A study of waterfowl production on artificial reservoirs in eastern Montana
by Richard H Smith

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University


Abstract:
A 3-year study of waterfowl production was made on 124 artificial reservoirs in 3 sections of eastern Montana during the summers of 1949 1950 and 1951. Twelve reservoirs were selected for concentrated studies in 1951. Data were gathered concerning the vegetative and physical characteristics of the reservoirs. Spring aerial waterfowl censuses, ground, and brood counts were made all 3 years; nesting studies and territorial pair counts the last 2 years. Observations showed that 12 species of waterfowl used the reservoirs but only 7 produced broods: mallard, gadwall, baldpate, pintail, green-winged teal, blue-winged teal and shoveller. Waterfowl usage and brood production were evaluated in relation to size, vegetative type and age. Size was shown to be the most important factor influencing each. Vegetation had a lesser effect, and age very little if any. Ihe importance of the reservoirs in relation to waterfowl production in eastern Montana was stressed. Areas formerly with very little water habitat are now producing considerable numbers of waterfowl.

# A STUDY OF WATERFOWL PRODUCTION ON ARTIFICIAL RESERVOIRS IN EASTERN MONTANA

by

RICHARD H. SMITH

A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

for the degree of

Master of Science in Fish and Wildlife Management

at

Montana State College

Approved:

J. A. Pepper
Head, Major Department

Dan C. Quimby
Chairman, Examining Committee

L. A. Nelson
Dean, Graduate Division

Bozeman, Montana
July, 1952

CONTENTS

ABSTRACT ..... 3

INTRODUCTION ..... 4

DESCRIPTION OF AREAS ..... 6

PHYSICAL CHARACTERISTICS OF THE RESERVOIRS ..... 8

Size ..... 8

Depth ..... 8

pH ..... 10

Turbidity ..... 10

Construction of Dams ..... 11

Seepage ..... 11

Age ..... 12

VEGETATIVE CHARACTERISTICS OF THE RESERVOIRS ..... 12

Adjacent Vegetation ..... 13

Emergent Vegetation ..... 15

Submerged Vegetation ..... 15

Vegetative Classification of the Reservoirs ..... 16

SPRING AERIAL COUNTS ..... 17

SUMMER GROUND COUNTS ..... 21

TERRITORIAL PAIRS ..... 27

NESTING STUDIES ..... 28

BROOD COUNTS ..... 31

CONCLUSION ..... 38

SUMMARY ..... 38

LITERATURE CITED ..... 42

ABSTRACT

A 3-year study of waterfowl production was made on 124 artificial reservoirs in 3 sections of eastern Montana during the summers of 1949, 1950 and 1951. Twelve reservoirs were selected for concentrated studies in 1951. Data were gathered concerning the vegetative and physical characteristics of the reservoirs. Spring aerial waterfowl censuses, ground, and brood counts were made all 3 years; nesting studies and territorial pair counts the last 2 years. Observations showed that 12 species of waterfowl used the reservoirs but only 7 produced broods: mallard, gadwall, baldpate, pintail, green-winged teal, blue-winged teal and shoveller. Waterfowl usage and brood production were evaluated in relation to size, vegetative type and age. Size was shown to be the most important factor influencing each. Vegetation had a lesser effect, and age very little if any. The importance of the reservoirs in relation to waterfowl production in eastern Montana was stressed. Areas formerly with very little water habitat are now producing considerable numbers of waterfowl.

## INTRODUCTION

Through the efforts of federal agencies (P.M.A. and S.C.S.) and private landowners, a large number of stock water ponds and irrigation dams have been constructed during recent years in the semi-arid portions of eastern Montana. The program is still in progress. Brown and Thoreson (1951) estimated there were 40,000 artificial ponds of 50 acres or less in the entire state in 1950. Thus a considerable amount of water area has been created.

An attempt is being made to evaluate waterfowl production on these areas in eastern Montana. In the spring of 1949, three trend areas in 3 counties (Musselshell, Carter and McCone) containing about 50 ponds each were selected by personnel of the Wildlife Restoration Division of Montana Fish and Game Department and the Missouri River Basin Studies, Billings, Montana, as being representative for study (fig. 1). During the next 3 summers, the writer gathered information between May 18 and Sept. 9(1949, June 26 to Sept. 9; 1950, May 18 to Aug. 14; and 1951, May 24 to Aug. 27) on the 124 that proved to be more or less permanent.

Most of 1949 was spent locating the reservoirs and charting them on a prepared map of each trend area. In 1950 at least 2 visits, about 5 weeks apart, were made to each reservoir. In 1951 the entire summer was spent visiting each trend area by car at approximately one-month intervals. At least 4 visits were made to each reservoir. Twelve, 4 in each county, were selected as being representative of sizes and vegetative types for more detailed study. Each had produced waterfowl during the previous summers. Eight or more visits (2 during each visit to the trend

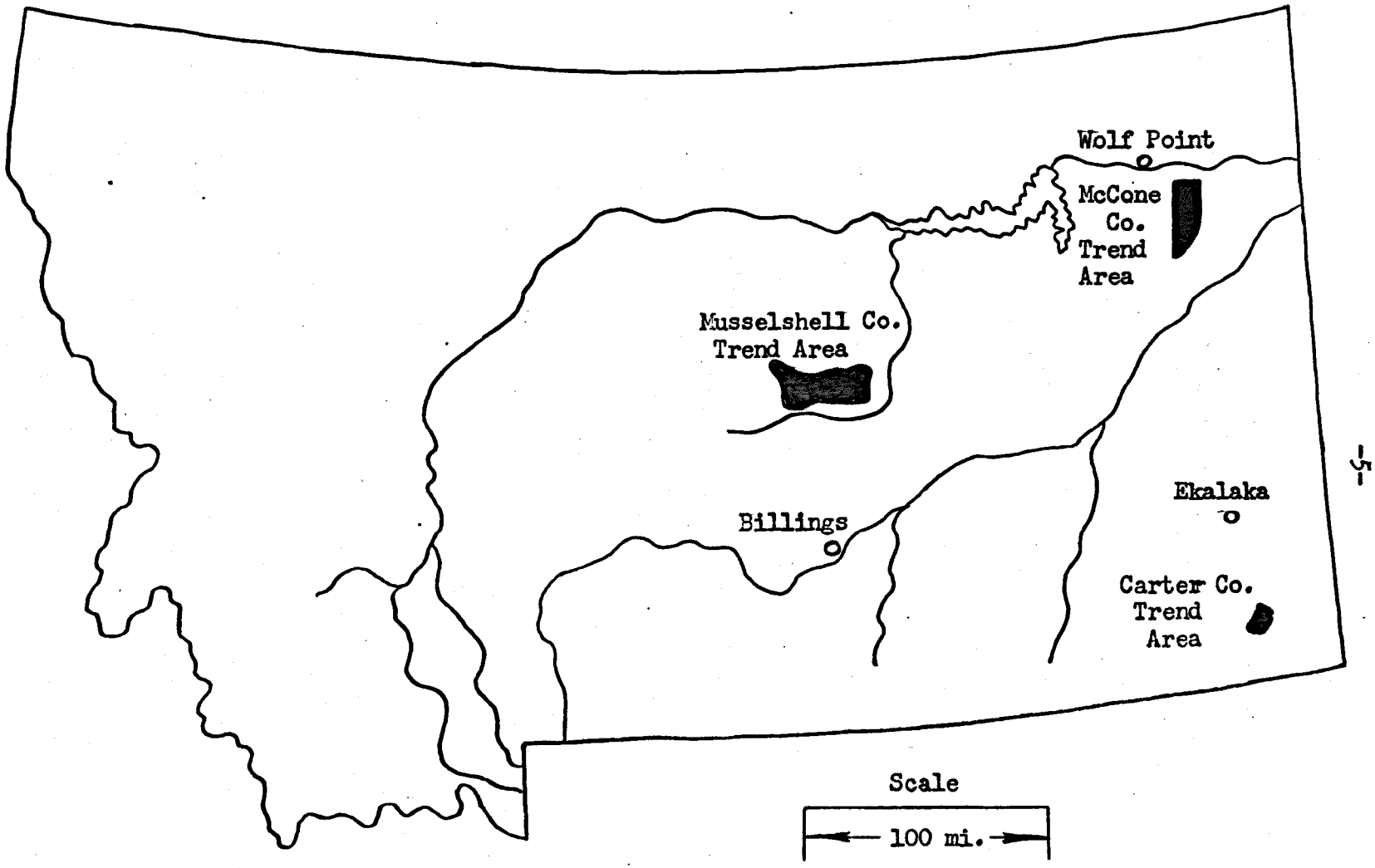


Fig. 1 Map of Montana showing waterfowl study areas

area) were made to these special study ponds.

The writer wishes to express his thanks to the Montana Fish and Game Department for financing the project; to Wynn Freeman for the initiation of the project, and general supervision throughout the study; to Gerry Salinas, Joe Mazuranich, Henry Ritzer, and Bob Cotner for field assistance; to Dr. W. E. Booth, Montana State College, for verifying the identification of plant collections; and to Adrien L. Hess, Montana State College, for aid in statistical treatment of the data. Further appreciation is extended to Dr. Don C. Quimby, Montana State College, for advice during field work and assistance in the preparation of the manuscript.

## DESCRIPTION OF AREAS

The climate of eastern Montana is characterized by heavy spring runoffs followed by a dry summer. Yearly rainfall recorded for all weather stations (Maughan 1941) in the three counties averaged 13.66 inches (Table I). Forty-three and four-tenths per cent of the yearly moisture was received in April, May and June; 27.6 per cent in July, August, and September. After filling in the spring, usually the water level of the reservoir gradually recedes as the summer progresses, some drying completely. Infrequently summer rains refill the ponds or maintain the water level.

The sparsely-populated Musselshell and Carter County trend areas consist mostly of unglaciated, rolling, sagebrush-grassland hills interrupted by eroded gullies and drainage bottoms. A strip of ponderosa pine occupies the sandstone ridges of the southern one-third of the Musselshell

Table I. Annual precipitation of the study areas.

| County | Station | Length of record (years) | Precipitation inches: Amount (April-May June) | % | Amount (July-Aug. Sept.) | % | Amount yearly total |
|---|---|---|---|---|---|---|---|
| McCone | Circle | 37 | 6.95 | | 4.25 | | 16.09 |
| | Vida | 12 | 5.91 | | 3.94 | | 15.05 |
| Mussel-shell | Melstone | 21 | 5.37 | | 3.16 | | 11.73 |
| | Roundup | 17 | 5.27 | | 3.23 | | 12.26 |
| Carter | Ekalaka | 37 | 6.14 | | 4.28 | | 13.17 |
| | | Average | 5.93 | 43.4 | 3.77 | 27.6 | 13.66 |

area, but contains only eight reservoirs. The Carter county area is for the most part treeless except for scattered box elder and cottonwood along the drainage bottoms. All streams are intermittent, flowing only during spring runoff or heavy summer rains. Livestock raising is the principal econony in both areas. The reservoirs are utilized largely for stock water and in most cases furnish the only water supply throughout the summer. Erosion is high and silting common.

