Waterfowl relationships to Greenfields Lake, Teton County, Montana
by Leroy J Ellig

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

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Abstract:

A study of waterfowl relationships to Greenfields Lake, Teton County, Montana, was conducted May 9 to November 30, 1951 and May 28 to September 20, 1952. Information on spring migration was obtained during week-ends in March, April, and May, 1952. Territorial pairs and lone males were censused to determine breeding population. A nesting study was conducted both years. An experiment on the effect of skunk control upon success of nests was carried out in 1952. Brood observations were made in 1951 and 1952. Information on hunter utilization and success was secured during the 1951 hunting season.

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TETON COUNTY, MONTANA

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Submitted to the Graduate Faculty

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ABSTRACT

A study of waterfowl relationships to Greenfields Lake, Teton County, Montana, was conducted May 9 to November 30, 1951 and May 28 to September 20, 1952. Information on spring migration was obtained during week-ends in March, April, and May, 1952. Territorial pairs and lone males were censused to determine breeding population. A nesting study was conducted both years. An experiment on the effect of skunk control upon success of nests was carried out in 1952. Brood observations were made in 1951 and 1952. Information on hunter utilization and success was secured during the 1951 hunting season.

INTRODUCTION

The constantly diminishing number of suitable water areas is one of the major concerns of waterfowl management throughout the United States (Day, 1950). Thus the proposed draining of Greenfields Lake (also known as Freezeout Lake) in Teton County, north-central Montana, by local groups to alleviate inundating of agricultural lands and waterfowl crop depredations caused considerable concern to the Montana Fish and Game Department. A study to determine waterfowl relationships to the area was conducted May 9 to November 30, 1951 and May 28 to September 20, 1952. Information on spring migration was secured during week-ends in March, April, and May, 1952.

The writer is grateful to the Montana Fish and Game Department for financing the study; to waterfowl biologists Wynn Freeman for supervision and Gerald Salinas for encouragement and assistance in field work; to other personnel and students of Montana State College who assisted in nest searches; to Dr. W. E. Booth, Montana State College, for verifying identification of plants; sincere appreciation is extended to Dr. Don C. Quimby, Montana State College, for advice and supervision during the study and preparation of the manuscript.

DESCRIPTION OF AREA

Greenfields Lake is located on the western edge of the Greenfields Division, Sun River Irrigation Project, approximately 2 miles northwest of Fairfield, Montana. It occupies the lower portion of a glacial lake bed, base elevation 3,654 feet, with no natural outlet. Long, sloping

plateaus, with elevations of approximately 4,000 feet, encompass the basin (Gieseke, 1937).

The lake was not a permanent body of water prior to irrigation of surrounding areas, initiated in 1919 (DeYoung, 1927), and increased to a maximum of 68,547 acres by 1945 (Bur. Rec., 1951). Residents report that previously the spring runoff generally dried up during the summer, but in "wet years" some water was retained. Nineteen-twenty was the last year the lake was dry. In 1941 it covered 1,900 acres, by 1952 it had increased to 4,100 acres with a maximum depth of 9.6 feet and a shoreline of 21.88 miles. The increase in size apparently resulted from waste and seepage waters flowing into the lake via 10 ditches from adjacent irrigated lands and/or above average precipitation during 1939 to 1951 (see below).

The lake supports abundant growths of submerged vegetation, mostly sago pondweed (Potamogeton pectinatus) and wigeongrass (Ruppia maritima); others include horned poolmat (Zannichellia palustris), muskgrass (Chara spp.), and water milfoil (Myriophyllum exalbescens). Alkali bulrush (Scirpus paludosus) is the only emergent species occurring in quantities, but softstem bulrush (S. validus), American bulrush (S. americanus), spike rush (Eleocharis macrostachya), wire rush (Juncus balticus), and cattail (Typha latifolia) are also found.

A marsh of 360 acres, connected to the lake by a $\frac{1}{2}$ mile drainage ditch (Fig. 1), provides the only substantial stand of emergent cover, mostly cattails (Fig. 2), on the area. Other emergent species include

Fig. 1. Map of Greenfields Lake study area.

Fig. 2. Cattail marsh showing extensive emergent cover.

Fig. 3. Small islands resulting from inundation of greasewood type shoreline.

those above.

Inundation has produced numerous small islands in two bays of the lake (Fig. 3). Dominant vegetation is generally greas^ewood (Sarcobatus vermiculatus).

The lake shore vegetation is mainly grass with greasewood dominant on alkali impregnated areas (Fig. 4). The greasewood type has a hummocky appearance, the result of soil erosion between plants (DeYoung, 1927). This type occupies 39.0 per cent (8.54 miles) of the shoreline (Fig. 1). Twenty-two 900 foot line intercepts (Canfield, 1942), each taken perpendicular to the shoreline, gave an average greasewood canopy cover of 14.1 per cent (2.0-34.4). Twenty-four 300 point transects (Coupland, 1950) were taken perpendicular to the shoreline to measure ground cover excluding greasewood. A board with 10 nails spaced 10 centimeters apart was placed on the ground at 12 step intervals starting at the shoreline. Vegetation touching the tip of each nail was recorded. Average density for 7,200 points was 23.6 per cent (7.0-53.0). Plants present and their percentage of ground cover were: foxtail barley (Hordeum jubatum), 22.6 per cent; saltgrass (Distichlis stricta), 19.3; western wheatgrass (Agropyron smithii), 11.7; Sandberg bluegrass (Poa secunda), 11.7; Nuttall saltbrush (Atriplex nuttallii), 9.7; bluegrass (Poa spp.), 9.1; alkali dropseed (Sporobolus airoides), 6.6; blue gramma (Bouteloua gracilis), 2.6; ^h ~~Myssopleaf~~ ^e Echinopsilon hyssopifolium, 2.2; seepweed (Suaeda depressa), 1.8; pepperwort (Lepidium virginicum), 1.5; Nuttall alkali-grass (Puccinellia nuttalliana) and junegrass (Koeleria cristata),

Fig. 4. Typical greasewood cover which constitutes 39 per cent of the shore line.

Fig. 5. Typical grass cover which constitutes 52.4 per cent of the shore line.

1.1.

Grass cover (Fig. 5) occupies 52.4 per cent (11.46 miles) of the shoreline (Fig. 1). The average density of 6,600 points was 47.3 per cent (27.0-72.3). Plants present and their percentage of ground cover were: blue gramma, 53.8 per cent; western wheatgrass, 21.4; needlegrass (Stipa comata), 8.6; saltgrass, 5.8; foxtail barley, 3.0; fringed sage (Artemisia frigida), 2.0; alkali dropseed, 1.2; junegrass, 1.0; gumweed (Grindelia squarrosa), seepweed, hyssopleaf echinopsilon, Nuttall alkali-grass, rabbit brush (Chrysothamnus nauseosus), Sandberg bluegrass, snake-weed (Gutierrezia sarothrae), Nuttall saltbrush, and unidentified plants, 3.0. Grazing pressure was considered heavy in grass and greasewood types. Monocot nomenclature follows Booth's (1950) Flora of Montana, Part I. Dicots follow Booth and Wright's (1953) Flora of Montana, Part II.

