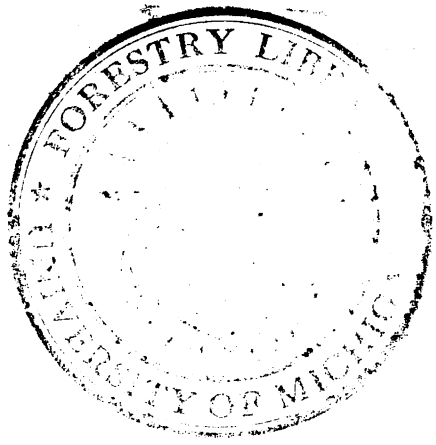
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Waterfowl mortality on the Pointe Mouille State Game Area with special reference to parasitism. 1950.

Stricker, L.C.


FORESTRY

Waterfowl Mortality During the Fall Season at the Pointe Mouillee State Game Area With Special Reference to Parasitism

This Thesis is presented
to fulfil one of the requirements
of the Master of Forestry degree
from the School of Forestry and Conservation
University of Michigan

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Laverne Stricker

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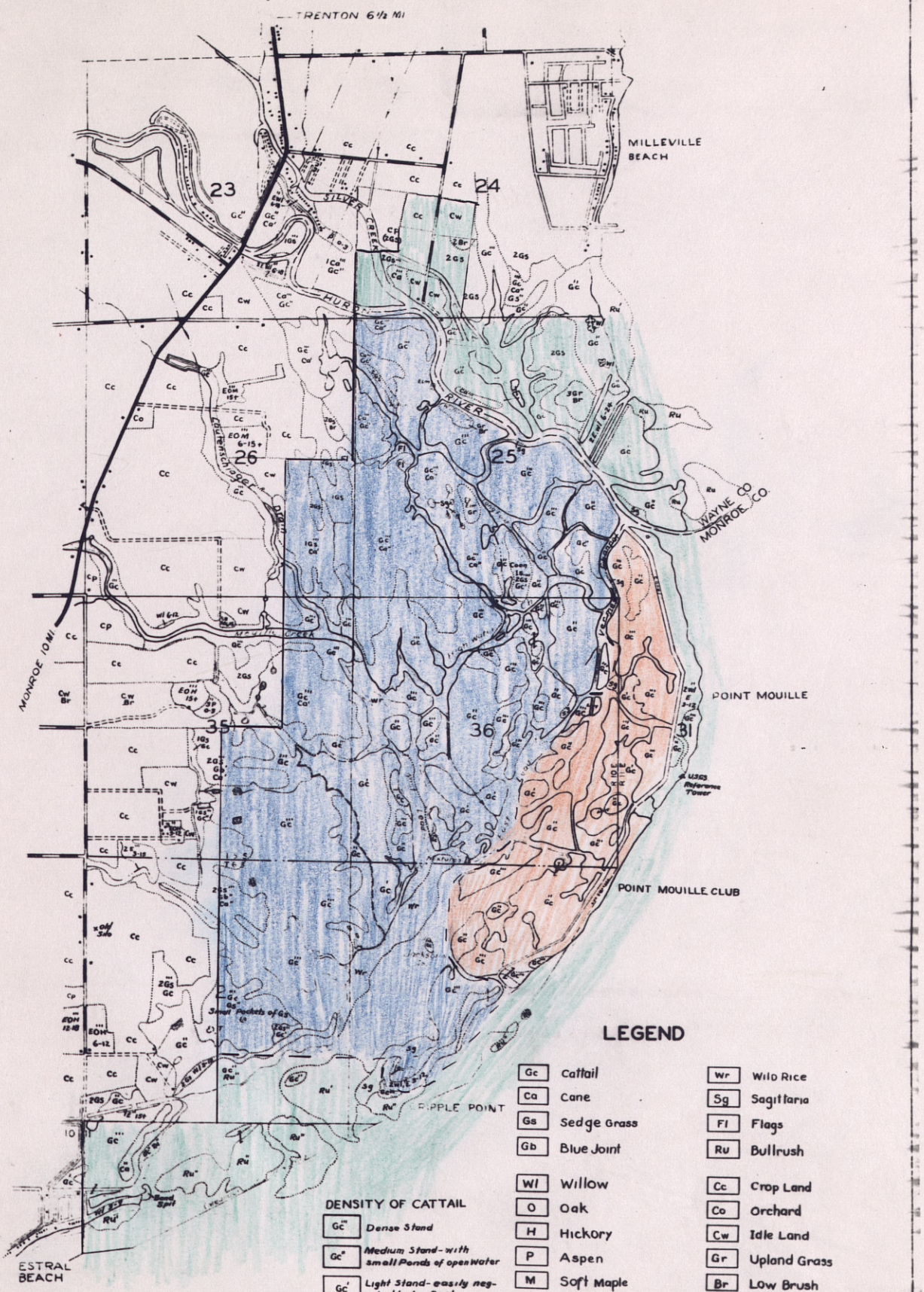
INTRODUCTION

This work was begun during the 1948 hunting season in an effort to discover the main causes of waterfowl mortality and their relative importance on the Pointe Mouillee State Game Area. Because of the material available in hunters' bags, this paper is to cover only those mortality factors found during the autumn months. Special reference has been placed on parasites for the same reason. Most hunters do not object to having their birds cut open at the checking station. Most of the information presented here was collected while the writer was employed by the Conservation Department in their sexing and ageing program.

DESCRIPTION OF THE AREA

The Pointe Mouillee State Game Area is located in Sections 23, 24, 25, 26, 35, and 36, T 5 S. R 10 E; Sections 1, 2, and 11, T 6 S. R 10 E; Sections 30, and 31 T 5 S. R 11 E. This is at the mouth of the Huron river on Lake Erie, near Rockwood, Michigan, about 20 miles south of Detroit. The Conservation Department has divided the area into three units as follows (see map); The Controlled Hunting Area may be described as starting at the northwest corner of Section 25, T 5 S. R 10 E; thence easterly along south bank of Huron River to Pointe Mouillee Canal in the SE¼ of said Section; thence southerly along said canal to the west line of Section 31, T 5 S. R 11 E: thence south along shore line to the most westerly part of Cripple Pointe in the SW¼ Section 1, T 6 S. R 10 E: thence west to the north and south quarter line of Section 2, T 6 S. R 10 E: thence north to the center of Section 35. T 5 S. R 10 E: thence east ¼ mile: thence north 1 mile: thence east ¼ mile more or less: thence north to the point of beginning, as posted; except the portion set aside as a waterfowl refuge.

The Waterfowl Refuge beginning near the mouth of the Huron River at the intersection of the Canal and Vermet Channel with the Huron River as posted; thence S 32 degrees W-13 chains along the east side of Vermet Channel; thence S 22 degrees E-12 chains to the northeast corner of Section 36, T 5 S. R 10 E; thence S 18 degrees W-13 chains;



MICHIGAN DEPARTMENT OF CONSERVATION
GAME DIVISION

POINT MOUILLE MARSH

MONROE AND WAYNE COUNTIES

COVER MAP

SCALE: ½ MI.

DATE: Oct 1949

thence S 36 degrees W-34 chains; thence S 5 degrees W-20 chains; thence S 62 degrees W-18 chains; thence S 28 degrees W-24 chains to the west side of Jackson's Island; thence S 65 degrees E-31 chains to Lake Erie shore. Thence northeasterly 68 chains to the "break through" to the canal in SW¼, SW¼ Section 31, T 5 S. R 11 E; thence N 61 degrees W-8 chains to the west bank of the Canal; thence northerly 94 chains along the west bank of the canal to the point of beginning.

