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FOODS EATEN BY AQUATIC FISH-EATING BIRDS¹

By Jerry Peterson

This report concerns the food habits of loons, gulls, grebes, and mergansers collected in 1963 and 1964, mainly on the northern and eastern shores of Lake Michigan. Extensive mortalities of loons and gulls that occurred in late summer and the fall of these years instigated the study. The mortalities are described in another report.² Except for the following paragraph, this discussion deals with the materials from 134 loons, 28 gulls, 16 grebes, and 2 mergansers that were examined recently.

Dr. G. P. Cooper analyzed the stomach contents of 15 loons picked up along Lake Michigan in Berrien and Ottawa counties in November and December 1963; the materials were submitted by L. D. Fay, Game Pathologist of the Research and Development Section. Dr. Cooper's findings are described in detail in a letter to Dr. Fay, dated January 24,

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¹ Contribution from Dingell-Johnson Project F-27-R-3, Michigan.

² Research and Development Report No. 25, "Field observations and laboratory investigations concerning recent Lake Michigan bird mortalities," by L. D. Fay, O. W. Kaufmann, and L. A. Ryel, April 13, 1965.

1964. Alewife (Alosa pseudoharengus), yellow perch (Perca flavescens), trout-perch (Percopsis omiscomaycus), and smelt (Osmerus mordax) were identified in 8 of the 15 stomachs. Unidentified fish remains occurred in the other 7 samples. Almost every stomach contained some plant material and small stones. The general conclusions were that all 15 loons had fed on fish, these were mostly alewives and perch, and probably every one of the stomachs contained the remains of either alewives or perch, or both.

Dr. Fay also provided the materials from the 180 birds that are of particular concern in this report. Employees of the Department of Conservation collected most of the specimens, but some were obtained by personnel of the U. S. Fish and Wildlife Service. Excepting one gull that was shot, all of the materials came from dead or dying birds.

The stomach or gizzard contents of 103 birds were removed from the organs before they were sent to Ann Arbor and were preserved in formalin in individual containers. Nearly all of these birds were picked up along the northern and eastern shores of Lake Michigan in November and December 1963 and in August, September, and October 1964; one of the Ring-billed Gulls was obtained in Crawford County, one loon in Alpena County, and one loon on the south shore of Lake Superior. The gizzards of 76 loons and the digestive organ of a gull from collections taken on the northern shore of Lake Michigan also were preserved in formalin. After much of the preservative was removed by soaking the materials in water, the author examined the

items carefully, identified those which were identifiable, and recorded the findings. The fish skeleton collection of the Fish Section, Museum of Zoology, The University of Michigan, was used extensively to aid identification.

All the loons involved in this study were Common Loons. They had eaten alewives oftener than any other food; this item certainly occurred in nearly three-fourths of the 134 specimens. Smelt were next in importance; they were definitely present in 12% of these birds. Other identified fishes in decreasing order of importance were sea lamprey (Petromyzon marinus), coregonids, mottled sculpin (Cottus bairdi), and yellow perch. Insect remains were found in 11% of the samples but made up only a small fraction of the contents. It would therefore seem that insects contributed little to the diet of these loons. Small feathers and pieces of plant material were encountered occasionally. Stones appeared in nearly all the gizzards and stomachs, as many as 30 of them were found per organ, and ranged mostly from 1/8 to 1/2 inch in diameter. They probably were consumed to aid digestion.

The gulls examined were as follows: Herring Gull (15), Ring-billed Gull (9), Bonaparte's Gull (2), unidentified gulls (2). Alewives were the predominant food of the gulls. They occurred in nearly two-thirds of the collection; yellow perch were next in frequency of occurrence (18%). Smelt, coregonid, and cottid were each found once in the 28 gulls. Insects occurred in 25% of the stomachs and gizzards. Feathers, plant material, and stones also were included. Stones appeared rarely, were never abundant, and generally were small.

The grebes examined were Horned Grebe (12) and Red-necked Grebe (4). Sculpins (Cottus bairdi) appeared most frequently among the items consumed by grebes; they were eaten by 9 of the 16 birds.

Alewife had been consumed by two grebes, and smelt and sea lamprey each occurred once. Insects appeared in 13 of the specimens. The digestive organs of all the grebes contained feathers (2-3 inches long), which were usually thickly matted together with plant material. It is reported in literature that grebes consume their own feathers. A few stones were in some of the samples. As in the case of loons and gulls, small amounts of sand were found occasionally. The sand could have been swallowed with stones or food.

