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Pheasant Use of Wetlands During The Winter and Application of Landsat Imagery For Assessing Winter Habitat

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PHEASANT USE OF WETLANDS DURING THE WINTER AND APPLICATION OF LANDSAT IMAGERY FOR ASSESSING WINTER HABITAT

BY

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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.

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Abstract

SIGNE SATHER-BLAIR

This study was designed to investigate 1) vegetative factors influencing ring-necked pheasant (Phasianus colchicus) use of wetlands during the winter, 2) the relationship of land use practices adjacent to wetlands and the use of such wetlands as winter cover by pheasants, and 3) the feasibility of assessing wetlands as pheasant winter habitat through the use of remote sensing data. Fifteen wetlands in Windsor Township, Brookings County, South Dakota, were randomly selected for study to estimate their use by pheasants. Use of cover types was analyzed by using multiple regression, chi-square, and t-tests. Correlation matrices were generated to locate significant relationships. Pheasant use of wetlands was analyzed using multiple regression. Height was the most important vegetative factor influencing loafing site selection. Shrubs were highly preferred over other cover types for loafing. Trees, phragmites (Phragmites communis), and cattails (Typha latifolia) were also used regularly. Smartweeds (Polygonum coccineum), roundstem bulrushes (Scirpus acutus and Scirpus validus), and grasses were seldom used. Density was the most important vegetative factor influencing selection of roost sites by pheasants. Most roosts were in cattails while phragmites had the greatest relative number of roosts. Size of wetland and the presence of emergency cover around the wetland were the most important factors influencing degree of pheasant use. Wetlands consistently used by pheasants were either large dense cattail wetlands or had considerable shrub growth. The small wetlands (<20 ha) with no shrub growth filled with snow early and were not utilized. Landsat data provided information on the winter cover potential of a wetland. There were sharp tonal differences on the Landsat imagery between the sparsely vegetated wetlands which supported no birds and the tall, dense cattail and shrub wetlands which supported winter populations each year. Wetland cover conditions were interpretable using data collected prior to considerable snow accumulation and using imagery enhanced by EROS Digital Imagery Processing System (EDIPS).

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INTRODUCTION

Availability of adequate winter cover is an important survival consideration for ring-necked pheasants (*Phasianus colchicus*) in the northern Great Plains. Severe winter storms may kill 50-90% of local pheasant populations (Green 1938, Kimball 1948, Klonglan 1971). Winter weather severity, besides directly influencing population levels through over-winter mortality, may also reduce the physiological fitness of the hens prior to egg laying possibly resulting in delayed reproduction, lower reproductive success, and higher spring to fall hen mortality (Gates 1971).

The Coteau des Prairies, characterized by glacial moraines with numerous wetlands interspersed within moraines, makes up an extensive portion of eastern South Dakota. Current land use practices in the region make the wetlands "wildlife habitat oases".

Use of wetlands as winter cover by pheasants has been documented by several investigators. Green (1938) and Grondahl (1953) working in northern Iowa observed that marsh vegetation was heavily used by pheasants for loafing and roosting until drifting snow filled the wetlands. The largest wetland on their study area, however, was 3.2 ha. In studying the winter-spring movements of pheasants in northern Iowa, Weston (1954) ranked river bulrush (*Scirpus fluviatilis*) second in importance to giant ragweed (*Ambrosia trifida*) as winter cover. Robertson (1958:20) observed that "marsh vegetation provided the most important winter cover" for pheasants in northern Illinois.

In Wisconsin, Wagner (1953) found that pheasant populations were low in counties with few wetlands, even though other habitat factors appeared to be good. Gates and Hale (1974) concluded that pheasant population density in Wisconsin tended to be roughly adjusted to the amount and distribution of wetland cover available, and that as wetland habitat was progressively destroyed, pheasant numbers dropped accordingly. They found 78-88% of the wintering pheasant population on the study areas associated with wetland cover.

The field of wildlife management has long used aerial photography as a tool in cover mapping and vegetation inventories. However, the photographic information used usually has not been current due to the high cost of obtaining up-to-date and continuous data. The launch of the satellite, Landsat 1, in June 1972 and subsequent launchings of Landsats 2 and 3 (Landsat 1 was shut down in January 1978) has made current, low cost, repetitive satellite data available to wildlife agencies. Currently the Landsat satellites record data for the same scene approximately every 9 days. However, Landsat data offer a view of the landscape at a considerably lower resolution than standard aerial photography. For a description of the Data Collection Systems on the Landsat satellites see Landsat Data Users Handbook (NASA publication, Goddard Space Center, Greenbelt, Maryland).

Interpretation of Landsat satellite imagery collected during periods of snow cover for winter wildlife habitat types in eastern South Dakota, e.g. wetlands and shelterbelts, is possible because of the high reflectance of snow and relatively lower reflectance of emergent vegetation (Best and Sather-Blair 1978). Wetlands may be interpreted from the imagery depending on their size and snow conditions.

The objectives of this study were to investigate: 1) vegetative factors influencing pheasant use of wetlands during the winter, 2) the relationship of land use practices adjacent to wetlands and the use of such wetlands as winter cover by pheasants, and 3) the feasibility of assessing wetlands as pheasant winter habitat through the use of remote sensing data.

STUDY AREA

The study wetlands were located in Windsor Township, Brookings County, South Dakota. Eastern South Dakota has a continental climate. Snowfall often accumulates during the winter with maximum depths recorded in February and March. During the winter average wind speeds are 18 to 19 km per hour and blizzards may be expected one or more times (Spuhler et al. 1971). Weather conditions during the 1977-78 and 1978-79 seasons were severe. First snowfalls were on 9 November and 11 November, respectively. Record consecutive daily low temperatures were recorded for both seasons (Table 1).

Agriculture is the principle land use of the area. Fall plowing during the study period was a common tillage practice (Table 2). During the 1977-78 season some corn was left unharvested due to the early snowfall in November and subsequent severe weather.

Table 1. Weather data for 1977-78 and 1978-79 pheasant study season as recorded at Bryant, South Dakota (U.S. Dept. of Commerce 1977-79). Average monthly mean temperatures in ( ) are 77 year averages (1893-1970) for Brookings, South Dakota (Spuhler et al. 1971).

Month	Average Monthly Mean Temperature C		Snow Depth (cm)	Average Wind Speed (km/hour)
9 Nov.-31 Nov. 1977	- 2.2[a]	(-0.3)	10.8	22.7
1 Dec.-31 Dec. 1977	-10.3	(-7.6)	13.3	20.6
1 Jan.-31 Jan. 1978	-18.4	(-10.9)	29.7	16.9
1 Feb.-28 Feb. 1978	-14.7	(-8.7)	36.3	19.5
1 Mar.-15 Mar. 1978	- 3.8[a]	(-1.5)	35.2	17.9
11 Nov.-31 Nov. 1978	- 1.9[a]	(-0.3)	2.3	17.4
1 Dec.-31 Dec. 1978	-10.9	(-7.6)	8.5	17.1
1 Jan.-31 Jan. 1979	-18.8	(-10.9)	26.3	16.9
1 Feb.-28 Feb. 1979	-16.7	(-8.7)	58.0	17.7
1 Mar.-15 Mar. 1979	- 4.7[a]	(-1.5)	35.1	22.5

[a] Averaged for month

Table 2. Mean percents and standard deviations of land use categories within 0.8 km from study wetland borders.[a]

Land Use	1978 $\bar{x}$	1978 s	1979 $\bar{x}$	1979 s
Corn Stubble	23.7	11.3	23.7	8.2
Standing Corn	1.2	3.0	0.0	0.0
Small Grain Stubble	19.7	10.1	12.9	10.2
Alfalfa Stubble	7.2	5.7	3.5	3.7
Winter Fallow	24.9	16.5	32.2	12.0
Pasture	9.5	9.9	9.8	11.4
Wetland	5.8	4.5	5.4	3.8
Shelterbelt	1.6	1.2	1.4	1.6
Uncultivated Land[b]	4.1	10.5	8.3	13.9
Farmstead	0.7	1.3	0.6	1.7
Roadway	1.6	1.3	2.2	1.8

[a] See page 11 for description of method used to estimate these percentages.

[b] This category includes abandoned farmsteads, upland nesting cover on waterfowl production areas, grain storage areas, etc.

MATERIALS AND METHODS

All wetlands supporting emergent hydrophytes (N=40) on the study area were planimetered and placed in 1 of 3 size categories: small (1-14 ha), medium (15-49), and large (>50 ha). Five wetlands from each of these categories were randomly selected for inclusion in the study (Figure 1). Stratification insured that a variety of wetland sizes would be sampled.

Transect lines spaced every 100 m were marked on each wetland starting 50 m from the edge. One transect line occurred on the small wetlands; 6 on 3 of the large wetlands. The total length of transect lines within each wetland was roughly proportional to the area of the wetland.

After field inspection 10 cover type categories were distinguished within or bordering the wetlands (Table 3). Combinations of these cover types were frequently observed. When combinations occurred the cover types were listed in order of dominance, i.e. a cattail-river bulrush association was dominated by cattails. In this case cattail was assumed to make up 60% of the association while river bulrush made up 40%. A 40-30-30% ratio was established for 3-way cover type associations. This procedure was designed to represent wetland vegetation makeup since cover type associations were common.

Estimates of use of wetland cover types by pheasants were obtained using the method described by Gates (1971). Transects were walked within 3 days after a fresh snowfall and all tracks, roosts, and flushed pheasants were counted within each cover type or cover type association. Counts of tracks and roosts were divided by the number of

