be used to confirm the concentration of the spiking solution used. If this value is found to be statistically different from the stated value via a t-test (α=0.05), the concentration determined by GC/FPD analysis will be used to calculate theoretical recovery for the fortified gizzard samples.

Fortification of Controls:

0.03 µg spiking level:
Spike each gizzard sample with 100 µL of the low level sample fortification solution.

0.5 µg spiking level:
Spike each gizzard sample with 100 µL of the intermediate level sample fortification solution.

3,000 µg spiking level:
Spike each gizzard sample with 1.5 mL of the concentrated sample fortification solution.

For each spike level, prepare a spike check standard by placing the appropriate aliquot of sample fortification solution into a pre-weighed clean 50 mL glass test tube containing 10.00 mL isooctane and about 5 grams of glass beads. Add 30.0 mL of helium sparged deionized water and shake on a mechanical shaker in the same way the sample extracts are treated.

Response Linearity

Two sets of nine white phosphorous standards ranging in concentration from 0.0015 µg/mL to 10 µg/mL were prepared (see Linear Regression Plots) and injected into the GC/FPD in duplicate. The results were analyzed using a SAS linear regression procedure.

Result:

A linear relationship exists between the white phosphorous concentration and peak response in the range of 0.01 µg/mL to 10 µg/mL, and the response is directly proportional to concentration over this range. Therefore, a single point calibration is valid for samples falling into this range.

Peak response vs. concentration:
$r^2 = 0.9987$

Log peak response vs. log concentration:
$r^2 = 0.9997$ slope = 0.995115

A linear relationship was observed between white phosphorous concentration and peak response in the range of 0.0015 µg/mL to 0.01 µg/mL, however the response is not proportional over this range. Therefore, a three point calibration curve was used to calculate recovery values for samples falling in this range.

Peak response vs. concentration:
$r^2 = 0.9898$

Log peak response vs. log concentration:
$r^2 = 0.9838$ slope = 0.811472

Matrix Interference

Five samples of control duck gizzard contents were extracted by the procedures outlined in the method and injected into the GC/FPD under the same conditions described in Section X.

Results: No chromatographic interferences were observed in the control samples. Chromatograms of control extracts and 0.773 µg extracts are attached.

Method Limit of Detection

The method limit of detection (MLOD) was estimated from the chromatographic responses of five control duck gizzard extracts. These values were compared against the responses from five duck gizzard extracts fortified with 0.03 µg white phosphorous. The MLOD is defined as the concentration of white phosphorous required to generate a signal equal to 3 times the baseline noise in the control chromatograms at the retention time of white phosphorous. Under the conditions stipulated in the method, the MLOD was determined to be 0.013 µg.

Bias and Repeatability

Replicate samples of control duck gizzard contents, fortified at concentrations ranging from 0.0300 µg to 3.000 µg, were prepared and analyzed using the procedures described in this method. The results are as follows:

Nominal Fortification Level and Percent Recovery

Replicate	0.03 µg	0.5 µg	3,000 µg
1	68.5	85.3	86.6
2	82.7	85.3	87.1
3	63.3	84.9	82.3
4	66.7	80.5	101
5	84.7	84.2	98.2
Mean =	73.(2)%	84.(0)%	91.(0)%
s =	9.8%	2.0%	8.1%
cv =	13%	2.4%	8.9%

XIII. References

Analytical Chemistry Section Notebook # AC 64: pages 25,58-59,69-76,81,83-101

Analytical Chemistry Section Notebook # QC 14: pages 49,50,61,70,76,81,85,86

Analytical Services Project Number: 98-034.

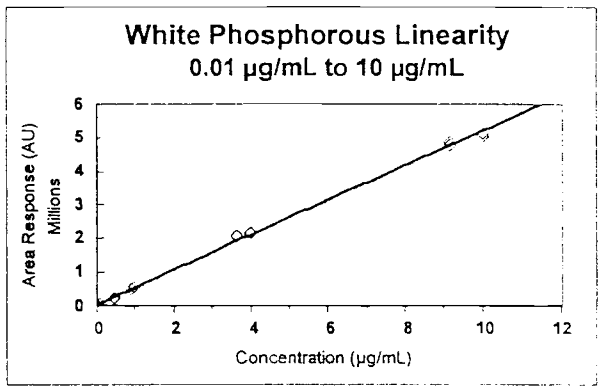
ACS Research Project R98-009.

