Survival and Movement Ecology of Ring-Necked Pheasants in Northern California Agricultural Areas

Craig A. Ramey and **Jean B. Bourassa**
USDA APHIS Wildlife Services, National Wildlife Research Center, Fort Collins, Colorado
Michael S. Furuta
Sutter County Department of Agriculture, Yuba City, California

ABSTRACT: Seventy-one Chinese ring-necked pheasants were radio-tracked in mixed crops in Sutter County, CA. Weekly survival of 39 wild (4 native and 35 translocated) versus 32 pen-reared birds were compared at 2 sites (~2,000 ha each) during the fall 1996 agricultural harvests. Pheasant survival after 1 week was wild 74% and 79% versus pen-reared 61% and 57% at the Meridian and Nicolaus sites, respectively. Thereafter, pooled sites survival was ~linear with ~1 wild bird dying every 2.8 weeks for 7 weeks and ~1 pen-reared bird death occurred every 4.7 days for 3 weeks. Several relocated and pen-reared pheasants joined wild flocks, and their survival improved with one of each harvested during the 1997 hunting season. Both survived >400 days. All affected pheasants changed their habitat utilization and movement ecology following the harvest of their primary cover and forage crop(s). Chi square analysis of habitat use by 30 wild and 19 pen-reared pheasants demonstrated habitat preferences were greater than its availability ($P < 0.01$) for milo (planted only in Meridian), weeds, and corn. Their preferences for alfalfa, beets, and safflower were equal to their availability. Rice was preferred when the fields were dry, but overall it was not preferred ($P < 0.01$). Also, orchards (cleared of ground vegetation for nut harvests) and fallow habitats were not preferred. Movement ecology data were separated by study site because of significant habitat differences. Home ranges (95% utilization areas) using the minimum convex polygon method to compare wild versus pen-reared pheasants averaged 74 and 67 ha at Meridian and 73 and 140 ha at Nicolaus. Daily rooster and hen movements averaged 295 m and 276 m for wild birds and 335 m and 382 m for pen-reared birds at the Meridian and Nicolaus sites, respectively. Results from the first fall pheasant study in California crops demonstrated they preferred the dynamic juxtaposition of grains and weeds for cover, shelter and forage with water. Twenty-nine pheasants (58%) demonstrated habitat preferences for grains–milo, rice, and corn. Pheasant survival was related to post-harvest habitat changes. Their home range, survival, and movements were very similar at both sites although the crop mosaic and habitat relationships were very different. These new results should be included in both public and private pheasant management practices.

KEY WORDS: crops, harvests, home ranges, movements, pen-reared, *Phasianus colchicus*, ring-necked pheasant, survival

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INTRODUCTION

Chinese ring-necked pheasants (*Phasianus colchicus*) occur throughout the United States, and they are associated with many different terrestrial habitats. The northern Sacramento Valley of California has some of the highest pheasant population densities in the U.S. (>0.5 pheasant/acre), according to the California Department of Fish and Game (CDFG) (CDFG 1962, Hart 1990, Littrell 1990). Free-ranging pheasants include both wild and pen-reared birds. Formerly CDFG and currently many private citizens and pheasant clubs in California release numerous pen-reared pheasants (>300,000 a year) for fall hunts (Hart 1990).

The primary objective of this study was to compare on farms in the northern Sacramento Valley the survival, habitat utilization, and movements of wild with pen-reared pheasants. Even though CDFG has studied pheasants on federal and state lands within primarily monocultural habitats, they have not been investigated in a crop mosaic of small fields on private farms. In addition, pen-reared pheasants were postulated to be initially naïve about predators and their need to obtain forage, cover, shelter, and water in their new free-ranging environment. Therefore, their survival was expected to decrease to about 20-40% at 4 weeks following release as documented by Hessler *et al.*(1970) and Krauss *et al.* (1987) on large farms.

STUDY AREA

Study Sites

This study was conducted concurrently with a study previously reported about the use of the pesticide zinc phosphide (Zn_3P_2) for vole control in some of these same pheasant areas (Ramey *et al.* 2000). Both investigations were conducted at 2 sites ~40 km apart, near the towns of Meridian and Nicolaus, in irrigated farmlands that have some of the highest pheasant population densities in the state (>0.5 pheasant/acre) as reported by Hart (1990) and more recently in unpublished data by D. Connelly (CDFG, Sacramento, 1995). The Meridian site (2,036 ha) was located southeast of the town and adjacent to the Sacramento River. These farms produced 29.1% rice (*Oryza sativa*), 15% walnut orchards (*Jugulans* spp.) or Asian persimmons (*Diospyros* spp.), 7.3% milo (sorghum – *Sorghum vulgare*), and 6.6% alfalfa (*Medicago sativa*) intermixed with or 2.6% beans (*Phaseollus* spp.), 2.5% corn (*Zea mays*), and 2.1% melons (*Cucumis melo*). Many fallow fields had been melons and beans before they were harvested, and fallow fields comprised 24.8% of the habitat at the beginning of the study. The Nicolaus site (1,983 ha) was located southwest of the town and adjacent to the Feather River, where the predominant crops were 40.4% rice, 13.2%, sugar beets (*Beta vulgaris*), 9.0% corn, 7.1% alfalfa, 2.0% walnut

