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An Ecological Study of Mourning Doves in a Cold Desert Ecosystem on the Idaho National Engineering Laboratory

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AN ECOLOGICAL STUDY OF MOURNING DOVES IN A COLD DESERT ECOSYSTEM ON THE IDAHO NATIONAL ENGINEERING LABORATORY

BY
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AN ECOLOGICAL STUDY OF MOURNING DOVES IN A COLD DESERT

ECOSYSTEM ON THE IDAHO NATIONAL ENGINEERING LABORATORY

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor — Date

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AN ECOLOGICAL STUDY OF MOURNING DOVES IN A COLD DESERT ECOSYSTEM ON THE IDAHO NATIONAL ENGINEERING LABORATORY

Abstract

Frank P. Howe

Mourning dove (*Zenaida macroura*) use of and movements around man-made ponds, as well as dove nesting ecology, were studied from 1983 through 1985 on the Idaho National Engineering Laboratory (INEL). Relative dove use was higher ($P < 0.01$) on some ponds than others, and multiple regression revealed a positive association ($R^2 = 0.49$) between relative use and the geographic isolation of ponds. Two peaks in diurnal pond use were exhibited by doves on the INEL: the mourning peak began around 0800 and lasted until approximately 1300, and the evening peak began at about 2030 and ended by 2150. Seasonal pond use fluctuated slightly through the summer then dropped rapidly in early September.

Average and average maximum movements indicated that the 41 mourning doves trapped and fitted with radio-transmitters at the Test Reactor Area (TRA) and the Naval Research Facility (NRF) did not move off of the INEL on a regular basis. The average distance from mourning dove locations to TRA and NRF was <2.0 km, and the average maximum dove location was <3.5 km from either facilility. Average (<2.0 km) and average maximum (<3.5 km) distances were also measured from dove locations to watering sites. Doves captured at both TRA and

NRF moved, on average, 1.5 km from their nests; the average maximum distance from a dove's location to its nest was 2.8 and 5.4 km for doves caught at TRA and NRF. The average maximum distance between any 2 locations (for the same individual) at both TRA and NRF was <4.0 km.

Mourning doves on the INEL are primarily ground nesters. Nesting success averaged 68% per year, with 1.8 fledglings produced per successful nest. Nesting densities averaged 0.02 nests/ha during the study. Three peaks in hatching occured on the INEL: 1 during the fourth week of June, another during the third week of July, and a third during the first and second weeks of August. Annual production estimates for the INEL ranged from 11,300 to 17,000 doves, based on a model using 2 and 3 nesting attempts per summer.

No differences ($P > 0.05$) were indicated in the percent coverage of shrubs, grasses, forbs, and bare ground, as measured with the line-intercept method, in the 5-m area surrounding dove nests and paired random sites. However, a difference in the percentage of grass cover and bare ground, as measured with a point-frame, was indicated in the 1-m^2 (microhabitat) centered on the nest or random site; nest sites contained more grass ($P = 0.02$) and less bare ground ($P = 0.02$) than random sites. No difference was found between nest and random site microhabitats in the percentage of shrub or forb cover. Also, no difference was indicated by chi-square analysis in vertical vegetation obstruction, as measured from 15 m, between nest and random sites. Twenty-three of the 28 ground nests on the INEL were located under big sagebrush *(Artemisia tridentata).*

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GENERAL INTRODUCTION

The mourning dove *(Zenaida macroura)* is an abundant summer resident on the Idaho National Engineering Laboratory (INEL) and is common throughout the state of Idaho. Doves arrive at the INEL in late April through mid-May; they court, breed, and nest during the months of June, July, and August. In late August and early September, doves gather in flocks and begin their southerly migration.

Doves frequently use the shorelines and peripheral areas of man-made ponds on the INEL; these areas are used as watering, gritting, and courting sites. Doves using the Test Reactor Area (TRA) radionuclide leaching pond are exposed to various gamma-emitting radionuclides and may experience significant, but relatively low levels of Cesium-137 contamination (Markham and Halford 1982).

Because of their potentially high mobility, doves using man-made ponds on the INEL are capable of feeding and/or nesting in areas adjacent to the INEL. Doves using contaminated ponds may thus provide a potential pathway for radionuclide transport to areas off the site.

There are no previously documented studies dealing with mourning dove movements or nesting ecology in areas, such as the INEL, which are dominated by big sagebrush *(Artemisia tridentata).* Previous studies on the INEL were concerned with radionuclide levels of doves, on and adjacent to the site (Markham and Halford 1982), and food habits of doves on the site (Trost et al. 1976). The abundance of doves on the INEL (Reynolds and Trost 1981) and dove use of the TRA doves on the INEL (Reynolds and Trost 1981) and dove use of the TRA radionuclide leaching pond and other man-made ponds on the site have been noted (Trost et al. 1976, Arthur and Markham 1978, Halford and Millard 1978).

The objectives of this study were to: 1) determine diurnal and seasonal dove use patterns and arrival rates of mourning doves at the major man-made ponds on the INEL, 2) estimate the number of individual mourning doves using selected man-made ponds, 3) identify the physical and geographical pond variables associated with relative use of man-made ponds by mourning doves, 4) determine daily movements, feeding, nesting, and alternate watering sites of mourning doves using selected man-made ponds, 5) provide estimates of nesting success, nest densities and productivity of mourning doves in a cold desert ecosystem, and 6) identify the vegetative cover variables associated with nest site selection by mourning doves on the INEL. Data was collected from 1983 through 1985.

This thesis is divided into 3 chapters in accordance with the major sections of the study. Chapter One concentrates on mourning dove use of man-made ponds, Chapter Two on daily movements around selected pond areas on the INEL, and Chapter Three on nesting ecology.

STUDY AREA

The Idaho National Engineering Laboratory (INEL) is located 80 km (50 miles) west of Idaho Falls on the upper Snake River Plain in southeastern Idaho (Fig. 1). The INEL encompasses approximately 231,600 ha (572,000 A) and is administered by the U.S. Department of Energy; public access is controlled and hunting is not allowed. The INEL is involved in a variety of nuclear testing programs and a wide range of ecological and environmental projects; it has been a National Environmmental Research Park since 1975. Markham and Halford (1982) described many of the individual facilities including the Test Reactor Area.

The INEL lies at the northern extent of the Great Basin desert and receives 18-20 cm of precipitation annually. The major vegetation types of the INEL were reported by McBride et al. (1978). Dominant shrubs on the INEL include big sagebrush (*Artemisia tridentata*) and green rabbitbrush (*Chrysothamnus viscidiflorus*); common grasses include squirrel tail (*Sitanion hystrix*), Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread grass (*Stipa comata*), and wheatgrasses (*Agropyron* spp.). Several areas on the INEL have been cleared of shrubs and planted with crested wheatgrass (*A. cristatum*). Common forbs on the INEL include prickly pear cactus (*Opuntia polyacantha*), Hood's phlox (*Phlox hoodii*), longleaf phlox (*P. longifolia*), and milkvetches (*Astragalus* spp.). Dense stands of Utah juniper (*Juniperus osteosperma*) occur at higher elevations on the INEL.

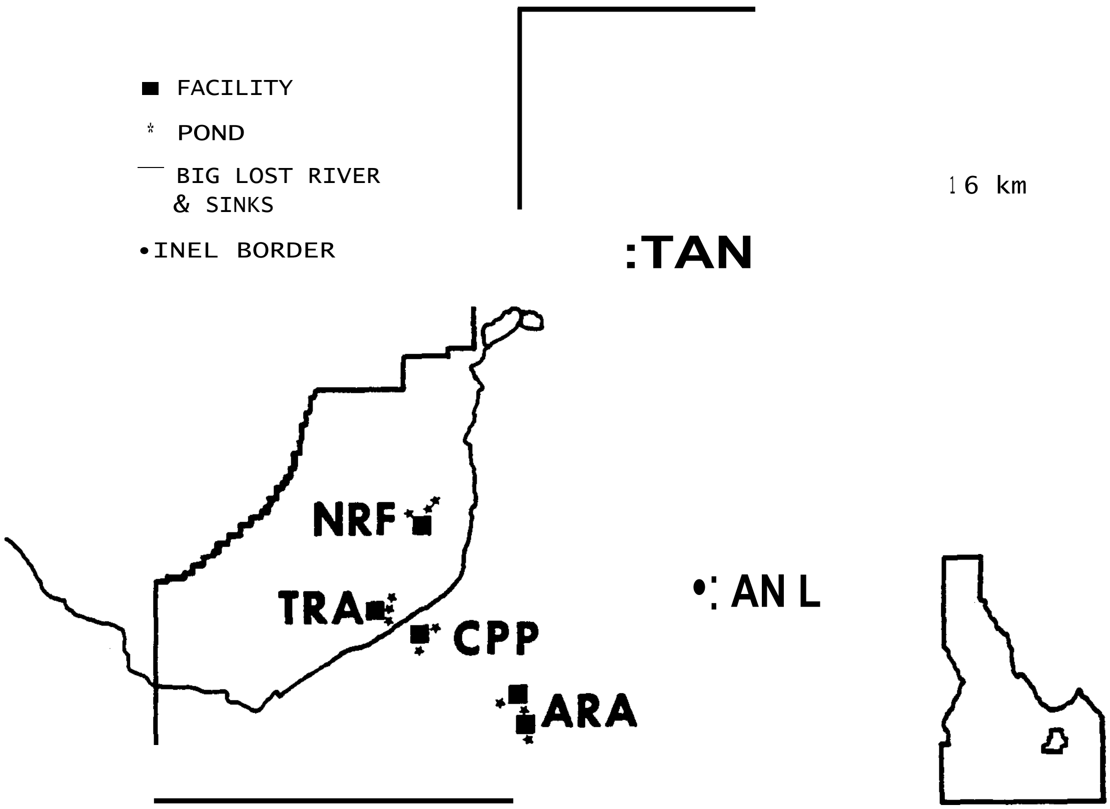

Fig. 1. Location of the Idaho National Engineering Laboratory. Facilities and associated pond areas are TAN= Test Area North, NRF=Naval Research Facility, TRA=Test'Reactor Area, ANL=Argonne National Laboratories, CPP=Chemical Processing Plant, and ARA=Auxilliary Reactors Area.

All water sources on the INEL, except ephemeral pools of rainwater, are controlled or manipulated by man. The Big Lost River historically flowed across the INEL, from south to north, and emptied into the Big Lost River sinks near the northern end of the site. Though the river still follows its historic course, it is presently controlled near the southwest corner of the INEL by a diversion dam; it is also subject to a high degree of fluctuation due to upstream irrigation. The river flowed continuously in 1983 but was dry across most of the INEL in August of 1984 and flowed intermittently from June through September in 1985. Several deep holes retained water 2 to 3 weeks after the main river channel went dry; these holes also collected rainwater and were often used by doves. The man-made ponds on the INEL are used for chemical, sewage, and radionuclide leaching. Other water sources include chemical leaching ditches and water tower overflows.