Irrigated farm lands of alfalfa, small grains, and summer fallow (Fig. 6) form 8.6 per cent (1.88 miles) of the shoreline (Fig. 1). The land is cultivated to a distance of 60 to 170 feet from the lake shore, depending on moisture conditions.

The climate is semi-arid; average annual precipitation at Fairfield during 1906-1938 was 11.53 inches (Maughan, 1941), for 1939-1951, 12.49 inches (U. S. Dept. of Commerce). The months of April, May, June, and July receive 56.9 per cent of the precipitation. The average temperature for January is 21.6° F., July, 65° F. The average last killing frost is May 19, the first September 20 (Maughan, 1941).

Fig. 6. Irrigated agricultural land adjacent to lake. This type occupied 8.6 per cent of the shore line.

SPRING MIGRATION

Observations of the spring migration were made by aerial flights, boat, and on foot. A 7 x 50 binocular and 20x spotting scope were used for sexing and identification.

A heavy spring run-off flooded pasture land bordering the lake by March 26, 1952. These flooded areas were used by ducks and geese. The lake became ice free April 14. Portions of bays and areas around points were open April 6.

Waterfowl observed included: Canada geese (Branta canadensis), lesser snow geese (Chen hyperborea hyperborea), whistling swans (Olor columbianus), mallards (Anas platyrhynchos), gadwalls (Anas strepera), pintails (Anas acuta tzitzihua), green-winged teals (Anas carolinensis), blue-winged teals (Anas discors), cinnamon teals (Anas cyanoptera septentrionalium), baldpates (Mareca americana), shovellers (Spatula clypeata), redheads (Aythya americana), canvas-backs (Aythya valisineria), lesser scaups (Aythya affinis), buffleheads (Bucephala albeola), American golden-eyes (Bucephala clangula americana), ruddy ducks (Oxyura jamaicensis rubida), and red breasted mergansers (Mergus serrator serrator). One white-winged scoter (Melanitta deglandi) was seen.

The earliest observation was made March 26, 1952. A resident farmer stated this was the first day he had noticed ducks on the area. Mallards, pintails, canvas-backs, and American golden-eyes were identified. The following day baldpates, redheads, lesser scaups, buffleheads, lesser snow geese, Canada geese, and whistling swans, plus the species above,

were seen with an estimated 8,000 birds present. Evidently large migrations occurred at night (Lincoln, 1950). Numbers increased noticeably from early evening to the following morning. The greatest number observed was an estimated 18,200 on March 29.

Late migrants could not be distinguished from early residents. Termination dates of migration were suggested by population numbers; numbers of lone pairs as compared to larger groups; and/or beginning of nesting. The spring migration extended over a minimum of 98 days, March 26-July 1. Arrival, peak migration, and terminal migration dates as the data suggest are given by species in Table I.

Girard (1939, 1941) gives quite similar dates for the main flight of mallards and shovellers in western Montana.

The maximum number of lesser snow geese observed, 12,000, April 6, was only 1/5 to 1/10 the number estimated by 2 residents for the previous day. Usage by large numbers is substantiated by a report of 150,000 for April 18-19, 1950 (U. S. Fish and Wildlife Service, Missouri River Basin Studies, correspondence).

Mallards, pintails, redheads and gadwalls displayed somewhat similar sex ratios throughout their migrations (Table II) suggesting no differential migration of the sexes. Hochbaum (1946) found the following sex ratios during the last two weeks of April and the first week of May in Manitoba, Canada: mallards, 102:100; pintails, 109:100; redheads, 138:100. The sex ratio of redheads during spring migration in Iowa was 142:100 (Low, 1945).

Table I. Arrival, peak, and terminal migration dates for waterfowl observed at Greenfields Lake, 1952.

Species	Arrived By	Peak	Terminated About
Mallard	3/26	3/26-4/2	4/20 ¹
Pintail	3/26	3/28-4/4	4/20 ¹
A. Golden-eye	3/26	4/4-10	
Canvas-back	3/26	4/9-15	5/20 ²
Baldpate	3/27	3/28-4/4	5/1 ¹
Redhead	3/27	4/16-22	5/5 ¹
Bufflehead	3/27	4/22-28	
Lesser Scaup	3/27	4/25-5/1	5/5 ¹
Shoveller	4/6	4/12-18	5/1 ¹
G. W. Teal	4/6	5/3-9	5/10 ¹
Gadwall	4/6	5/4-10	5/20 ³
Cinnamon Teal	4/6	5/9-15	5/20 ³
Ruddy duck	4/20	5/3-9	7/1 ³
B. W. Teal	4/28	5/14-20	5/25 ³
L. Snow Goose	3/27	4/1-7	
Canada Goose	3/27		
Whistling Swan	3/27		

- 1 - Majority of birds observed as lone pairs;
- 2 - Beginning of nesting;
- 3 - Population numbers.

Table II. Sex ratios⁴ of waterfowl identified during spring migration at Greenfields Lake, 1952.

Species	March 26-30	April 6-7	April 13-14	April 20-21	April 27-28	May 4-5	May 11-12	May 18-20	Average
Mallard	128:100 (405:317)	129:100 (27:21)	122:100 (67:55)						127:100 (499:393)
Pintail	105:100 (1501:1423)	104:100 (71:68)	127:100 (128:101)						107:00 (1700:1592)
Redhead	133:100 (4:3)		144:100 (13:9)	137:100 (41:30)	100:100 (7:7)	138:100 (22:16)			134:100 (87:65)
Gadwall			133:100 (12:9)	105:100 (20:19)	107:100 (29:27)	109:100 (50:46)	115:100 (23:20)		111:100 (134:121)
Canvas-back	1250:100 (50:4)		322:100 (87:27)	338:100 (88:26)	200:100 (6:3)	200:100 (8:4)	1300:100 (26:2)		402:100 (265:66)
Lesser Sc.	933:100 (28:3)		267:100 (8:3)	167:100 (55:33)	216:100 (54:25)	208:100 (52:25)			221:100 (197:89)
Cinnamon T.			(1:0)	(2:0)	200:100 (4:2)	225:100 (9:4)	213:100 (17:8)		236:100 (33:14)
B. W. Teal					(1:0)	133:100 (20:15)	190:100 (19:10)	290:100 (42:15)	205:100 (82:40)
Baldpate	116:100 (441:379)	114:100 (32:28)	133:100 (92:69)	143:100 (57:40)	156:100 (28:18)	150:100 (24:16)			123:100 (674:550)
G. W. Teal	100:100 (4:4)	100:100 (2:2)	129:100 (22:17)	194:100 (60:31)	110:100 (11:10)	140:100 (35:25)	150:100 (12:8)		147:100 (146:99)
Shoveller	100:100 (3:3)	163:100 (44:27)	200:100 (122:61)	516:100 (129:25)	470:100 (47:10)	453:100 (68:15)			293:100 (413:141)

⁴ Males:females

A differential migration, with an early movement of males, is suggested for the canvas-backs and lesser scaups. The same trend is possibly suggested for blue-winged and cinnamon teals. Smith (1946) found the canvas-backs sex ratio to be 230:100 in early migrants and 120:100 at the peak of migration in Minnesota. The canvas-backs sex ratio was 189:100 and lesser scaups, 201:100 during the spring migration in Manitoba, Canada (Hochbaum, 1946). The sex ratio of lesser scaups was 156:100 and 186:100 during March and April respectively in southwestern Washington (Beer, 1945). Bennett (1938) reported about 150:100 during migration of blue-winged teals in Iowa. In Minnesota, blue-winged teals showed a marked tendency for males to precede females (Erickson, 1943).