About one-third of the McCone County area is under dry-land strip farming. Wheat is the main crop. Sagebrush is lacking on the treeless, grassland terrain. Reservoirs are used for both stock water and erosion control. One was used for irrigation. Several small intermittent streams which bisect the area have water standing in much of their length throughout the summer and contain water after many of the nearby reservoirs have dried.

The 3 trend areas have a total area of 518 square miles (Mussel-shell County area 258, McCone 210, and Carter 50). The average distri-

bution of the ponds is about 1 every 4 square miles.

## PHYSICAL CHARACTERISTICS OF THE RESERVOIRS

### Size

The surface acreage of all ponds was roughly determined by drawing them to scale on graph paper and measuring with a planimeter. The dimensions of the ponds were determined by calibrated pacing. An aerial photograph of 3 ponds was taken at about the same time the above measurements were made as a check on their accuracy. All measurements were within 5 per cent.

The range in surface acreage of 124 ponds was 0.1 to 19.1 acres (Av. 3.2). Sixty-five (52.4%) were 2 acres or less. Only 6 (4.8%) were larger than 10 acres (fig. 2). By counties the ponds averaged as follows: McCone, 4.1 acres for 37; Musselshell, 3.3 for 44; and Carter, 2.3 for 43.

For convenience in discussion and analysis the ponds were grouped into 5 size groups as shown in Table II.

Table II. Size groupings by counties of 124 ponds.

| Group | Size range (in acres) | No. of Ponds | | | Total |
|---|---|---|---|---|---|
| | | Musselshell | Carter | McCone | |
| 1 | 0 - 1.05 | 12 | 19 | 6 | 37 |
| 2 | 1.05 - 3.05 | 14 | 16 | 15 | 45 |
| 3 | 3.05 - 5.05 | 9 | 4 | 7 | 20 |
| 4 | 5.05 - 10.05 | 8 | 2 | 6 | 16 |
| 5 | 10.05 & more | 1 | 2 | 3 | 6 |
| | | 44 | 43 | 37 | 124 |

### Depth

Depth was determined by sounding for the 12 special study reser-

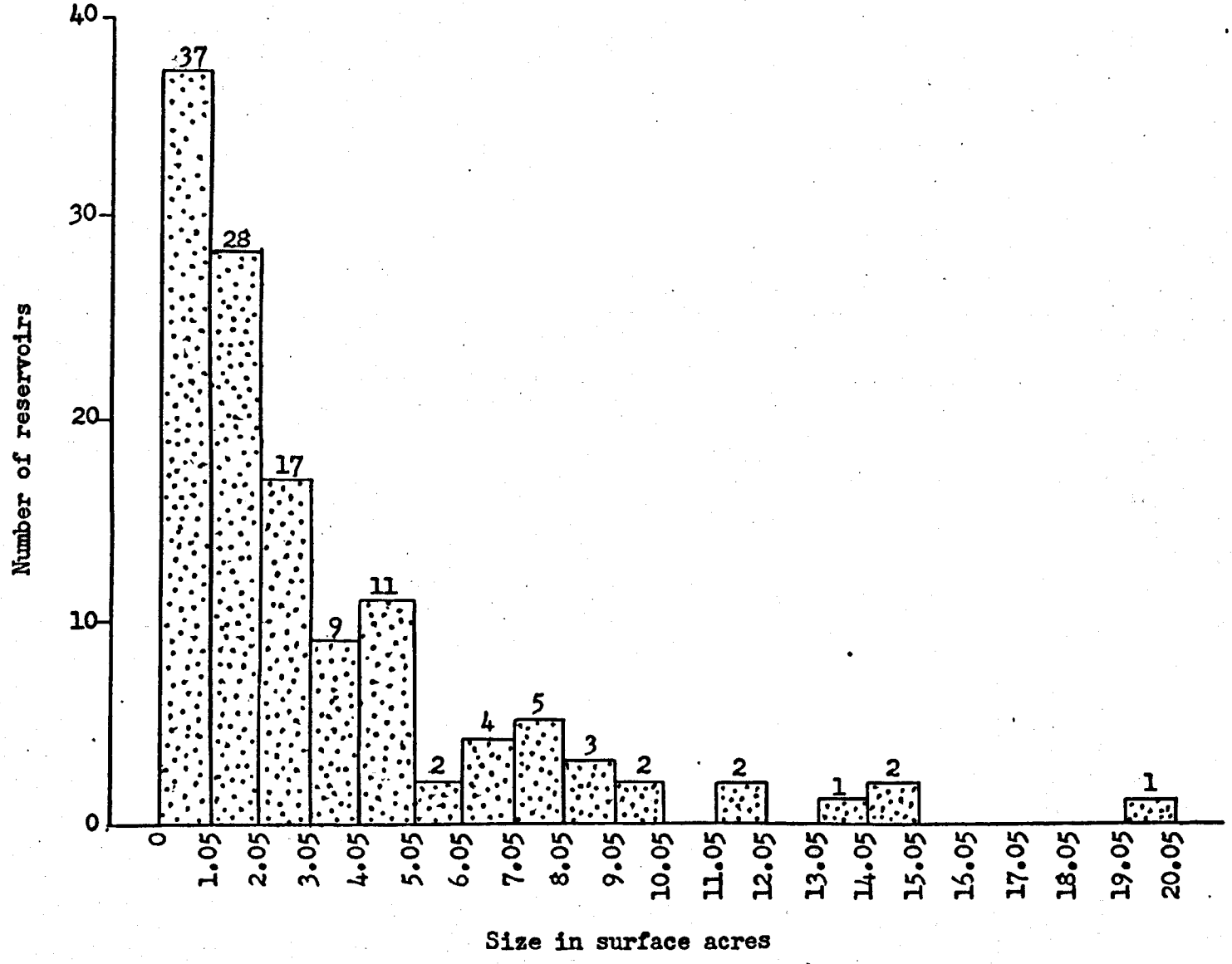


Fig. 2 Distribution of 124 reservoirs by size

voirs. The average maximum depth (at "normal" water level) was 6.9 ft. (4-10). The average depth, in most cases, was considerably less than the maximum depth. The area surrounding the original creek bed of many reservoirs is flooded during "normal" water. Silting has a tendency to level off the reservoir floor. Contour maps of 4 reservoirs over 9 years old and 1 only 3 years old showed neither a sharp demarkation of the bottom nor an old channel.

## pH

All pH determinations were made with a Taylor Colormetric Comparator. In 1950, 105 determinations were made on as many reservoirs between May 18 and Aug. 21. All were alkaline, 7.7 to 9.4. Some samples were higher than 9.4 but equipment to measure higher values was not available. In 1951, 45 determinations were made on 16 ponds from May 26 to Aug. 27. Readings averaged 8.9 (6.9-10.2). Four readings for different months were taken on each of 5 reservoirs. These indicated that the alkalinity increased through July and then decreased slightly during August (May av. 9.0; June, 9.4; July, 9.5; Aug., 9.1).

## Turbidity

Turbidity for special study reservoirs was determined with a 20 cm., alternate black and white quartered secchi disk during 1951. Depth of 42 readings (the depth a secchi disk disappeared from sight) is given in Table III. All ponds were muddy following spring runoff, but generally cleared as the summer progressed. Sometimes late summer rains and plankton growths increased the turbidity. During the last 2 periods, the

Table III. Reservoir turbidity readings in 1951.

| Date | Number of readings | Average turbidity (inches) |
|---|---|---|
| May 26 - June 7 | 12 | 25.2 (6-47) |
| June 15 - July 1 | 12 | 32.0 (2.5-50*) |
| July 11 - July 27 | 10 | 35.0 (13-59) |
| Aug. 14 - Aug. 27 | 8 | 21.8 (2-45*) |

*Disk visible at bottom of pond.

disk was visible at the bottom of the pond in some instances.

## Construction of Dams

All dams were earth-filled, the dirt being taken from the bottom of the reservoir or the most convenient spot. Nine reservoirs, 7 in Musselshell and 2 in McCone, had been rip-rapped with rock. Four of the 7 in Musselshell County had fences which were not effective through lack of repair. One Carter County dike was protected by a brush wave-breaker and one in McCone County by old rubber tires. Some ponds were without spillways. Others had dirt cuts. A few were lined with rocks and many had grown to grass.

## Seepage

The water may drain out of some ponds within a short period after filling. Others may leak slowly throughout the summer giving rise to small seep areas below the dike. Forty-six ponds had seep areas, none of which exceeded $\frac{1}{4}$ acre, and most were much smaller.

Age

Ages, obtained from P.M.A. records and landowners, of 88 ponds averaged 8.2 years (1 to 18). The distribution by age groupings is shown in fig. 3.