The gizzards of the two Red-breasted Mergansers contained little food. One contained remains of a smelt and the other contained bones of an unidentified fish.

Data on the frequency that food items and other materials occurred in each of the four categories of birds appear in Table 1. The food contents of each organ are recorded in annotated tables that are appended to the main part of the report. When the 180 birds are considered together, these percentages of them contained the respective foods: 64%, alewife; 11%, smelt; 8%, sculpin; 5%, sea lamprey; 4%, coregonid; 4%, yellow perch; 19%, insects; 12%, crayfish. Evidence of fish flesh and/or bones was found in 127 of the 134 loons, in all gulls, in 13 of the 16 grebes, and in the 2 mergansers.

Several other observations have some significance and interest.

Table 1. --Percentage of birds that contained food items and other materials. Birds collected in 1963 and 1964 on Lake Michigan.¹

Food item	Loons (134)	Gulls (28)	Grebes (16)	Mergansers (2)
Alewife	72	64	12	..
Smelt	13	3	6	50
Sculpin	3	3	56	..
Yellow perch	2	18
Coregonid	5	3
Sea lamprey	7	..	6	..
Unidentified fish	23	36	25	50
Crayfish	13	3	19	..
Insects	11	25	75	..
Plant material	28	32	69	50
Feathers	15	32	94	..
Stones	94	14	37	100

¹ Included are one gull and two loons collected elsewhere.

There were no indications that any of the fish remains was carrion. Although much of the material was examined with a compound microscope, no traces of fungus (Saprolegnia) were seen.

A few parasites (cestodes, nematodes, and acanthocephalans) occurred in the digestive organs. They were undigested, indicating that they were parasites of the birds rather than fish or other food organisms. The one exception was a nematode found within an insect larva.

Sea lamprey remains found in samples are of particular interest. Only teeth were found; these appeared in the gizzards of eight of the loons collected south of Gulliver, in the gizzard of a loon picked up south of Gould City, and in a Red-necked Grebe from Mackinac County. Most of these teeth were about the size of the teeth of an 18-inch sea lamprey.

INSTITUTE FOR FISHERIES RESEARCH

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Report approved by G. P. Cooper

Typed by M. S. McClure

Table A. --Items found in digestive organs of 58 loons from various locations

Specimen number, organ, location and date of collection	Items ¹	Remarks
63-258, gizzard Berrien Co. 11-19-63	1 alewife, 6". 1 coregonid, about 5".	Opercular, articular, and maxillary identify the alewife. Opercular bones, etc. identify the coregonid alewife and coregonid scales.
63-281, stomach Berrien Co. 12-8-63	Fish bones and scales, family Coregonidae. Alewife scale fragment. 2 acanthocephalan parasites, 1/8".	Parasphenoid, basipterygium etc. identify the coregonid. Many bone fragments not readily identifiable as the parasites were complete; I believe they were para- sites of the bird.
63-293, stomach Berrien Co. 12-12-63	1 alewife. Bone fragments. Trace of plant material.	Hypural plate and a parasphenoid of an alewife. Many bone fragments not readily identifiable.
63-305, organ undesignated Ottawa Co. 12-9-63	1 perch. Evidence of alewife.	Quadrates, and ctenoid scales identify perch. Cycloid scales identify alewife. Contents very fragmented, identifica- tion difficult.
64-18A, organ undesignated Ottawa Co. 12-9-63	4 alewives, 6". 2 perch. 2 crayfish.	Opercular bones identify alewives. Articular, cleithrum, dentary, etc. of perch. Two fragments of crayfish claws.