orchards, 1.9% safflower (*Carthamus tinctorius*), and 0.4% sudan grass (*Sorghum bicolor sudanensis*), intermixed with 14.4% fallow fields. The result was a mosaic of crop relationships that were ever changing due to the harvest operations. The topography at both sites was essentially level with a southern drainage. These farmlands contained numerous 1 to 3-m-deep irrigation ditches in which cattails (*Typha* spp.), blackberries (*Rubus* spp.), weeds, and wild grasses grew. Abundant pheasants were observed throughout these areas in the spring of 1995 and 1996, during site selection and cooperator approval processes.

Sutter County lies ~180 km east of the Pacific Ocean in the northern Sacramento Valley and has a mild climate characterized by a hot arid summer followed by wet fall, winter, and spring seasons. Annual maximum and minimum temperatures reported during 1996 were 45°C and -2°C. Annual precipitation occurs mainly as rain between October and April. Fields were irrigated from the Sacramento and Feather Rivers, which are bordered with tall levees to minimize periodic flooding. During the study (11 September to 7 November, 1996), maximum and minimum air temperatures were 25°C (±6.2°) and 9.2°C (±3.4°), respectively. All the precipitation during the study occurred in October and totaled 3.0 cm (1.2 in).

Predators observed in the study sites included red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus hudsonicus*), nocturnal birds of prey such as the barn owls (*Tyto alba*) and great horned owls (*Bubo virginianus*), red and gray foxes (*Vulpes fulva* and *Urocyon cinereoargenteus*), coyotes (*Canis latrans*), skunks (*Mephitis mephitis*), American raccoons (*Procyon lotor*), feral cats (*Felis domsticus*), and dogs (*Canis familiaris*). Great horned owls were observed twice to be successful pheasant predators.

Dates

The study began in early September 1996 and continued through the first week of November, ending just before the start of the pheasant hunting season. Crop harvesting in both areas occurred essentially simultaneously. Beans were cut during the last week in September and were plowed under and remained fallow for the remainder of the study. Rice was harvested during October. Some rice fields were burned after harvest; others were left with the rice straw unburned in the fields due to air pollution restrictions. Corn was harvested during the last 3 weeks of October leaving corn ears, kernels, and stubble. Alfalfa fields were harvested twice and were cut, dried, and baled during September 15-30 and October 20-30. Harvesting operations of crops increased pheasant movements due to the removal of forage, cover, and shelter as well as the disruption of their pre-harvest behavior.

MATERIALS AND METHODS

Pheasants

Wild pheasants were captured by spotlighting, a proven technique utilized regularly by the CDFG as reported by Hart (1990) and others (Hanson and Progulske 1973). Birds were captured using an Argo 8-wheeler all-terrain vehicle with a driver, two "netters" in the vehicle's front, and two "spotters" in the rear using 1-million-candlepower spotlights to locate pheasants (Ramey *et al.* 2000). A few pheasants were captured using 2 all-terrain vehicles (ATVs) moving parallel through pheasant habitat, each with a driver and a spotter/netter. Pheasant trapping in crops was limited to alfalfa stubble fields prior to their last growth of the year. Four indigenous wild pheasants were captured near Meridian ($n = 2$) and Nicolaus ($n = 2$) in alfalfa when raked into windrows. Overall trapping success for pheasants in alfalfa was 1 bird for 289 minutes of trapping. All other crops were nearing their harvest, so trapping was not allowed in them. Although some pheasants were observed in crop field edges or along the irrigation ditches, none of these pheasants could be captured before they ran or flew into the safety of adjacent crops. Small weedy areas surrounding the crops were also trapped, particularly along fence rows, without success because none of these pheasants remained stationary long enough to net, or when flushed they flew into the mature crops. A nearby large weed field was trapped and capture success increased, with an average of 1 bird captured every 19 trapping minutes. These wild but translocated, free-ranging birds ($n = 35$) were randomly relocated near the center of each study site at 1 of 5 locations. Thus, our wild pheasants ($n = 39$) included both endemic and translocated birds. All wild birds were located and observed during a 6-day acclimation period during which no native birds and 9 translocated birds were lost due to predation. Eight of the 9 did not survive ~24 h in their new surroundings and the 9th bird died on Day 6. Some of those that survived the first 6 days were assimilated into endemic flocks of wild, free-ranging pheasants.

