



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
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Abstract:

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A STUDY OF WATERFOWL PRODUCTION ON ARTIFICIAL RESERVOIRS
IN EASTERN MONTANA

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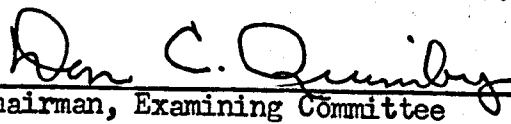
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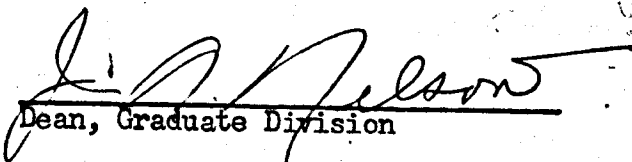
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ABSTRACT

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

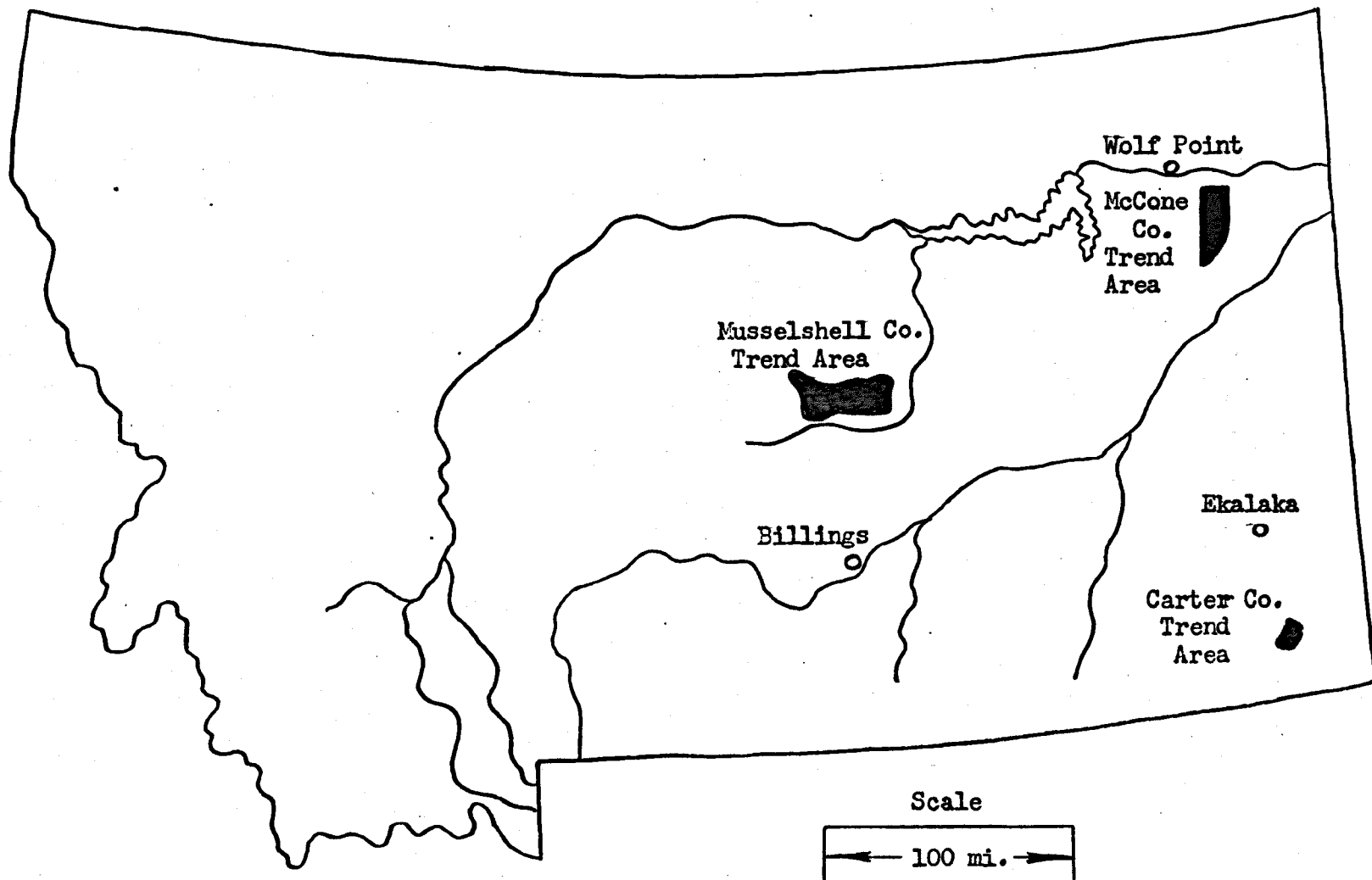


Fig. 1 Map of Montana showing waterfowl study areas

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 economy 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-