¹ Occurrences of stones, sand, and feathers omitted.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-18B, stomach Ottawa Co. 12-9-63	2 alewives, 5". 1 coregonid.	Cleithrum, parasphenoid, and opercular bones identify alewives. Post- temporals identify the coregonid.
64-18C, stomach Ottawa Co. 12-9-63	1 partially digested 6" alewife.	Opercular bones identify the fish.
64-18D, stomach Ottawa Co. 12-9-63	Portions of two 5" alewives.	Opercular, dentary, and articular bones and scales identify the fish. Many other bone frag- ments.
64-19A, stomach Ottawa Co. 12-9-63	1 yellow perch, 4'-5".	Hypural plate and quadrate identify perch. Numerous bone fragments, vertebrae, and fin rays not readily identifiable. No scales.
64-19B, stomach Ottawa Co. 12-9-63	Fish bones. Alewife scales.	Many fragmented fin rays, vertebrae, and other bones not identifiable.
64-20B, stomach Ottawa Co. 12-9-63	Fish bone fragments. One scale from alewife. Trace of plant material (green).	Vertebrae, fin rays, and rib bones present but not identifiable to species.
64-20C, stomach Ottawa Co. 12-9-63	1 alewife, 4". Many alewife scales.	Hypural plate identifies the fish. Many unidentifiable bone fragments.
64-81C, stomach Berrien Co. 12-63	Stomach empty.	
64-82, gizzard Allegan Co. 4-10-64	Fish bones. Much cellular plant material.	A few vertebrae and one spine. 3 ctenoid scales, 1/32".