VEGETATIVE CHARACTERISTICS OF THE RESERVOIRS

The principal plant species growing in and adjacent to the reservoirs were collected over the three year period. They were identified and representatives of each deposited in the Herbarium of Montana State College. Quantitative descriptions of vegetation were confined to the 12

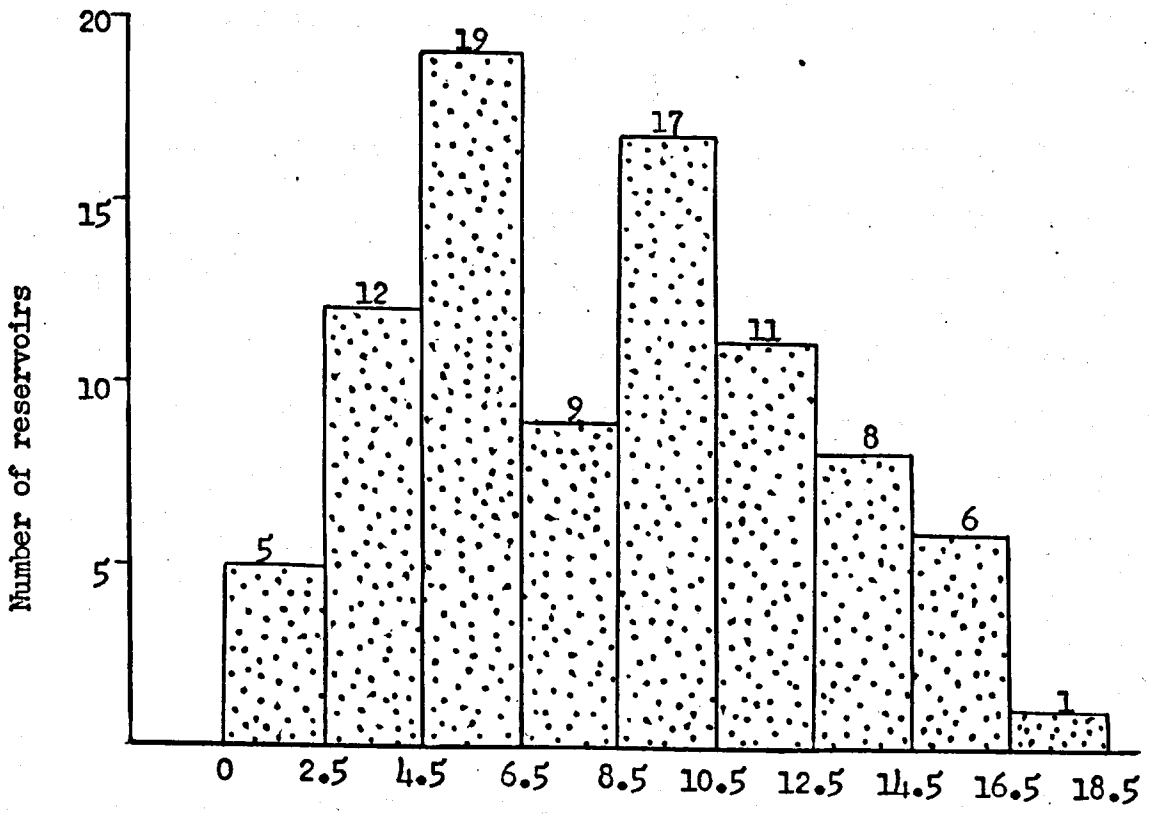


Fig. 3. Age distribution of 88 reservoirs.

selected reservoirs. One-quarter square meter and 1 square meter quadrats were made on the emergent vegetation; point transects and line intercepts on the adjacent vegetation. Monocot terminology is based on Booth's (1950) Flora of Montana, Part 1. Dicots follow Gray's Manual of Botany, (1950) 8th Ed.

## Adjacent Vegetation

Ninety-seven 100-point transects (Coupland 1950) were made at regular predetermined intervals around the shoreline of 10 reservoirs (one of the 12 was bordered by a hayfield, another by a grain field). A stick with 10 nails spaced at 10 cm. intervals was placed on the ground parallel with the shoreline. The area where each nail touched the ground was considered a point. The vegetation touching the nail was recorded. The first 10 points for each 100-point transect were taken at the "normal" waterline; the others at 3 pace intervals perpendicular to the shoreline. The average density for all transects was 55.4 per cent (Musselshell 41.0; Carter 67.4; and McCone 79.6). Seven species, western wheatgrass, blue grama, saltgrass, buffalo grass, Sandberg bluegrass, and two species of needlegrass made up 74.4 per cent of the total ground density (Table IV).

Forty-three 50-foot line intercepts (Canfield 1942) were made on sagebrush and greasewood cover on 4 reservoirs (Musselshell 3, Carter 1) parallel to the point transects. A 50-foot string was stretched above the vegetation. The shrub canopy beneath was recorded in inches by species. Then the per cent cover was determined by dividing the number of inches by the length of the string. The average canopy cover was 7.5 per cent (1.8

Table IV. Vegetative cover as indicated by ninety-seven 100-point transects.

| | Musselshell | Carter | McCone | Total | Per cent of total cover |
|---|---|---|---|---|---|
| Number of reservoirs measured | 4 | 3 | 3 | 10 | |
| Number of points taken | 5300 | 2500 | 1900 | 9700 | |
| Points occupied by species: | | | | | |
| Grasses: | | | | | |
| *Agropyron smithii* (western wheatgrass) | 748 | 626 | 298 | 1672 | 31.1 |
| *Bouteloua gracilis* (blue grama) | 545 | 127 | 114 | 786 | 14.6 |
| *Distichlis stricta* (saltgrass) | 320 | 29 | 314 | 663 | 12.3 |
| *Stipa comata, S. viridula* (needlegrass) | 56 | 33 | 358 | 447 | 8.3 |
| *Buchloe dactyloides* (buffalograss) | | 241 | | 241 | 4.5 |
| *Poa secunda* (Sandberg bluegrass) | | 110 | 86 | 196 | 3.6 |
| *Poa* spp. (bluegrass) | 86 | 9 | 10 | 105 | 2.0 |
| *Koeleria cristata* (junegrass) | | 79 | | 79 | 1.5 |
| *Hordeum jubatum* (foxtail barley) | 31 | 22 | 1 | 54 | 1.0 |
| Misc. grass | 3 | 102 | 68 | 173 | 3.2 |
| Unidentified grass | 65 | 22 | 3 | 90 | 1.7 |
| Forbs: | | | | | |
| *Opuntia polyacantha* (prickley pear) | 59 | 5 | | 64 | 1.2 |
| *Artemisia frigida* (fringed sage) | 37 | 24 | | 61 | 1.1 |
| *Melilotus officinalis* (sweet clover) | 110 | 68 | 3 | 181 | 3.4 |
| Misc. weeds | 106 | 68 | 13 | 187 | 3.5 |
| Others: | | | | | |
| *Carex* spp. | 9 | 87 | 167 | 263 | 4.9 |
| *Juncus balticus* | | | 8 | 8 | 0.1 |
| Misc. shrubs | | 32 | 69 | 101 | 1.9 |
| Number of points occupied | 2175 | 1684 | 1512 | 5371 | 99.9 |
| Per cent cover $\frac{\text{points occupied}}{\text{points taken}}$ | 41.0 | 67.4 | 79.6 | 55.4 | |

to 14.0). Percentages of total canopy cover were: Artemisia tridentata, 79.1; Artemisia frigida, 2.8; Artemisia cana, 6.0; and Sarcobatus vermiculatus, 12.1.

## Emergent Vegetation

Williams and Marshall (1938) measured emergent cover in culms per linear foot. Low (1945) counted culms or stalks per $\frac{1}{2}$ square meter quadrats on bulrush, cattail and sedge stands. The method in the present study was a modification of the latter.

Eighty-five $\frac{1}{4}$ square meter and 112 square meter quadrats were made on 10 special study reservoirs. The other 2 did not have appreciable amounts of emergent cover. Plots were selected at random throughout the stands of individual species, and a square of wood-laths was laid over the stands to delimit the quadrat area. The culms within the quadrat were counted. Ranges and averages are listed in Table V.

Other emergent or semi-aquatic species collected at other reservoirs include: Alisma gramineum (narrow-leaf water plantain), Eleocharis acicularis (needle spike sedge), Polygonum amphibium (water ladysthumb), P. coccineum (swamp knotweed), P. lapathifolium (dock-leaved ladysthumb), Rumex mexicanus (Mexican dock), R. maritimus (bristle dock), Juncus balticus (wire rush), and J. torreyi (bog-rush).

## Submerged Vegetation

The following is a list of aquatic plants occurring in the plant collections (species of very limited distributions are not included):

Table V. Quadrat measurements of emergent vegetation taken on 10 reservoirs.

| Species | No. of quadrats ¼ sq. meter | No. of quadrats 1 sq. meter | Culms per sq. meter range | Culms per sq. meter average* |
|---|---|---|---|---|
| Eleocharis macrostachya (spike rush) | 67 | | 640 - 3948 | 1996 |
| Scirpus americanus (American bulrush) | 18 | | 140 - 820 | 428 |
| Typha latifolia (cattail) | | 38 | 12 - 56 | 37 |
| Scirpus validus, S. acutus (bulrush) | | 7 | 99 - 271 | 176 |
| Beckmannia syzigachne (sloughgrass) | | 10 | 10 - 26 | 15 |
| Sagittaria cuneata (arrowhead) | | 21 | 20 - 67 | 42 |
| Alisma plantago-aquatica (water plantain) | | 18 | 10 - 85 | 40 |
| Alopecurus aequalis (foxtail) | | 10 | 12 - 23 | 17 |
| Miscellaneous** | | 8 | 102 - 278 | 174 |
| | 85 | 112 | | |

* Numbers are rounded off to the nearest whole number.
** Mixed stands of softstem and alkali bulrush (Scirpus paludosus), cattail and American bulrush.

Callitriche hermaphroditica (water starwort), Chara sp. (Muskgrass), Ceratophyllum demersum (coontail), Myriophyllum exalbescens (water milfoil), Potamogeton pectinatus (sago pondweed), P. pusillus (small pondweed), P. richardsonii (clasping-leaf pondweed), P. zosteriformis (flatstem pondweed), Ranunculus trichophyllus (water crowfoot), and Zannichellia palustris (horned poolmat).

## Vegetative Classification of Reservoirs

In 1951 each reservoir was classified into 1 of 5 types on the basis of emergent and/or adjacent vegetation:

Type I. Sagebrush-grassland. This type affords little or no emergent vegetation. The sagebrush and related plants such as grasses and greasewood extend to the water's edge (fig. 4). The mean age of 15 reservoirs was 6.5 years.

Type II. Marsh. Cattails and bulrush (hardstem and softstem) afford moderate to dense emergent cover. Spike rush or American bulrush often supply a minor amount of emergent cover (fig. 5). The mean age of 9 reservoirs was 9.4 years.

Type III. Meadow. This type is predominately spike rush or American bulrush in moderate to dense emergent stands (fig. 6). Other commonly associated emergents include: smartweeds, needle spike sedge, American water plantain, arrowhead and sloughgrass. The mean age of 28 reservoirs was 8.4 years.

Type IV. Woody. Willows (Salix spp.) and young cottonwoods (Populus sp.) usually form a dense stand bordering the shoreline (fig. 7). The mean age of 5 reservoirs was 7.0 years.

Type V. Open. Both emergent and adjacent cover are very sparse or lacking, frequently resulting from overgrazing (fig. 8). The mean age of 25 reservoirs was 8.7 years.

The results are summarized by trend areas in Table VI.