The Unrestricted Hunting Area includes all remaining lands purchased by the Department of Conservation from the Pointe Mouille Shooting Club not included in the Controlled Hunting Area and Waterfowl Refuge as posted above.

The Conservation Department has established the following regulations concerning the use of the Area: It shall be unlawful in the Controlled Hunting Area;

1. To enter or leave during the waterfowl hunting season without first registering with the duly authorized representative of the Conservation Department.
2. To fish during the waterfowl hunting season.
3. To hunt after 4:00 P. M. Eastern Standard Time.
4. To operate motor boats or outboard motors during the waterfowl hunting season.

It shall be unlawful in the Waterfowl Refuge;

1. To hunt, fish, trap, or disturb waterfowl, or without written permission to enter the refuge for any purpose during

the open waterfowl hunting season.

It shall be unlawful at any time in the Pointe Mouillee State Game Area;

1. To conduct commercial fishing operations of any kind.

2. To take fur bearing animals except under special permit.

3. To possess or use firearms during the closed seasons on waterfowl and upland game without written permission.

4. To establish a camp.

5. To build open fires without first obtaining written permission and without proper provision to prevent spread of fires or to leave the premises while the fire is still burning.

6. To anchor or leave boats unattended overnight or store or leave fish shanties without written permission.

7. To leave cans, bottles, papers, rubbish, refuse, or garbage on the ground or in the water.

8. To remove or injure live trees, shrubs or plants or to remove sand, gravel, marl, clay or other minerals without written permission.

9. To remove, deface, or injure any building, equipment, improvement, sign or other public property.

10. To place or distribute advertising signs or literature: To sell, to offer for sale, directly or indirectly, any goods, wares, or merchandise, or any membership, membership cards, applications, or certificates in any club or group

organization without written permission.

11. To engage in trap shooting or conduct organized trap shoots except by prior arrangement with the Department's authorized concessionaire who shall have direct supervision over all trap shooting activities.

Further description of the area is given by the following photographs taken by Mr. Malcolm MacDonald from the air.



(a)

Fig. 1., (a) Looking down the Huron River towards Lake Erie. Headquarters lower left.

(b) Looking east from back part of marsh. Tree line indicates eastern edge of refuge.

(c) From the refuge towards the back parts of marsh. Huron River upper right.

Photos through courtesy of Malcolm MacDonald.



(b)



(c)

HISTORY OF THE AREA

The following historical background of the marsh is taken from Beard's article, "Yesteryears on Pointe Mouillee", in the Michigan Conservation magazine, Volume 14, Number 12.

The Pointe Mouillee Shooting Club was organized in 1879. There were 10 members coming from Detroit, Houghton, Grand Rapids, Battle Creek, Niagara Falls, Cleveland, and Toledo. During the next 10 years its fame spread so widely that wealthy sportsman in the east attempted to buy membership whenever possible. The memberships changed hands from time to time until the marsh was purchased from the club by the Conservation Department in 1945.

Some of the names referring to locations in the marsh have interesting backgrounds. Pointe Mouillee (meaning "wet point") referred to a shoal which extends out from the shoreline into Lake Erie at the south side of the mouth of the Huron River. High Water Channel was so-called because it could only be reached during a period of high water. Because of a shoot held in 1899 when 112 ducks were killed in an hour's time in one pond, this pond was always thereafter known as One Hundred and Twelve.

Back in the early days the best positions were down in the southwestern part of the marsh. Later, the opening of the canal from the Huron River to the club buildings made the southeastern part of the marsh more attractive to the ducks and good shooting was had in some of the newer pond holes. The ducks shot in the marsh were mostly dabblers. Until changing currents cleaned out the old rice and bog in the bay, few diving ducks used the marsh. With the appearance of open water in these areas, the scaups, etc. came in from Lake Erie.

EFFECTS OF METHODS OF HUNTING

The best hunting spots on the area are not accessible by land so some sort of boat is necessary. The most popular form is the rowboat, with or without an outboard motor. The motor may be used on the lake and on the river but must be taken off the back of the boat when entering the marsh or when preparing to shoot. No shells are allowed in the chamber or magazine of a gun while a motor is in use. Over thirty guns were confiscated on opening day this year because this law was broken. The more experienced hunters sometimes use punt boats when desiring to move the parts of the marsh that have thick cover. These boats are small, flat bottomed affairs, usually with decking and a cockpit and holding one or two people. They are propelled by means of a long pole. Their particular advantage lies in moving through shallow water where a large, heavier rowboat could not be used. The user of the rowboat with a permit to hunt in the marsh usually goes down the river almost to its mouth, then off into Vermet channel, removes his motor, if he has one, and rows till he finds a spot to his liking. This is usually a clump of cat-tails near open water from which he can view several directions. The Vermet channel is a popular spot because of its nearness to the refuge (see map of the area). There is always movement of ducks to and from the refuge and many passing shots are to be had when setting up near there. This dense concentration of hunters around the

refuge isn't a desirable condition. The sport is reduced for each individual concerned. Decoys are useless and out of range shooting is common here. Another popular method of getting on the marsh is by way of Mouillee Creek. The route is probably shorter and easier. In discussing methods of travelling around the marsh, some mention should be made of the water level. There is daily cycle of water level fluctuation and one that extends over a period of years. Wind direction is of the most concern to hunters in this connection however. A westerly wind seems to drive the water out of the marsh and lower the water level. An easterly wind raises the water level in the marsh. This may happen with an unpleasant suddenness. A hunter may have plenty of water to get into a blind early in the morning under an eastwind but the wind may shift and leave him on a mud flat, fifty feet from the nearest water before he realizes what is happening. There were a few such days this season, leaving hunters in the marsh until after nine at night. Fig. 2 gives some idea on the rise and fall of the Huron River with a change in wind direction.

The use of decoys is not very prevalent. This is due mainly to the type of hunter that uses the area. Most of the week-end hunters especially know very little about ducks or duck hunting and are content with the recreation whether or not the ducks are bagged. Most of the week-day hunters and those that get away from the general concentration week-



(a)

Fig. 2. Variation in water level due to wind direction.

(a) Looking down the Huron river from headquarters, wind from the southwest.

(b) Same view several days later, wind from east.



(b)

enders on Vermet channel have made a science of the sport becoming very proficient. One person in particular uses all the accessories of the sport i.e. punt boat, decoys, duck call, etc. It takes him an hour to unload his supplies in the morning and another hour to load them at night, but when other hunters are having trouble getting one duck he brings in his limit consistently.

Two other methods of hunting that are practiced on the lake and sometimes provide ducks for checking at headquarters are the sneak boat and lay-out. Each of these methods has a characteristic boat. The lay-out boat is a flat bottomed, wide boat, with decking and a cockpit in which the hunter lies on his back. In both methods the decoys are set out in a tear drop design with the small end into the wind. The lay-out shooter is towed to his position by a launch, the decoys placed so that he is in the middle of a tear drop. The launch is stationed several hundred yards away to be used in picking up dead birds and returning for the hunter at his signal. The hunter waits until the ducks swerve into his decoys, then by having certain decoys placed at known distances, he is able to decide at what point the birds are in range for his gun. The launch picks him up, when his bag limit is collected and leaves another hunter in the lay-out boat. The sneak boat is on the order of a punt boat with a blind on the front of the cockpit.

The decoys are set out, then the hunter retires for a short distance. After ducks have entered the decoys, the hunter sneaks on them by using sculling movement of a rear oar.