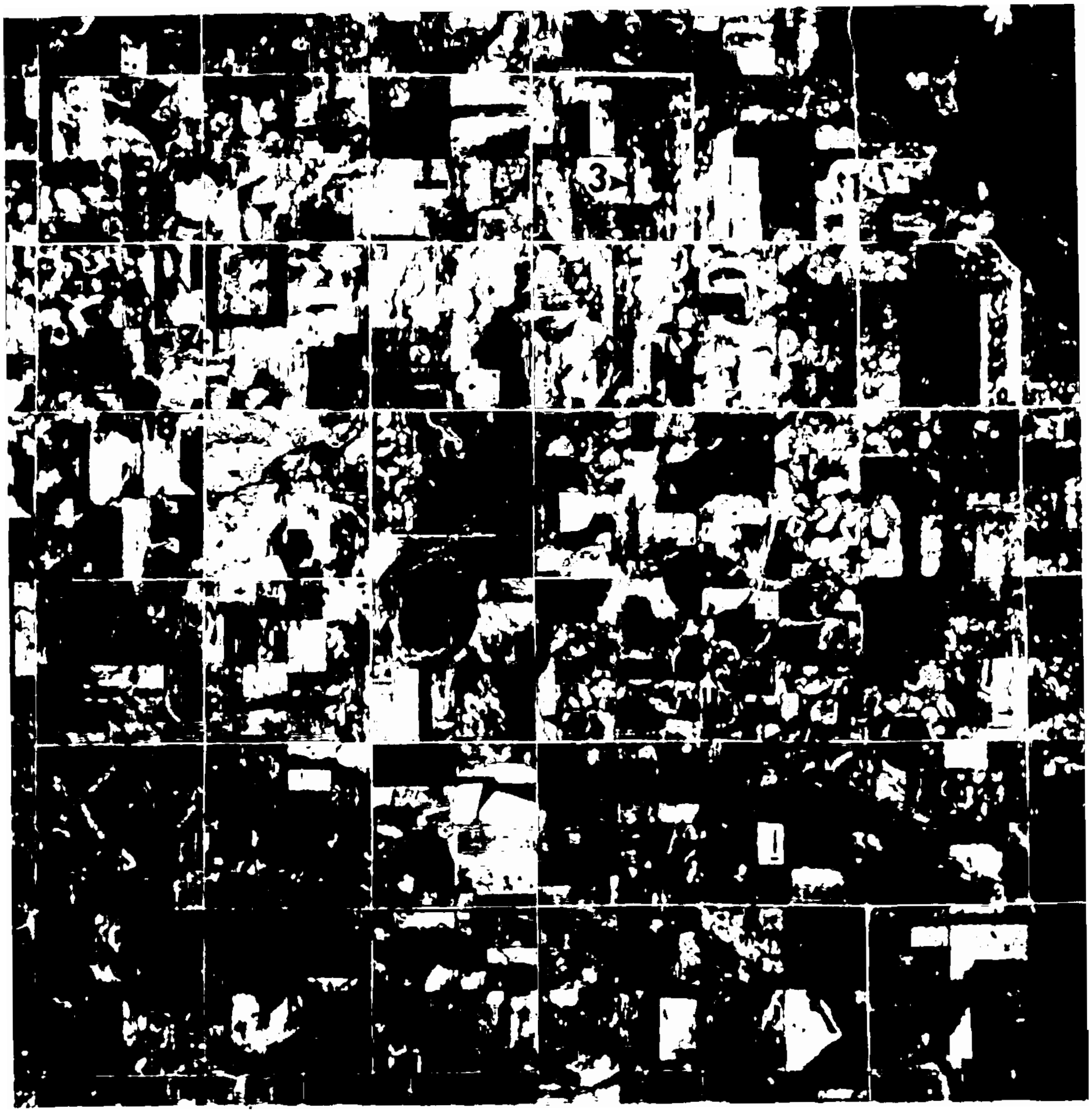


Figure 1. Location of randomly selected wetlands within the study area. Black and white print of color infrared photography acquired at 18,300 m AGL with a NASA RB-57 aircraft on June 12, 1972, Mission No. 205.

Table 3. Vegetation description of cover types bordering wetlands and within the wetlands.

Cover Type	Dominant Species
River Bulrush	*Scirpus fluviatilis*
Roundstem Bulrush	*Scirpus actutus*
	Scirpus validus
Cattail	*Typha* spp.
Phragmites	*Phragmites communis*
Shrubs	*Salix* spp.
Smartweed	*Polygonum coccineum*
Grasses	*Spartina pectinata*
	Bromus spp.
Herbaceous Cover	*Ambrosia trifida*
	Salsola iberica
	Aster spp.
Trees	*Populus deltoides*
	Fraxinus pennsylvanica
Open Water	

days since the snowfall. The number of tracks and roosts per 100 m of cover type was calculated to give relative estimates of these parameters. Tracks per wetland were tallied as an estimate of wetland use. This method assumed that the number of tracks per cover type related to loafing use and the number of roosts per cover type related to night-time roosting use.

During the winter of 1977-78,3 replications were obtained on 4 January, 20 January,and 4 March. Several incomplete censuses were also conducted. The winter of 1978-79 resulted in no complete replication. On 2 February, however, 13 of the 15 wetlands were censused; the 2 uncounted wetlands were covered with drifted snow and pheasant use was unlikely. On several occasions during both winters data collection was interrupted because of high winds and blowing snow.

Random measurements of vegetative density, vegetative height (above snow level), and snow depth were taken in each cover type or cover type association on each replication. Vegetative density was estimated using a 0.5 m^2 frame. By viewing the frame vertically the percentage of vegetation occupying the area within the frame was visually estimated and used to represent vegetative density. Average vegetation height and snow depth within the frame were measured. During the second field season (1978-79) additional measurements were taken. Vegetation density and height and snow depth were measured at the first track encountered in each cover type and also at the first roost encountered.

Land use was tabulated for 0.8 km from the edges of the wetlands. This distance was considered adequate since Bue (1949) noted a maximum 0.8 km travel radius around pheasant winter loafing areas in South Dakota, and Grondahl (1953) and Weston (1954) noted winter travel radii of 0.63 and 0.74 km respectively in Iowa. Cultivated field composition and stubble height measurements were recorded during field inspection. Heights of residual vegetation in shelterbelts, uncultivated land, and wetlands were also estimated. Vegetative cover was placed in 1 of 5 categories according to height: 1) 0 m; 2) 0.1-0.3 m; 3) 0.3-0.6 m; 4) 0.6-1.0 m; and 5) >1.0 m.

Eight lines extending 0.8 km from the wetland edge were drawn at 45° intervals around the wetland. The starting point for drawing the 8 lines was randomly selected each year. Land use types and stubble height categories were measured along each line. Percentages of each land use type and height category were calculated for each wetland both field seasons.

Landsat data were collected on 21 December, 1977; 3 March, 1978; and 8 February, 1979. Band 7 of the Multispectral Scanner (MSS) was used exclusively for interpretation since this band represents a longer wavelength portion of the light spectrum (0.8-1.1 μm spectral sensitivity) than Bands 4, 5, or 6. The amount of atmospheric backscattering is reduced at this longer wavelength. Pheasant concentration sites within Windsor Township were located and superimposed on Landsat image enlargements of the area. Comparisons of the image feature tone (lightness or darkness) of wetlands and actual pheasant use were made to determine Landsat's resolution capacity at recording pheasant wetland concentration areas. Tonal comparisons of wetland features between dates was not attempted since gray scales are not standardized on Landsat products.

Loafing and roosting use of cover types was analyzed with stepwise forward multiple regression, chi-square analysis, and t-tests. Correlation matrices were also generated to provide additional information. Variables used in the analyses are listed in Table 4. Wetlands with no pheasant activity were omitted.

Wetland use was also analyzed using multiple regression. Three complete replications in 1978 were used as well as the 2 February, 1979 replication. Vegetation height categories describe the land surrounding the wetlands in terms of emergency pheasant cover potential (Gates 1971). The height categories as well as percent corn stubble and standing corn were entered into the multiple regression analysis of pheasant use of wetlands (Table 5). A correlation matrix between land use types and vegetation height categories was generated to locate significant relationships.

Since both winters were severe, land use measurements extending 0.40 km from the wetlands were used for analysis. While Bue (1949) noted movements of up to 0.80 km from loafing areas, he also observed that during normal winter weather (temperature below freezing) daily movement did not exceed 274.3 m. Kirsch (1951) observed an average pheasant movement of 0.40 km from loafing areas in search of food in South Dakota. Data from other northern states also support a 0.40 km average travel distance (Shick 1952, Gates 1971).

Table 4. Independent variables included in stepwise forward multiple regression analysis of loafing and roosting site selection.

Cover Types (%)
River Bulrush
Roundstem Bulrush
Cattail
Phragmites
Shrubs
Smartweed
Herbaceous
Grasses
Trees
Open Water
Vegetation Measurements
Vegetative Density (%) [a]
Vegetative Height (m) [a]
Vegetative Density at first track encountered[b]
Vegetative Height at first track encountered[b]
Vegetative Density at first roost encountered[b]
Vegetative Height at first roost encountered[b]
Other Measurements
Snow Depth (m)
Snow Depth at first track encountered[b]
Snow Depth at first roost encountered[b]

[a] In the case of trees residual vegetation beneath the canopy was measured.

[b] Included in separate multiple regression analysis for 1978-79 season only.

Table 5. Independent variables entered into stepwise forward multiple regression analysis of pheasant use of wetlands.

Wetland Parameters

- Wetland Area
- % River Bulrush
- % Roundstem Bulrush
- % Cattail
- % Phragmites
- % Shrubs
- % Smartweeds
- % Herbaceous cover
- % Grasses
- % Trees
- % Open water
- % of wetland with 0%-100% vegetative density (10 density categories)[a]
- % of wetland with 0-.4 m vegetation height
- % of wetland with 0.5-0.9 m vegetation height
- % of wetland with 1.0-1.9 m vegetation height
- % of wetland with 2.0-2.9 m vegetation height
- % of wetland with >3.0 m vegetation height[a]
- Average snow depth for wetland

Surrounding Land Use Parameters (within 0.40 km of wetland)

- % of corn stubble
- % of standing corn
- % of land with 0 m vegetative height
- % of land with 0.1-0.3 m vegetative height
- % of land with 0.4-0.6 m vegetative height
- % of land with 0.7-1.0 m vegetative height
- % of land with >1.0 m vegetative height

[a] In the case of trees residual vegetation beneath the canopy was measured.

RESULTS AND DISCUSSION

Two types of cover considered important to pheasants are loafing and roosting; the former is thought to be the more critical habitat feature (Bue 1949, Gates 1971). These authors found that adequate loafing cover was the primary criterion for selection of wintering areas by pheasants.

During the winter of 1977-78 snow cover on the study area had reached 0.2 m at the time of the first census. Snow depth within the wetlands varied from 0.2 m to greater than 1.5 m. Cover conditions within cover types (especially extensive cover types such as cattail and river bulrush) varied greatly. Pheasant use of these respective cover types also varied.

While a small percentage of the total variance was explained in some of the regression models, these models represent the best fit for the variables measured. The models generally agreed with observations in the field. It should be noted that percent figures refer to explained variance and not to total variance.

Loafing Site Selection

During the winter of 1977-78 height was the most important vegetative factor influencing selection of loafing sites (Table 6). Comparison of the standardized partial regression coefficients indicated that vegetative height was more than 3 times as important in loafing site selection as the next variable entered, vegetative density. These two variables together accounted for 84% of the total explained variance. Trees had a slightly positive affect on the model. Shrubs

Table 6. Stepwise forward multiple regression analysis of pheasant loafing site selection during 1977-78 season. Dependent variable = tracks per 100 m of cover type. Independent variables are listed in order of inclusion into the model[a].

Independent Variables	Standard. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff. (r)	Coeff. of Determination (R^2)
Vegetative Height	7.811	1.089	.3493	.1220
Vegetative Density	2.533	0.532	.2656	.1492
Trees	0.127	0.031	.1052	.1761

[a] Sample size = 530 ($P<0.01$)

did not add significance to the model because of the high correlation between shrubs and vegetative height (Table 7). This high correlation in effect cancelled any influence of shrubs in the regression model.

Examination of loafing use of the various cover types through chi-square analysis revealed additional information not extracted from multiple regression analysis (Table 8). Shrubs were heavily used since 14 of 31 observations in shrubs or 45.2% had more than 10.0 tracks. A large percentage of the observations in trees and cattails also contained more than 10.0 tracks. Chi-square analysis of roundstem bulrush, smartweed, grasses, and open water cover types indicated infrequent use. These cover types offered little cover throughout the winter of 1977-78 because of snow accumulation within the wetland early in the season. Roundstem bulrush and grasses bent in the snow and were quickly covered. Smartweeds were never observed as a dominant cover type during this winter season.