Wheat fields and wheat storage areas existed outside of the INEL boundaries near Howe, Arco, Terreton, and Atomic City, Idaho. These areas are between 10 km and 30 km from man-made ponds on the INEL.

CHAPTER ONE

MOURNING DOVE USE OF MAN-MADE PONDS ON THE IDAHO NATIONAL ENGINEERING LABORATORY

INTRODUCTION

The Idaho National Engineering Laboratory is located on the cold desert of southeastern Idaho; mourning doves there depend largely on water sites that are either made or manipulated by man. The Big Lost River, which historically ran through most of the Idaho National Engineering Laboratory, is presently subjected to great amounts of diversion for irrigation. The Big Lost River flowed continuously in 1983 then went dry on most of the INEL in both 1984 and 1985; mourning doves in the area were then primarily dependent upon man-made ponds for water.

The objectives of this study were to: 1) determine diurnal and seasonal patterns of dove use and arrival rates of mourning doves at major man-made ponds on the INEL, 2) identify physical and geographical pond variables associated with the intensity of pond use by mourning doves on the INEL, and 3) estimate the number of individual mourning doves using selected man-made ponds on the INEL.

Elder (1956) documented the mourning dove and white-winged dove (*Zenaida asiatica*) use patterns of man-made water sources on the desert of southern Arizona. According to Elder, mourning doves drank in a short period of time (less than 1 minute) but spent a great deal of time (more than 15 minutes) in the pond area before and after drinking in order to loaf and obtain grit.

In laboratory studies, Bartholemew and Dawson (1954) stated that mourning doves were capable of taking in enough water in less than 1 minute (1 or 2 draughts) to satisfy their minimum requirements for several days; MacMillen (1962) suggested that mourning doves needed only to visit surface water for "a few minutes every day or so" in order to maintain a state of positive water balance. MacMillen added, however, that the daily ad *libitum* water uptake of mourning doves was nearly twice the minimum requirement.

METHODS

INTENSIVE POND OBSERVATIONS

Mourning dove use of selected man-made ponds on the INEL was measured by counting the number of doves visiting intensively monitored ponds during 1-hour observation periods. The 5 time periods chosen for pond observations were: 0630-0730, 0930-1030, 1230-1330, 1530-1630, and 2030-2130. There were 10 observations, 2 during each time period, conducted per month. Ponds were observed in late June, late July, and late August of 1984 and in late June, late July, and early September of 1985. The number of doves present at the beginning of the observation period (originals), the number of doves that arrived during the observation period (arrivals), and the total of both (total visits) were averaged each month. Technicians were available periodically; however, man power limitations made it inefficient to observe ponds constantly, so 26 all morning, all afternoon, and all evening observations were executed to supplement the periodic counts.

Intensively studied ponds were Argonne National Laboratories-Pond 4 (ANLP4) and Test Reactor Area-Pond 1 (TRAP1) in 1984, and Auxilliary Reactors Area-Pump House (ARAPH) and TRAP1 in 1985. Data gathered at intensively observed ponds was used to determine diurnal and seasonal patterns of pond use and to estimate the average number of mourning dove arrivals to these INEL ponds.

SIMULTANEOUS COUNTS

In order to determine the relative use by mourning doves of man-made ponds on the INEL, several ponds were monitored simultaneously from June through August; counts consisted of simultaneous 1-hour (0930-1030) observation periods, 1 day per month. Again, the number of originals, arrivals, and total visits were tallied. Technicians and volunteers simultaneously observed 10 ponds in 1984 and 11 in 1985. The information obtained from simultaneous counts was also used to help determine seasonal patterns of pond use by doves in the cold desert environment of the INEL.

POND VARIABLES AND DATA ANALYSIS

Multiple regression analysis (SAS 1985a) was used to find associations between relative mourning dove use of man-made ponds on the INEL, ie. simultaneous arrivals and total visits, and the following pond variables: shoreline length, length of bare shoreline (bare from the waterline to 35 cm away from the water), slope of shore (from waterline to 1 m away), length of adjacent shoreline within 1 km, the shortest distance to an alternate, summer-long water source outside 1 km, and water pH. Variables were measured near 3 of the 6 simultaneous count dates.

Analysis of variance (ANOVA)(SAS 1985a) was used to test for significant differences in dove count data gathered from the intensively studied ponds and from the simultaneous pond counts. With the intensive pond count data, ANOVA was used to test for significant differences in dove use between ponds in the same year, between months in the same year, and in the pond by month (in the same year) interaction. Significant differences in dove use were tested for in the simultaneous count data, between ponds in the same year, between months in the same year, and between years. Orthogonal comparisons were then used to contrast mourning dove use among those simultaneous count ponds that were observed 3 times per year.

A regression of arrivals on originals (number of doves present at the beginning count) was run for all of the 0930-1030 observation periods to determine if it was possible to estimate mourning dove use of ponds from the numbers of doves flushed by an observer arriving and walking around pond shorelines.

POPULATION ESTIMATES

A sample of mourning doves was captured and recaptured to estimate the number of individuals (White et al. 1982) using the TRA area in 1984 and 1985, the NRF area in 1985, and the ARA area in 1985. Program CAPTURE (Otis et al. 1978) was used to determine whether the populations in question met the assumption of closure, which model and Maximum Likelihood estimator was best used with the given data, population size, and 95% upper and lower confidence limits.

RESULTS

RELATIVE POND USE

There was a difference ($P < 0.01$) in the mean number of arrivals among ponds indicated by the simultaneous count data (Table 1). In 1984, analysis of variance and orthogonal comparisons showed that ANL-Pond 1 (ANLP1) had greater use ($P < 0.01$) than other study ponds on the INEL. It was also shown that ANLP4 and Auxilliary Reactors Area I (ARAI) were used more ($P < 0.01$) than all other ponds, except ANLP1; ANLP4 and ARAI were not different ($P = 0.17$) from each other. In addition, ANL-Pond 23 (ANLP23) had more use ($P = 0.05$) than all but the above ponds. All other ponds had similar ($P > 0.05$) mourning dove use. Ponds sampled less than 3 times per year (see footnote on page 13) were not included in the ANOVA, and since no doves were seen at Chemical Processing Plant-Lake Barraclough (CPPLB), no variance was obtained, and CPPLB was also excluded from the ANOVA.

In 1985, ANLP1 again had higher mourning dove use ($P < 0.01$) than all other ponds on the site, and ANL-P4 had higher use ($P < 0.01$) than all other ponds except ANL-P1 (Table 1). No difference ($P > 0.05$) was indicated in dove use among the remaining ponds. Again, CPPLB had no variance and was omitted from the analysis of variance, as were ponds sampled less than 3 times during the summer (see footnote on page 13).

Table 1. Simultaneous count arrivals (X and range) of mourning doves from 0930-1030 at major man-made ponds on the Idaho National Engineering Laboratory in 1984 and 1985. [a]

1984	Pond	X	Range
	ANLP1	116.7	102-143
	ANLP23	25.0	21-43
	ANLP4	56.7	44-63
	ARAI	43.0	34-53
	ARAIII	9.3	6-13
	CPPLB	0.0	0-0
	CPPP1	0.0	0-0
	NRFNWC	23.5	22-25
	NRFP1	3.0	0-6
	NRFP2	3.7	2-6
	TANP1	16.5	8-25
	TRANSD	13.3	7-21
	TRAP1	14.3	8-23
	TRAP3	7.3	0-11
1985			
	ANLP1	99.0	66-140
	ANLP23	9.0	6-12
	ANLP4	45.3	25-79
	ARAPH	13.0	5-23
	CPPLB	0.0	0-0
	NRFNWC	15.0	10-19
	NRFP1	4.0	0-12
	NRFP2	5.0	0-11
	TANP1	6.3	3-9
	TRANSD	2.0	1-3
	TRAP1	7.0	5-8
	TRAP4	4.3	1-10

[a] All means, except CPPP1, NRFNWC, NRFP1, and TANP1 in 1984 and ANLP23 in 1985, are based on 3 samples per year

POND VARIABLES

Multiple regression indicated only one variable, the shortest distance to an alternate, summer-long water source outside 1 km, was associated (R^2 = 0.49) with the number of mourning dove arrivals. The same analysis with total visits (arrivals plus originals) indicated similar results with an R^2 of 0.57. A positive correlation showed that the greater the distance from one pond to another, the greater the mourning dove use. In other words, geographically isolated ponds apparently received more dove use than ponds which were less insular.

DIURNAL AND SEASONAL POND USE

Mourning dove use of the intensively studied INEL ponds, peaked twice per day (Fig. 2). The morning peak began around 0800 and use remained high until around 1300. Pond use then declined and remained low throughout the afternoon and until about 1 hour before sunset (which occured at approx. 2130); at that time pond use climbed rapidly and reached an evening peak. During the evening peak, the majority of doves arrived from 2100 to 2120, and most doves had departed by 2150. The continuous morning, afternoon, and evening pond observations corroborated the general pond use patterns observed during intensive counts.

Seasonal pond use, measured as the average number of mourning dove arrivals per month, at both intensively and simultaneously monitored ponds, did not **vary** greatly during the summer on the INEL (Table 2, Fig. 2). Some temporary fluctuations in dove use did appear

