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Steven M. Huffaker, Director

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Completion Report

UPLAND GAME BIRD ECOLOGY

Study II: Effectiveness of Transplanting Pheasants as a Management Tool

July 1, 2003 to June 30, 2004

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COMPLETION REPORT
STATEWIDE WILDLIFE RESEARCH

STATE:	Idaho	**JOB TITLE:**	Upland Game Bird Ecology
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HUNTER HARVEST OF PEN-REARED AND WILD PHEASANTS IN IDAHO

Abstract

Fourteen days after the opening of the 1999 ring-necked pheasant (*Phasianus colchicus*) hunting season, 143 pen-reared male were released (30 radio-marked) on four isolated tracts (1,679 ha) of public land in south-central Idaho. Twenty-one (70%) of the radio-marked roosters were harvested, five (17%) were killed by predators, none (0%) survived the hunting season, and four (13%) were missing. Forty-five (38%) of the released pen-reared pheasants were harvested based on band and radio returns. During the ten days following release, 81 roving field surveys were conducted, 167 hunters were interviewed, and 59 pheasants (29 pen-reared, 30 wild) were harvested. No difference (P = 0.7142) was detected between hunter effort on pen-reared birds (0.59$\pm$0.58 birds/hour, mean$\pm$95% confidence interval) and wild birds (0.44$\pm$0.56 birds/hour) or hunter success (P = 0.4207, 0.26$\pm$0.05 pen-reared, 0.16$\pm$0.19 wild birds/hunter). Based on hunter interviews, an estimated 138 hunters harvested 74 pen-reared (51.8%) and 60 wild roosters during the ten-day survey period. Only two pen-reared birds were harvested off the isolated tracts where released.

Introduction

Releasing game-farm rooster pheasants before the gun has been a popular practice to enhance hunting opportunity on shooting preserves and state wildlife management areas. More return to the bag occurs when roosters are released immediately in front of hunters (Allen 1956:438). Idaho Legislation in 1999 directed the Department to release pen-reared roosters for additional pheasant hunting opportunity in Minidoka County in south-central Idaho. Monitoring the harvest is important to understand the effectiveness of the releases for future allocation of funds and release projects.

Objectives

1. Determine the number of hunters utilizing the isolated tracts where pen-reared pheasants were released.

2. Determine the effort per hunter on the isolated tracts.

3. Estimate harvest of both pen-reared and wild pheasants on the isolated tracts.

Study Area

Leptich (1988, 1992) described the study area in Minidoka county during his pheasant study. The isolated tracts, managed by the Bureau of Reclamation, are characterized by shrub-steppe and grasslands interspersed among irrigated farmland. The major agricultural crops include alfalfa, barley, wheat, beans, corn, potatoes, and sugar beets. Common grasses on the tracts include cheatgrass (*Bromus tectorum*), Sandberg's bluegrass (*Poa sandbergii*), bluebunch wheatgrass (*Agropyron spicatum*), and squirrel tail (*Sitanion hystrix*). Basin big sagebrush (*Artemesia tridentata tridentata*) and rabbit brush (*Chrysothamnus* spp.) are the common shrubs. Several small wetlands dominated by common cattail (*Typha latifolia*) or willow (*Salix* spp.) are associated with irrigation drain water. Topography of the area is gently rolling at an elevation of 1500 m. Annual mean precipitation is 23 cm, and temperature ranges from 38 C in the summer to -20 C in winter.

Methods

On October 29 1999, 143 pen-reared, male ring-necked pheasants were purchased locally (Leonard Huber, Rupert) and released on four tracts (1,679 ha) of public land in Minidoka County, Idaho (Figure 1). The release occurred 13 days after the pheasant season opened with a 46 day hunting season (October 16 - November 30) and three-bird bag limit. All birds were leg-banded and 30 (21%) were radio-marked with 14g necklace mounted transmitters (Riley and Fistler 1992). Thirty-four birds (seven with radios) were released on Tract One (366 ha), 20 birds (four with radios) on Tract Two (130 ha), 45 birds (nine with radios) on Tract Three (486 ha), and 44 birds (ten with radios) on Tract Four (697 ha). Radios were marked with a $10 reward message printed on the back including the address of the Department and were programmed with four-hour mortality sensors (Advanced Telemetry Systems, Isanti, MN 55040). Radio tracking was conducted with two-element and whip (omni directional) antennas and monitored daily.

Hunter interviews were conducted for ten days (October 29 to November 7, 1999) on the four tracts using a roving creel survey (Malvestuto 1983). To contact hunting parties on the study tracts, surveys were conducted by vehicle during one-hour observation periods. Four days were weekends (50% sampling days). On these days, tracts were surveyed for ½ of the survey time. For example, one technician surveyed for one hour on Tract One, followed by a survey on Tract Two for one hour; this was repeated throughout the day. The other technician surveyed Tracts Three and Four in the same manner. The remaining six days were weekdays (25% sampling days). On these days, one technician surveyed each tract for ¼ of the survey time. For both methods, the first tract sampled was randomly selected each day.

Information concerning group effort and success was gathered during each interview following standardized questions (Appendix A). Effort outside of the tracts was estimated beginning with the time each group began hunting for the day and ending with the time they began on the tract being surveyed. Effort within tracts of released pheasants was estimated from the time they

began on the tract to the time interviewed (Malvestuto 1983). Harvest data both inside and outside of the tract being surveyed was recorded.
Hunter harvest and effort during the survey period was estimated using the following equations.

Total number of hunters per hour is calculated using Equation 1:
hunters contacted per hour = (total # of hunters contacted) / (total # survey hours)

Estimate of the number of hunters using the isolated tracts is calculated with Equation 2:
hunters on study tracts = (# hunters contacted /hr) x (available shooting hours)

Average number of visible shooting hours was based on the shooting hours published in the IDFG waterfowl regulations and multiplied by the number of days in the survey period to estimate the available shooting hours.

Effort to harvest pheasants was estimated with Equation 3:
Harvest Per Unit Effort = HPUE (birds/hr) = (# birds harvested) / (# hours hunting)

Hunter success was estimated with Equation 4:
Hunter success = SUCCESS (birds/hunter) = # birds harvested / # hunters in group

Number of pheasants harvested was estimated with Equation 5:
birds harvested = # hunters x average trip length (hrs/hunter) x HPUE (birds/hr)

Average trip length is estimated from interviews of hunters with completed hunts.

HPUE and SUCCESS were obtained for each hunter group and these values were averaged for comparison of harvested wild and pen-reared pheasants using one-way analysis of variance (AOV) with a 0.05 level of significance. When variances were unequal, a Kruskal-Wallis one-way nonparametric AOV was used. Multiple comparisons among tracts were made when the overall AOV was significant.

Survival of radio-marked pheasants was estimated (Kaplan and Meier 1958) using the computer program Statistix 7 (Analytical Software, Tallahassee, FL) and multiple comparisons with the Gehan-Wilcoxon test. All birds were released on the same day so the staggard entry method (Pollock et al. 1989) was not required.

Results

During the first three days post-release, which included a weekend, ten (33%) of the radio-marked pen-reared pheasants were harvested, three (10%) were killed by predators, 14 (47%) survived, and three (10%) were missing. During the ten-day survey of hunters, which began immediately after release, 20 (67%) of the released pheasants were harvested, four (13%) were killed by predators, three (10%) survived, and three (10%) were missing. From the time of release to the end of the hunting season (31 days), 21 (70%) were harvested, five (17%) were killed by predators, four (13%) were missing, and none (0%) were known to survive. Survival estimates for the first ten days post-release was 11.5±12.2% and at the end of the hunting season, it was 0.0±0.0% (Figure 2). There was no difference detected in survival of radio-marked birds among the four tracts (P = 0.57, Figure 3). Assuming the telemetry data is representative of the 143 pen-reared pheasants released, at least 47 (33%) were harvested during the first weekend, 96 (67%) the first ten days, and 100 (70%) by the end of the hunting season.

Two technicians conducted 81 surveys for 83.8 hours of hunter interviews during the first ten days post-release. On weekends (50% sampling), 47 surveys for 48.1 hours were completed and during the week (25% sampling), 34 surveys for 35.7 hours were completed. The average available shooting hours was 11.2 hours/day providing 112.4 hours of hunting time during the ten-day sampling period. An average of 1.23 hunters/hr were contacted (Equation 1). An estimated 138 total hunter trips (Equation 2) occurred on the tracts.

We contacted 167 hunters (Table 1) in 109 groups and most (78%) of their harvest was wild pheasants. Eighty percent of the effort and 70% of the total pheasant harvest occurred on weekends. Only two pen-reared pheasants were harvested off the tracts. Hunter effort (HPUE, Equation 3) and success (SUCCESS, Equation 4) were not significantly different between hunting on and off the tracts for wild and pen-reared harvest combined (Table 1). There was no difference in effort or success between wild and pen-reared pheasants hunted on the tracts or between wild birds hunted on and off the tracts (Table 2).

Fifty-one hunters (22 groups) were interviewed with completed hunting trips and averaged 55.2±21.8 minutes/hunt. These hunters harvested 18 pen-reared and nine wild pheasants and spent 43.6 hours hunting the tracts. There was no difference in hunter effort or success between wild and pen-reared pheasants (Table 3). Total harvest from the tracts during the ten-day sampling period was estimated to be 74 pen-reared (51.8%) and 60 wild roosters (Equation 5).

Discussion

High return rates for game-farm pheasants released before the gun is important to shooting preserves and game agencies to maximize funds spent on stocking pen-reared birds. Most of the harvest occurred in our study during the first ten days after release, which is consistent with higher rates of return for birds released immediately before the gun. Burger (1964) reported 50% harvest of pen-reared pheasants released during the hunting season. For birds released 1-2 hours before the gun, Burger and Oldenburg (1972) found 64, 68, and 71% harvest rates for the three years of the study on a shooting preserve. They found 63% of the birds harvested were released the same day of harvest, another 20% were harvested within one week of release, and 94% of the birds harvested were released <4 weeks prior to harvest. During this study, hunter harvest of radio-marked birds within ten days of release was 67% with only an additional 3% by the end of the hunting season.

Game-farm birds released earlier than the hunting season show lower returns to the bag. Allen (1956:438) summarized Buss' (1946) study that showed hunters bagged 11% of pen-reared roosters released 35-110 days before the season as compared to 41% if released the day before shooting. Ginn (1947) found hunters harvested 3% of the 8,406 eight-week old chicks released the summer prior to the hunting season. Low (1954) reported 40-60% returns on game-farm birds released <4 weeks prior to the hunting season, 30% return for those released >4 weeks, and

10% return for birds released 31 weeks prior to the opening of the season. McNamara and Kozicky (1949) had higher harvest of game-farm birds released during the hunting season or <3 weeks prior, than for any other period. They also concluded the type of habitat pheasants were released into affected hunter harvest more than any other factor. Areas with better cover allowed greater survival of game-farm birds providing more for harvest. Diefenbach et al. (2000) found hunters harvested a greater proportion of pheasants released on public than private land because public land was more accessible.

Most studies of game-farm harvest have relied on band returns to monitor harvest. Using banding data to estimate harvest rates can produce unreliable data (Nichols et al. 1991). McNamara and Kozicky (1949) had their highest returns where check stations were maintained. Diefenbach et al. (2000) used reward bands ($5-$400) to determine hunter harvest of pen-reared roosters and hens. Our study monitored harvest of banded (no reward) and radio-marked ($10 reward collar) pheasants along with hunter interviews in the field using a roving survey technique. Our reward for the radios was not publicized so hunters probably did not target the release areas for the reward.

Hunting pressure may have been affected because of the unseasonably warm temperatures during the ten-day sampling period and the birds were released 13 days after the opening of the season. Typically, hunter pressure reduces after opening weekend (Allen 1956:70, 308).

Harvest rates appeared better on the isolated tracts (1.0±0.9 hrs/pen-reared and 3.2±3.2 hrs/wild bird from completed trip surveys) when compared to historical data and other studies. The historical Acequia Check Station (in same area as our study) operated prior to 1993, showed hunter harvest rates averaging 10.2±2.8hrs/bird during 1985-1992 (IDFG Magic Valley Region, unpublished data). Trautman (1982) found South Dakota hunters averaged 1.8±0.2 hours/wild bird harvested statewide during three-bird bag limit seasons in 1947-1974. It is unknown whether hunters were attracted to the isolated tracts because of the publicity of the game-farm releases or because of past hunting experience. Hunter effort and harvest on and off the tracts was not measured prior to release of pen-reared pheasants, so it cannot be determined if hunting pressure increased on the tracts because of the publicized releases.

Pen-reared pheasants tend to be more susceptible to predation. Low (1954) found that domestic dogs killed 38%, hawks 17%, house cats 13%, and skunks 3% of the game-farm pheasants he released. It could not be determined what kinds of predators killed the pheasants in our study, but most of the predation occurred during the first ten days after release.

Management Implications

If pen-reared pheasants are used to increase hunting opportunity, they should be released during the hunting season or immediately before the opening of the season to ensure maximum return to the bag. Managers should also advertise where birds are to be released to increase hunter harvest. Pen-reared birds released late in the season might not receive the same harvest rates as those released closer to opening weekend. These non-harvested birds may instead supplement food for predators. Leif (1994) suggested predation on wild birds might increase because predators may be attracted to the release of pen-reared pheasants.

The roving hunter survey provides a conservative estimate of harvest and effort. Harvest estimate from the roving hunter surveys was 38% lower than from telemetry data. Uncompleted trip harvest rates can be significantly different from completed trip interviews (Phippen and Bergersen 1991). Hunters may still be hunting when interviewed during a roving survey as compared to data obtained at check stations after the hunt is completed. In angler surveys, the probability of contacting an angler is proportional to the length of the trip (Malvestuto 1983). Malvestuto (1983) states that observers will tend to interview the public that spend more time in the area and overestimate the mean length of a trip. Pheasant hunters making quick trips might not be surveyed; thus, underestimating hunter effort. In our study, some hunters were not interviewed due to the size of two of the tracts and an insufficient number of surveyors. Vehicle access to several of the tracts provided "road hunting" opportunity which may have caused an underestimate of the actual hunter effort because these hunters were not interviewed. The use of strategically placed check stations is needed to obtain more reliable harvest estimates if telemetry is not used.

SURVIVAL OF PEN-REARED AND WILD PHEASANTS TRANSLOCATED INTO IDAHO

Abstract

Wild (52 males, 201 females) and pen-reared pheasants (470 males, 2130 females) were released into 6 areas in southern Idaho during 2000 and 2001, to augment low resident populations. Predators were removed in 2001 to increase survival of released pheasants. Survival was monitored using radio-marked wild (33 males, 182 females) and pen-reared (36 males, 179 females) pheasants. Wild hen survival was significantly greater than pen-reared hens in both years. For 323 documented radio-marked pheasant deaths; 54% were unknown causes, 26% mammalian predation, 11% avian predation, and 9% other causes. In 2001, wild hens had 56% nest success and pen-reared had 11%. Wild and pen-reared hens nested in similar habitat. Seven species of predators comprising 728 individual animals were removed by trapping prior to release and during the first 4 months post-release. Predator control did not increase wild or pen-reared hen pheasant survival. Due to low survival and production of young by pen-reared pheasants, spring releases to increase pheasant abundance should not be conducted in Idaho.

Introduction

Ring-necked pheasants have been studied extensively throughout North America (Olsen 1977, Trautman 1982), mainly due to its popularity as a game bird. Pheasants, as well as other small game in Idaho, are important for sport hunting and contribution to local economies (Young et. al. 1986). Declines in pheasant numbers in Idaho during the last two decades have initiated much controversy as to the proper management of the game bird. Habitat loss due to advances in farming practices, changes in predator compositions and abundance, increased use of pesticides, and combinations of these have been assumed the reasons for the declines.

The response of pheasants to predator removal has been documented for wild resident birds (Chesness et al. 1968, Trautman et al. 1974, Nohrenberg 1999, Frey et al. 2003) but not for augmenting populations with pen-reared and translocated wild pheasants. Releasing pen-reared and wild pheasants have been used by several state agencies in attempts to repopulate former pheasant range, supplement low populations, start new populations (Trautman 1982), and augment hunting opportunities in the fall (Hill and Robertson 1988). Releasing pen-reared birds has not been an effective or efficient method of increasing populations due to predation (Trautman 1982, Rodgers 1989, Leif 1994) and poor reproductive success (Hill and Robertson 1988). Harper et al. (2000) monitored pen-reared pheasant survival and reproduction but limited their predator removal to nest predators. No peer-reviewed studies have compared the combination of stocking pheasants with predator removal. The purpose of this research was to monitor a project initiated by the concerned sport-hunting public and Legislators of Idaho.

Objectives

1. Estimate the survival and reproduction of translocated wild and pen-reared pheasants released into areas with and without predator removal.

2. Estimate effectiveness of predator removal on predator abundance.

3. Estimate cost of translocating wild and pen-reared pheasants and cost of predator removal.

Project Areas

Wild and pen-reared pheasants were released in six areas in Idaho within the Snake River Plain in 2000 and 2001 (Figure 4). In 2000, four areas were monitored and in 2001, two of these same project areas were used again and two were added. One area was part of a separate pen-reared pheasant release project coupled with predator control in 2000 and then was added to our project in 2001.

The Snake River Plain was described by Davis (1952) and was originally dominated by semi-desert vegetation such as sagebrush (*Artemisia tridentata*) blue-bunch wheatgrass (*Psuedoroegneria spicata*), blue grasses (*Poa* spp.), and needle grasses (*Stipa* spp.). Currently, much of the Snake River Plain has been converted to irrigated agricultural crops dominated by alfalfa, winter wheat, corn, beans, sugar beets, potatoes, road and canal right-of-ways, and irrigated and non-irrigated pasture.

Release areas in 2000 were chosen by local advisory groups, which were appointed by state legislators to represent the interests of the local sport-hunting public. The advisory groups chose the sites based on their hunting experience and, in their opinion, areas having adequate habitat but low pheasant numbers.

Three project areas, each with pheasant monitoring in 2000 and 2001, were mapped in 2001 to determine cover types within a 4.8 km (three mile) radius of the center of the release sites. Aerial photos were used to identify edges of cover types, classified on the ground, and digitized with ArcView (ESRI Redlands CA 92373-8100).

C. J. Strike Wildlife Management Area (WMA)

This project area (87 km^2) borders C. J. Strike Reservoir in Owyhee County and has flat to rolling topography (756-856 m) and includes the state-managed C. J. Strike WMA, where the birds were released. The area is dominated by uplands with shrub-steppe cover, open water in the reservoir, wetlands at the mouth of the Bruneau River and Jacks Creek, groves of Russian olives (*Eleaegnus angustifolia*), and the adjacent private farmland is dominated by irrigated alfalfa and row crops. Several food plots with mixtures of corn and sorghum are intermingled among the tree groves on the WMA. This area was monitored in 2000 by Harper et al. (2000) and in 2001 for our project. Both years included predator removal.

