Land use and pheasant habitat in

north-central Iowa, 1938-1973

by

Connie K. Mohlis

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ABSTRACT

abstract
Land use changes and the consequent effects on ring-necked pheasant
(Phasianus colchicus) habitat from 1938 to 1973 were analyzed on four
2-section sample units from each of 27 counties in north-central Iowa
using sequential aerial photography and annual Iowa crop reports.

Though the total percentage of land used for agriculture remained
near 89 percent, there was a major shift in land use from small grains,
hay, and pasture to corn and soybeans. Row crops increased from 32.5
percent of the land area in 1939 to 58.4 percent in 1972, primarily
because of a ten-fold increase in soybean area. Small grains, hay,
and pasture together comprised 55.5 percent of the land area in 1939,
but only 11.7 percent in 1972. Oats, hay, and pasture, respectively,
declined 82.6, 55.6 and 63.0 percent. Land in federal retirement
programs occupied 10 to 12 percent of the land area after 1965.

Nonagricultural land use changes were significant, though individual
categories never comprised large percentages of the land area. Area
in wetlands, undisturbed grassland, fencerows, and farm groves,
respectively, declined 55 percent, 71 percent, 31 percent, and 13
percent from 1939 to 1972, while area in drainage ditches, roads, and
roadsides increased 45 percent, 25 percent, and 24 percent.

All pheasant nesting habitat declined only 44 percent, while
nesting cover from which high production was expected declined 76
percent, from 30 percent of the land area in 1939 to 7 percent in 1972.
Reductions of area in oats, clover, wetlands, and undisturbed grassland

were primarily responsible for reduction of good pheasant nesting cover.
Winter cover declined 33 percent, from 2.6 percent of the land area in
1939 to 1.8 percent in 1972, primarily because of reduced area in farm
groves and wetlands.

Management of roadsides, railroad right of ways, wetlands,
undisturbed grassland areas, and grassed waterways are necessary to
provide the quantity and quality of habitat required to produce more
pheasants in north-central Iowa.

INTRODUCTION

Several studies in Iowa and throughout the Midwest have related declining pheasant populations to changes in land use. Faber (1948) suggested that localized pheasant population declines in Iowa were associated with changes in agricultural crop patterns from 1937 to 1946 and the concurrent reduction of pheasant nesting cover. Besadny (1959) analyzed changes in major cultivated crops for several states in the Midwest, but concluded that such changes were not the principal cause of pheasant declines from 1954 to 1959, though they were affecting available nesting cover. In north-central Iowa, Nomsen (1969) found a major decline in the percentage of cropland in oats from 1948 to 1967, and therefore a major reduction in potential pheasant nesting cover. In 1948 oats occurred on 23 percent of all cropland in northern Iowa, but occurred on only 5 percent in 1967. Wetland drainage and loss of undisturbed grassland areas as well as agricultural changes, such as a shift from clover and other hay types to alfalfa, were also associated with pheasant declines and loss of habitat in many areas (Wagner et al. 1965, Baxter and Wolfe 1973). Loss of areas such as wetlands affects winter cover as well as nesting cover. Green (1938) evaluated winter cover and pheasant survival in northern Iowa and stressed the importance of food and cover in close proximity. Increased fall plowing has eliminated many food supplies and allowed wind-blown snow and soil to fill small grassed areas and many farm groves that otherwise had provided winter cover (Nomsen 1969, Klonglan 1971). Reduced diversity and interspersion of cover types was noted by Leite (1971) in evaluation of

pheasant habitat in Ohio from 1947 to 1967.

North-central Iowa was prime range for ring-necked pheasants from shortly after their introduction into Iowa in the early 1900's until 1965. Pheasant population levels fluctuated several times in Iowa as estimated by fall roadside census data collected in northern Iowa from 1936 to 1953 and state-wide August roadside census data collected since 1954 (Nomsen 1964:220, Farris 1973a:23). Averages of nearly 4 birds per mile were found in the early 1940's, but declined sharply by the end of the decade. Pheasant numbers then increased, with many yearly fluctuations, until a severe winter storm in 1965 eliminated large numbers of birds throughout northern Iowa (Klonglan 1971). Since 1965 state-wide counts have averaged 2 birds per mile, but the majority of Iowa's pheasants have been located in southern Iowa.

Post-hunting season census data for a pheasant study area in Winnebago County more clearly illustrate the reduction of pheasant populations that has occurred in north-central Iowa. In 1939 there were 50 birds per section. The population increased to a peak of 125 birds per section in 1941. The population declined to 75 birds per section in 1954 and to 64.7 birds per section in February of 1965. After the blizzard in March of 1965, the population was censused to determine the effect of the storm and only 32.3 birds per section were counted. The population continued to decline, and in 1972 only 15.7 birds per section were observed on the 3,840-acre study area (Farris 1973b:16).

The objective of this study was to determine the extent and trends of land use changes and the consequent effect on pheasant habitat as a possible explanation of the severe reduction of pheasant populations in north-central Iowa.

THE STUDY AREA

North-central Iowa has very productive agricultural land and the economy of the area is based on production and processing of agricultural products. The human population is primarily rural, located on farms or in small rural communities. The area includes only two metropolitan areas; Waterloo-Cedar Falls and Mason City.

The study area includes 27 counties in north-central Iowa (Fig. 1) characterized by level to gently rolling topography and scattered areas with moderate to steep slopes. Counties included in the study were selected to provide a sample homogeneous in land use and topography. Though several large rivers are located in north-central Iowa, well-developed drainage systems are located primarily in the eastern and western counties. The central counties have less developed drainage patterns, because this area, formed from Wisconsin glacial till, is geologically younger than the land surface to the east or west (Ruhe 1969:107-111). Since the topography is nearly level and drainage problems are easily corrected by tiling, the central counties are suitable for intensive cultivation. The eastern and western counties can also be heavily cultivated, but not to the degree possible in the central counties. Soil types, topographical features, and farming suitability for north-central Iowa are completely discussed by Oschwald et al. (1965).

Figure 1. The north-central Iowa study area.
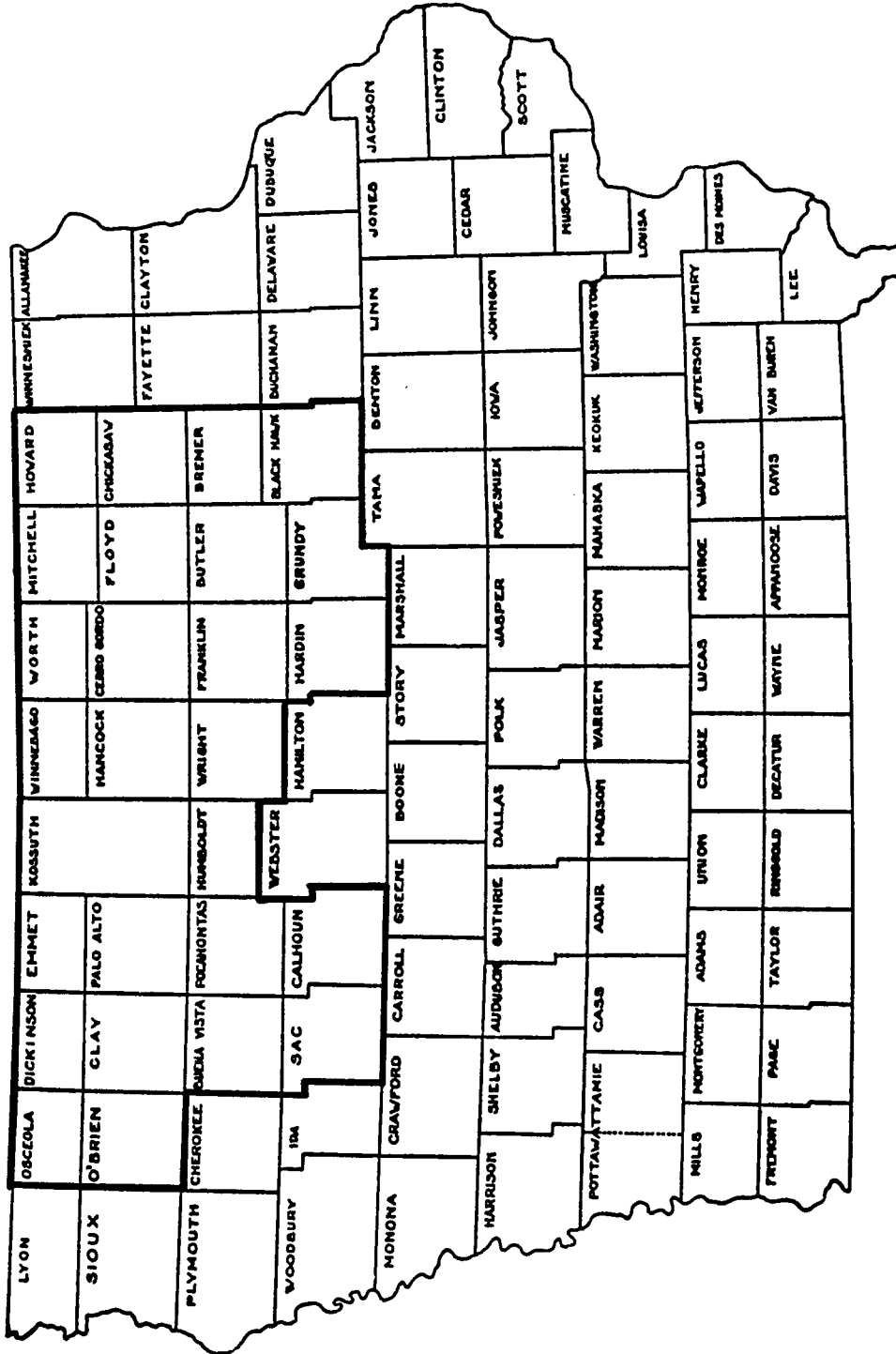
MATERIALS AND METHODS

Four 2-section (518 hectares) rural areas from each county in
north-central Iowa (Fig. 1 and Appendix I) were selected randomly
and analyzed to determine land use changes and consequent effects
on pheasant habitat using sequential aerial photography and annual
Iowa crop reports. The 108 518-hectare sample units represent a
1.51 percent sample of north-central Iowa. Every sample unit was
analyzed once for each of the following time periods: 1938-1941,
1948-1953, 1954-1958, 1961-1965, and 1968-1973. Hereafter the time
periods will be referred to as 1939, 1953, 1958, 1965, and 1972,
respectively, since the majority of the samples were from those years.

Thirty land-use categories were designated and hectarage for
each was calculated or estimated (Table 1 and Appendix II). Measure-
ments of area in nonagricultural land uses were made on ASCS-USDA
aerial photographs. The scale was approximately 1:20,000 for all
photographs except those taken in 1970, 1971, and 1972, when the
scale for contact prints was approximately 1:40,000. Measurements
of area in feedlots, farmsteads, forests, fencerows, undisturbed
grassland, industrial, commercial, residential, and other uses
(cemeteries, churches, airports, etc.) were made with dot-sampling.
The dot density (1.55 dots/sq. cm. and 6.20 dots/sq. cm.) was
determined using a technique described by Spurr (1960:418-422). Area
in brush, farm groves and wetlands was determined using a planimeter
(Keuffel and Esser, Model 4212). Areas for all other nonagricultural

land uses were measured with a magnifying comparator (Laboratory
Supplies Company, Inc., Model C46), a map measure (Keuffel and
Esser, Model 62-0300) and a metric rule (Keuffel and Esser, Model
56-3276). Because some aerial photographs were taken in early spring
and late fall when crop types could not be accurately identified,
agricultural land-use data were obtained from annual township crop
reports (U.S. Bureau of Agricultural Economics 1938-1941, 1948-1953,
1954-1958, 1961-1965, 1968-1972). Acreages for crops as recorded
were converted to the percentage of all cropland recorded for the
township in each time period. The approximate hectarage of each crop
type on a study area was calculated using the following formula:

$$\text{Hectarage in a crop type} = \left(518 - \begin{array}{l} \text{Total hectarage of} \\ \text{all nonagricultural} \\ \text{land uses} \end{array} \right) \times \left(\begin{array}{l} \text{Percentage of total} \\ \text{township cropland} \\ \text{in crop type} \end{array} \right)$$

Yearly acreage in federal land retirement programs since 1956 was
obtained from the ASCS (unpublished national records) for each county
and an estimate of hectarage per section was calculated.