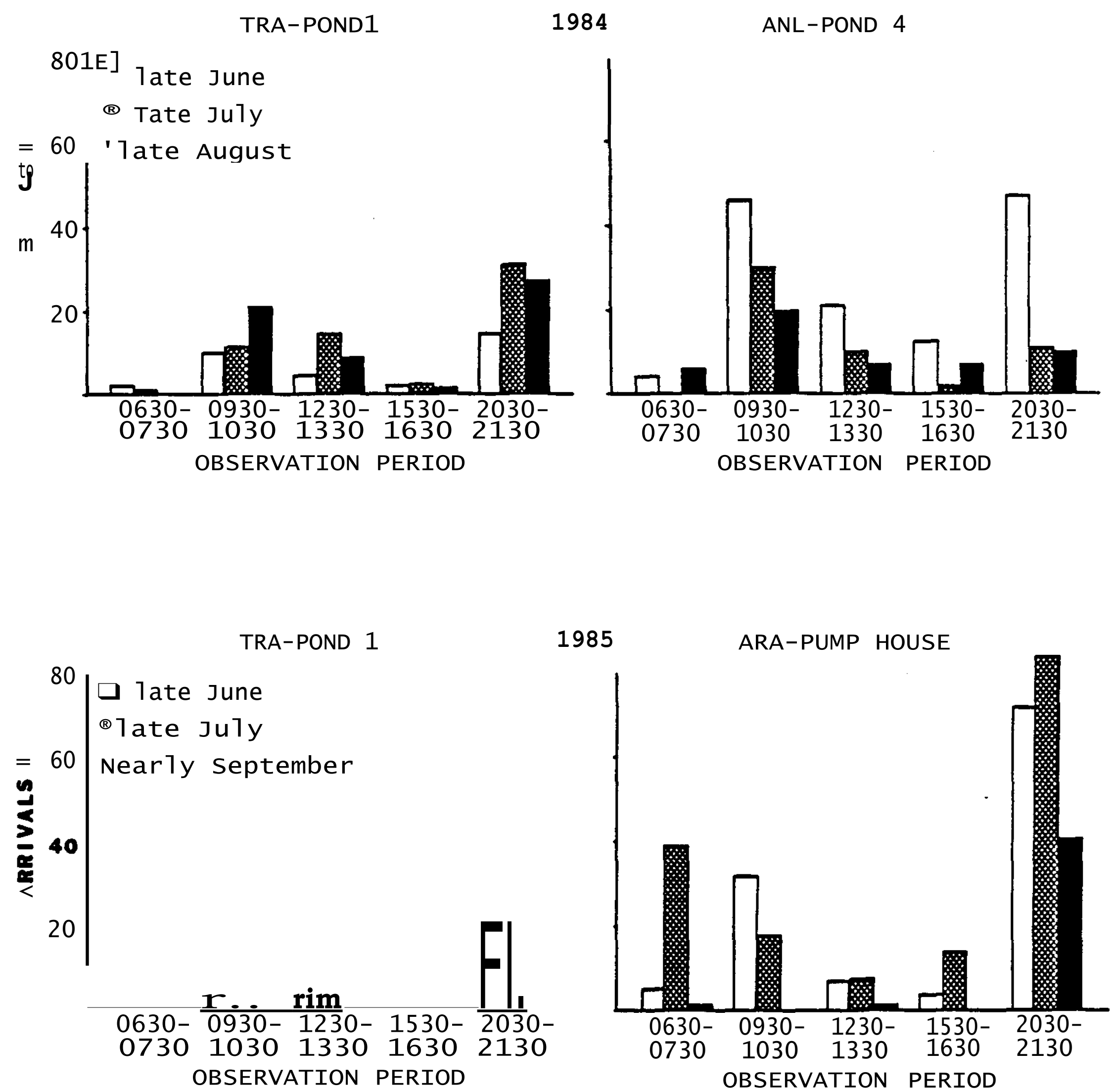

Fig. 2. Monthly arrival rates (X arrivals/hr) and diurnal arrival patterns of mourning doves at selected man-made ponds on the Idaho National Engineering Laboratory. Averages taken from 10, 1-hour counts in late June, late July, and late August of 1984 and late June, late July, and early September of 1985.

Table 2. Hourly mourning dove arrivals (X) by month at selected man-made ponds on the Idaho National Engineering Laboratory in 1984 and 1985.

Pond	Month	Year	X arrivals/ hr. observed[a]
ANLP4	late June	1984	29.5a
ANLP4	late July	1984	12.0b
ANLP4	late August	1984	10.7b
TRAP1	late June	1984	7.9c
TRAP1	late July	1984	13.2c
TRAP1	late August	1984	13.4c
ARAPH	late June	1985	23.9d
ARAPH	late July	1985	32.3d
ARAPH	early September	1985	8.4e
TRAP1	late June	1985	4.0f
TRAP1	late July	1985	2.2f
TRAP1	early September	1985	0.5f

a Means from the same pond in the same year with different letters are different ($P < 0.05$). The number of hours observed was 36 in 1984 and 30 in 1985.

and were probably associated with weather. Analysis of variance on simultaneous count data indicated no difference ($P = 0.51$) in the number of dove arrivals between months, suggesting little change in pond use throughout the summer. The same type of analysis on the intensively studied ponds indicated no difference between months ($P = 0.08$), but an interaction of ponds by months ($P = 0.02$)(Table 2). There were more dove arrivals in June of 1984 at ANLP4 than during the rest of the summer ($P < 0.01$); however, this trend was not repeated at TRAP1 in the same year, or at either pond in 1985. Also, there were fewer dove arrivals at ARAPH in September of 1985 than during the previous months ($P < 0.04$); this trend was repeated, though it was not significant ($P = 0.64$), at TRAP1 in that year.

ORIGINALS AND ARRIVALS

The best correlation provided between the number of originals and the number of arrivals was at the cubic level, and the R^2 value was only 0.56. This implies that an observer would have limited confidence in predicting the amount of pond use from the number of doves present at the time of his arrival at the pond.

POPULATION ESTIMATES

The Naval Research Facility appeared to attract a greater number of mourning doves than either the Test Reactor Area or the Auxilliary Reactors Area in 1985 (Table 3). The population estimate for TRA in 1984 was higher than that for TRA in 1985; however, 1985

Table 3. Closure criteria, model and ML estimator selection, mourning dove population estimates, and 95% confidence limita for selected pond areas on the Idaho National Engineering Laboratory.

Pond[b] area	Closure criteria met	Model selected	Estimator selected	Mourning dove population estimate	Upper limit	Lower limit
TRA-1984	YES	M(0)	NULL	107	174	45[c]
TRA-1985	NO	M(T)	DARROCH	66	88	44
NRF-1985	NO	M(T)	DARROCH	260	336	184
ARA-1985	YES	M(H)	JACKKNIFE	121	156	87

a Results based on the program CAPTURE (Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed populations. Wildl. Monogr. 62:135pp.).

b TRA=Test Reactor Area, NRF=Naval Research Facility, ARA=Auxilliary Reactors Area

c Equal to the total number of doves caught.

confidences limits (95%) fell almost entirely within 1984 confidence limits; this indicated that the TRA populations were not significantly different between years.

DISCUSSION

In cold desert areas, such as the INEL, where food, grit, and nesting habitat are readily available, but where surface water is limited, water provided by man-made ponds, ditches, and stock-watering tanks is important to the survival.and production of mourning doves.

It was apparent that mourning doves on the INEL were not attracted to a pond because of its size (length of shoreline), but rather by its geographic location in relation to other water sources. High relative mourning dove use (number of arrivals and total visits) was associated, though not strongly, with geographically isolated water sources. Thus, the provision of small, relatively inexpensive water sources, such as stock-watering tanks or guzzlers, placed far from existing water sources would probably enhance mourning dove use of cold desert areas similar to the INEL.

Radio-telemetry data, observations of marked birds (see page 38), and pond variable data (length of adjacent shoreline within 1 km was not associated with dove use) indicated that when there were two or more ponds within a 1 km area, individual mourning doves used the ponds interchangeably. Such pond clusters did not, however, attract more doves than individual ponds. Thus, the creation of single water sources in isolated areas should suffice to attract mourning doves.

Mourning dove use of man-made ponds on the INEL exhibited pronounced morning and evening peaks. A strong mid- to late afternoon depression in the diurnal watering pattern was also evident. Elder (1956) found that the daily water use patterns of mourning doves in southern Arizona demonstrated only slight increases in both the morning and evening. Also, mourning doves on his study site apparently did not exhibit a marked lull in watering activity in the afternoon. He did find, however, that white-winged dove water use patterns on the same study site illustrated pronounced morning and evening peaks and an afternoon depression.

Elder (1956) also found that mourning dove use of man-made water sources was highest from about May 1 to August 30, and then declined steadily from early September through late October. The results of this study were similar, though seasonal pond use by doves on the INEL usually peaked later (around May 15) and declined more abruptly after August. Mourning dove use of the intensively studied man-made ponds on the INEL fluctuated during the summer but remained relatively high until early September. The difference in mourning dove use, between early September and late June and July on the ARAPH in 1985, can be attributed to fall migration; the same trend can be seen at TRAP1 in 1985. It appeared, from intensive count data at ARAPH and observations at other ponds, that many doves may water only during the evening in early September.

CHAPTER TWO

MOURNING DOVE MOVEMENTS IN RELATION TO MAN-MADE PONDS ON THE IDAHO NATIONAL ENGINEERING LABORATORY

INTRODUCTION

Mourning doves on the Idaho National Engineering Laboratory (INEL) in southeastern Idaho are dependent primarily on water sources either made or manipulated by man. Some mourning doves use man-made ponds on the INEL which have been contaminated with radionuclides; relatively low levels of Cesium-137 contamination have been reported in some of these doves (Markham and Halford 1982).

Trost et al. (1976) found that a high percentage of dove crops collected on the INEL contained food products such as wheat which, they reasoned, could only have been obtained in agricultural fields or storage areas such as those which border the site. Based on their data, Trost et al. (1976) reported that doves from the TRA and NRF regularly travelled 13 to 19 km to off-site areas to feed and/or water.

The objectives of this study were to: 1) determine daily movements and activity patterns of mourning doves on the INEL and 2) locate feeding, nesting, and watering sites of doves on the site. Particular attention was paid to doves that used the Test Reactor Area (TRA) radionuclide leaching pond to discern whether they were providing a pathway for contaminant transport to areas off the INEL. Mourning doves were also monitored at the Naval Research Facility (NRF), which does not contain a radionuclide leaching pond.

Most mourning dove movement studies have been based on recaptures and band returns. For example, Channing (1979) and Leopold and Dedon (1983) reported movements, based on band returns, of nonmigratory mourning doves in central California. Tomlinson et al. (1960) studied the local movements of mourning doves in Missouri by recording recaptures in Thompson walk-in traps placed at 0.4 km (1/4-mile) intervals over a 800 ha (5-mile^2) area.

Few movement studies of mourning doves have been conducted with the use of radio-telemetry equipment. Hitchcock and Mirarchi (1984) and Grand et al. (1984) did extensive telemetry studies on fledgling doves in Alabama, and Sayre et al. (1980) used radio-telemetry to determine daily maximum movements and activity patterns of adult mourning doves in Missouri. No radio-telemetry studies of the mourning dove in a cold desert environment, such as that on the INEL, have been documented.

METHODS

Mourning doves were trapped with Kniffin-type funnel traps (Reeves et al. 1968) baited with whole wheat. Trap sites were set up near the major man-made ponds on the INEL. Mist nets were used to capture doves on their nests, either by flushing the nest attendant into the net or by dropping the net over the dove as it flushed. Mist nets were also used in pond areas where funnel trapping was ineffective. Sex was determined by plumage characteristics (Petrides 1950) and age of immature (hatch year) birds was estimated by primary molt progression (Swank 1955a).

Captured doves were banded with U.S. Fish and Wildlife Service (USFWS) bands, size 3A, and 3 additional celluloid leg bands of various colors. Doves were wing-tagged with colored, numbered strips of acrylic flagging which were inserted between the third and fourth secondaries and fastened around the leading edge of the wing (D. Blockstein, Univ. of Minn., Bell Museum, 10 Church St., Minneapolis, MN 55455. pers. commun.).

Radio-telemetry transmitters were attached to the clipped, acetone-cleansed, back feathers of doves using a cyano-acrylate based adhesive (Perry et al. 1981). Transmitters had a 1-km range, a 20-day estimated life span, and a weight of approximately 2.5 g. Only doves that weighed over 100 g received wing-tags or radio-transmitters; both were never placed on the same dove. The frequency used in this study was 216-217 MHz.