The ratio of baldpate males to females increased as migration progressed. Spring sex ratio in Minnesota was 121:100 (Erickson, 1943). Beer (1945) recorded 114:100 and 115:100 during March and April respectively.

Early migrants of green-winged teals showed equal numbers of males and females. Later the ratio of males increased. Beer (1945) reported 103:100 for March and 100:100 for April.

Shovellers exhibited a balanced sex ratio in early migrants, with ratios becoming unbalanced in favor of males as migration progressed. Erickson (1943) found a sex ratio of 115:100 in early spring and 165:100 in late spring.

BREEDING POPULATION

A breeding population of at least 341 pairs (Table III) on the lake

Table III. Breeding population as indicated by territorial pairs and pairs/mile of shoreline type at Greenfields Lake, 1952.

Species	Total Pairs	Greasewood ⁵ Pairs/mile	Grass ⁶ Pairs/mile	Agricultural Land ⁷ Pairs/mile
Pintail	83	5.3	3.1	1.1
Mallard	39	2.3	1.6	.5
Gadwall	55	3.3	2.1	1.6
B. W. Teal	42	2.5	1.4	2.7
G. W. Teal	23	1.3	1.0	.5
Cinnamon Teal	6	.5	.2	
Shoveller	31	1.8	1.2	1.1
Baldpate	20	1.4	.5	1.1
Lesser Scaup	21	1.5	.6	.5
Redhead	9	.7	.3	
Canvas-back	4	.5		
Ruddy duck	8	.9		
Total	341	21.9	12.0	9.0

- ⁵ - 8.54 miles shoreline;
⁶ - 11.46 miles shoreline;
⁷ - 1.88 miles shoreline.

in 1952 was indicated by counting territorial pairs and lone males (Hochbaum, 1944). Species composition was as follows: pintails, 24 per cent; gadwalls, 16; blue-winged teals, 12; mallards, 11; shovellers, 9; green-winged teals, 7; baldpates, 6; lesser scaups, 6; redheads, 3; ruddy ducks, 2; cinnamon teals, 2; canvas-backs, 1. These figures do not include the extensive cattail marsh and therefore do not reflect the true proportion of water nesting species for the entire area. Nesting studies indicate the redhead, for example, is one of the more common nesters.

The greasewood shoreline, 39.0 per cent of the total shoreline, supported 55 per cent of the territories; grass, 52.4, 40; agricultural land, 8.6, 5. Irregularity of shoreline, presence of small islands, and bushes restricting vision were factors which may have been responsible for the greater density of territorial pairs along the greasewood shoreline (Table III). See Hochbaum (1944) for a discussion of environmental influences on size of territory.

Other species nesting on the area included: common tern (Sterna hirundo hirundo), Franklin's gull (Larus pipixcan), ring-billed gull (L. delawarensis), California gull (L. californicus), Wilson's phalarope (Steganopus tricolor), marbled godwit (Limosa fedoa), willet (Catoptrophorus semipalmatus inornatus), avocet (Recurvirostra americana), sora (Porzana carolina), eared grebe (Colymbus nigricollis californicus), yellow-headed blackbird (Xanthocephalus xanthocephalus), red-winged blackbird (Agelaius phoeniceus), long-billed marsh wren (Telmatodytes

palustris), coot (Fulica americana), ring-necked pheasant (Phasianus colchicus torquatus), crow (Corvus brachyrhynchos), short-eared owl (Asio flammeus flammeus), marsh hawk (Circus hudsonius).

NESTING STUDY

Methods

Complete nest searches of all cover was not feasible. Twenty-seven rectangular plots, 150 by 300 yards, each including 150 yards of shoreline, were selected as being representative for searches of grass and greasewood cover types. The 300 yard depth was considered sufficient as similar studies indicated that the majority of nests are found within this distance from water (Bennett, 1938; Girard, 1941). Additional areas were searched as time permitted. It was not considered desirable to search agricultural types. Interviewing land owners engaged in agricultural activities provided some information. The entire cattail marsh (Fig. 2) was covered. The dates of, and efforts expended in organized nest searches are given in Table IV. Supplementary searches were made by the author during revisits.

Sixty foot ropes, with tin cans attached at 10 foot intervals, were dragged between two men in areas where cover permitted to flush nesting females (Sowls, 1950). Greasewood and emergent vegetation were walked in a weaving manner with approximately 20 to 30 foot intervals between men.

A total of 222 active and 112 inactive nests were found during 1951 and 1952 as indicated by species in Table V. Nests were classified as active if the female was still attending. Those terminated by hatching,

Table IV. Dates and man hours of organized nest searches at Greenfields Lake, 1951 and 1952.

1951			1952		
Date	Number Men	Man Hours	Date	Number Men	Man Hours
5/26, 5/27	11	175	5/30, 5/31, 6/1	11	242
6/13, 6/14, 6/15, 6/16	6	138	6/30, 7/1	9	106
7/6, 7/7	7	133			
Total Man Hours		446			348

Table V. Number of active and inactive duck nests found at Greenfields Lake, 1951 and 1952.

Species	Number of active nests found			Number of inactive nests found		
	1951	1952	Total	1951	1952	Total
Pintail	19	35	54	13	27	40
Mallard	16	16	32	4	11	15
Gadwall	22	12	34	13	6	19
B. W. Teal	8	12	20	6	6	12
G. W. Teal	6	9	15	2	5	7
Unid. Teal				4	4	8
Shoveller	3	5	8		2	2
Baldpate	2	3	5			
Lesser Scaup	9	10	19	2	5	7
Redhead	17	8	25		2	2
Canvas-back	1	3	4			
Ruddy duck	4	2	6			
Total	107	115	222	44	68	112

destruction, or desertion when found were classed as inactive. These were identified to species by comparing the eggs, feathers, and down with reference collections. Subsequent discussions refer to active nests only unless specified otherwise.

Nest locations were marked by placing a 2 foot lath 15 steps or a willow stake 15 feet from land and water nests respectively. Water nests include those on small islands as well as those in emergent vegetation. Nest number, date, species, number of eggs and other pertinent data were recorded on the marker and in a field notebook. Location was plotted on a map. Precautions were taken to avoid trampling vegetation about nests to lessen danger of predation (Bennett, 1938; Kalmbach, 1938). Nests were revisited at approximately weekly intervals until termination. Pertinent data pertaining to the history of the nest were recorded. The cause of terminated nests was determined after careful examination of nest and eggs.

The heavy intact egg membranes (Fig. 7) were the most conspicuous features of a successful nest. This membrane is evidently pliable enough at hatching to resist crushing. From a sample of 223 successful eggs, 212 membranes were found. The activities of female and young evidently crush the hatched egg shells into fragments. From 108 successful nests, only 2 intact hatched egg shells were found, both ruddy duck. Egg caps from successful eggs were present, but others undoubtedly suffered the same fate as the egg shells. Somewhat similar descriptions of successful nests have been given by Williams and Marshall (1938), Bennett (1938),

Fig. 7. Membranes from hatched eggs characteristic of a successful nest.