EFFECTS OF WATERFOWL BEHAVIOR

Certain habits of waterfowl have great effect on their hunting mortality. Bellrose (4) lists these as inherent wariness, flight, flocking, and feeding habits. He states that certain food may bring one species of duck into heavily gunned areas while another remains in open water, out of reach of hunters. In this connection it should be noted that the kill at Pointe Mouillee consists mainly of dabbling ducks that feed in the marsh and doesn't swing to the lake feeding diving ducks until late in the season. Bellrose also states that flocking habits influence the vulnerability of a species. Generally singles are more readily decoyed than a flock of 10, which in turn is more easily decoyed than a flock numbering 100. Blacks, mallards, and pintail constitute the bulk of the duck kill at Pointe Mouillee and these species usually fly in pairs or small flocks at least until late in the season. The diving ducks are in the process of migrating when they reach the area and are usually in large flocks. The breeding and migration habits affect the mortality. Those local ducks which breed and spend the summer in the general vicinity are sure to bear the brunt of the early season attack. Most of the dabblers are good examples; the blue winged teal especially. This bird is an early migrant and although there was a good kill on opening day, by the end of the first week most of these ducks had left for the south. This year saw a big increase in total kill of these ducks

over last. Another factor determining the kill of teal is its flight speed. The teal are small ducks and may appear to be going faster than they are. This makes it difficult for the gunner to judge the correct lead. The local mallards and blacks may leave the area early but are replaced by ducks of the same species that bred farther north. These two species are well represented in the kill throughout the season.

The age and sex of each species has a certain effect on hunting mortality. There is a much larger population of juveniles than adults with a resultant larger proportion of them in hunters bags. When this proportion gets too low it may be an indication of a declining population in this species. On a breeding marsh there is usually a larger kill of females than males. The males have their flightless period earlier than the females and as a result migrate earlier. Pointe Mouillee couldn't be considered a breeding marsh and the sex ratio in hunters bags doesn't follow this pattern (fig. 3).

Daily Hunting Kill on Pointe Mouillee State Game Area
Waterfowl Season - 1949

	Hunter Report	Total Kill	Duck Loss	Coot Loss	Coot	BW Teal	GW Teal	Baldpate	Gadwall	Black	Mallard	Redhead
Oct. 7	279	609	258	25	75	123	58	30	1	162	131	
8	270	177	46	10	61	35	13	5		19	24	
9	279	123	35	10	19	2	6	6		24	30	
10	185	81	24	12	8	3		4		11	34	
11	201	69	20	6	11	10	2	6		12	17	
12	260	121	30	12	42	27	3	8		4	19	
13	168	30	2	1	3	5	3	6		6	3	2
14	129	47	4		2	5	1	6	1	8	13	1
15	103	80	15	2	24	2	1	3	2	10	19	6
16	131	56	11		5		4	3	1	7	26	3
17	43	40	7	1	5	2	4	5	1	5	5	1
18	54	50	6		2		5	15		8	10	
19	58	28	5		1	4	2	7		3	6	
20	59	47	5		4	1	4	14		5	12	
21	68	50	6		1	2	12	8		6	17	
22	167	77	10	1	12	1	12	3		7	13	
23	166	97	23	8	18	5	16	14	2	8	16	1
24	54	65	9	1	9		7	10	4	12	12	
25	58	126	15	2	11		9	8	9	6	28	1
26	93	79	16	2	5	2	6	10	3	11	12	1
27	79	93	27		5	1	9	22	6	13	15	
28	102	58	8	1	5		6	12		7	12	1
29	185	66	22	1	3	1	12	2	2	6	6	2
30	241	48	17		5	2	6	7	3	7	7	1
31	106	32	3		1		5	5	1	3	5	1
Nov. 1	125	91	21		1		5	20	2	20	15	1
2	108	50	11		3		3	16	1	12	10	
3	112	53	15		2	1	2	6	4	4	10	1
4	140	84	11		1	1	1	3	1	11	4	2
5	291	69	15		3		3	2	1	12	4	
6	208	67	8				4	1	1	7	8	3
7	62	20	3		2		2		1	1		2
8	73	20	2				1	1	1	1	3	1
9	53	25	4				2			1	3	4
10	50	29	10				1			6	3	
11	79	22	4				1	2	4	3	2	1
12	197	54	14				9	1	1	14	8	3
13	53	12	8				2	2	2	3	2	
14	50	26	9				3	2		6	4	
15		26	5				2				5	

Daily Hunting Kill (Con't)

	Pintail	Shoveler	Ruddy	Wood Duck	Lesser Scaup	Greater Scaup	Ringneck	Canvasback	Goldeneye	Bufflehead	Mergansers	Total Duck Kill
Oct. 7	10	1		13							1	532
8	13			4				1				114
9	11	1		5				5				104
10	19			2								73
11	9		1	1								58
12	11		3	11							1	79
13	2											27
14	5		4							1		45
15	4	2	3				1	3				56
16	2	2		2				1				51
17	7	2	1	1	1	2	2	1				45
18	4		3			1		2				48
19	3			1								27
20	3				1		1	1				42
21	5		1	1	1							49
22	11	1	2	1								55
23	5		2	1	2							79
24	11		2		1			3			1	57
25	4			1	34			7	1	4	3	115
26	4		2	3	7	1				10		72
27	6				6			2		4	5	88
28				2	5		2	3	1	2		53
29	4		2	1	12	1	3	3		2	4	63
30			1	1	1		2			3	2	43
31	2		2		2	2		1	1		2	31
Nov. 1	5		2		3			1	1	4	11	90
2	3				1			1			1	47
3	1			1	6				1	1	12	51
4	3		1	1	15	2		2	4	11	15	83
5			2	1	4				1		36	66
6	3		3	2	6	2			2	1	24	67
7	2				1			1			8	18
8	1				4	1		2			3	20
9											14	25
10					4			1	1	3	9	28
11	1		1		4				2		1	22
12		1			10			1	2	1	2	56
13	1		1		2						9	22
14	2	1	1		8			1			10	38
15					2						4	13

Daily Hunting Kill (Con't)

	Snow Goose	Blue Goose	Canada Goose
Oct. 7			
8			
9		4	
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			3
24			
25		1	1
26			
27			
28		1	
29			
30			
31			
Nov. 1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Fig. 3 Sex and Age Data on Ducks in Hunters Bags at Pointe Mouillee State Game Area

From Michigan Conservation Dept. Records

Species	Year	Total Number Exam.	Female Ad	Female Juv	Male Ad	Male Juv
Black	1948	374	115	71	65	123
	1949	317	39	106	74	98
Mallard	1948	357	94	73	65	126
	1949	174	18	60	48	48
BW Teal	1948	55	6	14	16	19
	1949	156	34	69	16	37
GW Teal	1948	106	16	30	13	47
	1949	148	17	50	32	49
Pintail	1948	102	41	25	11	25
	1949	76	6	34	15	21
Baldpate	1948	191	32	77	16	66
	1949	141	13	50	17	34
Wood Duck	1948	17	9	0	3	5
	1949	44	5	16	12	11
Ringneck	1948	22	1	9	0	12
	1949	9	0	4	3	2
Shoveler	1948	15	0	6	3	6
	1949	10	1	6	0	3
Ruddy	1948	159	23	53	16	67
	1949	20	2	8	4	4
Scaup	1948	117	13	67	11	26
	1949	55	12	23	5	15

(cont. on next page)

Sex and Age Data (Cont.)