## SPRING AERIAL COUNTS

To determine spring usage, aerial censuses were made during all 3 years by Wynn Freeman and Missouri River Basin studies personnel (Table VII). Of the 1700 waterfowl observed, 1066 (62.7%) were identified to

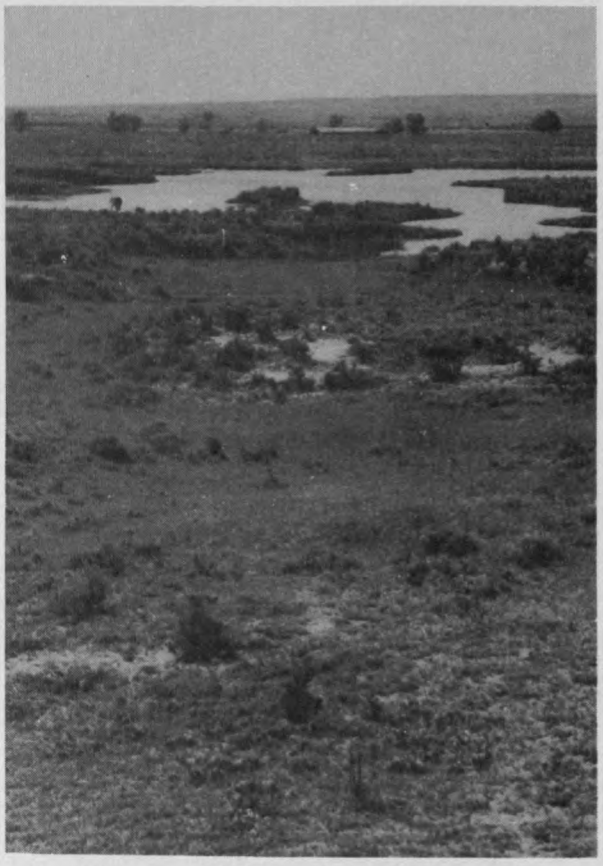

Fig. 4 A type I (Sagebrush-grassland) reservoir

Fig. 5 A type II (Marsh) reservoir

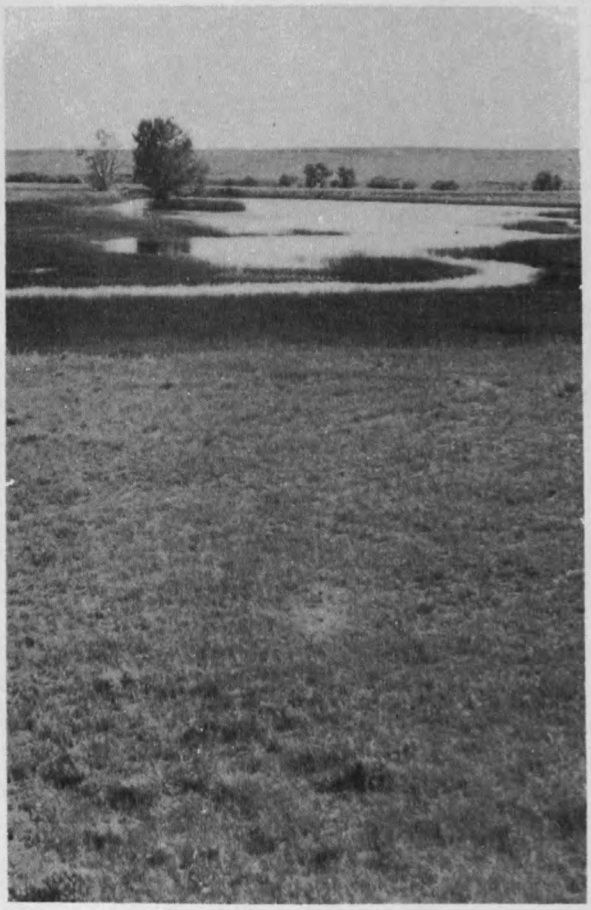

Fig. 6 A type III (Meadow) reservoir

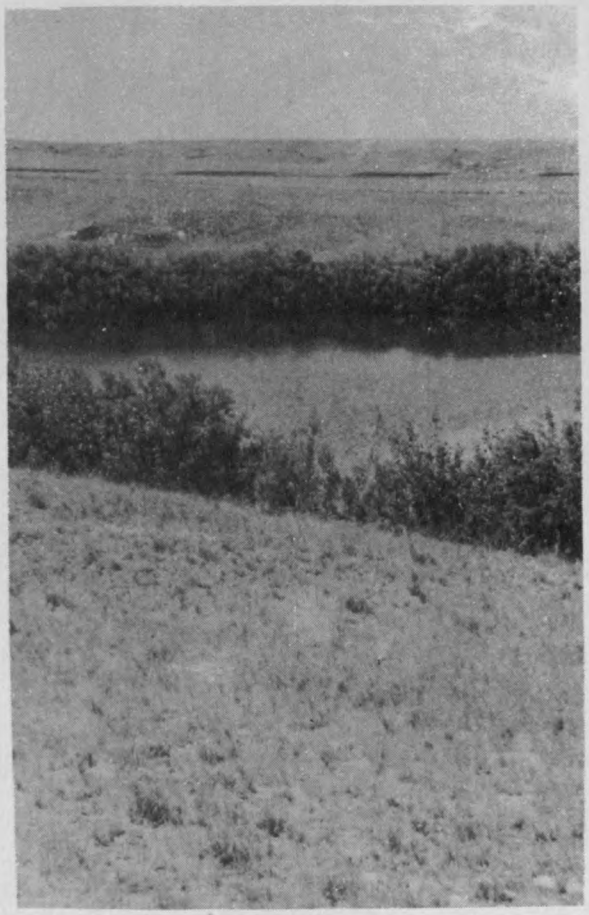

Fig. 7 A type IV (Woody) reservoir

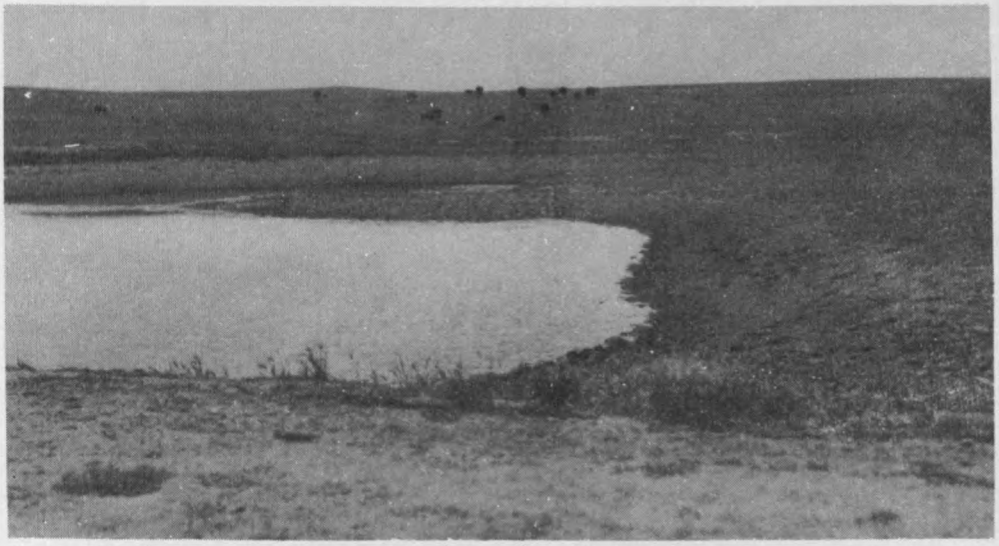

Fig. 8 A type V (Open) reservoir

Table VI. Vegetative classification of 124 reservoirs by trend areas.

| | Musselshell | Carter | McCone | Totals |
|---|---|---|---|---|
| Type I | 20 | 1 | 0 | 21 |
| Type II | 4 | 10 | 2 | 16 |
| Type III | 6 | 20 | 18 | 44 |
| Type IV | 0 | 1 | 5 | 6 |
| Type V | 14 | 11 | 12 | 37 |
| | 44 | 43 | 37 | 124 |

species. The mallard, pintail and blue-winged teal comprised 42.6, 18.0 and 17.5 per cent respectively or 78.1 per cent of all birds identified. Species identified in order of abundance were: mallard, pintail, blue-winged teal, shoveller, gadwall, scaup, baldpate, ruddy, redhead, coot, bufflehead, and cinnamon teal. In birds/sq. mi. the 3 areas (2 in 1949) averaged 1.0, 0.9 and 1.1 for 1949, 1950 and 1951 respectively.

Table VII. Results of spring aerial counts by counties in 1949, 1950 and 1951.

| | Reservoirs flown | No. of ducks observed | Ducks per reservior | Reservoirs occupied | Per cent occupied |
|---|---|---|---|---|---|
| Musselshell Co. | | | | | |
| May 23, 1949 | 54 | 144 | 2.7 | 32 | 59.3 |
| May 9, 1950 | 45 | 200 | 4.4 | 27 | 60.0 |
| May 10, 1951 | 53 | 218 | 4.1 | 25 | 47.2 |
| McCone Co. | | | | | |
| May 17, 1949 | 51 | 314 | 6.2 | 34 | 66.7 |
| May 5, 1950 | 46 | 179 | 3.9 | 25 | 54.3 |
| Apr. 12, 1951 | 59 | 310 | 5.3 | 23 | 39.0 |
| May 17, 1951 | 40 | 142 | 3.6 | 26 | 65.0 |
| Carter Co. | | | | | |
| May 7, 1950 | 46 | 64 | 1.4 | 23 | 50.0 |
| May 10, 1951 | 48 | 129 | 2.7 | 32 | 66.7 |
| | 442 | 1700 | 3.8 | 247 | 55.9 |

## SUMMER GROUND COUNTS

The twelve species of waterfowl observed during the yearly summer visits were: mallard, gadwall, baldpate, pintail, green-winged teal, blue-winged teal, shoveller, redhead, lesser scaup, bufflehead, ruddy and coot. Pied-billed grebes, eared grebes and American mergansers, seen in small numbers on several occasions, are not included in the totals.

A record was kept of all waterfowl observed during each visit to a reservoir to obtain information on usage and a population index. An attempt was made to avoid duplications throughout a single day, i.e. counting same bird(s) on 2 or more reservoirs. No attempt was made to avoid duplication from one day to the next. The figures include all birds other than non-flying broods (broods are handled separately). In the case of special study reservoirs and several others, visited 2 or more times during monthly trips, the first count was used for the monthly compilations. If in any subsequent visit during the same monthly trip, a new species was observed, it was included.

A total of 820 ducks was observed in 1949 (1 visit per reservoir), 1698 in 1950 (2.3) and 2663 in 1951 (4) (Tables VIII, IX, X). Fluctuations in monthly numbers are probably due to movements and sampling errors.