These methods of determining area for crop types were compared
with data and cover maps prepared by Baskett (1947) and Fischer (1974)
for a pheasant study area in Winnebago County to assess the error involved.
The maximum error for estimates of crop areas as compared to the actual
data when expressed as percentage of the total area in the section, was a
5.5 percent overestimate of land area in pasture for 1939. The largest
errors for both comparisons were associated with corn, soybeans, and
pasture estimates.

A cover type index and a fencerow index were calculated to
estimate the amount of interspersion of cover types and increases
in field size by using a modification of the techniques described
by Baxter and Wolfe (1972). To compensate for the quarter-sectional
geometry of Iowa field patterns, transect lines were arranged at angles
of 18, 34, 56, and 71 degrees from a section corner (Fig. 2). For the
first 5 counties sampled, the section corner from which the transect
lines radiated was randomly selected for each section. For the remaining
2-section sample units, transect lines were drawn at the same angles
into both sections from the same section corner; the corner was located
at the midpoint of the southern or eastern border of the sample unit.
Every land-use unit crossed by the transect lines was counted once for
the cover type index, while only fencerows were counted for the
fencerow index. The cover types crossed by line A in Figure 2, starting
at the southwest section corner are: road, road ditch, fencerow,
field, fencerow, field, fencerow, field, fencerow, field, drainage
ditch, field, fencerow, road ditch, road. Index values recorded were
the total number of cover types crossed by the eight transect lines
in both sections of a sample unit and the total number of fencerows
crossed by eight transect lines in both sections of a sample unit.

Three categories of pheasant habitat were defined: all nesting
cover, high-production nesting cover, and winter cover (Table 2).
Land-use categories included in each were determined after
a review of pheasant nesting literature (Baskett 1947, Trautman 1960,
Klonglan 1962, Joselyn and Warnock 1964, Wagner et al. 1965, Gates

and Ostrum 1966, Baxter and Wolfe 1973) and winter cover literature (Green 1938, Grondahl 1953, Klonglan 1971). All nesting cover includes any cover type likely to be used by pheasants for nesting, while good nest cover includes those cover types with good nest success and from which high production could be expected. Winter cover includes only cover types that would provide some protection from winter storms and wind.

Table 1. List of land-use categories and definitions.

Land-use category	Definition
I. Agricultural land uses	
1. Corn (<u>Zea</u> <u>mays</u>)	All field corn harvested for all purposes, with the exception of 1972 when field corn cut for silage was included with other crops.
2. Soybean rows (<u>Glycine</u> <u>max</u>)	Soybeans grown as row crops.
3. Soybean hay	Soybeans grown as a hay crop. Discontinued as a crop category in Iowa crop reports after 1967.
4. Alfalfa (<u>Medicago</u> <u>sativa</u>)	Alfalfa and alfalfa-mixtures grown for hay.
5. Clover (<u>Trifolium</u> sp. and <u>Melilotus</u> sp.)	Clover and clover-mixtures grown for hay.
6. Other hay types	Wild hay, or prairie species, soybean hay in 1972, small grains cut for hay, and grasses grown for hay, such as smooth brome (<u>Bromus</u> <u>inermis</u>) and orchardgrass (<u>Dactylis</u> <u>glomerata</u>).
7. Clover and timothy seed	Clover and timothy (<u>Phleum</u> <u>pratense</u>) grown for seed production.
8. Oats (<u>Avena</u> <u>sativa</u>)	Oats grown for grain.
9. Other small grains	Wheat (<u>Triticum</u> <u>aestivum</u>), barley (<u>Hordeum</u> <u>vulgare</u>), and rye (<u>Secale</u> <u>cereale</u>) grown for grain.
10. Pasture	Includes all areas of pasture, including wooded pasture.

Table 1 (Continued)

Land-use category	Definition
11. Other crops	Flax (_Linum usitatissimum_) popcorn, sorghum (_Sorghum vulgare_), silage, and other crops not listed individually in Iowa crop reports.
12. Retired land	Land retired under the Cropland Adjustment, Feed Grain, Wheat and Acreage Reserve Programs.
13. Conservation Reserve	Land retired in the Conservation Reserve Program (Soil Bank).
II. Nonagricultural land uses	
1. Farmsteads	House, yard, driveway and outbuildings, lawn trees and single rows of trees.
2. Feedlots	Livestock yards around farmsteads, turkey yards and cattle-feedlots.
3. Farm groves	Wind breaks and groves around farmsteads.
4. Fencerows	The fence and associated vegetation. Identified by differences in reflection between two fields, by patterns of plowing near field corners, and by configurations of field patterns in relation to farmsteads.
5. Grassed waterways	Vegetation on a semi-permanent waterway. Narrow waterways with little vegetation were not included.

Table 1 (Continued)

Land-use category	Definition
6. Drainage ditches	Drainage channels with steep banks or a band of vegetation.
7. Wetlands	Marshes, sloughs, and small potholes.
8. Rivers, streams, ponds, and lakes	All rivers and streams, drainage channels without the bank or margin of a drainage ditch, farm ponds, large water-filled potholes and lakes.
9. Undisturbed grassland	River and stream banks, odd areas extending from road-side ditches and railroad right of ways, open land not grazed or cropped.
10. Brushy areas	Brush and tall forbs, or scattered young trees and tall forbs. Not grazed.
11. Forest	A stand of trees, larger than farmgroves, that was not grazed, and had a crown cover density of at least 65 percent (25 ft. crowns) on Michigan Photo Interpreter's Scale (University of Michigan School of Natural Resources, scale 1:20,000).
12. Stringers	Narrow rows of trees and brush along fencerows, drainage ditches and narrow strips of trees and brush not classed as forest, or too small to be included as farm groves.

Table 1 (Continued)

Land-use category	Definition
13. Railroad	The railroad bed.
14. Roads	The road surface.
15. Road and railroad ditches	The area between the road surface or railroad bed and the adjoining cover type.
16. Industrial, commercial developed residential	Land used for a housing district, or industrial or commercial purposes, except those included in Other.
17. Other	Cemeteries, churches, country schools, airports, parks, quarries.

Figure 2. Transect lines for calculating cover type
and fencerow indices on Section 27,
Gillett Grove Twp., Clay County, Iowa,
for the 1968 photograph.
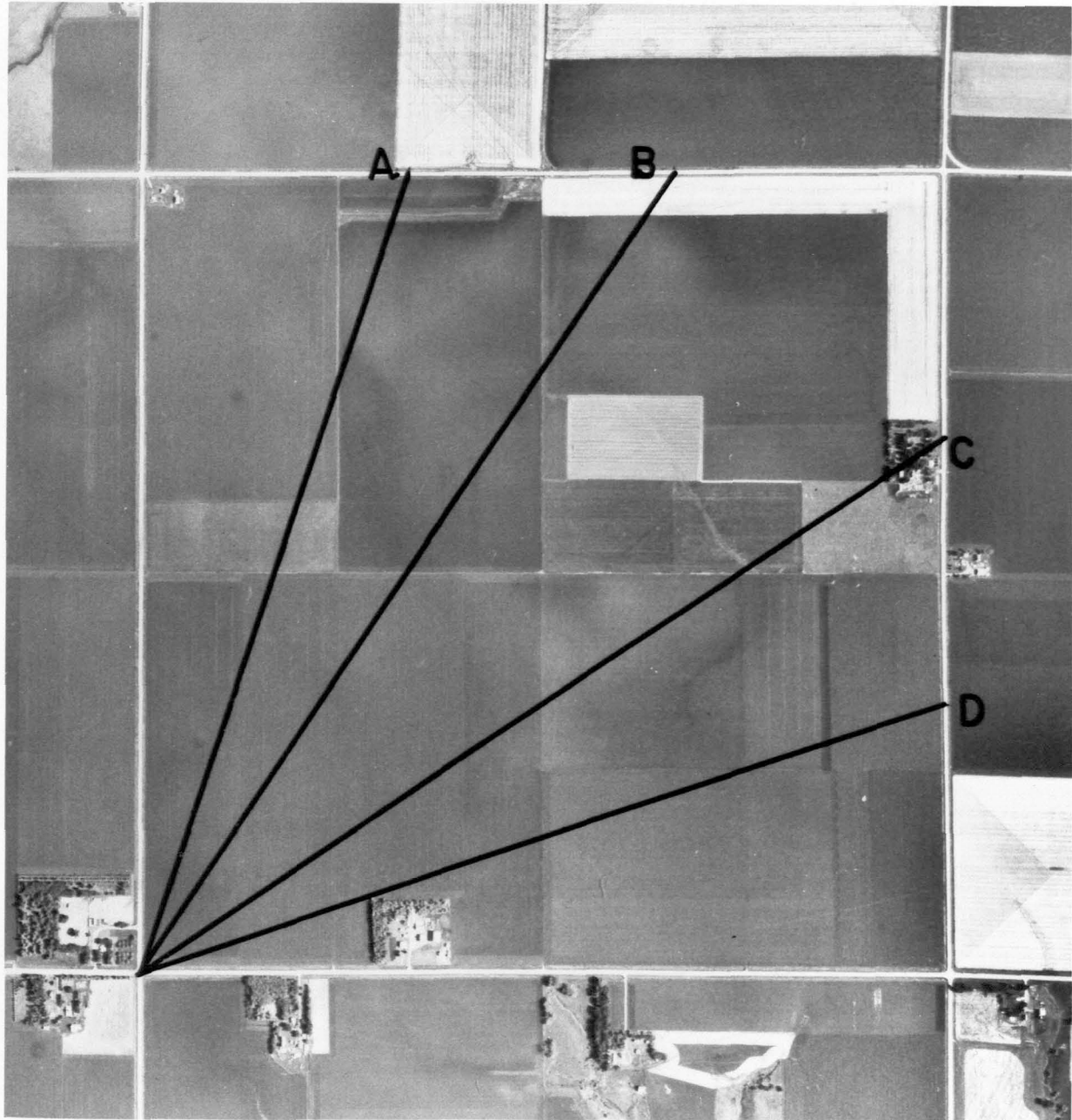
Table 2. Cover types included in three categories
of pheasant habitat.

All nest cover	Good nest cover	Winter cover
Soybean hay	Clover	Conservation reserve
Alfalfa	Other hay types	Undisturbed grass-land
Clover	Clover and timothy seed	Farm groves
Other hay types	Oats	Brushy areas
Clover and timothy seed	Conservation reserve	Stringers
Oats	Undisturbed grassland	Drainage ditches
Other small grains	Brushy areas	Wetlands
Pasture	Wetlands	
Retired land	Drainage ditches	
Conservation reserve	Grassed waterways	
Fencerows	Road and railroad ditches	
Undisturbed grassland		
Farm groves		
Brushy areas		
Wetlands		
Stringers		
Drainage ditches		
Grassed waterways		
Road and railroad ditches		

RESULTS AND DISCUSSION

Agricultural Land Uses

For each time period the percentage of the total land area sampled
and the percentage of the hectarage recorded for 1939 were calculated
for all land uses (Tables 3, 4, and Appendix III) and for selected
combinations of land uses (Table 5). Although the percentage of land
in all agricultural land uses (Table 3) remained near 89 percent
throughout the entire time period, several significant changes occurred
in uses of agricultural land.

A steady increase in row crops (corn and soybeans) from 32.5 percent
of the land area in 1939 to 58.4 percent in 1972 (Table 5) occurred
mainly due to increases in the area planted in soybeans since 1953
(Table 3). Soybeans were nearly ten-fold higher in hectarage between
1939 and 1972, while corn area was increased only 13.5 percent. Corn
and soybeans were recorded for all areas and time periods (Table 6).
F tests were used to determine if significant differences between
period means existed for the sample as a whole and to determine if
crop percentage trends varied among counties. Both tests were highly
significant (P = 0.0001) for corn and soybeans. The highest percentages
of land area in both corn and soybeans occurred in the central counties.