Species	Year	Total Number Exam.	Female Ad	Female Juv	Male Ad	Male Juv
Redhead	1948	56	8	18	7	23
	1949	13	2	6	2	3
Bufflehead	1948	7	1	2	1	3
	1949	20	2	13	2	3
Canvasback	1948	31	5	8	3	15
	1949	14	5	5	3	1
Goldeneye	1948	-				
	1949	7	2	3	0	2
Mergansers	1948	6	2	4	0	0
	1949	73	15	24	19	15
Scoters	1948	4	0	3	0	1
	1949	3	0	3	0	0
Gadwall	1948	19	2	7	3	7
	1949	27	6	5	5	11
Geese	1948	7	1	2	0	4
	1949	9	1	0	2	6
Totals	1948	1,645	369	468	233	575
	1949	1,286	180	484	259	363

Age and Sex Ratios

Year	Adults Male/Females	Juveniles Males/Females	Juveniles /Adults	Tot. No Exam.
1947	138/100	73/100	159/100	1,263
1948	63/100	122/100	173/100	1,645
1949	143/100	75/100	192/100	1,286

Comparison of the Waterfowl Kill for the Last Four Seasons at Pointe Mouille - From Conservation Department Records

Hunters Reporting	1949		1948		1947		1946	
	Total Kill	% of Total	Total Kill	% of Total	Total Kill	% of Total	Total Kill	% of Total
Coots	350	12	2265	42	1236	36	1769	46
Blacks	470	16	488	9	473	14	552	15
Mallard	575	19	725	13	392	11	781	21
B.W. Teal	235	8	107	2	507	15	86	2
G.W. Teal	246	8	201	4	106	3	79	2
Pintail	172	6	209	4	131	4	58	2
Baldpate	275	9	291	5	157	5	95	2
Wood Duck	56	2	21	.5	17	.5	45	1
Ringneck	11	.5	24	.5	39	1	26	.5
Shoveler	11	.5	24	.5	15	.5	7	-
Ruddy	39	1	501	9	140	4	20	.5
Scaup	156	5	261	5	92	3	184	5
Redhead	39	1	114	2	36	1	29	.5
Canvasback	38	1	105	2	32	1	18	.5
Buffehead	48	2	54	1	13	.5	4	
Gadwall	53	2	27	.5	14	.5	5	
Merganser	178	6	32	.5	6	-	24	.5
Goldeneye	17	.5	9	-	6	-	7	-
Rail	-	-	-	-	3	-	8	-
Gallinule	5	-	7	-	4	-	1	-
Canada Goose	4	-	7	-	-	-	-	-
TOTAL	2984		5475		3434		3805	

(Cont. on next page)

Comparison of Water Fowl Kill (Con't)

Hunters Reporting	Total Kill	% of Total	Total Kill	% of Total	Total Kill	% of Total	Total Kill	% of Total
Total less Coot	2634		3210		2198		2036	
Hunters	5148		4669		4158		4907	
Ducks Crippled	764		1128		835		770	
Coots Crippled	96		665		199		291	

CRIPPLING LOSSES

In any public hunting ground of this sort, crippling losses are expected to be high. Shooting at birds out of range is mainly responsible and with the concentration of inexperienced hunters around the refuge this practice is common. Some hunters can't tell when a bird is in range and others want to get the first shot. Each hunter using the controlled area is required to fill out a form, one part of which lists the waterfowl crippled. In compiling this data for the past four years, the duck killed per duck crippled is seen to be rising also the actual number of cripples this year was less than ever before. This may be the result of many of the hunters returning to the same place year after year and becoming more proficient in the use of their gun. The kill per cripple in coot is falling although the actual number crippled this year is small. This year doesn't present a true picture of the trend in crippling of coot because of the small number on the area. Probably it is safe to assume that a large proportion of the cripples find their way to the refuge. Many hunters think they should be allowed to retrieve cripples from the refuge. This could hardly be allowed and still maintain the purpose of this section. Another factor raising the number of cripples is the use of dogs on the area. A dog would be of great advantage here but most of the hunters don't go out enough to warrant the expense of one. Probably a dog does

his best work from a shore blind and there are few locations for these on the controlled area.

Some importance of the crippling losses is given by Whitlock and Miller (37) in their study made in southern Michigan during the winters of 1941 and 42. Fluoroscopic examination of trapped ducks at Otter creek in Monroe county in 1941 showed that 30% gave evidence of having suffered gunshot wounds at one time. Eight of these ducks had wind fractures that had healed. At Sugar Island in the Detroit River there was the same incidence of wounded and recovered ducks out of 131 trapped. During the winter of 1942, 436 wintering ducks were trapped in the Detroit River with 23% of them wounded. Of the 105 lesser scaup trapped at the Swan Creek Wildlife Experiment Station in southwestern Michigan, 10% were carrying shot in their bodies. A total of 900 trapped ducks were examined with 19 or 2% found to have sustained wing fractures and recovered to fly again. Sixty dead ducks were picked up in the Lake Erie marshes and 27 of these had detectable gunshot wounds. Thirteen had wing fractures which was the apparent mortal factor. These findings indicate that one out of every four ducks that pass through Michigan in the spring or stay here over the winter has experienced a gunshot wound.

PARASITISM

Seasonal infestation with parasites seems to depend mainly on the manner in which the infective stage is made available to the final host. Duck parasites fall into five groupings on this basis. The larvae may encyst, free i. e. on vegetation; in crustaceans; in snails; in aquatic insects or their larvae; and in fishes. The biology of the host in which encystment occurs is most likely to control infection in the final host.

Gower (10) states that the degree of specification of the worm for the second intermediate host is very important. For instance the fluke, Echinostoma revolutum, apparently encysts in almost any kind of snail, as well as in tadpoles and catfishes in a leter stage. So far as ducks are concerned, however, snails constitute the main source of infection. The various species of snails reaching peak numbers at different times of the year, afford a constant source of infection from this parasite. On the other hand, a worm which is rigidly host specific for the second intermediate host, as the fluke Typhlocoelum seems to be, is much more seasonal in distribution with respect to the final host. Figure (4) gives the comparative seasonal infection of helminths that Gower found in 104 ducks at the W. K. Kellogg bird sanctuary. Those that seem to be most common at the time of the fall flight belong to the genera Cotylurus, Echinostoma, Prosthogonimus, Fimbriaria, and Hymenolepis.

Cotylurus, Echinostoma and Prosthogonimus are trematode

worms or flukes. The body of the adult trematode is leaflike, occasionally cylindrical and frequently covered with scale-like spines. Except for the blood flukes all trematodes of waterfowl are hermaphroditic. Their life history is briefly as follows; the eggs that are passed by the mature fluke customarily reach the exterior in the feces. On reaching the water the eggs undergo embryonation and in the course of time hatch. The embryo or miracidium then swims about in search of a snail intermediate host.

Fig. 4 Comparative Seasonal Infection of 104 Ducks with Helminths at W. K. Kellogg Bird Sanctuary Near Augusta, Michigan

After Gower 1938 (10.)