In 1951 the monthly figures show the total population decreased from late May through July in Musselshell and Carter County trend areas, and from late May into June in the McCone County trend area. An influx occurred in August in the Musselshell and Carter areas, in July in McCone. A similar pattern was suggested in 1950. Too few 1949 data are available

Table VIII. Summer waterfowl observations in 1949.

| | Musselshell August | McCone Sept. | Carter July | Summer Total |
|---|---|---|---|---|
| Mallard | 71 | 121 | 31 | 223 |
| Baldpate | 2 | 2 | | 4 |
| Pintail | 194 | 54 | 4 | 252 |
| G.W.T. | 18 | 68 | 2 | 88 |
| B.W.T. | 61 | 164 | 8 | 233 |
| Shoveller | 5 | 1 | | 6 |
| Redhead | | 1 | | 1 |
| Unident. | | | 13 | 13 |
| | 351 | 411 | 58 | 820 |

Table IX. Summer waterfowl observations in 1950.

| | Musselshell | | | | McCone | | | Carter | | | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | June | July | Total | June | Aug. | Total | July | Aug. | Total | Total |
| Mallard | 40 | 73 | 52 | 165 | 91 | 243 | 334 | 49 | 28 | 77 | 576 |
| Gadwall | 13 | 1 | 7 | 21 | 2 | 2 | 4 | | | | 25 |
| Baldpate | 13 | 7 | 2 | 22 | | 3 | 3 | | | | 25 |
| Pintail | 37 | 26 | 32 | 95 | 31 | 305 | 336 | 10 | 37 | 47 | 478 |
| G.W.T. | 23 | 9 | 4 | 36 | 5 | 71 | 76 | | 5 | 5 | 117 |
| B.W.T. | 58 | 62 | 28 | 148 | 57 | 81 | 138 | 7 | 31 | 38 | 324 |
| Shoveller | 34 | 17 | 2 | 53 | 13 | 11 | 24 | | | | 77 |
| Redhead | 2 | | 2 | 4 | | | | | | | 4 |
| Scaup | 12 | 4 | | 16 | | | | | | | 16 |
| Ruddy | 3 | | | 3 | 5 | | 5 | | | | 8 |
| Coot | 3 | 7 | | 10 | | | | | | | 10 |
| Unident. | 3 | | 2 | 5 | | | | | 33 | 33 | 38 |
| | 241 | 206 | 131 | 578 | 204 | 716 | 920 | 66 | 134 | 200 | 1698 |

Table X. Summer waterfowl observations in 1951.

| | Musselshell | | | | | McCone | | | | | Carter | | | | | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | June | July | Aug. | Total | May | June | July | Aug. | Total | May | June | July | Aug. | Total | Total |
| Mallard | 60 | 58 | 21 | 44 | 183 | 88 | 69 | 44 | 121 | 322 | 59 | 49 | 31 | 122 | 261 | 766 |
| Gadwall | 31 | 28 | 5 | 12 | 76 | 3 | 4 | 4 | | 11 | 5 | 3 | | | 8 | 95 |
| Baldpate | 28 | 21 | 12 | 26 | 87 | 4 | 5 | 1 | 3 | 13 | 15 | 5 | 4 | 23 | 47 | 147 |
| Pintail | 33 | 23 | 10 | 84 | 150 | 34 | 27 | 286 | 118 | 465 | 14 | 6 | 8 | 66 | 94 | 709 |
| G.W.T. | 10 | 7 | 8 | 91 | 116 | 3 | 2 | | 42 | 47 | 2 | 2 | | 33 | 37 | 200 |
| B.W.T. | 41 | 44 | 24 | 14 | 123 | 54 | 29 | 18 | 101 | 202 | 26 | 35 | 11 | 120 | 192 | 517 |
| Shoveller | 16 | 38 | 2 | 1 | 57 | 16 | 5 | 8 | 8 | 37 | 12 | | | | 12 | 106 |
| Redhead | | 18 | | 1 | 19 | | | | | | | | | | | 19 |
| Scaup | 19 | 11 | 2 | 1 | 33 | 4 | 2 | | | 6 | 4 | | | | 4 | 43 |
| Bufflehead | | | | | | | | | | | 1 | | | | 1 | 1 |
| Ruddy | 2 | 6 | | | 8 | | 3 | | | 3 | | | | | | 11 |
| Coot | 7 | | 1 | | 8 | 2 | 3 | | | 5 | | 4 | 1 | 5 | 10 | 23 |
| Unident. | 3 | 8 | 3 | | 14 | 5 | 1 | 5 | | 11 | | | 1 | | 1 | 26 |
| | 250 | 262 | 88 | 274 | 874 | 213 | 150 | 366 | 393 | 1122 | 138 | 104 | 56 | 369 | 667 | 2663 |

for comparison.

Although the number of ducks observed has increased each year along with the number of visits, the species composition has remained about the same (Table XI). The 3 most abundant species, mallard, pintail and blue-winged teal, comprised 86.3, 81.2 and 74.8 per cent of the total summer population in 1949, 1950 and 1951 respectively. It appears that the Musselshell area had a greater variety and more evenly distributed species composition than either of the other areas for 1950 and 1951. The combined mallard, pintail and blue-winged teal percentage composition was from 10.5 to 29.8 per cent lower than the lowest for the other 2 areas in 1950 and 1951 (Table XI).

Only the 1951 data (more complete) are used to evaluate size and/or vegetative type in relation to waterfowl usage of the reservoirs.

Table XI. Per cent species composition of summer waterfowl population by trend areas for 1949, 1950 and 1951.

| | Musselshell | | | McCone | | | Carter | | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1949 | 1950 | 1951 | 1949 | 1950 | 1951 | 1949 | 1950 | 1951 | 1949 | 1950 | 1951 |
| Mallard | 20.2 | 28.5 | 20.9 | 29.4 | 36.3 | 28.7 | 53.4 | 38.5 | 39.1 | 27.2 | 33.9 | 28.8 |
| Gadwall | | 3.6 | 8.7 | | 0.4 | 1.0 | | | 1.2 | | 1.5 | 3.6 |
| Baldpate | 0.6 | 3.8 | 10.0 | 0.5 | 0.3 | 1.2 | | | 7.0 | 0.5 | 1.5 | 5.5 |
| Pintail | 55.3 | 16.4 | 17.2 | 13.1 | 36.5 | 41.4 | 6.9 | 23.5 | 14.1 | 30.7 | 28.2 | 26.6 |
| G.W.T. | 5.1 | 6.2 | 13.3 | 16.5 | 8.3 | 4.2 | 3.4 | 2.5 | 5.5 | 10.7 | 6.9 | 7.5 |
| B.W.T. | 17.4 | 25.6 | 14.1 | 39.9 | 15.0 | 18.0 | 13.8 | 19.0 | 28.8 | 28.4 | 19.1 | 19.4 |
| Shoveller | 1.4 | 9.2 | 6.5 | 0.2 | 2.6 | 3.3 | | | 1.8 | 0.7 | 4.5 | 4.0 |
| Redhead | | 0.7 | 2.2 | 0.2 | | | | | | 0.1 | 0.2 | 0.7 |
| Scaup | | 2.8 | 3.8 | | | 0.5 | | | 0.6 | | 0.9 | 1.6 |
| Bufflehead | | | | | | | | | 0.1 | | | + |
| Ruddy | | 0.5 | 0.9 | | 0.5 | 0.3 | | | | | 0.5 | 0.4 |
| Coot | | 1.7 | 0.9 | | | 0.4 | | | 1.5 | | 0.6 | 0.9 |
| Unident. | | 0.9 | 1.6 | | | 1.0 | 22.4 | 16.5 | 0.1 | 1.6 | 2.2 | 1.0 |
| | 100.0 | 99.9 | 100.1 | 99.8 | 99.9 | 100.0 | 99.9 | 100.0 | 99.8 | 99.9 | 100.0 | 100.0 |

Waterfowl were observed on 102 (82.3%) of the 124, but records are complete for only 116. Use by size groups and vegetative types is presented in Table XII. Inspection of the table reveals a definite relationship between size and waterfowl numbers observed. Considering size alone it is obvious that on the average the larger the reservoir the greater the waterfowl use (Group 1, average 4.2 ducks per 4 visits; Group 2, 8.3; Group 3, 29.1; Group 4, 47.0; and Group 5, 131.7). A single variable classification analysis of variance (Dixon-Massey 1951, Snedecor 1934) of both the means of the size groups and the total numbers in each vegetative type showed these differences were statistically significant at the 1 per cent level. Considering size by vegetative type the same trend is apparent. Without exception the average usage increased with size within each individual vegetative type (Table XIII). Of the unused 22, twenty-one were 3 acres or less.

Evaluation of usage in relation to vegetative types alone shows considerable differences for the 5 types. The mean use of the Type III (Meadow) reservoirs, 28.2, was considerably above the average use for each of the others: Type I (Sagebrush-grassland), 14.7; Type II (Marsh), 18.3; Type IV (Woody), 10.8; and Type V (Open), 20.4, but these differences were not statistically significant at the 5 per cent level by the same test as above. The average usage of Type III reservoirs within each size group is consistently above the average use for all types in each group, but in size groups 2 and 3 it is exceeded by the Type IV and I averages respectively. Type IV reservoirs had the lowest average usage of the 5 types, but none were larger than 3 acres.

Table XII. Total waterfowl observed (4 visits) in 1951 by vegetative types and size.

| | | Vegetative Type | | | | | No. of res. (size groups) | No. of ducks observ. | Av. ducks (tot. of 4 visits) |
|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | | | |
| Size Group | 1 | 5*<br>7**<br>1.4*** | 5<br>12<br>2.4 | 13<br>92<br>7.1 | 1<br>2<br>2.0 | 10<br>31<br>3.1 | 34 | 144 | 4.2 |
| | 2 | 5<br>11<br>2.2 | 6<br>39<br>6.5 | 13<br>142<br>10.9 | 5<br>63<br>12.6 | 13<br>92<br>7.1 | 42 | 347 | 8.3 |
| | 3 | 2<br>84<br>42.0 | 1<br>13<br>13.0 | 9<br>345<br>38.3 | | 7<br>111<br>15.9 | 19 | 553 | 29.1 |
| | 4 | 2<br>104<br>52.0 | 2<br>88<br>44.0 | 8<br>448<br>56.0 | | 3<br>65<br>21.7 | 15 | 705 | 47.0 |
| | 5 | | 2<br>141<br>70.5 | 1<br>215<br>215.0 | | 3<br>434<br>144.7 | 6 | 790 | 131.7 |
| No. of res. (veg. type) | | 14 | 16 | 44 | 6 | 36 | 116 | | |
| No. of ducks observed | | 206 | 293 | 1242 | 65 | 733 | | 2539 | |
| Av. ducks (for total of 4 visits) | | 14.7 | 18.3 | 28.2 | 10.8 | 20.4 | | | 21.9 |

*Number of reservoirs of Type I Group 1.
**Total number of ducks observed during summer (4 visits) on the 5 reservoirs.
***Average number of ducks per reservoir (for total of 4 visits).