All birds were sexed, aged, and weighed and then fitted with radio-collars and leg bands with a unique number (size 14, National Band and Tag Co., Newport, KY). All pheasants were considered adults by CDFG staff and weighed >624 g (wild $\bar{x}$ wt. = 1,029 g and pen-reared $\bar{x}$ wt. = 1,368 g). Many wild birds corresponded in age to adults-of-the-year, which Hayne (1951) believed comprised the largest cohort of the wild population in the fall of the year versus our pen-reared birds, where >50% were >1 year old.

Radio-Transmitters and Radio-Locations

Radio-transmitters were a neck pendant attachment design weighing ~12g. The broadcast frequency was from 164.4375 MHZ to 167.1575 MHZ with a normal operating pulse rate of either 60 or 90 pulses per minute (ppm), and a mortality mode of 150 ppm that activated after 1 h of no movement. All transmitters and some receivers were built by Advanced Telemetry Systems (ATS) (Isanti, MN), and a few receivers were from Custom Electronics (Urbana, IL). Vehicles were equipped with dual beam, 3-element Yagi antennas. A Cessna airplane was equipped for radio-tracking and was used to locate pheasants with more extensive movements and 1 bird that was poached.

The total radio-transmitter package, including the battery, neck pendant, and antenna, were <1.9% of the smallest pheasant's weight. Study personnel had previously concluded pheasant behavior and flight were not adversely affected by telemetry packages that were ~2% or less of a pheasant's weight (Ramey *et al.* 1994, unpubl. data). The adjustable collar was a neck-pendant design with the antenna positioned ~180° from the transmitter and battery pack. When the elastic collar was slipped over the pheasant's head,

the transmitter and battery pack rode under the neck and the flexible antenna was on the dorsum of the bird and pointed up and slightly backwards. This arrangement produced the best signal reception when the pheasant was foraging, running, or flying (Ramey and Sterner 1995, and unpubl. data). Our 1995 conclusion that this was an excellent configuration for the telemetry collar was reinforced during the current study by their movement behavior and ability to fly with the other wild endemic birds that were not part of this investigation.

All pheasants were radio-tracked using methods modified from Dodge (1967), Mech (1983), and Hegdal and Colvin (1986). We also employed GPS tracking stations and computers in the field (Ramey *et al.* 2000) for data entry and data analysis. Tracking stations were established using a Trimble Geo Explorer GPS instrument with ~2 m accuracy and were positioned for the triangulation of pheasants in various habitats at each site. At each tracking station, before locating the radio signals, the vehicle was oriented north using a large compass mounted on the inside roof of the vehicle. The compasses were regularly checked for accuracy at the Yuba City airport using a ground compass rose. When first locating a bird using a directional antenna and a peak/null box, the peak signal was used for the general location and then the box was switched to the more precise "null" signal for recording the bearing. The observation number, date, time, station number, bearing from the station, and habitat were documented.

Birds were located at least once each day using generally 3 bearings with an effort to take one bearing at ~0°, 90°, 180°, or 270° angle from the pheasant. When 3 or more bearings were taken, an error polygon was generated by the LOCATE II computer program Version 1.3 (Pacer, Truro, Nova Scotia, Canada). Error polygons (i.e., mainly triangles) ranged from 3 m^2 to 38,863 m^2, with a mean of 2,845 m^2 (±922 S.E.) at Meridian and 4,500 m^2 (±2,013 S.E.) at Nicolaus. Pheasants spent much of the day in the center fields (averaging ~65 ha) and away from the harvesting activities. Pheasants frequently spent their early mornings near irrigation ditches with water and nights in heavy cover. After locating all birds each day, the information was entered into the LOCATE II program on a laptop computer, and individual pheasant maps were printed so they could be more easily located the following day. Between 16 and 48 observations were made for each pheasant included in the movement ecology analyses ($\bar{x} = 33.6 \pm 10.1$ SD) from Day 7 thru ~Day 50.