Fig. 8. Pintail eggs destroyed by skunk showing characteristic crushing.

Girard (1939), Low (1945), and SOWLS (1948). Destruction was attributed to various sources (see below). A nest was considered deserted when it became evident that the female was no longer in attendance.

Nesting Cover

The 222 nests found were located as follows: greasewood, 115; islands, 43; emergent vegetation, 38; grass, 26. Location by species is given in Table VI.

Eighty-three per cent of the nests in greasewood were at the base of bushes, 17 per cent in grass between bushes. The dominant plant at 65 per cent was foxtail barley or bluestem. About 95 per cent of island nests were in greasewood (Fig. 3), the others in grass. No more than one nest was found on any island. Ninety-seven per cent of nests in emergent vegetation were in cattail, 3 per cent in alkali bulrush.

Fall and early spring plowing eliminated approximately 80 per cent of the agricultural type as nesting cover. The remainder in alfalfa was available. Interviewing landowners indicated alfalfa was little utilized for nesting. Only two nests were reported during haying operations, and both were destroyed by mowing. Early irrigation followed by mowing suggested alfalfa would be hazardous nesting cover.

The average distances from nest to water in grass and greasewood respectively were: pintails, 109 yards, 61 yards; mallards, 90, 55; gadwalls, 90, 34; shovellers, 39, 28; lesser scaups, —, 27; baldpates, —, 55; green-winged teals, 17, 39; blue-winged teals, 36, 28; redheads, —, 10. Bennett (1938) found blue-winged teal nests to average 41.5 yards

Table VI. Cover type of active nests found at Greenfields Lake, 1951 and 1952.

Species	Total Nests	Percentage of nests in			
		Greasewood	Islands	Emergents	Grass
Pintail	54	57.4	25.9		16.7
Mallard	32	37.5	25.0	34.4 ⁸	3.1
Gadwall	34	85.3	2.9		11.8
B. W. Teal	20	65.0			35.0
G. W. Teal	15	86.7			13.3
Shoveller	8	37.5	25.0		37.5
Baldpate	5	100.0			
Lesser Scaup	19	36.8	63.2		
Redhead	25	8.0	4.0	88.0	
Canvas-back	4		100.0		
Ruddy duck	6		16.7	83.2	
Total	222	51.8	19.4	17.1	11.7

⁸ - Muskrat houses and matted emergent vegetation.

from water in Iowa. Girard (1941) reported mallard nests averaged 118.7 yards from water and green-winged teals 34.2 yards in western Montana, with blue-winged teals, cinnamon teals, shovellers and baldpates within these extremes.

Nests in emergent vegetation were never far from open water provided by "natural openings" or muskrat activity. Redhead nests averaged 11 yards. Sixty-four per cent were near "natural openings". Low (1945) found redhead nests averaged 28 yards from muskrat lodges which were the nearest open water for 64 per cent of the nests.

During 1951, approximately 1/3 of the cattail marsh had been winter grazed by cattle, 41 per cent of the redhead nests were found in this portion.

Fate of eggs and nests

Nest construction, eggs, and clutch size were similar to those described by various authors.

The hatching success of 503 eggs from land and 469 eggs from water nests was 25.8 and 45.8 per cent respectively in 1951 (Table VII). Williams and Marshall (1938) recorded an egg success in Utah as follows: gadwalls, 85 per cent; cinnamon teals, 84; redheads, 26; mallards, 60; pintails, 82; ruddy ducks, 52; shoveller, 80. Girard (1941), in western Montana, found an egg success range of 69.7 per cent for shovellers to 75.2 per cent for green-winged teals, with mallards, baldpates, cinnamon teals and blue-winged teals within these extremes. Low (1945) reported an egg success of 45 per cent for redheads in Iowa.

Table VII. Egg success of land and water nests at Greenfields Lake, 1951.

Species	No.	Percent	Per cent Unsuccessful from					
			Unknown	Late				
		Eggs Hatched	Skunk	Predator	Undeveloped	Embryo	Misc.	Desertion
EGGS OF LAND NESTS								
Pintail	100	58.0	30.0		4.0	1.0	7.0	
Mallard	23	78.3	17.4					4.3
Gadwall	200	18.0	73.5		1.5		6.5	.5
Shoveller	18	55.6	38.9					5.5
Baldpate	17	0.0	100.0					
B. W. Teal	75	10.7	76.0	12.0	1.3			
G. W. Teal	49	0.0	79.6					20.4
Lesser Sc.	21	0.0	57.1	42.9				
Total	503	25.8	62.2	3.6	1.6	.2	4.0	2.6
EGGS OF WATER NESTS								
Pintail	35	45.7	17.1		5.7		2.9	28.6
Mallard	120	50.0			.8	6.7	15.0	27.5
Lesser Sc.	66	83.3	12.1		1.5	1.5	1.5	
Redhead	205	35.1			10.2	20.5	13.6	20.5
Ruddy Duck	33	36.4			6.1	9.1	3.0	45.5
Canvas-back	10	0.0						100.0
Total	469	45.8	3.0		5.8	11.5	10.4	23.5

Predation caused the failure of 69.8 per cent of eggs from land and 3.0 per cent of eggs from water nests. The majority of eggs from water nests listed as having a miscellaneous fate in Table VII were recorded following a sudden rise of water level in the cattail marsh. This necessitated rapid addition of new nest materials by the females to prevent nests from being inundated. It is possible that the eggs were either pushed into the water or buried in the nest during this construction. Late embryos refer to unhatched eggs which contained embryos in various stages of development. The frequent occurrence of late embryos and undeveloped eggs in redhead clutches possibly was a result of strange females depositing eggs in the nests after incubation began. This habit has been described for redheads by Low (1945). Late embryos and undeveloped eggs of other species generally were restricted to a single egg from successful clutches.

Sixty-one land and 46 water nests had a hatching success of 26.2 and 69.7 per cent respectively in 1951 (Table VIII). Kalmbach (1939) in a review of more than 7,600 waterfowl nests in 22 studies found an average success of 60 per cent. A nest success of 54.8 per cent for 250 blue-winged teal nests in Iowa was recorded by Bennett (1938). Low (1945) found a nesting success of 56.2 per cent for 160 redhead nests in Iowa. Sows (1948), in Manitoba, Canada, reported the following nest success: Mallards, 36 nests, 33 per cent; gadwalls, 6, 16; pintails, 34, 23; blue-winged teals, 33, 35; shovellers, 8, 25; redheads, 52, 42; canvas-backs, 24, 58; lesser scaups, 10, 20; ruddy ducks, 3, 33. Earl (1950) found 60

Table VIII. Success of land and water nests at Greenfields Lake, 1951.

Species	No. Nests	Percent Hatched	Per cent destroyed by			
			Skunk	Unknown Predator	Misc.	Desertion
LAND NESTS						
Pintail	14	57.1	35.7		7.1	
Mallard	4	50.0	25.0			25.0
Gadwall	22	18.2	72.7		4.5	4.5
Shoveller	3	33.3	33.3			33.3
Baldpate	2	0.0	100.0			
B. W. Teal	8	12.5	75.0	12.5		
G. W. Teal	6	0.0	83.3			16.7
Lesser Scaup	2	0.0	50.0	50.0		
Total	61	26.2	60.7	3.3	3.2	6.6
WATER NESTS						
Pintail	5	60.0	20.0			20.0
Mallard	12	66.7			8.3	25.0
Redhead	17	76.5			5.9	17.6
Lesser Scaup	7	85.7	14.3			
Ruddy Duck	4	50.0				50.0
Canvas-back	1	0.0				100.0
Total	46	69.7	4.3		4.3	21.7

mallard nests to have a 52 per cent hatching success in California.