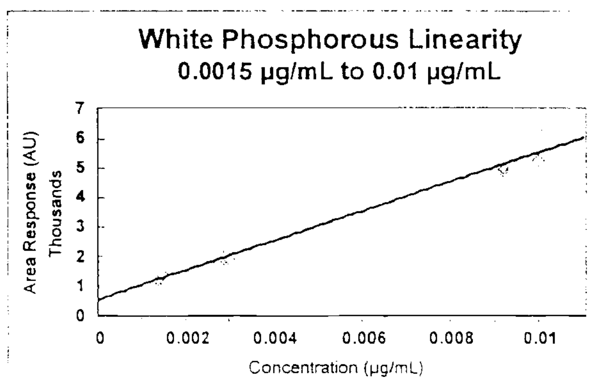
XIV. Standard Operating Procedures

The following SOP's were applicable at the time of method validation.

CH-001	WRC-175.R5	WRC-193.R4	WRC-401.R2	WRC-458
HS-001	WRC-178.R6	WRC-194.R2	WRC-402.R1	WRC-461.R1
HS-004	WRC-180.R4	WRC-197.R5	WRC-414.R2	WRC-462.R1
IE-001	WRC-185.R1	WRC-223.R6	WRC-419.R2	WRC-463.R1
WRC-169.R5	WRC-186.R6	WRC-224.R6	WRC-444.R2	WRC-464.R1
WRC-170.R5	WRC-187.R5	WRC-225.R5	WRC-450.R1	WRC-465.R1
WRC-171.R6	WRC-189.R5	WRC-229.R4	WRC-451.R3	WRC-470.R1
WRC-172.R6	WRC-191.R7	WRC-380.R1	WRC-454.R3	WRC-482.R1
WRC-174.R5	WRC-192.R5			

Linear Regression Plots (GC/FPD)

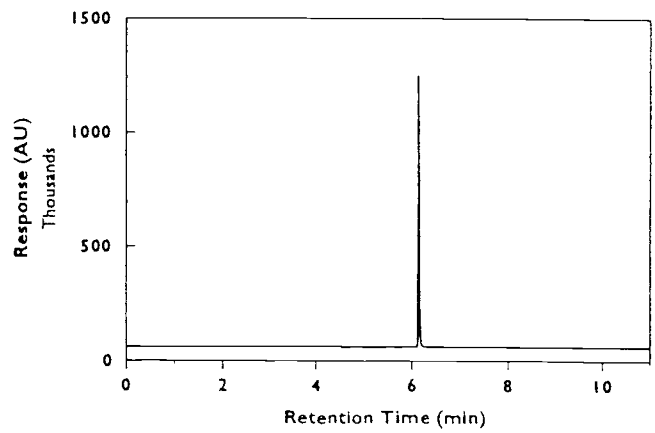




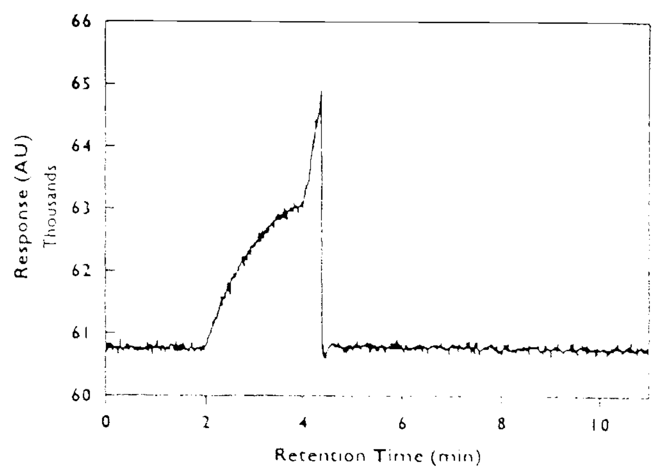
Standard Level (ug/mL)	Aliquot Volume	Source
10	250 µL	Stock
4	100 µL	Stock
1	100 µL	100 µg/mL
0.5	50 µL	100 µg/mL
0.1	100 µL	10 µg/mL
0.05	50 µL	10 µg/mL
0.01	100 µL	1 µg/mL
0.003	30 µL	1 µg/mL
0.0015	150 µL	0.1 µg/mL