Procedures

Radio-collared native birds were placed into CDFG wooden pheasant crates and transported to an instrumentation truck parked at the field's edge. Pheasant transportation, instrumentation, and obtaining demographic data required an average of ~65 minutes from the time of its capture to the time of its release at its capture point. Translocated pheasants were caught during nocturnal trapping activities and were transported while still dark from their capture sites in air-conditioned trucks to their release point using CDFG wooden crates. These pheasants were transported to one of 5 randomly assigned release sites at field edges within 4-6 hours of their capture. These pheasants were released at the intersection of several different crops allowing them a choice from a variety of habitats. The initial 39 wild (4 native and 35 relocated) pheasants were randomly divided between Meridian, where 19 pheasants (11 males and 8 females) were released on September 18, 19, and 21, and Nicolaus, where 20 pheasants (7 males and 13 females) were released on September 13, 15, 18, and 23. None of the pheasants died during captivity (instrumentation, data collection, transportation, and release).

Adult pen-reared pheasants raised for private hunting clubs are normally initially released from a few hours up to a day prior to the pheasant hunting season. Thirty-two pen-reared birds were purchased on October 11 and 12, and released about 1 month earlier than usual. Pen-reared pheasants had spectacles designed to lessen fighting, which were removed by the breeders just prior to crating for transportation to the study sites. Immediately before release, these birds were weighed, banded, and radio-collared using the same techniques as employed for the wild pheasants. After a random selection process, 18 birds (8 males and 10 females) were released at the Meridian study area on October 11, and 14 birds (8 males and 6 females) were released at Nicolaus on October 12. The pen-reared birds were released ~4 weeks later than wild birds due to their anticipated higher mortality. Thirteen died during the first week (i.e., acclimation period).

Statistical Analyses

Chi-square goodness-of-fit tests ($P = 0.01$) were used to determine if the number of radio-locations in a given habitat were proportional to its availability in the study area and whether pheasants avoided or used habitats in proportion to their availability (SAS 1987). Sequential movements (except for one 3-day mid-study rest period) for each pheasant were measured using GPS locations on digitized maps. Mean movements (±S.E.) were calculated for each pheasant, and males versus females and free-ranging versus pen-reared pheasants were compared using t-tests ($P = 0.001$).

Survival rates for radio-collared wild versus pen-reared pheasants were compared using a Kaplan-Meier product-limit function (Kaplan and Meier 1958) and weekly intervals (Heisey and Fuller 1985). The estimation and analysis of survival distributions for radio-tagged animals have been described by Pollock *et al.* (1989). We modified their methods to employ not only a random sample of N animals that are radio-instrumented and monitored daily for survival or death but also their movements and crop utilization. In this study, pheasant losses for which dates of death are not known are called censored observations. They mainly occur from either radio failure or the pheasant's survival beyond the completion of the study. This model requires 3 basic assumptions: 1) survival times are independent among the different individuals; 2) the censoring mechanism is random; and 3) a random, unbiased sample of animals is obtained.

Home range was calculated for each pheasant with >15 locations using the adaptive kernel method to estimate their 95% utilization area (UA) and 50% core utilization area(s) using the methods of Worton (1989). The 95% UA was used to minimize the effects of outliers, since some pheasants sometimes wander beyond their normal activity area. The

50% UA indicated core areas receiving the most consistent or intense use by each pheasant. We used the kernel method to calculate UAs because it has fewer deficiencies than: 1) the minimum convex polygon method of Mohr (1947) which is substantially influenced by sample size and outliers (Harris *et al.* 1990); 2) the harmonic mean method (Dixon and Chapman 1980), which is mathematically less robust and sophisticated than the kernel method; and 3) elliptical methods which are based on unrealistic assumptions of animal use of space (Van Winkle 1975, Harris *et al.* 1990). In addition, the minimum convex polygon home range areas of Mohr (1947) were also calculated to compare with early papers on pheasant home range.

Some alfalfa fields (~81 ha) were treated for rodent control by cooperators using the California Department of Food and Agriculture's (CDFA) 2% Zn_3P_2 treated grain bait (Reg. No. CA890027) manufactured as steam-rolled oat (SRO) groats. The Zn_3P_2 technical product was purchased from Bell Laboratories, Inc. (Madison, WI) and broadcast to control California voles (*Microtus californicus*) and montane voles (*M. montanus*) in some alfalfa fields. Sub-lethal pesticide effects (Janda and Bosseova 1970) were not observed as described by Ramey and Sterner (1995). No mortalities resulted from the broadcasting of Zn_3P_2 SRO baits for vole control in alfalfa (Ramey *et al.* 2000). Some non-target deaths were anticipated during following baiting based on the extensive literature review of Johnson and Fagerstone (1994), but few were observed and none were upland game birds (Ramey *et al.* 2004).