With the expansion of row crops, the area utilized for all hay,
small grains (Table 5), and pasture (Table 3) declined 55.6 percent,
82.6 percent, and 63.0 percent, respectively, from 1939 to 1972.

Table 3. Agricultural land uses expressed as percentage of total area sampled for each time period with 95 percent confidence intervals (A), and percentage of hectarage recorded for 1939 (B).

Land-use type		1939	1953	1958	1965	1972
Corn	A	29.96±1.04	36.10±1.08	34.00±0.84	34.10±0.99	34.01±1.09
	B	100.00	120.40	113.48	113.81	113.52
Soybean rows	A	2.58±0.33	6.14±0.66	12.31±1.30	18.25±1.48	24.37±1.45
	B	100.00	237.92	476.81	707.25	944.35
Soybean hay	A	2.58±0.24	0.01±0.006	0.02±0.01	Tr.[a]	0.00
	B	100.00	0.52	0.75	0.01	0.00
Alfalfa	A	2.36±0.25	2.13±0.24	5.18±0.50	5.18±0.45	4.35[b]±0.50
	B	100.00	90.26	219.39	219.39	73.81[c]
Clover	A	3.54±0.56	5.94±0.58	4.15±0.57	2.15±0.52	
	B	100.00	167.81	117.40	60.67	
Other hay	A	1.30±0.23	0.39±0.09	0.18±0.06	0.12±0.04	0.14±0.05
	B	100.00	29.97	14.09	8.90	10.83
Clover & timothy seed	A	0.34±0.12	0.18±0.06	0.04±0.02	0.01±0.01	0.00±0.00
	B	100.00	55.17	11.49	3.45	0.00
Oats	A	21.24±0.85	20.97±0.53	17.14±0.63	7.00±0.52	4.01±0.41
	B	100.00	98.72	80.67	32.94	18.87
Other small grains[d]	A	1.75±0.42	0.07±0.02	0.08±0.02	0.07±0.04	0.01±0.004
	B	100.00	3.74	4.51	3.74	0.44

Pasture	A	22.41+1.04	16.40+1.16	14.14+1.08	11.14+1.05	8.30+1.04
	B	100.00	73.19	63.10	49.72	37.05
Other crops	A	1.03+0.18	0.96+0.36	0.59+0.12	0.47+0.14	2.05+0.31
	B	100.00	92.87	57.22	45.78	199.06
Retired land[e]	A	--	--	1.71+0.51	10.36+1.41	12.27+1.15
	B	--	--	100.00[f]	605.62	715.43
Conservation reserve[e]	A	--	--	0.06+0.03	0.45+0.27	0.02+0.03
	B	--	--	100.00[f]	745.16	32.26
Total Agricultural Land	A	89.09+1.00	89.29+1.03	89.60+0.99[g]	89.30+1.23[g]	89.53+1.21[g]
	B	100.00	100.22	100.56	100.22	100.48

[a]Tr. < 0.006 percent.

[b]Alfalfa and clover were combined as a single category in Iowa crop reports after 1967.

[c]The percentage is based on the combined hectarage of clover and alfalfa in 1939.

[d]Other small grains include wheat, barley and rye.

[e]Federal land retirement programs included in the study were not in effect prior to 1956.

[f]Percentages were based on the 1958 hectarage.

[g]Confidence intervals calculated for total crop land, which does not include Retired land or Conservation reserve.

Table 4. Nonagricultural land uses expressed as percentage of total area sampled for each time period with 95 percent confidence intervals (A), and percentage of hectarage recorded for 1939 (B).

Land-use type		1939	1953	1958	1965	1972
Farmsteads	A	1.18+0.13	1.19+0.13	1.19+0.13	1.19+0.09	1.18+0.11
	B	100.00	100.49	100.81	100.49	99.67
Feedlots	A	0.21+0.07	0.27+0.09	0.17+0.07	0.22+0.07	0.21+0.07
	B	100.00	125.45	81.82	104.54	98.18
Farm groves	A	0.80+0.08	0.84+0.07	0.80+0.07	0.75+0.07	0.69+0.09
	B	100.00	104.58	100.00	93.49	86.75
Fencerows	A	2.48+0.19	2.25+0.17	2.17+0.16	2.23+0.16	1.72+0.13
	B	100.00	90.82	87.55	89.88	69.42
Grassed waterways	A	0.04+0.02	0.06+0.02	0.08+0.02	0.13+0.03	0.12+0.04
	B	100.00	142.86	195.24	309.52	290.48
Drainage ditches	A	0.27+0.10	0.29+0.11	0.30+0.10	0.31+0.09	0.39+0.11
	B	100.00	107.97	105.07	118.12	144.93
Wetlands	A	0.30+0.14	0.23+0.10	0.17+0.10	0.15+0.09	0.13+0.09
	B	100.00	78.06	56.77	50.32	45.16
Rivers, streams, ponds & lakes	A	0.40+0.16	0.46+0.17	0.40+0.15	0.41+0.16	0.40+0.16
	B	100.00	114.01	100.48	102.41	99.03
Undisturbed grassland	A	1.01+0.46	0.60+0.24	0.40+0.19	0.35+0.15	0.29+0.14
	B	100.00	59.85	39.58	34.61	29.06

Brushy areas	A	0.12±0.07	0.11±0.08	0.07±0.04	0.07±0.04	0.13±0.09
	B	100.00	88.71	58.06	58.06	109.68
Forest	A	1.35±0.63	1.36±0.67	1.46±0.68	1.60±0.74	1.75±0.79
	B	100.00	100.86	107.99	118.54	129.10
Stringers	A	0.11±0.03	0.09±0.02	0.09±0.02	0.09±0.02	0.09±0.03
	B	100.00	83.64	87.27	83.64	85.45
Railroads	A	0.04±0.02	0.04±0.02	0.04±0.02	0.04±0.02	0.04±0.02
	B	100.00	115.79	115.79	115.79	110.53
Roads	A	0.81±0.03	0.89±0.03	0.94±0.03	0.95±0.03	1.01±0.06
	B	100.00	109.81	116.03	117.46	124.64
Road and rail-road ditches	A	1.67±0.10	1.83±0.11	1.92±0.12	2.00±0.12	2.07±0.12
	B	100.00	109.24	115.01	119.86	123.79
Industrial, commercial, residential	A	0.05±0.08	0.04±0.07	0.04±0.06	0.04±0.08	0.07±0.10
	B	100.00	91.67	91.67	91.67	150.00
Other	A	0.07±0.06	0.16±0.14	0.16±0.12	0.17±0.14	0.18±0.14
	B	100.00	231.43	234.29	245.71	262.86

Table 5. Grouped land uses expressed as percentage of total land area sampled for each time period with 95 percent confidence intervals (A), and percentage of the hectarage recorded for 1939 (B).

Land-use group		1939	1953	1958	1965	1972
Row crops	A	32.54 ± 1.06	42.24 ± 1.58	46.31 ± 1.57	52.35 ± 2.08	58.38 ± 2.23
	B	100.00	129.82	142.31	160.90	179.43
All hay	A	10.12 ± 0.62	8.65 ± 0.50	9.57 ± 0.38	7.46 ± 0.43	4.49 ± 0.51
	B	100.00	85.62	94.63	73.69	44.42
Alfalfa	A	2.36 ± 0.25	2.13 ± 0.24	5.18 ± 0.50	5.18 ± 0.45	4.35 ± 0.50
	B	100.00	90.26	219.39	219.48	184.53
Late-cut hay	A	7.42 ± 0.71	6.34 ± 0.56	4.35 ± 0.56	2.27 ± 0.51	0.14 ± 0.05
	B	100.00	85.80	58.74	30.50	1.90
All small grains	A	22.99 ± 0.90	21.04 ± 0.53	17.22 ± 0.62	7.07 ± 0.53	4.02 ± 0.41
	B	100.00	91.48	74.87	30.71	17.45

Table 6. Percentage frequency of occurrence for land-use categories for each time period.

Land-use category	1939	1953	1958	1965	1972
Corn	100.00	100.00	100.00	100.00	100.00
Soybean rows	100.00	100.00	100.00	100.00	100.00
Soybean hay	100.00	29.63	25.93	0.93	0.00
Alfalfa	100.00	99.07	100.00	99.07	100.[a]
Clover	100.00	100.00	100.00	91.67	
Other hay	97.22	79.63	62.04	59.26	64.81
Seed	70.37	49.07	27.78	8.33	0.00
Oats	100.00	100.00	100.00	100.00	100.00
Other small grains	100.00	50.00	54.63	21.30	11.11
Pasture	100.00	100.00	100.00	100.00	100.00
Other crops	97.22	78.70	88.89	78.70	91.67
Retired acres	--[b]	--[b]	77.78	92.59	100.00
Conservation reserve	--[b]	--[b]	66.67	77.78	7.41
Feedlots[c]	31.48	37.04	25.00	35.18	31.48
Forest[c]	25.93	25.00	25.93	25.93	25.93

Farmsteads[c]	96.30	96.30	94.44	100.00	98.15
Industrial commercial & residential fencerows[c]	100.00	100.00	99.07	100.00	100.00
Undisturbed grassland[c]	42.59	35.18	25.93	26.85	22.22
Other[c]	7.41	8.33	9.26	9.26	9.26
Farmgroves	100.00	100.00	100.00	100.00	99.07
Brush	31.48	31.48	25.00	25.93	29.63
Wetlands	51.85	52.78	39.81	33.33	34.26
Stringers	84.26	75.00	76.85	75.00	70.37
Drainage ditches	34.25	40.74	46.30	54.63	58.33
Rivers, streams, & lakes	62.96	64.81	62.04	62.04	60.18
Grassed waterways	34.26	58.33	59.26	65.74	60.18
Road & railroad ditches	100.00	100.00	100.00	100.00	100.00
Roads	100.00	100.00	100.00	100.00	100.00
Railroads	20.37	20.37	20.37	20.37	20.37

[a] In the 1972 time period alfalfa and clover were combined as a single category in Iowa crop reports.

[b] Federal land retirement programs were not initiated until 1956.

[c] Dot-sampling technique, used to measure area, is not an accurate measure of frequency of occurrence.

All hay declined in every time period except 1958 (Table 5).
Soybean hay and other hay, which in 1939 was primarily wild hay,
declined most from 1939 to 1953. Though clover was the most important
hay crop in 1939 and 1953, later reductions in total hay area were
primarily due to decreased clover area, and alfalfa became the principal
hay crop. Alfalfa and clover, combined as a single category in Iowa
crop reports after 1967 (Table 3), declined in 1972. The shift to
alfalfa as the primary hay crop produced adverse effects on pheasant
nesting (see section on Pheasant Habitat), because alfalfa matures
earlier than other hays and in later years has been mowed even earlier
to preserve its nutrient value (Van Horn et al. 1968:18). Soybean hay,
dropped as a separate category in Iowa crop reports after 1967, occurred
primarily on sample areas in the eastern and western counties. Other
hay types, though distributed throughout the region, increased only in
the eastern and western counties in 1972. Grasses, such as smooth
brome and orchardgrass, have replaced alfalfa as both hay and pasture
in many cattle-feeding, cow-calf, and dairy operations, which are
located primarily in the western and eastern counties (Schaller 1967,
Van Horn et al. 1968). Clover and timothy seed were recorded for 70.4
percent of the sample units in 1939 (Table 6), but were totally absent
in 1972, a serious loss for pheasant nesting habitat. F tests were
significant for changes in period means and differences in the trends
of means among counties (P = 0.0001) for each hay category.

Oats, the most important small grain crop in Iowa, declined more
than any other crop between 1939 and 1972. The largest reduction

occurred between 1958 and 1965 (Table 3) in conjunction with increasing importance of federal land retirement programs. Although the reduction in the area in oats was very large, oats were recorded for all samples in all time periods. Other small grains (wheat, barley and rye) declined to less than 0.1 percent of the total land area after 1939 (Table 3), and their distribution declined from 100 percent of the sample units in 1939 to only 11.1 percent in 1972. F tests were significant for period differences and for differences in county trends (P = 0.0001) for oats and other small grains.