Radio-teler,ietry was conducted both aerially (Gilmer et al. 1981) and from the ground using a 64-channel receiver equipped with a scanner and null/peak box. Two, 5-element yagi antenni were attached to a mobile ground tracking unit to facilitate a null/peak detection scheme (Cochran 1980). Bearings for triangulation were separated by 5-15 minutes but were considered as simultaneous unless evidence of movement was detected by changes in the signal amplitude or frequency (Cochran 1980) or by discrepancies between consecutive bearing measurements. Mourning doves rarely appeared to take flight between "simultaneous" readings. Homing was performed with a hand-held yagi antenna when visual contact with the subject was desired.

Mourning dove locations were taken during 8, 2-hour time periods beginning at 0600 and ending at 2200. Daily movements of mourning doves on the INEL were determined by attempting to locate each radio-tagged dove 6 times (3 times visually) within each time period during the 20-day life of the radio.

Mourning dove locations were mapped on U.S. Geological Survey maps. The distance was measured from each dove's location to: 1) its point of capture, 2) its closest known-use watering site, ie. a water source at which the radio-tagged individual was known to water, and 3) its nest. Average movements were found by dividing the above distances by the number of locations in each category.

Using the average movement data, an analysis of variance (ANOVA) (SAS 1985a) was conducted for each of the 3 distance measurements to determine if there were differences between telemetry types (ground and aerial), years (1984 and 1985), areas (TRA and NRF), and all interactions thereof. The results are expressed as mean distances, in km, plus or minus 1 standard error (SE).

The maximum distance was measured from each radio-tagged dove's location to its capture site, known-use watering site, and nesting site; the longest distance between any 2 of its locations was also measured. The average maximum movements were obtained by dividing the total of each distance by the number of individuals.

An ANOVA was conducted for each of the 4 average maximum distance measurements. The difference between telemetry types (aerial and ground) was not a factor in this analysis because most of the maximum distances were recorded from the air. The ANOVA tested for significant differences between areas, between years, and for the area by year interaction. Results are expressed as mean distances, plus or minus 1 SE.

Daily maximum movements were obtained for 8 radio-tagged doves located on more than 5 days (with an average of 2 or more locations per day). The greatest distance was measured from location to capture site, known-use watering site, and nest for each individual. The mean daily maximum distances and standard errors were then found.

Locations of doves known to be on their nests were excluded from average and daily maximum distance data sets. If these locations were not removed, the average distance from the location of a nesting dove to its nesting site would tend toward zero, and the average distance from the location of a nesting dove to its capture and watering sites would tend toward the distance from its nest to its capture and watering sites. Average distances were measured from the nests of radio-tagged doves to their capture sites and known-use watering sites.

A chart recorder, connected to a radio-telemetry receiver and 12-volt car battery, was used to monitor the nests of 3 radio-tagged doves. The timing of nest attendant switches and the length of nest attendance were determined with the use of this chart recorder and traditional telemetry methods.

Mourning dove crops were collected at TRA, NRF, and the Argonne National Laboratories (ANL). A total of 30 crops were collected in the evening when doves were coming in to water; the contents of the crops were inspected to determine if the doves had ingested seeds, such as wheat, which could normally only be obtained in areas off the INEL.

RESULTS

TRAPPING AND RADIO-TELEMETRY

A total of 402 mourning doves was captured during 3 years of study; these consisted of 163 adult males, 140 adult females, and 72 immatures. Twenty-seven doves were caught as nestlings. Funnel traps proved to be the most effective means of capturing doves in various pond areas. Most doves were captured during mid-morning or late evening.

Information gathered with radio-telemetry provided insights into the average, average maximum, and daily maximum movements of mourning doves on the INEL; however, transmitter failure prevented the collection of the desired 6 locations per dove, per 2-hour period. Single strand antenna transmitters functioned poorly as a component of mourning dove radio-telemetry in the shrub dominated environment of the INEL.

AVERAGE AND AVERAGE MAXIMUM MOVEMENTS

Distance from location to capture site

Since the capture site of any individual was always near either the TRA or NRF pond area, the distance from location to capture site gives the best estimate of mourning dove movements around man-made ponds on the INEL. A difference ($P < 0.01$) between aerial and ground telemetry types was the only difference indicated by analysis of variance in the average movement data (Table 4).

Table 4. Average movements of mourning doves at the Naval Research Facility (NRF) and the Test Reactor Area (TRA) on the Idaho National Engineering Laboratory.

	Telemetry type	N[a]	area	year	X(km)+SE	
Distance from location to capture site	aerial	107	TRA & NRF	1984 & 1985	2.6	0.21 [b]
	ground	249	TRA & NRF	1984 & 1985	1.0	0.1
	both	180	NRF	1984 & 1985	1.7	0.2
	both	176	TRA	1984 & 1985	1.8	0.2
	both	30	NRF	1984	2.0	0.4
	both	82	TRA	1984	1.7	0.3
	both	150	NRF	1985	1.4	0.2
	both	94	TRA	1985	2.0	0.2
Distance from location to watering site	aerial	107	TRA & NRF	1984 & 1985	2.4	0.21
	ground	249	TRA & NRF	1984 & 1985	0.8	0.1
	both	180	NRF	1984 & 1985	1.7	0.2
	both	176	TRA	1984 & 1985	1.5	0.2
	both	30	NRF	1984	1.9	0.4
	both	82	TRA	1984	1.6	0.3
	both	150	NRF	1985	1.4	0.1
	both	94	TRA	1985	1.4	0.2
Distance from location to nesting site[c]	both	82	TRA & NRF	1984 & 1985	1.5	0.1
	both	25	NRF	1984 & 1985	1.5	0.3
	both	57	TRA	1984 & 1985	1.5	0.2
	both	9	NRF	1984	1.3	0.4
	both	15	TRA	1984	1.1	0.3
	both	16	NRF	1985	1.7	0.3
	both	42	TRA	1985	1.9	0.2

a N=Number of locations

b Means connected by a line are different ($P < 0.01$).

c Because only a small number of aerial telemetry locations from doves off of their nests were collected, aerial and ground telemetry types were combined.

The average distance of mourning doves from NRF and TRA, in 1984 and 1985, indicated that they did not travel off of the INEL on a regular basis. The nearest off-site areas were 9.9 km from NRF and 11.3 km from TRA. The average distance from location to capture for mourning doves at both of these facilities was less than 3.0 km. The closest any radio-tagged dove was located to the INEL border was 1.0 km; a second dove was located 2.3 km inside of the INEL boundary.

The average maximum movement data also indicated that doves normally remained on the INEL. The average maximum distance from location to capture site of 20 doves caught at NRF was 3.5 km (SE = 0.7); this was similar ($P = 0.76$) to the average maximum distance from location to TRA (3.2 km, SE = 0.6, N = 21). There was also a similarity between years ($P = 0.71$), and there was no area x year interaction ($P = 0.49$). No radio-tagged doves were located off the INEL, though 1 dove travelled 12.4 km from his capture site at NRF, another moved 10.8 km from her capture site at NRF, and a third dove was located 9.5 km from her capture site at TRA.

Distance from location to watering site

Locations of mourning doves taken from the air (aerial telemetry type) were approximately twice as far from known-use watering sites ($P < 0.01$) as locations taken from the ground (ground telemetry type) (Table 4).

There were no differences between years ($P = 0.15$) or areas ($P = 0.58$), and the year x area interaction was not significant (P =

0.39); also, the 3-way interaction, telemetry type x year x area, was not significant (P = 0.09).

There were no differences between years (P = 0.89) or areas (P = 0.42) in the average maximum distances from location to watering site. Also, there was no year x area interaction (P = 0.75). Doves at NRF were located, on average, a maximum of 3.5 km (SE = 0.7) from water, whereas the maximum distance from location to water for doves at TRA averaged 2.8 km (SE = 0.6).

Distance from location to nesting site

Because of the limited number of aerial telemetry locations acquired for doves off their nests, aerial and ground telemetry types were combined in the analysis of variance procedures in this section (Table 4). Doves at TRA and NRF travelled similar distances (P = 0.95) from their nests, as did doves in 1984 and 1985 (P = 0.07). There was no year x area interaction (P = 0.52).

Average maximum distances from location to nest were not different between years (P = 0.54), between areas (P = 0.17), or for the year x area interaction (P = 0.34). The average maximum distance from location to nest was 5.4 km (SE = 1.4) based on the 4 radio-tagged doves which were captured at NRF. The same maximum distance, averaged for 8 doves caught at TRA, was 2.8 km (SE = 1.0). The greatest distance from location to nest at either NRF or TRA was 6.0 km.

Longest distance between 2 locations

There were no differences in the longest distance between any 2 locations for individuals tracked at TRA and NRF (P = 0.40), or for doves tracked in 1984 and 1985 (P = 0.85), and the interaction of years x areas (P = 0.47) was not important. The average maximum distance between 2 locations for mourning doves was 3.9 km (SE = 0.7) at NRF and 3.7 km (SE = 0.7) at TRA. Again, these figures indicated that doves did not travel to areas off of the INEL on a regular basis.

DAILY MAXIMUM MOVEMENTS

Individual mourning doves on the INEL remained relatively close to their capture, watering, and nesting sites (Table 5). The range of daily maximum distances (X) from location to capture was 0.7 km (SE = 0.1) to 2.8 km (SE = 1.1). One individual, dove number 245, travelled an average of 0.5 km from his watering site for 14 days. In contrast, female number 257 travelled 2.0 km around her watering site at NRF. The daily maximum distances (X) from location to the nest for 5 mourning doves ranged from 1.1 km (SE = 0.2) to 3.8 km (SE = 0.6).

ADDITIONAL NEST INFORMATION AND CROP ANALYSIS

The average distance from the nests of 8 radio-tagged doves to the nearest known-use watering site at TRA was 1.3 km (SE = 0.3); the same average distance for 4 radio-tagged doves at NRF was 2.4 km (SE = 1.2). The average distance from nest to capture site was 1.7 km (SE = 0.3) at TRA and 2.3 km (SE = 1.2) at NRF.

Table 5. Daily maximum movements and nest locations of individual mourning doves at the Naval Research Facility (NRF) and the Test Reactor Area (TRA), on the Idaho National Engineering Laboratory.

Dove	Sex	Days of obs-' erva- tion	Area	Daily maximum distance in km from location to: capture		water		nest		Distance in km from nest to: capture	water
				X	+SE	X	+SE	X	+SE		
210	F	21	NRF	1.0	0.2	0.9	0.2				
241	F	8	TRA	2.2	0.6	1.9	0.7	3.8	0.6	3.0	3.0
257	F	10	TRA	2.8	1.1	2.0	1.0				
259	F	11	TRA	1.7	0.3	1.6	0.3	1.6	0.2	1.9	2.1
988	F	6	NRF	1.0	0.5	0.9	0.5	1.7	0.4	0.9	1.1
224	M	12[a]	NRF	0.8	0.3	1.0	0.3	1.1	0.2	0.6	0.6
245	M	14	NRF	0.7	0.1	0.5	0.1				
258	M	7[b]	TRA	1.6	0.4	0.9	0.3	2.2	0.3	1.6	2.6

[a] Distance from location to nest based on 10 days of observation.
[b] Distance from location to nest based on 6 days of observation.