Species	Spring	Summer	Fall	Winter
Amphimerus	11.7%	11.6%	2.0%	30.0%
Cotylurus	5.9%	27.0%	41.0%	10.0%
Echinostoma	35.0%	27.0%	39.0%	50.0%
Maritrema	5.9%	0	2.0%	30.0%
Prosthogonimus	17.5%	0	27.0%	20.0%
Typhlocoelum	17.5%	3.8%	12.0%	0
Zygotyle	17.5%	23.0%	4.0%	10.0%
Fimbriaria	5.9%	65.0%	21.0%	40.0%
Hymenolepis	47.0%	57.0%	61.0%	60.0%
Tetrameres	11.7%	31.0%	4.0%	10.0%
Filicollis	5.9%	3.8%	12.0%	0

In some instances, the egg contains a fully formed miracidium at the time it is laid, and hatching takes place soon after it reaches water. In other instances, the egg contains at the time of deposition a fully formed miracidium which is not liberated until the egg is ingested by the snail host. On reaching a suitable location in the snails tissues the miracidium is transformed into a sporocyst. When fully developed the sporocyst may give rise to a larva provided with a mouth and gut, which is known as a redia, and to cercariae, or it may give rise to daughter sporocysts and cercariae. The cercaria consists of a body, which becomes the mature fluke, and a tail which enables it to swim about. In some instances the cercaria may become encysted in the water on various objects or penetrate into the secondary intermediate hosts, such as snails, tadpoles and fishes and become encysted. The encysted cercaria is known as a metacercaria. When the young encysted fluke or metacercaria, is eaten by the final host the cyst wall is digested, and the young fluke is liberated to grow into maturity. The genus Cotylurus occurs in the intestines of wild ducks. The adult worms have a short life, remaining in the duck only a few days. The cercaria that escape from the primary snail intermediate host penetrate into other snails and develop into larvae. Heavy infestations may damage the epithelium of the intestine causing loss of blood. Echinostoma never seem to appear in large numbers. The larger specimens are in the colon and

the younger stages are in the upper intestine. The larval stages of this fluke develop in fresh water mollusks. The cercaria escape and usually encyst in snails and tadpoles. The final hosts become infected through ingestion of the secondary hosts. Prosthogonimus occurs in the oviduct of laying birds in the spring and in the bursa of Fabricius of young birds in the fall. The sporocyst found in the snail (genus Amnicola) produces the cercaria directly. This enters the body of a dragonfly naiad through the anal opening and encysts in the body cavity. Affected birds lose their normal appetite and activity, and in domestic fowl there is a dropping off of egg productivity. There may be extreme emaciation, anemia and an adhesive peritonitis in bad cases.

Hymenolepis and Fimbriaria are cestodes or tapeworms. These worms are flattened and ribbon shaped. As adults they are usually found in the intestines of their host. They are hermaphroditic and lack both a mouth and an alimentary canal. Hymenolepis cornula may sometimes cause mortality in ducklings. This species produces eggs which are ingested by small crustaceans, the embryos hatching and developing to cysticercoids in the body cavity of these animals. When these infected crustaceans are swallowed by waterfowl, the cysticercoids develop to adult tapeworms in the intestines of the birds. This genus has been reported in practically all species of waterfowl. It is very common and probably causes little damage. Fimbriaria is a relatively large

worm (9-10 inch maximum). Masses of worms great enough to distend the intestine have been reported but this worm too probably does little damage. The intermediate host is a crustacean and infection takes place in the same manner as in Hymenolepis.

There has been some discussion lately of the possibility of damage from Amidostomum anseris. Fig. 5) This thread-like nematode worm works under the mucosa of the gizzard, causes lesions and by so doing may provide an entrance point for botulism and other diseases, (O'Roke 20) Cram (7) describes them as being slender, reddish worms, their cuticle transversely striated, with longitudinal pseudo-striations due to musculature. The head end slightly enlarged and bears 2 pairs of large, submedian papillae. The mouth aperture is oval and the short wide buccal capsule has 3 pointed teeth at the base with 6 ridges grouped in pairs. The esophagus has 3 chitinous ridges along its entire length. The male is 10-17 mm's long and 250-350 microns wide. It has a bursa with 2 large lateral lobes and a small median lobe. The female is 12-25 mm's long, is slender anteriorly, widens at the vulva to 300-400 microns and thins abruptly behind the anus. The tail is long, straight and bluntly pointed. The life history of this parasite is as follows; eggs pass out in the droppings of infected birds in a partly developed stage, hatching taking place in a few days. Susceptible ducks become infected by swallowing these infective larvae with their food or drinking water. Adult worms may be recovered within

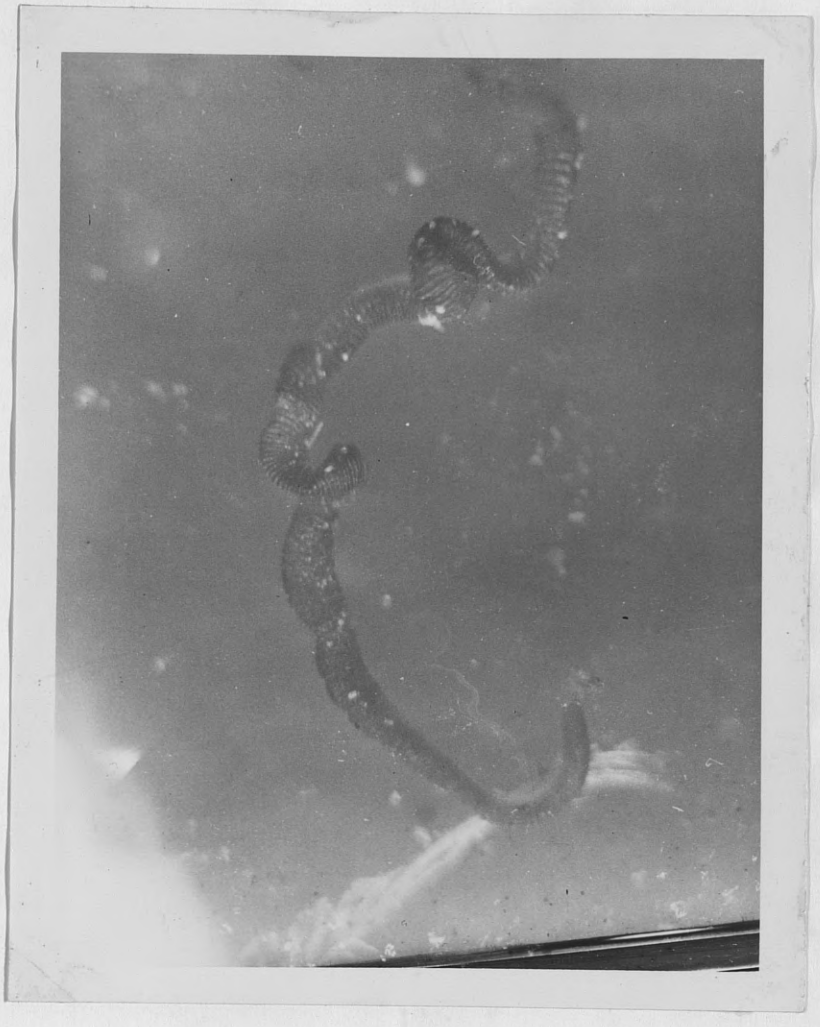


Fig. 5 Amidostomum anseris found in the gizzard of a baldpate shot at Pointe Mouillee. 20X magnification. Photo through courtesy of A. Doll.

approximately 40 days after the feeding of infective larvae. Young birds show symptoms of loss of appetite, dullness and emaciation. At neocropsy the lining of the gizzard of a heavily parasitized bird appears necrotic, loosened, often sloughed in places, and is dark brown or black in color in area adjacent to the cite of the worms.