Although there appears to be a definite relationship between usage and vegetative type it is not so striking or consistent as the relationship between usage and size.

Considering both size and vegetation together, one would expect from the above analysis that the Type III - Group 5 reservoirs would be used most. This is borne out by the figures in the table.

Seventy-seven known age reservoirs with complete summer waterfowl observations were separated into 4 age groups (Table XIII) for evaluation of age in relation to usage. Although there was considerable range in the average use of the groups (youngest and oldest used most), an analysis of variance showed no statistical significance at the 5 per cent level.

Table XIII. Waterfowl usage (4 visits) of 77 known-age reservoirs by year groupings for 1951.

| Age grouping by years | Number of reservoirs | Total ducks observed | Average ducks observed |
|---|---|---|---|
| A (1-4) | 15 | 681 | 45.4 |
| B (5-8) | 24 | 326 | 13.6 |
| C (9-12) | 25 | 559 | 22.4 |
| D (13 ) | 13 | 398 | 30.6 |
| | 77 | 1964 | 25.5 |

## TERRITORIAL PAIRS

Low (1947) referring to the work of Hochbaum (1944) suggests the study of territorial pairs as a measurement of the nesting population in preference to the slower and less accurate nest counts. In 1951 there were 213 territorial pairs of all species observed from May 26 to July 11 (Table XIV). Late spring and early summer data from 1949 and 1950 are insufficient for comparisons.

Since mallard and pintail broods were observed in late May 1951, this figure obviously does not include the early nesting pairs. Lone drakes were not included because the single monthly visit to most areas was not considered conclusive in determining territorial drakes. In all probability, some of the pairs moved out of the areas before nesting as

Table XIV. Territorial pairs in 1951.

| Species | Musselshell | McCone | Carter | Total |
|---|---|---|---|---|
| Mallard | 15 | 17 | 18 | 50 |
| Gadwall | 12 | 1 | 1 | 14 |
| Baldpate | 12 | 2 | 9 | 23 |
| Pintail | 7 | 6 | 1 | 14 |
| G.W.T. | 6 | 2 | 2 | 10 |
| B.W.T. | 26 | 21 | 19 | 66 |
| Shoveller | 9 | 3 | 10 | 22 |
| Scaup | 10 | 2 | 2 | 14 |
| | 97 | 54 | 62 | 213 |

evidenced by the presence of scaup pairs in early summer, but the absence of scaup broods in later summer.

## NESTING STUDIES

Nesting studies consisted of a single nest search of all Musselshell County ponds in late May, 1950 and 4 concentrated searches on each of the 12 selected reservoirs in May and June of 1951.

Nest searches by rope dragging were patterned after the methods of Bennett (1938) and Sowls (1950). Unless the sagebrush or greasewood cover or the topography prevented it, a 120 ft. rope with 2 tin cans (on the end of a 3 ft. length of heavy wire) attached at 12 ft. intervals was dragged between 2 men. Otherwise the cover was walked in strips or in a zig-zag manner at approximately 30 ft. intervals. The perimeter of all reservoirs was searched out to a minimum of 100 yds. Girard (1941) found in western Montana that the average distance to water for 252 mallard nests was 118.67 yds. The average distances from water for 321 shoveller, blue-winged teal, cinnamon teal, baldpate and green-winged teal nests were

all less than 100 yds. Bennett's (1938) blue-winged teal nests averaged 41.5 yds. from water and 95.6 per cent were within 220 yds. In 1951 most special study reservoir perimeters were searched to a distance of 200 yds. or more from water. The upper drainage bottom and heavier cover was usually covered more extensively. All searches were made between 8:00 A.M. and 12:30 P.M.

Eight nests were found in 1950 and 14 in 1951. Because of the small number, the data for both years are combined in Table XV. Only puddle duck nests were found: mallard, pintail, blue-winged teal, green-winged teal and gadwall. Identification for 19 was established by flushing the female; for the other 3 by the use of Broley's (1950) key to the nests of the Anatidae. The average distance to water was 208.3 yds., but 18 (81.8%) were less than 100 yds. The 70.3 per cent egg success was high, compared to Kalmback's (1939) hypothetical satisfactory egg hatch of 70 per cent for refuge waterfowl. Girard's (1941) per cent egg hatch varied from 69.7 for the shoveller to 75.2 for the green-winged teal. Per cent egg hatches for the mallard, blue-winged teal, cinnamon teal and baldpate were within these limits. Williams and Marshall (1938) had an average egg hatch of 81.1 per cent (60-85) for 11,395 gadwall, cinnamon teal, mallard, pintail and shoveller eggs in Utah. The per cent nest success in the present study was 77.3. Bennett (1938) had a 54.8 per cent nest success for 250 blue-winged teal nests in Iowa. Causes of nest destruction in the present study were: flooding 2, desertion 1, destroyed by observer 1, and unknown (suspected bullsnake) 1.

Although the information is inadequate for statistical analysis,

Table XV. Nesting data for 1950 and 1951.

| | Mallard | B.W.T. | Pintail | G.W.T. | Gadwall | Totals |
|---|---|---|---|---|---|---|
| No. of nests | 10 | 6 | 4 | 1 | 1 | 22 |
| Per cent of nest success | 70.0 | 83.3 | 75.0 | 100.0 | 100.0 | 77.3 |
| Av. number of eggs | 9.7(1-17) | 8.4(7-11) | 6.8(6-7) | 9.0 | 10.0 | 8.4(1-17) |
| Percent egg success | 58.8 | 81.0 | 77.8 | 100.0 | 90.0 | 70.3 |
| Av. distance to water (yds.) | 319.9 (1-1760) | 50.5 (3-234) | 258.8 (1-880) | 42.0 | 3.0 | 208.3(1-1760) |
| Dominant cover type of nest site: | | | | | | |
| Sagebrush-greasewood | 3 | 1 | 2 | 1 | | 7 |
| Western wheatgrass | 3 | 2 | | | | 5 |
| Rosebush | 1 | | 1 | | 1 | 3 |
| Wheat stubble | | | 1 | | | 1 |
| Bulrush | 2 | | | | | 2 |
| Miscellaneous | 1 | 3 | | | | 4 |
| Reservoir type(vegetation) | | | | | | |
| Type I | 6 | 2 | 3 | 1 | | 12 |
| Type II | 2 | | | | 1 | 3 |
| Type III | 1 | 3 | 1 | | | 5 |
| Type IV | | | | | | 0 |
| Type V | 1 | 1 | | | | 2 |
| Reservoir Group (size) | | | | | | |
| Group 1 | | | | | | 0 |
| Group 2 | 2 | 2 | 2 | | | 6 |
| Group 3 | 5 | 2 | 2 | 1 | | 10 |
| Group 4 | 2 | 1 | | | | 3 |
| Group 5 | 1 | 1 | | | 1 | 3 |

certain preferences may be indicated. Twelve nests (54.5%) were located in sagebrush-greasewood or western wheatgrass cover and 11 of these were on Type I (Sagebrush-grassland) reservoirs. The remaining 10 were located in 7 different cover types. All vegetative types of reservoirs except IV (Woody) were represented. Sixteen or 72.7 per cent were located near size groups 2 and 3 (1.05 to 5.05 acres). None were discovered near size group 1 (1 acre or less).

## BROOD COUNTS

Mallard, gadwall, baldpate, pintail, green-winged teal, blue-winged teal and shoveller broods were seen during the 3 summers. Apparently the reservoirs were not suitable breeding areas for the diving ducks (redhead, ruddy, scaup) present in early summer. Low (1945) indicated that water habitat desirable for redhead nesting was not conditioned by area alone but by its nearness to large permanent bodies of water. Marshes of 10 to 20 acres or larger within a quarter mile of large permanent lakes were most heavily used. Since no trend area reservoir exceeded 20 acres and none were within 30 miles of a large body of water, this may represent the limiting factor of redhead and possibly ruddy breeding. Although scaup pairs were common in early summer, none have been observed to nest within the trend areas.

Brood observations were made continuously throughout the day from extremes of 5:30 A.M. to 8:00 P.M. It was necessary to search the perimeter of all reservoirs during each visit to flush hiding broods, especially during midday and windy and stormy weather.

The small number of broods on most ponds aided in distinguishing individual broods. In all cases where doubt existed, a minimum figure was used. The month interval between visits in 1951 was less than the juvenile developmental period for any of the breeding species. Bennett (1938) stated that blue-winged teal young had begun to fly at 6 weeks. Hochbaum (1944) lists 38 to 52 and 49 to 60 days as the developmental period for captive pintail and mallard young respectively. The gadwall, baldpate and shoveller young had longer developmental periods. In 1951 approximately 25 per cent of the broods were considered to have been seen more than once, and undoubtedly some escaped discovery. Thus production figures probably represent a minimum.

Twenty-eight individual broods were seen in 1949, one hundred six in 1950, and 196 in 1951 (Tables XVI, XVII & XVIII). Broods were classified into 3 age classes: Class I (downy, 0-1/3 grown); Class II (partly feathered, 1/3-2/3 grown); and Class III (wing feathers appearing, 2/3 to full grown). In 1951 ninety broods (47.6%) were seen first as Class I broods; 58 (30.7%) as Class II; and 41 (21.7%) as Class III.

Percent species composition of broods roughly corresponds to the per cent species composition of the total waterfowl counts. The mallard, pintail, and blue-winged teal have been the 3 most important breeders, producing about 75 per cent of the broods observed each summer (Table XIX). In 1951 brood counts show a greater variety and more evenly distributed species composition in Musselshell County (Table XX) similar to the total waterfowl species distribution. The fewer 1950 counts indicate a similar distribution. The 1949 data are too few to draw conclusions.