The timing of nest attendant changes appeared, from the chart recorder and other radio-telemetry data, to be highly variable depending on the individual pair. The nest attendants changed, from female to male, between 0830 and 1200, and from male to female between 1900 and 2100.

Thirty dove crops were collected in 1984 and 1985; only 4 of these contained any agriculturally produced seed, ie. wheat. The majority of the crops (19) contained primarily Indian ricegrass (*Oryzopsis hymenoides*); of these, 10 contained only Indian ricegrass. The contents of 10 crops consisted either exclusively (8) or primarily (2) of prickly wild lettuce (*Lactuca serriola*) or blue lettuce (*L. pulchella*).

DISCUSSION

Considering the distances between potential mourning dove watering, nesting, and feeding sites in this cold desert area, doves exhibited less mobility than might be expected. According to the average, average maximum, and daily maximum movement data presented here, doves did not travel great distances (13-19 km) daily to feed and water as was suggested by Trost et al. (1976). Rather, doves on the INEL travelled extensively within a few kilometers of their capture and watering sites (average maximum distance of 3.5 km or less) at the Test Reactor Area and Naval Research Facility.

Trost et al. (1976) found that a high percentage of mourning dove crops collected at TRA and NRF contained a predominance of wheat and concluded that doves must be travelling to areas adjacent to the INEL to ingest these grains. The majority (19) of 30 crops collected in 1984 and 1985 contained primarily Indian rice grass and only 13% (4) contained any wheat. Anderson et al. (1978) reported a large increase in the cover and distribution of Indian ricegrass from 1965 to 1975 on the INEL. If this trend continued for another decade, it is likely that Indian ricegrass was more available to mourning doves during this study than during Trost et al. (1976). Also, a lack of natural seed availability due to drought, or availability of commercial grains due to spills along roads on or near the INEL, may explain the different findings of the 2 studies.

Indian rice grass and a variety of annual weed seeds were available to mourning doves on most of the INEL desert. Thus, it was not necessary for mourning doves to travel off the INEL to obtain food. One heavily used feeding area was located 2.6 km south of NRF. This expanse of open, grassy field contained a few islands of big sagebrush (*Artemisia tridentata*), and was used by several radio- and wing-tagged doves from NRF, and a few from TRA. The major grasses in this area were squirrel tail (*Sitanion hystrix*) and Indian rice grass. Similar feeding areas could not be found in the TRA area, though a number of doves in the vicinity were seen feeding and/or obtaining grit around old road beds which had grown over with grasses. Also, doves at both TRA and NRF fed and obtained grit in disturbed areas around the facilities, roads, and pond areas.

In this desert situation, where the only natural sources of surface water were periodically depleted, man-made ponds, ditches, and stock-watering tanks provided a cardinal source of water to mourning doves. Average, average maximum, and daily maximum movements of mourning doves obtained during this study indicated that mourning doves were not dependent on water sources other than those found on the INEL. The distances that doves moved in relation to their water sources suggested that mourning doves which used the TRA and NRF pond areas did not, on a regular basis, move off the INEL. Radio-telemetry data and visual observations of marked birds at TRA and NRF also indicated that individual doves did not consistently use only 1 water source but often used several or all available water sources within 1 km of those facilities.

Distances between located mourning doves and their capture and known-use watering sites were greater when doves were located with aerial telemetry than when they were located with ground telemetry. This is because mourning doves that were more than a km from TRA, NRF, or known water sources were more difficult to locate from the ground. The use of an airplane, as opposed to the use of a ground-tracking unit, enhanced ability to survey the largely inaccessible and expansive area of the INEL. Also, reception distance of transmitter signals was nearly 4 times greater from the air than from the ground. These 2 factors normally allowed the rapid location of all radio-tagged doves from the air regardless of their dispersal or distances from TRA, NRF, or water sources. Conversely, ground radio-telemetry was hampered by the distance between radio-tagged doves and the scarcity of roads away from the major site facilities.

Sayre et al. (1980) stated that dove feeding areas were often considerable distances from dove nests. One dove they mentioned travelled between 5.3 and 7.8 km daily from its nest to a feeding area. They did not mention the importance of watering sites in relation to dove movements, apparently because water was abundant on their study area in Missouri.

The daily maximum distances from location to nest found in this study are similar but near the low end of those reported by Sayre et al. (1980) in Missouri. Their study concentrated on males and had stricter criterion for inclusion of daily maximum movement data.

The variability of average maximum and daily maximum mourning dove movements found in this study was an indication of the mutable selections, by individual doves on the INEL, of nesting, feeding, and watering sites, and the distances between those sites. Despite some of the greater distances travelled by a few individuals and intensive aerial telemetry searches of areas adjacent to the site, no marked doves were ever located off the INEL.

CHAPTER THREE

THE NESTING ECOLOGY OF MOURNING DOVES ON THE SHRUB DESERT OF THE IDAHO NATIONAL ENGINEERING LABORATORY

INTRODUCTION

Mourning doves are widely distributed across the shrub deserts and grasslands of the western United States (McClure 1950) even where there are few or no trees. Doves are adaptable nesters, and a number of studies have dealt with or mentioned ground nesting by mourning doves (Cowan 1952, Hon 1956, and Downing 1959).

There have been no published studies on ground nesting mourning doves in intermountain shrub deserts. However, Fitcher (1959) studied dove production in 4 Idaho orchards, and Dahlgren (1955) studied tree nesting doves in the intermountain region of Utah.

This study of ground nesting mourning doves on the Idaho National Engineering Laboratory (INEL) was conducted from 1983 to 1985. The objectives were to: 1) provide estimates of mourning dove nesting success, nesting densities, and productivity on the INEL, and 2) identify the vegetative cover variables associated with nest site selection of ground nesting mourning doves on the INEL.

METHODS

Mourning dove nests were found by searching 4-ha plots, located at random, within the major vegetative communities on the INEL (McBride et al. 1978). Sixteen plots were established: 6 in communities dominated by big sagebrush (*Artemisia tridentata*), 4 in planted crested wheatgrass (*Agropyron cristatum*) communities, and 2 each in communities dominated by bluebunch wheatgrass (A. *spicatum*), Indian ricegrass (*Oryzopsis hymenoides*), and Utah juniper (*Juniperus osteosperma*). Plots were searched by towing a rope drag between 2 or 3 persons, on foot. The rope drag was 7.5 m long with 1-m weighted trailers fixed at 30-cm intervals. Portions of the plots which could not be searched with a rope drag, were searched by hand, ie. a 4 to 5 person crew beating the brush and trees with sticks.

Nests were also found by locating radio-tagged male and female doves on their nests and by investigating chance flushes. Nests abandoned before laying were not considered as initiated or as nesting attempts and were not used in analysis. Random sites were chosen within 50 m of each nest site for paired comparisons of all nest cover measurements.

The age of nestlings or incubation stage of the eggs (Hanson and Kossack 1957, Muller et al. 1984) was estimated during the initial nest visit. A complete nesting cycle began when the first egg was deposited in a nest and ended when the last young dove was fledged. Observed success and the average number of fledglings per successful nest, ie. a nest which yielded at least 1 fledgling, were determined. Nests were visited infrequently to reduce the risk of human induced abandonment (Swank 1952).

The ages of immature doves were estimated by primary molt progression (Swank 1955a); periods of peak productivity were then estimated by backdating. The estimated number of young mourning doves produced on the INEL was calculated by multiplying the nesting density by the number of hectares on the INEL; the product was then multiplied by the estimated number of nesting attempts, estimated nesting success, and average number of fledglings per successful nest. Immature mourning dove wings were collected by hunters within 65 km of the INEL. All hunter collected wings were obtained in the Arco, Atomic City, and Blackfoot, Idaho areas during the first week of September. Immature doves were live-trapped throughout the summer on the INEL; they were also collected by shotgunning in July and September.

Horizontal nesting cover was measured with a point-frame (Floyd and Anderson 1983) in the 1-m^2 (microhabitat) around dove nests and at random sites. Percent vegetative cover by species and by cover type, ie. shrub, grass, forb and bare ground, were recorded.

Vertical vegetative obstruction was measured with a 30-cm wide vegetative profile board (Nudds 1977) divided in 1/2-m intervals. Obstruction (0%, 1-20%, 21-40%, 41-60%, 61-80%, and 81-100% of the board obstructed by vegetation) in the first m above nest and random sites was estimated from 5, 10, 15, 20, and 25 m in the cardinal directions and 1 random direction. Vegetative obstruction above 1 m was negligible on the INEL. The variation in vertical vegetative obstruction was greatest when measured from 15 m, thus all obstruction measurements used in analysis were taken from that distance. When compared using analysis of variance (ANOVA)(SAS 1985a) the 5 directions were found to be similar (P = 0.61) and were combined in further analyses.

The line-intercept method (Stoddart et al. 1975) was used to determine the major vegetative components and general cover composition in a 5-m area around each nest and at random sites. The number of cm covered on a 5-m tape measure was recorded for each cover type (shrub, grass, forb, and bare ground) found along 1 transect in each cardinal direction. The dominant shrub, grass, and forb species in the 5-m area were also recorded. Directions were found to be not different (ANOVA)(P = 0.54) and were thus combined in analysis.

Differences in both the point-frame and line-intercept data were tested for between nest sites and random sites using ANOVA. Discriminant analysis (SAS 1985a) was used to determine which of the cover type variables, from the point-frame data, best revealed differences between random and nest sites. Vertical vegetative obstruction data was subjected to chi-square analysis (SAS 1985b) and differences between nest and random sites were identified.

RESULTS

Twenty-eight ground and 2 tree nests of mourning doves were located on the INEL from 1983 to 1985. One of the tree nests was abandoned and the other successfully yielded 2 fledglings. Since tree nests were rare on the INEL, only ground nests were further considered in nesting success and density estimates.

NESTING SUCCESS, DENSITIES, AND PRODUCTIVITY

Ground nests were widely dispersed and difficult to find. The yearly number of nests sampled, percent of successful nests, and average number of young fledged per successful nest are as follows: 1983 (N=7, 71%, and 1.8 young), 1984 (N=10, 70%, and 2.0 young), and 1985 (N=11, 64%, and 1.7 young). The average nesting success over 3 years was 68%, with 1.8 fledglings produced per successful nest (1.25 fledglings per nesting attempt).

Mourning dove nests on the desert area of the INEL were widely scattered, and estimated nesting densities were low--0.02 nests/ha. Because of the sparsity of nests, no comparisons of nesting densities were made between the major vegetative communities on the INEL. Reynolds and Trost (1981), who also used a rope drag to search for dove nests on the INEL, found mourning dove nesting densities identical to those reported in this study.

Three marked hatching peaks occurred in the INEL area: 1 during the fourth week of June, another during the third week of July, and a third during the first and second weeks of August. The number and spacing of hatching peaks found in this study (Fig. 3) indicated that doves may have nested up to 3 times per summer.

In this study, annual production was calculated using 2, 2.5, and 3 nesting attempts per season (Fig. 4). Average annual production estimates for mourning doves on the INEL ranged from 11,300 to 17,000 doves.