Human interference is thought to have caused the desertion of 3 nests containing 1 egg each and 5 with complete clutches. Sixteen inactive deserted nests or nest forms of 5 species with 1 to 9 eggs each were found, suggesting that females not uncommonly abandon uncompleted nests without human interference. Six nests were deserted for unknown reasons.

Surplus irrigation water entering the cattail marsh flooded two nests. California gulls were suspected of destroying one nest. Other avian predators present which may have been responsible were crows and ring-billed gulls. Two nests were destroyed by unknown predators, and one incubating female was killed by an unknown mammalian predator, possibly a mink (Mustela vison) or weasel (M. frenata). Striped skunks (Mephitis mephitis) were responsible for the greatest nest destruction, 60.7 per cent of land and 4.3 per cent of water nests. Characteristics of skunk destruction were: nest usually torn apart; egg shells left in immediate vicinity of nest; some egg contents remaining in nest and on egg shells; and 1/4 to entire egg characteristically crushed (Fig. 8). These characteristics agree with those reported by SOWLS (1948) and REARDEN (1951).

Human intrusion is not believed to have increased nest vulnerability to skunks. Thirty-six inactive land nests found in 1951 had a hatching success of 16.7 per cent and 49 for 1952 had a success of 20.4 per cent. Success was below that of active nests both years. KALMBACH (1938) found

similar results and concluded that intrusion by careful observers does not afford skunks a marked advantage.

Water was an effective skunk barrier as indicated by the minor predation, 4.3 per cent, on water nests. Only one of many skunks seen was observed walking in shallow water. Cuyler (1924) states "skunks are chiefly terrestrial, although they hunt along the edges of streams for frogs and crayfish, and like raccoons even slosh minnows out of water with their paws". The two water nests destroyed by skunks were on small islands a few feet from the mainland, with water depth less than an inch in the intervening space.

Land nests on the large peninsula in the south-central part of the lake (Fig. 1) suffered the greatest skunk predation, 77.3 per cent; other land nests about the lake 51.3 per cent. The unusual severity of skunk predation gave impetus to conduct an experiment on the effect of skunk reduction upon success of land nests.

From April 6 to August 2, 1952, a string of number 1 steel traps baited with chicken eggs and meats were set across the peninsula at approximately 100 foot intervals to catch skunks moving into the area. No skunk dens were found on the peninsula in 1951 or 1952, possibly due to the high water table. No skunks were removed from other nesting areas about the lake.

Twenty-three skunks were captured. Five caught previous to June 24 were adults. Four adults, 12 juveniles and 2 of unknown age were caught during the remainder of the removal program. The number of skunks cap-

tured increased suddenly during the last week of June. The first dates (June 29, 1951 and July 7, 1952) that lone juvenile skunks were observed foraging correlates rather closely with the time of the increased rate of skunk capture. Data indicate that skunk predation was not in proportion to the number of nests available (Table IX). It appears significant that the early nesting species, pintails and mallards, received the least skunk predation (Table X). Possibly an increase in skunk activity after juveniles are able to leave the dens accounts for the greater predation on late nesters.

Skunk destruction of nests was 51 per cent greater on the peninsula than on other areas in 1951. After the skunk removal program in 1952, skunk destruction was 79 per cent less on the peninsula than on other areas (Table X). In 1952, skunk predation decreased 92 per cent from 1951 on the peninsula; 40 per cent on other areas.

Nest success was 75 per cent less on the peninsula than on other areas in 1951. After the skunk removal program in 1952, nest success was 132 per cent greater on the peninsula than on other areas. In 1952, nest success increased 786 per cent over 1951 on the peninsula, but decreased 3 per cent on other areas.

Only two nests were destroyed by skunks on the peninsula in 1952 (July 20-26) indicating that the trapline was successful in preventing large scale movements into this area.

Kalmbach (1938) in a skunk removal study in North Dakota found 30.4 per cent skunk nest destruction and 54.4 per cent nest success in 1936

Table IX. Number of active nests under observation and percentage destroyed by skunk at Greenfields Lake, 1951 and 1952.

1951 1952	No. active nests	Per cent skunk destroyed
4/27-5/3	1	0.0
5/4-10	1	0.0
5/11-17	1	0.0
5/20-26 5/18-24	8	0.0
5/27-6/2 5/25-31	19	0.0
6/3-9 6/1-7	21	0.0
6/10-16 6/8-14	40	7.5 (3)
6/17-23 6/15-21	40	20.0 (8)
6/24-30 6/22-28	36	22.2 (8)
7/1-7 6/28-7/5	40	20.0 (8)
7/8-14 7/6-12	31	41.9 (13)
7/15-21 7/13-19	14	35.7 (5)
7/22-28 7/20-26	10	50.0 (5)
7/29-8/4	3	33.3 (1)
8/5-11	2	100.0 (2)

Table X. Success of land nests on the peninsula and other areas at Greenfields Lake, 1951 and 1952.

Species	No. Nests	Percent Hatched	Per cent Destroyed by			
			Skunk	Unknown Predator	Misc.	Desertion
<u>1951</u>						
Other Areas						
Pintail	10	70.0	30.0			
Mallard	4	50.0	25.0			25.0
Shoveller	3	33.3	33.3			33.3
Gadwall	11	27.3	63.6		9.1	
Baldpate	1	0.0	100.0			
G. W. Teal	4	0.0	75.0			25.0
B. W. Teal	5	20.0	60.0	20.0		
Lesser Scaup	1	0.0	100.0			
Total	39	35.9	51.3	2.6	2.6	7.7
Peninsula						
Pintail	4	25.0	50.0		25.0	
Gadwall	11	9.1	81.8			9.1
Baldpate	1	0.0	100.0			
G. W. Teal	2	0.0	100.0			
B. W. Teal	3	0.0	100.0			
Lesser Scaup	1	0.0		100.0		
Total	22	9.1	77.3	4.5	4.5	4.5
<u>1952</u>						
Other Areas						
Pintail	17	47.1	11.8	23.5	5.9	11.8
Mallard	6	50.0	16.7			33.3
Shoveller	2	50.0				50.0
Gadwall	2	0.0	50.0			50.0
Baldpate	1	0.0		100.0		
G. W. Teal	6	33.3	50.0		16.7	
B. W. Teal	11	9.1	72.7	9.1		9.1
Lesser Scaup	2	50.0				50.0
Redhead	2	50.0			50.0	
Total	49	34.7	30.6	12.2	6.1	16.3
Peninsula						
Pintail	9	77.8				22.2
Mallard	3	100.0				
Gadwall	9	100.0				
Shoveller	1	100.0				
Baldpate	2	0.0			50.0	50.0
G. W. Teal	3	66.7	33.3			
B. W. Teal	1	0.0	100.0			
Lesser Scaup	3	100.0				
Total	31	80.6	6.5		3.2	9.7

before skunk removal, and following removal in 1937, skunk nest destruction of 6.5 per cent and nest success of 69.3 per cent. He concluded that the increase in nesting success was due to reduction of skunk destruction, shift of the duck population center and possibly some unknown factors.