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-90, gizzard Alpena Co. 4-6-64	Fish bones. Ctenoid scales.	Many unidentifiable bones. Some thick bones that may be of perch. Some ctenoid scales, badly fragmented and not identifiable to species. Gizzard very dark green in color, probably influenced by algae.
64-269, stomach Delta Co. 9-21-64	2 alewives, one about 8" and the other about 5".	Dentary, cleithrum, maxillary, and articular identify the fish. The 5" alewife was partially complete.
64-270, stomach Delta Co. 9-21-64	1 alewife, 4"-5". 1 statoblast, <u>Pectinatella</u> , 1/32".	Post temporal, articular, and scales identify the fish. Many fish bone fragments not readily identifiable.
64-271, stomach Delta Co. 9-21-64	2 or 3 alewives.	Post temporals, dentary, and parasphenoid and scales of alewives. Some ear bones which may be from an alewife. Many other unidentifiable bone fragments.
64-272, stomach Delta Co. 9-21-64	1 alewife.	Parasphenoid and ear bones identify the alewife. Many fish bones that are frag- mented and generally unidentifiable.
64-276, stomach Delta Co. 9-21-64	2 alewives, 4"-5". Crayfish.	Partially complete specimens. Head bones and scales identify fish. Many vertebrae and other unidentifiable bone fragments. Mandibular teeth of crayfish.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-278, stomach So. shore, Lake Superior, 4-24-64	1 coregonid of large size. Trace of shredded plant material.	Opercular, cleithrum, preopercle, and post temporal identify the fish.
64-280, stomach Delta Co. 8-30-64	Fish bone fragments. One cycloid scale, 1/32". Otoliths. Trace of plant material.	Many bone fragments, not identifiable. The scale is probably from a minnow.
64-296, gizzard Leelanau Co. 10-13-64	1 alewife.	Articular identifies the alewife. Many disarticulated vertebrae, rib bones, and other bones not readily identifiable.
64-297, gizzard Leelanau Co. 10-13-64	3 alewives; two 5" and the other 8". Alewife scales. Small amount of detritus.	The alewives only partially digested. Preopercular, parasphenoid and cleithrum, identify them.
64-298, gizzard Leelanau Co. 10-13-64	1 alewife.	Parasphenoid and quadrate identify the fish. Many other fragmented bones.
64-301, stomach Charlevoix Co. 10-14-64	Fish bone fragments. A few eggs, probably from a fish, 1/32". Trace of plant material.	Bone fragments not readily identifiable.
64-302, gizzard Charlevoix Co. 10-14-64	1 alewife, 6". Crayfish. Some unidentified brown flaky material.	3/4 of an alewife present. Opercular bones and scales aided identification. Claws and mandibular teeth of crayfish.
64-303, gizzard Charlevoix Co. 10-14-64	Fish bone fragments. One feather, 1.5".	Bone fragments not identifiable. One ear bone found similar to that of an alewife, but identification not positive.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-304, gizzard Charlevoix Co. 10-14-64	3 alewives, 6"-7". One skull and vertebrae of an unidentified fish. 1 coregonid.	Opercular bones and scales, etc. identify the alewives. Frontal bone and scales identify the coregonid.
64-305, gizzard Charlevoix Co. 10-14-64	2 alewives, one about 9" the other about 5". 2 smelt.	Opercular series identify the alewives. Post temporal and quadrate identify the smelt.
64-306, gizzard Charlevoix Co. 10-14-64	1 alewife. 1 coregonid.	Cleithrum, hyomandibular, and opercle identify alewife. Quadrate and cleithrum are similar to those of the family Coregonidae. Many fragmented fish bones not identifiable.
64-307, gizzard Charlevoix Co. 10-14-64	5 entire alewives, three 5" and two 7"-8".	Head bones, scales, etc. identify the alewives. Many fish bone fragments not readily identifiable.
64-308, gizzard Charlevoix Co. 10-14-64	2 alewives, 5".	Quadrate and articular identify the alewives. Most of contents made up of unidentifiable, fragmented fish bones.
64-309, gizzard Charlevoix Co. 10-14-64	Fish bones. Trace of plant material.	Many disarticulated fish bones.
64-310, gizzard Charlevoix Co. 10-14-64	3 sculpins (<u>Cottus bairdi</u>), 3"-4". Some long, hard, curly, green objects. Crayfish.	Cleithrum and parasphenoid identify the sculpins. Many unidentifiable vertebrae and other bone fragments. Fragments of crayfish.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-324, gizzard Mackinac Co. 10-6-64	Fish bone fragments. Alewife scales. Crayfish.	Many disarticulated vertebrae, rib bones and other bones not readily identifiable. Fragment of an ear bone, similar to that of an ale- wife. Mandibular teeth of a crayfish.
64-326, stomach Mackinac Co. 10-6-64	1 alewife. 1 large crayfish, <u>Orconectes virilis.</u> Plant material (microscopic particles).	Fragment of parasphenoid and articular of alewife. Fragmented fish bones not readily identifiable. Large chelipeds identify the crayfish.
64-327, gizzard Mackinac Co. 10-6-64	2 alewives, one about 7", the other smaller.	Preopercular, parasphenoid, hyomandi- bular, and scales identify the alewife. One specimen was complete. Many bone fragments unidentifiable.
64-328, gizzard Mackinac Co. 10-6-64	Fish bones. Some plant and other (?) green material. Some black-green flaky material.	Many unidentifiable vertebrae, ribs, and other bones.
64-330, stomach Mackinac Co. 10-6-64	Fish bones. Crayfish remains. Trace of ground plant material.	Many unidentified dis- articulated vertebrae, rib bones, and other bones. Mandibular teeth of crayfish.
64-331, stomach Mackinac Co. 10-6-64	1 alewife, 6". 1 mottled sculpin. Insects.	Fragments of dentaries identify the fish. Frag- ments of body (elytra, legs, etc.) indicate presence of insect. Most of contents fragmented and not identifiable.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-332, stomach Mackinac Co. 10-6-64	1 alewife, 6". Shredded plant material.	Post temporal, parasphenoid, and articular of alewife. 1 oval structure with a membranous outer covering and a soft interior, possibly a cocoon of a leech. Rest of contents composed of disarticulated vertebrae, fin rays, and ribs.
64-333, gizzard Mackinac Co. 10-6-64	3 alewives, 7". Insects. Flaky, brown detritus.	Post temporals, articular, parasphenoid, and quadrate and scales of alewives. One specimen was complete. Claws and legs of insects.
64-334, stomach Mackinac Co. 10-6-64	3 alewives, 5"-6". 3 smelt. Some unidentified brown, flaky material.	Parasphenoid, cleithrum, dentary, other bones and scales identify the alewives. Cleithrum, dentary, etc. of 3 smelt. Many vertebrae, ribs, etc. not identifiable.
64-335, gizzard Mackinac Co. 10-6-64	Fish bone fragments.	Many vertebrae, ribs, and other bones.
64-336, stomach Mackinac Co. 10-6-64	1 alewife, 9". 1 cleithrum, probably from a minnow.	Opercular, other head bones, and scales identify alewife. Other unidentifiable bones.
64-337, gizzard Mackinac Co. 10-6-64	1 alewife, 5". Insects. Some plant material.	The alewife partially digested. Dentary, parasphenoid, and scales identify it. Many bone fragments not readily identifiable. Elytra indicate the presence of insects, probably Coleoptera.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-339, gizzard Mackinac Co. 10-6-64	Fish bones. Some plant material (brown).	Bones very fragmented and unidentifiable. The plant material ranges in size from very small to 1" long.
64-343, gizzard Mackinac Co. 10-12-64	1 whole alewife, 8". 1 mottled sculpin, about 3"-4". 5 crayfish, 3", <u>Orconectes</u> <u>virilis</u> , two specimens complete.	Preopercle, dentary, articular identify alewife. Articular, premaxillary, dentary identify the cottid.
64-345, gizzard Mackinac Co. 10-12-64	Fish bones. Much green plant material in shredded masses. Brown detritus.	Many disarticulated vertebrae, rib bones and other bones not readily identifiable.
64-346, gizzard Leelanau Co. 10-13-64	2 alewives, 5"-6".	Cleithrum, articular, dentary, quadrate, etc. identify the alewives. Many other disarticulated vertebrae and other bones not identifiable.
64-348, gizzard Leelanau Co. 10-13-64	1 alewife. Many crayfish. Some plant material.	Fragment of an articular identifies the alewife. Many unidentifiable vertebrae and other bones. Legs, uropods, and fragments of carapace of crayfish.
64-349, gizzard Leelanau Co. 10-13-64	2 alewives, 7" and 5.5". 1 cestode tapeworm, 1/32".	One alewife entire, the other disarticulated. Opercular, and maxillary, dentary, and scales identify the fish. Distinct segmentation identifies the cestode.
64-350, gizzard Leelanau Co. 10-13-64	1 alewife. Some scale fragments. Some detritus.	Articular of an alewife was found. Many bone fragments, not identifiable.