NESTING COVER

Because of the low number (N=10) of unsuccessful nests and the probability of human induced abandonment of at least 4 nests, the vegetative characteristics at all nests in which at least 1 egg was layed, regardless of whether a young dove was fledged or not, were combined and compared to the vegetative variable measurements taken at adjacent random sites.

Vegetative characteristics of nest site microhabitat

Analysis of variance revealed differences in the percentage of bare ground (P = 0.02) and grass cover (P = 0.02), between nest and random site microhabitats. Nest sites contained less bare ground and more grass than random sites (Table 6). The difference in shrub cover between random and nest sites was not significant (P = 0.20), and forb cover was similar (P = 0.43) in random and nest sites.

In discriminant analysis, bare ground (P = 0.02) and grass cover (P = 0.04) were the 2 variables chosen that discriminated

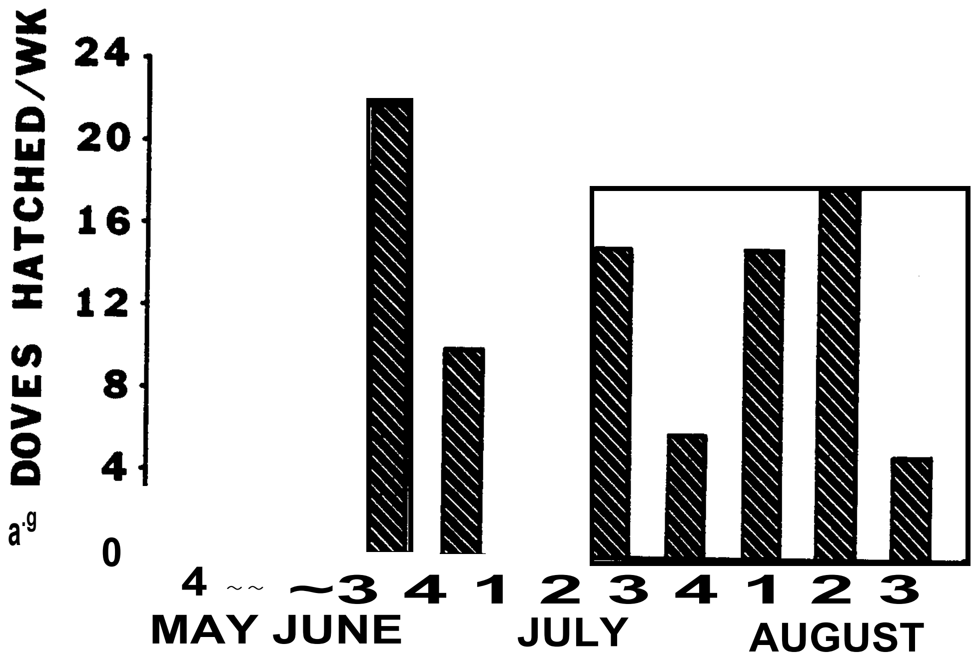

Fig. 3. Estimated percentage of mourning doves hatched per week on the Idaho National Engineering Laboratory from 1983 through 1985. Data based on age estimations of nestlings (from successful nests) and immature doves (total of all weeks = 100%).

0.02 NESTS/HA	X NESTING DENSITY
x	
231,600 HA	AREA OF 1NEL
4,632 NESTS	x NESTS/ NEST ATTEMPT
X	
68x	x NESTING SUCCESS RATE
3,150 NESTS	x SUCCESSFUL NESTS/ NEST ATTEMPT
x	
1.8 FLEDGLINGS	x FLEDGLINGS/ SUCCESSFUL NEST
5,670 FLEDGLINGS	x FLEDGLINGS/ NEST ATTEMPT
X X X	
2.0 **2.5** **3.0**	NEST ATTEMPTS/ YEAR
11,340 **14,175** **17,010**	FLEDGLINGS/YEAR

Fig. 4. Estimated number of mourning dove fledglings produced per year from 1983 through 1985 on the Idaho National Engineering Laboratory.

Table 6. Percent vegetative coverage (X), by cover type, of mourning dove nest site and paired random site microhabitats and 5-m areas on the Idaho National Engineering Laboratory.

	Microhabitat[a]				5-m area[b]			
	Cover type[c]							
Site	Shrub	Bare	Grass	Forb	Shrub	Bare	Grass	Forb
Random	37.8a	53.9a	5.4a	5.0a	29.5a	57.5a	8.6a	4.4a
Nest	44.0a	43.9b	10.0b	6.6a	30.5a	57.4a	7.6a	4.6a

a Horizontal cover measured with a point-frame in the 1-m^2 centered on the nest or random site.

b Horizontal cover measured in the four cardinal directions from the nest or random site with a 5-m line-intercept tape divided into 1-cm intervals. The number of cm of each cover type was combined across directions at all sites.

c Means in the same column with different letters are different ($P < 0.05$).

between nest sites and random sites. When combined, these 2 variables explained only 17% of the variation between nest and random sites.

Of the 23 plant species found frequently at nest and random sites, only big sagebrush was found to be important to nesting mourning doves on the INEL. Though no dove nests were found in big sagebrush, 23 of 28 ground nests were found under big sagebrush; the remaining were under green or grey rabbitbrush (*Chrysothamnus viscidiflorus* or *C. nauseosus*). The average percentage of big sagebrush in the 1-m^2 around each nest was higher ($P = 0.06$) than the percentage at random sites. Though this difference is not significant at the 95% confidence level, it may have biological meaning.

Commonly occuring shrub, forb, and grass species, with comparable cover characteristics, were combined into categories, and used in an ANOVA (Table 7). No differences in 1) *Artemisia tridentata*, dead or live ($P = 0.15$), 2) *Chrysothamnus* spp. ($P = 0.80$), 3) *Descurainia* spp. ($P = 0.24$), 4) *Agropyron* spp. ($P = 0.18$), or 5) *Phlox* spp. ($P = 0.95$), were found between nest sites and random sites.

Vertical Vegetative Obstruction

Vertical vegetative obstruction, as read from 15 m, was not different between the nest sites and random sites at either the 0.0-0.5 m ($X^2 = 5.74$) height or the 0.5-1.0 m ($X^2 = 2.96$) height. Most of the 0.0-0.5 m vertical vegetative samples taken indicated 41-100% obstruction, but the majority of the 0.5-1.0 m samples indicated 0-20% obstruction (Table 8).

Table 7. Percent cover (X) by species category at mourning dove nest site and paired random site microhabitats[a] on the Idaho National Engineering Laboratory.

	Species Category[b]				
Site	Chry.	Arti.	Desc.	Agro.	Phlox
Random	10.2	25.6	0.5	1.2	1.9
Nest	8.6	35.2	1.1	2.1	1.6

a Horizontal cover measured with a point-frame in the 1-m^2 centered on the nest or random site.

b Species categories are as follows: Chry.=*Chrysothamnus viscidiflorus* and *C. nauseosus,* Arti.=*Artemisia tridentata,* dead and live, Desc.=*Descurainia pinnata* and *D. sophia,* Agro.=*Agropyron spicatum* and A. *dasystachyum,* and Phlox=Phlox *hoodii* and P. *longifolia*

Table 8. Frequency distribution[a] of vertical vegetative obstruction estimates at mourning dove nest sites and paired random sites on the Idaho National Engineering Laboratory.

	Vertical obstruction[b]	Nest	Random
	0%	0	1
	1-20%	5	7
0.0-0.5 m above nest/random site	21-40%	11	7
	41-60%	10	11
	61-80%	10	11
	81-100%	14	13
	0%	14	16
0.5-1.0 m above nest/random site	1-20%	27	29
	21-40%	5	2
	41-100%[c]	4	3

a percent of 260 samples from 52 sites

b read from 15 m and measured as percent of vegetative profile board (Nudds, T. D. 1977. Quantifying vegetative structure of wildlife cover. Wildl. Soc. Bull. 5:113-117.) obscured by vegetation

c Because of poor representation in individual categories, the higher vertical obstruction categories in this section were combined

Plant coverage within 5 m of the nest site

The ANOVA results from the line-intercept data indicated no differences between nest sites and random sites in shrub (P = 0.67), bare ground (P = 0.96), grass (P = 0.45), or forb (P = 0.86) cover types (Table 6). The shrub, grass, and forb species most often encountered along the line-intercept line were considered as dominant species in the nest and random areas. Big sagebrush, thickspike wheatgrass (*Agropyron dasystachyum*), and phlox (*Phlox hoodii* or *P. longifolia*) were usually the dominant species. Prickly pear cactus (*Opuntia polyacantha*) and bushy birdbeak (*Cordylanthus ramosus*) were other dominant forbs present in the nest and random areas (Table 9).

Table 9. Frequency distribution[a] of dominant shrub, grass, and forb species found within 5 meters of mourning dove ground nests and paired random sites on the Idaho National Engineering Laboratory.

	Site	
	Nest	Random
Dominant shrub species		
Artemisia tridentata	48	43
Chrysothamnus viscidiflorus	2	7
Dominant grass species		
Agropyron dasystachyum	19	21
Poa spp.	12	5
Sitanion hystrix	5	10
Bromus tectorum	5	5
Oryzopsis hymenoides	7	2
Stipa comata	2	7
Dominant forb species		
Phlox hoodii	14	7
Phlox longifolia	12	7
Opuntia polyacantha	10	10
Cordylanthus ramosus	7	7
Aster spp.	2	12
Lupinus spp.	5	2
Thelypodium lanciniatum	0	2
Sphaeralcea munroana	0	2

a percent of 42 sites

DISCUSSION

Estimates of success for ground nesting mourning doves in this study (68% success, with 1.8 fledglings per successful nest or 1.25 fledglings per nesting attempt) were similar to those from other studies done in the intermountain region. Fitcher (1959) reported nesting success of 66.5%, and 1.21 fledglings produced per nesting attempt for mourning doves nesting in orchards in southeastern Idaho. Dahlgren (1955) reported 58% nesting success and 1.8 mourning doves fledged per successful nest, averaged over a 2-year period, in orchards and canal bank vegetation in the intermountain region of Utah.

Other studies of ground nesting mourning doves reported lower nesting success estimates than this study. Downing (1959), in northwestern Oklahoma, found that only 29% of ground nesting attempts were successful. Hon (1956) reported ground nesting success rates of only 33% for mourning doves on the coastal islands of North Carolina; however, he noted high abandonment, at least 50%, due to human interference.

Nesting density estimates of 0.02 nests/ha from the INEL were consistent with reports of low nesting densities for other ground nesting mourning doves. Downing (1959) found nesting densities of 0.06 nests/ha (0.025 nests/A) and Hon (1956) found 0.08 nests/ha (0.03 nests/A).

The age estimates of immature mourning doves used in this study were based on primary feather molt categories reported by Swank (1955a). Other studies of primary feather molt in immature mourning doves have offered different age estimates (Allen 1963 and Haas and Amend 1976). If these age estimates had been used in this study, hatching peaks in the INEL area would have appeared 1 (Allen 1963) to 2 (Haas and Amend 1976) weeks earlier; however, the spacing and number of hatching peaks would not have been affected.