RESULTS AND DISCUSSION

Survival

Figure 1 illustrates wild and pen-reared survival from Day 0 (i.e., release) to the end of the study for each pheasant group and site location. The first week was considered an acclimation period for all the pheasants to get used to the telemetry unit, plus new surroundings for translocated and pen-reared birds, plus new freedom and predators for pen-reared pheasants. During the 55-day Nicolaus study from 13 September to 6 November, 17 pheasants were victims of avian and mammalian predation (7 translocated and 10 pen-reared pheasants released 12 October). Originally, 34 pheasants were released at this site (20 wild and 14 pen-reared). Mortality was higher for pen-reared than for wild pheasants: 7 of 20 wild pheasants (35%) died during ~8 weeks of study, compared to 10 of 14 (71%) of the pen-reared birds that died during the corresponding final 4 weeks of the study. During a similar 50-day study at Meridian from 18 September until 7 November for wild birds, and from 11 October until 7 November for pen-reared birds, 20 of the original 37 pheasants were found dead (7 were translocated and 13 pen-reared released ~4 weeks later). Of these, 17 died from avian or mammalian predation and 1 each from harvesting operations, poaching, and an unknown cause (only the radio-transmitter was found). Similarly, mortality was higher for pen-reared than for wild pheasants at Meridian; 7 of 19 wild pheasants (37%) died during ~7 weeks, while 13 of 18 (72%) of the pen-reared birds were found dead during ~4 weeks after release. All wild pheasants found dead at each site were translocated birds. No endemic pheasants died during the 8-week study.

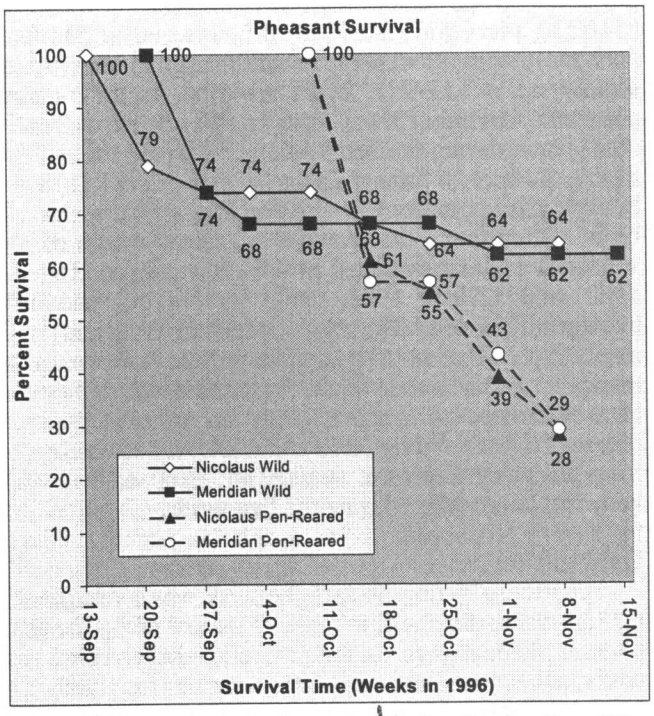

Figure 1. Weekly Kaplan-Meirer survival estimates for wild caught and pen-reared pheasants at the Meridian and Nicolaus study sites during September - November 1996.

Weekly Kaplan-Meier survival analyses after the acclimation period (Days 1-6) for all pheasants showed 7 weeks later that wild bird survival decreased 16% at Meridian and 19% at Nicolaus. In comparison, pen-reared pheasants' survival decreased 54% at Meridian and 49% at Nicolaus during the final 3 weeks of the study. Combining the separate site data yielded survival estimates that were ~linear with ~1 wild bird death every 2.8 weeks and ~1 pen-reared bird death every ~4.7 days. During the 3 weeks the pen-reared pheasants were studied, some of them joined wild flocks and their survival improved. Pheasant deaths increased as the fall crops were harvested, probably associated with changes in their movement ecology. Two pheasants, 1 wild and 1 pen-reared, were harvested during the 1997 hunting season, and they had survived >400 days.

To compare our results with other earlier investigations, we also analyzed our results from the time of release on Day 0 until the end of study. In Figure 1, Meridian pheasant overall survival from release to the end of study was lower among pen-reared pheasants, 28% at 4 weeks, than among the wild pheasants, 62% at ~8 weeks. Similarly, Nicolaus overall survival rate from release to the end of study was lower among pen-reared pheasants (29% at Meridian at ~4 weeks) than among the wild pheasants (64% at ~8 weeks). Pen-reared pheasants were more vulnerable to predators, especially avian predators, than were the wild pheasants, based on the cause of death at kill sites. A difference in behavior was reported at the time of their release; wild pheasants moved immediately, either running or flying into dense cover, while some pen-reared pheasants seemed to be confused, sat down and did not move, while others walked slowly into cover or ran a short distance before sitting down. Many of these remained either in open fields or along field

edges the first day and/or night after release.