Minidoka/Cassia

This area (77 km^2) of private land is at the southern boundary of Minidoka County and separated from the northern boundary of Cassia County by the Snake River and hereafter called Mini-Cassia. The area is surrounded by rural urban development (Burley, population 8,700, is on the southeast edge of the study area) and row crops. The release site was a wetland with small ponds surrounded by shrub-steppe habitat paralleling the Snake River. Agricultural crops dominating the area includes sugar beets, alfalfa, and winter wheat. Topography is mostly flat with an elevation range of 1,262-1,281 m. A Pheasants Forever corn food plot is also at the release site. This area was monitored in 2000 and 2001.

Jefferson

The area (75 km^2) is entirely on private land in Jefferson County and bisected by the convergence of the Snake River and a tributary (Dry Bed). The area is dominated by small farm fields of alfalfa, grass hay, and winter wheat and large irrigated and non-irrigated pastures dominated by orchard grass (*Dactylis glomerata*) and cheatgrass, respectively. Dry-land pastures also contain rabbitbrush and scattered sagebrush. Riparian zones are dominated by willow, Woods' rose (*Rosa woodsii*), and golden current (*Ribes aereum*). The topography is flat along the rivers (1,453 m) and rises to the southeast to Lewisville Knolls (1,498 m) which are dominated by cheatgrass and sagebrush. This area was monitored in 2000 and 2001.

Minidoka

This area (31 km^2) is 16 km north of the Mini-Cassia study area in Minidoka County. Farm fields are larger, dominated by potato/sugar beet crops with escape cover limited to small knolls of unfarmed lava rock protrusions supporting annual herbaceous cover. The topography is mostly flat and rises to the northwest to Kimama Butte, a rocky knoll of public land dominated by sagebrush with an understory of cheatgrass. Elevation ranges from 1,290-1,550 m. This area was studied in 2000, only.

Madison

This area (18 km^2) of private land is at the confluence of the Teton River and Henrys Fork of the Snake River in Madison County and is dominated by grazing pastures with willows, cottonwoods (*Populus trichocarpa*), red osier dogwood (*Cornus sericea*), sedges (*Carex* spp.), and rushes (*Juncus* spp.). Dryer portions are farmed with small fields of winter wheat, potatoes, and alfalfa. The topography is flat with an elevation range of 1,471-1,476 m. The rivers have numerous oxbows that flood in late spring-early summer (May-June). This area was monitored in 2000.

Mud Lake WMA

This project area (36 km^2) is on the north side of Mud Lake (irrigation reservoir) in Jefferson County having flat topography (1,463-1,476 m). The area is dominated by wetlands along the shore of the lake, alfalfa fields grown as nesting cover on the state managed WMA, and shrub-steppe along the edge of the desert. Annual release of pen-reared rooster pheasants occurs on the WMA during the pheasant hunting season. This area was monitored in 2001.

Methods

Wild Pheasant Translocation

Wild pheasants were captured in Oregon (Malheur National Wildlife Refuge) and California (Sacramento Valley) during the last week of both February and March 2000, respectively (Table 4), and exclusively from California during the last week of March 2001 (Table 5). Mist nets and walk-in baited traps (Nohrenberg 1999) were used in Oregon and night-lighting (Giesen et al. 1982, Wakkinen et al. 1992) was used in California. All wild birds were tested for diseases and were not released into Idaho if positive for: *Mycoplasma gallisepticum*, *M. synoviae*, *M. meleagridis*, *Salmonella pulorum*, *S. typhimurium*, Avian hemorrhagic enteritis, Avian influenza, and Avian Paramyxovirus. Birds were weighed prior to transport and reweighed before release in 2000. Only radio-marked birds were weighed prior to release in 2001. Wild birds were transported in padded wooden crates and given sliced melons during transportation by open-bed truck.

While in captivity and awaiting results of blood tests in 2001, pheasants were held in transport boxes for six days under a three-walled metal equipment shed (open on shaded side) and provided small grain, water, grit, and a mixture of watermelons and cantaloupe. Straw was replaced once/day in the crates.

Battery-powered 14g necklace radio transmitters (Riley and Fistler 1992) were attached prior to transport to release sites. Only pheasants weighing >700g were radio-marked to keep transmitters ≤2% of body weight (Kenward 1987). The transmitters were programmed with four-hour mortality sensors (Advanced Telemetry Systems, Isanti, MN 55040).

Wild translocated pheasants were passively released in both years. The padded lids of the transport crates were pulled open simultaneously with a string by observers in concealment. The birds were allowed to walk or flush from the site.

Game Farm Pheasant Releases

In 2000, ten-month-old pen-raised stock were purchased ($9.50/bird) from Dorris Gamebird Farm, Marsing, Idaho, during the first week of April 2000. Birds were raised with rubber nasal blinders in typical open flight pens. Birds were transported in wooden crates during late afternoon-early evening in open-bed trucks from the game farm to the Magic Valley Regional Office in Jerome (2.5-hour drive), held overnight, then fitted with bands, radio-collars, and blinders removed prior to release. Of the 319 hens and 70 roosters released, 99 hens and 16 roosters were radio-marked (Table 6).

Pheasants were released within 32 hours of removal from the game farm in 2000. Only radio-marked birds were weighed before release. The game farm transport crates had wire mesh sides that allowed birds to poke their heads out of the crate. To avoid damage to the radio transmitters, radio-marked birds were transported from the office to the release site in the same padded crates used to transport wild birds. The non-marked birds were transported to the release sites in wooden crates used by the game farm. The birds were actively released from all the crates. Pen-reared pheasants tend to stay in transport crates when opened and, therefore, need to be shaken out to be released, which is typically done when releasing birds before the gun.

Similar aged birds were released in 2001, but pheasant stock was purchased from the Simpson Gamebird Farm, Grandview, Idaho ($9.50/bird). Birds were radio-marked three days prior to release and held in pens with the other birds to allow acclimation to the radios upon request of the game farm owner. Of the 1,811 hens and 400 roosters released in 2001, 80 hens and 20 roosters were radio-marked (Table 6). The birds were released within ten hours of leaving the game farm and were released in two stages, corresponding with favorable ground conditions at the release sites. The C. J. Strike WMA and Mini-Cassia sites were stocked March 15 and 16, respectively. Birds were stocked 2 weeks later on March 29 and 30, at Mud Lake WMA and Jefferson, respectively. The areas stocked later are at higher elevations and become snow free later than C. J. Strike WMA and Mini-Cassia.

Radio-marked pen-reared pheasants were transported in the same style of transport crates as non-radio-marked birds in 2001. These transport crates were designed differently than the ones used in 2000; the wire mesh sides were more tightly woven and did not allow heads to poke out of the crates. All pen-reared birds in 2001 were actively released, similar to the 2000 birds.

As part of a separate project in 2000, 290 hens (74 radios) and 50 roosters (no radios) were purchased from the Simpson farm and released at C. J. Strike WMA (Harper et al. 2000). A local hunting enthusiast purchased a majority of the birds and the game bird farm donated the rest. Birds were radio-marked and held three days then released. The radio-marked birds were released in three stages, a group of 50 with the original release on April 7, then two groups of 12 hens each, ten and 20 days after the initial release. The 24 late-released birds were fitted with radios recovered from deceased birds from the initial release. In 2001, I used the same release area and game farm stock as used by Harper et al. (2000).

Telemetry and Survival

Radio tracking was conducted on the ground with three-element yagi antennas 2 times/week in 2000 and 3-5 times a week in 2001 from day of release to October 1 each year. Aerial telemetry was used to locate missing transmitters. A dual yagi four-element null/peak system mounted in the bed of a truck was used in 2001 but was found to be inaccurate for triangulation due to interference with overhead power lines.

Mortalities were recovered to determine cause of death (Einarsen 1956). During 2001, whole carcasses and fragments were retrieved and frozen for later necropsy. Field notes describing the death location and other information, e.g. predator tracks and sign, and conformation to characteristics presented by Einarsen (1956) were used to determine cause of death. Coordinates (UTM) for radio recovery sites were recorded in 2001 to measure distances from release sites. Time of death was defined as the mid-point between the first mortality signal and the last live contact. Kaplan-Meier staggard entry survival (Pollock et al. 1989) was estimated with the computer program STAGKAM (Kulowiec 1988). Chi-square tests were used to protect multiple comparison Chi-square tests (Hines and Sauer 1989).

Pheasant Abundance and Production

Roadside crow counts (Luukkonen et al. 1997) were conducted three times during the breeding season (April 15 - May 30) as an index to pheasant abundance in 2001. Three roadside brood counts were conducted during the first two weeks of August 2001, on the same routes as the crow counts.

Immediately upon hatching, abandonment, or destruction of the nest, the following observations were recorded: fate of nest (Rearden 1951), number of eggs hatched as determined by membrane counts, cover-board measurement (Jones 1968) at the nest bowl, height of cover over nest bowl, cover type, minimum distance to change in cover, and the UTM coordinate of the site with a GPS unit. Clutch size was determined in 2001 by flushing the hen from the nest during the last week of incubation. Nest success was defined as the successful hatch of at least one egg. Hens with successful nests were monitored for brood survival by flush counts at four and eight weeks post-hatch (Nohrenberg 1999) in 2001. A radio-marked hen with at least one chick was considered a successful brood.

Release Site Cover

Cover type was determined in 2001 for project areas that were monitored in both 2000 and 2001 (C. J. Strike WMA, Mini-Cassia, and Jefferson). Aerial photos were obtained from the Department of Lands and were used as a base layer to classify cover in 2001. Aerial photos were digitized using ArcView (ESRI, Redlands CA 92373) to determine percent cover within 4.8 km of the release site for 2001 cover.

Predator Abundance

Predator abundance was estimated in 2001. Scent station surveys and spotlight counts were conducted on the same routes used for crow counts and brood surveys. Scent station surveys (Roughton and Sweeny 1982, Travaini et al. 1996, Sargeant et al. 1998) were conducted on 20 stations in each 2001 project area during the first week of August, after predator removal ceased on August 1. Stations were monitored for four evenings of exposure. Roadside spotlight counts were conducted June-July and involved one person driving a truck 16-24 kph while an observer scanned with a one million candle power spotlight from the open bed of a pick-up. Animals were identified with binoculars. Raptors were counted (Hatfield et al. 1996) along the same survey routes throughout the entire project period (April-August) in 2001.

Predator Control

Predator control was contracted to private trappers within the 2001 study areas (Jefferson, Mini-Cassia, C. J. Strike WMA, and Mud Lake WMA) and in 2000 on C. J. Strike WMA. Predator removal started at least one week before pheasants were released. Target species are listed in Appendix B. Predators were removed within a radius of 4.8 km (72 km^2) from the release site. No trapping occurred within 0.8 km (½ mile) of city limits. Padded leg-hold (#1.5, #3) traps were provided for trapping near residences to avoid harming domestic pets (Olsen et al. 1988, Onderka et al. 1990, Hubert et al. 1997). Unpadded steel jawed traps and conibear (#120) were used when trapping in remote areas. Some trappers also preferred using snares in addition to leg-hold traps. Walk-in circular live traps (Alsager et al. 1972) were used to remove corvids. Chicken eggs and carrion were used as attractants. Trappers concentrated their efforts within 1.6 km of the release site prior to pheasant release and targeted mammalian predators. Avian predator (corvids) trapping started after pheasants were released.

Trapping was concentrated on suitable cover, i.e., travel lanes and den sites. Landowners were mailed information regarding the predator control project and trappers were restricted to those granting permission. All captured predators were euthanized and disposed of according to rules set by the Department (Appendix B). Trappers recorded their time, number of trap nights, and number and species of predators trapped for two-week periods throughout the trapping season.

Results

Translocation

Wild Pheasants - In 2000, 149 wild pheasants (117 hens, 32 roosters) were released within 72 hours of capture. In 2001, 104 wild pheasants (84 hen and 20 rooster) were released within 144 hours of capture. Birds were held four days longer in 2001 due to a delay in obtaining the results of the blood tests. I compared the release weight of hens captured from the same location in California (Upper Butte Basin WMA) between years to test the effect of being held longer in captivity. Hens ($n = 64$) held six days in 2001 weighed 921 ± 20 g and were significantly heavier ($P = 0.0002$, Wilcoxon Rank Sum test) than hens ($n = 46$) held two days in 2000 and weighing 856 ± 26 g. Hens in 2000 from the Upper Butte Basin WMA lost 144 ± 12 g from time of capture until release. This is possibly the amount of weight the hens gained back while in captivity in 2001, but weight change was not measured in 2001. There was no difference (P = 0.1979, Wilcoxon Rank Sum test) in exposure days after release for the 2000 (109 ± 17 days) and 2001 (114 ± 17 days) Upper Butte Basin WMA hens. Exposure days is defined as the number of days a bird was tracked alive to the last point of contact. Kaplan-Meier survival estimates of hens from Upper Butte Basin WMA were not different (P = 0.7483, Gehan-Wilcoxon test) between 2000 (35.2 ± 14.9 %) and 2001 (39.9 ± 12.4 %).

Pen-reared Pheasants - Birds from the Simpson Gamebird Farm were noticeably more shy to human presence while in the pens than the Dorris Gamebird Farm stock. Upon entering a pen, birds quickly walked to the opposite end of the holding pen at Simpson's farm. At Dorris', the birds appeared to remain closer to humans in the pens and did not move to the opposite end of the pen, en masse.

Weight

Pen-reared hens were not different in weight between the two game farms but were significantly heavier than wild hens (Table 7). Weight of pen-reared roosters were similar between the game farms (Table 7). Wild roosters in 2000 were lighter than both years for pen-reared and wild roosters in 2001.

Survival

Survival was estimated for each project area (Table 8). Survival estimates were pooled by gender and year (Table 9). Survival estimates from C. J. Strike WMA was not pooled because it had predator control and the other areas did not in 2000. Survival for C. J. Strike was pooled with the other areas in 2001.

Wild hen pheasants had higher survival than pen-reared hens for both 2000 and 2001 (Table 9). Wild roosters had higher survival than pen-reared roosters only during 2001 (Table 9).

Jefferson and Mini-Cassia were the only areas where the effects of predator control on pheasant survival can be compared; both areas had no predator control in 2000 and one season of predator control in 2001 (Table 10). The only increase in survival was detected for wild roosters in 2001.

Differences in survival of pen-reared hens released at C. J. Strike WMA (Table 8) could not be detected (Chi-square = 1.660, 1 df, P = 0.1976) between 2000 (0.11 ± 0.07) and 2001 (0.26 ± 0.22) release years.

Time Specific Mortality

Most mortalities of pen-reared pheasants occurred during the first week post-release in 2000 for both hens and roosters (Figures 5 and 6, respectively). Most of the radio-marked wild roosters died within 30 days of release, but most of the wild hens died >30 days post-release in 2000. In 2001, most of the pen-reared hens (Figure 5) and pen-reared and wild roosters (Figure 6) died within 30 days of release, but most of the wild hens died >30 days post-release.

Daily survival showed a steady rate of decline for wild hens in both years and appeared to decline at a more steady rate for pen-reared hens in 2001 (Figure 7) than in 2000. Daily survival rates for pen-reared roosters showed a more drastic and rapid decline in 2000 than in 2001 (Figure 8). Wild roosters in 2000 showed a more steady decline than pen-reared roosters in both years. Wild roosters in 2001 had a stable survival curve for most of the monitoring season.

Only two project areas (Mini-Cassia, Jefferson) were consistent in their treatments during 2000 and 2001 to warrant comparisons pre- and post-predator removal. Survival curves (Figure 9) show a greater rate of mortality for pen-reared hens during the year before predator removal (2000) and a more steady rate after predator removal (2001). Wild hens appeared to be unaffected by the influence of predator control. Sample sizes for pen-reared and wild roosters are too low to make comparisons but are shown in Figure 10. Also, no wild roosters were radio-marked in Mini-Cassia in 2000.

Cause Specific Mortality

Specific causes of mortality could not be determined for a majority (54%) of the documented pheasant deaths (Table 11). The amount of deaths classified as unknown were reduced in the second year of the project due to doubling the number of personnel monitoring the radios. Increased monitoring in 2001 allowed technicians to determine cause of death before the carcasses were scavenged.

Mammalian predation was the dominant cause of mortality during both years. Avian predation increased during the second year but is most likely a result of quicker retrieval times and does not necessarily invoke an actual increase, more likely an increase in detection. Though no radio-marked birds were killed by predator traps, at least five pen-reared pheasants were found dead caught in leg-hold traps in 2001.

It appears pen-reared hens had higher predation-induced deaths than wild hens (Figure 11). Deaths caused by hay swathers occurred for hens attempting to incubate nests on private land within the C. J. Strike project area.

No avian mortality for pen-reared/wild roosters was detected in 2000 and no mammalian mortality was detected for wild roosters in 2001 (Figure 12).

One wild hen died of a herniated cloaca and was found next to her nest of viable eggs in 2000. One pen-reared rooster was found with a willow branch completely penetrating his torso in 2001. Bruising of the muscle surrounding the stick was definitive evidence the bird was alive when it struck the willow patch, possibly while attempting to land on a river bank. One wild hen was determined by clinical examination of tissue to have died of avian tuberculosis in 2001.

Dispersal

Pen-reared hens in 2000 were found dead further from their release site than 2001 pen-reared and wild hens (Table 12). Wild hens in 2000 were found dead further than 2001 pen-reared hens.

Differences between wild and pen-reared roosters could not be determined due to low sample sizes (Table 13). All birds were generally found dead within 3 km of release sites.

One wild hen in 2000 moved > 5 km from her release site in Madison and then was missing. One wild hen in 2001 was tracked 11.4 km from her release site one month after she was released in Mini-Cassia and stayed in this area throughout the tracking period. In general, most of the released pheasants remained within 5 km of the release sites.

Nesting

Seventeen wild radio-marked hen pheasants attempted nests and nine (53%) were successful in 2000 (Table 14). Only one pen-reared hen was detected nesting in 2000, but was depredated by an avian predator in a pasture next to a nest bowl with no eggs laid and within two meters of a perch site.

Eighteen of 32 (56%) wild nests and one of nine (11%) pen-reared nests were successful in 2001 (Table 14). Most nests of wild hens in 2000 were in winter wheat fields and most were in idle herbaceous cover (weeds) in 2001. Most of the pen-reared hens in 2001 nested in weed patches, but the only successful nest was in a potato field. This nest was 490 m from her first abandoned attempt in shrub-steppe cover. No patterns could be determined for the cause of nest failures in 2000 (Table 15) or 2001 (Table 16) due to small sample sizes. There were no differences in three habitat variables compared between wild and pen-reared nests (Table 17). Pen-reared hens nested closer to the release sites than wild hens in 2001 (Table 18).

Production

Clutch sizes were not different between wild and pen-reared nests during their first year of release (Table 19). Statistical comparisons could not be conducted due to poor sample sizes for the number of eggs hatched, hatch date, and brood sizes. Hatch dates for wild hens in 2000 (July 4 ± 31 days, n = 6) appeared to have more variation than wild hens in 2001 (June 28 ± 13 days, n = 15).

Release Site Cover

Only three project areas had consecutive-year releases of pheasants and were cover mapped in 2001 (Table 20). Seventeen cover types were identified with alfalfa and right-of-way ranking in the top five categories for all three areas.

Pheasant abundance

Pheasant abundance counts were only conducted in 2001. C. J. Strike WMA appeared to have the highest crow counts with Mud Lake WMA having the lowest (Table 21). C. J. Strike appeared to have the highest production of broods with Mini-Cassia the lowest (Table 22).