Sample Chromatograms

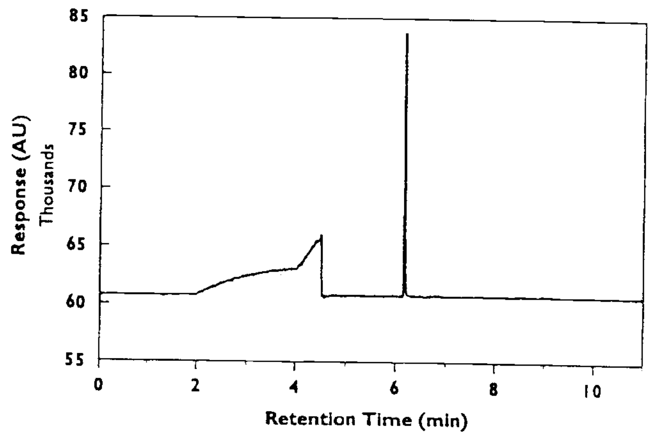
3.66 μg/mL White Phosphorous Working Standard



Extract of Control Duck Gizzard Contents



Extract of Duck Gizzard Contents Fortified at 0.773 µg



Appendix 9: Results of White Phosphorus Residue Analysis of Radio-marked Mallards and Other Waterfowl Recovered from Eagle River Flats, Fort Richardson, Alaska.

United States Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services
National Wildlife Research Center
Product Development Section
Analytical Chemistry Project

Analytical Services Report

Invoice Number: 98-048

Date: August 13, 1998

To: John Cummings
Subject: White Phosphorous Residue Determination in Duck Gizzards (QA-313)
Method: 82A
Analysis Date(s): 7/16/98 to 7/22/98
AC Notebook Reference: AC40: 186-197
QC Notebook Reference: QC14: 91,96,98
Analyst: Daniel B. Hurlbut

Sample Description:

Received 16 duck gizzards on 7/15/98. The following ACP tracking numbers were assigned to each:

ID Number	Band Number	ACP Number
Gizzard #1	1477-73442	S980715-1
Gizzard #2	1477-73498	S980715-2
Gizzard #3	1477-73488	S980715-3
Gizzard #4	1477-73639	S980715-4
Gizzard #5	1477-73471	S980715-5
Gizzard #6	2387-80993	S980715-6
Gizzard #7	1477-73678	S980715-7
Gizzard #8	1477-73649	S980715-8
Gizzard #9	2387-80977	S980715-9
Gizzard #10	1477-73614	S980715-10
Gizzard #11	2387-80947	S980715-11
Gizzard #12	No Band	S980715-12
Gizzard #13	2387-80905	S980715-13
Gizzard #14	2387-80991	S980715-14
Gizzard #15	1477-73589	S980715-15
Gizzard #16	No Band	S980715-16

Method Modification(s)/Comments:

The contents from each gizzard were removed and analyzed for white phosphorous (P_4). The initial evaluation of samples S980715-2,3,7,8 and 10 produced P_4 responses that were outside of the method's linearity range. Aliquots (100 μL) from these sample extracts were diluted 1:100 with isooctane and re-analyzed for P_4 content. Extracts from samples S98-0715-4 and 16 were re-injected into the GC to confirm their P_4 amounts since their initial injections occurred after sample injections that contained high P_4 amounts. Due to formation of a gelatinous layer, all samples were sonicated for 1½ hours in a ambient temperature water bath then centrifuged for an additional 5 minutes, prior to removal of the isooctane layer.