Table A. --continued

Specimen number, organ, location and date of collection	Items	Remarks
64-360, stomach Leelanau Co. 10-13-64	2 alewives, one about 8"-9" and the other about 5". Crayfish.	Parasphenoid, dentary, articular and post temporal identify the alewives. Mandibular teeth of crayfish.
64-361, stomach Leelanau Co. 10-13-64	3 alewives, 4"-7". Crayfish. Some plant material -- long, shredded pieces.	Articular, cleithrum, etc. identify the alewives. Many vertebrae and other bones not readily identifiable. Mandibular teeth of crayfish.
64-362, stomach Leelanau Co. 10-13-64	Fish bones. Trace of plant material, branching leaves, 1/8". Crayfish.	Many disarticulated vertebrae, rib bone and other bones not identifiable. Mandibular teeth of crayfish.
Unnumbered Organ undesignated Suttons Bay 8-64	Many fish bones.	Numerous disarticulated vertebrae, fin rays and rib bones not identifiable.

Table B. --Items found in gizzards of 70 unnumbered loons from shore of
Lake Michigan, south of Gulliver, November 1964

Speci- men	Items ¹	Remarks
A	3 alewives, 6". Insects. Trace of plant material.	Articular, dentary, and quadrate of alewives. Pieces of legs and body parts of insects. Oval structures, cocoon-like, possibly from a leech; mentioned also for other loons. Contents predominantly fragmented vertebrae and other fish bones.
B	Fish bones. Insects.	Bones too fragmented for identification. Parts of exoskeleton of insects.
C	Fish bones.	Many unidentified vertebrae, rib bones, and other fish bones.
D	1 smelt. Trace of stringy plant material. Moderate amount of yellow, flaky material, probably detritus.	Vomer and quadrate of a smelt. Numerous fish vertebrae and other bones not readily identifiable. An oval capsule found (of leech?).
E	Fish bones. An oval capsule (of leech?).	Contents very fragmented and not readily identifiable. One articular and maxillary, possibly from an alewife.
F	2 alewives. Insects.	Fragments of parasphenoid and articular identify the alewives. Many vertebrae and other bones not identifiable. Parts of exoskeletons of unidentified insects.
G	2 alewives, one about 7". Alewife scales. Trace of long, shredded plant material. Some detritus.	Articular, quadrate, and parasphenoid identify the fish. One fish was entire except for the head. Many vertebrae, rib bones, and other bones not identifiable.

¹ Occurrences of stones, sand, and feathers omitted.