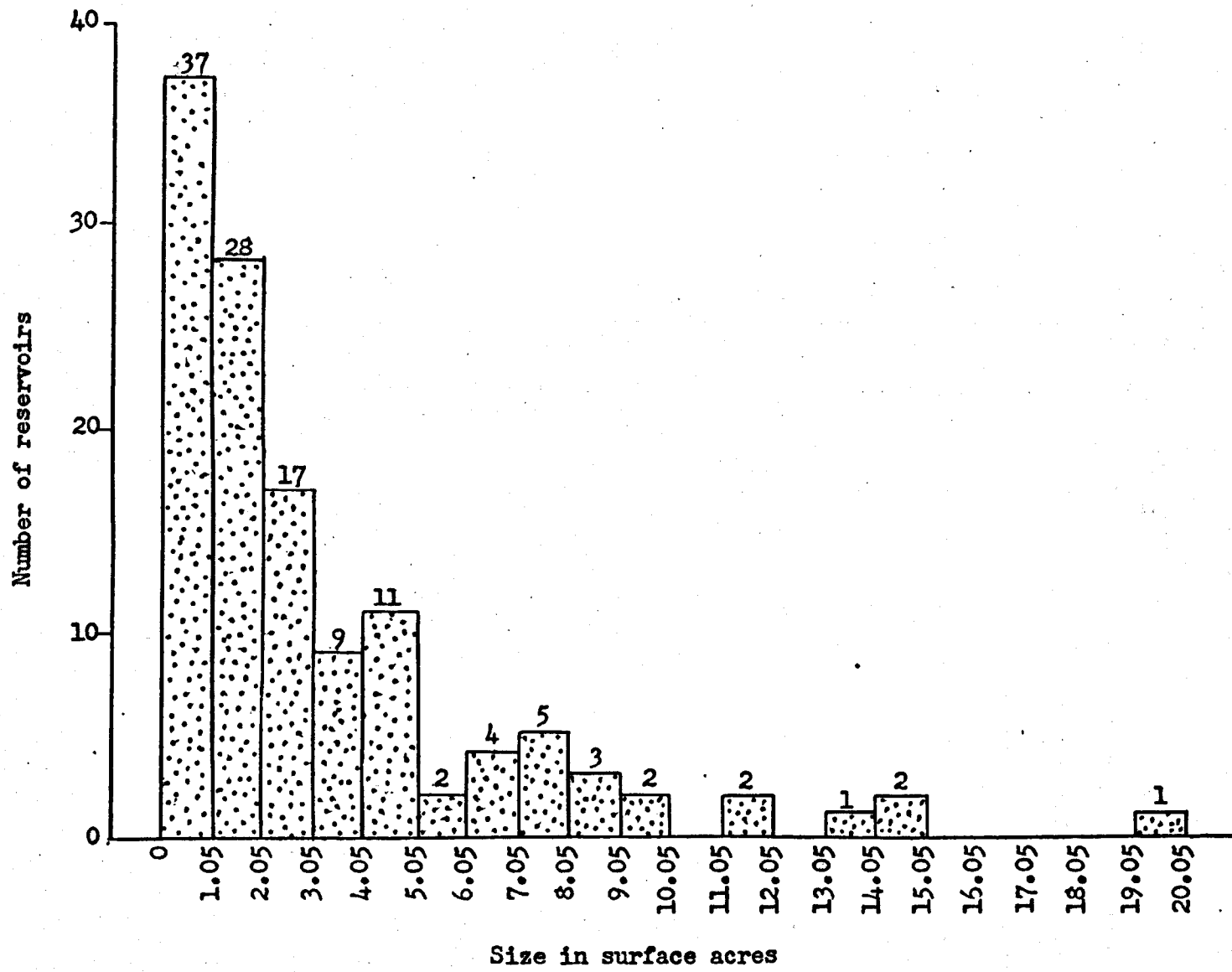


Fig. 2 Distribution of 124 reservoirs by size