Since the completion of a mourning dove nesting cycle takes about 4 weeks, 2 weeks each for the incubation of eggs and fledging of young, it is possible that each of the 3 peaks in hatching found in this study represented the completion of successful nesting attempts by a principal component of doves on the INEL. This would be the case if the majority of breeding doves overlapped successive nesting cycles or exhibited a brief interval between the completion of a successful nest and the initiation of the next nest. Both of these situations have been reported (Swank 1955b, Hanson and Kossack 1963, Harris et al. 1963, and Caldwell 1964). Hanson and Kossack (1963) stated that the most frequently occurring interval between a successful clutch, ie. the laying of 2 eggs, and the initiation of the next clutch was 30 days. If a large number of breeding pairs did not initiate nests while fledging young or had long intervals between successful nestings, then it is likely that only 2 nesting cycles were completed by most mourning doves on the INEL. Fitcher (1959) used 3 nesting attempts when calculating productivity for orchard nesting doves in southeastern Idaho, and Dahlgren (1955) estimated an average of "about 2 successful broods per breeding pair" for tree nesting doves in Utah. Most authors (Nice 1922, McClure 1943, Cowan 1952, Harris et al. 1963, and Hanson and Kossack 1963) have reported from 3 to 5 nesting attempts during the breeding season.

Fitcher (1959) also reported that nesting activity of mourning doves in 4 orchards in southeastern Idaho peaked in the latter two-thirds of July. Dahlgren (1955) estimated that the greatest number of breeding pairs on his study site in Utah were actively nesting during mid-June and late July.

Nesting densities and dove production on the INEL may have been lower in areas where crested wheatgrass had been planted. No mourning dove nests were found in 64 ha of crested wheatgrass fields on the INEL, ie. 16 ha searched by Reynolds and Trost (1981) and 48 ha searched during this study. These areas were nearly void of shrubs which were closely associated with all ground nests in this study. Thus, removal of shrubs and planting of crested wheatgrass appears to be incompatible with mourning dove habitat management on areas such as the INEL.

Cover measured with the line-intercept method in the 5-m area around nest and random sites indicated that mourning doves on the INEL selected ground nesting sites that were no different from adjacent random sites. Also, the lack of difference in cover types and dominant species within 5 m of the nest and random sites indicated that doves chose nest sites which exhibited similar general cover characteristics to those of the surrounding area.

However, differences in the nest and random site microhabitat, the 1-m^2 area immediately surrounding the nest and random site, were indicated by the point-frame data. Doves chose nest sites which contained less bare ground and more grass than random sites. Shrubs, particularly big sagebrush, provided shade and cover for all of the mourning dove ground nests discovered during this study; however, the percentage of horizontal shrub cover (big sagebrush plus green and grey rabbitbrush) in nest site microhabitats was not significantly different from that in random site microhabitats. Additional microhabitat data indicated that particular plant species, with the possible exception of big sagebrush, were not selected for by mourning doves when chosing a nesting site.

Burning has been used extensively as a method of habitat manipulation in the cold desert (Stoddart et al. 1975). By removal of big sagebrush and other shrubs, burning may discourage mourning doves from nesting within burned areas. However, burned areas probably provide valuable mourning dove food sources and may encourage dove nesting in areas nearby. Researchers (Ken Petersen, Dep. Animal Ecol., Iowa State Univ., Ames, IA, 50011, pers. commun.) at an INEL experimental burn site recorded 5 mourning dove nests in control plots within 1/2 km of the burned area, but only 1 nest in a plot on the burned area; the latter nest was in a patch of big sagebrush that was skipped by the fire.

Vertical vegetative obstruction was nearly identical in nest sites and random sites. This indicates that mourning doves on the INEL did not select nest sites with vertical vegetative obstruction different from that at random sites.

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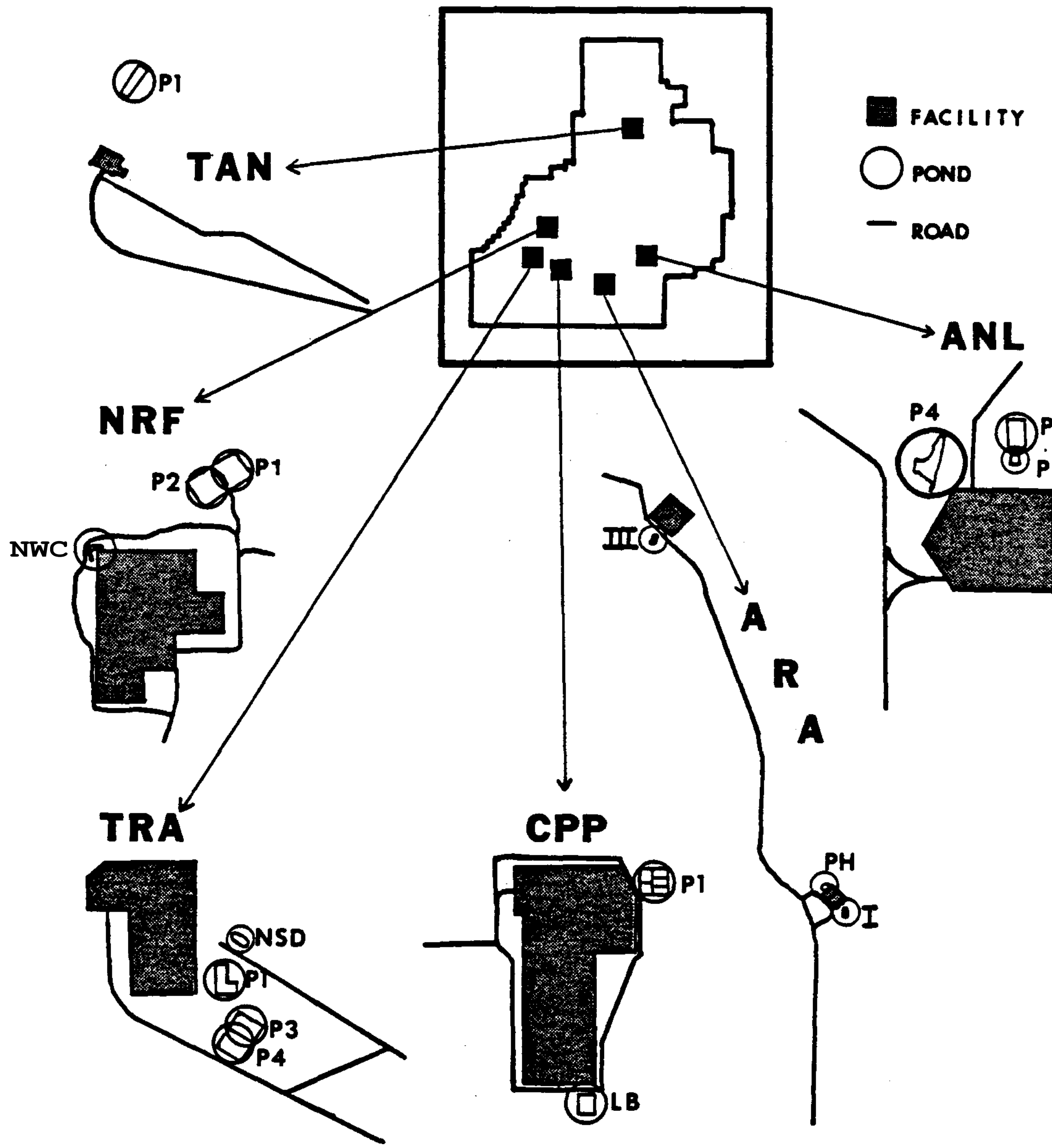
APPENDIX



Appendix Fig. 1. Location of facilities and man-made ponds on the Idaho National Engineering Laboratory. Abbreviations are as follows: TAN=Test Area North,NRF=Naval Research Facility, TRA=Test Reactor Area, CPP=Chemical Processing Plant, ARA=Auxilliary Reactor Area (I and III), ANL=Argonne National Laboratories, P1=Pond 1, P2=Pond 2, etc., NWC=Northwest Corner, NSD=Northern Sewage Ditch, LB=Lake Barraclough, and PH=Pump House.

Appendix A. Pond variables[a], simultaneous mourning dove visits[b], and sample dates at man-made ponds on the Idaho National Engineering Laboratory.

Pond	Date	Shore	Bare	Slope	Adjsh	pH	Dist	Dove visits Arr	Tot
ANLP1	15 Aug 1984	331	331	14	1040	7.0	16.0	143	162
ANLP1	19 Jun 1985	331	331	21	1246	8.0	16.1	91	116
ANLP1	13 Aug 1985	448	448	21	1457	7.0	16.1	140	149
ANLP23	15 Aug 1984	189	140	12	1182	7.0	16.0	21	22
ANLP23	13 Aug 1985	257	213	21	1648	7.5	16.0	12	14
ANLP4	15 Aug 1984	851	272	18	520	6.5	15.6	44	49
ANLP4	19 Jun 1985	1046	259	24	531	6.5	15.6	79	101
ANLP4	13 Aug 1985	1200	333	24	705	7.0	15.6	25	29
TRAP1	15 Aug 1984	440	277	-	520	5.0	1.3	23	34
TRAP1	19 Jun 1985	551	231	-	566	4.5	2.9	8	9
TRAP1	13 Aug 1985	539	226	-	524	4.5	2.9	8	8
TRAP3	15 Aug 1984	370	252	32	590	5.5	1.2	0	1
TRAP4	19 Jun 1985	417	46	31	700	6.0	3.8	2	6
TRAP4	13 Aug 1985	370	70	31	693	6.5	2.8	1	1
TRANSD	15 Aug 1984	150	15	30	810	6.5	1.6	7	7
TRANSD	19 Jun 1985	149	144	30	968	7.0	3.0	2	5
TRANSD	13 Aug 1985	154	144	30	909	7.0	3.0	1	1
NRFP1	15 Aug 1984	612	171	11	809	10.0	2.9	0	1
NRFP1	19 Jun 1985	745	745	30	963	7.0	8.3	12	27
NRFP1	13 Aug 1985	725	725	28	491	8.0	8.3	0	0
NRFP2	15 Aug 1984	612	147	10	809	10.0	2.9	2	2
NRFP2	19 Jun 1985	764	155	7	944	8.0	8.1	11	14
NRFP2	13 Aug 1985	295	0	2	921	9.5	8.1	0	0
NRFNWC	15 Aug 1984	197	87	22	1224	6.0	3.5	22	29
NRFNWC	19 Jun 1985	199	29	14	1509	6.0	7.8	16	24
NRFNWC	13 Aug 1985	196	86	14	1020	7.0	7.8	19	27
ARAI	15 Aug 1984	<1	<1	1	0	6.0	6.0	34	46
ARAIII	15 Aug 1984	<1	<1	3	0	6.0	4.2	13	15
ARAPH	19 Jun 1985	28	3	2	1	6.5	5.8	23	32
ARAPH	13 Aug 1985	34	10	2	1	7.0	5.8	5	8
TANP1	19 Jun 1985	738	520	22	0	6.5	1.7	7	11
TANP1	13 Aug 1985	618	542	71	0	7.0	1.7	3	3
CPPLB	15 Aug 1984	500	500	26	0	6.0	1.2	0	0
CPPLB	19 Jun 1985	508	504	27	0	7.0	2.8	0	0
CPPLB	13 Aug 1985	508	504	27	0	7.0	2.8	0	0

[a] Shore=length (m) of shoreline; Bare=length (m) of bare shoreline; Slope=% slope of shore; Adjsh=length (m) of adjacent shoreline within 1 km; Dist=the shortest distance (km) to an alternate, summer-long water source outside 1 km.