Using the 4-week survival of pen-reared pheasants at each site, the results were typical of findings in other studies. Hessler *et al.* (1970) found survival of radio-tagged pheasants was only 19% at 4 weeks after release. Mortality was greater during the first 15 days following release than during the later 16 through 28 days. Krauss *et al.* (1987) in Pennsylvania compared the survival of game-farm and wild birds. They found that survival of game-farm birds at 4 weeks after release averaged 24-44% in studies conducted in 1982, and 32% in 1983, while survival of wild birds averaged 72% and 88% after 4 weeks in 1982 and 1983, respectively. They noted that game-farm birds showed a low avoidance behavior to approach by the observer, so they may have been more susceptible to predation. In our study, many pen-reared birds did not seek suitable cover for protection from predators; therefore, we were not surprised that ~40% were lost to predation during the first week.

Habitat Use

Habitat use by ring-necked pheasants was investigated in CA farmlands for the first time. Classical components of pheasant habitat such as forage crops, shelter belts, strip cover, and water (Edminster 1954) were all involved. The habitat utilization by both wild and pen-reared pheasants at Meridian was generally similar particularly after the first week. Only a slightly decreased use of rice fields by pen-reared birds occurred, probably because these fields were being harvested. Crop preferences were certainly affected by their ability to provide cover, shelter, and/or forage until harvested. Wild pheasants had 2.6 times as many observations (n = 1,258) versus pen-reared birds (n = 484) which were initially fewer in number, released ~4 weeks later, and had more mortalities.

Meridian pheasants selected many habitats in different proportions than their availability during the study. Milo was the most preferred habitat at Meridian, with 45% of pheasant locations in it even though it constituted only 7.3% of the habitat. Corn and ditches (weeds) were also used more than expected ($P < 0.01$) based on availability and illustrated habitat preferences that were similar for both wild and pen-reared pheasants. Milo and corn provided excellent pheasant cover for both foraging and shelter until their harvest, then their subsequent use decreased although corn and to a lesser extent milo received some use after their harvest. As the harvest proceeded, the use of ditches and field edges by all pheasants increased, and many pheasants were flushed from ditches with water, especially in the early morning. Alfalfa fields were used as its cover potential increased. Rice, fallow fields, and orchards were used less than their availability would indicate ($P < 0.01$). Rice was generally avoided by pheasants early in the study, because they preferred to use only the higher ground found on the rice berms between the flooded fields rather than the actual flooded rice fields. Once the fields began to dry up for harvesting, some pheasants preferred the rice fields, probably because they provided both good cover and forage until harvested.

At Meridian, 7 of 14 (50%) wild pheasants that survived >6 days demonstrated habitat fidelity, defined as being in a crop for >50% of their locations. However, this definition was very dependent on the date of each field's harvest, with most pheasants located almost exclusively in one habitat until it was harvested. Early in the study, we were able to separate pheasants into those that used primarily milo, rice, and corn. These pheasant flocks were composed of both radio-collared and non-collared pheasants. As the harvest proceeded from field to field and crop to crop, the pheasants moved to other fields or crops. Four pheasants (3 roosters and 1 hen) utilized milo fields that were not harvested during the study for >90% of their locations. Three other roosters used rice for >73% of their locations until it was harvested, they then moved to other crops such as corn and weeds.

Ten of 11 (91%) pen-reared pheasants at Meridian demonstrated habitat fidelity after surviving the acclimation period. Seven pheasants (5 hens and 2 roosters) were located almost exclusively in milo before its harvest (>59% of locations) and then moved to ditches, alfalfa, and orchards. One rooster and 1 hen were found almost daily in corn (>90%) until its harvest. One rooster stayed predominately in ditches (>56%) while using milo (28%), orchards (12%) and a fallow field (4%).

Wild pheasants used rice at Nicolaus but less than expected based on its availability ($P < 0.01$), 40.4% of the habitat was rice and 29.9% of the locations were in rice. Corn, alfalfa fields, and ditches were used more than their availability ($P < 0.01$), while fallow fields were significantly underutilized ($P < 0.01$). Fields of sugar beets and safflower were used in proportion to their availability. Sudan grass, orchards, and harvested bean fields had insufficient data to analyze.

Among wild pheasants at Nicolaus that survived >6 days, 5 of 16 (31%) (4 hens and 1 rooster) demonstrated habitat fidelity. Three hens used mainly corn (>56% of their locations) and 1 rooster and 1 hen used mainly rice (>73% of the time). Corn was the first crop to be harvested at this site followed by rice. Five pen-reared pheasants (2 roosters and 3 hens) of 8 that demonstrated habitat fidelity (62.5%) utilized mainly rice (80%), and 1 rooster used fallow fields in 60% of its locations (n = 25).

