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A B S T R A C T

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A survey was conducted in 1953 to determine the feasibility of using aerial photography to measure the trends in available waterfowl habitat in the Nebraska Sandhills. This pilot survey included 96 one-square-mile sections systematically distributed over the area to give a 0.49 percent sampling rate.

The basic waterfowl habitat types apparent on the aerial photos of these sections were identified and measured with a planimeter and map measure. These ascertained totals were then projected to obtain the estimated total of each habitat type in the study area.

A statistical analysis of the survey revealed that it would be necessary to use a sampling rate of approximately 22 percent rate in order to estimate the totals of each habitat type within an error not to exceed 5 percent of the estimated totals. Indications were that a 0.5 to 1.0 percent sampling rate would then be sufficient to measure the change in available habitat.

Because of the magnitude of the survey required, this study was discontinued and no further attempt has been made to relate population trends to changes in the available habitat.

MEASURING WATERFOWL HABITAT - POPULATION CHANGES FROM AERIAL PHOTOS

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One of the major problems in waterfowl management is the determination of the trends in the breeding populations and in the habitat available to those populations. The surveys necessary to determine these trends must be extensive enough to produce reasonably reliable trend data yet fast, economical and simple enough to be accomplished by a small field staff. An ideal survey would not be subject to the discrepancies of human interpretation.

This paper will report on a pilot study designed to determine the feasibility of using aerial photography to measure the trends in available waterfowl habitat and the possibility of relating the trends in breeding populations to these habitat trends in Nebraska.

The major waterfowl breeding grounds in Nebraska are the wetlands in the Sandhills region, an area of approximately 23,000 square miles of gently rolling to rough dune sands in the north-central part of the State. These wetlands are of several types ranging from temporary to more-or-less permanent areas, all of which are dependent upon runoff or ground-water levels. The average annual rainfall in the region ranges from 18 inches to 24 inches and may vary from less than 50 percent of average to more than 200 percent of average during any one year. Therefore, the amount of available habitat will vary considerably from year to year or even from season to season.

The major portion of the region is maintained as native mixed-prairie grasslands devoted to the production of cattle and hay. Most of this region is privately owned by large ranches. The human population is sparse and much of the country is isolated from all-weather roads.

It was theorized that the size of the breeding population in Nebraska during any one year could be directly correlated to the amount of habitat available to that population at the outset of that breeding season. This was based on the assumption that, because Nebraska is on the southern limits of most species' breeding grounds, the ducks would completely occupy the available habitat and then move on north until, at the northern limits of the breeding grounds, they may become crowded to more than carrying capacity by limited available habitat or vica versa in relatively unrestricted areas.

On the basis of this theory, a pilot survey was initiated in 1953 to determine the feasibility of using aerial photography to sample the Sandhills breeding grounds. From these photos, the amount and extent of each type of wetlands would be measured as a basis for determining the trends in habitat available to the breeding populations. Subsequent surveys would then be designed to determine the relationship between trends in the population and this available habitat.

Figure 1 shows an outline of the area included in the survey. This area contained 19,596 square miles and included the major portion of the Sandhills which contained significant amounts of wetlands.

A total of 96 one-square-mile study units were selected from a systematic grid over the study area. This provided a sampling rate of approximately 0.5 percent (0.4899%) or a projection factor of 204.12.

Each study section was visited and marked for identification from the air prior to the survey. The markers were constructed of discarded truck tires split in half along the circumference and painted with aluminum paint. (These markers were readily visible from the air when placed near the southern boundary of the study sections).

A Fairchild K-20 Aerial Camera was used to photograph the study sections. The exposures were made by holding the camera from the open doors of a Piper Super Cub 135 airplane flying at 10,000 feet above the ground. The exposure was 1/250 second at f-8 or f-11 on Type 1A -- Class L Kodak Super-XX Aerographic film.

One mechanical problem encountered was the determination of the true verticle over the center of the study section. It was almost impossible to visually determine this position in the western portion of the study area where sections were not always deliniated by fences or roads; it was literally impossible to tell what was "straight up". Generally, the distortion caused by this error could be corrected by tilting the enlarging easel; however, it would be desireable to use a sighting device which would enable the determination of the aircraft's verticle position in relation to the study section.

Inclement weather delayed the survey somewhat and the first complete coverage was not accomplished until June 1 - 3, 1953. Several selected areas were resurveyed on July 7 and again on July 28 to determine seasonal changes in the available habitat.

The negatives were enlarged to a scale of 8 inches per mile and printed on Kodak Resisto Rapid paper, a special paper which can be air dryed without shrinkage. The easel on the enlargement machine was tilted to correct for minor distortion caused by the aircraft not being directly above the center of the study area at the time the exposure was made.

A general, rudimentary wetlands classification table was established (Table I) and all wetlands shown on the study area photos were delineated and classified. A map measure and a planimeter were used to determine the total amount of habitat by types on each study section. A summary of the measurements and the projection to the entire study area is shown in Table II.