Table B. --continued

Specimen	Items	Remarks
H	2 alewives, 6 ¹ -7 ¹ . Insects. Crayfish. Alewife scales.	Parasphenoid, dentary, articular, quadrate, and opercle of alewives. Parts of exoskeletons of insects, probably Coleoptera. Fragments of legs, claws, and exoskeleton of crayfish. Rest of contents very fragmented.
I		Gizzard completely empty except for stones.
J	2 alewives. Trace of shredded plant material.	Identification of 3 maxillaries would indicate 2 alewives. The parasphenoid also identifies the fish. Rest of contents unidentifiable fragments.
K	1 alewife.	Fragments of dentary, maxillary, and parasphenoid identify the fish. Rest of contents very fragmented and unidentifiable.
L	1 alewife, 6 ¹ . Evidence of sea lamprey.	Cleithrum, articular and hyomandibular identify the fish. Rest of contents very fragmented and unidentifiable. Teeth of sea lamprey.
M	1 alewife. Traces of shredded plant material and detritus.	Two articulars and a fragment of a parasphenoid identify the fish. Rest of contents made up of fragmented vertebrae, rib bones, and other bones.
N	1 alewife. 1 smelt. Traces of plant material, detritus, and sand.	Many scales and the premaxilla identify the alewife. Cleithrum, vomer and premaxillary identify the smelt. Unidentifiable fish bones.
O	Fish bones.	Very few bones.

Table B. --continued

Specimen	Items	Remarks
P	1 alewife. 1 minnow. Insects. Trace of plant material.	Quadrate bone identifies the alewife, and pharyngeal teeth, the minnow. Legs, exoskeleton and other parts of insects. Gizzard and contents very green, probably from algae.
Q	1 alewife, 5". Alewife scales. Much detritus (reddish).	The alewife was only partially digested. Opercular and premaxillary identify the fish. Many other unidentified fish bone fragments.
R	1 alewife. Insects. Trace of chunky plant material, 1/32"-1/16".	Fragments of alewife parasphenoid and premaxillary. Rest of bones badly fragmented. Pieces of jaw and exoskeleton of insects.
S	Fish bones.	Very few fragmented bones. Gizzard very green in color; may be due to algae.
T	1 alewife, 4". One half of a tabanid larva.	Fragment of parasphenoid and maxillary identify the fish. Part of an oval capsule, also observed in other loons. Rest of contents very fragmented.
U	2 alewives.	Fragments of maxilla identify the fish. Rest of contents made up of disarticulated vertebrae, ribs, and other bones not readily identifiable.
V	1 alewife. Small amount of detritus.	Fragments of maxilla and parasphenoid identify the alewife. Many unidentified, fragmented bones.
W	2 alewives, 6"-7". Alewife scales.	Specimens complete except for the heads. Identified by the operculars.
X	2 alewives. Trace of plant material (chunky).	Identification based on articular and maxillary. Much of the contents composed of bones not identifiable.

Table B. --continued

Specimen	Items	Remarks
Y	2 alewives, 7"-8". Lamprey remains. Alewife scales. Trace of stringy plant material.	Opercular series identify the alewives. Both specimens partly intact. Teeth of sea lamprey.
Z	1 alewife. Lamprey remains. Trace of small, chunky plant material.	Fragments of alewife parasphenoid and quadrate. Many other fragmented bones not identifiable. Lamprey teeth were those of sea lamprey.
AA	1 alewife.	Fragments of quadrate, maxillary, and parasphenoid of alewife. Other bone fragments not identifiable.
BB	1 alewife.	Fragment of parasphenoid and quadrate identify the fish. Rest of contents very fragmented. Contents of the gizzard were very green; probably from algae.
CC	2 alewives. 1 smelt.	Articular and parasphenoid identify the alewives; scales also found. Fragments of dentary and some teeth of a smelt.
DD	2 alewives, 7". Alewife scales. Coregonid scales. 1 oval capsule.	Alewives identified by articulars and parasphenoids. No coregonid bones found. Many unidentifiable fragmented bones. Capsule like capsules seen before.
EE	2 alewives.	Fragments of parasphenoid identify the alewives. Large, fragmented pharyngeal teeth of unidentified fish. Unidentified fish bones.
FF	Fish bones. Bits of flaked plant and detritus material mixed together; very fine in texture.	Very few unidentifiable bone fragments. Gizzard almost empty; lining very green in color.