Table 7. Correlation coefficients of cover types and descriptive measurements for both years.

	Vegetative Density		Vegetative Height		Snow Depth	
	1978	1979	1978	1979	1978	1979
River Bulrush	.0656	.0365	-.850*	-.1149*	-.0239	.0067
Roundstem Bulrush	-.0331	-.0765	-.1099*	.1796*	-.1329*	.0265
Cattail	.3076*	.3379*	.0042	.0356	.1940*	.1050*
Phragmites	.0482	.1546*	.1393*	.3470*	.3106*	.1801*
Shrubs	.0593	.0076	.6389*	.6924*	.2783*	-.0183
Smartweeds	-.0211	-.0437	-.0242	-.0627	.1079*	-.0463
Herbaceous	-.2012*	-.1703*	-.1533*	-.1066*	-.2304*	.0558
Grasses	-.2096*	-.1947*	.1495*	-.1556*	-.2344*	-.1215*
Trees	-.1713*	-.1632*	-.0864*	-.1427*	.0744*	-.1587*
Open Water	-.1461*	-.1399*	-.0997*	-.1094*	-.2008*	-.1649*

* Significant, $P < 0.05$. Because of the large sample sizes involved in these correlations many weak associations are significant.

Table 8. Chi-square analysis of dominant cover type used for loafing during 1977-78 season. Numbers in each cell represent the number of observations recorded within each of the categories. () represent percentage values of the categories for each cover type[a].

	Loafing Use Categories (number of tracks observed)			
Dominant Cover Types	0.0-1.0 Tracks	1.1-10.0 Tracks	>10.0 Tracks	Total
River Bulrush	82(54.7)	42(28.0)	26(17.3)	150(27.7)
Roundstem Bulrush	20(90.0)	2(9.1)	0(0.0)	22(4.1)
Cattail	66(40.2)	54(32.9)	44(26.8)	164(30.3)
Phragmites	15(78.9)	1(5.3)	3(15.8)	19(3.5)
Shrubs	12(38.7)	5(16.7)	14(45.2)	31(5.7)
Smartweeds	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Herbaceous	42(65.6)	8(12.5)	14(21.9)	64(11.8)
Grasses	35(85.4)	6(14.6)	0(0.0)	41(7.6)
Trees	14(43.8)	6(18.8)	12(37.5)	32(5.9)
Open Water	11(57.9)	8(42.1)	0(0.0)	19(3.5)
Total	297(54.8)	132(24.4)	113(20.8)	542

[a] $\underline{X}^2$ = 78.007, df = 16, $\underline{P}$<0.000

The strong preference for shrubs is supported by the observations of other authors. Bue (1949) noted that second growth boxelder thickets and plum thickets offered excellent loafing cover in central South Dakota. Green (1938) and Weston (1954) observed heavy use of green ash and willow patches in Iowa. Gates (1971) found that while shrub-carr occupied less than 1.0 percent of his total study area in Wisconsin, nearly half of the winter pheasant population was in this cover type under heavy snow conditions.

Phragmites, a tall cover type, was often associated with deep drifted snow during the 1977-78 season (Table 7) thereby reducing its usefulness for loafing.

First snowfall in the winter of 1978-79 was in mid-November. Snow accumualtion within the wetlands was minimal until mid-January; wetlands offered excellent cover for nearly half the winter. The amount and extent of drifted snow within the wetlands were not as great as during the previous winter.

During the 1978-79 season height was again the most important vegetative factor influencing cover type selection (comparison of standardized partial regression coefficients). Shrubs were heavily used as indicated by the fact that 93.8% of the explained variance was due to shrubs despite the high correlation between shrubs and vegetative height (Table 9).

Multiple regression analysis that used vegetative measurements taken at the first track, indicated no particular change in the model except that the coefficient of determination increased to 0.4098 (Table 10).

Table 9. Stepwise forward multiple regression analysis of pheasant loafing site selection during 1978-79 season. Dependent variable = tracks/100 m cover type. Independent variables are listed in order of inclusion into the model[a].

Independent Variables	Standard. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff.(r)	Coeff. of Determination (R^2)
Shrubs	4.448	0.547	.5826	.3394
Vegetative Height	37.256	13.766	.3833	.3541

[a] Sample Size = 324 ($\underline{P}<0.05$)

Table 10. Stepwise forward multiple regression analysis of pheasant loafing site selection during 1978-79 season. Dependent variable = tracks/100 m of cover type. Vegetative measurements taken at the first track encountered in each cover type replaces random measurements. Independent variables are listed in order of inclusion into the model[a].

Independent Variables	Standard. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff.(r)	Coeff. of Determination (R^2)
Shrubs	5.161	0.815	.6273	.3934
Vegetative Height	46.484	21.537	.4426	.4098

[a] Sample Size = 170 ($\underline{P}<0.05$)

Chi-square analysis of the use of cover types indicated that the percent of phragmites cover type containing more than 10 tracks increased to 35.3% during the 1978-79 season (Table 11) from 15.8% the previous season. However, 58.8% of the phragmites observations in 1978-79 had one or fewer tracks. The increase in pheasants loafing in phragmites was thought to be due to the reduced snow depth and greater vegetative height of phragmites in 1978-79 (Table 7). Green (1938) observed that pheasant use of a phragmites wetland was considerable until snow accumulation forced the birds to seek better shelter.

The high percentage of observations of smartweeds with more than 10.0 tracks is not explainable since this cover type consisted of a stem with usually 1 to 2 leaves attached. Vegetative density and height measurements were always low. The small sample size (7) contributes to the argument that the results concerning pheasant use of smartweeds cannot be interpreted with confidence.

Cattails and river bulrush have been noted to provide loafing cover under limited snow depth (Green 1938, Weston 1954, Gates 1971). During this study, drifted snow rapidly covered even the largest wetland leaving the major portions of cattail and river bulrush areas snow filled. However, pheasants were observed using isolated pockets of these cover types where heavy snow failed to accumulate. Therefore cattail and river bulrush, extensive cover types, typically had much reduced relative loafing use indices due to their long transect line length.

Table 11. Chi-square analysis of dominant cover types used for loafing during 1978-79 season. Numbers in each cell represent the number of observations recorded within each of the loafing use categories. ( ) represent percent values of the loafing use categories for each cover type[a].

Dominant Cover Types	Loafing Use Categories (number of tracks observed)			
	0.0-1.0 Tracks	1.1-10.0 Tracks	>10.0 Tracks	Total
River Bulrush	48(60.0)	18(22.5)	14(17.5)	80(17.9)
Roundstem Bulrush	43(55.1)	24(30.8)	11(14.1)	78(17.4)
Cattail	53(49.5)	41(38.3)	13(12.1)	107(23.9)
Phragmites	10(58.8)	1(5.9)	6(35.3)	17(3.8)
Shrubs	13(40.6)	4(12.5)	15(46.9)	32(7.2)
Smartweed	3(42.9)	1(14.3)	3(42.9)	7(1.6)
Herbaceous	17(77.3)	1(4.5)	4(18.2)	22(4.9)
Grass	53(68.8)	14(18.2)	10(13.0)	77(17.2)
Trees	13(68.4)	4(21.1)	2(10.5)	19(4.3)
Open Water	7(87.5)	1(12.5)	0(0.0)	8(1.8)
Total	260(58.2)	109(24.4)	78(17.4)	447

[a] $\underline{X}^2 = 54.315$, df = 16, $\underline{P}<0.005$

Gates (1971) observed that herbaceous cover was third in importance for loafing behind shrubs and cattails. Like cattails, he found that herbaceous cover was utilized most in snow depths of 30-38 cm. Weston (1954) also found that tall, dense stands of giant ragweed offered excellent loafing cover in Iowa. Overall, little use of herbaceous cover for loafing was observed in this study. One explanation is that herbaceous cover usually consisted of a narrow band around the periphery of the wetland and density was usually low. Observations of heavy pheasant use in a thick herbaceous uncultivated area near one wetland suggest that this cover type is indeed important if thick stands exist.

Roosting Site Selection

Analysis of pheasant roosting in wetland cover types was difficult due to the few roosts encountered. During the 1977-78 season so few roosts were seen that analysis by multiple regression could not be used.

Two multiple regression analyses of roost site selection by pheasants were generated for the 1978-79 season (Tables 12 and 13). The vegetative measurements used in these analyses differed. The first model used random vegetative measurements while the second model used the vegetative measurements taken at the first roost encountered. In the second model only those observations with roosts were included (note the differences in number of observations and coefficients of determination for the two models).

Table 12. Stepwise forward multiple regression analysis of pheasant roosting site selection during 1978-79 season. Dependent variable = roosts/100 m cover type. Independent variables are listed in order of inclusion into the regression model[a].

Independent Variables	Standard. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff.(r)	Coeff. of Determination (R^2)
Vegetative Density	0.121	0.033	.2530	.0640
Phragmites	0.031	0.008	.2013	.1029
Cattail	0.007	0.002	.1937	.1231

[a] Sample size = 325($\underline{P}$<0.05)

Table 13. Stepwise forward multiple regression analysis of pheasant roost site selection during 1978-79 season. Dependent variable = roost/100 m cover type. Vegetation measurements taken at the first roost encountered in each cover type replace random measurements. Independent variables are listed in order of inclusion into the model[a].

Independent Variables	Standard. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff. (r)	Coeff. of Determination (R^2)
Phragmites	0.169	0.030	.6063	.3676
Roundstem Bulrush	0.034	0.021	.0805	.3998

[a] Sample size = 54($\underline{P}$<0.05)

Density was an important vegetative condition for roosting in wetlands (Table 12). Height of vegetation was not a significant factor. This trend was opposite of that found for loafing site preference during the 1978-79 season (Table 14) and is contrary to that found by some investigators. Bue (1949) found that pheasants preferred to roost in low density vegetation. He noted little roosting in densities above 40%. Lyon (1954:183) also observed no connection between roosting site preference and vegetative density in north-central Colorado. He stated "...it appears that cover can be judged for its roosting value on the basis of height alone". However, Lyon estimated density using stems/ft^2 which did not take into account the influence of snow depth on density.

Phragmites was used sporadically; at times it contained no roosts, and other times many were observed. There was a high standard deviation of phragmites observations (Table 15). In Iowa, Green (1938) observed that use of phragmites for roosting increased as shorter cover types, e.g. slough grass (Spartina michauxiana), filled with snow. He noted, however, that phragmites was abandoned by the pheasants later in the season due to increasing snow depth. During the 1978-79 winter season drifted snow did not accumulate in the phragmites as much as the previous season thereby improving its value as cover.

Cattail was observed to have roosts on several occasions (Table 15) but roost density was low due to the great areal extent of cattail cover. This cover type also had a significant positive correlation with vegetative density (Table 7) which affected its contribution in the regression model.

Table 14. T-test analysis of pheasant roosting and loafing use during 1978-79 season for two categories of vegetative height and vegetative density.