Pheasants in west Texas preferred row crops and small grains such as corn, cotton, and sorghum, during the fall, and alfalfa (Whiteside and Guthery 1983). Hanson and Progulske (1973) found that when the alfalfa fields were cut in early September in South Dakota, some pheasants moved to corn or other crops, producing larger home ranges averaging 55 acres (22 ha). Although their pheasants used 9 cover types, they preferred corn (33%) and small grains (23%). In our study, pheasants preferred milo, corn, and weeds, but many pheasants used a mosaic of crops not observed in other studies, probably because of small field sizes and overlapping harvest dates (Figure 2).

Home Range

Pheasant home ranges at Meridian, using the adaptive kernel 95% utilization distributions, varied considerably, from 22.7 ha for one wild bird (n = 13) to 313.9 ha for a pen-reared bird (n = 10). One pen-reared rooster was excluded because it did not form a home range and covered an area that increased up to 3,578 ha. Home range averaged 116.7 and 117.2 ha for the wild and pen-reared pheasants, based on an average of 41 and 25 locations, respectively. The 50%

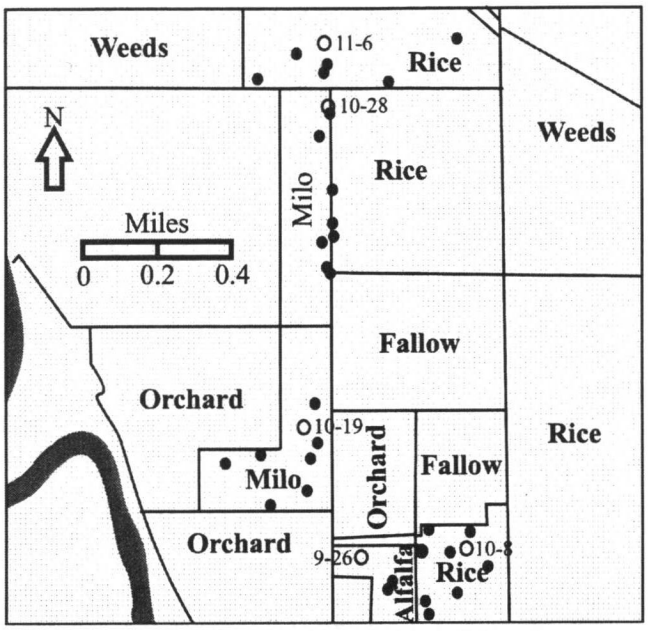

Figure 2. Movements of a wild (translocated) female pheasant from September 19 through November 7 in a cropland mosaic following various harvests in Meridian, California, 1996. Examples of its movements are from alfalfa on 9/26, to rice on 10/8, to milo on 10/19, to weeds on 10/28, and to rice on 11/6, all associated with various harvests.

core utilization areas averaged 20 to 21 ha (range 5.2-68.3) for the two groups. At Nicolaus, home ranges of wild birds were similar to those at Meridian (n = 15), while those of pen-reared birds were larger (n = 8). Wild pheasants had adaptive kernel 95% utilization distributions averaging 122 ha while pen-reared pheasants had 95% UAs averaging 254 ha, based on an average of 25 and 49 observations, respectively. Pen-reared birds at Nicolaus had UAs more than twice the area utilized by pen-reared birds at Meridian.

Because many previous pheasant studies estimated home ranges using the minimum convex polygon method, we also calculated these home ranges for comparison. The home ranges of wild and pen-reared pheasants averaged 74 ha and 67 ha, respectively, at Meridian, and 73 ha and 140 ha at Nicolaus. These results are higher than several earlier studies, such as Whiteside and Guthery (1983). They found that endemic pheasant home ranges in the west Texas high plains during October for roosters averaged 18.8 (n = 3) and for hens 17.3 (n = 7). Hanson and Progulske (1973) reported summer-fall home ranges which were larger in South Dakota for hen pheasants, averaging 36.6 ± 19.4 ha, whereas Gates and Hale (1974) reported spring-summer home ranges for both sexes to be 145.8 ha. Therefore, our results are within the continuum reported in the literature, but they seemed to be qualitatively different because of the mosaic of habitats utilized (Figure 2).