Table B. --continued

Specimen	Items	Remarks
GG	2 alewives. 1 statoblast (<u>Pectinatella</u>).	Articular, parasphenoid, and maxillary identify the fish. Rest of contents composed of fragments not identifiable.
HH	2 alewives, 7". Alewife scales. Insects.	Articular, parasphenoid and maxillary identify the fish. Much of contents made up of unidentifiable bone fragments. Large jaws of an unidentified insect plus 2 larvae (Tabanidae).
II	2 alewives.	Parasphenoid and maxillary identify the fish. Contents very fragmented and generally not identifiable.
JJ	3 alewives. Alewife scales.	Opercular series, post temporal, dentary, and maxillary identify the fish.
KK	2 alewives, 6"-7". Alewife scales.	Opercular, dentary, and parasphenoid identify the fish. Many other fish bone fragments.
LL	2 alewives.	Fragments of parasphenoid and maxillary of alewives. Rest of contents composed of bones not readily identifiable.
MM	2 alewives, about 6" and 8". Alewife scales. 1 oval capsule.	Maxillary, quadrate, parasphenoid and articular identify the fish. Ribs, vertebrae, and bone fragments. Capsule perhaps of a leech; mentioned before.
NN	Few fish bones. Trace of flaky detritus.	Very few fragments. Gizzard very green colored.
OO	Few fish bones. Trace of flaky detritus.	Few fragmented vertebrae and other bones. Gizzard very green in color.
PP	Unidentified object, possibly a rib bone of a fish. Some green material which may be algae or detritus.	

Table B. --continued

Specimen	Items	Remarks
QQ	1 smelt. 1 mottled sculpin.	Vomer identifies the smelt. Quadrate and dentary identify the sculpin.
RR	1 alewife. Insect (?). Plant material.	Fragments of quadrate, parasphenoid and maxillary identify the fish. Plant material in the form of long chunks. Rest of contents very fragmented; a little of it may be of an insect.
SS	2 alewives. Lamprey remains.	Parasphenoid, articular, quadrate, and maxillary identify the alewives. Teeth identified as those of a sea lamprey. Rest of contents not identifiable.
TT	3 alewives. 1 smelt. Lamprey remains. Crayfish remains.	Parasphenoid, quadrate, and articular from alewives of different sizes. Fragment of dentary of a smelt. Sea lamprey teeth. Fragments of claws indicate 3-4 crayfish. Rest of contents not identifiable.
UU	3 alewives. 1 smelt. 1 oval capsule.	Articular, parasphenoid, quadrate and fragments of scales identify the alewives. Canine tooth of a smelt found. Capsule like that found in other loons. Fragmented vertebrae, ribs and other bones.
VV	1 alewife.	Fragment of articular, quadrate, maxillary, parasphenoid, and scales of alewife. Rest of contents fragmented and not identifiable.
WW	1 alewife. 1 smelt.	Fragment of a parasphenoid and maxilla identify the alewife. Dentary and quadrate of a smelt. Rest of contents very fragmented and not identifiable. Gizzard green; probably from algae.

Table B. --continued

Specimen	Items	Remarks
XX	3 alewives.	Fragments of articular, maxillaries, and parasphenoids and fragments of scales identify the fish. Fragmented, unidentified fish bones.
YY	Fish bones.	Very few bones. Gizzard very green.
ZZ		Gizzard empty except for 12 stones (3/16"-3/8"), trace of sand, and 2 feathers. Very green; probably from algae.
AAA	2 alewives. 1 smelt. Insect remains. Plant material. 1 oval capsule.	Maxilla, quadrates, parasphenoids and articular identify the fish. 1 canine tooth of a smelt. Fragment of an insect wing. Capsule mentioned before. Rest of contents composed of unidentifiable bones.
BBB		Gizzard empty except for 16 stones, a large accumulation of stringy feathers, and a trace of detritus.
CCC	3 alewives, one about 6". Chunky plant material.	Maxillary, articular, quadrate, and dentary identify the fish.
DDD		Gizzard empty except for 6 stones and green flaky material which probably is a mixture of detritus and algae. Gizzard very green.
EEE	Fish bones.	A few vertebrae and other bone fragments.
FFF		Gizzard empty except for some detritus, 37 stones, and trace of sand.
GGG	1 alewife. Alewife scales. 4 crayfish. 1 statoblast of a Bryozoan (<u>Pectinatella</u>).	Parasphenoid, articular, and maxilla identify the fish. Identification of crayfish based on chelipeds and body fragments.