Predator control and abundance

Predator control started two days to six weeks prior to pheasant release. C. J. Strike WMA had the longest predator trapping period before pheasants were released and Mini-Cassia had the shortest. Mini-Cassia had the most predators removed (Table 23). Magpies were trapped more than any other species (74%), followed by feral cats (10%), red fox (8%), coyote (7%), and others (1%). In 2001, trapping efficiency for magpies increased as the season progressed for all the project areas (Figures 13-16) and increased for skunks in Jefferson and Mini-Cassia. Coyote removal was steady for C. J. Strike WMA (Figure 13) and Mud Lake WMA (Figure 14), but declined in Jefferson (Figure 15) and Mini-Cassia (Figure 16). Red fox removal slowed during July in all areas.

Spotlight counts were conducted throughout the trapping season (Figure 17). Mud Lake WMA showed very little predator activity. Coyotes were still present at C. J. Strike WMA in late July but showed a declined in raccoon activity through the season. Mini-Cassia showed an increase in house cat presence. Jefferson increased in skunk activity during the season.

Scent stations were conducted immediately after the end of the trapping season (Figure 18), which ended 1 August. Coyotes and red fox were still present at C. J. Strike, Jefferson, and Mud Lake WMAs. A majority of attendance in Mini-Cassia was by house cats.

Roadside raptor surveys during 2001, showed a decline in numbers at C. J. Strike and Mud Lake WMAs, a steady increase for Jefferson, and a stable abundance at Mini-Cassia (Figure 19). Red-tailed hawk, Swainson's hawk, and northern harrier were the most abundant raptor species on the project areas.

Costs

Cost estimates were not determined for wild pheasant trapping in 2000. In 2001, an estimated $5,500 ($53/bird) was needed to capture 84 female and 20 male pheasants in California, transport them to Idaho, and release them on four areas. Pen-reared pheasants cost $9.50/bird to be released and totaled $21,000 for 400 males and 1,811 females. Using production estimates from radio-marked pheasants and the cost of release in spring, it cost $155/pen-reared egg hatched and $39/wild egg hatched. Estimates for brood survival were too limited to estimate cost/bird available for the fall harvest. In 2001, predator trapping cost $29.07/animal and $1.65/trap night. Cost of traps were not included in the estimate, only the contracted labor.

Discussion

Pheasant stocking

Pen-reared pheasants released into the same Idaho habitats as translocated wild pheasants had significantly lower survival. Leif (1994) had similar results in South Dakota when comparing survival of radio-marked pen-reared (7.8 $\pm$ 4.7 % [95%CI]) and wild (54.6 $\pm$ 11.8%) hens released in early April and monitored until October. He captured wild pheasants and translocated them within the same state. Leif (1994) excluded survival data from pen-reared hens that did not survive during the first three days post-release, which may have artificially increased his survival estimates. In 2001, we acclimated pen-reared pheasants to radio-collars but could not detect an increase in survival. Wilson et al. (1992) found 26-42% survival (February-June) for wild hens released within the same state where captured. Anderson (1964) released game farm and wild pheasants during the winter and found 28% and 52% survival to May, respectively. Ellis and Anderson (1963) hatched eggs from game farm stock in California and released the young during February and March and found 18-29% survival through June. Brittas et al. (1992) found significantly higher survival for wild hen pheasants (74%) than pen-reared (52%) for three months post-release (May-July) but found no difference in breeding success. They did find wild brood size was significantly larger 40 days after hatch than for pen-reared hens with broods. Niewoonder et al. (1998) found hybrid survival (28%) was greater than for both ring-necked (12%) and Sichuan (11%) pen-reared pheasants (April-October), but determined that survival was not adequate to sustain wild populations.

Wild roosters had higher survival during the year of predator control in our project. This may be because they were significantly heavier and possibly in better physical condition.

High mortality commonly occurs immediately after release of translocated stock as birds become acclimated to their new environment and is supported by our data. Wilson et al. (1992) found 20-25% mortality for wild hen pheasants during the first week after release. Translocated game birds may be more vulnerable to predation immediately after release due to increased movements while searching for adequate habitat (Kurzejeski and Root 1988, Musil et al. 1993). Burger (1964) attributed heavy initial mortality of game farm stock to “release shock,” rendering pheasants more vulnerable to predation. Allen (1956:351) recommended a “gentle release” of game farm stock to prevent release shock. This acclimation period in a “hardening pen” (Krauss et al. 1987) allows birds to explore their new environment while still being provided food, water, and shelter, especially if young birds are released. This would not be practical, though, if used on a wide-scale basis to supplement wild populations. Krauss et al. (1987) suggested that adding natural shelter to game farm pens during development may increase use of cover when birds are released and thereby reduce vulnerability to predators.

Several studies, including this project, have shown the inefficient ability of game farm stock to augment wild populations. Haensly et al. (1985) found it required seven game farm hens released in the spring to produce one rooster in the fall. They estimated releasing hens in the spring costs 14 times more than releasing roosters in the fall. Hill and Robertson (1988) determined breeding success was 2-5 times greater for wild than hand-reared roosters. They also found wild hens were four times more productive than hand-reared hens and hand-reared hens were three times more vulnerable to predation during April-August. Hill and Robertson (1988) estimated wild pheasants produce seven times more 12-week-old chicks than hand-reared hens. Wilson et al. (1992) suggested a February release of 150 translocated wild hens would be needed to have 50 survive to reproduction. Rodgers (1989) concluded stocking “…diverts attention and resources away from the real problems pheasants face, such as habitat loss.” Leif (1994) concluded, “Releasing pen-reared hens in spring to augment wild ring-necked pheasant populations is not a practical management option in South Dakota”.

Leif (1994) also suggested that releasing pen-reared pheasants increase predation on wild birds by attracting predators to the area. DeVos and Speake (1995) questioned whether they trained predators to hunt and capture wild northern bobwhite quail (*Colinus virginianus*) on areas where pen-raised bobwhites were released. Brennan (1991) raised concerns regarding spreading disease and forcing wild birds out of habitat due to releasing game farm bobwhites into wild populations. DeVos and Speake (1995) also speculated whether crossing wild bobwhites with game farm stock might lead to biologically inferior offspring.

Artificially supplementing game birds for harvest is not without criticism. Leopold (1933:394) cautioned the use of artificial means for wildlife management. He stated "A proper game policy seeks a happy medium between a game supply and that which deteriorates its quality or recreational value." He also stated, "The recreational value of a head of game is inverse to the artificiality of its origin."

Predator Control

Predation is a natural factor of population dynamics and its effect on upland game birds has been recognized for a long time (Leopold 1933, Trautman 1982). I could not detect an increase in pheasant survival in this project due to predator removal. Possibly, removal efforts were not conducted long enough prior to pheasant release and/or our sample sizes were too low. C. J. Strike WMA had >1 month of predator removal prior to pheasant release for both years, but we could not detect a significant increase in pen-reared hen survival. Wild hen survival was not different for C. J. Strike hens when compared to the other project areas where predator control occurred within two weeks of release. Predator control does appear to decrease the rate of mortality for pen-reared pheasants early after release.

Several studies have measured the effects of predator removal to benefit pheasants. Chesness et al. (1968) removed 16 species of predators (no red fox were present) and observed an average of 23%, 52%, and 123% higher nest success in trapped vs. un-trapped areas for three consecutive years. Pheasants averaged 28.9% nest success for the trapped area and 18.6% for the un-trapped area. They also found lower nest predation (18.7% depredation) in trapped areas than un-trapped areas (30.5% depredation). Hay mowing was the largest overall cause of nest destruction on both trapped and un-trapped areas combined (25% and 26%, respectively). Despite the benefit of predator removal on pheasant nest success, Chesness et al. (1968) concluded predator removal was not economically feasible for increasing pheasants over large agriculturally dominated areas because factors other than predation were affecting pheasant production.

Trautman et al. (1974) found intensive fox-only control showed little effect (19% pheasant increase), whereas multi-species predator control with strychnine-treated draw stations and treated eggs was effective (132% increase in pheasants). Nohrenberg (1999) could not show significant increases in pheasant abundance after multi-species predator removal. He suggested predator removal may have a threshold at which pheasant populations begin to respond positively. Possibly, our predator removal did not reach this "threshold" to show an increase in survival. Frey et al. (2003) detected no difference in pheasant recruitment, pheasants bagged/hunter hour, or hunter satisfaction between an area treated with multi-species predator removal and a non-treated area.

Most predator removal studies to benefit other upland game birds have been conducted in Europe where "game keepers" control predators. Parker (1984) found no effect on chick mortality, production, or nesting densities for willow ptarmigan (*Lagopus lagopus*) and black grouse (*Lyrurus tetrix*) after removal of hooded crows (*Corvus corone cornix*), ravens (*C. corax*), and black-billed magpies. He noted that compensatory nest predation by ermine (*Mustella erminea*) occurred in the absence of corvids. Marcstrom et al. (1988) removed foxes and martins (*Martes martes*) on two islands with capercaillie (*Tetrao urogallus*), black grouse (*Tetrao tetrix*), hazel grouse (*Bonasa bonasia*) and willow ptarmigan. Seventy-seven percent of hens had broods and averaged 5.2 chicks/brood and 4.2 chicks/hen with predator control, compared to 59% of hens with broods, 4.25 chicks/brood, and 1.94 chicks/hen without predator removal. They concluded predator removal produced a 2.2-fold improvement in productivity for grouse. Removal of fox, carrion crow (*Corvus corone*), jackdaws (*C. monedula*), magpie, and weasels (*Mustela* spp.) increased August numbers of grey partridge by 75% and increased the following spring breeding numbers by 36% (Tapper et al. 1996). Jenkins et al. (1964) determined that predation was not important in limiting red grouse breeding numbers because it was the dispersing birds that were susceptible to predation. Territorial birds were protected from predators because of the higher quality of habitat, which is limited. They concluded predators were taking surplus birds leaving managed areas. Schroeder and Baydack (2001) stated the reason Europe uses predator control more extensively than North America is they 1) have smaller and more isolated habitat, 2) depend more on pen-reared stock, and 3) are pressured economically to provide a harvestable product.

Few studies have occurred in the United States to test the effects of predator control on game birds other than pheasants. Edminster (1939) removed raptors and mammalian predators but concluded the effect on ruffed grouse (*Bonasa umbelus*) was not reflected in the fall harvest. Beasom (1974) controlled predators with traps and poison baits and concluded this "seemed to enhance reproductive success of wild turkeys…to a lesser extent, bobwhite quail…", but his results were not statistically tested. Guthery and Beasom (1977) found no increase in density trends of northern bobwhite (*Colinus virginianus*) or scaled quail (*Callipepla squamata*) after predator control.

Most predator removal studies in North America have centered around benefits to nesting waterfowl. These studies have shown nest success and production increases for waterfowl in areas with predator removal. Balser et al. (1968) found 60% more duckling production on areas with predator control but cautioned control should only be conducted on intensively managed production areas. Sargeant et al. (1995) studied the effects of predator removal on waterfowl production areas (WPAs). WPAs are small federal areas (61-301 ha) managed specifically for nesting waterfowl. They concluded it was difficult to efficiently control predators on the WPAs alone. The WPAs are in highly fragmented agricultural landscapes, similar to the Isolated Tracts in Minidoka County, Idaho (Leptich 1992). Sargeant et al. (1995) found that habitat fragmentation increased predator activity on the WPAs. Trappers were limited to padded leg-holds and could not use poison bait due to federal regulations on public land. They observed the hatch rate of ducks for predator removal areas and non-control areas at 13.5% and 5.6%, respectively. This hatch rate, despite predator removal, was below the recommended 15-20% threshold suggested to maintain waterfowl populations (Cowardin et al. 1985, Klett et al. 1988).

Sargeant et al. (1995) believed predators would have been more vulnerable outside the WPAs at den sites and buildings, and trapping could have been more efficient if multiple control methods could have been used. Greenwood (1986) found little benefit for waterfowl from removing only skunks (*Mephitis mephitis*) when fox and Franklin's ground squirrels (*Spermophilus franklinii*) were also present.

McCabe (1985) criticized the management of Horicon National Wildlife Refuge, which was experiencing >85% nest predation. He argued the area was no longer a waterfowl refuge, as originally intended when purchased, but rather a predator refuge. Duebbert and Lokemoen (1980) suggested predator control in combination with habitat management should be emphasized on land intensively managed for waterfowl production.

Predator removal effects may be short lived. Duebbert and Kantrud (1974) found no difference in predation rates within nine months after cessation of predator removal when comparing areas previously treated and areas with no removal. Beasom (1974) found predator numbers returned to pre-treatment levels within one year after trapping and poisoning stopped. Frey et al. (2003) suggested the short duration of predator removal effects are influenced by the size of the area treated. They concluded removal of predators from small plots (1,036 ha) allow predators from surrounding areas to quickly fill the empty territories, whereas larger plots (4,144 ha) appeared to reduce predator abundance for an extended period. Predator control areas in our project were 3,600-8,700 ha, but the trappers concentrated their effort near the release areas.

Along with red fox, the removal of corvid species has received much attention by the Idaho sporting public (pers. comm. with the general public). Jones and Hungerford (1972) determined the black-billed magpie was the most detrimental nest predator for pheasants but Novak (1956) concluded it played an insignificant predatory role, mainly eating insects during the pheasant nesting period. Removal of magpies and American crows (*Corvus brachyrhynchos*) is not new to the Department. Traps were constructed and tended by conservation officers, and bounties were paid on 55,675 magpies during 1938-1940 (Idaho Department of Fish and Game 1940). Raptors are also known to prey significantly upon pheasants. Wooley and Rybarczyk (1981) documented 32% hen mortality attributed to Federally protected raptors.

Domestic cats can also be a threat to several wildlife species including pheasants and other game birds. Warner (1985) found 12% of material deposited on door steps were pheasant parts. Hubbs (1951) and Eberhard (1954) found 11% and 2% of the cat stomachs they analyzed had pheasant remains, respectively, but failed to determine if the cats were scavenging. Coleman and Temple (1993) estimated an average density of 10-14 cats/km^2 for the entire state of Wisconsin and as high as 40-44 free-ranging cats/km^2 in two rural counties.

Petersen et al. (1988) summarized several pheasant studies and found mean annual hen survival ranged 22-53% and averaged 30-35% for a self-maintaining population. They concluded a minimum survival of 20% is needed for population maintenance and rates >40% are characteristic of rapidly increasing populations. Peterson et al. (1988:177) also stated "Findings indicate that, over time, fluctuations in pheasant abundance are more closely related to hen survival in winter and in spring than to reproductive performance. Therefore, predators of greatest concern are those that prey upon hen pheasants—nest predators or egg eaters are of secondary concern."

An alternative to predator removal is the use of non-lethal means to reduce predation. Training predators to avoid eggs treated with irritating chemicals and then spraying the chemical in the area of nesting birds might be an effective means to reduce predation without predator removal (Hoover and Conover 1998). They used pulegone to reduce egg depredation by coyotes but suggested it may be more useful for conspicuous eggs, such as colony nesting shorebirds, than cryptic eggs of upland game birds. Mason (1990) found D-pulegone was effective in reducing European starlings (*Sturnus vulgaris*) from depredating eggs. Crabtree and Wolfe (1988) reduced depredation of waterfowl nests from skunks by providing alternative food, which reduced the natural foraging behavior in nesting areas, but predation rates by other mammalian predators increased. Electric exclosures have been used to reduce depredation of waterfowl nests but are only effective for certain mammals and not for avian predators (LaGrange et al. 1995, Greenwood et al. 1990). Riley and Schulz (2001) summarized several habitat options to increase pheasant abundance and moderate the impacts of predators.

Diethylstilbestrol, a synthetic estrogen, has been used as an anti-fertility agent to reduce reproductive activity of red foxes (Linhart and Enders 1964) and coyotes (Balser 1964). Doses can be placed in bait and distributed in the wild prior to and during the mating season. The advantages of using non-toxic anti-fertility agents includes: it is more practical to prevent birth than to remove fully grown adults; it prevents compensation by the population to replace the missing individuals as occurs with removal methods; it eliminates the aversion to bait thereby increasing effectiveness; and it is safer to use than toxic agents (Balser 1964).

Reynolds et al. (1988:94) suggested "increasing interference" to reduce predators without physically removing them. They suggest predators may be "fooled" into believing a territory is occupied if scent could be applied to simulate a boundary. Fox are highly territorial and avoid other fox (Sargeant 1972) and coyote territories (Voigt and Earle 1983, Major and Sherburne 1987, Sargeant et al. 1987, Harrison et al. 1989).

Managing for coyote populations could be used as an alternative means to control red fox. Coyotes are less effective than red fox on depredating upland nesting waterfowl (Sovada et al. 1995), but this has not been studied for pheasants. Sovada et al. (1995) found 32% nest success on 17 study areas where coyotes were the principal canid and 17% nest success on 13 sites where foxes were the most abundant canid. If coyotes were not removed but foxes were, this might increase pheasant survival, at least for nesting hen pheasants. Sovada et al. (1995) suggested a density of one coyote family (2-4 adults)/25 km^2 would be enough to depress fox populations and benefit nesting ducks. They point out increasing coyote populations may effect other desirable species like big game and domestic livestock.

Few studies have measured effects of predator removal on species other than desirable game birds. Trautman et al. (1974) found 15% higher small rodent populations in fox-only control areas and 18% higher levels where fox, raccoon, badger and skunks (striped and spotted *Spilogale putorius*) were removed than in areas with no predator control. Marcstrom et al.

(1988) found no significant effect on small mammal abundance after removal of foxes and martins. Guthery and Beasom (1977) could not detect increases in rodents or lagomorphs when a variety of predators were removed but did see an increase in productivity and production of white-tailed deer (*Odocoileus virginianus*).

Removing predators to increase a game bird population may have indirect negative effects. In England, a parasitic worm (*Trichostrongylus tenuis*) that damages the intestinal lining of red grouse (*Lagopus lagopus scoticus*) reduces chick production and productivity (Hudson 1986). Highly infected red grouse are more susceptible to predation, and when depredated, are less likely to spread the infection to other grouse. "So, when predators remove a few of the heavily infected grouse they inadvertently reduce the worm population by a greater extent" (Hudson 1986:131). Removing predators increases the probability of spreading the parasite to uninfected grouse and ultimately reducing the grouse population.

McCabe and Kozicky (1972) supported predator control especially when their impact is excessive and also stated "Man is the only animal with the capacity to exercise restraint through judgment, but this capacity will avail him nothing unless he understands and believes that all things wild and free have a place in the natural order." … "If man takes this responsibility lightly, he may alter the natural order and indirectly threaten his own place in the unnatural order thus created."

Caution in predator control has been expressed by several wildlife professionals. Peek (1986) stated "Nowhere in wildlife management is the practice of using 'scapegoats' more prevalent than in issues involving predators." Peek (1986) also stated "It is much easier to investigate, place the blame, and control the fox in order to save the pheasant than it is to solve the ultimate problem of habitat loss." Berryman (1972) recommended use of predator control for disease suppression, protecting wildlife, and protecting domestic animals. He also recommended involving all agencies when deciding to conduct predator control. McCabe (1985) wrote "The application of predator control, like the use of wonder drugs, must be considered only as a last resort and in kind, amount, and timing to achieve a desired objective. To default on its use to avoid public criticism from an emotionally motivated minority is an error in moral as well as professional judgment. In short, at some times or in some places, predator control is necessary to maintain or obtain a given number of prey species."