No apparent factor replaced the skunk in nest destruction on the peninsula during 1952. Kalmbach (1938) found a slight increase in destruction by crows and red foxes after skunk removal.

Egg success on the peninsula and other areas corresponds in general to nest success for the two years. Egg success on the peninsula in 1952 compared to 1951 and to other areas in 1952 did not increase as greatly as nest success (Tables X and XI). This is largely attributable to the more frequent occurrence of undeveloped eggs and late embryos on the peninsula in 1952, 15.5 per cent, as compared to 1951, 0.0 per cent. On other areas the percentage of undeveloped eggs and late embryos are quite similar for both years; 2.8 per cent, 1951 and 3.4 per cent, 1952. Although no factor appeared to replace the skunk in nest destruction during 1952, these data suggest an intercompensation (Errington, 1946) through egg success. This and the fact that ducks reneest make evaluation of skunk nest predation difficult. Renests have been reported less efficient than first nests (Bennett, 1938; Low, 1945). Sowl (1949) in his quantitative experiments on reneesting found "the average number of eggs in first clutches is statistically greater than the number of eggs in renests". This suggests that heavy predation could substanti-

Table XI. Egg success of land nests at Greenfields Lake, 1951 and 1952.

Species	No.	Percent Eggs Hatched	Per cent unsuccessful from					
			Unknown	Late				
			Skunk	Predator	Undeveloped	Embryo	Misc.	Desertion
<u>1951</u>								
Other areas								
Pintail	72	69.4	23.6		5.6	1.4		
Mallard	23	78.3	17.4					4.3
Shoveller	18	55.6	38.9					5.6
Gadwall	110	24.5	60.9		2.7		11.8	
Baldpate	6	0.0	100.0					
G. W. Teal	30	0.0	66.7					33.3
B. W. Teal	54	14.8	66.7	16.7	1.9			
Lesser Sc.	12	0.0	100.0					
TOTAL	325	34.8	52.0	2.8	2.5	.3	4.0	3.7
<u>Peninsula</u>								
Pintail	28	28.6	46.4				25.0	
Gadwall	90	10.0	88.9					1.1
Baldpate	11	0.0	100.0					
G. W. Teal	19	0.0	100.0					
B. W. Teal	21	0.0	100.0					
Lesser Sc.	9	0.0		100.0				
TOTAL	178	9.6	80.9	5.1			3.9	.6
<u>1952</u>								
Other areas								
Pintail	112	44.6	8.0	25.9	.9	1.8	12.5	6.3
Mallard	54	46.3	16.7		3.7			33.3
Shoveller	18	61.1						38.9
Gadwall	19	0.0	57.9					42.1
Baldpate	11	0.0		100.0				
G. W. Teal	49	30.6	49.0		2.0	2.0	16.3	
B. W. Teal	83	14.5	72.3	12.0				1.2
Lesser Sc.	16	62.5						37.5
Redhead	21	23.8			28.6		47.6	
TOTAL	383	33.4	29.5	13.1	2.6	.8	8.4	12.3
<u>Peninsula</u>								
Pintail	53	73.6			18.7	1.9	1.9	3.8
Mallard	27	85.2		14.8				
Shoveller	12	100.0						
Gadwall	88	77.3			10.2	12.5		
Baldpate	20	0.0					50.0	50.0
G. W. Teal	24	66.7	33.3					
B. W. Teal	9	0.0	100.0					
Lesser Sc.	30	80.0			16.7	3.3		
TOTAL	263	69.2	6.5		10.6	4.9	4.2	4.6

ally decrease potential reproduction even if all females renested successfully. Since skunk predation increased later in the season renests would be more vulnerable than first nests.

BROODS

Brood observations began June 1 both years and terminated September 10, 1951 and September 1, 1952. The majority of the broods were observed during weekly brood counts made by walking the shoreline or by boat from sunrise to 9:00 A. M. Broods were classified according to size as follows: Class I (0-1/3 grown), Class II (1/3-2/3 grown), Class III (2/3-full grown). A total of 735 broods was observed: 353 in 1951; 382, 1952. Broods seen and average size by species are given in Table XII. Brood ages were estimated (Hochbaum, 1944; Southwick, 1953) so their hatching dates could be assigned to a 10 day period (Table XIII). Eighty-four per cent of the broods hatched from June 1-July 31 in 1951; 79 per cent, 1952. Girard (1941) reported "with the exception of the ruddy duck, the months of June and July cover the height of the hatching season of ducks in western Montana."

Lower temperatures and greater precipitation (Table XIV) apparently retarded hatching peaks (Table XIII) in 1951 as compared to 1952. Low (1945) reported subnormal temperatures, excess precipitation and excess cloudy days delayed the redhead in migration and egg laying. Yocum (1950) found a positive correlation between hatching of waterfowl and meteorological conditions.

Average Class III brood size was greater than Class I in some cases.

Table XII. Number and average size of broods observed at Greenfields Lake, 1951 and 1952.

Species	Class I		Class II		Class III		Total Broods
	Number Broods	Average Size	Number Broods	Average Size	Number Broods	Average Size	
Pintail							
1951	36	4.4(1-7)	38	4.4(1-9)	42	5.1(2-8)	116
1952	34	6.2(1-10)	36	6.9(2-10)	44	6.8(3-10)	114
Gadwall							
1951	42	7.0(4-10)	51	6.9(4-11)	7	6.4(5-9)	100
1952	42	7.7(1-12)	54	7.6(3-12)	21	7.9(3-12)	117
Lesser Sc.							
1951	18	6.5(3-12)	20	7.1(3-12)	1	5.0	39
1952	37	6.9(1-10)	27	7.5(5-10)	18	8.3(7-10)	82
Mallard							
1951	4	7.3(6-10)	6	7.5(5-11)	6	5.2(3-7)	16
1952	7	7.4(5-10)	5	6.2(3-10)	3	8.7(7-10)	15
Baldpate							
1951	4	6.0(4-8)					4
1952	4	5.5(3-7)	1	6.0	1	6.0	6
Shoveller							
1951	11	6.2(1-13)	1	7.0			12
1952	2	3.5(2-5)	1	7.0	4	8.3(8-9)	7
G. W. Teal							
1951							
1952	1	5.0	1	7.0	1	8.0	3
B. W. Teal							
1951	11	7.7(4-9)	15	7.1(3-11)	1	8.0	27
1952	13	8.5(5-10)	3	6.3(5-8)	2	8.0	18
Redhead							
1951	9	6.1(4-9)	8	5.9(4-9)			17
1952	11	4.0(2-7)	1	7.0			12
Canvas-back							
1951	2	4.0(1-7)	3	3.3(1-5)			5
1952	2	2.5(2-3)	2	3.0			4
Ruddy Duck							
1951	10	7.2(5-10)	7	6.4(1-11)			17
1952	2	5.5(5-6)			1	7.0	3
Total							
1951	147	6.2	149	6.2	56	5.3	352
1952	155	6.7	131	7.2	96	7.5	382

Table XIII. Hatching dates of broods observed at Greenfields Lake, 1951 and 1952.