[b] Arr=number of dove arrivals in the pond area during the 0930-1030 observation period. Tot=number of arrivals plus number of doves present at the beginning of the observation period.

Appendix B. List and frequency distribution of plant species encountered in more than 5% of the mourning dove nest and paired random site microhabitats on the Idaho National Engineering Laboratory.

Plant species	%
Agropyron dasystachyum	24
Agropyron spicatum	15
Artemisia tridentata	78
Artemisia tridentata (dead)	50
Bromus tectorum	19
Chrysothamnus nauseosus	11
Chrysothamnus viscidiflorus	31
Cordylanthus ramosus	19
Descurainia pinnata	13
Miscellaneous forb (dead)	28
Miscellaneous grass	9
Moss	43
Opuntia polyacantha	17
Oryzopsis hymenoides	11
Phlox hoodii	26
Phlox longifolia	9
Poa spp.	22
Sitanion hystrix	31
Stipa comata	9

Appendix C. Analysis of variance for mourning dove use (X arrivals per month) at intensively (N=2 in 1984 and 1985) and simultaneously monitored ponds (N=9 in 1984, and N=10 in 1985) on the Idaho National Engineering Laboratory.

Intensively monitored ponds

Source	df	MS	F Value	Probability of > F
Year	1	214.6677	0.77	0.3816
Pond(Year)[b]	2	3105.7861	11.16	0.0001
Month(Year)	4	606.1403	2.18	0.0756
PondxMonth(Year)	4	864.7903	3.11	0.0179
Error	120	278.3556		

Simultaneously monitored ponds

Source	df	MS	F Value	Probability of > F
Year	1	1785.9053	10.06	0.0030
Month(Year)	4	148.6712	0.84	0.5100
Pond(Year)	19	3188.3029	17.96	0.0001
Error	38	177.5258		

a number of months is 3 in both years
b (Year)=within the same year

Appendix D. Analysis of variance and orthogonal comparisons of simultaneous mourning dove arrivals (X per month) from 0930-1030, in June, July, and August of 1984, at major man-made ponds (N=9) on the Idaho National Engineering Laboratory.

Pond	ANLP1	ANLP4	ARAI	ANLP23	TRAP1	TRANSD	ARAIII	TRAP3	NRFP2
Mean	116.7	56.7	43.0	25.0	14.3	13.3	9.3	7.3	3.7

Comparison

1 ANLP1 vs. All other ponds
2 ANLP4 & ARAI vs. All other ponds except ANLP1
3 ANLP4 vs. ARAI
4 ANLP23 vs. TRAP1, TRANSD, ARAIII, TRAP3, & NRFP2
5 TRAP1 vs. TRANSD, ARAIII, TRAP3, & NRFP2
6 TRANSD vs. ARAIII, TRAP3, & NRFP2
7 ARAIII vs. TRAP3 & NRFP2
8 TRAP3 vs. NRFP2

Analysis

Source	df	MS	F Value	Probability of > F
Month	2	72.7037	0.53	0.5984
Pond	8	3949.5884	28.81	0.0001
Comparison 1	1	24108.9074	175.88	0.0001
Comparison 2	1	6384.5000	46.58	0.0001
Comparison 3	1	280.1667	2.04	0.1721
Comparison 4	1	592.9000	4.33	0.0540
Comparison 5	1	84.0167	0.61	0.4451
Comparison 6	1	96.6944	0.71	0.4134
Comparison 7	1	29.3889	0.21	0.6496
Comparison 8	1	20.1667	0.15	0.7064
Error	16	137.0787		

Appendix E. Analysis of variance and orthogonal comparisons of simultaneous mourning dove arrivals (X per month) from 0930-1030, in June, July, and August of 1985, at major man-made ponds (N=10) on the Idaho National Engineering Laboratory.

Pond	ANLP1	ANLP4	NRFNWC	ARAPH	TRAP1	TANP1	NRFP2	TRAP4	NRFP1	TRANSD
Mean	99.0	45.3	15.0	13.0	7.0	6.3	5.0	4.3	4.0	2.0

Comparison

1	ANLP1 vs. All other ponds
2	ANLP4 vs. All other ponds except ANLP1
3	NRFNWC vs. ARAPH
4	NRFNWC & ARAPH vs. TRAP1, TANP1, NRFP2, TRAP4, NRFP1, & TRANSD
5	TRANSD vs. TRAP1, TANP1, NRFP2, TRAP4, & NRFP1
6	TRAP1 vs. TANP1, NRFP2, TRAP4, & NRFP1
7	TANP1 vs. NRFP2, TRAP4, & NRFP1
8	NRFP2 vs. TRAP4 & NRFP1
9	TRAP4 vs. NRFP1

Analysis

Source	df	MS	F Value	Probability of > F
Month	2	255.1000	1.02	0.3797
Pond	9	2787.6333	11.17	0.0001
Comparison 1	1	20750.7000	83.15	0.0001
Comparison 2	1	3901.5000	15.63	0.0009
Comparison 3	1	6.0000	0.02	0.8785
Comparison 4	1	382.7778	1.53	0.2315
Comparison 5	1	27.7778	0.11	0.7425
Comparison 6	1	10.4167	0.04	0.8404
Comparison 7	1	8.0278	0.03	0.8597
Comparison 8	1	1.3889	0.01	0.9414
Comparison 9	1	0.1667	0.00	0.9797
Error	18	249.5444		

Appendix F. Analysis of variance for distances from mourning dove locations to their capture, watering, and nesting sites at the Test Reactor Area and Naval Research Facility in 1984 and 1985 on the Idaho National Engineering Laboratory.

Distance from location to capture site

Source	df	MS	F Value	Probability of > F
Teltype[a]	1	121.5775	38.32	0.0001
Year	1	1.3129	0.41	0.5204
TeltypexYear	1	8.5781	2.70	0.1010
Area	1	0.8485	0.27	0.6054
TeltypexArea	1	2.3370	3.22	0.3913
YearxArea	1	7.8304	2.47	0.1173
TeltypexYearxArea	1	10.2239	3.22	0.0735
Error	348	3.1726		

Distance from location to watering site

Source	df	MS	F Value	Probability of > F
Teltype	1	121.4729	41.54	0.0001
Year	1	6.1523	2.10	0.1478
TeltypexYear	1	8.5337	2.92	0.0885
Area	1	0.8971	0.31	0.5800
TeltypexArea	1	2.7630	0.94	0.3317
YearxArea	1	2.1583	0.74	0.3909
TeltypexYearxArea	1	8.3981	2.87	0.0910
Error	348	2.9242		

Distance from location to nesting site

Source	df	MS	F Value	Probability of > F
Year	1	5.5553	3.36	0.0706
Area	1	0.0059	0.00	0.9524
YearxArea	1	0.7023	0.42	0.5165
Error	78	1.6534		

a Teltype=telemetry type, ground or aerial

Appendix G. Analysis of variance for maximum distances from location to capture, watering, and nesting sites, and maximum distance between any two locations, for individual mourning doves at the Test Reactor Area or Naval Research Facility in 1984 or 1985 on the Idaho National Engineering Laboratory.

Distance from location to capture site

Source	df	MS	F Value	Probability of > F
Year	1	1.2192	0.14	0.7116
Area	1	0.8503	0.10	0.7575
YearxArea	1	4.3449	0.49	0.4836
Error	36	8.7821		

Distance from location to watering site

Source	df	MS	F Value	Probability of > F
Year	1	0.1481	0.02	0.8943
Area	1	5.6033	0.68	0.4158
YearxArea	1	0.8210	0.10	0.7545
Error	36	8.2696		

Distance from location to nesting site

Source	df	MS	F Value	Probability of > F
Year	1	3.0899	0.40	0.5447
Area	1	17.9299	2.32	0.1661
YearxArea	1	8.0960	1.05	0.3359
Error	8	7.7230		

Distance between any two locations

Source	df	MS	F Value	Probability of > F
Year	1	6.7020	0.73	0.3984
Area	1	0.3407	0.04	0.8483
YearxArea	1	4.8874	0.53	0.4702
Error	37	9.1820		

Appendix H. Analysis of variance for coer type differences between site types (neest and random) in the 1-m areas around mourning dove nests and random sites on the Idaho National Engineering Laboratory.

Bare ground in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	1355.5657	6.08	0.0170
Error	52	222.9247		

Shrub cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	516.9430	1.68	0.2012
Error	52	308.5007		

Grass cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	287.1795	5.33	0.0249
Error	52	53.8491		

Forb cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	34.9406	0.66	0.4208
Error	52	53.0734		

Appendix I. Analysis of variance for cover type differences between site types (nest and random) in the 5-m areas around mourning dove nests and random sites on the Idaho National Engineering Laboratory.

Bare ground in the 5-m area around nest and random sites

Source	df	MS	F Value	Probability of >F
Site type	1	15.4821	0.00	0.9600
Error	166	6134.5897		

Shrub cover in the 5-m area around nest and random sites

Source	df	MS	F Value	Probability of >F
Site type	1	1136.7202	0.19	0.6651
Error	166	6042.6038		

Grass cover in the 5-m area around nest and random sites

Source	df	MS	F Value	Probability of >F
Site type	1	1210.7202	0.58	0.4482
Error	166	2094.9936		

Forb cover in the 5-m area around nest and random sites

Source	df	MS	F Value	Probability of >F
Site **type**	1	25.1488	0.03	0.8555
Error	166	755.8576		

Appendix J. Analysis of variance for differences in speci~s categories[a] between site types (nest or random) in the 1-m areas around mourning dove nests and random sites on the Idaho National Engineering Laboratory.

CHRY cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	33.8756	0.11	0.7379
Error	52	299.3599		

ARTI cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	1242.8800	3.09	0.0845
Error	52	401.7395		

DESC cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	5.5714	0.49	0.4858
Error	52	11.3063		

AGRO cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	10.3542	0.76	0.3863
Error	52	13.5633		

PHLOX cover in the nest and random site microhabitats

Source	df	MS	F Value	Probability of >F
Site type	1	1.6670	0.11	0.7471
Error	52	15.8597		

a Species categories are as follows:CHRY=Chrysothamnus viscidiflorus and C. nauseosus, ARTI=Artemisia tridentata, live and dead, DESC=Descurainia pinnata and D. sophia, AGRO=Agropyron dasystachyum and A. spicatum, and PHLOX=Phlox hoodii and P. longifolia.