Table XVI. Total broods observed in 1949.

| | Class I | | | Class II | | | Class III | | | Un- | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Broods | Juv. | Av. | Broods | Juv. | Av. | Broods | Juv. | Av. | classified | Total Broods |
| Mallard | 3 | 10 | 3.3 | 3 | 12 | 4.0 | 6 | 25 | 4.2 | | 12 |
| Pintail | | | | | | | 3 | 20 | 6.7 | | 3 |
| G.W.T. | 1 | 6 | 6.0 | 3 | 28 | 9.3 | 1 | 6 | 6.0 | | 5 |
| B.W.T. | | | | 2 | 13 | 6.5 | 3 | 9 | 3.0 | | 5 |
| Shoveller | | | | | | | 1 | 9 | 9.0 | | 1 |
| Unident. | | | | 1 | 9 | 9.0 | 1 | 1 | 1.0 | | 2 |
| | 4 | 16 | 4.0 | 9 | 62 | 6.9 | 15 | 70 | 4.7 | | 28 |

Table XVII. Total broods observed in 1950.

| | Class I | | | Class II | | | Class III | | | Un- | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Broods | Juv. | Av. | Broods | Juv. | Av. | Broods | Juv. | Av. | classified | Total Broods |
| Mallard | 21 | 83 | 4.0 | 17(4)* | 80 | 4.7 | 7(3) | 17 | 2.4 | | 38 |
| Gadwall | 4 | 31 | 7.8 | 1 | 7 | 7.0 | | | | | 5 |
| Baldpate | | | | 3 | 20 | 6.7 | | | | 1 | 4 |
| Pintail | 10 | 41 | 4.1 | 7(1) | 32 | 4.6 | 9(1) | 19 | 2.1 | 1 | 25 |
| G.W.T. | 3 | 14 | 4.7 | 3 | 18 | 6.0 | | | | | 6 |
| B.W.T. | 10 | 75 | 7.5 | 3 | 14 | 4.7 | 2 | 6 | 3.0 | | 15 |
| Shoveller | 2 | 13 | 6.5 | 2 | 15 | 7.5 | | | | | 4 |
| Unident. | 2 | 9 | 4.5 | 6 | 34 | 5.7 | 1 | 4 | 4.0 | | 9 |
| | 52 | 266 | 5.1 | 42(5) | 220 | 5.2 | 19(4) | 46 | 2.4 | 2 | 106 |

* Figures in parentheses are broods that were considered to have been observed previously as Class I or Class II broods.

The same statistical analysis was made of the 1951 brood production in relation to size, vegetative type and age of the reservoirs as for waterfowl use. The 1949 and 1950 data were considered incomplete. In 1951, sixty-seven (57.8%) of the 116 ponds produced broods (Musselshell 50.0%; McCone 75.7; and Carter 48.8). Brood production by size groups and vegetative types is presented in Table XXI. The definite relationship be-

Table XVIII. Total broods observed in 1951.

| | Class I | | | Class II | | | Class III | | | Un-classified | Total Broods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Broods | Juv. | Av. | Broods | Juv. | Av. | Broods | Juv. | Av. | | |
| Mallard | 36 | 232 | 6.4 | 40(10)* | 216 | 5.4 | 33(21) | 176 | 5.3 | 1 | 79 |
| Gadwall | 3 | 25 | 8.3 | 7 | 39 | 5.6 | | | | | 10 |
| Baldpate | 12 | 77 | 6.4 | 5 | 35 | 7.0 | 7(4) | 39 | 5.6 | | 20 |
| Pintail | 14 | 71 | 5.1 | 9(1) | 30 | 3.3 | 21(7) | 74 | 3.5 | 5 | 41 |
| G.W.T. | 3 | 27 | 9.0 | 1 | 6 | 6.0 | 4(1) | 19 | 4.8 | | 7 |
| B.W.T. | 17 | 109 | 6.4 | 3 | 15 | 5.0 | 13(4) | 92 | 7.1 | | 29 |
| Shoveller | 1 | 4 | 4.0 | 2 | 13 | 6.5 | 1(1) | 3 | 3.0 | | 3 |
| Unident. | 4 | 15 | 3.8 | 2 | 5 | 2.5 | 1(1) | 2 | 2.0 | 1 | 7 |
| | 90 | 560 | 6.2 | 69(11) | 359 | 5.2 | 80(39) | 405 | 5.1 | 7 | 196 |

* Figures in parentheses are broods that were considered to have been observed previously as Class I or Class II broods.

Table XIX. Per cent brood species composition by trend areas* and yearly totals for 1949, 1950 and 1951.

| | Musselshell | | McCone | | Carter | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1951 | 1950 | 1951 | 1950 | 1951 | 1949 | 1950 | 1951 |
| Mallard | 23.8 | 18.0 | 42.5 | 50.0 | 45.8 | 50.9 | 42.9 | 35.8 | 40.3 |
| Gadwall | 9.5 | 14.8 | 2.5 | 1.2 | | | | 4.7 | 5.1 |
| Baldpate | 2.4 | 23.0 | 7.5 | 1.2 | | 9.4 | | 3.8 | 10.2 |
| Pintail | 28.6 | 19.7 | 15.0 | 22.0 | 29.2 | 20.8 | 10.7 | 23.6 | 20.9 |
| G.W.T. | 7.1 | 9.8 | 7.5 | | | 1.9 | 17.9 | 5.7 | 3.6 |
| B.W.T. | 9.5 | 9.8 | 17.5 | 18.3 | 16.7 | 15.1 | 17.9 | 14.2 | 14.8 |
| Shoveller | 4.8 | 1.6 | 5.0 | 2.4 | | | 3.6 | 3.8 | 1.5 |
| Unident. | 14.3 | 3.3 | 2.5 | 4.9 | 8.3 | 1.9 | 7.1 | 8.5 | 3.6 |
| | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.1 | 100.1 | 100.0 |

* The 1949 data were too limited to allow a breakdown by trend areas.

tween size and number of broods produced is comparable to the trend shown by waterfowl usage. On the average, the larger the reservoir the greater the number of broods produced (Group 1, 0.4; Group 2, 0.9; Group 3, 2.4; Group 4, 4.3; and Group 5, 5.7 - significant at the 1% level). The same trend was apparent, without exception, within each individual vegetative

Table XX. Brood observations in Musselshell, McCone and Carter counties in 1951.

| | Class I | | | Class II | | | Class III | | | Un-classified | Total Broods |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Broods | Juv. | Av. | Broods | Juv. | Av. | Broods | Juv. | Av. | | |
| Musselshell | | | | | | | | | | | |
| Mallard | 7 | 47 | 6.7 | 3(1)* | 10 | 3.3 | 3(1) | 11 | 3.7 | | 11 |
| Gadwall | 3 | 25 | 8.3 | 6 | 38 | 6.7 | | | | | 9 |
| Baldpate | 8 | 61 | 7.6 | 3 | 19 | 6.3 | 6(3) | 36 | 6.0 | | 14 |
| Pintail | 7 | 38 | 5.4 | 1 | 6 | 6.0 | 7(4) | 34 | 4.9 | 1 | 12 |
| G.W.T. | 3 | 27 | 9.0 | 1 | 6 | 6.0 | 3(1) | 16 | 5.3 | | 6 |
| B.W.T. | 3 | 18 | 6.0 | | | | 4(1) | 27 | 6.8 | | 6 |
| Shoveller | | | | 1 | 6 | 6.0 | | | | | 1 |
| Unident. | 1 | 1 | 1.0 | 1 | 3 | 3.0 | | | | | 2 |
| | 32 | 217 | 6.7 | 16(1) | 88 | 5.5 | 23(10) | 124 | 5.4 | 1 | 61 |
| McCone | | | | | | | | | | | |
| Mallard | 16 | 111 | 6.9 | 25(6) | 154 | 6.2 | 18(12) | 116 | 6.4 | | 41 |
| Gadwall | | | | 1 | 1 | 1.0 | | | | | 1 |
| Baldpate | 1 | 1 | 1.0 | | | | | | | | 1 |
| Pintail | 4 | 20 | 5.0 | 6(1) | 17 | 2.8 | 9(1) | 26 | 2.9 | 1 | 18 |
| G.W.T. | | | | | | | | | | | |
| B.W.T. | 8 | 51 | 6.4 | 2 | 11 | 5.5 | 6(1) | 50 | 8.3 | | 15 |
| Shoveller | 1 | 4 | 4.0 | 1 | 7 | 7.0 | 1(1) | 3 | 3.0 | | 2 |
| Unident. | 2 | 11 | 5.5 | 1 | 2 | 2.0 | | | | 1 | 4 |
| | 32 | 198 | 6.2 | 36(7) | 192 | 5.3 | 34(15) | 195 | 5.7 | 2 | 82 |
| Carter | | | | | | | | | | | |
| Mallard | 13 | 74 | 5.7 | 12(3) | 52 | 4.3 | 12(8) | 49 | 4.1 | 1 | 27 |
| Baldpate | 3 | 15 | 5.0 | 2 | 16 | 8.0 | 1(1) | 3 | 3.0 | | 5 |
| Pintail | 3 | 13 | 4.3 | 2 | 7 | 3.5 | 5(2) | 14 | 2.8 | 3 | 11 |
| G.W.T. | | | | | | | 1 | 3 | 3.0 | | 1 |
| B.W.T. | 6 | 40 | 6.7 | 1 | 4 | 4.0 | 3(2) | 15 | 5.0 | | 8 |
| Unident. | 1 | 3 | 3.0 | | | | 1(1) | 2 | 2.0 | | 1 |
| | 26 | 145 | 5.6 | 17(3) | 79 | 4.6 | 23(14) | 86 | 3.7 | 4 | 53 |

*Figures in parentheses are broods that were considered to have been observed previously as Class I or Class II broods.

type (Table XXI). Of the 49 reservoirs on which no broods were observed, 43 (87.8%) were 3 acres or less.