Pasture area declined 63 percent from 1939 to 1972. Though the decline appeared more extensive in the central counties, pasture, more than any other agricultural land use, has become more closely tied to localized topographical influences. Pasture was particularly important in all time periods on sample units with many steep slopes. Many low and poorly drained areas along streams have been retained as pasture, while several areas of wooded pasture were allowed to grow into brush or forest. F tests were significant for period differences and for differences in county trends (P = 0.0001).

Federal land retirement programs have been in effect since the 1930's. The earliest programs applicable in Iowa were designed to limit acreage in corn, but acreage diverted from corn production could be planted in any other crop. Major replacements for corn were soybeans and oats (Shepherd 1964:40). The Soil Bank (Conservation Reserve) program, initiated in 1956, was the first program designed to completely remove land from crop production. This was a long-term program and required protective cover crops or development of some other conservation

practice on the land retired. Where it was utilized, this program
improved pheasant cover (Dahlgren 1967:17), but Conservation Reserve
never occupied a significant amount of land area in north-central Iowa
(Table 3).

Other land retirement programs (Retired land, Table 3) included the
Feed Grain Program, Acreage Reserve, Cropland Adjustment Program (CAP),
and the Wheat Program. All of these, with the exception of CAP, were
annual contract programs not requiring a cover crop. Because no
vegetative cover was required, their value as wildlife cover varied.
With the introduction of short-term programs, retired land gained
immediate importance as a land use in north-central Iowa. CAP, a
long-term program first offered in 1966, was supplemental to other
programs and emphasized open space and recreation for urban areas
through development of land for hunting and fishing (U.S. Department
of Agriculture 1972). This program accounted for about 1 percent of
the area recorded as retired land in 1972 (Table 3), or about 0.1 percent
of the total land area.

Nonagricultural Land Uses

Though the percentage of the total land area in nonagricultural
uses remained between 10 and 11 percent from 1939 through 1972, most
nonagricultural uses were affected by agricultural changes. Percentage
of land area occupied was not large for any nonagricultural category in
any time period (Table 4), but changes in land area as compared to 1939
hectarage were extreme in many categories.

While the total number of farmsteads declined from 833 to 801 from 1939 to 1972 (Table 7), farmstead area did not change significantly. The decrease in the number of farmsteads was only 4 percent for the 35-year period, as compared to a decline of 31.7 percent in the total number of farms on the 27-county area from 1939 to 1972 (Iowa Department of Agriculture 1939, 1954, 1960, 1966, 1972). The total number of farms decreased steadily after 1939; however, the number of farmsteads on the areas sampled increased in 1953 and then declined in subsequent time periods. Farmsteads occurred on all sample units in all sample periods, though the sampling technique did not measure all farmsteads that existed.

Percentage of land area in feedlots fluctuated between time periods. The addition of a large turkey farm on one sample in 1953 increased feed-lot area substantially, while increases in the number of calves born and the number of sows bred (Iowa State Department of Agriculture, 1939, 1954) also may have influenced that increase. In 1958 feedlot area decreased, corresponding with a decline in the number of both dairy and beef cattle. Total numbers of dairy cattle for the 27-county area declined through 1972, while the number of beef cattle increased after 1958. The increasing number of beef cattle and the addition of several cattle feedlot operations caused the increase of feedlot area in 1965. Low frequency of occurrence for feedlots was again caused by the sampling technique, dot-sampling, that is accurate for area measurements but inadequate for determining frequency of occurrence for the tracts sampled (Spurr 1960). No significant period differences (P = 0.2737)

Table 7. Total number of selected cover types sampled (A) and the average number per 2-section sample unit (B) in each time period.

Cover type		1939	1953	1958	1965	1972
Forests	A	74	77	88	93	92
	B	0.7	0.7	0.8	0.9	0.8
Farmsteads	A	833	837	832	820	801
	B	7.7	7.7	7.7	7.6	7.4
Undisturbed	A	78	69	50	53	40
grassland	B	0.7	0.6	0.5	0.5	· 0.4
Brushy	A	61	60	42	41	55
areas	B	0.6	0.6	0.4	0.4	0.5
Wetlands	A	142	130	85	65	64
	B	1.3	1.2	0.8	0.6	0.6
Stringers	A	379	331	301	312	258
	B	3.5	3.1	2.8	2.9	2.4
All farm	A	652	703	699	658	633
groves	B	6.0	6.5	6.5	6.0	5.9
Suitable cover	A	132	174	165	148	126
groves	B	1.2	1.6	1.5	1.4	1.2
Unsuitable	A	520	529	534	510	507
cover groves	B	4.8	4.9	4.9	4.7	4.7

were found with an $\underline{F}$ test, nor were differences in county trends significant (P = 0.0875).

The area and total number of farm groves (Tables 4 and 7) increased from 1939 to 1953, but both declined in subsequent time periods. The reduction of area after 1953 resulted from total or partial removal of groves, leaving only a single row of trees or scattered lawn trees. Differences in farm grove area were significant for periods (P = 0.0001), as were differences in county trends (P = 0.0032). Period differences in the number of farm groves were also significant (P = 0.0001).

Fencerow area (Table 4) declined 30.6 percent from 1939 to 1972. Major declines occurred between 1939 and 1953 and again between 1965 and 1972. A slight increase occurred in 1965 as a result of increasing fencing for land retirement. By 1972 fencerow area again declined due to a shift to very large fields and the consequent removal of many fences. The 1972 value for fencerow area was also affected by the change of photo scale, and some fencerows were undoubtedly not counted by the sampling method on photographs with a 1:40,000 scale. But even on areas with similar photo scales for all time periods, fencerow area declined significantly in 1972. Period differences were significant (P = 0.0001), but county trend differences were not (P = 0.1466). Fencerows were present on all sample units in all time periods.

Area in grassed waterways tripled between 1939 and 1972, because grass cover to prevent erosion was necessitated by the trend from forage and small grains to corn and soybeans. Period differences were significant (P = 0.0001), but no significant difference in county trends

was observed (P = 0.0773). Reduced frequency of occurrence in 1972 was a result of photo scale reduction. The corresponding reduction in image size and resolution resulted in failure to detect and measure smaller grassed waterways visible on larger-scale photographs.

Area in drainage ditches increased 44.9 percent from 1939 to 1972. Drainage ditches were measured on 34.3 percent of the sample units in 1939 and on 58.3 percent in 1972. Significant period differences (P = 0.0001) and significant differences in county trends (P = 0.0017) were found with F tests. The majority of drainage ditches were located in the central and two lakes counties (Dickinson and Emmet), though at least one drainage ditch was located in each county. While most drainage ditches were permanent, a few were repositioned, replaced by tile, or meandered and became streams.

Wetland drainage was the major cause for an increase in drainage ditch area. Area in wetlands decreased 54.8 percent from 1939 to 1972, while the number of wetlands declined 54.9 percent over the same period. Though the entire period from 1939 to 1965 was important for wetland drainage, the major decline in both area and numbers occurred between 1953 and 1958. The loss of area in this time period occurred despite the addition to wetlands of portions of a large, drained lake. Period differences in wetland area and in numbers of wetlands were significant (P = 0.0001), as were differences in county trends (P = 0.0001).

Surface area of rivers, streams, ponds, and lakes decreased only slightly, even though drainage ditches increased. Water area was at a high in 1953, but occupied the same percentage of area in 1972 as in

1939 (Table 4). Increased flow in areas that were dry during the Dust Bowl years, and the flooding of one marsh to form a lake account for the increase in water area in 1953. The addition of some farm ponds in the last time periods countered some loss of area to drainage ditches. Significant period differences were found with an $\underline{F}$ test (P = 0.0415).

Areas of undisturbed grassland declined from a total of 78 in 1939 to only 40 in 1972 (Table 6), while the land area occupied declined 70.9 percent, from 1.0 percent of the land area sampled in 1939 to 0.3 percent in 1972 (Table 4). Period differences were significant for both the number of undisturbed grassland areas (P = 0.0007) and the land area occupied (P = 0.0001).

Brushy area increased only slightly from 1939 to 1972. Occurrence was sporadic, though the number of sample units with brush recorded remained fairly stable. Brush was a temporary occupant of land area in most instances, since the area was either cleared or had become forest by the subsequent time period. No significant period differences were evident (P = 0.1837), though a significant difference in county trends was found (P = 0.0284). Brushy areas were often associated with forest areas and were common remnants if farmsteads, farm groves, or both were removed.

Forested areas, primarily located along large rivers, deep drainage patterns, and lakes, increased 29.1 percent from 1939 to 1972, an increase from 1.4 percent of the land area to 1.8 percent in 1972 (Table 4). Forest was recorded on 25.9 percent of the study areas in all time periods except one. The increase in area of forest was caused

by decreased pasturing of wooded areas and an increase in wooded areas along streams and rivers. Period differences were significant (P = 0.0192).

Percentage of the land area in stringers declined only from 1939 to 1953, though the total number of stringers declined from 379 in 1939 to 258 in 1972. The stringers lost were primarily those located along fencerows, while those associated with forest areas increased in size. Stringers associated with farmsteads increased in the last time periods as the number of farm windbreaks consisting of only a single row of trees increased. Period differences were not significant for area changes (P = 0.5626), but the change in the number of stringers was significant (P = 0.0046).

Railroads occupied the same percentage of the land area in all time periods, 0.04 percent, even though there was a measurable widening of some railroad beds in 1953. This resulted in significant period differences (P = 0.0440).

Road area increased 24.6 percent from 1939 to 1972; an increase from 0.8 percent of the land area in 1939 to 1.0 percent in 1972 (Table 4). This was primarily a result of road widening, though some new roads were built, including an interstate highway. Road ditches (Table 4) were usually widened when roads were improved, but the size of railroad right of ways normally did not change. The increase in road and railroad ditch area, 23.8 percent, was only slightly less than the increase in road area. Period differences were significant for both roads (P = 0.0001) and road and railroad ditches (P = 0.0001).

Industrial, commercial and residential land uses were found on only three sample units. Though area increased almost 60 percent from 1965 to 1972, period differences were not significant (P = 0.5419). The increase in area resulted from slight increases in residential and industrial area on two sample units, but was also a result of the dot-sampling technique. Other land uses (Table 4) increased most between 1939 and 1953, with the addition of an airplane landing strip on one sample unit. Period differences were not significant (P = 0.2672).

Cover Type and Fencerow Indices

The average cover type index declined from 175 to 155 between 1939 and 1972 (Table 8). The major decline in the number of cover types throughout north-central Iowa occurred between 1965 and 1972. This reduction corresponded with declining numbers of farmsteads and farm groves and removal of fencerows and stringers. Period means were significantly different (P = 0.0001) as were differences in county trends (P = 0.0004). The range of index values was extreme in all time periods (Appendix IV). On some areas the number of cover types crossed by transect lines increased in 1953 and 1958 as large areas of pasture and undisturbed grassland were put into crop production. But in nearly all study units the number of cover types decreased in 1965 and 1972, as the sizes of corn and soybean fields increased.

The fencerow index average declined from 68 in 1939 to 56 in 1972. This occurred because of increasing field sizes and because fencerows between different crop types were no longer present on many areas.

Table 8. Cover type and fencerow index values for the average 2-section sample unit in each time period.

Index	1939	1953	1958	1965	1972
Cover type	175	174	170	169	155
Fencerow	68	66	64	62	56

Table 9. Pheasant habitat expressed as percentage of the total area sampled in each time period with 95 percent confidence intervals (A), and as percentage of the hectarage recorded for 1939 (B).

Habitat type		1939	1953	1958	1965	1972
All nest	A	62.32+0.96	52.40+1.32	48.69+1.24	42.55+1.68	34.74+1.67
cover	B	100.00	84.08	78.13	68.27	55.74
Good nest	A	29.83+0.84	30.60+0.61	24.49+0.92	12.73+0.89	7.30+0.44
cover	B	100.00	102.59	82.12	42.68	24.47
Winter	A	2.60+0.56	2.16+0.37	1.87+0.28	2.17+0.27	1.75+0.25
cover	B	100.00	82.88	71.90	83.25	67.23

Reductions in cover type index values and fencerow index values in the later time periods represents the trend to clean farming in north-central Iowa. The reduction also represents less interspersion of cover types, another change that has affected pheasant habitat.