Analyst	Date	QA\QC Specialist	Date	Reviewer	Date
Daniel B. Hurlbut	8/13/98	[signature]	8/13/98	[signature]	8-13-98

Sample Results:

Sample	Observed P_4 Content (µg/g)
S980715-1	0.0944
S980715-2	148
S980715-3	367
S980715-4	0.100
S980715-5	0.0950
S980715-6	< MLOD*
S980715-7	538
S980715-8	159
S980715-9	7.74
S980715-10	473
S980715-11	0.152
S980715-12	2.49
S980715-13	< MLOD*
S980715-14	2.38
S980715-15	12.1
S980715-16	1.17

*MLOD= 0.003 µg/g
(The MLOD was calculated from a control gizzard fortified with 0.132 µg/g P_4)

Quality Control Data:

QC Sample	P_4 Content (µg) Target	Observed	% Recovery
QC-1	0.752	0.553	73.5
QC-2	0.752	NR*	----
QC-3	0.752	0.629	83.6
		Average =	78.6

*NR-Not Reported due to sample loss during centrifugation

cc:
J. Johnston
P. Pochop
D. Goldade
D. Kohler
D. Hurlbut

USDA	Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Product Development Section Analytical Chemistry Project	Invoice #: 99-007 Date: 11/30/98 Page 1 of 1

To: John Cummings
Wildlife Biologist
National Wildlife Research Center

Subject: White Phosphorous in Duck Gizzards (QA-313) (Preliminary Data)

Method: 82A

Analysis Date: 11/23/98 to 11/30/98

AC Notebook Reference: AC-64, pp195-197

QC Notebook Reference: -

Analyst: Dennis J. Kohler

Sample Description	Cross Reference #	Conc. of P4 in Gizzard contents (µg/g)
S981117-17	#1 2387-81111 8/26/98	37.8
" -18	#2 2387-81162 8/26/98	273
" -19	#3 1036-05001 8/26/98	<MLOD
" -20	#4 No Band 8/26/98	0.60
" -21	#5 No Band 8/26/98	0.25
" -22	#6 2387-81121 8/26/98	1.28
" -23	#7 2387-81120 8/26/98	<MLOD
" -24	#8 2387-81221 8/26/98	217
" -25	#9 2387-81138 8/26/98	82.3
" -26	#10 2387-81117 8/26/98	60.8
" -27	#11 No Band 8/26/98	72.8
" -28	#12 1477-73499 8/26/98	0.11
" -29	#13 No Band 8/26/98	0.41
" -30	#14 No Band 8/26/98	0.16
" -31	#15 No Band 8/26/98	0.32
" -32	#16 No Band 8/26/98	0.05
" -33	#17 No Band 8/26/98	0.05
" -34	#18 No Band 8/26/98	154
" -35	#19 2387-81106 10/10/98	<MLOD
" -36	#20 2387-81141 10/10/98	<MLOD
" -37	#21 2387-81205 10/10/98	0.11
" -38	#22 No Band 10/10/98	329
" -39	#23 2387-81103 10/10/98	741
" -40	#24 2387-81139 10/10/98	105
" -41	#25 No Band 10/10/98	6.66
" -42	#26 No Band 10/10/98	0.46
" -43	#27 No Band 10/10/98	95.9

USDA	Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Product Development Section Analytical Chemistry Project	Invoice #:99-007 Date:01/07/99 Page 1 of 2

To: John Cummings
Wildlife Biologist
National Wildlife Research Center

Subject: White Phosphorous in Duck Gizzards (QA-313)

Method: 82A

Analysis Date: 11/23/98 to 11/30/98

AC Notebook Reference: AC-64, pp 189-197, 205-208, AC-68, pp 17-18
AC-60, pp 174-176
AC-66, pp 28-29
AC-61, pp 107-117

QC Notebook Reference: QC-14, pp 165,168,207,208
QC-15, pp 2,7,10,11,12,18

Analyst: Dennis J. Kohler

Sample Description:

Sample Description	Cross Reference #	Collection Date	Conc. of white phosphorous in Gizzard contents (µg/g)
S981117-17	#1- 2387-81111	8/26/98	40.7
" -18	#2- 2387-81162	8/26/98	294
" -19	#3- 1036-05001	8/26/98	<MLOD
" -20	#4- No Band	8/26/98	0.656
" -21	#5- No Band	8/26/98	0.268
" -22	#6- 2387-81121	8/26/98	1.41
" -23	#7- 2387-81120	8/26/98	<MLOD

Method Modification:

- Gizzard results are reported in concentration of White Phosphorous in gizzard contents.
- Data were generated using a Hewlett Packard (5890 series II) Gas Chromatagraph, equipped with a Flame Photometric Detector and a Chemstation Software package.