One such time for using predator control might be when threatened or endangered species are at risk of extinction. Schroeder and Baydack (2001) concluded that predator control is an additional option as certain prairie grouse populations approach threatened status. Rollins and Carroll (2001) recommend the level of damage by predators be estimated beforehand as well as the economic and social cost associated with predator control.

Opposing public attitudes are important to consider when conducting predator control. The Department was picketed twice by the public prior to Nohrenberg's (1994) predator removal study (personal observation). Messmer et al. (1999) surveyed U. S. households and found the general public supports "…predator control more readily when it is used 'surgically' than when applied broadly." Support of predator control was greater when prey species were threatened or endangered and when predators were less charismatic. The public also had greater support for predator control to protect native vs. non-native avian species. We had no opposition from the public to our predator removal.

There is argument whether the red fox is native to Idaho and whether it should be controlled to benefit the non-native pheasant (pers. comm. with general public). Larrison (1967) commented the red fox in Idaho was found in mountainous areas but did not occur south of the Snake River Valley. Fichter and Williams (1967) determined the red fox has been present in western North America for at least 14,000 years based on skeletal remains in excavations and was first recorded in Idaho in 1891. They also documented the expansion of red fox in Idaho as reported by conservation officers, trappers, biologists, and predator control agents. Sargeant (1982) documented a similar expansion of red fox in the mid-west.

Predation may not be the ultimate limiting factor in pheasant abundance in habitat limited areas. Tapper et al. (1982) suggested other factors play an important role only when predators are removed. Reynolds et al. (1988:89) speculated if predation is removed, "…the prey population will shift to another equilibrium level determined by the remaining processes." In Idaho, the remaining processes may be territorial cover for roosters (Robertson 1996); undisturbed nesting habitat (Warner and Etter 1989); insect abundance for chicks (Southwood and Cross 1969, Rands 1985); severe winter weather (Leptich 1992, Perkins et al. 1997); or a combination of these.

Management Implications

Wildlife managers cannot expect adequate survival and production from pen-reared pheasants released in the spring even with birds appearing "wilder". To supplement wild populations, wild birds should be used. For wild pheasants, it cost 5.3 times more per bird to capture and release in the spring but 4.1 times less per bird produced in the summer than for pen-reared birds. Wild hen pheasants were 23 times more productive (eggs hatched/hen) than pen-reared hens in our project. Wild birds may cost more per bird initially, but ultimately cost less because they produce more than pen-reared stock. If stocking with pen-reared birds is to occur with the intent of increasing hunter harvest, then releasing roosters before the gun is more cost effective than releasing hens in the spring.

It cost the Department $155/pen-reared pheasant produced. If half the chicks are male and all survive to the opening day of pheasant season, then it costs $309/rooster available for hunting. This is about 30 times more expensive than purchasing pen-reared roosters in the fall and releasing them before the gun. For wild pheasants, it costs $77/wild rooster available in the fall produced by hens released in the spring. This is seven times more expensive than pen-reared roosters released before the gun but four times less expensive than spring release of pen-reared birds.

If wild pheasants are held in captivity prior to translocation, supplemental food and water can be easily provided at least up to six days without affecting survival. Wild pheasants will readily eat small grain and melons when held in padded transport crates.

Predator control immediately before translocation appears to slow the rate of mortality for pen-reared pheasants but does not increase overall survival for either pen-reared or wild translocated pheasants. Predators were still present after trapping ended in our project, so managers cannot expect all the predators to be removed.

Before predator control is used, baseline predation rates should be determined so effectiveness of predator control can be evaluated. Balser et al. (1968) recommended determining the severity of predator impacts before predator control is initiated. Jimenez and Conover (2001) also recommend decisions to implement predator control should be based on a cost-benefit analysis and stated "…there are no panaceas for the problem of reducing predation on nesting birds." They recommend managers use the right technique for the particular landscape and predators.

Pheasant surveys should be conducted prior to predator control or release of pheasants to properly evaluate population changes. Our project lacked the proper control and treatments needed to rigorously determine cause and effect of combining predator removal and pheasant stocking. In essence, the scientific method (Ratti and Garton 1994) should be used to develop future predator control or translocation projects, so proper inferences can be attained from the data.

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Cover photograph, courtesy of Bob Cameron, was taken during a release of wild pheasants into Minidoka County, Idaho, 2000.

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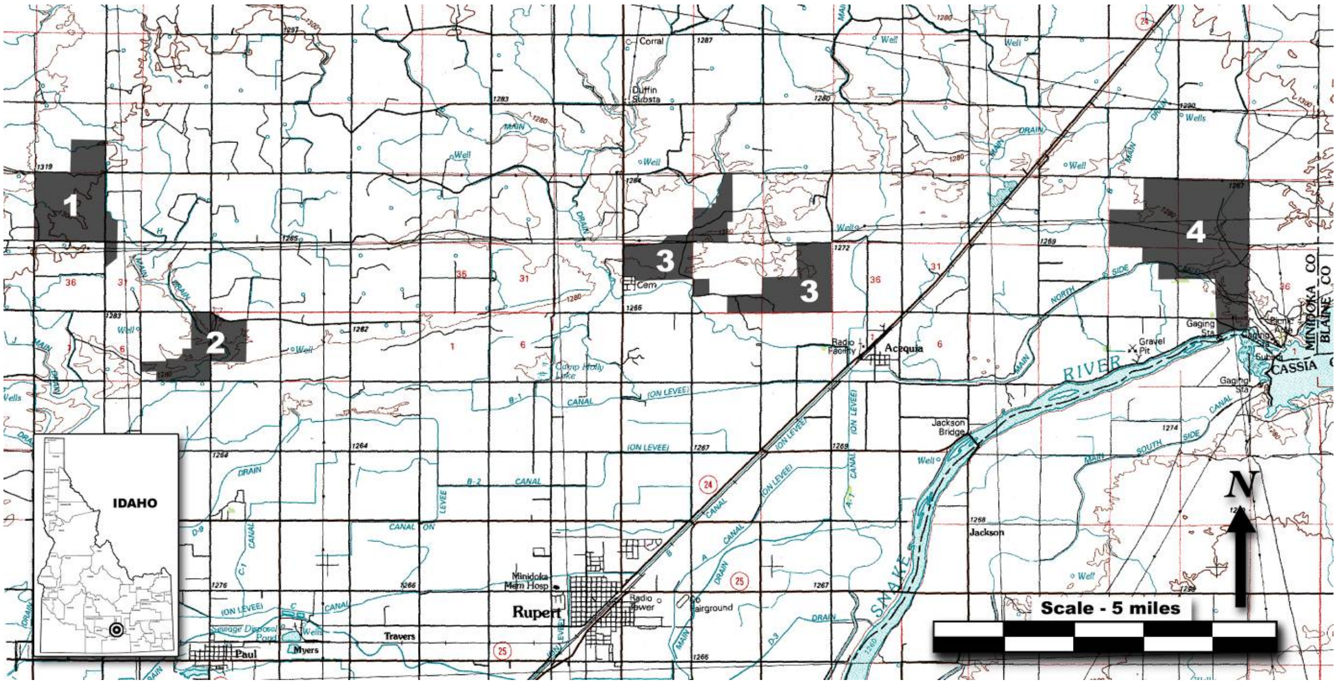

Figure 1. Four isolated tracts of public land (dark shaded areas with tract number) where 143 pen-reared rooster pheasants were released October 29, 1999, Idaho.

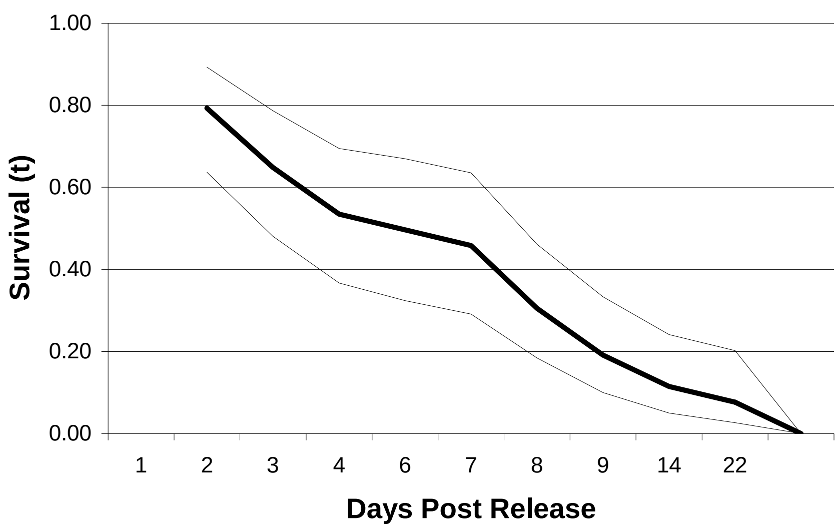

Figure 2. Survival S(t) estimates (thick line) bounded by 95% Confidence Intervals (thin lines) for 30 radio-marked pen-reared rooster pheasants released in Idaho October 29, 1999.

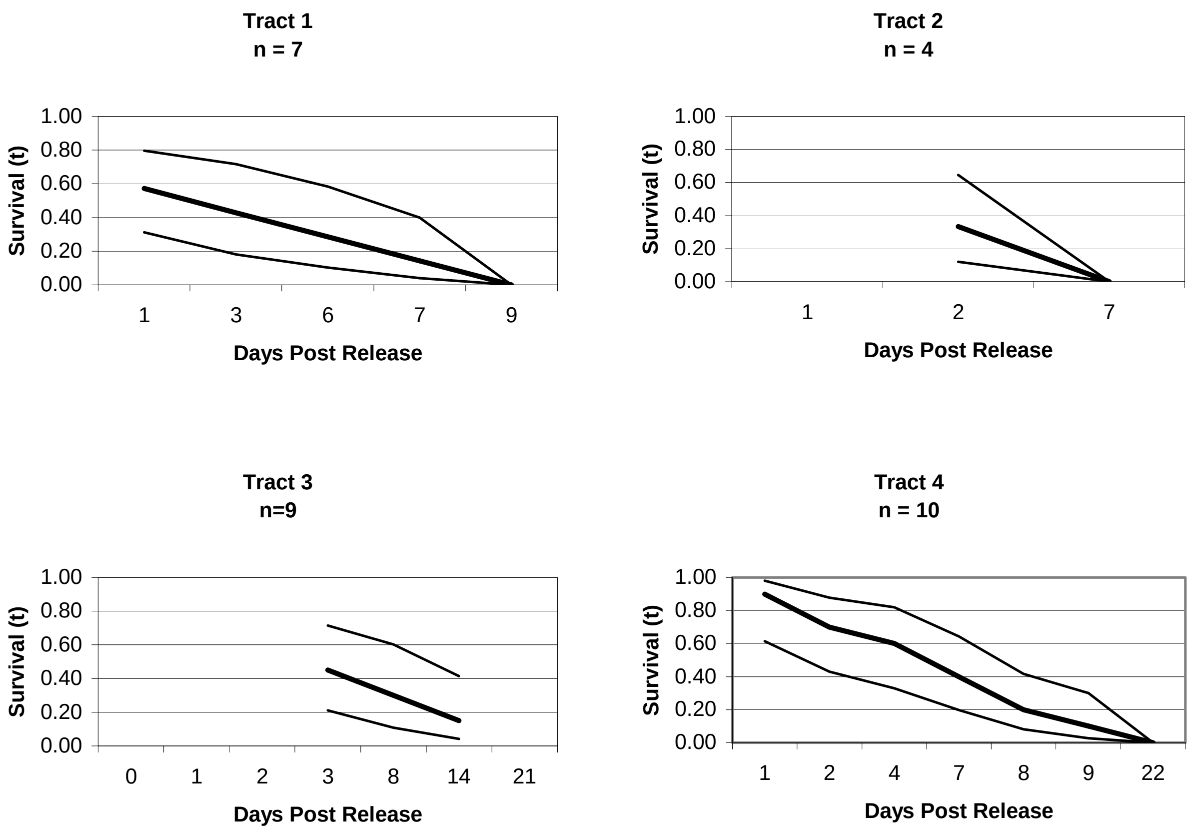

Figure 3. Survival S(t) of 30 radio-marked pen-reared rooster pheasants released into four tracts of public land October 29, 1999. Estimates (thick line) bounded by 95% Confidence Intervals (thin line).

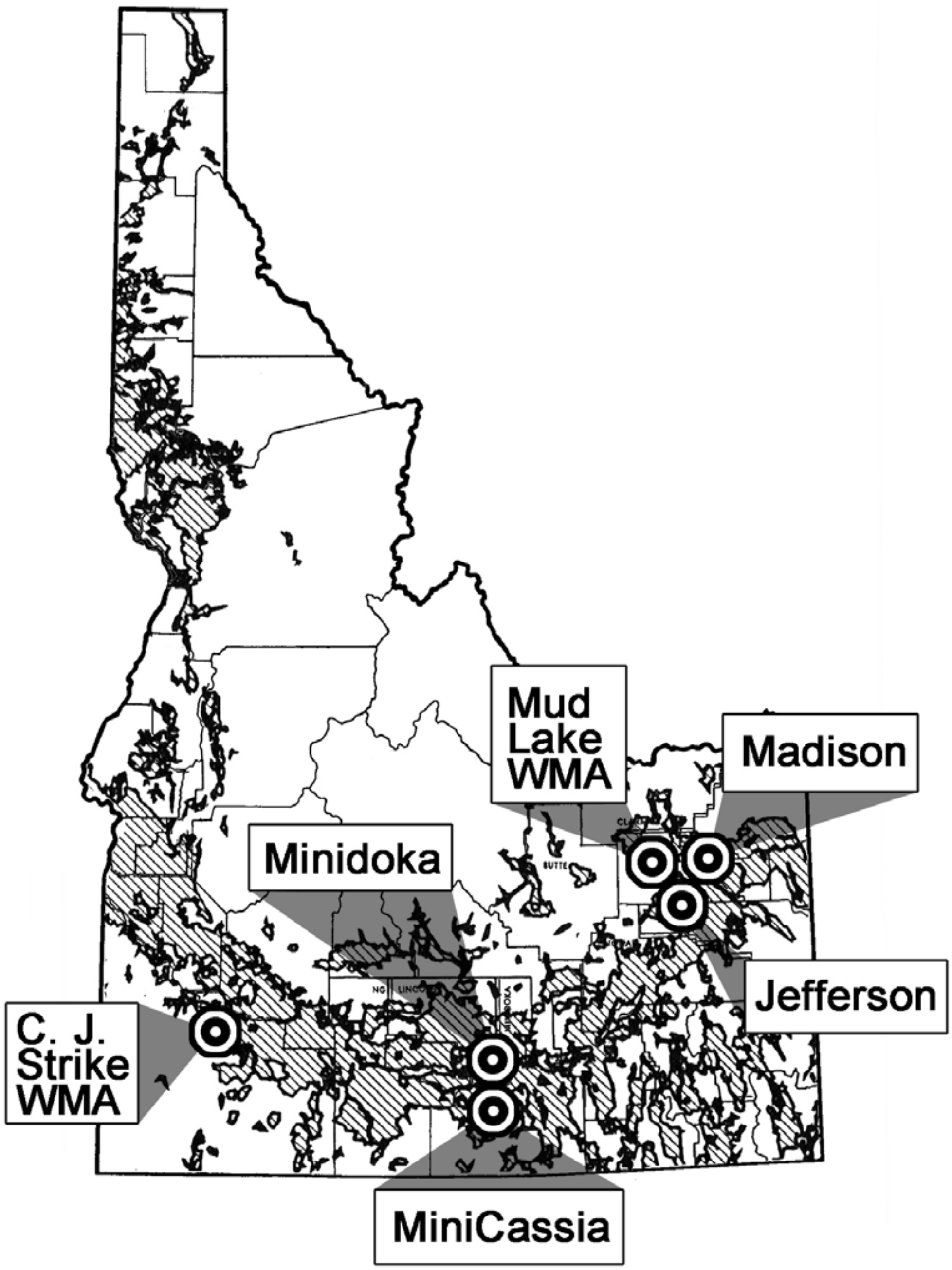

Figure 4. Project areas (circles) where pheasants were released and monitored in 2000-2001, Idaho. Cross hatching denotes pheasant distributions throughout Idaho (Groves et al. 1997).

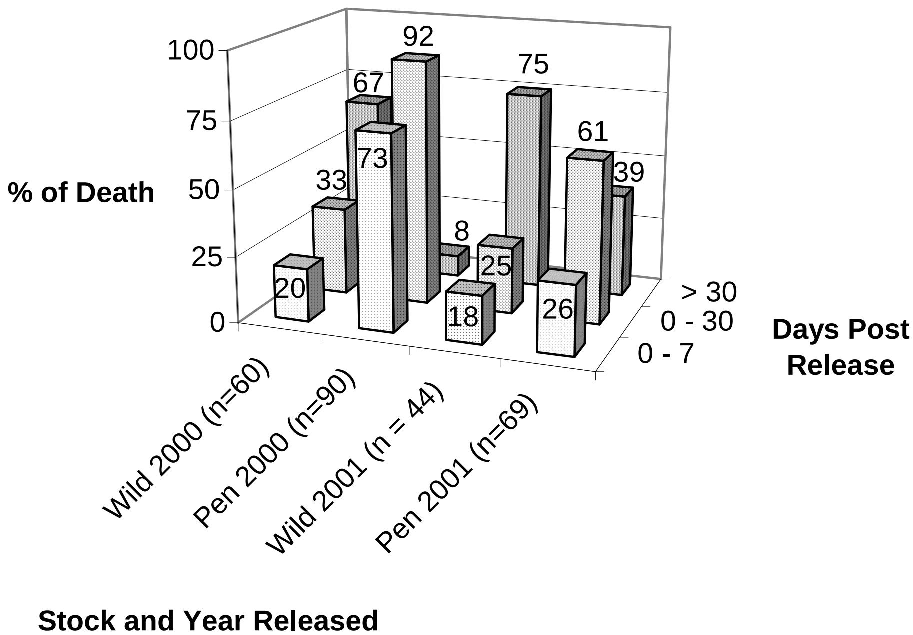

Figure 5. Time specific percent of death for radio-marked hen pheasants released into Idaho, 2000-2001.