In order to determine the amount of parasitism in waterfowl at Pointe Mouillee as many birds as possible were autopsied. Each infestation was labeled heavy, medium or light. These degrees have no actual quantitative meaning but give some idea of the relative number of parasites present. Identification of all the parasites found would be tedious and probably would not be worth the time spent. The birds were examined closely for Amidostomum by peeling away the mucosa of the gizzard. Examination for all parasites was conducted after the manner described by O'Roke (20). "The intestinal tract is removed from the bird and placed in a pan of water. It is then slit open with a small scissors and examined in the water. Using a pipette or medicine dropper to squirt little jets of water into the opened intestine serves to free the surrounding material. When a parasite is found, it is worked free, lifted out by means of a camels hair brush and placed in the preserving fluid. Round worms and flukes can be handled with a small pair of forceps but tapeworms are usually broken by this method of handling. The greatest danger of destroying tapeworms is to break off the scolices (heads) which are attached

to the intestinal wall. It is important that these heads be intact for they are invaluable for identification. For collecting the small gizzard worms, a sharp pointed pair of forceps should be used. Results of the autopsies are given below.

Date	Species	Sex	Age	Weight	Remarks
Oct. 7 1949	B. W. Teal	F	J	1 lb	Amidostomum in gizzard
" 15 "	Ruddy duck	F	J	1 lb	light parasitism in small intestine
" "	Baldpate	F	J	1 lb 8 oz	
" "	Black duck	F	J	2 lb 10 oz	light parasitism caeca
" "	Ruddy duck	F	A	1 lb 2 oz	
" "	Black duck	M	A	2 lb 10 oz	17 shot in gizzard light parasitism large intestine
" "	Baldpate	F	J	1 lb 12 oz	
" "	Coot	M	J	1 lb 4 oz	light parasitism in large intestine
" "	Coot	M	A	1 lb 8 oz	light parasitism in small intestine
" "	Baldpate	F	J	1 lb 14 oz	Amidostomum
Nov. 12 "	Goldeneye	F	J	1 lb 4 oz	2 shot in gizzard light parasitism in cloaca and sm. intestine
" "	Lesser scaup	M	J	14 oz	Cripple - broken leg no shop in body enlarged gall bladder no food in gizzard
" "	Lesser scaup	F	J	1 lb 6 oz	light parasitism small intestine, cloaca
" "	G. W. Teal	M	J	1 lb	light small intestine
" "	Coot	M	J	1 lb	light parasitism small intestine, cloaca

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Date	Species	Sex	Age	Weight	Remarks
Nov. 12 1949	G. W. Teal	M	J	14 oz	
" "	Baldpate	F	J	1 lb 14 oz	light in large intestine
" "	G. W. Teal	F	J	13 oz	light in large intestine, cloaca
" "	G. W. Teal	M	J	12 oz	
" "	Lesser scaup	F	A	1 lb 14 oz	light in large intestine
" "	Bufflehead	F	J	1 lb	light in large intestine, cloaca
Nov. 13 "	G. W. Teal	M	A	14 oz	light parasitism in small intestine
" "	Ruddy	M	A	1 lb 12 oz	Amidostomum in gizzard light in small intestine
" "	Baldpate	M	J	1 lb 12 oz	light in small intestine
" "	Black duck	F	J	2 lb 10 oz	light in large intestine
Nov. 25 "	Mallard	F	J	1 lb 12 oz	cripple - 1 shot in left wing 1 shot in pelvic region light parasitism large intestine

Key

M male
F female
J juvenile
A adult

In the process of sexing and ageing the ducks some of them were noted to contain flukes in the cloaca and bursa. Probably the genus Prosthogonimus. A spot check was made on all the birds checked Nov. 6th to determine the percentage infected. Of the 45 birds checked, 12 or 27% were found to contain these parasites. Figure 6 gives the results of this check.

Fig. 6 Results of cloacal check for flukes on ducks in hunters bag at the Pointe Mouillee State Game Area Nov. 6, 1949

Species	Heavy	Medium	Light	None
Gadwall			1	
Hooded Meganser			5	10
Pintail				2
G. W. Teal			1	2
Greater scaup			1	1
Black				5
Mallard			3	2
Lesser scaup			1	1

SARCOCYSTIS

On October 16 and again on October 23 hunters brought in black ducks infected with Sarcocystis rileyi (fig. 7). This parasite was formerly thought to be a protozoan but recent investigations by Spindler (31) may prove it to be a fungus. From a review of the literature it has been found to occur in the following ducks: Anas platyrhynchos platyrhynchos; Stiles 1893, C. V. Riley 1869, Leidy 1875, Crawley 1911, W. A. Riley 1931, Green and Shillinger 1933: 1935 Shillinger and Wetmore 1938, Erickson 1940. Anas platyrhynchos domesticus; Betegh and Dorcich 1912 Germany, Hall 1925.
Anas rubripes (black duck); Mathews 1930, Gower 1938.
Chaulelasmus streperus (gadwall); Erickson 1940.
Dafila acuta tzitzihoa (American pintail); Erickson 1940, Herman and Bolander 1943.
Quequedula discors (blue winged teal); Erickson 1940.
Spatula clypeata (shoveler); Stiles 1893, Erickson 1940.

The infection isn't detected very frequently. Erickson (9) reports that of 279 ducks of 18 species examined in the Division of Economic Zoology, University of Minnesota from 1931 to November 1939, eight or 2.86% were infected with Sarcocytis rileyi. Six were mallards and two shovelers. Autopsy records of the Minnesota Wildlife Disease Investigation indicate that of 43 ducks of 8 species collected from 1933 to March 27, 1939, three or 6.9% were infected. All three were mallards. To date all records of Sarcocystis in ducks pertain to the puddle or dabbling variety. A possible explana-





Fig. 7 Black ducks shot at the Pointe Mouillee State Game Area infected with Sarcocystis rileyi. Photos courtesy of R. Snell.

tion for this may be that the ducks become infected either by eating flesh containing ripe cysts or by eating food contaminated with excrement of an infected animal and since pond ducks feed in shallow water, they would probably be much more exposed to fecal contamination than diving ducks that feed in deeper water. Also they are more prone to feed in corn and stubble fields than are the diving ducks and would again be more exposed to contamination. Scott (28) says that results of transmission experiments suggest that infection in nature takes place by way of the alimentary canal. Sarcocystis tenella has been transmitted experimentally by feeding either infected muscle or food contaminated by feces from infected animals. The parasite develops within the muscle fibers of the breast, sometimes extending into the head and wing muscles. In both cases at Pointe Mouillee the parasite was found extensively in the wing muscles. Heavy infestation probably represents destruction of muscle fibers. It is difficult to see how such heavily laden muscle is able to function properly. In none of the cases reviewed in the literature were any flight abnormalities observed. Riley (26) found 2000 cysts per ounce of meat in a mallard shot in 1919 on an island in the Mississippi river below St. Paul, Minnesota. Crawley (8) suggests that the distinction between the inter and intramuscular stages of the parasite is merely a question of development. The young stages lie within the muscle fiber but as they

grow, they become too large to be contained within it. According to Minchen, the originally parasitized fiber is ruptured and the cyst escapes. It seems more probably however, that the fibre is merely almost wholly destroyed, its remnants remaining around the parasite as an adventitious cyst. Crawley finds that the individual spores show the following internal features counting from broad to narrow end: vacuole, chromatin body, vacuole, chromatin body. He says each spore is 14-15 microns long and 2-3 microns wide. One end is broad and rounded and the other end tapering.

The two black ducks shot at Pointe Mouillee were brought into the wildlife management laboratory at the University of Michigan for autopsy. Other than the presence of Sarcocystis the ducks were found to be normal in all respects.