Dennis J. Kohler 2-17-99 | [signature] 2/18/99 | [signature] 2/17/99
Analyst Date | QA/QC Specialist Date | Reviewer Date

Sample Description Continued

Sample Description	Cross Reference #	Collection Date	Conc. of white phosphorous in Gizzard contents (µg/g)
" -24	#8- 2387-81221	8/26/98	228
" -25	#9- 2387-81138	8/26/98	89.1
" -26	#10- 2387-81117	8/26/98	69.1
" -27	#11- No Band	8/26/98	80.1
" -28	#12- 1477-73499	8/26/98	0.125
" -29	#13- No Band	8/26/98	0.449
" -30	#14- No Band	8/26/98	0.168
" -31	#15- No Band	8/26/98	0.348
" -32	#16- No Band	8/26/98	0.049
" -33	#17- No Band	8/26/98	0.062
" -34	#18- No Band	8/26/98	175
" -35	#19- 2387-81106	10/10/98	<MLOD
" -36	#20- 2387-81141	10/10/98	<MLOD
" -37	#21- 2387-81205	10/10/98	0.121
" -38	#22- No Band	10/10/98	367
" -39	#23- 2387-81103	10/10/98	833
" -40	#24- 2387-81139	10/10/98	120
" -41	#25- No Band	10/10/98	6.93
" -42	#26- No Band	10/10/98	0.51
" -43	#27- No Band	10/10/98	113

<MLOD = Below Method Limit Of Detection @ 0.014µg

QC Results

Sample	Total Mass of White Phosphorous (µg)	%Recovery
QC - 1	nr	nr
QC - 2	0.0188	N/A
QC - 3	0.293	81.6
QC - 4	0.281	78.3
QC - 5	0.337	85.3

nr = No Response

cc: J. Johnston
M. Goodall
D. Goldade
D. Kohler
P. Pochop

Results:

White Phosphorous Residue Assay

Sample ID#	Cross Reference #	Analysis Date	Observed Mass of P_4 (µg)	Concentration of P_4 Gizzard Contents (µg/g)
S991006-2	Gizzard #1 1477-73719	10/21/99	1.06	0.116
-3	Gizzard #2 1477-73715	10/22/99	1,250	155
-4	Gizzard #3 1477-73708	10/21/99	4.12	0.633
-5	Gizzard #4 2387-81095	10/22/99	36,600	3,110
S991006-6	Gizzard #5 2387-81090	10/22/99	5,530	728
-7	Gizzard #6 2387-81082	10/22/99	13,900	3,210
-8	Gizzard #7 2387-81067	10/22/99	213	38.0
-9	Gizzard #8 06 0355169	10/21/99	ND	ND
-10	Gizzard #9 2387-81051	10/22/99	22.2	13.5
S991006-11	Gizzard #10 2387-81020	10/22/99	2,030	505
-12	Gizzard #11 2387-81040	10/21/99	ND	ND
-13	Gizzard #12 2387-81038	10/21/99	0.654	0.228
-14	Gizzard #13 2387-81027	10/21/99	ND	ND
-15	Gizzard #14 Unknown #77	10/22/99	71.3	9.74
S991006-16	Gizzard #15 2387-81023	10/21/99	0.013	0.0013
-17	Gizzard #16 Non-transmitted	10/21/99	6.61	1.34
-18	Gizzard #17 Unmarked Duck	10/21/99	0.504	0.350
-19	Gizzard #18 Unmarked Duck	10/21/99	5.24†	0.509†
-20	Gizzard #19 Unmarked Duck	10/22/99	173	61.6
S991006-21	Gizzard #20 Unmarked Duck	10/22/99	9,950	1,170
-22	Gizzard #21 Unmarked Duck	10/21/99	0.399	0.0926
-23	Gizzard #22 Non-transmitted	10/21/99	0.345	0.0437
S991018-1	Gizzard #23 2387-81014	10/21/99	ND	ND
-2	Gizzard #24 2387-81025	10/21/99	ND	ND
-3	Gizzard #25 1477-73645	10/21/99	<MLOD	<MLOD
-4	Gizzard #26 2387-80974	10/22/99	10,400	1,220
-5	Gizzard #27 2387-80973	10/22/99	340	110
-6	Gizzard #28 2387-80925	10/22/99	1,380	315
-7	Gizzard #29 Unmarked Duck	10/21/99	1.88	0.603