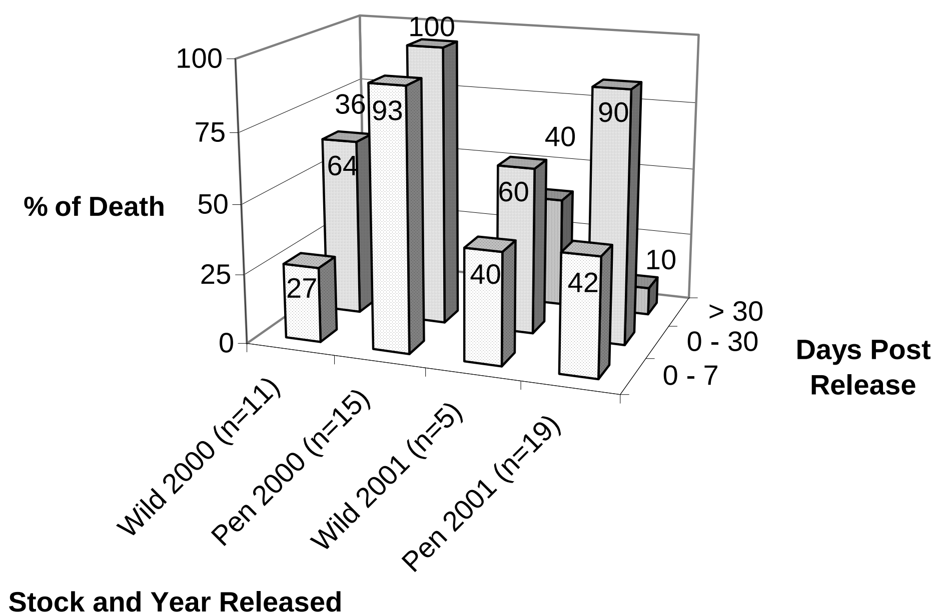

Figure 6. Time specific percent of death for radio-marked rooster pheasants released into Idaho, 2000-2001.

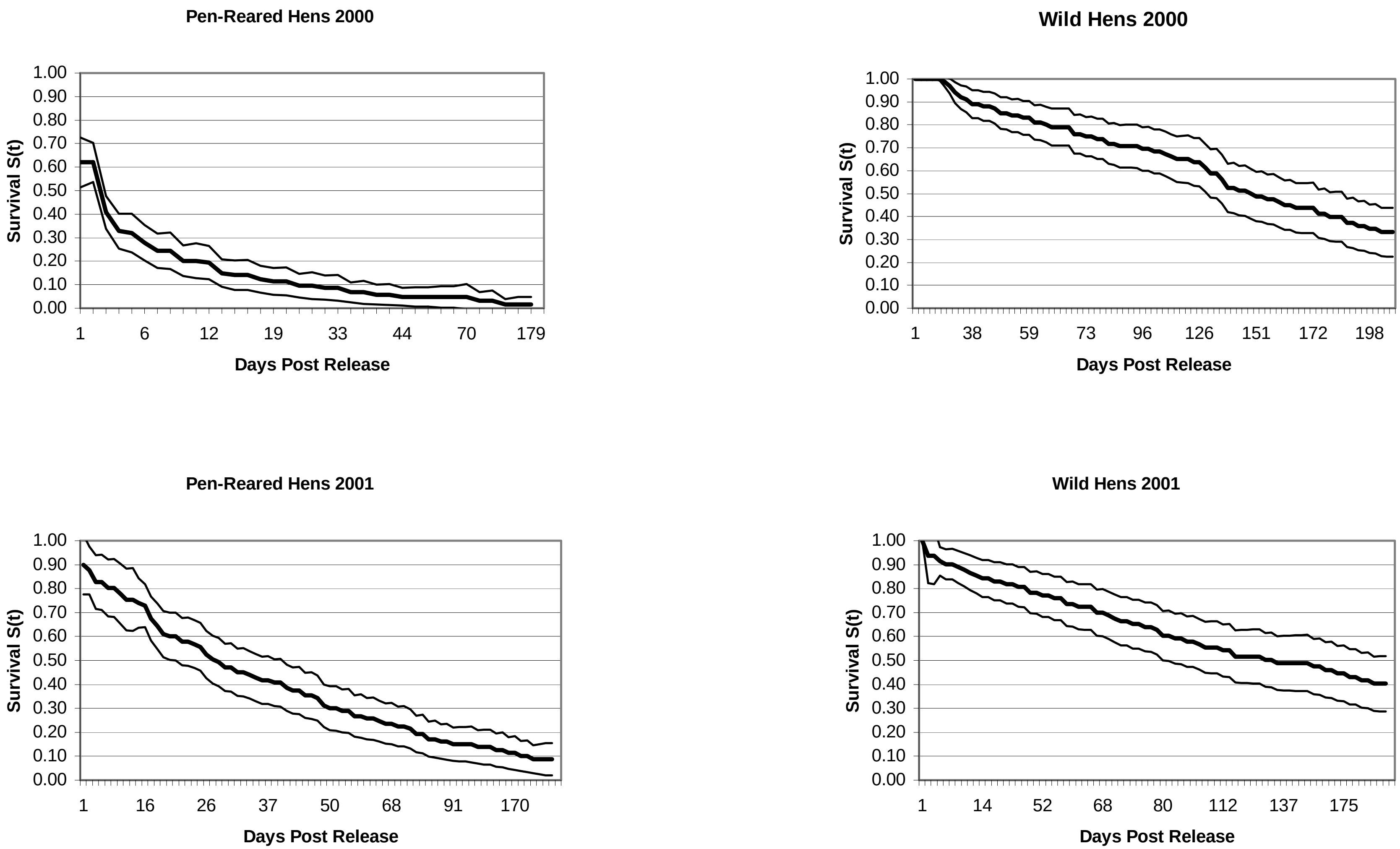

Figure 7. Survival S(t) estimates (thick line) bound by 95% Confidence Intervals (thin lines) for pen-reared and wild hen pheasants released into Idaho, 2000-2001.

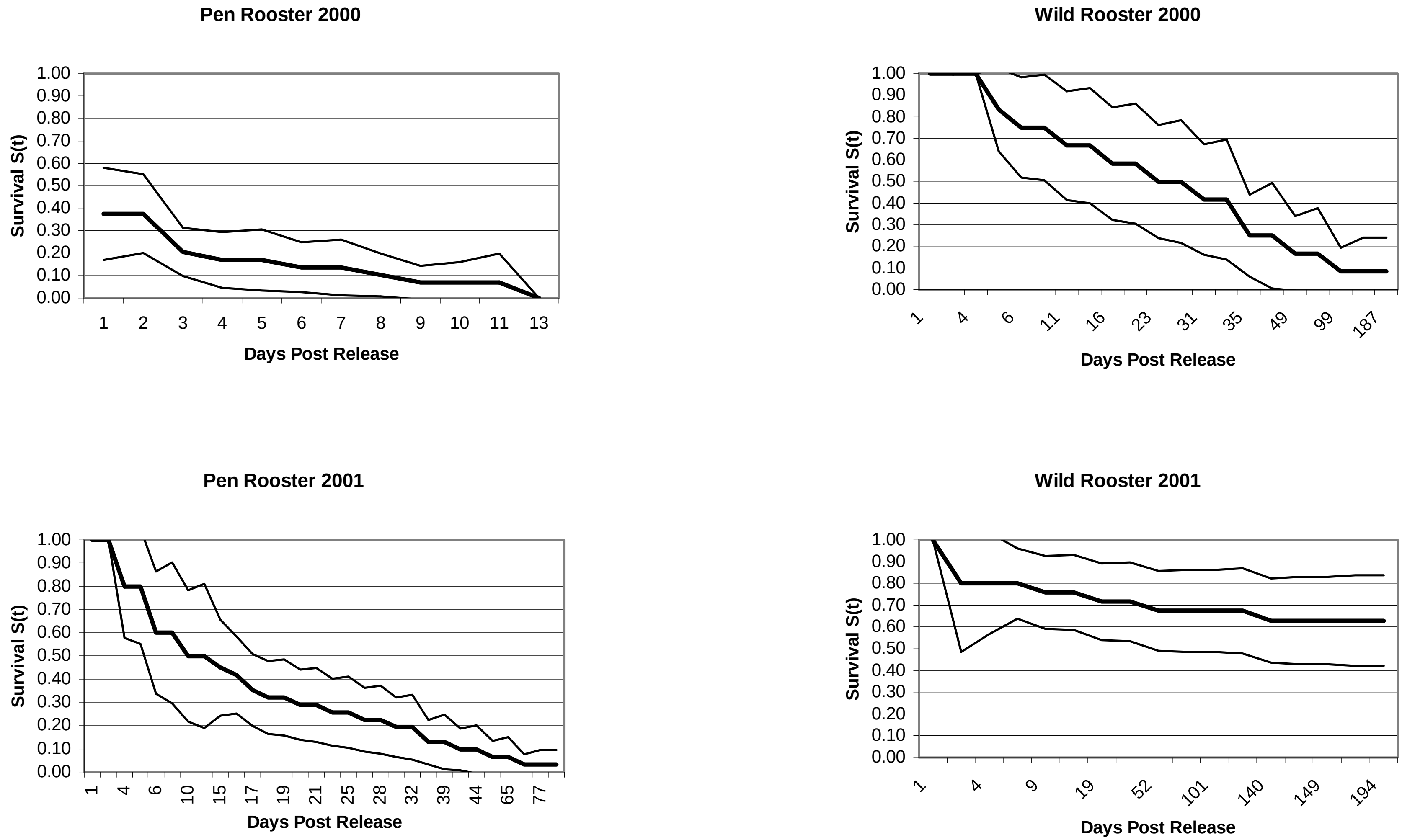

Figure 8. Survival S(t) estimates (thick line) bound by 95% Confidence Intervals (thin lines) for pen-reared and wild rooster pheasants released into Idaho, 2000-2001.

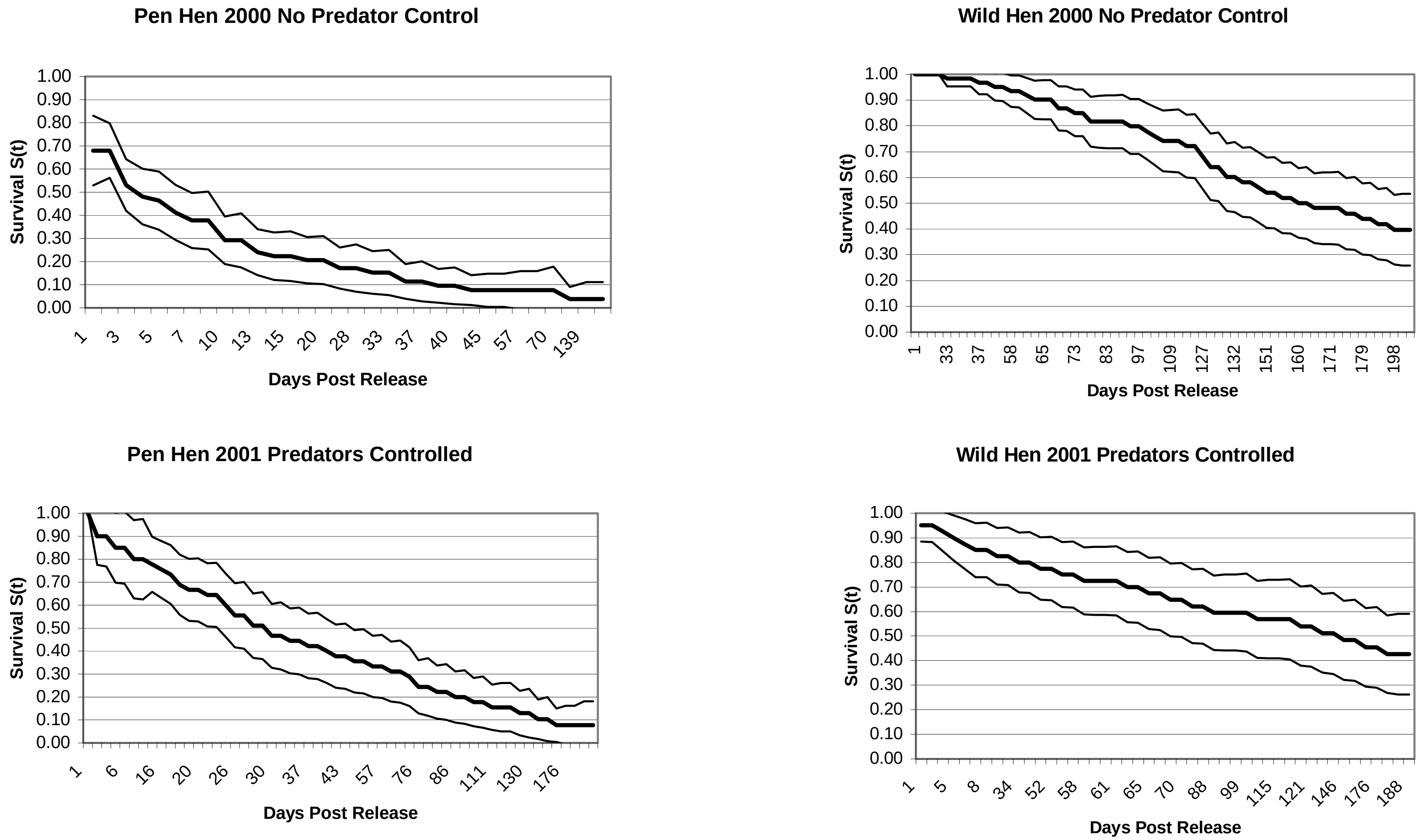

Figure 9. Survival S(t) estimates (thick line) bound by 95% Confidence Intervals (thin lines) for pen-reared and wild hen pheasants released into Jefferson and Mini-Cassia study areas, Idaho. No predator control was conducted during 2000, but predators were controlled during 2001.

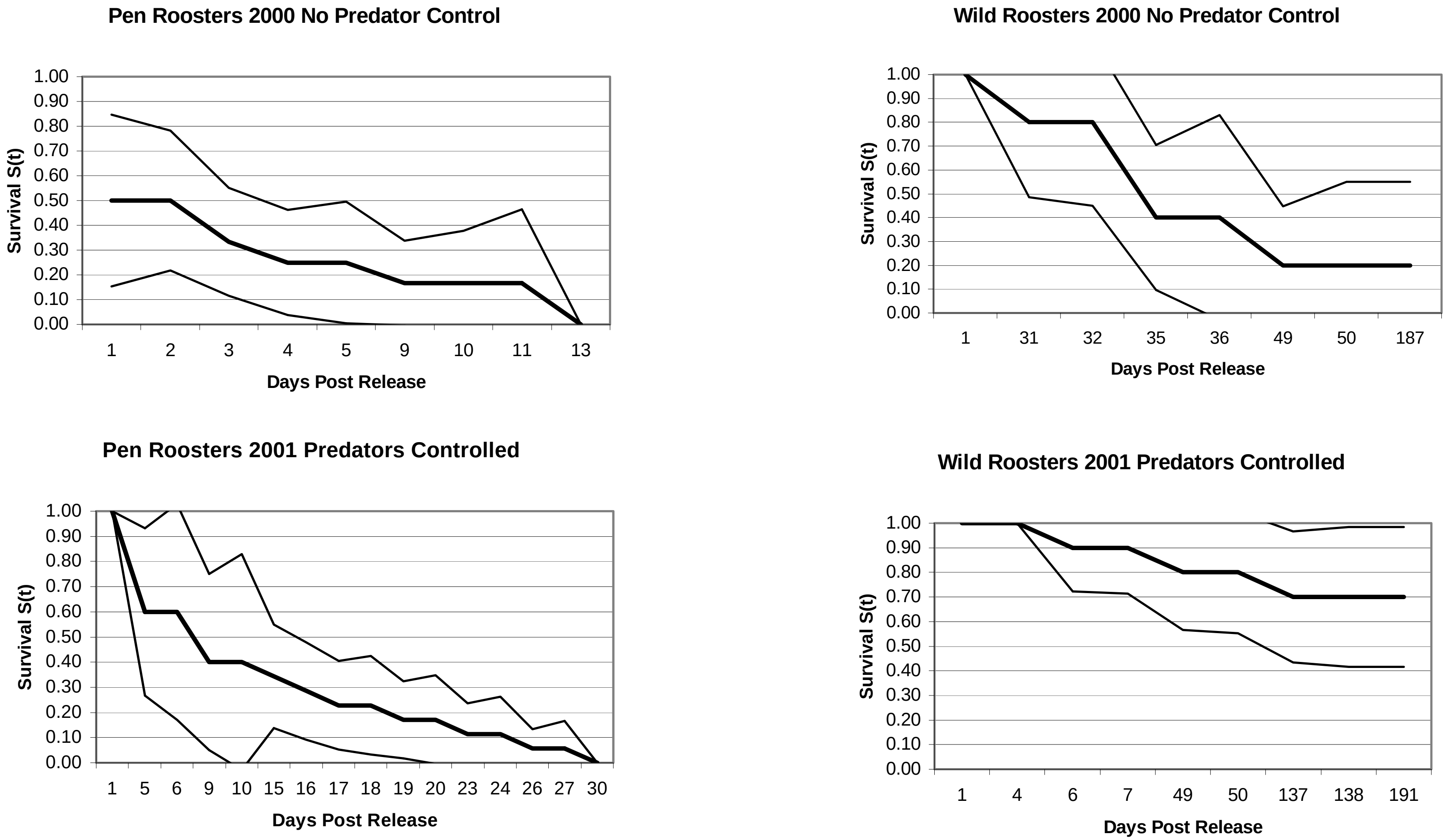

Figure 10. Survival S(t) estimates (thick line) bound by 95% Confidence Intervals (thin lines) for pen-reared and wild rooster pheasants released into Jefferson and Mini-Cassia project areas, Idaho. Predators were controlled during 2001. Wild roosters were only radio-marked in the Jefferson area during 2000.

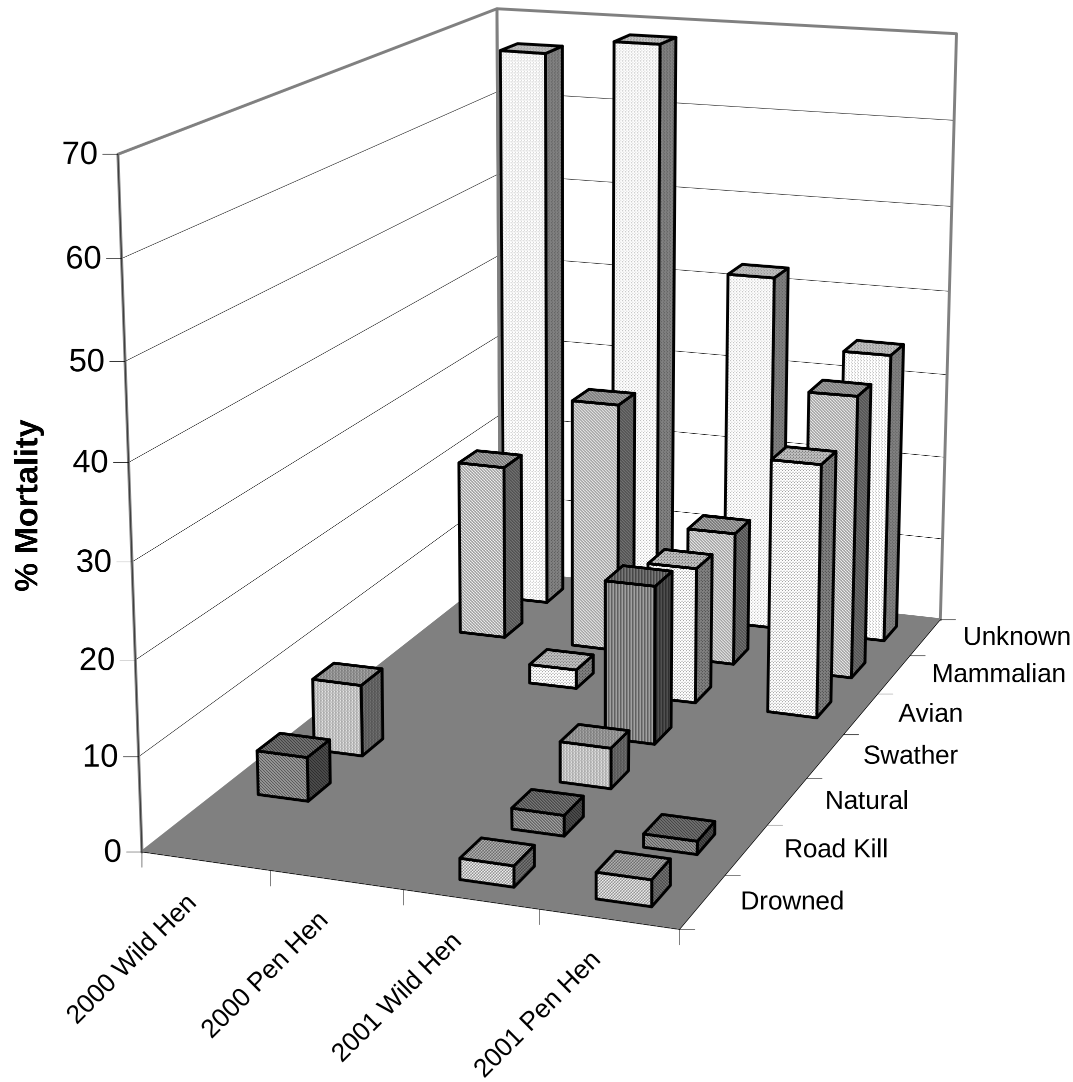

Figure 11. Cause specific mortality for wild and pen-reared hen pheasants release 2000-2001, Idaho.