Concerning the fungoid nature of Sarcocystis I wish to quote from Spindler (31).

"The biological status of parasites comprising the genus Sarcocystis has been somewhat in doubt. An investigation on the species infecting swine showed that this parasite is a fungus and not a protozoan as commonly supposed. The main points of the investigation are as follows:

Sarcocysts or Merschers sacs removed aseptically from the muscles of swine were ruptured in sterile dextrose culture solution to release the spores; the preparations were cultured at 37 C. for 24 hours and subsequently at room



Fig. 8 Longitudinal section of cyst of Sarcocystis rileyi X20. Taken from one of the two Black ducks found with the parasite this fall at Pointe Mouillee. Photo through courtesy of A. Doll.

temperature. After a few days to two weeks of culturing, the spores budded off minute coccoid bodies which developed, by incomplete budding, into a septate myceleum with vertical hyphae bearing spores. The fungus has been identified as Aspergillus sp.

Twenty-five of fifty young pigs injected with, or fed, conidia harvested from the cultures harbored at necropsy, four to six months after infection, typical sarcocysts in the muscles; controls escaped infection. Cultures made from the mature sarcocysts yielded a fungus like that injected.

Pigs, rats, and mice, fed sarcocysts, discharged with their urine and feces yeast-like bodies which, in culture, produced a fungus like that originally cultured from sarcocysts. Sections of kidneys of infected mice showed yeast-like bodies in the tubules. In rats and mice clumps of a fungus were found attached to the walls of the ileum and caecum; yeast-like bodies similar to those found in feces and urine budded from the internal walls of this fungal growth."

LEUCOCYTOZOON

A total of thirty-five ducks were examined for blood parasites with particular emphasis being placed on the presence of the gametcyte stage of Leucocytozoon simondi (Synonym L. anatis).

The samples were collected over a period of several weeks from ducks submitted by hunters and from cripples. A sample was usually obtained from a wound or in some cases from an internal organ as the bird was being autopsied.

In taking a blood sample, it was necessary to make sure that only a very thin film of blood was placed on each slide. This was accomplished by drawing the end of another slide over the face of the slide to be used, the slides were fixed for a few minutes in Methyl alcohol, stained two hours in a dilute solution of Giems azure-rosin stain and washed in distilled water. The dilution of the stain was twenty drops of stain to twenty cc of distilled water. Examination of the slides for Leucocystozoon anatis showed negative results. (Fig. 9) This isn't definite proof that none of these ducks were carriers of the disease. It was expected that the local ducks, sampled early in the season, would not be carriers because the black fly (Simulium venustum) which transmits the disease is not found in the vicinity of Pointe Mouillee. Leucocytozoon simondi is ordinarily not found in the peripheral blood late in the fall and winter months as it remains in the spleen and other



Fig. 9 Microfilaria in the blood of a coot shot at Pointe Mouillee. This was one of the slides examined for Leucocytozoon simondi. 1200X magnification. Photo through courtesy of A. Doll.

internal organs in an inactive stage. Because of this, the parasites might not be detected in those late migrants that bred within the range of the black fly and were actually carriers of the disease.

Because Leucocytozoon infection is so prevalent, negative results on all samples does have some significance. The indications are that there is little movement of duck from black fly regions into the Pointe Mouillee region before the main fall migration.

LEAD POISONING

Symptoms of lead poisoning are a general weakness of the voluntary muscles with definite paralysis gradually ensuing. When a sufficient number of these muscles are put out of action in chronic cases, starvation follows. Other than the weakness or paralysis referred to, and a greenish diarrhea, no pronounced symptoms are observable anti-mortem. On autopsy the gizzard is frequently found to contain shot in various stages of erosion. The contents of the gizzard are about normal. Due however to the apparent paralyzed state of the muscles of the gizzard and the reverse action of the upper intestinal tract, the gizzard contents are stained green. The appetite of the birds suffering from lead poinsoning show no apparent decrease and some cases an actual stimulation is apparent. This regular intake of food and the paralyzed state of the gizzard muscles results in an overfilling of the upper digestive tract anterior to this organ. This overfilling may be so pronounced as to distend the proventriculus and esophagus to several times their normal size. After the lead is eaten, it is rapidly eroded by the grinding action of sharp grit under the action of the gizzard muscles. The finely divided particles of lead cut off by this erosion process become partly absorbable in the presence of the digestive fluids, are absorbed over a long period and result in lead poisoning.

According to Dr. S. J. Whitlock, pathologist for the Michigan Department of Conservation, the losses from lead poisoning in Michigan are uniformly small from year to year although on some occasions large losses may occur. At Pointe Mouillee during the past two hunting seasons, no birds were found showing the advanced symptoms of the disease. Under flouroscopic examination of birds in hunters bags, varying percentages according to species were found to contain lead in the gizzard (fig. 10). It seems probably that later on many of these ducks will become afflicted with the disease. Knowing that this hunting ground is an ideal spot for ducks to pick up lead, the Conservation Department conducted a lead shot survey of Pointe Mouillee last June (fig. 11). Sample strips were run through open water areas of the marsh. The Peterson dredge which sampled on area of .0931 sq. yds. was used to collect bottom material. Bottom samples were run through a series of three cylindrical strainers whose mesh sizes were 6/16", 3/16" and 1/16". The strainers were floated on a rack alongside the boat and the bottom material washed through. These mesh sizes were used because lead shot sizes are seldom less than 5/64" in diameter. Samples were taken 100 yards apart. Results showed estimated shot per sq. yd. of area sampled to range from 4.5 to 8.2 with the average being around 5.5 shot per square yard.

Fig. 11 Lead Shot Survey of Pointe Mouillee undertaken in June 1949 by the Michigan Conservation Dept.

Line	Length	Bottom Composition	Average Silt Depth	No. of Samples	No. of Shot	Shot/ Sq. Yd.
1	3040 yd.	70% silt - 30% clay	over 4 inches	19	8	4.5
2	2350 yd.	60% silt - 40% sand	" "	18	8	4.7
3	1700 yd.	coarse silt	" "	22	17	8.2
4	1500 yd.	80% c. silt - 20% f. sand	" "	16	5	3.3
5	960 yd.	coarse silt	" "	12	7	6.2
					Ave.	5.5

Fig. 10. Results of Fluoroscopic Examination of Ducks for lead in gizzards at Pointe Mouillee. From Michigan Conservation Dept. Records

Species	Year	Tot. No. X-rayed					No. with shot in gizzard					% of Tot. with shot in gizzard				
		JM	AM	JF	AF	TOT.	JM	AM	JF	AF	TOT.	JM	AM	JF	AF	TOT.
Black	1948	-	-	-	-	340	-	-	-	-	16					4.7
	1949	85	63	93	30	271	6	2	9	1	18	7.1	4.1	9.7	3.6	6.5
Mallard	1948					333					13					3.9
	1949	42	44	57	17	160	4	2	7	0	13	9.6	4.6	12	0	8.1
Pintail	1948					85					6					7.0
	1949	21	12	30	6	69	4	2	1	0	7	19	17	3.6	0	10.1
Baldpate	1948					160					7					4.4
	1949	32	16	47	12	107	0	0	1	1	2	.0	.0	2.1	8.4	1.9
BW Teal	1948					54					0					0
	1949	33	16	62	28	159	0	0	2	0	2	0	0	3.2	0	1.4
GW Teal	1948					92										
	1949	40	27	45	17	129	3	1	2	1	7	7.5	3.7	4.4	5.9	5.4
Wood duck	1948					14										
	1949	9	12	16	5	42	0	0	1	0	1	0	0	6.2	0	2.4
Shoveler	1948					15					1					6.6
	1949	3	0	3	0	9	0	0	0	0	0	0	0	0	0	0
Gadwall	1948					19					0					0
	1949	11	5	4	6	26	0	0	0	0	0	0	0	0	0	0
Ruddy	1948					142					2					1.4
	1949	4	2	7	2	15	0	0	0	0	0	0	0	0	0	0
Scaup	1948					109					7					6.4
	1949	13	5	19	9	46	2	2	1	1	6	15	40	5.3	11	13.1
Redhead	1948					52					6					11.5
	1949	3	1	6	1	11	1	0	1	0	2	33	0	17	0	18.1
Canvasback	1948					28					3					10.7
	1949	0	3	3	5	11	0	1	0	2	3	0	33	0	40	27.3
Bufflehead	1948					7					0					0
	1949	3	2	12	2	19	0	0	0	0	0	0	0	0	0	0