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

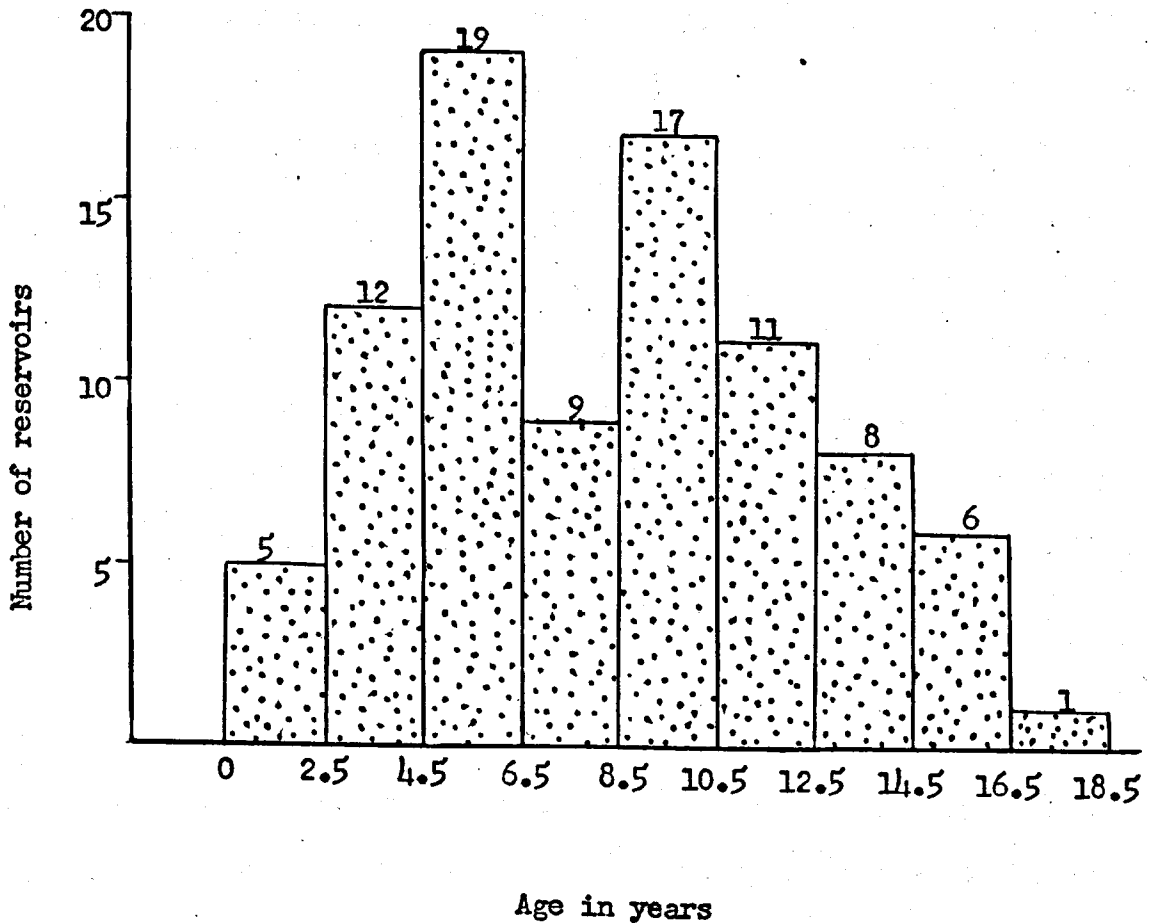


Fig. 3. Age distribution of 88 reservoirs.