Roosting

Vegetative Height	Number of Observations	Mean Number of Roosts	Standard Deviation	Significance
<1.0 m	355	0.345	1.291	0.116
≥1.0 m	85	1.200	4.929	

Vegetative Density	Number of Observations	Mean Number of Roosts	Standard Deviation	Significance
<50%	382	0.322	2.124	0.006
≥50%	62	1.925	4.135	

Loafing

Vegetative Height	Number of Observations	Mean Number of Tracks	Standard Deviation	Significance
<1.0 m	356	5.128	13.899	0.021
≥1.0 m	85	82.680	303.953	

Vegetative Density	Number of Observations	Mean Number of Tracks	Standard Deviation	Significance
<50%	382	20.974	146.144	0.419
≥50%	62	13.595	41.026	

Table 15. General description of 1978-79 roost data by dominant cover types.

Dominant Cover Type	Number of Observations	Total Roosts	Roosts/ Observation	Standard Deviation
River Bulrush	13	28.6	2.200	1.916
Roundstem Bulrush	3	14.4	4.800	2.784
Cattail	39	106.3	2.730	3.238
Phragmites	5	173.8	34.760	62.323
Shrubs	1	38.2	38.2	0.000
Grass	1	5.0	5.0	0.000

Several studies have shown the importance of cattails for roosting cover. Weston (1954) reported that while cattails and bulrushes were occasionally used for loafing, they were also regularly used for roosting. Lyon (1954) found that cattail sloughs were 1 of the 2 most important areas for roosting that he investigated. Gates (1971) observed that dense stands of cattails received maximum use at snow depths from 0.30 to 0.38 m. He found that stands of bent over cattails made attractive roost sites for pheasants.

The negative correlation coefficient and positive standardized partial regression coefficient for roundstem bulrush in Table 13 indicates that there was interaction between roundstem bulrush and other variables, thus making interpretation difficult. Vegetation at roosts in three roundstem bulrush stands (Table 15) had densities of 90, 40, and 30%. These values were high considering that roundstem bulrush was negatively correlated with vegetation density for the 1978-79 season. Roundstem bulrush usually existed in sparse stands or was bent over and covered with snow. The areas of roundstem bulrush containing roosts consisted of dense erect stands.

Gates (1971) and Lyon (1954) observed heavy use of herbaceous cover for pheasant roosting. Observations of large herbaceous cover tracts near my wetlands indicated that this cover type was heavily used for roosting. On the wetland areas, however, no such use was observed, probably due to the narrow width and low density of herbaceous cover around the wetlands.

Vegetative density did not emerge as a significant factor in the regression model using only roost observations (Table 13). This is explained since there was little variance between vegetative densities of different roost sites.

Density was apparently the most important vegetative factor influencing the selection of roosting sites. Gates (1971) contended that loafing and roosting cover preference was related to thermoregulation. Dense vegetative cover as offered by cattails and phragmites may function as windbreaks to conserve the pheasant's body heat. Loafing cover sites such as shrubs would offer little protection during cold windy weather. Shrubs, however, because of their low density, allow sunlight to enter on clear days so pheasants can keep warm by taking advantage of solar energy.

Pheasant Wetland Use

In the northern states pheasant move into traditional wintering areas in late fall. Populations ranging from 10 to 1,000 birds have been recorded for such areas (Green 1938, Bue 1949, Gates 1971). Gates

(1971) defined traditional wintering areas as those that are occupied by pheasants each year. He divided traditional wintering areas into 3 categories according to the number of pheasants the areas supported. Primary concentration sites seldom held less than 50 birds and held more than 100 most winters. Secondary concentration sites usually held near 50 birds and tertiary concentration sites held 5 to 10 birds consistently each winter.

In this study pheasant use of wetlands varied considerably. Three primary concentration sites, 2 secondary sites, and 1 tertiary site were observed (Table 16). Little or no pheasant use was observed in the remaining 9 wetlands.

Multiple regression analysis indicated that the size of a wetland was a significant factor influencing the degree of pheasant wetland use (Table 17). Wetland area along accounted for 58.5% of the total explained variance. Table 16 indicates that a pattern of use according to wetland size was evident. Only 1 of the 5 large wetlands (Wetland 16) was not a concentration site.

No pheasant tracks or pheasants were observed in Wetland 16 during the 1977-78 season since during that winter no standing residual cover was present in the wetland. This wetland was dominated by sparse stands of roundstem bulrush which offered little or no cover. During the 1978-79 season dense stands of roundstem bulrush and cattail were observed and some tracks were seen that season. The regression model indicated that the percent of roundstem bulrush in a wetland had a negative influence on pheasant wetland use (Table 17).

Table 16. Description of wetland study areas in terms of size, pheasant use, vegetative composition, and traditional wintering area types, 1977-78 and 1978-79.

Wetland ID	Area (ha)	Average # of tracks	Estimated # of wintering pheasants	Dominant cover type(s)	Type of Concentration site[a]
27	123.7	237.6	100-200	River Bulrush Cattail	Primary
14	115.5	71.0	50-75	Cattail	Primary
16	88.2	6.2	0	Roundstem Bulrush	Not used
21	77.8	42.3	25-50	Cattail	Secondary
6	61.2	113.2	50-100	Cattail	Primary
26	25.2	0.5	0	Cattail	Not used
5-1	20.5	41.6	10-30	Shrubs	Secondary
1	19.7	0.0	0	River Bulrush	Not used
5-2	15.0	33.8	5-10	Phragmites-shrubs	Tertiary
18	14.9	0.0	0	River Bulrush	Not used
7-1	12.9	1.9	0-5	River Bulrush-shrubs	Not used consistently
7-2	11.8	14.4	0-5	Phragmites-shrubs	Not used consistently
5-6	4.5	0.0	0	River Bulrush	Not used
5-4	3.2	0.6	0	River Bulrush	Not used
3	1.6	0.0	0	Smartweeds-Herbaceous	Not used

[a] Traditional winter concentration areas from Gates (1971). See text for explanation.

Table 17. Stepwise forward multiple regression analysis of pheasant use of wetlands. Dependent variable = total number of tracks/wetland. Independent variables are listed in order of stepwise inclusion[a].

Independent Variables	Stand. Part. Regression Coeff.	Standard Error	Simple Correlation Coeff.(r)	Coeff. of Determination (R^2)
Area of Wetland	1.224	0.151	0.5975	0.3570
% of Round-stem Bulrush within wetland	-2.552	0.518	-0.0634	0.5398
% of land 0.40 km out from wetland with vegetation >1.0 m in height	3.335	1.275	0.3006	0.5906
% of land 0.40 km out from wetland with vegetation 0.6-1.0 m in height	0.509	0.314	0.1187	0.6100

[a] Sample Size = 58 ($P < 0.05$)

Of the 10 remaining small wetlands only 2, 5-1 and 5-2, were considered to be traditional wintering areas. Both of these areas had considerable shrub and/or phragmites cover associated with them (Figure 2). It was in these cover types that the majority of tracks and pheasants were found.

Figure 2. Oblique aerial photograph of wetland 5-1 (20.5 ha) taken March 3, 1979. Notice the dark band of shrubs around the periphery. The majority of pheasant tracks seen in this wetland were in these shrubs.

Two other small wetlands, 7-1 and 7-2, also contained considerable shrub growth. Loafing cover conditions in both wetlands remained adequate during both years despite deep drifted snow. In Wisconsin, Gates (1970) felt that shrub or tamarack areas as small as 2.02 to 4.05 ha provided adequate winter cover for pheasants, if the areas were in close proximity to each other. Wetland 7-1 and 7-2 were 12 and 13 ha in size respectively and were approximately 300 m apart. They therefore appeared to have excellent potential as winter cover but they were used only sporadically. Other factors must have adversely influenced pheasant selection of these wetlands as concentration sites.

Pheasant use of wetlands 5-1 and 5-2 may have been due to their close proximity to wetland 6, a primary concentration site (Figure 1). There is evidence that a strong tendency exists for adult hens to return to traditional wintering areas each year and, as such, lead juveniles to these areas (Gates 1971). He also found that 80% of the pheasants associated with traditional areas moved to summer range within a 3.22 km radius of these sites. This limited spring dispersal from wintering areas is supported by findings of other investigators (Grondahl 1953, Weston 1954, Robertson 1958). Robertson (1958) suggested that movement to adequate winter cover may result in a semipermanent population shift that carries over into the breeding season. During moderate weather in November and March pheasants were often observed in the fields between wetlands 6 and 5-1. Wetlands 7-1 and 7-2 were isolated (>1.6 km) from any primary or secondary traditional concentration sites,and this may have accounted for their limited use.

The remaining small wetlands consisted of emergent hydrophytic vegetation, smartweeds, grasses and herbaceous cover. These wetlands filled with drifted snow early each season so that little winter cover was available. In Iowa, significant reduction in pheasant use of small wetlands early in winter due to drifting snow has also been reported (Green 1938, Grondahl 1953).

Little research has been done on the availability of emergency cover around pheasant winter concentration areas. Gates (1971:183) defined emergency cover as ". . . cover relied upon when normal cover preferences were precluded by heavy snow conditions and severely reduced cover availability". In South Dakota, where winters can be severe and long, the availability of this cover may be an important factor governing pheasant concentration sites.

Multiple regression analysis of wetland use indicated that cover conditions of the surrounding area influenced use during this study (Table 17). The large standardized partial regression coefficient of the percent of surrounding land with vegetation in excess of 1.0 m illustrates the relative importance of this factor in the regression model for estimating pheasant use of wetlands.

Vegetation in excess of 0.6 m in height, surrounding the wetland, had significant positive correlations with percents of standing corn, uncultivated areas, pasture, wetlands, shelterbelts, and farmsteads (Table 18). Significant negative correlations existed with percent of fallow land.

Table 18. Correlation matrix of percent land use categories versus the percent vegetation height categories.

	Land Use Vegetation Height Categories				
Land Use Categories	%0m	%.1-.3m	%.3-.6m	%.6-1.0m	% 1.0m
% corn stubble 0.40 km from wetland	-.3427*	.0351	.3967*	.1494*	-.1000
% standing corn 0.40 km from wetland	-.3209*	.1577	-.0691	.2398*	-.0351
% small grain 0.40 km from wetland	-.3113*	.5568*	-.2700*	.0187	-.0034
% alfalfa 0.40 km from wetland	-.0102	.3831*	-.0629	-.2221	-.2713*
% fallow 0.40 km from wetland	.9980*	-.4258*	-.1557	-.5848*	-.2631*
% pasture 0.40 km from wetland	-.1057	.2793*	.1711	-.1822	.3794*
% wetland 0.40 km from wetland	-.2621*	.1025	.0015	.0465	.7106*
% shelterbelt 0.40 km from wetland	-.2152	.1235	.1072	.0260	.3185*
% unused area 0.40 km from wetland	-.3466*	-.3899	.0047	.6802*	.1032
% farmstead 0.40 km from wetland	-.2162	.2686*	-.0117	-.0834	.4657*

* Significant, $\underline{P}<0.05$.

These findings suggest that large dense cattail wetlands within a wetland complex, near woody vegetation, or near uncultivated areas consisting of tall vegetation, were used each year by many pheasants. Other wetlands in the middle of fallow and/or short stubble fields, with no emergency cover nearby, were used but did not attract large numbers of birds and support them throughout the winter.