Brood production on the 5 vegetative types showed differences; but not significant at the 5 per cent level. The type III (Meadow) reservoirs

Table XXI. Total broods produced by vegetative types and size in 1951.

| Size Group | Vegetative Type I | II | III | IV | V | No. of res. (size groups) | Total broods | Average broods/ reservoir |
|---|---|---|---|---|---|---|---|---|
| 1 | 5* | 5 | 13 | 1 | 10 | 34 | 14 | 0.4 |
| | 1** | 2 | 10 | 1 | 0 | | | |
| | 0.2*** | 0.4 | 0.8 | 1.0 | 0 | | | |
| 2 | 5 | 6 | 13 | 5 | 13 | 42 | 37 | 0.9 |
| | 2 | 3 | 20 | 7 | 5 | | | |
| | 0.4 | 0.5 | 1.5 | 1.4 | 0.4 | | | |
| 3 | 2 | 1 | 9 | | 7 | 19 | 46 | 2.4 |
| | 8 | 1 | 27 | | 10 | | | |
| | 4.0 | 1.0 | 3.0 | | 1.4 | | | |
| 4 | 2 | 2 | 8 | | 3 | 15 | 65 | 4.3 |
| | 10 | 10 | 40 | | 5 | | | |
| | 5.0 | 5.0 | 5.0 | | 1.7 | | | |
| 5 | | 2 | 1 | | 3 | 6 | 34 | 5.7 |
| | | 10 | 7 | | 17 | | | |
| | | 5.0 | 7.0 | | 5.7 | | | |
| No. of res. (veg. type) | 14 | 16 | 44 | 6 | 36 | 116 | | |
| Total broods | 21 | 26 | 104 | 8 | 37 | | 196 | |
| Average broods/res. | 1.5 | 1.6 | 2.4 | 1.3 | 1.0 | | | 1.7 |

* The number of reservoirs of Type I Group 1.
** Total number of individual broods observed during the summer on the 5 reservoirs.
*** Average broods/reservoir produced during entire summer.

produced on the average almost 1 brood/reservoir more than each of the other types. The data are not wholly comparable, however, since 4 of the larger size groups were not represented in 2 of the types (one Type I, three Type IV). The most obvious difference occurs between Type III reservoirs (37.9% of the 116 reservoirs) which produced 53.1 per cent of

the broods, and Type V (Open) (31.0%) which produced only 18.9 per cent of the broods (Table XXII). The Type III reservoirs brood production averages were the greatest in every size group except 3 and 4; the Type V reservoirs the least in every size group except 3 and 5. Of the 49 reservoirs on which no broods were observed, 24 (49.0%) were Type V, 11 (22.4%) Type III, 7 (14.3%) Type I, and 7 (14.3%) Type II.

Table XXII. Brood production by vegetative types.

| Vegetative Type | Per cent of reservoirs | Per cent of broods produced |
|---|---|---|
| Type I | 12.1 | 10.7 |
| Type II | 13.8 | 13.3 |
| Type III | 37.9 | 53.1 |
| Type IV | 5.2 | 4.1 |
| Type V | 31.0 | 18.9 |
| | 100.0 | 100.1 |

A further illustration of these relationships is shown by an evaluation of brood production by trend areas. McCone County reservoirs averaged the largest, 4.1 acres; Musselshell, 3.3; and Carter, 2.3. All 3 areas have about equal percentages of Type V reservoirs, but McCone and Carter each have almost 30 per cent more Type III reservoirs than Musselshell. McCone County produced the most broods, 82 (2.2 per reservoir); Musselshell, 61 (1.7); and Carter, 53 (1.2). In addition McCone County had the largest percentage of productive reservoirs, Carter County the least. Thus it appears that size is a more important factor than vegetative type in determining brood production; a relationship previously noted concerning waterfowl usage.

Brood production in relation to age was evaluated by the same age grouping of 77 known-age reservoirs used in the evaluation of waterfowl usage and age. The differences in average brood production (Table XXIII) are not significant at the 5 per cent level. The youngest (1-4 years) and the oldest (13+) ponds produced almost 1 brood/reservoir more than the middle age groupings.

Table XXIII. Brood production of 77 known-age reservoirs by year groupings for 1951.

| Age grouping by years | Number of reservoirs | Total broods observed | Average broods/ reservoir |
|---|---|---|---|
| A (1-4) | 15 | 43 | 2.9 |
| B (5-8) | 24 | 41 | 1.7 |
| C (9-12) | 25 | 42 | 1.7 |
| D (13+) | 13 | 32 | 2.5 |
| | 77 | 158 | 2.1 |

## CONCLUSIONS

It is obvious that the recent construction of a large number of reservoirs has had considerable impact on waterfowl production in eastern Montana. Based on the 1951 trend area production figures, it appears that areas devoid of water habitat in the past produced an average of almost 2 ducks per square mile. Although the figure is small, the importance is manifest when the large area involved is considered. These facts should certainly be considered in the waterfowl management program.

## SUMMARY

1. A study was made of waterfowl production on 124 artificial reservoirs

on 3 trend areas in Musselshell, McCone and Carter counties of eastern Montana during the summers of 1949, 1950 and 1951.

2. The trend areas are located in semi-arid, sagebrush or grassland prairie regions. Livestock raising, with some dryland farming, is the principal economy. Most ponds are used for livestock watering.
3. One visit was made to each reservoir in 1949, two or more in 1950, and 4 or more in 1951. Twelve representative reservoirs were selected in 1951 for concentrated studies.
4. The average surface acreage for 124 ponds was 3.2 acres. Sixty-five (52.4%) were 2 acres or less. The ponds were grouped into 5 size groups (Group 1, 0-1.05 acres; Group 2, 1.05-3.05; Group 3, 3.05-5.05; Group 4, 5.05-10.05; and Group 5, 10.05 or larger) for evaluation of waterfowl usage and brood production.
5. Data concerning depth, pH, turbidity, dam construction and seepage were collected.
6. The mean age of 88 reservoirs was 8.2 (1-18) years.
7. The average density for ninety-seven 100-point line transects was 55.4 per cent (Musselshell 41.0, Carter 67.4, and McCone 79.6). Western wheatgrass, blue grama, saltgrass, buffalograss, Sandberg bluegrass and needlegrass made up 74.4 per cent of the total ground density. The average canopy cover of forty-three 50-ft. line intercepts was 7.5 per cent. Artemisia tridentata made up 79.1 per cent of the total canopy cover. Principal emergent and submerged species are recorded. Ranges and averages of one-quarter and 1 square meter quadrat measurements on 8 emergent species are listed.

8. The 124 reservoirs were classified into 5 vegetative types on the basis of emergent and/or adjacent vegetation (Type I - Sagebrush-grassland, Type II - Marsh, Type III - Meadow, Type IV - Woody, and Type V - Open), for evaluation of waterfowl usage and brood production.
9. Aerial counts were made each spring. One thousand and sixty-six of the 1700 waterfowl observed were identified to species. The mallard, pintail, and blue-winged teal comprised 78.1 per cent.
10. Twelve species of waterfowl were observed using the reservoirs during summer ground counts. The mallard, pintail and blue-winged teal comprised 86.3, 81.2, and 74.8 per cent of the total summer population in 1949, 1950 and 1951 respectively. The Musselshell trend area had a greater variety and more evenly distributed species composition than either of the others. Data showed that the total population decreased from late May through July in the Musselshell and Carter County trend areas, and from late May into June in the McCone County trend area. An influx occurred in August in the Musselshell and Carter areas, in July in McCone.
11. An evaluation of waterfowl use by size and vegetative type showed that on the average the larger the pond the greater the usage (significant at the 1% level). The Type III reservoirs were used more on the average than the reservoirs of the other types (but not significant at the 5% level).
12. Two hundred thirteen territorial pairs were observed in 1951 but the data were known to be incomplete.

13. Twenty-two nests, 8 in 1950, 14 in 1951, of 5 species (mallard, pintail, green-winged teal, blue-winged teal and gadwall) were discovered. The average distance to water was 208.3 yds. but 18 (81.8%) were less than 100 yds. Seventy and three-tenths per cent of the eggs and 77.3 per cent of the nests were successful.

14. Twenty-eight individual broods were seen in 1949, one hundred six in 1950, and 196 in 1951. No species of diving duck was represented by broods. The brood species composition corresponded roughly to the per cent species composition of the total waterfowl counts. The mallard, pintail, and blue-winged teal were the 3 most important breeders, producing about 75 per cent of the broods observed each summer.

15. An evaluation of brood production in relation to size and vegetative type showed that on the average, the larger the reservoir the greater the number of broods produced (significant at the 1% level). Differences in the average brood production between the vegetative types were not significant at the 5 per cent level. The most striking difference in the vegetative types was between Type III reservoirs (37.9% of the 116 reservoirs) which produced 53.1 per cent of the broods, and Type V (31.0%) which produced only 18.9 per cent of the broods. As in waterfowl usage, the relationship between brood production and vegetative type was not as pronounced and striking as the relationship between brood production and size.

16. Four age groupings of 77 reservoirs showed differences in average

waterfowl use and brood production, but these differences were not statistically significant. The youngest and the oldest age groups rated highest for both average waterfowl usage and brood production.

## LITERATURE CITED

Bennett, Logan J. 1938. The blue-winged teal, its ecology and management. Collegiate Press, Inc. Ames, Iowa. 144 pp.

Booth, W. E. 1950. Flora of Montana, Part I, Conifers and Monocots. Montana State College Research Foundation. 232 pp.

Broley, Jeanne. 1950. Identifying nests of the Anatidae of the Canadian prairies. Jour. Wildl. Mgt. 14(4):452-456.

Brown, C. J. D. and Nels A. Thoreson. 1951. Ranch fish ponds in Montana, their construction and management. Montana State College Agr. Exp. Sta. Bull. 480. Dec. 1951. 30 pp.

Canfield, R. H. 1942. Sampling ranges by the line interception method. Southwestern Forest and Range Exp. Sta. Research Report #4, 28 pp. mimeo.

Coupland, Robert T. 1950. Ecology of mixed prairie in Canada. Ecol. Monog. 20(4):271-315.

Dixon, Wilfrid J. and Frank J. Massey, Jr. 1951. Introduction to statistical analysis. McGraw-Hill Book Co., Inc. New York. 370 pp.

Fernald, M. L. 1950. Gray's manual of Botany. 8th ed. American Book Co. New York. 1632 pp.

Girard, George L. 1941. The mallard: its management in western Montana. Jour. Wildl. Mgt. 5(3):233-259.

Hochbaum, H. Albert. 1944. The canvasback on a prairie marsh. The American Wildlife Institute, Washington, D. C. 201 pp.

Kalmbach, E. R. 1939. Nesting success: Its significance in waterfowl reproduction. Trans. 4th No. Am. Wildl. Conf. 591-604.

Low, Jessop B. 1945. Ecology and management of the redhead, (Nyroca americana), in Iowa. Ecol. Monog. 15(1):35-69.

Low, Jessop B. 1947. Review of new techniques-waterfowl. Trans. 12th No. Am. Wildl. Conf. 339-343.

Maughan, William E. 1941. Climate of Montana. Climate and Man. U. S. Dept. of Agr. yearbook, 1941:955-966.

Sowls, Lyle K. 1950. Techniques for waterfowl-nesting studies. Trans. 15th No. Am. Wildl. Conf. 478-489.

Snedecor, George W. 1934. Calculation and interpretation of analysis of variance and covariance. Collegiate Press Inc. Ames, Iowa 96 pp.

Williams, Cecil S. and William H. Marshall. 1938. Duck nesting studies, Bear River Migratory Bird Refuge, Utah, 1937. Jour. Wildl. Mgt. 2(2):29-48.