Pheasant Habitat

Both the quantity and the quality of pheasant habitat declined between 1939 and 1972 as changes occurred in agricultural and non-agricultural land uses in north-central Iowa.

All pheasant nesting habitat declined 44.3 percent between 1939 and 1972 (Table 9 and Appendix V). Cover types used for nesting occurred on 62.3 percent of the land area in 1939, but on only 34.7 percent in 1972. A more significant decline occurred in cover types from which good production of pheasants could be expected. Good nesting cover occurred on 29.8 percent of the land in 1939, but in 1972 only 7.3 percent of the land was in high-production cover types.

Reductions in the quantity of pheasant nesting habitat occurred primarily as oats, hay and pasture were replaced by corn, soybeans, and land retired in annual programs. Pheasant production from nests in oats has been significant in most pheasant nesting studies. In north-central Iowa, Baskett (1947) found 37 percent of all successful nests in oats or other small grains, while Klonglan (1955) found 32 percent of all successful nests in oats. Trautman (1960) found that nests in oats produced 27.0 and 20.7 percent of all chicks in 1938 and 1959, respectively.

Loss of hay area was important in reducing pheasant nesting cover; particularly important losses for good nesting cover were reductions in hay types other than alfalfa (Table 5, late-cut hay). Though many pheasants nest in alfalfa, nest success is low due to mowing losses. Baskett (1947) found 6 percent of all successful nests in alfalfa while 31 percent of all successful nests were in other hay types. Klonglan (1962) found 8.7 percent and 45.6 percent of all successful nests in alfalfa and other hay, respectively.

Production from nests in pastures has varied in nesting studies. An important criterion in determining the value of pasture as nesting cover is grazing pressure. Trautman (1960) found that 14.1 percent of all production was from nests in grazed pasture in 1959, but only 1.4 percent of total production occurred in ungrazed pasture. Baskett (1947) and Klonglan (1955 and 1962) found 6 percent, 7 percent, and 16 percent, respectively, of all successful nests in pasture, but grazed and ungrazed pastures were not separated.

Important losses of good nesting cover occurred with wetland drainage. Wagner et al. (1965:94-97) stated that a positive correlation existed between pheasant densities and percentage of the land area in wetlands in Wisconsin. The value of wetlands as nesting cover is dependent on water levels. Baxter and Wolfe (1973:23-25) found that 0 to 30.8 percent of total chick production came from nests in wetlands between 1959 and 1964. Hamerstrom (1936) found 19.23 percent of all successful pheasant nests were produced in wetlands in northern Iowa from 1933 to 1935. This value was below what might have been expected,

since a fire destroyed 13 pheasant nests in a slough on his study area. Another slough, not included in the study area, contained 51 pheasant nests that were also destroyed by fire.

Land area declined in undisturbed grassland and in brushy areas except in 1972 and reduced potential nesting cover for pheasants. Though area in undisturbed grassland and brush was not extensive and contained very few nests in any nesting study, nest success rates were usually high. Fencerow area declined and consequently reduced nesting habitat, but the reduction of fencerow area was not a serious loss to pheasant production because nest success in fencerows is minimal. Since few pheasants nest in stringers and farm groves, loss of area in those cover types had no effect on good nesting cover.

Several cover types increased in land area and thus some nesting cover has been maintained. These cover types include roadside ditches, railroad right of ways, drainage ditches, and grassed waterways. Roadsides and railroad right of ways have been one of the important cover types for pheasant production. Seventeen percent of all successful nests observed by Baskett (1947) were in roadside ditches. Klonglan (1955) found 28.6 percent of all successful nests in roadsides, and Baxter and Wolfe (1973) found 25.2 percent of total chick production from roadside nests. Production of pheasants in roadsides depends on the vegetative quality of the road ditch and upon management procedures such as mowing and weed control. Railroad right of ways produced 2.7 and 1.6 percent of total pheasant production in South Dakota in 1958 and 1959 (Trautman 1960). Quality of right of ways also depends on

vegetative cover and management. Grassed waterways probably have more value as renesting cover than they do for initial nesting attempts.

Federal land retirement programs slowed the decline of pheasant nesting cover from 1958 to 1972 (Table 3). The value of long term programs, such as Conservation Reserve and the Cropland Adjustment Program, for nesting was undisputed. However, considerable variability in the value of annual-contract programs to nesting pheasants has been observed. Though land in annual-contract retirement programs contributed significantly to pheasant production (Joselyn and Warnock 1964, Gates and Ostrum 1966), many suggestions were made to improve the quality of retirement land as nesting cover. Only about 25 percent of all retired lands in Minnesota had adequate cover for wildlife (Harmon and Nelson 1973), while the remaining land was fallow or had sparse seedings of oats. Mead (1973) reported the potential importance of retired land for pheasant production if specially managed as wildlife habitat. In north-central Iowa he found 74 percent of all successful nests located in diverted fields that were managed for nesting cover.

Area usable as winter cover declined 32.8 percent from 2.6 percent of the land area in 1939 to 1.8 percent in 1972 (Table 9). Area in wetlands and undisturbed grassland were significantly reduced in all time periods, while farm groves also declined after 1953. Winter cover increased in 1965 as area in Conservation Reserve increased, but near elimination of that program and reductions in other important winter cover types left only 1.8 percent of the total land area in winter cover in the 1972 time period. Wetlands, undisturbed grassland and drainage ditches provide best

cover in early winter before vegetation is weighted with snow, while brush and farm groves provide cover during late winter and severe storms (Green 1938, Grondahl 1953, Weston 1954, Klonglan 1971). Farm groves, as observed on the aerial photographs, were tabulated according to suitability as winter cover (Table 7). Judgment of grove suitability was based on density of crown cover, size of the grove, and the amount of protection from north winds and storms provided to some adjacent area which could be used by pheasants for feeding or loafing. In 1939 and 1972 approximately 20 percent of all farm groves were classed as suitable winter cover, while the percentages of groves that were suitable as cover in 1953, 1958, and 1965 were 25, 24, and 22, respectively.

Increasing field sizes, clean farming, removal of fencerow stringers, and reduced interspersion of cover types diminished winter cover quality, because the distances between good cover and feeding areas increased. Though severe winter storms have not occurred yearly, reduction of winter cover area and interspersion have increased the possibility of significant pheasant mortality during such storms (Klonglan 1971).

Differences in period means for all nest cover, good nest cover, and winter cover were significant (P = 0.0001 for all three F tests).

CONCLUSIONS

Pheasant nesting habitat and winter cover have been seriously reduced because of changing land use patterns in north-central Iowa. Reductions in oats, clover, wild hay, hay seed crops, and wetlands were the most serious influences on good nesting cover, and consequently on pheasant production. A correlation of land use changes and pheasant census data for the counties included in this study would statistically indicate the cover type reductions that have been involved in the pheasant decline in north-central Iowa.

With the elimination of federal land retirement programs, emphasis for pheasant production must be placed on maximum utilization of nesting cover types available and development of areas less suitable for intensive cultivation. Areas of most concern should be management of roadsides, railroad right of ways, remaining wetlands, undisturbed grassland areas and grassed waterways. These cover types must necessarily provide the quantity and quality of habitat required to produce pheasants in north-central Iowa, since present economic incentives in agriculture require maximum food production using row crops.

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APPENDIX I

A list of the sample units by county and the years

for which each unit was sampled.

Table 1.   List of sample units by counties and the years of sampling.

County	Township		Section Nos.	Years
Black Hawk	Bennington	T90N,R12W	18,19	1941, 1952, 1957, 1964, 1970
	Eagle	T87N,R13W	4,9	1941, 1952, 1957, 1964, 1970
	Orange	T88N,R13W	17,20	1941, 1952, 1957, 1964, 1970
	Poyner	T88N,R12W	15,22	1941, 1952, 1957, 1964, 1970
Bremer	Douglas	T93N,R13W	7,8	1941, 1952, 1957, 1964, 1971
	Franklin	T91N,R11W	5,6	1941, 1952, 1957, 1964, 1971
	Jefferson	T91N,R13W	1,2	1941, 1952, 1957, 1964, 1971
	Polk	T93N,R14W	15,16	1941, 1952, 1957, 1964, 1971
Buena Vista	Coon	T91N,R35W	15,16	1939, 1949, 1954, 1961, 1968
	Fairfield	T92N,R35W	33,34	1939, 1949, 1954, 1961, 1968
	Lee	T93N,R36W	19,20	1939, 1949, 1954, 1961, 1968
	Maple Valley	T90W,R38W	23,24	1939, 1949, 1955, 1961, 1968
Butler	Fremont	T93N,R15W	1,2	1939, 1952, 1957, 1964, 1972
	Madison	T91N,R18W	25,26	1939, 1952, 1957, 1964, 1972
	Pittsford	T92N,R18W	17,18	1939, 1952, 1957, 1964, 1972

Table 1 (Continued)

County	Township		Section Nos.	Years
Butler	Ripley	T91N,R17W	15,16	1939, 1952, 1957, 1964, 1972
Calhoun	Center	T88N, R32W	14,25	1939, 1953, 1958, 1965, 1972
	Elm Grove	T87N,R34W	13,24	1939, 1953, 1958, 1965, 1972
	Lincoln	T89N,R31W	1,12	1939, 1953, 1958, 1965, 1972
	Lincoln	T89N,R31W	29,32	1939, 1953, 1958, 1965, 1972
Cerro Gordo	Geneseo	T94N,R20W	5,6	1939, 1953, 1958, 1965, 1970
	Geneseo	T94N, R20W	33,34	1939, 1953, 1958, 1965, 1970
	Lime Creek	T97N,R20W	23,24	1939, 1953, 1958, 1965, 1970
	Owen	T95N,R19W	15,16	1939, 1953, 1958, 1965, 1970
Chickasaw	Bradford	T94N,R14W	29,30	1941, 1952, 1957, 1964, 1971
	Dresden	T94N,R12W	31,32	1941, 1952, 1957, 1964, 1971
	Jackson-ville	T97N,R12W	35,36	1941, 1952, 1957, 1964, 1971
	Utica	T96N,R11W	5,6	1941, 1952, 1957, 1964, 1971
Clay	Garfield	T94N,R35W	5,6	1939, 1949, 1955, 1962, 1968
	Gillett Grove	T95N,R35W	27,28	1939, 1949, 1955, 1962, 1968

Table 1 (Continued)

County	Township		Section Nos.	Years
Clay	Lone Tree	T96N,R38W	7,8	1939, 1949, 1955, 1962, 1968
	Summit	T97N, R37W	19,20	1939, 1949, 1955, 1962, 1968
Dickinson	Excelsior	T99N,R38W	25,26	1939, 1949, 1954, 1962, 1968
	Lloyd	T98N,R35W	33,34	1939, 1949, 1954, 1962, 1968
	Silver Lake	T100N,R38W	29,30	1939, 1949, 1954, 1962, 1968
	West Port	T98N,R38W	5,6	1939, 1949, 1954, 1962, 1968
Emmet	Denmark	T98N,R31W	33,34	1939, 1953, 1958, 1965, 1972
	High Lake	T98N,R33W	23,24	1939, 1953, 1958, 1965, 1972
	Jack Creek	T98N,R32W	3,4	1939, 1953, 1958, 1965, 1972
	Twelve Mile Lake	T98N,R34W	1,2	1939, 1953, 1958, 1965, 1972
Floyd	Cedar	T97N,R16W	35,36	1939, 1952, 1957, 1964, 1971
	Rock Grove	T96N,R18W	21,22	1939, 1952, 1957, 1964, 1971
	Rudd	T96N,R17W	7,8	1939, 1952, 1957, 1964, 1971
	St. Charles	T95N,R16W	25,26	1939, 1952, 1957, 1964, 1971

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Table 1   (Continued)