Observations of wetland 27 illustrate the importance of the surrounding emergency cover. Throughout most of the 1977-78 winter the pheasants stayed near the wetland usually loafing in the shrubs on the west side. As the winter progressed and the wetland filled with snow more and more pheasants were observed in the nearby shelterbelts and uncultivated areas. By March, cover in the wetland was limited to a few isolated pockets that were still used. Most of the pheasants, however, were in the shelterbelts to the north and even in the farm-yards. The presence of this emergency cover no doubt was a factor enabling pheasants to survive that severe winter. The following season, none of the wetlands filled with snow to the extent they did the previous year. At wetland 27 little or no movement to emergency cover was noted in late winter although an uncultivated area of dense herbaceous cover north of the wetland held pheasants all season.

Use of Landsat data to evaluate wetlands as winter cover for pheasants

This study indicates that large wetlands with dense cattails and associated small shrub plots provide excellent winter cover for pheasants. The attractiveness of such a wetland is enhanced if emergency cover, i.e. shelterbelt, uncultivated area, or wetland, is in close proximity. Landsat satellite imagery can be of value for pheasant management purposes if wetland and emergency cover features can be interpreted.

Each Landsat image has dimensions of 185 km x 185 km (Figure 3). This allows coverage of a large area at a reasonable cost (available from EROS Data Center, Sioux Falls, SD). The multispectral scanner (MSS) system on each Landsat satellite has an instantaneous field of view of approximately 0.45 ha. The Return Beam Vidicon (RBV) system that is functional only on Landsat 3 has an apparent resolution approximately 2 times this. RBV imagery would undoubtedly provide the most detailed information. Unfortunately no RBV data could be obtained during the 1978-79 winter season due to cloud cover conditions each time Landsat 3 was over the study area. No RBV sensor was available in 1977-78.

Best and Sather-Blair (1978) reported that many landscape features were interpretable from Landsat imagery of a snow covered landscape (Figure 4). In some cases it was difficult to distinguish between small wetlands, farmsteads, and agricultural fields on the imagery. Much of this confusion could have been alleviated by using additional information, i.e. topographic maps, to aid in interpretation.

A total of 9 pheasant concentration areas was located in Windsor Township. Eight of these areas were wetlands and 1 was a shelterbelt (Figure 5). Pheasants were observed in these locations both seasons. During the 1977-78 season pheasants were observed in

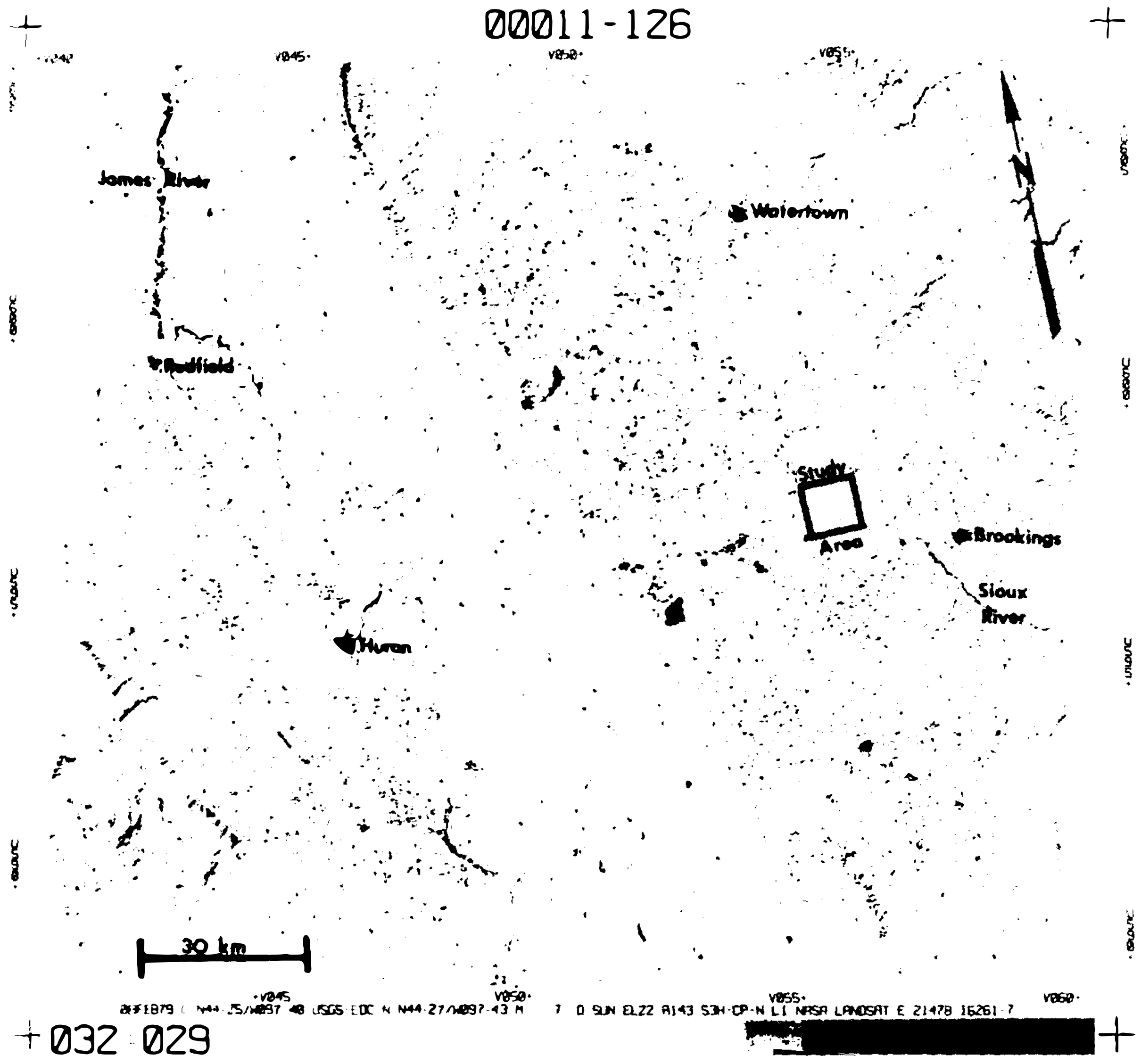
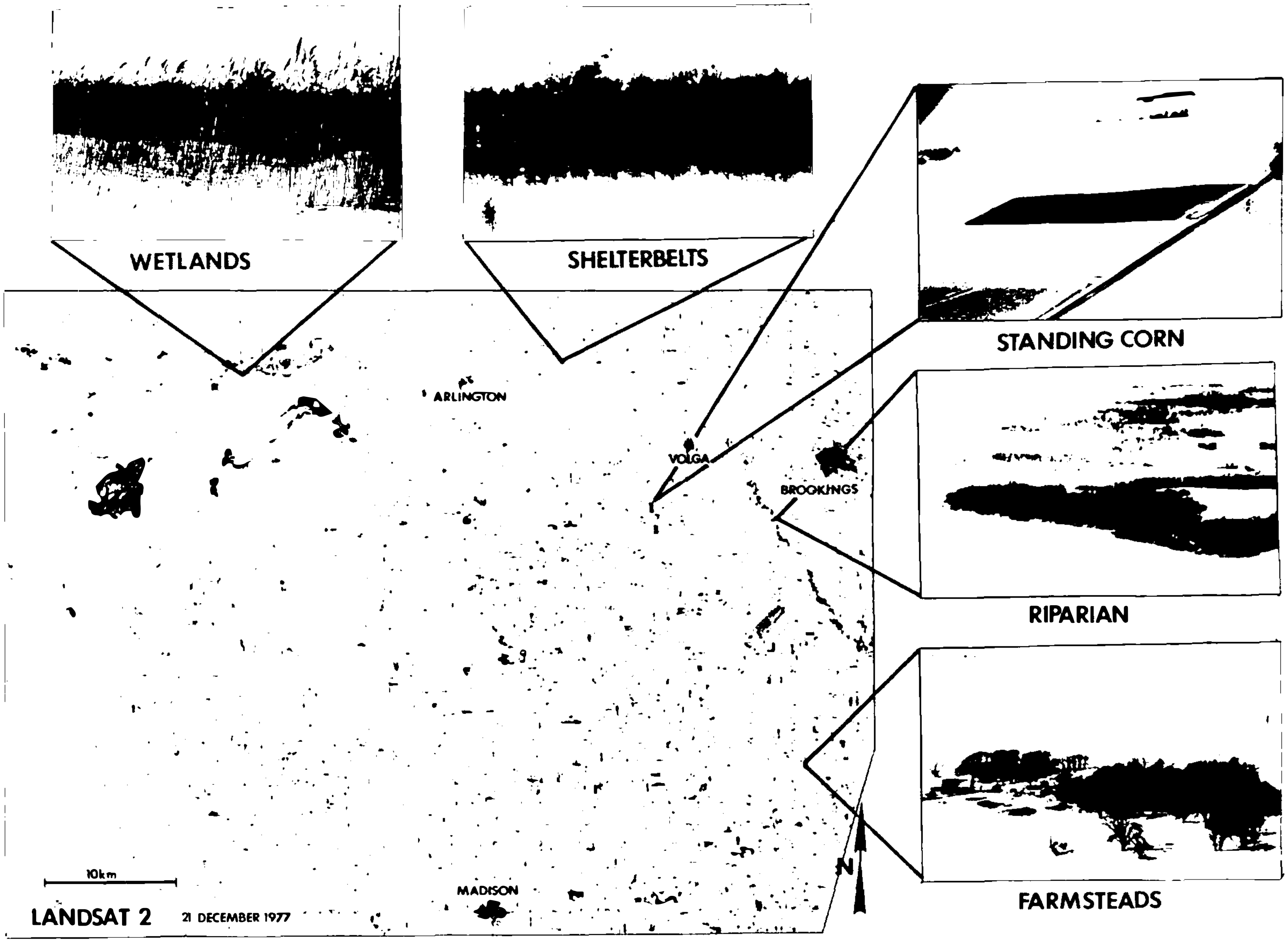


Figure 3. Positive print of Landsat 3 scene (EDIPS) image ID #21478-16261, MSS Band 7, February 8, 1979.

Figure 4. Illustration of interpretation of winter habitat on Landsat imagery (Best and Sather-Blair 1978).