The results of this survey were statistically analyzed by Dr. Donald Kavel, Department of Agricultural Economics, Extension Service, University of Nebraska. A summary of his analysis is presented in Table III.

This analysis indicated that at the 95 percent confidence level, the standard error exceeded 20 percent of the estimated total for one relatively important type. Obviously, considerably more accuracy is required, particularly if population trends are to be determined by the projection of a population - habitat relationships.

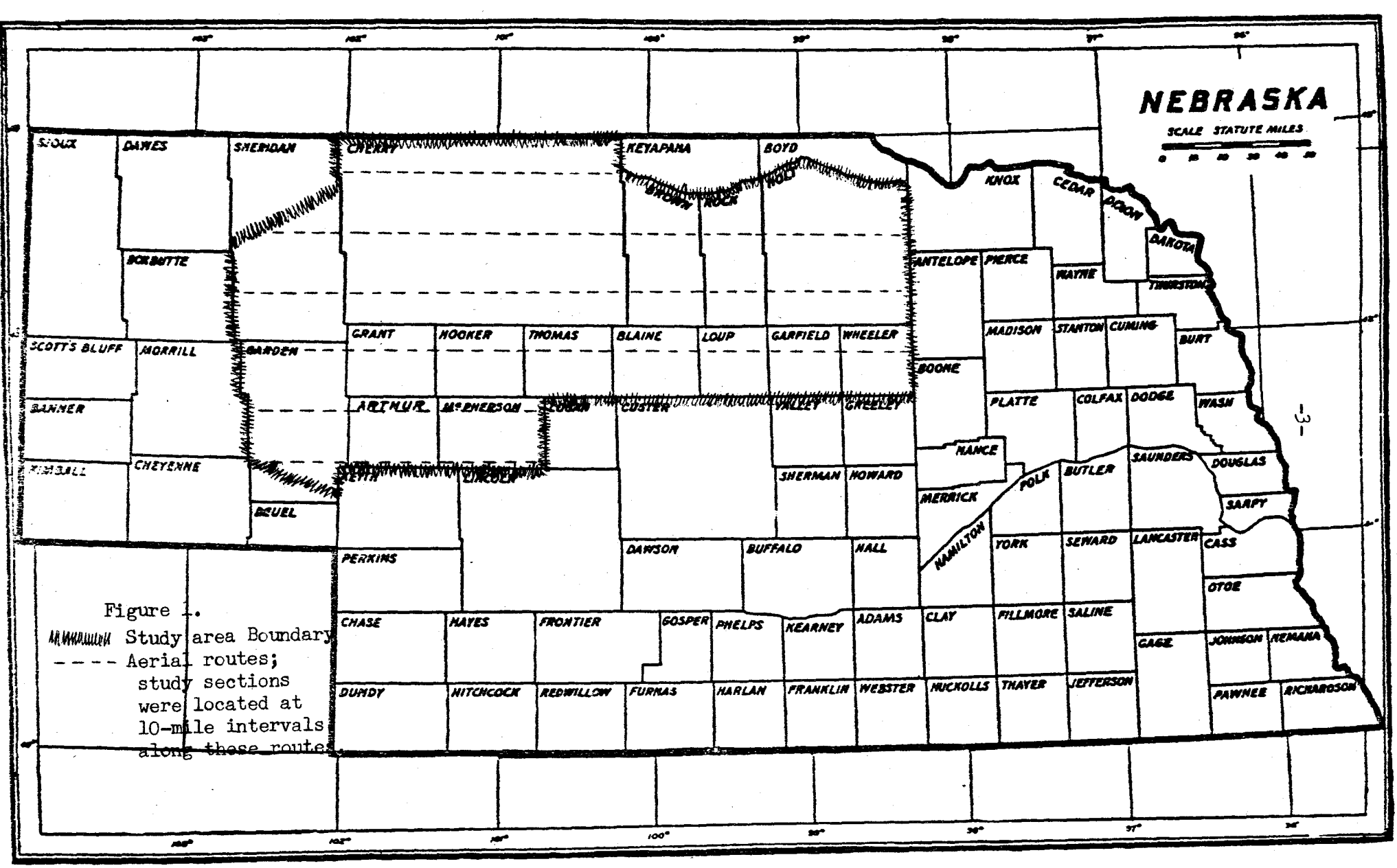

Figure 1.

Study area Boundary

Aerial routes; study sections were located at 10-mile intervals along these routes.