County	Township		Section Nos.	Years
Franklin	Marion	T92N,R21W	23,24	1939, 1953, 1958, 1965, 1970
	Morgan	T91N,R22W	25,26	1939, 1953, 1958, 1965, 1970
	Mott	T92N,R20W	23,24	1939, 1953, 1958, 1965, 1970
	Scott	T92N,R22W	25,26	1939, 1953, 1958, 1965, 1970
Grundy	Beaver	T89N,R16W	27,34	1939, 1952, 1958, 1965, 1971
	Black Hawk	T87N,R15W	5,8	1939, 1952, 1958, 1965, 1971
	Colfax	T88N,R17W	4,9	1939, 1952, 1958, 1965, 1971
	Lincoln	TuuN,R16W	27,34	1939, 1952, 1958, 1965, 1971
Hancock	Avery	T94N,R23W	33,34	1939, 1953, 1958, 1965, 1972
	Britt	T96N,R25W	25,26	1939, 1953, 1958, 1965, 1972
	Ell	T95N,R23W	23,24	1939, 1953, 1958, 1965, 1972
	Ellington	T97N,R23W	35,36	1939, 1953, 1958, 1965, 1972
Hardin	Buckeye	T88N,R22W	18,19	1939, 1953, 1958, 1965, 1971
	Eldora	T87N,R19W	30,31	1939, 1953, 1958, 1965, 1971
	Grant	T86N,R21W	27,34	1939, 1953, 1958, 1965, 1971

Table 1 (Continued)

County	Township		Section Nos.	Years
Hardin	Pleasant	T87N,R20W	13,24	1939, 1953, 1958, 1965, 1971
Howard	Albion	T100N,R11W	17,18	1941, 1952, 1957, 1964, 1970
	Forest City	T100N,R12W	13,14	1941, 1952, 1957, 1964, 1970
	Howard Center	T99N,R12W	9,10	1941, 1952, 1957, 1964, 1970
	Vernon Springs	T99N,R11W	31,32	1941, 1952, 1957, 1964, 1970
Humboldt	Humboldt	T93N,R28W	29,30	1939, 1953, 1958, 1965, 1972
	Lake	T92N,R27W	15,16	1939, 1953, 1958, 1965, 1972
	Wacousta	T93N,R30W	33,34	1939, 1953, 1958, 1965, 1972
	Weaver	T91N,R30W	19,20	1939, 1953, 1958, 1965, 1972
Kossuth	Irvington	T95N,R28W	19,20	1939, 1953, 1958, 1965, 1973[a]
	Ledyard	T99N,R28W	27,28	1939, 1953, 1958, 1965, 1973[a]
	Lincoln	T99N,R27W	25,26	1939, 1953, 1958, 1965, 1973[a]
	Portland	T97N,R28W	7,8	1939, 1953, 1958, 1965, 1973[a]
Mitchell	Douglas	T98N,R15W	25,26	1939, 1952, 1957, 1964, 1971

[a]Crop data were not available for 1973, so 1972 crop data were substituted.

Table 1 (Continued)

County	Township		Section Nos.	Years
	East Lincoln	T97N,R15W	9,10	1939, 1952, 1957, 1964, 1971
Mitchell	Wayne	T100N,R15W	19,20	1939, 1952, 1957, 1964, 1971
	West Lincoln	T98N,R 16W	33,34	1939, 1952, 1957, 1964, 1971
O'Brien	Carroll	T96N,R42W	3,4	1938, 1949, 1954, 1962, 1968
	Dale	T95N,R41W	31,32	1938, 1949, 1954, 1962, 1968
	Hartley	T97N,R39W	9,10	1938, 1949, 1954, 1962, 1968
	Waterman	T94N,R39W	19,20	1938, 1949, 1954, 1962, 1968
Osceola	Harrison	T98N,R39W	31,32	1938, 1949, 1954, 1962, 1968
	West Holman	T99N,R42W	15,16	1938, 1949, 1955, 1962, 1968
	Wilson	T100N,R41W	11,12	1938, 1949, 1955, 1962, 1968
	Wilson	T100N,R41W	27,28	1938, 1949, 1955, 1962, 1968
Palo Alto	Booth	T94N,R34W	29,30	1939, 1953, 1958, 1965, 1972
	Fern Valley	T95N,R31W	9,10	1939, 1953, 1958, 1965, 1972
	Independence	T97N,R31W	17,18	1939, 1953, 1958, 1965, 1972
	Rush Lake	T94N,R33W	15,16	1939, 1953, 1958, 1965, 1972

Table 1 (Continued)

County	Township		Section Nos.	Years
Pocahontas	Bellville	T90N,R32W	31,32	1940, 1953, 1958, 1965, 1972
	Cummins	T93N,R33W	5,6	1940, 1953, 1958, 1965, 1972
	Lincoln	T91N,R32W	7,8	1940, 1953, 1958, 1965, 1972
	Lizard	T90N,R31W	17,18	1940, 1953, 1958, 1965, 1972
Sac	Boyer Valley	T88N,R37W	14,23	1939, 1949, 1954, 1961, 1968
	Cedar	T88N,R35W	25,36	1939, 1949, 1954, 1961, 1968
	Coon Valley	T87N,R35W	27,34	1939, 1949, 1954, 1961, 1968
	Wall Lake	T87N,R36W	1,12	1939, 1949, 1954, 1961, 1968
Winnebago	Center	T99N,R23W	23,24	1939, 1953, 1958, 1965, 1972
	King	T99N,R25W	3,4	1939, 1953, 1958, 1965, 1972
	King	T99N,R25W	19,20	1939, 1953, 1958, 1965, 1972
	Newton	T99N,R24W	1,2	1939, 1953, 1958, 1965, 1972
Worth	Brookfield	T99N,R21W	17,18	1939, 1953, 1958, 1965, 1971
	Fertile	T98N,R22W	7,8	1939, 1953, 1958, 1965, 1971
	Fertile	T98N,R22W	23,24	1939, 1953, 1958, 1965, 1971

Table 1 (Continued)

County	Township		Section Nos.	Years
Worth	Grove	T100N,R20W	25,26	1939, 1953, 1958, 1965, 1971
Wright	Dayton	T91N,R25W	29,30	1939, 1953, 1958, 1965, 1972
	Eagle Grove	T91N,R26W	5,6	1939, 1953, 1958, 1965, 1972
	Lake	T92N,R25W	23,24	1939, 1953, 1958, 1965, 1972
	Woolstock	T90N,R25W	23,24	1939, 1953, 1958, 1965, 1972

[a]Crop data were not available for 1973, so 1972 crop data were substituted.

APPENDIX II

The data collection and key-punch form
used to record land use data.

Date_____

County No.[a]____   County_____

Sample No.[b]____   Twp._____ Sec. Nos._____

Photo Date_____   Photo Code_____

Land use category	Acres per Twp.	% of Agri. land
1-1 Corn		
1-2 Soybean rows		
1-3 Soybean hay		
1-4 Forbs for hay		
1-5 Alfalfa		
1-6 Clover		
1-7 Other hay types		
1-8 Clover and timothy seed		
1-9 Oats		
1-10 Wheat		
1-11 Other small grains		
1-12 Pasture		
1-13 Other crops		
Total acres	Total percent	
1-14 Retired land		
1-15 Conservation Reserve		

Begin Card 1 in Col. 72

1

a

b

Photo date

Corn

Sb. rows

Sb. hay

Forbs

Alfalfa

Clover

Other hay

Seed

Oats

Wheat

Sm. grains

Pasture

Other crops

Retired

Cons.

End Card 1 in Col. 72

Date_____

County No.[a]_____   County_____

Sample No.[b]_____   Twp._____   Sec. Nos._____

Photo Date[A]_____   Photo Code_____

Hect/Dot_____

Land use category	Dots per tract	Total dots
2-1 Feed lots		
2-2 Forest		
2-3 Farmsteads		
2-4 Industrial, commercial developed residential		
2-5 Fencerows		
2-6 Undisturbed grassland		
2-7 Other		

Conversion Factor[B]_____

Land use category	Measurements	Average
2-8 Farm groves		

Begin Card 2 in Col. 1

2-8

Col. 39

Continue Card 2 on next page

2 a b Photo date 2-1 2-2 2-3 2-4 2-5 2-6 2-7 A B

Date_____

County No.[a]_____   County_____

Sample No.[b]_____   Twp._____   Sec. Nos._____

Photo Date_____   Photo Code_____

Land use category	Measurements	Average

2-9 Brushy areas

2-10 Wetlands

Continue Card 2

2-9

2-10

End Card 2 in Col. 49

Date_____

County No.[a]_____   County_____

Sample No.[b]_____   Twp._____   Sec. Nos._____

Photo Date_____   Photo Code_____

Conversion Factor[c]_____

Land use category	length	width	area in sq. cm.

3-1   Stringers

3-2   Drainage ditches

3-3   Rivers, streams, lakes

3-4   Grassed waterways

3-5   Road and railroad ditches

3-6   Roads

3-7   Railroads

Begin Card 3 in Col. 1

a

b

Photo date

C

3-1

3-2

3-3

3-4

3-5

3-6

3-7

Col. 50

Card 3 continued on next page

Date_____

County No.^a_____   County_____

Sample No.^b_____   Twp._____ Sec. Nos._____

Photo Date_____   Photo Code_____

Land use category

3-8 Cover type index

3-9 Fencerow index

Category	Total no. tracts
3-10 Forests	
3-11 Farmsteads	
3-12 Undisturbed grassland	
3-13 Brushy areas	
3-14 Wetlands	
3-15 Stringers	
3-16 Farm groves	
3-17 Suitable groves for cover	
3-18 Unsuitable for cover	

Continue Card 3

3-8
3-9
3-10
3-11
3-12
3-13
3-14
3-15
3-16
3-17
3-18

End Card 3
in Col. 74

APPENDIX III

Means, low and high values, and confidence intervals for all land use

groups for each year expressed as hectarage and percentage

of the area sampled.

Table 1. Means, low and high values, and 95 percent confidence
intervals for all land uses[a] in 1939 expressed as (A)
hectarage and (B) percentage of the area sampled.

Land-use type		Mean	Low	High	Confidence Interval($\pm$)
Corn	A	155.19	87.34	204.24	5.41
	B	29.96	16.86	39.43	1.04
Soybean rows	A	13.37	.50	44.33	1.72
	B	2.58	0.10	8.56	0.33
Soybean hay	A	13.35	1.24	29.44	1.23
	B	2.58	0.24	5.68	0.24
Alfalfa	A	12.22	.38	28.56	1.32
	B	2.36	0.07	5.51	0.25
Clover	A	18.33	.28	62.99	2.93
	B	3.54	0.05	12.15	0.56
Other hay	A	6.74	0.00	32.46	1.20
types	B	1.30	0.00	6.27	0.23
Clover and	A	1.74	0.00	21.72	.62
timothy seed	B	0.34	0.00	4.19	0.12
Oats	A	110.04	63.56	159.45	4.41
	B	21.24	12.27	30.78	0.85
Wheat	A	.63	0.00	7.06	.17
	B	0.12	0.00	1.36	0.03
Other small	A	8.45	0.00	57.31	2.17
grains	B	1.63	0.00	11.06	0.42
Pasture	A	116.10	63.24	196.73	5.39
	B	22.41	12.21	37.98	1.04
Other crops	A	5.34	0.00	24.80	0.95
	B	1.03	0.00	4.79	0.18
Total crop	A	461.52	347.48	488.72	5.17
land	B	89.10	67.08	94.35	1.00

[a]Retired land and Conservation Reserve were not included
because they were not in effect until 1956.