WETLANDS
SHELTERBELTS
STANDING CORN
RIPARIAN
FARMSTEADS
ARLINGTON
VOLGA
BROOKINGS
MADISON
10km
N
LANDSAT 2
21 DECEMBER 1977

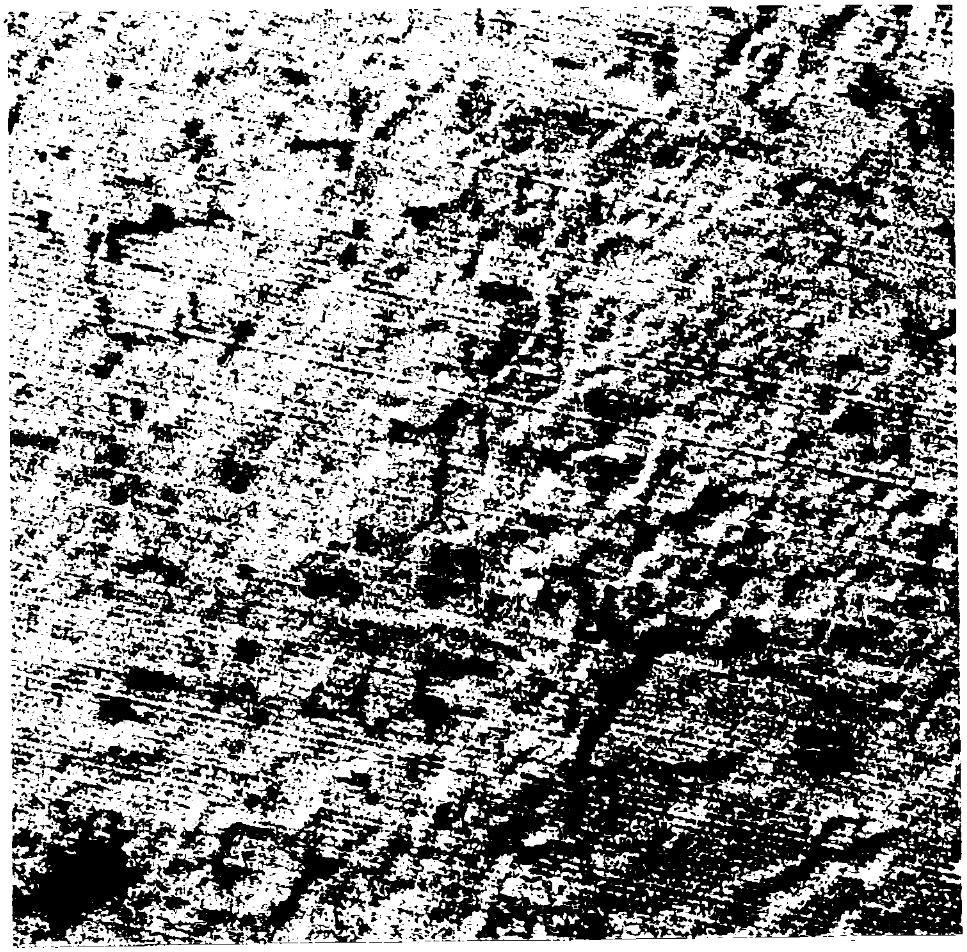


Figure 5. Landsat 2 positive print enlargement of study area. Scene ID #064-16075, MSS Band 7, December 21, 1977. Snow depth at this time was approximately 0.2 m. Wetland pheasant concentration sites are generally a darker tone than those wetlands not attracting pheasants.

Selected wetlands and pheasant winter concentration sites(+) are illustrated.

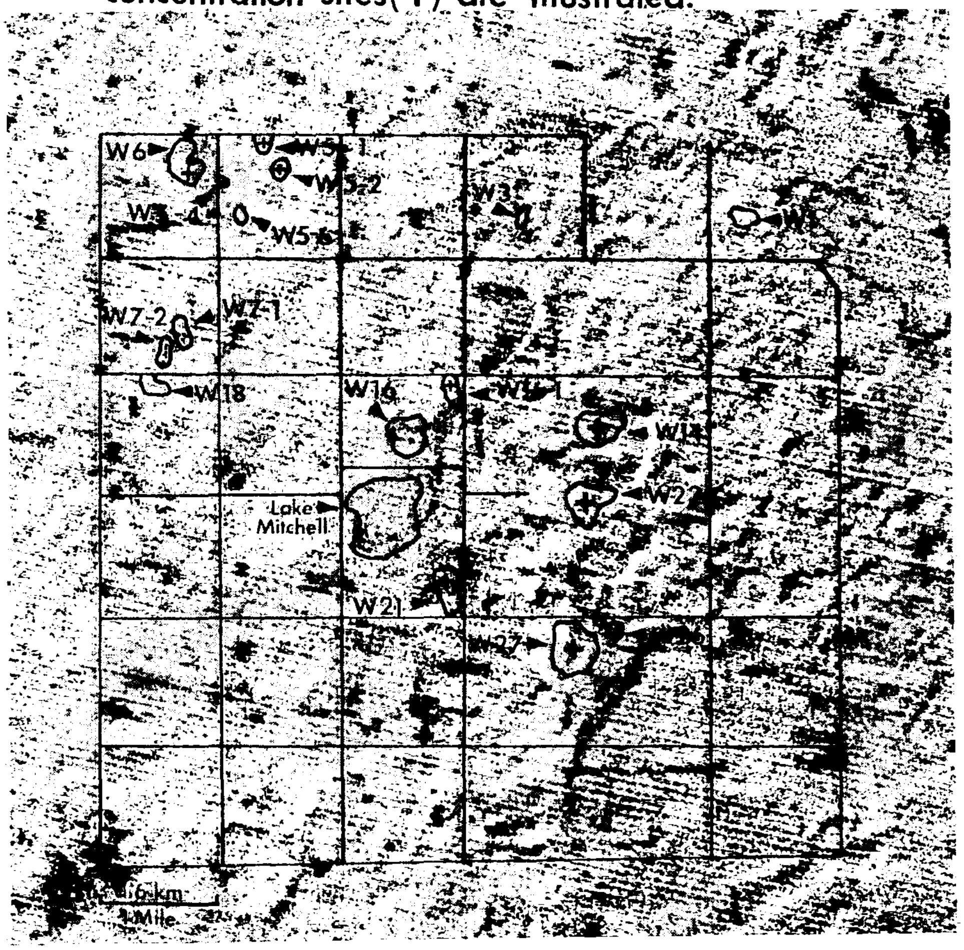


Figure 5. Landsat 2 positive print enlargement of study area. Scene ID #064-16075, MSS Band 7, December 21, 1977. Snow depth at this time was approximately 0.2 m. Wetland pheasant concentration sites are generally a darker tone than those wetlands not attracting pheasants.

shelterbelts abutting standing cornfields, the following year no pheasants were observed in these locations. These areas probably represented "temporary concentration sites" (Gates 1971).

The 1977-78 winter season was harsh with high winds during November and December. Small wetlands and portions of the large wetlands were quickly filled with drifting snow. Interpretation of the 21 December, 1977 Landsat data indicated that many of the larger wetlands with pheasant concentrations were a darker tone than the surrounding landscape (Figure 5). The dark tone indicated the presence of tall, dense emergent hydrophytic cover. Wetland 16, which attracted no birds that season, was a light tone feature on the imagery due to sparse vegetative cover.

By March deep snow was present in many of the wetlands. Pheasants, however, were still concentrating in and near traditional wintering areas. In some areas pheasants were seen in nearby emergency cover. The 3 March, 1978 data lack quality but still illustrate the blanketing effect of the snow on the vegetation (Figure 6). Attempts at interpreting wetland pheasant concentration sites using the 3 March data would be misleading, for while none of the concentration sites appear as darker features on the imagery pheasants were still concentrating in them and in the surrounding emergency cover. The dark area just northwest of wetland 27 is the farmstead and shelterbelt that served as emergency cover during late February and early March (Figure 1).

During the 1978-79 winter season snow did not accumulate in the wetlands to the extent it had the previous season. Wetlands and other

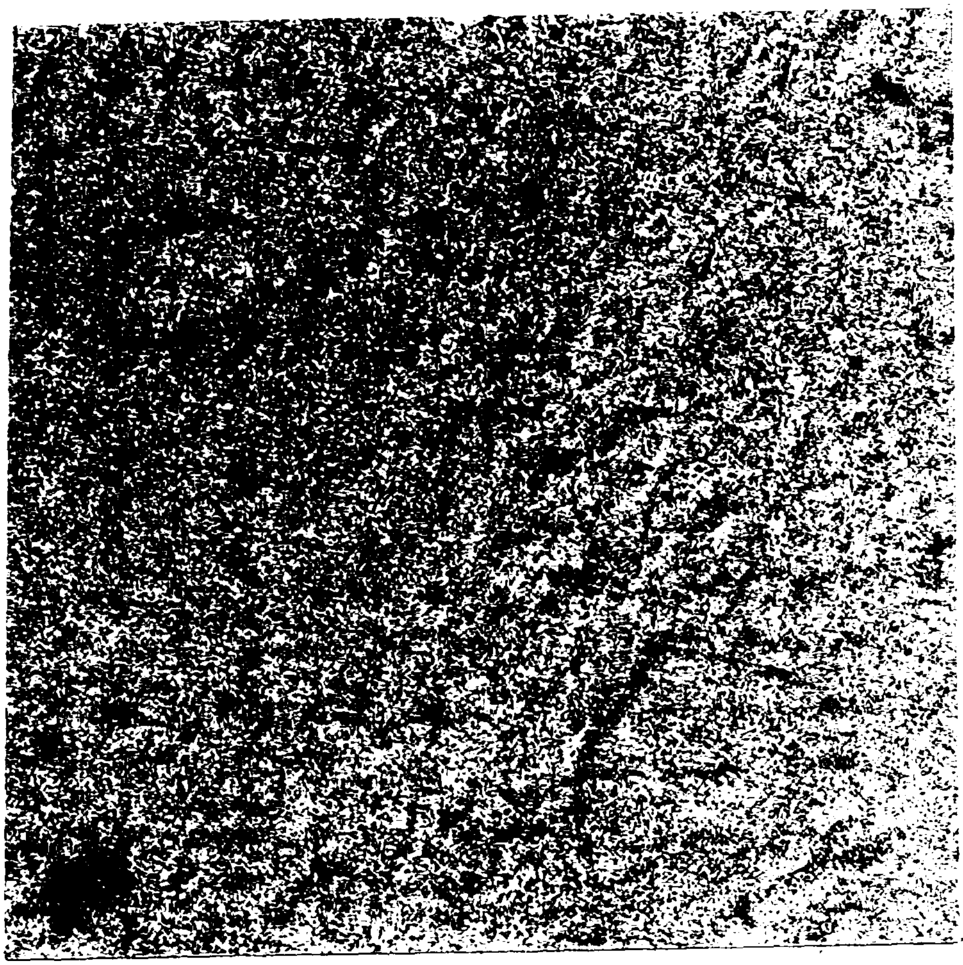


Figure 6. Landsat 2 positive print enlargement of study area. Scene ID #21136-16102, MSS Band 7, March 3, 1978. Snow depth at this time was approximately 0.4 m. Wetland features cannot be interpreted from this imagery.