(Con't. on next page)

Results of Fluoroscopic Examination (Con't)

Species	Year	Total No. X-Rayed					No. with shot in gizzard					% of Tot. with shot in gizzard				
		JM	AM	JF	AF	TOT.	JM	AM	JF	AF	TOT.	JM	AM	JF	AF	TOT.
Goldeneye	1948					-					-					
	1949	2	0	3	2	7	0	0	0	0	0	0	0	0	0	0
Ringneck	1948	0	0	0	0	21					2					9.5
	1949	2	2	3	0	7	1	1	1	0	3	50	50	33	0	42.8
Others	1948					16					0					0
	1949					-					-					-
TOTAL	1948					1488					63					
	1949	303	200	410	142	1055	21	11	26	6	64	6.9	5.5	6.3	4.2	6.2

JM-Juvenile male
AM Adult Male

JF Juvenile female
AF Adult female

PREDATORS

Because of their power of flight and habit of spending a large part of the time on bodies of water, waterfowl are not greatly menaced by predators at this season of the year. However, when a duck has been weakened by disease, parasitism or gunshot wounds, predators may often prove to be the final cause of death. The crippling losses at Pointe Mouillee have already been discussed, these have brought about an ideal set of conditions for the survival of raccoons especially. After a light snow the eastern edge of the refuge and the barrier beach were covered with raccoon tracks. In about an hour's time, eight duck remains were discovered in this area (fig. 12), presumably cripples finished by raccoons. There are few large hollow trees on the area, but those located on it are in use as dens. Probably most of the raccoon make their home to the north across the Huron river where there are a number of trees suited to dens. Under conditions similar to this on the Lake Chautauqua National Wildlife Refuge in Marion Co. Illinois, Yeager and Anderson (38) report the raccoon, opossum and mink as the chief predators. Of 26 mink scats studied, feathers made up the entire content of 18 and were represented in 23. Only a few oppossum scats were studied but these all showed feathers and of the 140 raccoon scats examined, duck feathers were represented in 78 or 55.7%. Both mink and oppossum are known to be present at Pointe Mouillee and probably contribute to the loss from



Fig. 12 Two examples of duck remains found near the refuge at Pointe Mouillee. These ducks were presumably cripples finally killed and eaten by raccoon.

predators. The refuge is rather isolated by water though and this might prevent oppossum from reaching it.

Other animals known to be on the area that might prey on crippled ducks are the weasel, marsh hawk and great horned owl. Pirnie (24) rates the great horned owl as the most destructive natural enemy of adult ducks. A marsh hawk was seen to dive on a crippled duck near the refuge in late fall. The duck was still in sufficient health to escape by flying to open water but later on in the season this same duck becoming progressively weaker might have fallen victim to the attack. Two sight records of the snowy owl on the area were received this fall; one of an owl chasing a female mallard in flight. This bird is fully capable of destroying healthy, adult ducks and need not depend on cripples for food. It is doubtful whether it does much damage however, because of the small population of the owls and because other prey species, when available, are easier to catch. This bird seems to have a cyclic migration into this part of the country which may be controlled by its regular food supply.

CONCLUSIONS

1. Hunting Mortality

The main recommendation here is an attempt to provide a more even distribution of the hunters on the area and thereby reduce crippling. There are 1770 acres on the controlled area and with a full 300 permits out, this would mean an average of over 5 acres per man. An estimated 500 acres get very little use. This still leaves 4 acres per hunter not considering that most men hunt in groups of 2 and 3. However one-half to three-fourths of the hunters probably station themselves around the refuge or move up and down the channel near there. A possibility of relieving this situation might be to set up a second controlled area immediately surrounding the refuge in which a smaller number of hunters were allowed each day. Another possibility might be to erect permanent blinds in the area near the refuge and allow hunters to use only these locations when hunting in this area. By keeping each hunter a maximum distance from his neighbor there might be a psychological effect on the need for shooting before the bird is in range. Considering that each hunter could be allowed 5 acres as a minimum, it would be possible to leave around 160 yards between blinds. Allow no less than 2 hunters to a blind and from 300 to 400 yards could be left between blinds around the refuge. This still isn't enough to give the hunter a chance to use decoys and a dog to best advantage but it would be an improvement over

the present situation. The area around the refuge would need around 25 blinds and this would represent a considerable cost in building and maintenance. An admission fee to those using the blinds might be necessary. The blinds should be given daily to those first in line each morning.

2. Parasitism

The conclusions that light parasitism occurs very frequently and is probably a normal thing. Mortality from this cause is rather obscure but in this study at least no material autopsied was in such a condition that parasitism could definitely be stated as the cause of death.

3. Lead Poisoning.

Between 5 and 10 percent of all the birds examined were found to have lead in the gizzard. None of these birds showed any advanced symptoms of lead poisoning but it was thought that over a period of time as the lead is eroded in the gizzard and passes into the body many of these birds would become affected with the disease. By this time many of the birds would have reached the wintering grounds where this disease takes its greatest toll.

4. Predation.

The greatest losses from this source occur as a result of crippling and it probably isn't of much importance with normal adult ducks. Most of the birds that are

taken by predators are in a very weakened state and the predator probably does more good than harm by ending their suffering. Any control on this cause should be started, with a view toward lessening crippling losses. Education of the hunter regarding the range at which his gun has maximum killing power is the foremost consideration here. Other improvements such as distributing the hunters more evenly on the area and the use of dogs could bring the bird crippled per bird killed considerably below the present level.

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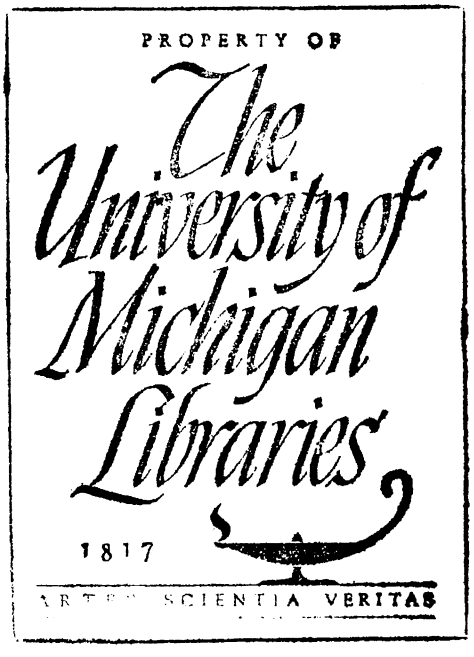
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