† = Laboratory accident. Sample broke in the centrifuge. Some of sample was saved and analyzed. Results could be suspect.

Quality Control Data

Sample ID#	Analysis Date	Observed Mass P_4 (µg)	% Recovery		
QC-1	10/21/99	ND	ND		
QC-2	10/21/99	0.0207	N/A	Mean =	84.(0)%
QC-3	10/21/99	0.411	84.2	s =	2.0 %
QC-4	10/21/99	0.419	85.9	cv =	2.4 %
QC-5	10/21/99	0.400	82.0		

Sample ID#	Analysis Date	Observed Mass P_4 (µg)	% Recovery		
QC-3	10/22/99	0.413	84.6	Mean =	81.(9)%
QC-4	10/22/99	0.424	86.9	s =	6.8%
QC-5	10/22/99	0.362	74.2	cv =	8.3%

ND = Not Detectable. No peak greater than 3 times the baseline noise of the instrument was observed.

MLOD: QC-1 and QC-2 were used to calculate a MLOD value. The MLOD was found to be 0.013 µg of White Phosphorous.

cc: J. Johnston
D. Griffin
D. Goldade

Results:

White Phosphorous Residue Assay

Sample ID#	Cross Reference #	Observed Mass of P_4 (µg)	Concentration of P_4 Gizzard Contents (µg/g)
S010823-1	Gizzard #1	<MLOD	<MLOD
-2	Gizzard #2	ND	ND
-3	Gizzard #3	355	433
-4	Gizzard #4	259	201
S010823-5	Gizzard #5	0.933	0.841
-6	Gizzard #6	21.4	2.92
-7	Gizzard #7	136	40.0
-8	Gizzard #8	113	22.8
-9	Gizzard #9	121	32.5
S010823-10	Gizzard #10	0.372	0.0727
-11	Gizzard #11	237	32.3
-12	Gizzard #12	1.85	0.510
-13	Gizzard #13	0.626	0.154
-14	Gizzard #14	2.21	1.94
S010823-15	Gizzard #15	0.0244	0.00478
-16	Gizzard #16	<MLOD	<MLOD
-17	Gizzard #17	1.04	0.839
-18	Gizzard #18 08/18/01	5,890	771
S011018-6	Duck Gizzard #6 10/12/01	ND	ND
-9	Treated Duck Gizzard #19	ND	ND
-10	Treated Duck Gizzard #20	57.8	19.0
-11	Treated Duck Gizzard #21	1,220	142
-12	Treated Duck Gizzard #22	94.0	21.1
S011018-13	Treated Duck Gizzard #23	4,140	726
-14	Treated Duck Gizzard #24	4.24	1.18
-15	Treated Duck Gizzard #25	196	37.8
-16	Treated Duck Gizzard #26	10.1	0.163

Results (Continued):

Quality Control Data

Sample ID#	Observed Mass P_4 (µg)	% Recovery	
QC-1	ND	ND	
QC-2	N/A	N/A	
QC-3	0.490	71.8	Average = 76.1 %
QC-4	0.548	80.4	
QC-5	0.0680	10.0†	

† = Sample matrix interference with recovery. Sample is not included in average percent recovery calculations.

ND = Not Detectable No peak greater than 3 times the baseline noise of the instrument was observed.

P_4 = White Phosphorous

MLOD: QC-1 and QC-2 were used to calculate an MLOD value. The MLOD was found to be 0.015 µg of White Phosphorous.

cc: J. Johnston
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D. Goldade