Species	May 1-10	May 11-20	May 21-31	June 1-10	June 11-20	June 21-30	July 1-10	July 11-20	July 21-31	Aug. 1-10	Aug. 11-20
Pintail											
1951			10	48	22	12	14	2	1		
1952	3	18	23	10	13	7	5	2			
Gadwall											
1951					4	7	16	29	10	15	1
1952					13	29	18	10	14	1	
Mallard											
1951			3		5	3	2		1		
1952			3		3	4	1	2	1		
Shoveller											
1951					3	1	5	2			
1952			3		1	2					
Baldpate											
1951								3			1
1952					2	3	1				
B. W. Teal											
1951							3	5	2	5	3
1952					7	2	3	1	1	1	
G. W. Teal											
1951											
1952				1	1			1			
Lesser Sc.											
1951					3	4	5	10	3	2	1
1952					5	10	14	9	7	6	
Canvas-back											
1951				1	2		2	1	1		
1952					1	2	1				
Redhead											
1951				1		1	3	5	1	2	
1952				2		2	1	1	3	2	
Ruddy Duck											
1951						1	1	3	3	4	2
1952								1	2		
TOTAL											
1951			13	50	39	28	51	60	22	28	8
1952	3	18	29	13	46	62	44	27	28	10	

Table XIV. Average precipitation and temperature at Fairfield, Montana, 1951 and 1952.

Month	Average Temp. °F.		Departure Normal		Precipitation in inches		Departure Normal	
	1951	1952	1951	1952	1951	1952	1951	1952
March	20.5	28.2	-11.7	-4.0	.33	.29	-.23	-.27
April	40.3	49.4	-3.1	6.0	.54	.23	-.22	-.53
May	52.0	53.9	0.0	1.9	1.42	1.87	-.36	.09
June	53.0	59.7	-6.2	0.5	2.86	1.14	-.11	-1.83

Table XV. Average clutch size and eggs hatched of successful nests at Greenfields Lake, 1951 and 1952.

Species	Number Nests Hatched	Average Clutch Size	Av. No. Eggs Hatched
Pintail	31	7.5	6.7
Gadwall	13	9.8	8.0
Lesser Scaup	15	9.5	8.5
Mallard	20	9.1	8.1
Shoveller	4	10.1	9.5
G. W. Teal	4	8.3	7.8
B. W. Teal	2	10.5	10.0
Redhead	14	10.9	5.4
Canvas-back	2	10.0	4.5
Ruddy duck	3	8.7	5.3

This may indicate females losing smaller broods or broods of 2 or more females combining. From observations of broods with excessive numbers and mixed size classes they were known to combine. All "obvious" combined broods were not included in the brood data.

Average brood size was greater in 1952 than in 1951. This was especially apparent in pintails, gadwalls, and lesser scaups, possibly because of larger numbers observed. The fact that the pintail hatching peak in 1951 coincided with a period of abnormally cold and wet weather probably accounts for the small broods as compared to 1952.

The average number of eggs hatched per successful nest (Table XV) compared to average brood size (Table XII) indicates that juvenile mortality was slight. Juvenile mortalities observed during 1951 and 1952 were: 6 Class I juveniles dead from unknown causes on the shoreline and islands; 21 Class I juveniles dead in nests, possibly hatched after the female left nest and died of exposure. Minor outbreaks of botulism in 1951 and 1952 may have affected some juveniles. Past records indicate that major outbreaks have occurred, the last being in 1942.

Broods were found in cattails, alkali bulrush, and small bays barren of emergent vegetation. Broods on the lake generally swam from the shoreline into open water to escape the observer; those in the marsh swam into cattail cover.

HUNTING SEASON

Hunter utilization was obtained by personal interviews in the field (165 parties) and by postal questionnaires left on cars (17 parties),

Oct. 12-Nov. 18, 1951. Supplemental information was obtained from a checking station operated by the Montana Fish and Game Department.

The waterfowl hunting season extended through 50 consecutive days, Oct. 12-Nov. 30. With the exception of opening day, hunting pressure in October was approximately 4 times as great on week-ends as on week days. The number of parties present, average party size, and hours hunted are given in Table XVI. Kill figures include reported crippling loss which was 26 per cent of the kill. Kill per hunter was slightly greater on week-ends than week days; kill per hour slightly less. The kill per hunter and hour was about 2 1/2 times as great on opening day as the season average. Of the hunters checked, 7.7 per cent had limit bags (5 ducks); 55.2 per cent of these were on opening day.

The day before the season opened species composition of an estimated 10,300 ducks was: mallards, 50 per cent; pintails, 10; baldpates, 6; blue-winged teals, 6; gadwalls, 5; green-winged teals, 4; shovellers, 3; canvas-backs, 9; ruddy ducks, 4; miscellaneous ducks, 2.

The species composition of 250 ducks checked the first three days was: mallards, 37.2 per cent; pintails, 14.8; baldpates, 5.6; blue-winged teals, 9.2; gadwalls, 13.2; green-winged teals, 6.8; shovellers, 10.0; canvas-backs, 1.2; ruddy ducks, .4; other ducks, 1.6.

Assuming that the species composition remained relatively constant the first three days, pintails, blue-winged and green-winged teals composed a slightly greater percentage of the bag than of the population. Gadwalls and shovellers occurred 2-3 times more frequently in bags than

Table XVI. Hunter use and success at Greenfields Lake, 1951.

Items	Season Total	OCTOBER			NOVEMBER
		Opening Day	Sat. & Sun. (week-ends)	Week- Days	All Days
Number days checked	31.5	.5	6	11	14
Parties ⁹ present	384	52	211	102	19
Parties checked	182	25	100	49	8
Average No. hunters in party	2.05	2.0	2.11	1.88	2.38
Average No. hours hunted per hunter	3.57	3.48	3.63	2.97	6.05
Average No. ducks in bag per hunter	1.34	3.30	1.04	.91	1.68
Average No. ducks lost per hunter	.45	.88	.42	.36	.11
Average kill per hunter	1.79	4.18	1.46	1.27	1.79
Average kill per hour	.50	1.20	.40	.43	.30

⁹ - Determined by counting cars.

in the population. Baldpates and other ducks percentage of bag was approximately that of the population; mallards, less. Canvas-backs and ruddy ducks composed little of the bag in proportion to population present. The fact that practically all hunting was done on the shoreline and there are no good passes on the lake probably accounts for the small number of divers bagged.

Species composition of 501 ducks examined in hunters' bags during the season was: mallards, 37.8 per cent; pintails, 14; gadwalls, 11.6; shovellers, 9.8; blue-winged teals, 6.2; green-winged teals, 5.8; baldpates, 4.2; lesser scaups, 3.2; canvas-backs, 2.0; redheads, 1.6; others, 4.0.

Of 85 geese examined, 77.6 per cent were lesser snow; 20.0, Ross (Chen rossii); 1.2, white-fronted (Anser albifrons frontalis); 1.2, Canada.