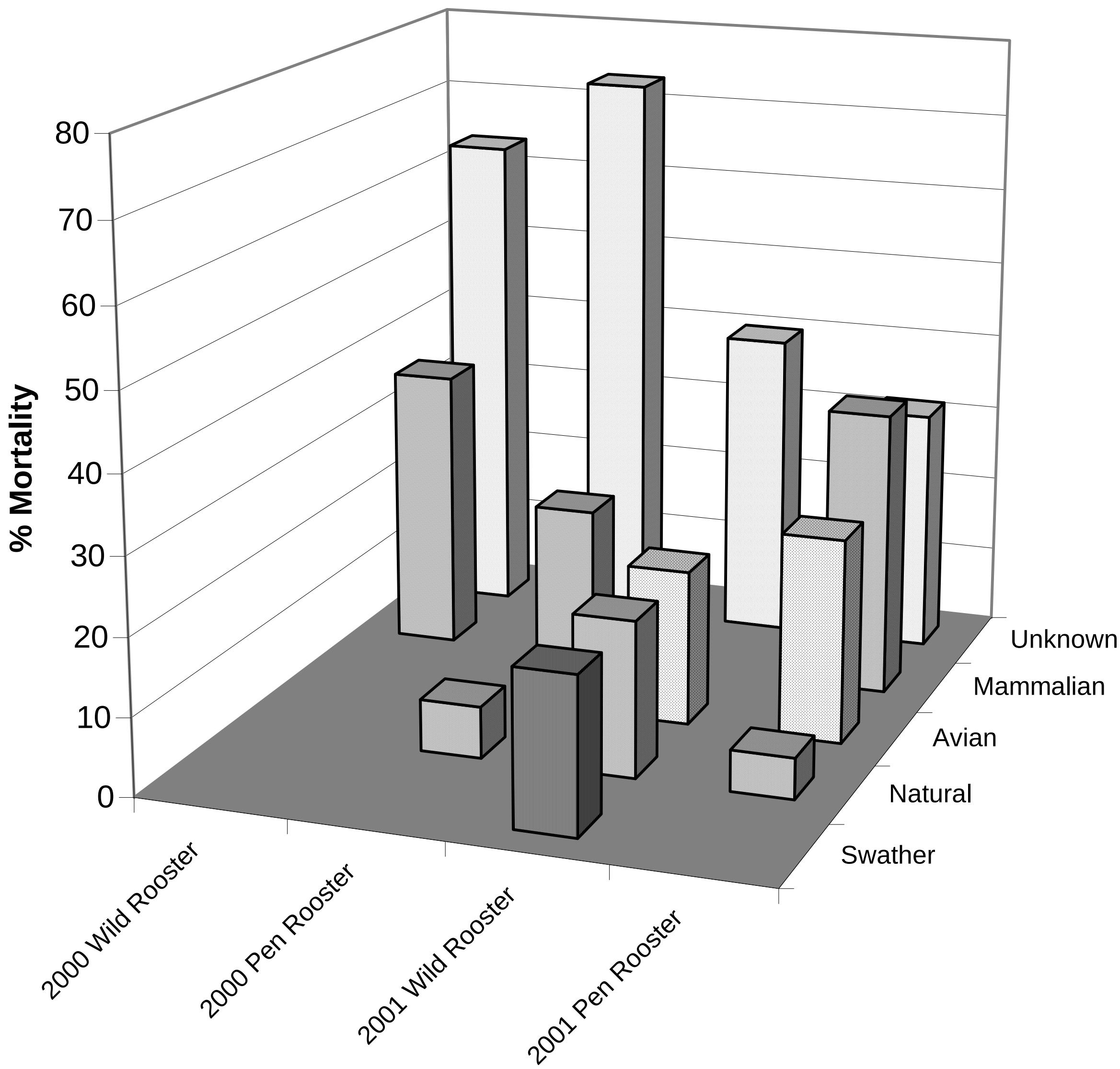

Figure 12. Cause specific mortality for wild and pen-reared rooster pheasants released 2000-2001, Idaho.

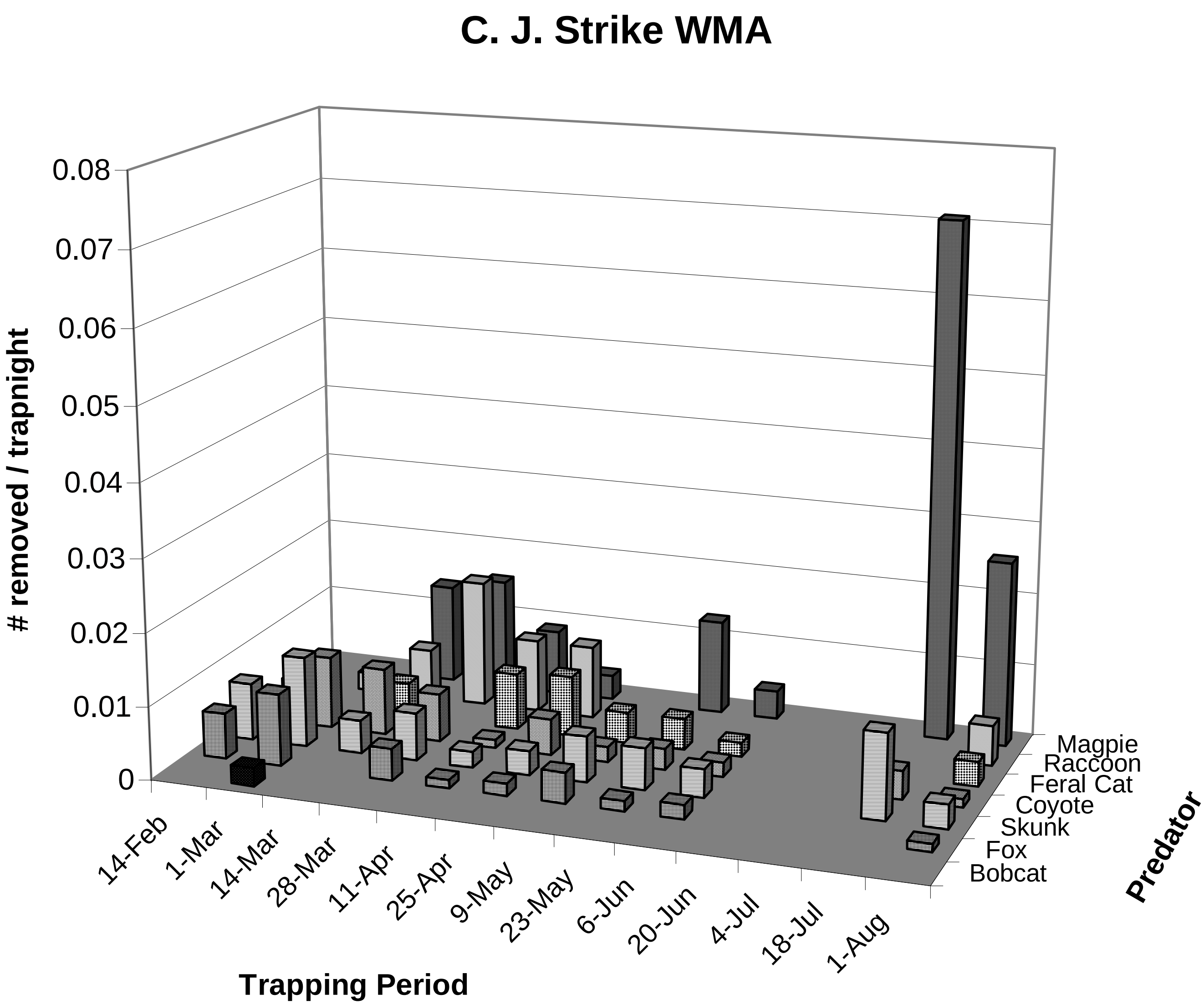

Figure 13. Predator control in C. J. Strike WMA project area where wild and pen-reared pheasants were released, Idaho, 2001.

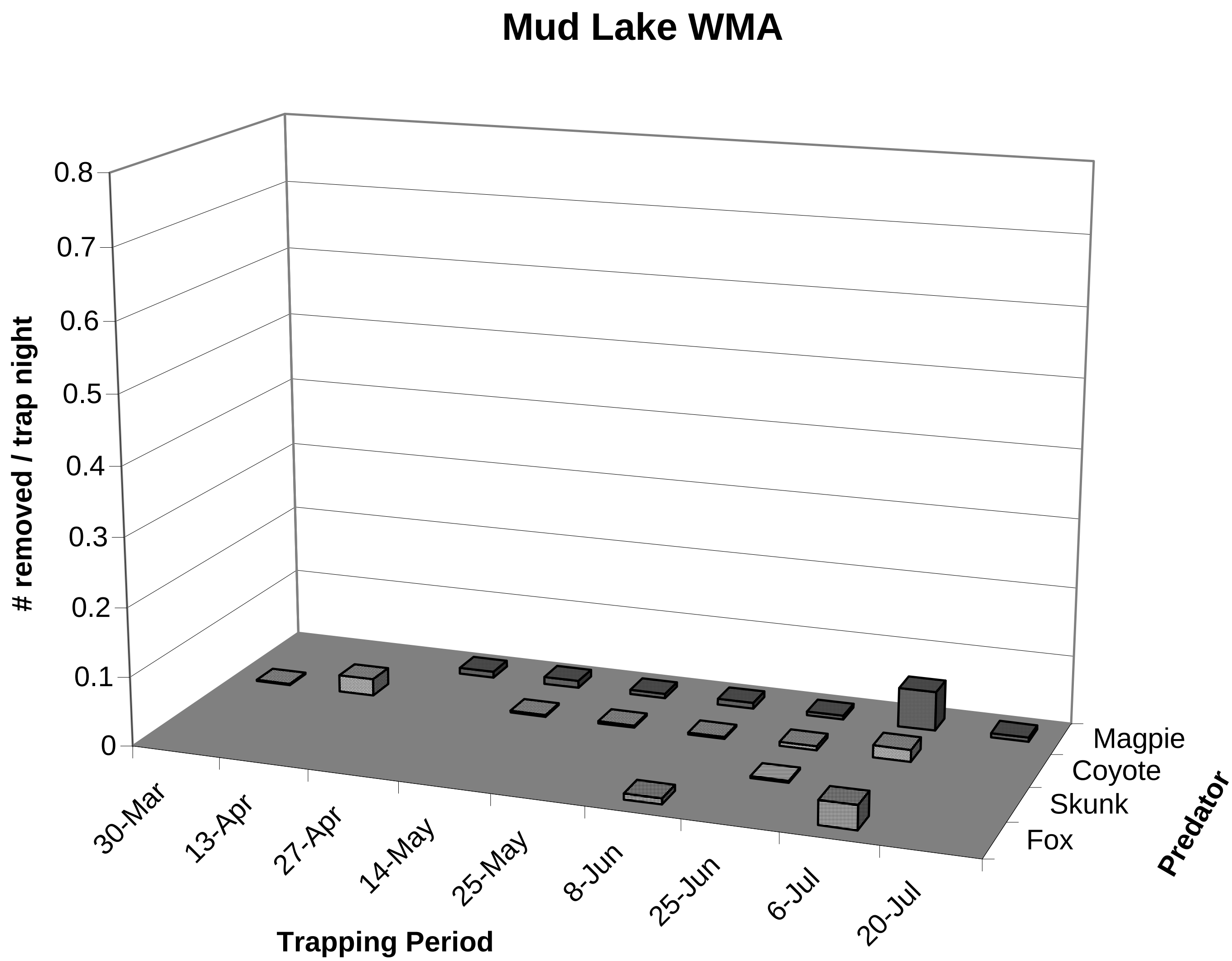

Figure 14. Predator control in Mud Lake WMA project area where wild and pen-reared pheasants were released, Idaho, 2001.

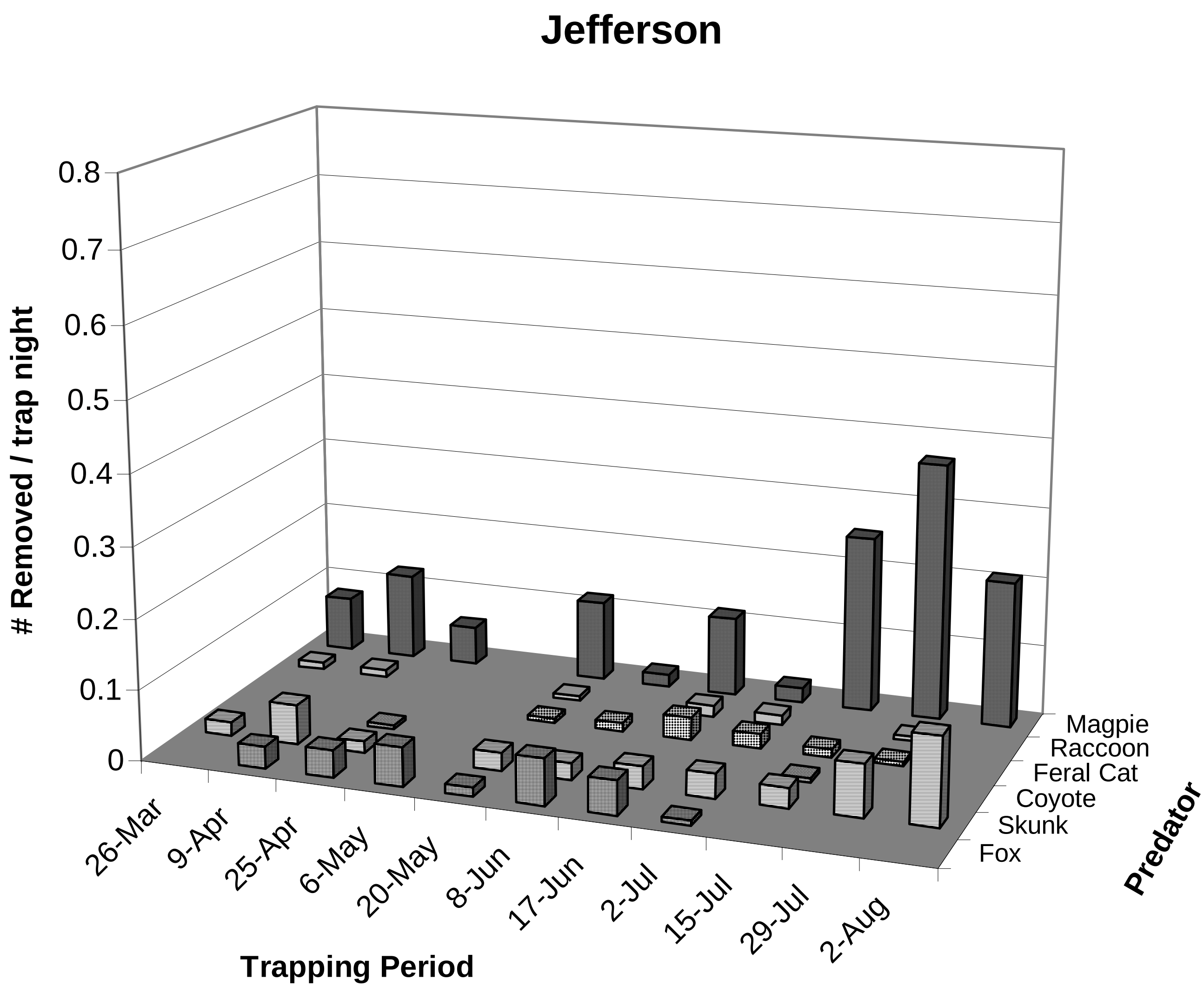

Figure 15. Predator control in Jefferson project area where wild and pen-reared pheasants were released, Idaho, 2001.

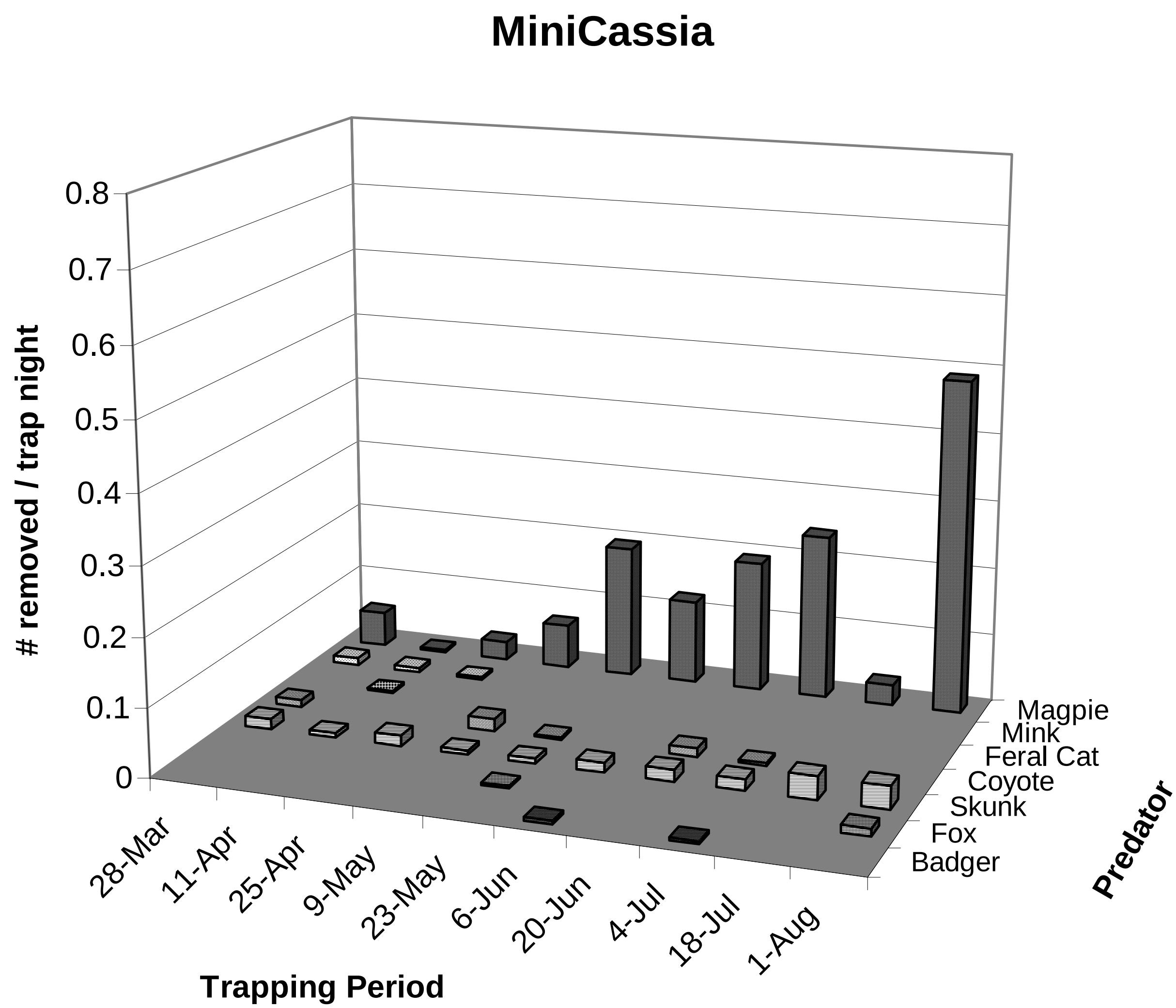

Figure 16. Predator control in Mini-Cassia project area where wild and pen-reared pheasants were released, Idaho, 2001.