Table 1 (Continued)

Land-use type		Mean	Low	High	Confidence Interval(±)
Feedlots	A	1.10	0.00	9.00	0.35
	B	0.21	0.00	1.74	0.07
Forest	A	7.01	0.00	79.15	3.25
	B	1.35	0.00	15.28	0.63
Farmsteads	A	6.14	0.00	17.66	0.66
	B	1.18	0.00	3.41	0.13
Industrial, commercial, residential	A	.24	0.00	23.33	0.43
	B	0.05	0.00	4.50	0.08
Fencerows	A	12.85	2.73	25.37	1.01
	B	2.48	0.53	4.90	0.19
Undisturbed grassland	A	5.23	0.00	95.86	2.37
	B	1.01	0.00	18.50	0.46
Other	A	.35	0.00	14.69	.31
	B	0.07	0.00	2.84	0.06
Farm groves	A	4.15	.25	10.95	.41
	B	0.80	0.05	2.11	0.08
Brushy areas	A	.62	0.00	11.39	.35
	B	0.12	0.00	2.20	0.07
Wetlands	A	1.56	0.00	28.67	.73
	B	0.30	0.00	5.53	0.14
Stringers	A	.55	0.00	4.14	.16
	B	0.11	0.00	0.80	0.03
Drainage ditches	A	1.38	0.00	11.72	.52
	B	0.27	0.00	2.25	0.10
Rivers, streams, lakes & ponds	A	2.07	0.00	29.17	.83
	B	0.40	0.00	5.63	0.16
Grassed waterways	A	.21	0.00	2.39	.08
	B	0.04	0.00	0.46	0.02

Table 1 (Continued)

Land-use type		Mean	Low	High	Confidence Interval (+)
Road & rail- road ditches	A	8.66	3.96	20.76	.53
	B	1.67	0.76	4.01	0.10
Roads	A	4.18	1.73	6.54	.16
	B	0.81	0.33	1.26	0.03
Railroads	A	.19	0.00	2.13	.08
	B	0.04	0.00	0.41	0.02

Table 2. Means, low and high values, and 95 percent confidence intervals for land use groups in 1939 expressed as (A) hectarage and (B) percentage of the area sampled.

Land-use group		Mean	Low	High	Confidence Interval (+)
Row crops	A	168.55	104.42	231.90	5.52
	B	32.54	20.16	44.77	1.06
All hay	A	52.38	27.72	99.67	3.23
	B	10.11	5.35	19.24	0.62
Early cut hay	A	12.22	0.38	28.56	1.32
	B	2.36	0.07	5.51	0.25
Late cut hay	A	38.42	11.15	91.39	3.66
	B	7.42	2.15	17.64	0.71
All small grains	A	119.12	66.02	161.13	4.65
	B	23.00	12.74	31.11	0.90

Table 3. Means, low and high values, and 95 percent confidence
intervals for all land uses[a] in 1953 expressed as (A)
hectarage and (B) percentage of the area sampled.

Land-use type		Mean	Low	High	Confidence Interval ($\pm$)
Corn	A	187.00	105.15	230.34	5.58
	B	36.10	20.30	44.47	1.08
Soybean rows	A	31.81	2.93	76.24	3.44
	B	6.14	0.56	14.71	0.66
Soybean hay	A	0.07	0.00	0.85	0.03
	B	0.01	0.00	0.16	0.006
Alfalfa	A	11.04	0.00	32.05	1.23
	B	2.13	0.00	6.19	0.24
Clover	A	30.76	1.27	62.42	2.99
	B	5.94	0.24	12.05	0.58
Other hay types	A	2.02	0.00	11.53	0.49
	B	0.39	0.00	2.22	0.09
Clover and timothy seed	A	0.96	0.00	8.88	0.33
	B	0.18	0.00	1.71	0.06
Oats	A	108.63	66.88	144.17	2.76
	B	20.97	12.91	27.83	0.53
Wheat	A	0.10	0.00	3.90	0.07
	B	0.02	0.00	0.75	0.01
Other small grains	A	0.24	0.00	2.86	0.09
	B	0.05	0.00	0.55	0.02
Pasture	A	84.98	35.16	193.85	6.03
	B	16.40	6.79	37.42	1.16
Other crops	A	4.94	0.00	60.41	1.84
	B	0.95	0.00	11.66	0.36
Total crop land	A	462.56	319.22	493.57	5.35
	B	89.30	61.62	95.28	1.03

[a]Retired land and Conservation Reserve were not included
because they were not in effect until 1956.

Table 3 (Continued)

Land-use type		Mean	Low	High	Confidence Interval (+)
Feedlots	A	1.38	0.00	15.82	0.45
	B	0.27	0.00	3.05	0.09
Forest	A	7.07	0.00	105.25	3.46
	B	1.36	0.00	20.32	0.67
Farmsteads	A	6.17	0.00	15.69	0.66
	B	1.19	0.00	3.03	0.13
Industrial, commercial, residential	A	0.22	0.00	18.54	0.35
	B	0.04	0.00	3.58	0.07
Fencerows	A	11.68	2.64	26.07	0.89
	B	2.25	0.51	5.03	0.17
Undisturbed grassland	A	3.12	0.00	42.44	1.22
	B	0.60	0.00	8.19	0.24
Other	A	0.81	0.00	27.56	0.70
	B	0.16	0.00	5.32	0.14
Farm groves	A	4.34	1.02	10.37	0.37
	B	0.84	0.20	2.00	0.07
Brushy areas	A	0.55	0.00	20.02	0.41
	B	0.11	0.00	3.86	0.08
Wetlands	A	1.21	0.00	21.01	0.54
	B	0.23	0.00	4.06	0.10
Stringers	A	0.46	0.00	3.87	0.12
	B	0.09	0.00	0.75	0.02
Drainage ditches	A	1.49	0.00	16.83	0.56
	B	0.29	0.00	3.25	0.11
Rivers, streams, lakes & ponds	A	2.36	0.00	30.44	0.88
	B	0.46	0.00	5.88	0.17
Grassed waterways	A	0.30	0.00	2.83	0.09
	B	0.06	0.00	0.55	0.02

Table 3 (Continued)

Land-use type		Mean	Low	High	Confidence Interval(±)
Road & rail-	A	9.46	4.22	21.49	0.57
road ditches	B	1.83	0.81	4.15	0.11
Roads	A	4.59	1.81	6.90	0.16
	B	0.89	0.35	1.33	0.03
Railroads	A	0.22	0.00	2.30	0.10
	B	0.04	0.00	0.44	0.02

Table 4. Means, low and high values, and 95 percent confidence intervals for land use groups in 1953 expressed as (A) hectarage and (B) percentage of the area sampled.

Land-use group		Mean	Low	High	Confidence Interval (±)
Row crops	A	218.81	113.80	283.97	8.18
	B	42.24	21.97	54.82	1.58
All hay	A	44.84	17.09	77.27	2.61
	B	8.66	3.30	14.92	0.50
Early cut hay	A	11.04	0.00	32.05	1.23
	B	2.13	0.00	6.19	0.24
Late cut hay	A	32.85	6.09	64.10	2.88
	B	6.34	1.18	12.37	0.56
All small	A	108.97	66.88	144.50	2.75
grains	B	21.04	12.91	27.90	0.53

Table 5. Means, low and high values, and 95 percent confidence intervals for all land uses in 1958 expressed as (A) hectarage and (B) percentage of the area sampled.

Land-use type		Mean	Low	High	Confidence Interval (+)
Corn	A	176.11	113.99	226.99	4.38
	B	34.00	22.00	43.82	0.84
Soybean rows	A	63.75	3.91	135.12	6.73
	B	12.31	0.75	26.08	1.30
Soybean hay	A	0.10	0.00	1.54	0.05
	B	0.02	0.00	0.30	0.01
Alfalfa	A	26.81	1.52	62.83	2.61
	B	5.18	0.29	12.13	0.50
Clover	A	21.52	0.00	69.64	2.94
	B	4.15	0.00	13.44	0.57
Other hay types	A	0.95	0.00	11.49	0.29
	B	0.18	0.00	2.22	0.06
Clover and timothy seed	A	0.20	0.00	3.56	0.11
		0.04	0.00	0.69	0.02
Oats	A	88.77	52.44	132.22	3.26
	B	17.14	10.12	25.52	0.63
Wheat	A	0.22	0.00	4.84	0.12
	B	0.04	0.00	0.93	0.02
Other small grains	A	0.19	0.00	2.25	0.08
	B	0.04	0.00	0.43	0.02
Pasture	A	73.26	27.70	205.90	5.59
	B	14.14	5.35	39.75	1.08
Other crops	A	3.05	0.00	15.12	0.62
	B	0.59	0.00	2.92	0.12
Total crop land[a]	A	454.95	319.21	486.73	5.12
	B	87.83	61.62	93.96	0.99

[a]Total crop land includes all crop types but excludes Retired land and Conservation Reserve.

Table 5 (Continued)

Land-use type		Mean	Low	High	Confidence Interval (±)
Feedlots	A	0.90	0.00	11.24	0.35
	B	0.17	0.00	2.17	0.07
Forest	A	7.57	0.00	101.83	3.52
	B	1.46	0.00	19.66	0.68
Farmsteads	A	6.19	0.00	15.42	0.66
	B	1.19	0.00	2.98	0.13
Industrial, commercial, residential	A	0.22	0.00	13.16	0.29
	B	0.04	0.00	2.54	0.06
Fencerows	A	11.25	0.00	23.10	0.83
	B	2.17	0.00	4.46	0.16
Undisturbed grassland	A	2.08	0.00	37.01	1.01
	B	0.40	0.00	7.14	0.19
Other	A	0.82	0.00	23.93	0.65
	B	0.16	0.00	4.62	0.12
Farm groves	A	4.15	0.80	8.22	0.36
	B	0.80	0.15	1.59	0.07
Brushy areas	A	0.36	0.00	7.62	0.20
	B	0.07	0.00	1.47	0.04
Wetlands	A	0.88	0.00	22.75	0.51
	B	0.17	0.00	4.39	0.10
Stringers	A	0.48	0.00	3.69	0.13
	B	0.09	0.00	0.71	0.02
Drainage ditches	A	1.45	0.00	14.02	0.51
	B	0.28	0.00	2.71	0.10
Rivers, streams, lakes & ponds	A	2.08	0.00	29.10	0.80
	B	0.40	0.00	5.62	0.15
Grassed waterways	A	0.41	0.00	3.30	0.12
	B	0.08	0.00	0.64	0.02

Table 5 (Continued)

Land-use type		Mean	Low	High	Confidence Interval (±)
Road & rail-	A	9.96	4.08	23.45	0.60
road ditches	B	1.92	0.79	4.53	0.12
Roads	A	4.85	2.12	7.20	0.16
	B	0.94	0.41	1.39	0.03
Railroads	A	0.22	0.00	2.45	0.09
	B	0.04	0.00	0.47	0.02
Retired land	A	8.88	0.00	20.93	2.65
	B	1.71	0.00	4.04	0.51
Conservation	A	0.30	0.00	1.71	0.18
Reserve	B	0.06	0.00	0.33	0.03

Table 6. Means, low and high values, and 95 percent confidence intervals for all land use groups in 1958 expressed as (A) hectarage and (B) percentage of the area sampled.

Land-use group		Mean	Low	High	Confidence Interval (±)
Row crops	A	239.86	128.81	330.15	8.14
	B	46.30	24.87	63.74	1.57
All hay	A	49.57	32.96	81.09	1.95
	B	9.57	6.36	15.65	0.38
Early cut hay	A	26.81	1.52	62.83	2.61
	B	5.18	0.29	12.13	0.50
Late cut hay	A	22.56	0.00	72.32	2.92
	B	4.36	0.00	13.96	0.56
All small	A	89.19	53.54	132.22	3.22
grains	B	17.22	10.34	25.52	0.62

Table 7. Means, low and high values, and 95 percent confidence intervals for all land uses in 1965 expressed as (A) hectarage and (B) percentage of the area sampled.

Land-use type		Mean	Low	High	Confidence Interval ($\pm$)
Corn	A	176.63	107.09	239.88	5.12
	B	34.10	20.67	46.31	0.99
Soybean rows	A	94.56	16.16	183.43	7.69
	B	18.25	3.12	35.41	1.48
Soybean hay	A	0.002	0.00	0.24	0.004
	B	Tr.[a]	0.00	0.05	N.A.[b]
Alfalfa	A	26.82	0.00	65.89	2.32
	B	5.18	0.00	12.72	0.45
Clover	A	11.12	0.00	67.50	2.68
	B	2.15	0.00	13.03	0.52
Other hay types	A	0.50	0.00	5.82	0.19
	B	0.12	0.00	1.12	0.04
Clover and timothy seed	A	0.06	0.00	1.39	0.04
	B	0.01	0.00	0.27	0.01
Oats	A	36.25	12.83	85.18	2.72
	B	7.00	2.48	16.44	0.52
Wheat	A	0.10	0.00	3.88	0.09
	B	0.02	0.00	0.75	0.02
Other small grains	A	0.24	0.00	10.90	0.22
	B	0.05	0.00	2.10	0.04
Pasture	A	57.72	16.80	171.12	5.44
	B	11.14	3.24	33.03	1.05
Other crops	A	2.14	0.00	22.04	0.72
	B	0.47	0.00	4.25	0.14

[a]Tr. < 0.006 percent.