After severe weather in late October and early November the lake was ice covered with the exception of several small areas. Following this, mallards were estimated to compose at least 95 per cent of the population for the remainder of the season. Mallard habits of resting in small open areas of the lake and feeding in fields early morning and late evening hours was not conducive to hunting on the lake. They furnished some hunting in fields and excellent hunting during inclement weather when they took refuge in drainage ditches on irrigated farm lands. Mallards generally fed in harvested grain fields. Only two unharvested fields of small grain were known to have been damaged by feed-

ing mallards and a few pintails. Practically all fields had been harvested when this damage occurred.

SUMMARY

1. A study to determine waterfowl relationships to Greenfields Lake, Fairfield, Montana, was conducted May 9 to November 30, 1951 and May 28 to September 20, 1952. Information on spring migration was secured during week-ends in March, April, and May, 1952.
2. The lake has an area of 4,100 acres; maximum depth of 9.6 feet; shore line of 21.88 miles. It has abundant growths of sago pondweed and wigeon grass. Alkali bulrush is the only emergent species occurring in quantities. A cattail marsh of 360 acres, connected to the lake with a 1/2 mile drainage ditch, supports the only substantial stand of emergent cover.
3. Lake shore vegetation was of three main types: greasewood, 39 per cent (8.54 miles); grass, 52.4 per cent (11.46 miles); agricultural land, 8.6 per cent (1.88 miles).
4. Nineteen species of waterfowl utilized the area during the spring migration, extending over an estimated 98 days. Pintails had the most balanced sex ratio (107:100) of the puddlers; shovellers, most unbalanced (293:100); redheads had the most balanced sex ratio (134:100) of the divers; canvas-backs, most unbalanced (402:100).
5. Counts of territorial pairs and lone males indicated a breeding population of 341 pairs of 12 species on the lake in 1952. Greasewood shoreline supported 55 per cent of the territories; grass, 40; agri-

- cultural land, 5. Irregularity of shoreline, presence of small islands, and bushes restricting vision were factors which may have been responsible for the greater density of territorial pairs along the greasewood shoreline.
6. A total of 222 active nests of 11 species was found, 107 in 1951 and 115 in 1952. Locations of nests were as follows: greasewood, 115; islands, 43; emergent vegetation, 38; grass, 26.
 7. Hatching success of 503 eggs from land and 469 eggs from water nests was 25.8 and 45.8 per cent respectively in 1951. Predation caused the failure of 69.8 per cent of eggs from land nests and 3.0 per cent of the eggs from water nests.
 8. Nest success in 1951 was 26.2 per cent for 61 land nests and 69.7 per cent for 46 water nests. Striped skunks were responsible for the greatest destruction, 60.7 per cent of land nests and 4.3 per cent of water nests. Water was an effective skunk barrier as indicated by the minor predation on water nests.
 9. From April 6 to August 2, 1952 an experiment was conducted on the effect of skunk reduction upon success of land nests. Skunk destruction decreased 92 per cent from 1951 on the controlled area; 40 per cent on other areas not controlled. Nest success increased 786 per cent over 1951 on the controlled area, but decreased 3 per cent on other areas. Although no factor appeared to replace the skunk in nest destruction, data suggest an intercompensation through egg success.

10. A total of 735 broods was observed, 353 in 1951 and 382 in 1952. Eighty-four per cent hatched June 1 to July 31 in 1951; 79 per cent in 1952. Lower temperatures and greater precipitation apparently retarded hatching peaks in 1951. Average brood size was greater in 1952 than in 1951.
11. Hunter contacts provided information on hunter utilization and success. Kill per hunter and hour was about 2.5 times as great on opening day as the season average. Reported crippling loss was 26 per cent of the kill. Of hunters checked, 7.7 per cent had limit bags of 5 ducks; the average was 1.8. Five species of puddle ducks made up a greater percentage of the bag than of the population; one about the same, one less. Diving ducks composed little of the bag in proportion to numbers present.

LITERATURE CITED

- Beer, James R. 1945. Sex ratios of ducks in southwestern Washington. Auk, 62(1):117-124.
- 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.
- and J. C. Wright. 1953. Flora of Montana, Part II, Dicotyledons. Herbarium, Montana State College. 124 pp. mimeo.
- Bureau of Reclamation. 1951. Supply and use of water. Operating projects, 1927-1948. Prepared by Operations and Development Division,

Yellowstone District, Billings, Montana.

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.
Monogr., 20(4):271-315.

Cuyler, W. Kenneth. 1924. Observations on the habits of the striped
skunk, Mephitis mesomelas varians. Jour. Mamm., 5(3):180-189.

Day, Albert M. 1950. North American waterfowl. Trans. 15 No. Am. Wildl.
Conf., 99-105.

DeYoung, William. 1927. Soil survey of the Sun River Irrigation Project.
University of Montana Ag. Exp. Sta., Bozeman, Mont., Bull. #207,
48 pp.

Earl, John P. 1950. Production of mallards on irrigated land in the
Sacramento Valley, Calif. Jour. Wildl. Mgt., 14(3):332-342.

Erickson, Arnold B. 1943. Sex ratios of ducks in Minnesota, 1938-1940.
Auk, 60(1):20-34.

Errington, Paul L. 1946. Predation and vertebrate populations. Quart.
Rev. Biol., 21(2):144-177, 21(3):221-245.

Gieseke, L. F. 1937. Soils of Teton County. Mont. State Coll. Ag. Exp.
Sta., Bozeman, Mont. Bull. #332, 63 pp.

Girard, George L. 1939. Notes on the life history of the shoveller.
Trans. 4 No. Am. Wildl. Conf., 364-372.

———. 1941. The mallard: Its management in Montana. Jour. Wildl.

Mgt., 5(3):233-260.

Hochbaum, H. Albert. 1944. The canvasback on a prairie marsh. The Am.

Wildl. Inst., Washington, D. C. 201 pp.

———. 1946. Recovery potentials in North American waterfowl. Trans.

11 No. Am. Wildl. Conf., 403-419.

Kalmbach, E. R. 1938. A comparative study of nesting waterfowl on the

Lower Souris Refuge: 1936-1937. Trans. 3 No. Am. Wildl. Conf., 610-623.

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

Lincoln, Fredrick C. 1950. Migration of birds. Fish and Wildlife Service, U. S. Dept. of Int., Circ. 16, 102 pp.

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

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

Rearden, Jim D. 1951. Identification of waterfowl nest predators. Jour. Wildl. Mgt., 15(4):386-395.

Smith, J. Donald. 1946. The canvas-back in Minnesota. Auk, 63(1):73-81.

Sowls, Lyle K. 1948. The Franklin ground squirrel, Citellus franklinii Sabine, and its relationship to nesting ducks. Jour. Mamm., 29(2): 113-137.

———. 1949. A preliminary report on renesting in waterfowl. Trans. 14 No. Am. Wildl. Conf., 260-273.

Sowls, Lyle K. 1950. Techniques for waterfowl-nesting studies. Trans.

15 No. Am. Wildl. Conf., 478-487.

Southwick, Charles. 1953. A system of age classification for field studies of waterfowl broods. Jour. Wildl. Mgt., 17(1):1-8.

U. S. Department of Commerce. 1938-1951. Climatological data, Montana.

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

Yocum, Charles F. 1950. Weather and its effect on hatching of waterfowl in eastern Washington. Trans. 15 No. Am. Wildl. Conf., 309-318.

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