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:					
<u>Agropyron smithii</u> (western wheatgrass)	748	626	298	1672	31.1
<u>Bouteloma gracilis</u> (blue grama)	545	127	114	786	14.6
<u>Distichlis stricta</u> (saltgrass)	320	29	314	663	12.3
<u>Stipa comata</u> , <u>S. viridula</u> (needlegrass)	56	33	358	447	8.3
<u>Buchloe dactyloides</u> (buffalograss)		241		241	4.5
<u>Poa secunda</u> (Sandberg bluegrass)		110	86	196	3.6
<u>Poa spp.</u> (bluegrass)	86	9	10	105	2.0
<u>Koeleria cristata</u> (junegrass)		79		79	1.5
<u>Hordeum jubatum</u> (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:					
<u>Opuntia polyacantha</u> (prickley pear)	59	5		64	1.2
<u>Artemisia frigida</u> (fringed sage)	37	24		61	1.1
<u>Melilotus officinalis</u> (sweet clover)	110	68	3	181	3.4
Misc. weeds	106	68	13	187	3.5
Others:					
<u>Carex spp.</u>	9	87	167	263	4.9
<u>Juncus balticus</u>			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		Culms per sq. meter	
	$\frac{1}{4}$ sq. meter	1 sq. meter	range	average*
<u>Eleocharis macrostachya</u> (spike rush)	67		640 - 3948	1996
<u>Scirpus americanus</u> (American bulrush)	18		140 - 820	428
<u>Typha latifolia</u> (cattail)		38	12 - 56	37
<u>Scirpus validus</u> , <u>S. acutus</u> (bulrush)		7	99 - 271	176
<u>Beckmannia syzigachne</u> (sloughgrass)		10	10 - 26	15
<u>Sagittaria cuneata</u> (arrowhead)		21	20 - 67	42
<u>Alisma plantago-aquatica</u> (water plantain)		18	10 - 85	40
<u>Alopecurus aequalis</u> (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 (flat-stem pondweed), Ranunculus trichophyllus (water crowfoot), and Zanichellia 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