Table I. General Water Area Classification

Water area	Size limits	Units of measure	Normal permanancy	Description
Puddle	less than 3 acres	number	does not remain through breeding season	shallow areas following spring thaw or rain, no aquatics, relatively unimportant except as breeding areas associated with adjacent permanent water areas.
Pothole	less than 3 acres	number and acres	lasts through breeding season	of sufficient depth to support acquatics, relatively unimportant in itself but very important as associated with adjacent permanent water areas.
Lake	three acres or more	shoreline distance	lasts through breeding and brooding seasons	supports aquatics on less than 50 percent of surface area, is self-suffi-breeding area, very important as shoreline available for territorial sites.
Marsh	three acres or more	acres	lasts through breeding and brooding seasons	supports aquatics on more than 50 percent of surface area, territorial sites limited by vegetative cover, importance dependent upon territorial sites such as muskrat houses.
Wet Meadow	three acres or more	acres	does not remain through breeding season	flooded hay meadows as large puddles, no aquatics, relatively unimportant except as associated with permanent water areas.
Ditch (hiway and drainage)		length	lasts through breeding and brooding seasons	relatively important as dependent upon bank height, aquatics and width of open water, usually self-sufficient breeding area.
Stream and river		length	permanent	natural flowing water of importance relative to width of open water, height of bank and bank condition.
Mill Ponds		number	permanent	stock tank overflows, relatively unimportant except as associated with permanent lake-type areas.

Table II. Summary of Photo Measurement and Projected Estimated Totals

habitat type	totals as measured on aerial photos of study sections			totals as projected to entire study area. (sample rate = 0.4899 pct. projection factor = 204.12)		
	number	acres	linear feet	number	acres	linear feet
no wetlands on section	24			4,899		
puddles	733			149,620		
wet meadow		453.1			92,487	
potholes	138	170.0		28,169	34,700	
lakes	38*			7,348		
lakes shoreline			176,595			36,046,571
ditch			51,600			10,532,592
stream			140,310			28,640,077
mill ponds	33			6,736		

* Includes only those lakes one-half or more on the study section.

Table III. Statistical Analysis of Estimated Total Waterfowl Habitat

habitat type	projected estimated totals	standard error of the estimated totals	coefficient of variation*
puddles (numbers)	149,620	36,065	.241
wet meadow (acres)	92,487	38,207	.413
potholes (number)	28,169	7,413	.263
lakes (shoreline feet)	36,046,571	8,425,253	.234
ditch (linear feet)	10,532,592	3,734,584	.355
stream (linear feet)	28,640,077	7,984,736	.279

* The standard error of the estimated total divided by the estimated total.

The accepted maximum standard error strived for in waterfowl surveys is 20 percent of the estimated totals. If we assume some error in population - habitat relationships, it would appear necessary to reduce the standard error to less than 10 percent and preferably less than 5 percent of the estimated totals. The statistician concluded from these survey data that a survey to measure the total of each habitat type would have to include 344 sample sections to reduce the standard error to less than 20 percent of the estimated totals or 4,362 sample sections to reduce the error to less than 5 percent of the estimated totals.

The cost of this survey was approximately $9.00 for each sample section in the early June survey including the cost of marking the section for identification from the air. Based on these data, the cost of subsequent surveys of marked sections would be approximately $5.00 per study section.

Obviously, the cost of a survey to determine the total amount of available habitat would be prohibitive. Just as obviously, the work involved in processing, printing and measuring 4,362 aerial photographs would be nearly overwhelming. However, the statistician has concluded that, once the estimated totals of each habitat type have been ascertained, it is entirely possible that a survey at this 0.50 percent sampling rate would reliably indicate the annual changes in available habitat. Therefore, it may be economically feasible to use a sample of 4,362 photos (a sampling rate of 22.3 percent) from the Government files maintained by the U. S. Department of Agriculture, Soil Conservation Service. This would require an estimated maximum of 90 man-days to determine the total of each wetlands habitat type; however, this survey would be based upon the particular year the latest photos were taken and therefore, would not necessarily need be completed before the field surveys to obtain trend data were initiated. The principal question concerns the value of knowing how much of each kind of wetlands habitat is available.

No actual population - habitat relationships were determined. It is interesting to note that the general observations of several field workers during subsequent years have indicated that there may be a reasonable constant relationship between the population and the available habitat in Nebraska.

An example of the application of the theory stated at the beginning of this paper can be based on the average habitat requirements for the blue-winged teal (Waterfowl and Land Use, M. C. Hammond, Unpubl. 1953) of 175 feet of space per pair. Therefore the capacity of the lakes would be 36,046,571 feet divided by 175 feet per pair or 205,980 pairs, the capacity of ditches would be 10,532,592 feet divided by 175 feet per pair or 60,186 pairs and etc.

In conclusion, it is evident that an extensive aerial photography survey at a high sampling rate is required to ascertain the amount of each type of wetlands in the Nebraska Sandhills. Such a survey would be prohibitive from the cost standpoint; however, it may be economically feasible to use aerial photos from the files of the U. S. Soil Conservation Service. Subsequent surveys to determine trends should then be relatively inexpensive. Certainly the information obtained from this pilot survey indicates the desireability of further study into the subject.