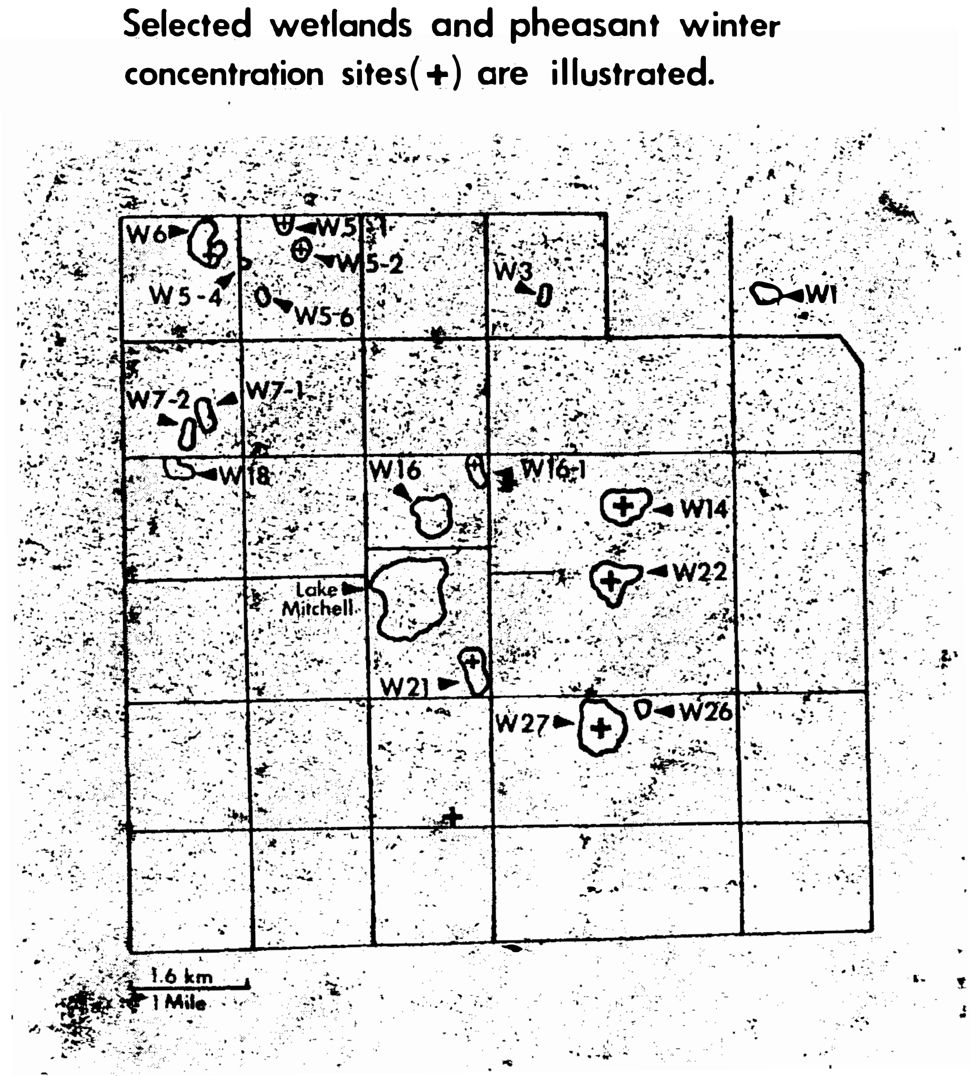


Figure 6. Landsat 2 positive print enlargement of study area. Scene ID #21136-16102, MSS Band 7, March 3, 1978. Snow depth at this time was approximately 0.4 m. Wetland features cannot be interpreted from this imagery.

landscape features are very clear on the 8 February, 1979 Landsat imagery (Figure 7) due to the new EROS Digital Image Processing System (EDIPS) that is now an enhancement technique used on current data. Notice how the scan lines that are so evident on the 21 December, 1977 data are gone from this imagery. Contrast improvements are also evident.

With this imagery the tone contrast between wetland 16 and those large wetlands containing dense hydrophytic vegetation is even more apparent. The western half of wetland 14 which was composed of dense stands of cattail has a much darker tone than the eastern half where roundstem bulrush was dominant. An oblique photograph of wetland 14 illustrates the contrast in vegetation (Figure 8).

Landsat data cannot be used exclusively in interpreting value of wetlands as winter cover. The dark diagonal features southeast of wetland 27 (Figures 5 and 7) appear to be exposed vegetation and would probably be interpreted as such if Landsat imagery were the only data used. This dark area is an exposed northwest slope where winds kept the snow from accumulating. In such cases topographic maps help imagery interpretation.

The Landsat system can provide current, low cost information concerning the value of wetlands as wintering concentration areas. Wetland 16 appears as a dense emergent type 4 marsh in the summer (Shaw and Ferdine 1956) while its appearance in the winter is different. Inspection of Landsat data at a time of minimal snow cover suggested that wetland 16 did not contain appreciable stands of dense

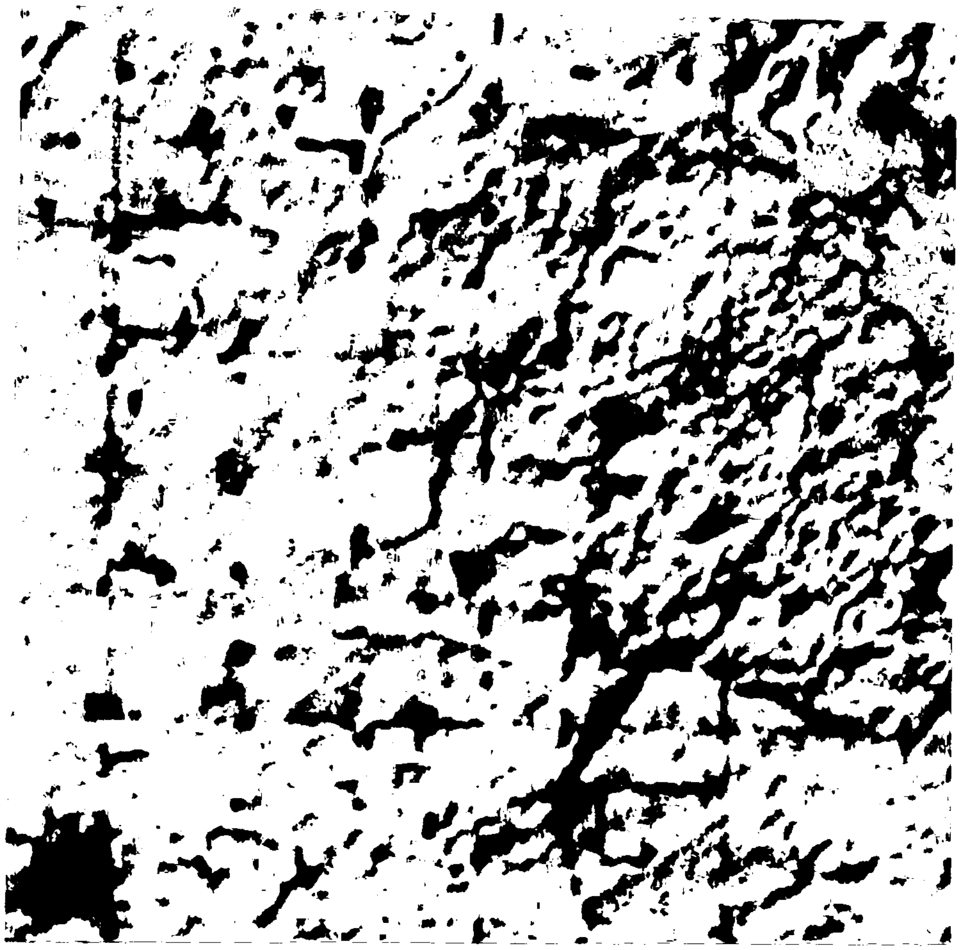


Figure 7. Landsat 3 positive print enlargement of study area. Scene ID #21478-16261, MSS Band 7, February 8, 1979. Snow depth at this time was approximately 0.6 m. Notice the improved contrast and lack of scan lines in this product due to EROS Digital Image Processing System (EDIPS).

Selected wetlands and pheasant winter concentration sites(+) are illustrated.

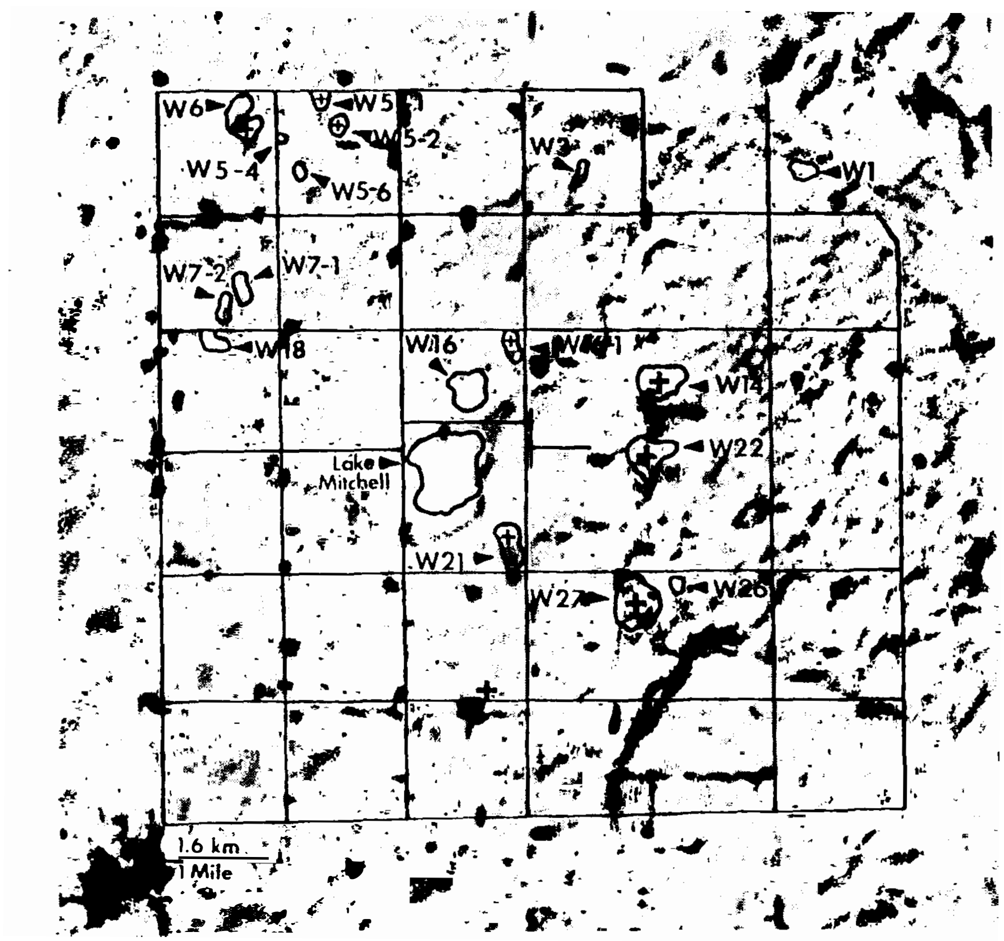


Figure 7. Landsat 3 positive print enlargement of study area. Scene ID #21478-16261, MSS Band 7, February 8, 1979. Snow depth at this time was approximately 0.6 m. Notice the improved contrast and lack of scan lines in this product due to EROS Digital Image Processing System (EDIPS).