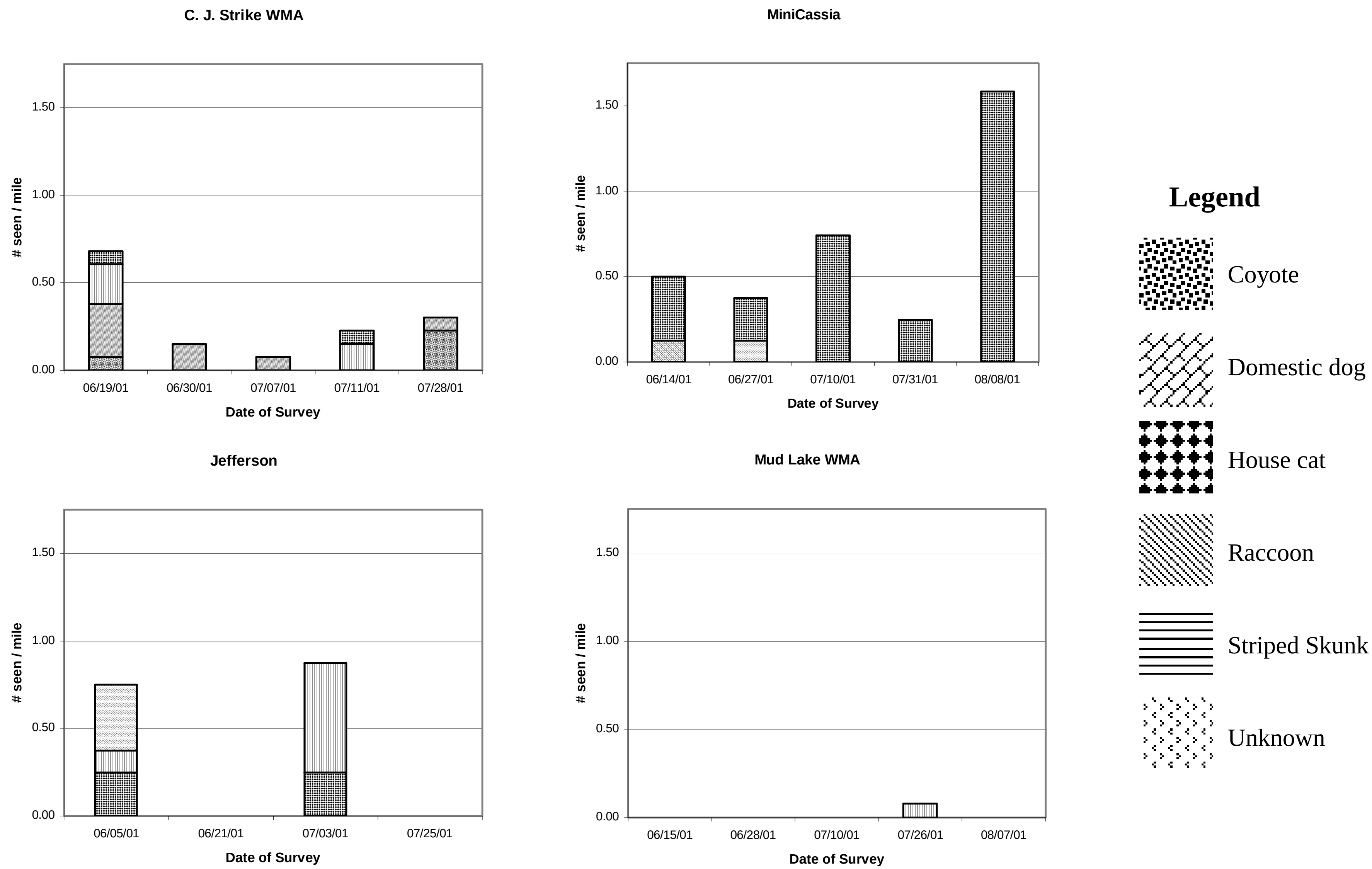

Figure 17. Spotlight counts in study areas where predators were controlled and pheasants released, Idaho, 2001.

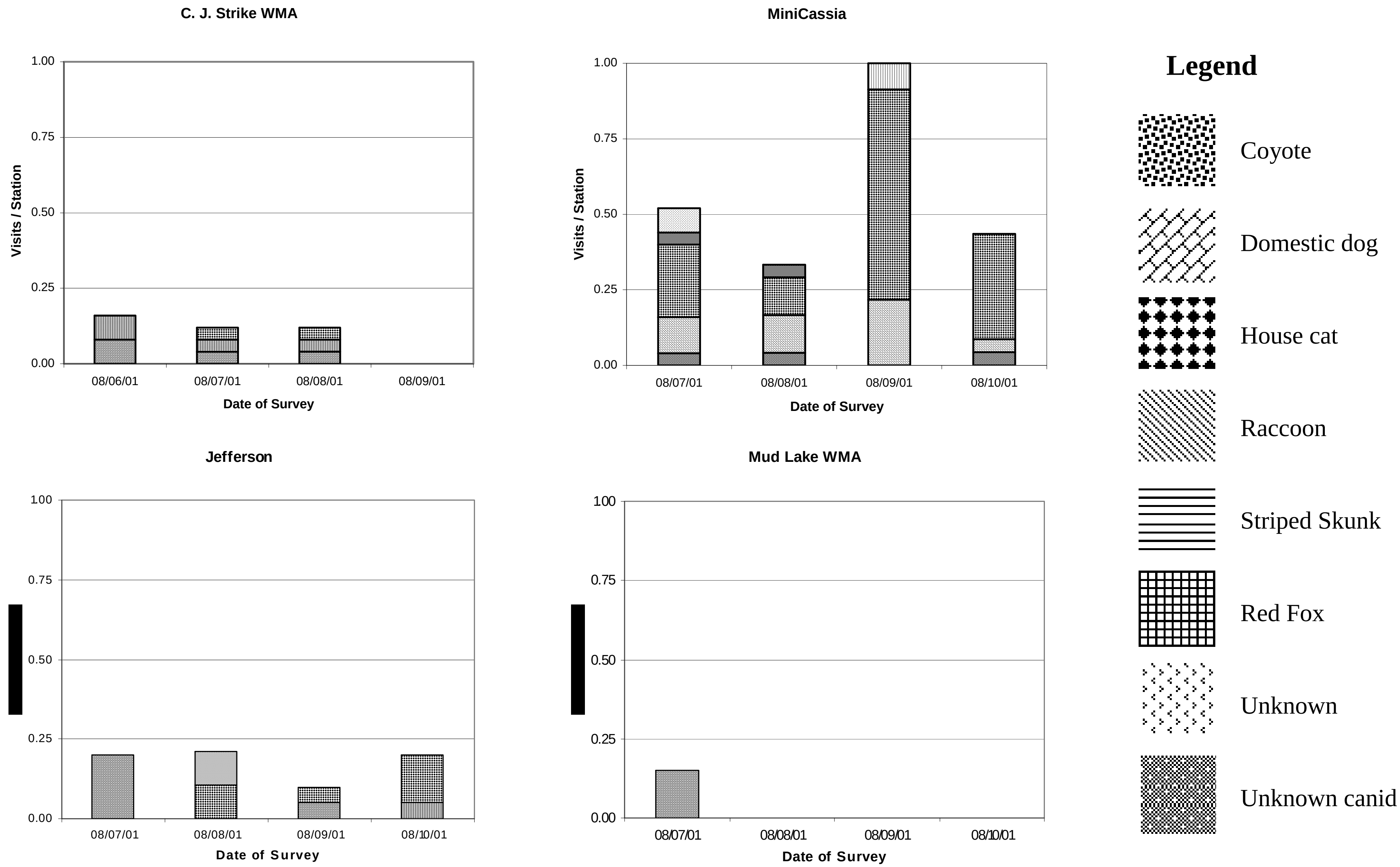

Figure 18. Scent station counts in study areas where predators were controlled and pheasants released, Idaho, 2001.

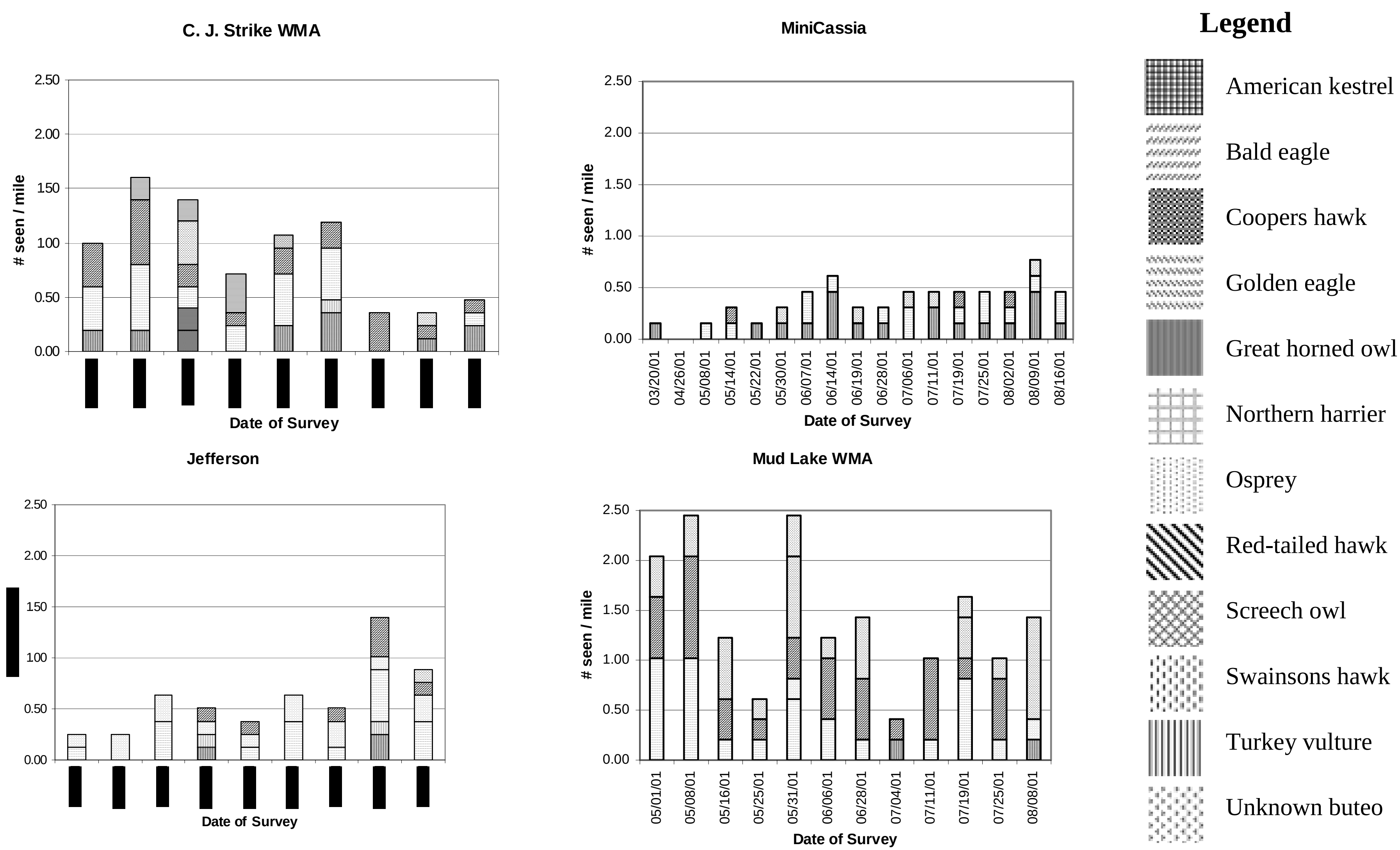

Figure 19. Roadside raptor surveys in study areas where predators were controlled and pheasants released, Idaho, 2001.

Table 1. Results of hunter interviews for harvest of pen-reared and wild pheasants on and off four tracts of public land during a ten-day roving hunter interview, October 29 - November 7, 1999, Idaho.

Location	Effort (hrs)	Hunters	Harvest *n* (%) Wild	Pen-reared	Total	HPUE[a]	SUCCESS[b]
On tracts	97.7	103	27 (71)	11 (29)	38 (100)	1.14±0.76	0.49±0.24
Off tracts	202.6	64	19 (90)	2 (10)	21 (100)	0.31±0.22	0.31±0.22
Total	300.3	167	46 (78)	13 (22)	59 (100)	*P*=0.0758[c]	*P*=0.0546[c]

[a] Harvest Per Unit Effort (all birds harvested/hour) mean ± 95% CI for groups interviewed.
[b] Hunter success (all birds harvested/hunter) mean ± 95% CI for groups interviewed.
[c] Result of one-way AOV for comparison within column.

Table 2. Hunter harvest rates of pen-reared and wild pheasants for hunters interviewed[a] while hunting four tracts of public land October 29 - November 7, 1999, Idaho.

	HPUE[b]			SUCCESS[c]		
Location	Wild	Pen-reared	*P*[d]	Wild	Pen-reared	*P*[d]
On tracts	0.44±0.56	0.57±0.58	0.7142	0.16±0.19	0.26±0.05	0.4207
Off tracts	0.13±0.13			0.26±0.2		
	P=0.2563[e]			*P*=0.4978[e]		

[a] Data omitted from three groups because interviews did not separate effort for pen-reared and wild pheasants when both types were harvested during the same trip.
[b] Harvest Per Unit Effort (all birds harvested/hour) mean ± 95% CI for groups interviewed.
[c] Hunter success (all birds harvested/hunter) mean ± 95% CI for groups interviewed.
[d] Result of one-way AOV between wild and pen-reared birds harvested on the tracts.
[e] Result of one-way AOV between wild pheasants harvested on and off the tracts.

Table 3. Hunter harvest rates of pen-reared and wild pheasants for hunters completing[a] their hunting trip on four tracts of public land October 29 - November 7, 1999, Idaho.

Birds harvested	HPUE[b]	SUCCESS[c]
Wild	0.31±0.32	0.27±0.36
Pen-reared	0.96±1.07	0.33±0.22
	P = 0.2018[d]	*P* = 0.1828[d]

[a] Data omitted from two groups because interviews did not separate effort for pen-reared and wild pheasants when both types were harvested during the same trip.
[b] Harvest Per Unit Effort (all birds harvested/hour) mean ± 95% CI for groups interviewed.
[c] Hunter success (all birds harvested/hunter) mean ± 95% CI for groups interviewed.
[d] Result of one-way AOV.

Table 4. Demographics of wild pheasants (radio-marked) translocated during 2000, Idaho.

	Capture sites									
	Oregon		California							
	Malheur NWR		Bufferlands		Upper Butte Basin		Grey Lodge		Total	
Release site	M[a]	F	M	F	M	F	M	F	M	F
Mini-Cassia	9 (0)	3 (3)	-	-	-	11 (10)	-	20 (16)	9 (0)	34 (29)
Jefferson	-	-	12 (6)	1 (1)	-	36 (32)	-	-	12 (6)	37 (33)
Madison	-	-	5 (1)	11 (11)	1 (1)	12 (6)	-	-	6 (2)	23 (17)
Minidoka	-	-	-	-	-	-	5 (5)	23 (23)	5 (5)	23 (23)
Total	9 (0)	3 (3)	17 (7)	12 (12)	1 (1)	58 (48)	5 (5)	43 (39)	32 (13)	117 (102)

[a] M = males, F = females.

Table 5. Demographics of wild pheasants (radio-marked) translocated during 2001, Idaho.

	California capture sites							
	Hills Slough		Bufferlands		Upper Butte Basin		Total	
Release site	M[a]	F	M	F	M	F	M	F
Mini-Cassia	-	-	5 (5)	-	-	21 (20)	5 (5)	21 (20)
Jefferson	-	-	-	-	5 (5)	20 (20)	5 (5)	20 (20)
C. J. Strike WMA	2 (2)	3 (3)	3 (3)	13 (13)	-	7 (4)	5 (5)	23 (20)
Mud Lake WMA	-	-	-	-	5 (5)	20 (20)	5 (5)	20 (20)
Total	2 (2)	3 (3)	8 (8)	13 (13)	10 (10)	68 (64)	20 (20)	84 (80)

[a] M = males, F = females.

Table 6. Demographics of wild and pen-reared pheasants (radio-marked) translocated during 2000-2001, Idaho.

	2000				2001			
	Wild		Pen-reared		Wild		Pen-reared	
Study area	M[a]	F	M	F	M	F	M	F
Madison	6 (2)	23 (17)	30 (4)	119 (25)	-	-	-	-
Jefferson	12 (6)	37 (33)	20 (4)	119 (24)	5 (5)	20 (20)	100 (5)	450 (20)
Mini-Cassia	9 (0)	34 (29)	10 (4)	40 (25)	5 (5)	21 (20)	100 (5)	450 (20)
Minidoka	5 (5)	23 (23)	10 (4)	41 (25)	-	-	-	-
C. J. Strike WMA	-	-	-	-	5 (5)	23 (20)	100 (5)	461 (20)
Mud Lake WMA	-	-	-	-	5 (5)	20 (20)	100 (5)	450 (20)
Total	32 (13)	117 (102)	70 (16)	319 (99)	20 (20)	84 (80)	400 (20)	1,811 (80)

[a] M = males, F = females.

Table 7. Mean weights (g ± 95% Confidence Interval) of pheasants released into Idaho.