Small field sizes and the effect of successive harvests seemed to push the pheasants from habitat to habitat. For example, at Meridian, some pheasants were located in various crops being harvested, so they then moved among milo, rice, and/or corn. This resulted in a split home ranges for 8 of 22 birds (4 wild and 4 pen-reared). In Nicolaus, 10 pheasants (6 wild and 4 pen-reared) moved among rice, corn, beets, and/or safflower after successive harvesting operations. In summary, most pheasants seemed to maintain a dynamic juxtaposition in both their home ranges and core use areas, associated with minimizing the inclusive area among forage, shelter, cover, and water during the fall harvest season.

Distance Moved

After determining the difference between the pooled mean daily movements of wild versus pen-reared pheasants was significant (t = 9.74, P = 0.001), we further compared them by study site and sex. At Meridian, the average daily movements were 290 m (±14 SE, n = 8) for wild roosters and 285 m (±17 SE, n = 5) for wild hens. While pen-reared rooster pheasants moved 390 m (±43 SE, n = 4) and hens moved 327 m (±21 SE; n = 6). Sequential movement differences between wild versus pen-reared pheasants compared by sex were different (P = 0.001); rooster (t = 3.53, df = 375, P = 0.001) and hens used less habitat than their wild counterparts (t = 24.7, df = 350, P = 0.001). One Meridian pen-reared rooster was excluded from these calculations just as in our home range analyses because he averaged 788 m daily (±188 SE), far greater than any other bird. Mean sequential movements of pheasants at Nicolaus were compared by sex. Daily wild rooster movements averaged 295 m (±13 SE, n = 5) and hens averaged 276 m (±12 SE, n = 11) versus pen-reared roosters averaged of 335 m (±28 SE, n = 4) and hens averaged 382 m (±35 SE, n = 4). Movement differences between wild versus pen-reared Nicolaus pheasants also demonstrated a difference between hens (t = 3.58, df = 569, P = 0.001) but not roosters (t = 1.48, df = 324, P > 0.80).

In summary, at both study sites, the mean sequential movements of pen-reared pheasants were greater for each sex compared with the movements of wild pheasants. All pheasant movements seemed to be very dependent on the harassment from the harvesting operations. These sequential pheasant movements at Meridian and Nicolaus were similar to other studies. In west Texas, wild pheasants' October movements were similar to ours– males 253.5 m, females 247 m (Whiteside and Guthery 1983), and also to those reported in South Dakota by Bue (1949), <275 m. However, our results were shorter than the ~400 m values reported by Kirsch (1951) in large fields in South Dakota.

CONCLUSION

Due to a lack of access, pheasant investigations on private agricultural lands have been non-existent in California. The objective of this study was to determine the use of farm habitats by both wild and pen-reared pheasants during the fall agricultural harvests in northern California. The overall majority of pheasants were found in grain fields and ditches during the study. Pheasants avoided areas lacking cover, such as harvested and fallow fields, as well as walnut orchards devoid of weeds in preparation for harvest. Harvesting activities increased the size of home ranges (i.e., 95% UAs). Habitat fidelity was observed by 28 pheasants (57%) that survived >6 days with >50% of the locations in

one crop. Preferred habitats were milo at Meridian versus rice, corn, and weeds at Nicolaus, where no milo was planted. As expected, pheasant survival was best for wild pheasants (endemic pheasants > translocated pheasants > pen-reared pheasants). Some relocated and pen-reared pheasants moved with flocks of endemic pheasants, and this behavior seemed to improve their survival with at least 2 pheasants (1 relocated and 1 pen-reared) surviving >400 days (both were harvested during the 1997 hunting season). Although the survival curves were at the 2 sites were similar, they are discussed separately because of the very different mosaics of habitats involved. For instance, milo was >45% of the habitat at Meridian but not grown at Nicolaus. Rice was >40% of the habitat at Nicolaus and 29% at Meridian. The resulting survival of wild pheasants (all mortalities were translocated pheasants) including the acclimation week, after 8 weeks were surprisingly similar (62% at Meridian and 64% at Nicolaus). In contrast, pen-reared pheasant survival at 4 weeks was 29% at Meridian in mainly milo, and 28% at Nicolaus in mainly rice. The most surprising result was that the average home range for each study area by the type of pheasant was generally similar, even with a mosaic of habitats and harvest dates. In conclusion, pheasants used the dynamic (i.e., ever changing with various harvests) juxtaposition of mixed grain habitats and weeds for cover, shelter, food, and water in forming their home ranges and core use areas. These results should be useful in improving both public and private pheasant management practices.

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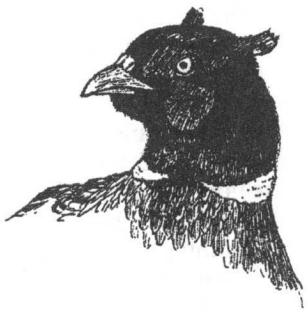
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