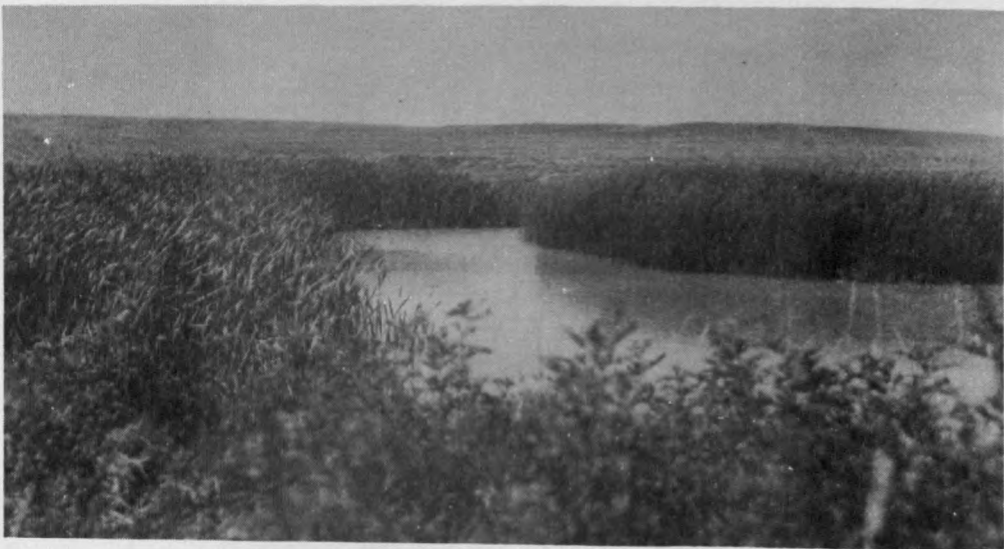


Fig. 5 A type II (Marsh) reservoir



Fig. 6 A type III (Meadow) reservoir

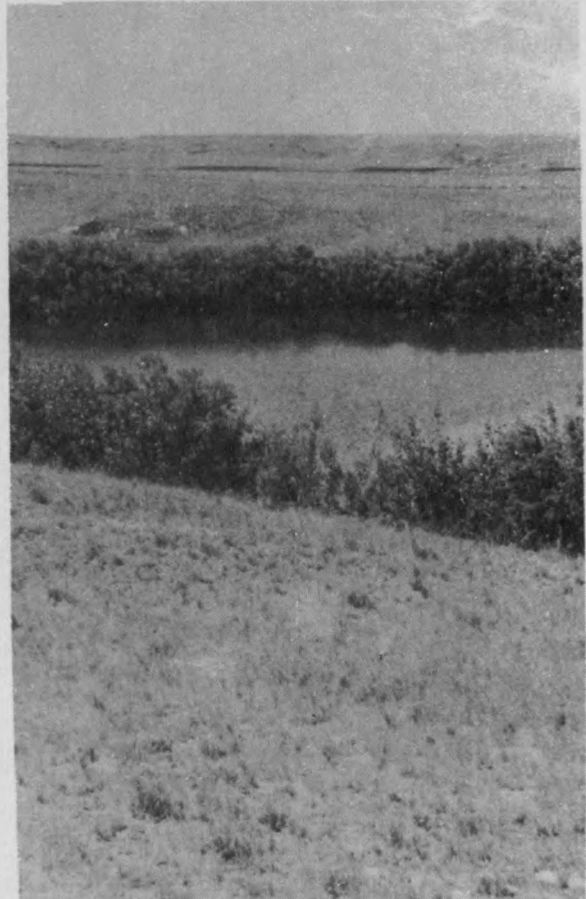


Fig. 7 A type IV (Woody) reservoir

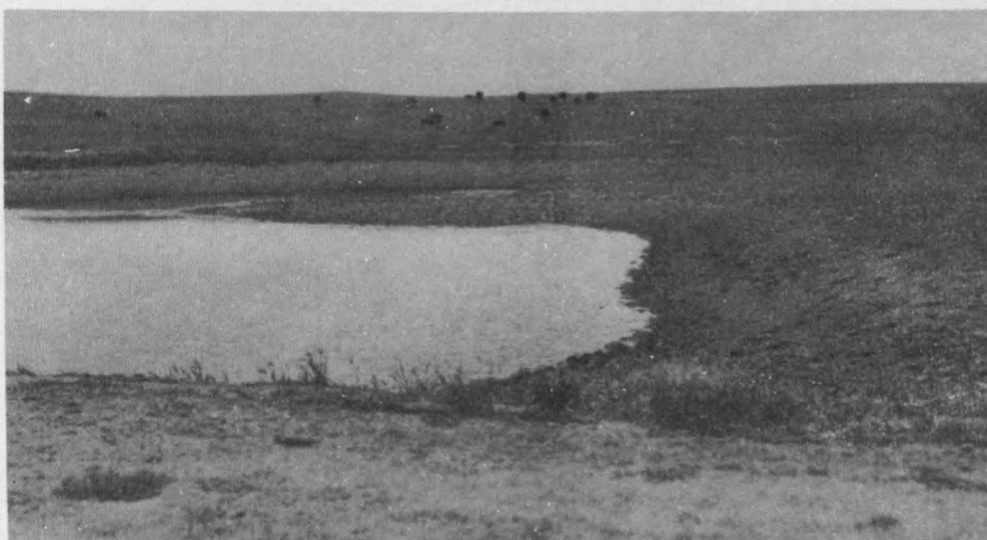


Fig. 8 A type V (Open) reservoir

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 reservoir	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 Total
	May	June	July	Aug.	Total	May	June	July	Aug.	Total	May	June	July	Aug.	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 XII). 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.

Size Group	Vegetative Type					No. of res. (size groups)	No. of ducks observ.	Av. ducks (tot. of 4 visits)
	I	II	III	IV	V			
1	5*	5	13	1	10	34	114	4.2
	7**	12	92	2	31			
	1.4***	2.4	7.1	2.0	3.1			
2	5	6	13	5	13	42	347	8.3
	11	39	142	63	92			
	2.2	6.5	10.9	12.6	7.1			
3	2	1	9		7	19	553	29.1
	84	13	345		111			
	42.0	13.0	38.3		15.9			
4	2	2	8		3	15	705	47.0
	104	88	448		65			
	52.0	44.0	56.0		21.7			
5		2	1		3	6	790	131.7
		141	215		434			
		70.5	215.0		144.7			
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.