	Year	
Stock/Gender	2000 (n)	2001 (n)
Hens[a]		
Pen-reared	1062 ± 23 (99) a	1052 ± 25 (80) a
Wild	890 ± 21 (97) b	936 ± 19 (80) b
Roosters[b]		
Pen-reared	1277 ± 49 (16) a	1254 ± 43 (20) a
Wild	1135 ± 58 (13) b	1263 ± 49 (20) a

[a] Kruskal-Wallis one-way AOV statistic = 121.645, $P < 0.0001$, values with same letter are similar at 0.05 level of significance.

[b] Kruskal-Wallis one-way AOV statistic = 12.3302, $P = 0.0044$, values with same letter are similar at 0.05 level of significance.

Table 8. Kaplan-Meier staggered entry survival estimates for radio-marked pheasants from pen-reared and wild stock released into Idaho March-September 2000 and 2001.

Year/Study area	Hen survival[a]				Rooster survival[a]			
2000	Pen-reared		Wild		Pen-reared		Wild	
Minidoka	0.00 ± 0.00	(25)	0.28 ± 0.23	(22)	0.00 ± 0.00	(4)	0.00 ± 0.00	(5)
Mini-Cassia	0.02 ± 0.14	(25)	0.34 ± 0.20	(29)	0.00 ± 0.00	(4)	-	(0)
Jefferson	0.04 ± 0.08	(24)	0.44 ± 0.19	(33)	0.00 ± 0.00	(4)	0.20 ± 0.35	(6)
Madison	0.06 ± 0.12	(25)	0.16 ± 0.20	(17)	0.00 ± 0.00	(4)	0.00 ± 0.00	(2)
C. J. Strike WMA[b]	0.11 ± 0.07	(74)	-	(0)	-	(0)	-	(0)
2001[c]								
Mud Lake WMA	0.00 ± 0.00	(20)	0.38 ± 0.24	(20)	0.00 ± 0.00	(5)	0.80 ± 0.35	(5)
Mini-Cassia	0.13 ± 0.16	(20)	0.54 ± 0.23	(20)	0.00 ± 0.00	(5)	1.00 ± 0.00	(5)
Jefferson	0.05 ± 0.10	(20)	0.30 ± 0.22	(20)	0.00 ± 0.00	(5)	0.40 ± 0.43	(5)
C. J. Strike WMA[d]	0.26 ± 0.22	(20)	0.47 ± 0.25	(20)	0.20 ± 0.35	(5)	0.80 ± 0.50	(5)

[a] S(t) ± 95% Confidence Interval (*n*).
[b] Data for C. J. Strike WMA is from Harper et al. (2000) with predator removal.
[c] All study areas in 2001 received predator removal.
[d] Includes two years of predator control at C. J. Strike WMA.

Table 9. Survival estimates (Kaplan-Meier S(t) ± 95% Confidence Interval [Kulowiec 1988]) and comparisons (chi-square tests [Hines and Sauer 1989]) for pheasants released into Idaho.

	Stock		
Year/Gender	Pen-reared (*n*)	Wild (*n*)	*P*
2000[a]			
Hens	0.02 ± 0.03 (99)	0.33 ± 0.11 (102)	0.0025
Roosters	0.00 ± 0.00 (16)	0.08 ± 0.16 (13)	0.2963
2001[b]			
Hens	0.09 ± 0.07 (80)	0.40 ± 0.12 (80)	<0.0001
Roosters	0.03 ± 0.06 (20)	0.63 ± 0.21 (20)	<0.0001

[a] Data pooled for Mini-Cassia, Jefferson, Minidoka, and Madison project areas and no predator control.

[b] Data pooled for Mini-Cassia, Jefferson, Mud Lake WMA, and C. J. Strike WMA project areas with predator control.

Table 10. Survival estimates (Kaplan-Meier S(t) ± 95% Confidence Interval [Kulowiec 1988]) and comparisons (chi-square tests [Hines and Sauer 1989]) for pre- (2000) and post-predator (2001) removal for pheasants released into Jefferson and Mini-Cassia project areas, Idaho.

	Year (*n*)		
Stock/Gender	2000	2001	*P*
Pen-reared			
Hens	0.04 ± 0.07 (49)	0.08 ± 0.10 (40)	0.5407
Roosters	0.00 ± 0.00 (8)	0.00 ± 0.00 (6)	1.0000
Wild			
Hens	0.40 ± 0.14 (62)	0.42 ± 0.16 (40)	0.7901
Roosters[a]	0.20 ± 0.35 (10)	0.70 ± 0.28 (10)	0.0299

[a] No wild roosters were released with radio transmitters in Mini-Cassia in 2000, only in Jefferson.

Table 11. Cause specific mortality for radio-marked wild and pen-reared pheasants (sexes combined) for March-October 2000 and 2001, Idaho.

	2000, *n* (%)[a]		2001, *n* (%)[b]		
Cause of death[b]	Wild	Pen-reared	Wild	Pen-reared	Total
Unknown	49 (66)	74 (69)	21 (42)	31 (34)	175 (54)
Mammalian predation	17 (23)	30 (28)	7 (14)	31 (34)	85 (26)
Avian predation	0 (0)	2 (2)	8 (16)	26 (28)	36 (11)
Natural causes	5 (7)	1 (1)	3 (6)	1 (1)	10 (3)
Hay swather	0 (0)	0 (0)	9 (18)	0 (0)	9 (3)
Vehicle collision	3 (4)	0 (0)	1 (2)	1 (1)	5 (2)
Drowned	0 (0)	0 (0)	1 (2)	2 (2)	3 (1)
Total	74 (100)	107 (100)	50 (100)	92 (100)	323 (100)

[a] No predator control occurred in 2000, data from C. J. Strike WMA from Harper et al (2000) not included because it included predator control.
[b] All release areas in 2001 had predator control.

Table 12. Mean distance (m ± 95% Confidence Interval) from release site to mortality site of hen pheasants released into Idaho.

	Year	
Stock	2000 (*n*)	2001 (*n*)
Pen-reared	1931 ± 716 (27) a[a]	867 ± 181 (69) c
Wild	1886 ± 706 (23) ab	1389 ± 513 (39) bc

[a] Kruskal-Wallis one-way AOV statistic = 20.1248, $P = 0.0002$, values with same letters are similar at 0.05 level of significance.

Table 13. Mean distance (m ± 95% Confidence Interval) from release site to mortality site of rooster pheasants released into Idaho.

	Year	
Stock	2000 (*n*)	2001 (*n*)
Pen-reared	1576 ± 825 (4) a[a]	854 ± 332 (19) a
Wild	491 ± 0 (1) a	503 ± 197 (5) a

[a] Kruskal-Wallis one-way AOV statistic = 4.6368, $P = 0.2024$, values with same letters are similar at 0.05 level of significance.

Table 14. Nest site selection and nest fate of radio-marked hen pheasants 2000-2001, Idaho.

	2000				2001			
	Wild		Pen-reared		Wild		Pen-reared	
Nest cover	Attempts	Successful hatch[a]	Attempts	Successful hatch	Attempts	Successful hatch[a]	Attempts	Successful hatch
Winter wheat	7	6	-	-	1	0	1	0
Idle herbaceous	3	2	-	-	13	9	4	0
Beets/potatoes	3	0	-	-	1	1	1	1
Pasture	2	0	1	0	1	0	0	0
Alfalfa	1	0	-	-	7	1	1	0
Oats	0	0	-	-	2	1	0	0
Wetland	0	0	-	-	4	4	1	0
Shrub-steppe	0	0	-	-	3	2	1	0
Total	16	8	1	0	32	18	9	1

[a] One wild hen successfully nested (seen with chicks) but the nest was never found. Therefore, the total number of successful nests is nine and total number of nests is 17 for the year 2000.

[b] Three wild hens that were released in 2000 nested successfully in 2001; two in Jefferson, one in Mini-Cassia.

Table 15. Cause of failure within habitat types for nests of wild (W) and pen-reared (P) pheasants during first year of release into Idaho, 2000.

	Habitat type											
	Alfalfa		Beet/potato		Idle		Pasture		Wheat		Total	
Cause of failure	W	P	W	P	W	P	W	P	W	P	W	P
Abandoned	-	-	-	-	-	-	1	-	-	-	1	-
Hen died	-	-	1	-	-	-	-	1	-	-	1	1
Infertile	-	-	-	-	-	-	-	-	1	-	1	-
Flooded	-	-	1	-	-	-	-	-	-	-	1	-
Unknown	1	-	-	-	1	-	1	-	-	-	3	-
Total	1	0	2	0	1	0	2	1	1	0	7	1

Table 16. Cause of failure within habitat types for nests of wild (W) and pen-reared (P) pheasants during first year of release into Idaho, 2001.

	Habitat type															
	Alfalfa		Idle		Oats		Pasture		Shrub-steppe		Wetland		Wheat		Total	
Cause of failure	W	P	W	P	W	P	W	P	W	P	W	P	W	P	W	P
Abandoned	1	-	2	-	-	-	1	-	-	-	-	1	-	-	4	1
Hen died	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0
Avian predation	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	1
Mammalian pred.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	0	1
Unknown pred.	-	-	-	2	-	-	-	-	1	1	-	-	1	-	2	3
Swathed	4	-	-	-	1	-	-	-	-	-	-	-	-	-	5	0
Unknown	1	-	-	1	-	-	-	-	-	-	-	-	-	1	1	2
Total	6	1	4	4	1	0	1	0	1	1	0	1	1	1	14	8

Table 17. Mean percent cover of nest bowl, height of cover over nest (cm), and distance from nest to change in habitat (m) for wild and pen-reared pheasants during their first year released into Idaho, 2001.

Stock	Percent cover[a]	Height	Distance
Wild	99 ± 1 (27)	114 ± 86 (22)	28 ± 10 (24)
Pen-reared	96 ± 5 (8)	65 ± 27 (8)	39 ± 57 (8)
P[b]	0.4194	0.4389	0.3061

[a] Mean ± 95% Confidence Interval (*n*).
[b] Wilcoxon Rank Sum test.

Table 18. Mean distance (± 95% Confidence Interval [m]) from pheasant nest site to release site for first year of release into Idaho.

Year released	Wild (*n*)	Pen-reared (*n*)	*P*[a]
2000	1815 ± 913 (5)	- (1)[b]	-
2001	1748 ± 312 (29)	1079 ± 590 (9)	0.0394

[a] Wilcoxon Rank Sum test within same year.
[b] Accurate release location data not available for pen-reared hen that nested in 2000.

Table 19. Mean (mean ± 95% Confidence Interval [*n*]) production for wild and pen-reared pheasants during first year of release into Idaho, 2001.

				Brood size	
Stock	Clutch size	Eggs hatched	Hatch date	4 weeks	8 weeks
Wild[a]	8.4 ± 0.9 (27)	7.9 ± 1.1 (14)	Jun 28 ± 13 (15)	1.6 ± 1.3 (11)	1.0 ± 1.7 (7)
Pen-reared	7.4 ± 2.8 (8)	6 (1)	Jul 27 (1)	2 (1)	0 (1)
P[b]	0.5771				

[a] Wild hens in 2000 had mean clutch sizes of 9.8 ± 1.8 (n = 8), eggs hatched of 4.0 ± 2.2 (n = 5), and hatch dates of July 4 ± 31 days (n = 6).
[b] Wilcoxon Rank Sum test.

Table 20. Percent cover within 4.8 km (three miles) of release sites of pen-reared and wild pheasants and with predator removal in Idaho, 2001.

	Study area		
Cover type	C. J. Strike WMA[a]	Jefferson	Mini-Cassia
Alfalfa	13.6	21.2	14.0
Beans	0.0	0.0	2.5
Beets[b]	3.0	0.0	10.7
Corn	2.3	3.8	1.7
Dry pasture[c]	0.0	3.2	0.0
Grass hay	0.0	15.9	0.0
Idle[d]	2.7	3.3	2.7
Oats	0.4	0.0	0.5
Irrigated pasture[e]	5.9	2.7	5.1
Potatoes	2.2	0.0	5.8
Right-of-way[f]	4.2	5.9	8.0
Shrub-steppe	50.6	11.2	4.0
Urban[g]	1.3	3.3	18.7
Water[h]	9.2	5.4	1.9
Wetland	4.0	2.5	1.9
Wheat	0.2	19.8	18.4
Woodland[i]	0.4	1.6	0.1

[a] WMA managed by the Idaho Department of Fish & Game and cover estimates include adjacent private land.
[b] Sugar beets.
[c] Grass pasture that is not irrigated, few shrubs present.
[d] Previously farmed land but not cultivated now or areas dominated by herbaceous annual plants.
[e] Grass pasture that is irrigated and does not include shrubs.
[f] Access roads, county roads, interstate highways, and their ditches.
[g] Farmsteads, livestock holding facilities, subdivisions, and municipalities.
[h] Open water in livestock ponds, sewage lagoons, creeks, rivers, and reservoirs.
[i] Riparian zones, woodlots, and shelterbelts.

Table 21. Pheasant crow counts (two minutes/station) on project areas where wild and pen-reared pheasants were released in Idaho, 2001.

Area	Number stations	Number replications	Mean[a] calls/station	Maximum[b] calls	Peak calls/station	
					Mean	Date
Jefferson	20	6	1.28 ± 0.26	11	1.80	Apr 27
Mud Lake WMA	20	6	0.80 ± 0.28	16	1.28	May 17
Mini-Cassia	8	7	2.18 ± 0.52	12	3.13	May 22
C. J. Strike WMA	11	5	5.07 ± 1.18	20	6.91	May 17
Total			2.33 ± 1.88			

[a] Mean ± 95% Confidence Interval.
[b] Maximum number of calls heard for one station for the entire monitoring period.

Table 22. Roadside pheasant counts on project areas where wild and pen-reared pheasants were released and predators removed in Idaho, 2001.

Area	Route distance (km)	Number/km[a]				
		Adult males	Hens without broods	Hens with broods	Number of broods	Total
Jefferson	12.8	0.29	0.08	0.04	0.08	0.50
Mud Lake WMA	8.1	0.07	0.14	0.07	0.20	0.48
Mini-Cassia	12.8	0.04	0.08	0.00	0.00	0.12
C. J. Strike WMA	20.9	0.05	0.10	0.13	0.61	0.88
Total[b]		0.11±0.12	0.10±0.03	0.06±0.05	0.22±0.26	0.49±0.3

[a] Three replications/area.
[b] Mean ± 95% Confidence Interval.

Table 23. Demographics of predators removed, starting date, and costs for trapping on project areas where pen-reared and wild pheasants were released in Idaho.

	Area					
	C. J. Strike[a]	C. J. Strike[b]	Jefferson[b]	Mini-Cassia[b]	Mud Lake[b]	
Predator	12/16/99	2/1/01	3/19/01	3/14/01	3/19/01	Total
Badger	0	0	0	2	0	2
Bobcat	1	1	0	0	0	2
Coyote	3	21	2	13	21	60
Feral cat	43	25	11	1	0	80
Magpie	50	75	189	271	28	613
Mink	0	0	0	5	0	5
Red fox	1	17	33	2	11	64
Total	98	139	235	294	60	826
Total trap nights	4,715	5,835	1,526	2,358	3,118	17,552
Labor cost	$3,025	$9,998	$5,441	$3,119	$2,604	$24,187

[a] Trapping ended 3/31/00.
[b] Trapping ended 8/1/01.

Appendix A

ROVING BAG CHECK INTERVIEW

DATE ________ TIME _________ ISOLATED TRACT# __________ #IN PARTY __________
#OF DOGS_____ SEX: M ______ F______

"Good morning (afternoon). My name is ____________________and I am conducting a bird hunter survey for the Idaho Department of Fish and Game. We are collecting information that will be used to help manage game birds. Do you mind if I ask you a few questions about your hunting trip today?"

What County and State do you live? County____________State _____________
County ____________ State ______________County ___________ State _____________
County ____________ State ______________County ___________ State _____________
County ____________ State ______________County ___________ State _____________

"What time did you begin hunting?" ______ "On this location?" ______________

"What time do you think you will quit hunting at this location?" ______________

"Now I would like to ask you some questions about your hunting success?"

"What kind of birds are you hunting for?" _______________________________________

"Have you harvested any birds today?" ____
(record what kind and how many).

"Would you mind if I checked your birds for bands and radio-collar?"
Enter band number, radio-collar frequency and kill location.

____
____

"How would you rate your hunting experience today?" Excellent______ Good _______
Fair_______ Poor_______

"This completes the interview. Thank you for your time. Do you have any comments that you would like to make about the management of game birds?"

____
____
____
____

Appendix B

TRAPPING PROTOCOL

The listed activity items are to be followed by the contracted trapper, at a minimum, while predator trapping for the Department's pheasant release project. More stringent requirements of the trapper may be requested by the Department's Regional Supervisor.

1. The trapper will complete the "Biweekly Trapper Report".
2. Soft catch (padded leg-hold) traps, provided by the Department, are to be used on private property and returned to the Department after the trapping season. Walk-in traps will also be provided by the Department.
3. Permission must be obtained by the trapper from the landowner before trapping starts. Landowner must be informed of the type of traps to be used. Landowners may not want certain types of traps used, such as snares, or certain areas, such as homesteads.
4. Target species are limited to:

Common name	Scientific name	Common name	Scientific name
Coyote	*Canis latrans*	Red fox	*Vulpes fulva*
Striped skunk	*Mephitis mephitis*	Feral cat	*Felis domesticus*
Feral dog	*Canis familiarus*	Raccoon	*Procyon lotor*
Badger	*Taxidea taxus*	Weasel	*Mustela* spp.
Townsend ground squirrel	*Citellus townsendi*	Mink	*Mustela vison*
Black-billed magpie	*Pica pica*	Common raven	*Corvus corax*
American crow	*Corvus brachyrhynchos*		

5. Term "feral" is defined as a domestic pet that does not have a collar. Collared pets and non-target species are to be released.
6. The trapper will concentrate efforts before March 15 on coyotes and red fox. After March 15, all target species will be included in the trapping effort.
7. All euthanized predators will be transported from the field in garbage bags provided by the Department. Trapper may retain any pelt. Refuse is to be disposed of properly.
8. No magpies will be left in baited walk-in traps. Walk-in traps will be placed out of view from public roads. Walk-in traps are to be closed when not in use.
9. Minimum trapping effort will include:

Trap	# of traps	Trap nights
# 3 leg-hold	12	1,000
# 1½ leg-hold	24	2,000
# 120 conibear	12	800
Live walk-in	5	340

10. Trapping will be conducted within the boundary shown on maps provided by the Department. Names and addresses of landowners will be provided by the Department.
11. No trapping within ½ mile of city limits.
12. Traps are to be checked once every 24 hours.

Submitted by:

David D. Musil

Senior Wildlife Research Biologist

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Dale E. Toweill
Wildlife Program Coordinator
Federal Aid Coordinator

James W. Unsworth, Chief
Bureau of Wildlife

FEDERAL AID IN WILDLIFE RESTORATION

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sale of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program then allots the funds back to states through a formula based on each state's geographic area and the number of paid hunting license holders in the state. The Idaho Department of Fish and Game uses the funds to help restore, conserve, manage, and enhance wild birds and mammals for the public benefit. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes necessary to be responsible, ethical hunters. Seventy-five percent of the funds for this project are from Federal Aid. The other 25% comes from license-generated funds.