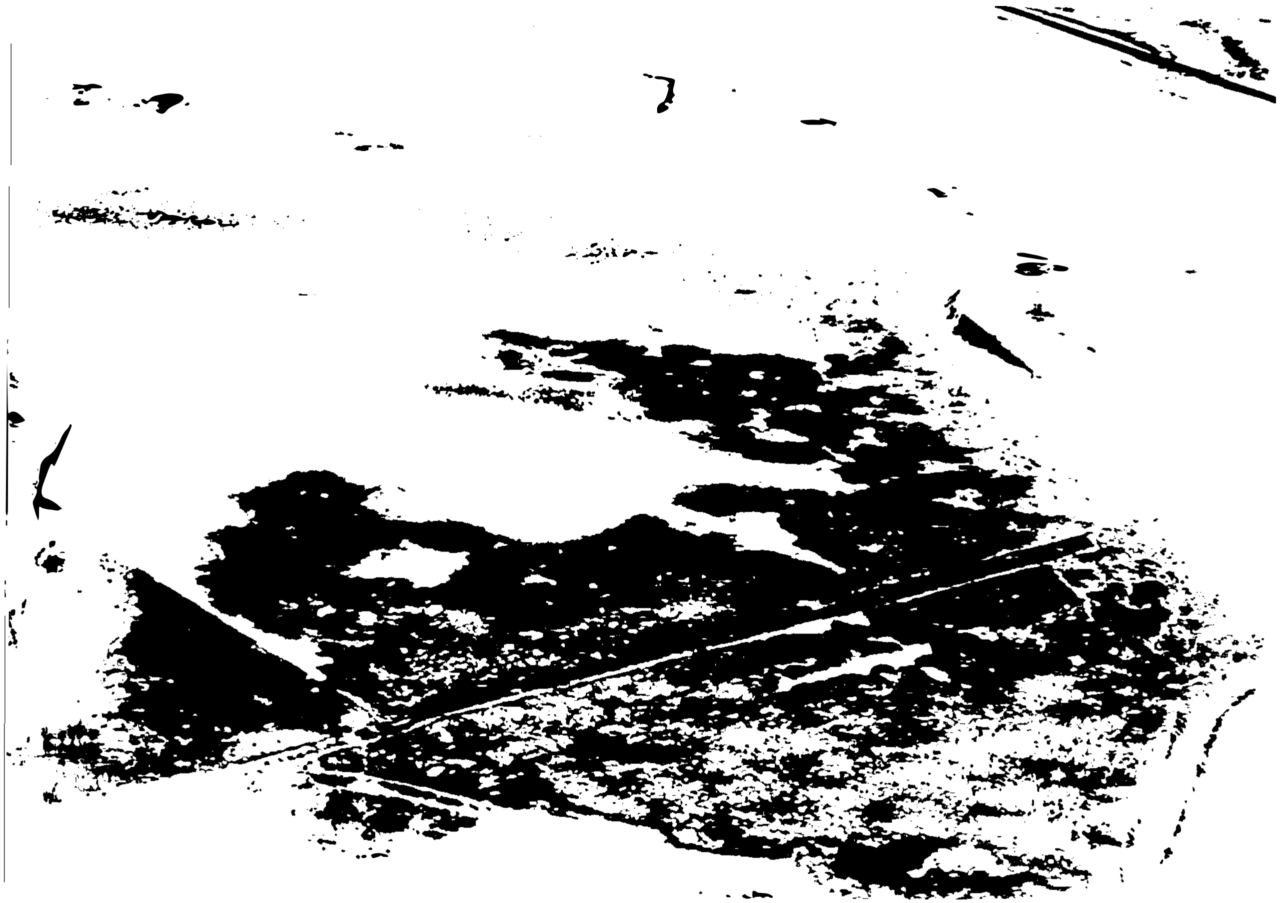


Figure 8. Oblique aerial photograph of wetland 14 (115.5 ha) taken March 3, 1979. Dark area is dominated by cattail while lighter shaded area of the wetland in the background is dominated by sparse stands of roundstem bulrush.

vegetation and as such was probably not a winter concentration site for pheasants.

Historic high altitude photography (Figure 1) also indicates that a complex of 4 wetlands existed south of wetland 14 in 1972. The EDIPS Landsat data (Figure 7) indicated that only wetland 22 contained dense emergent hydrophytes. The other three wetlands have been drained and converted to agricultural use.

The graininess and lack of high contrast of the standard Landsat imagery (Figure 5) seriously affects the resolution capacity so that many small wetlands are difficult to interpret. Note the difference of wetlands 7-1 and 7-2 reflectance on the 21 December, 1977 imagery, compared with their reflectance on the 8 February, 1979 EDIPS enhanced imagery (Figure 7). Wetlands this size can be very important for pheasants during the winter months. For many years enhancement techniques have been used by remote sensing technicians to improve interpretability of standard products of Landsat data. Only recently have these techniques been implemented at EROS on incoming Landsat data. This development makes available a much improved product to wildlife agencies that often lack the expertise, facilities, and monies needed for imagery enhancement.

If Landsat data are used for locating possible pheasant winter concentration sites it is suggested that EDIPS imagery and/or RBV data be obtained. Aircraft imagery and/or topographic maps are also needed to aid in interpretation. The data should be obtained at the earliest date possible during the winter or before considerable snow accumulation in the wetlands.

SUMMARY

Height was the most important vegetative factor influencing loafing site selection during both winters. Shrubs were the preferred cover type for loafing. Trees, phragmites, and cattails were also utilized during the day though not to the extent of shrubs. Roundstem bulrushes, smartweeds, and grasses were seldom used since drifted snow often covered these cover types. Dense herbaceous cover did not exist near the wetlands so little use was documented. Observations of pheasants loafing in an uncultivated area with dense herbaceous cover suggested that this cover type was heavily used when present.

Density was the most important vegetative factor influencing pheasant selection of roost sites. Dense stands of phragmites and cattails seemed to be preferred roost sites. The majority of pheasant roosts located during the 1978-79 season was in cattails while phragmites had the greatest relative number of roosts. Shrubs were not used as roosting cover to the extent that they were used as loafing cover. Pheasant roosts were observed in herbaceous cover near the study wetlands.

The size of a wetland and the presence of emergency cover around the wetland were the most important factors influencing degree of pheasant use. Three primary concentration sites, two secondary sites, and one tertiary site were observed for the selected wetlands. Concentration sites were dense cattail wetlands or had considerable shrub growth. The small wetlands with no associated shrub growth filled with snow early in the season and were not used. Emergency

cover in the form of shelterbelts, uncultivated areas, wetlands, and standing corn was used to a greater extent late in the season when snow had filled large portions of the wetlands.

Landsat data coupled with topographic information and/or aerial photography can supply accurate information on winter cover conditions in wetlands if (1) data are collected early in the season before considerable snow accumulation in the wetlands and (2) the imagery is EDIPS or RBV. Interpretation of small wetlands is difficult on the standard Landsat imagery due to the graininess and lack of high contrast of the product.

Management Recommendations

1. Wetlands and wetland complexes should be preserved. This study found that large dense cattail wetlands with associated small shrub plots supported large winter concentrations of pheasants. Smaller shrub and phragmites wetlands also supported wintering pheasants each year if they were in close proximity to a primary concentration site.
2. Winter habitat improvement on existing state and federally owned land is urged. No management per se of the wetlands is recommended but rather of the upland associated with the wetland. Loafing cover could be improved by planting small compact (not linear) plots of shrubs near the wetland. Tracts of tall herbaceous cover would act as additional loafing and roosting cover as well as emergency cover. Emergency cover could also be improved by restoring shelterbelts and woodlots in close proximity to the wetlands.
3. If existing traditional pheasant wintering sites are to be located, use of remote sensing technology would be of special value. Current Landsat imagery with additional data could be used to locate wetlands containing dense hydrophytic vegetation which are potential concentration sites. Imagery data should be collected early during the winter season before considerable snow accumulation. An effort should be made to acquire either EDIPS or RBV imagery.

LITERATURE CITED

Best, R.G. and S. Sather-Blair. 1978. The interpretation of winter wildlife habitat in eastern South Dakota on Landsat imagery. Pages 50-55 in Proc. Pecora IV Symposium, Application of Remote Sensing Data to Wildlife Management, Sioux Falls, S.D., Oct. 10-12. Nat. Wildl. Fed. Scientific and Tech. Series 3.

Bue, I.E. 1949. Winter behavior and mortality of pheasants in relationship to various types of cover, food and predation. S.D. Dept. Game, Fish and Parks, Spec. Rep. for P-R Projects 19-D-2 and 17-R-3, 38 pp.

Gates, J.M. 1970. Recommendations for a scattered wetlands program of pheasant habitat preservation in southeast Wisconsin. Wis. Dep. Natur. Resour., Res. Rep. No. 63. 24 pp.

________. 1971. The ecology of a Wisconsin pheasant population. Ph.D. Thesis, Univ. of Wisconsin, Madison. 912 pp.

________, and J.B. Hale. 1974. Seasonal movement, winter habitat use and population distribution of an East-Central Wisconsin population. Wis. Dep. Natur. Resour., Tech. Bull. No. 76. 56 pp.

Green, W.E. 1938. The food and cover relationship in the winter survival of the ring-necked pheasant, *Phasianus colchicus torquatus* Gmelin, in northern Iowa. Iowa St. Coll. J. Sci. 12:285-314.

Grondahl, C.R. 1953. Winter behavior of the ring-necked pheasant, *Phasianus colchicus*, as related to winter cover in Winnebago County, Iowa. Iowa St. Coll. J. Sci. 27:447-465.

Kimball, J.W. 1948. Pheasant population characteristics and trends in the Dakotas. Trans. N. Am. Wildl. Conf. 13:291-314.

Kirsh, L.M. 1951 Our winter storm losses. So. Dak. Conserv. Dig. 18:2-3.

Klonglan, E.D. 1971. Effects of some Iowa winter on pheasants. Pages 268-278 *in* Pro. Snow and Ice in Relation to Wildl. and Recreation Sym, Ames, Iowa, Feb. 11-12. Iowa Coop. Wild. Res. Unit, Iowa State Univ., Ames, Iowa.

Lyon, L.J. 1954. Pheasant winter roosting cover preference in north-central Colorado. J. Wildl. Manage. 18:179-184.

Robertson, W.B., Jr. 1958. Investigation of ring-necked pheasants in Illinois. Ill. Dep. Conserv., Tech. Bull. No. 1. 137 pp.

Shaw, S.P., and C.G. Ferdine. 1956. Wetlands of the United States, their extent and their value to waterfowl and other wildlife. U.S. Fish and Wildl. Ser. Circ. 39, Washington, D.C. 67 pp.

Shick, C. 1952. A study of pheasants on the 9,000 acre Prairie Farm, Saginaw County Michigan. Mich. Dep. Conserv. Lansing. 134 pp.

Spuhler, W., W.F. Lytle, and D. Moe. 1971. Climate of South Dakota. South Dakota State Univ., Agric. Exp. Sta. Bull. 582. 30 pp.

U.S. Dept. of Commerce. 1977-1979. Climatological Data: South Dakota. National Oceanic and Atmospheric Administration National Climatic Center: Asheville, N.C.

Wagner, F.H. 1953. Pheasant population distribution survey and range analysis. Wisc. Wildl. Res. 12:21-47.

Weston, H.G., Jr. 1954. The winter-spring movements of the ring-necked pheasant in northern Iowa. Iowa St. Coll. J. Sci. 29:39-60.