[b]N.A. < 0.001 percent.

Table 7 (Continued)

Land-use type		Mean	Low	High	Confidence Interval($\pm$)
Total crop	A	406.54	281.24	478.69	6.39
land[c]	B	78.48	54.29	92.41	1.23
Feedlots	A	1.15	0.00	10.92	0.35
	B	0.22	0.00	2.11	0.07
Forest	A	8.31	0.00	99.10	3.86
	B	1.60	0.00	19.13	0.74
Farmsteads	A	6.18	2.48	12.81	0.48
	B	1.19	0.48	2.47	0.09
Industrial,	A	0.22	0.00	20.89	0.39
commercial,	B	0.04	0.00	4.03	0.08
residential					
Fencerows	A	11.55	2.60	24.64	0.81
	B	2.23	0.50	4.76	0.16
Undisturbed	A	1.81	0.00	4.19	0.78
grassland	B	0.35	0.00	4.19	0.15
Other	A	0.86	0.00	28.66	0.71
	B	0.17	0.00	5.53	0.14
Farm groves	A	3.88	0.55	8.38	0.35
	B	0.75	0.11	1.62	0.07
Brushy areas	A	0.36	0.00	9.62	0.22
	B	0.07	0.00	1.86	0.04
Wetlands	A	0.78	0.00	21.24	0.47
	B	0.15	0.00	4.10	0.09
Stringers	A	0.46	0.00	3.70	0.13
	B	0.09	0.00	0.71	0.02
Drainage	A	1.63	0.00	12.71	0.49
ditches	B	0.31	0.00	2.45	0.09

[c]All agricultural land except Retired land and Conservation reserve.

Table 7 (Continued)

Land use type		Mean	Low	High	Confidence Interval($\pm$)
Rivers,	A	2.12	0.00	27.70	0.82
streams, lakes	B	0.41	0.00	5.35	0.16
& ponds					
Grassed	A	0.64	0.00	5.09	0.17
waterways	B	0.12	0.00	0.98	0.03
Road & rail-	A	10.38	4.28	23.66	0.61
road ditches	B	2.00	0.83	4.57	0.12
Roads	A	4.91	2.10	7.09	0.15
	B	0.95	0.40	1.37	0.03
Railroads	A	0.22	0.00	2.10	0.09
	B	0.04	0.00	0.40	0.02
Retired land	A	53.69	0.00	82.87	7.32
	B	10.36	0.00	16.00	1.41
Conservation	A	2.31	0.00	14.37	1.40
reserve	B	0.44	0.00	2.77	0.27

Table 8. Means, low and high values, and 95 percent confidence
intervals for all land use groups in 1965 expressed as (A)
hectarage and (B) percentage of the area sampled.

Land use group		Mean	Low	High	Conficence Interval (+)
Row crops	A	271.20	126.46	364.01	10.79
	B	52.36	24.41	70.27	2.08
All hay	A	38.60	22.67	72.34	2.23
	B	7.45	4.38	13.96	0.43
Early cut hay	A	26.82	0.00	65.89	2.32
	B	5.18	0.00	12.72	0.45
Late cut hay	A	11.72	0.00	67.50	2.66
	B	2.26	0.00	13.03	0.51
All small	A	36.58	14.56	85.18	2.76
grains	B	7.06	2.81	16.44	0.53

Table 9. Means, low and high values, and 95 percent confidence
intervals for all land uses[a] in 1972 expressed as (A)
hectarage and (B) percentage of the area sampled.

Land use type		Mean	Low	High	Confidence Interval (±)
Corn	A	176.17	85.28	255.62	5.65
	B	34.01	16.46	49.35	1.09
Soybean rows	A	126.26	31.58	200.38	7.51
	B	24.37	6.10	38.68	1.45
Alfalfa[b] and clover	A	22.54	1.67	64.92	2.62
	B	4.35	0.32	12.53	0.50
Other hay types	A	0.73	0.00	8.47	0.25
	B	0.14	0.00	1.64	0.05
Seed	A	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00
Oats	A	20.78	3.68	60.82	2.13
	B	4.01	0.71	11.74	0.41
Wheat	A	0.01	0.00	0.32	0.01
	B	Tr.	0.00	0.06	N.A.
Other small grains	A	0.03	0.00	0.84	0.02
	B	Tr.	0.00	0.16	N.A.
Pasture	A	43.02	2.60	161.05	5.39
	B	8.30	0.50	31.09	1.04
Other crops	A	10.62	0.00	41.27	1.60
	B	2.05	0.00	7.97	0.31
Total crop land[c]	A	400.14	268.66	446.29	6.28
	B	77.25	51.86	86.16	1.21

[a]Soybean hay was not included because it was eliminated as a
category in Iowa crop reports after 1967.

[b]Alfalfa and clover were combined as a single category in Iowa
crop reports after 1967.

[c]All agricultural land except retired land and conservation
reserve.

Table 9 (Continued)

Land use type		Mean	Low	High	Confidence Interval (+)
Feedlots	A	1.08	0.00	11.70	0.36
	B	0.21	0.00	2.25	0.07
Forest	A	9.05	0.00	93.14	4.09
	B	1.75	0.00	17.98	0.79
Farmsteads	A	6.12	0.00	20.13	0.58
	B	1.18	0.00	3.89	0.11
Industrial, commercial, residential	A	0.36	0.00	25.55	0.51
	B	0.07	0.00	4.93	0.10
Fencerows	A	8.92	2.45	19.88	0.68
	B	1.72	0.47	3.84	0.13
Undisturbed grassland	A	1.52	0.00	22.30	0.74
	B	0.29	0.00	4.30	0.14
Other	A	0.92	0.00	22.53	0.71
	B	0.18	0.00	4.35	0.14
Farm groves	A	3.60	0.00	16.82	0.46
	B	0.69	0.00	3.25	0.09
Brushy areas	A	0.68	0.00	24.05	0.48
	B	0.13	0.00	4.64	0.09
Wetlands	A	0.70	0.00	22.79	0.49
	B	0.14	0.00	4.40	0.09
Stringers	A	0.47	0.00	4.01	0.14
	B	0.09	0.00	0.77	0.03
Drainage ditches	A	2.00	0.00	12.43	0.55
	B	0.39	0.00	2.40	0.11
Rivers, streams, lakes & ponds	A	2.05	0.00	29.87	0.83
	B	0.40	0.00	5.77	0.16
Grassed waterways	A	0.61	0.00	9.07	0.23
	B	0.11	0.00	1.75	0.04

Table 9 (Continued)

Land use type		Mean	Low	High	Confidence Interval(±)
Road & rail- road ditches	A	10.72	4.53	23.12	0.65
	B	2.07	0.87	4.46	0.12
Roads	A	5.21	2.46	19.58	0.32
	B	1.00	0.47	3.78	0.06
Railroads	A	0.21	0.00	2.14	0.09
	B	0.04	0.00	0.41	0.02
Retired land	A	63.54	35.58	92.58	5.94
	B	12.27	6.87	16.87	1.15
Conservation reserve	A	0.10	0.00	1.88	0.15
	B	0.02	0.00	0.36	0.03

Table 10. Means, low and high values, and 95 percent confidence intervals for all land use groups in 1972 expressed as (A) hectarage and (B) percentage of the area sampled.

Land use group		Mean	Low	High	Confidence Interval (±)
Row crops	A	302.43	135.65	387.67	11.54
	B	58.38	26.19	74.84	2.23
All hay	A	23.27	1.67	64.92	2.66
	B	4.49	0.32	12.53	0.51
Early cut hay	A	22.54	1.67	64.92	2.62
	B	4.35	0.32	12.53	0.50
Late cut hay	A	0.73	0.00	8.47	0.25
	B	0.14	0.00	1.64	0.05
All small grains	A	20.79	3.68	60.82	2.13
	B	4.01	0.71	11.74	0.41

APPENDIX IV

Means, low and high values and 95 percent confidence intervals for the cover type and fencerow indices in all time periods.

Table 1. Means, low and high values, and 95 percent confidence
intervals for the cover type index in all time periods.

Year	Mean	Low	High	Confidence Interval (+)
1939	175	126	235	4.0
1953	174	109	249	4.6
1958	170	113	250	4.6
1965	169	112	229	4.6
1972	155	82	219	5.0

Table 2. Means, low and high values, and 95 percent confidence
intervals for the fencerow index in all time periods.

Year	Mean	Low	High	Confidence Interval (+)
1939	68	49	95	1.5
1953	66	32	92	1.8
1958	64	36	93	1.8
1965	62	36	90	1.8
1972	56	29	85	2.0

APPENDIX V

Means, low and high values, and 95 percent confidence intervals

for pheasant habitat types in each sample period expressed

as hectarage and percentage of the area sampled.

Table 1. Means, low and high values, and 95 percent confidence
intervals for pheasant habitat types in 1939 expressed
as (A) hectarage and (B) percentage of the area sampled.

Pheasant habitat types		Mean	Low	High	Confidence Interval (±)
All nest cover	A	322.82	266.68	397.88	4.98
	B	62.32	51.48	76.81	0.96
Good nest cover	A	154.50	86.71	259.98	4.33
	B	29.83	16.74	50.19	0.84
Winter cover	A	13.49	1.88	123.23	2.93
	B	2.60	0.36	23.79	0.56

Table 2. Means, low and high values, and 95 percent confidence
intervals for pheasant habitat types in 1953 expressed
as (A) hectarage and (B) percentage of the area sampled.

Pheasant habitat types		Mean	Low	High	Confidence Interval (±)
All nest cover	A	271.42	196.54	359.85	6.85
	B	52.40	37.94	69.47	1.32
Good nest cover	A	158.51	112.42	194.86	3.14
	B	30.60	21.70	37.62	0.61
Winter cover	A	11.18	2.35	70.09	1.92
	B	2.16	0.45	13.53	0.37

Table 3. Means, low and high values, and 95 percent confidence
intervals for pheasant habitat types in 1958 expressed
as (A) hectarage and (B) percentage of the area sampled.

Pheasant habitat types		Mean	Low	High	Confidence Interval (+)
All nest cover	A	252.22	171.80	347.55	6.40
	B	48.69	33.17	67.09	1.24
Good nest cover	A	126.87	70.99	184.16	4.78
	B	24.49	13.70	35.55	0.92
Winter cover	A	9.70	2.18	51.57	1.43
	B	1.87	0.42	9.96	0.28

Table 4. Means, low and high values, and 95 percent confidence
intervals for pheasant habitat types in 1965 expressed
as (A) hectarage and (B) percentage of the area sampled.

Pheasant habitat types		Mean	Low	High	Confidence Interval (+)
All nest cover	A	220.39	135.64	343.42	8.73
	B	42.55	26.18	66.30	1.68
Good nest cover	A	65.94	24.47	140.10	4.61
	B	12.73	4.72	27.05	0.89
Winter cover	A	11.23	1.01	40.86	1.42
	B	2.17	0.19	7.89	0.27

Table 5. Means, low and high values, and 95 percent confidence
intervals for pheasant habitat types in 1972 expressed
as (A) hectarage and (B) percentage of the area sampled.

Pheasant habitat types		Mean	Low	High	Confidence Interval (±)
All nest cover	A	179.94	111.61	319.83	8.64
	B	34.74	21.55	61.74	1.67
Good nest cover	A	37.81	14.60	68.56	2.29
	B	7.30	2.82	13.24	0.44
Winter cover	A	9.08	0.52	38.98	1.29
	B	1.75	0.10	7.52	0.25