Table B. --continued

Specimen	Items	Remarks
HHH	3 alewives. 1 smelt. Lamprey remains. Plant material.	Fragments of parasphenoid, maxillary, articular, and scales identify the alewives. One canine (1/16") of a smelt. Bicuspid and unicuspid teeth of sea lamprey found. Rest of contents composed of unidentifiable fish bones.
III	2 alewives. Alewife scales.	Fragments of maxillary, articular, and parasphenoid identify the fish. Rest of contents badly fragmented.
JJJ	3 alewives.	Fragments of parasphenoid, and maxillary identify the fish. Unidentified, fragmented material.
KKK	2 alewives, 5"-6". Alewife scales.	Opercular, maxillary, and articular bones of alewives.
LLL	1 alewife. 1 smelt, very small. Lamprey remains.	Articular and maxillary fragments identify the alewife. Quadrate of a smelt. Sea lamprey teeth. Many unidentifiable fish bones and some teeth. Gizzard lining very green.
MMM	3 alewives. Shredded plant material.	Fragments of maxillary, parasphenoid, and articular identify the fish. Rest of contents very fragmented and not identifiable. Gizzard very green.
NNN	Few fish bone fragments. Lamprey remains. Shredded plant material.	Gizzard almost empty. Small lamprey teeth similar to those of a sea lamprey used for comparison.
OOO	2 alewives, one about 7". 1 minnow (?). Insect remains.	Opercular, cleithrum, post temporal, etc. identify the alewives. Another cleithrum probably of a minnow. Parts of leg and body of an insect. Most of contents fragmented and not identifiable.
PPP		Gizzard empty except for 9 stones and a feather.

Table B. --continued.

Speci- men	Items	Remarks
QQQ	4 alewives of different sizes. 1 smelt.	Maxillary, articular, quadrate and opercular identify the alewives. Fragment of dentary and a canine indicate the presence of a smelt.
RRR	3 alewives. 1 smelt. Insect remains.	Maxillary, parasphenoid, and articular identify the alewives. Large canine teeth and dentaries of smelt. Fragments of insect legs.

Table C. --Items found in gizzards of 6 unnumbered loons from shore of Lake Michigan, south of Gould City, November 1964

Speci- men	Items ¹	Remarks
A	1 alewife. Alewife scales. 1 smelt. Small amount of chunky and shredded plant material.	Parasphenoid, articular, quadrate, and opercular identify the alewife. Vomer quadrate and fragments of dentary identify the smelt.
B	3 alewives. Lamprey remains. Crayfish remains. Some chunky and shredded plant material.	Maxillary, parasphenoid, quadrate, and articular identify the alewives. Teeth of sea lamprey. Chelipeds of crayfish. Much of contents very fragmented.
C	3 alewives. 1 smelt. Some long, stringy plant material.	Fragments of articular, parasphenoid, quadrate, and dentary identify the alewives. Fragments of dentary, vomer, and quadrate of a smelt.
D	1 alewife. 2 smelt.	Fragments of maxillary of an alewife. Fragments of dentary, quadrate, and canine teeth from smelt. Rest of contents very fragmented and not identifiable. Gizzard very green.
E	1 alewife (?). Crayfish remains.	One bone that may be a fragment of an alewife maxillary. Many frag- ments of crayfish. Disarticulated vertebrae, rib bones, and other unidentified bones.
F	2 alewives. Crayfish remains.	Articular and maxillary fragments identify the fish. Very fragmented remains of crayfish.

¹ Occurrences of stones, sand, and feathers omitted.

Table D. --Items found in digestive organs of 28 gulls

Specimen and number, organ, location, and date of collection	Items ¹	Remarks
Herring Gull 63-256, stomach Muskegon Co. 11-16-63	Fish bone fragments. 1 scale fragment.	Many bone fragments. The scale possibly from a coregonid.
Herring Gull 63-257, organ undesignated Muskegon Co. 11-16-63	1 coregonid.	Post temporal, dentary, basipterygium, and scales of a coregonid.
Ring-billed Gull 63-260, gizzard Berrien Co. 11-13-63	1 alewife, 5". 1 minnow (?).	Cleithrum, opercular, and preopercular of alewife. One tiny (1/32") cycloid scale, probably from a minnow. Rest of contents very fragmented and not identifiable.
Herring Gull 63-260, gizzard Berrien Co. 11-13-63	Fish bones. Alewife scales.	Many vertebrae and other bone fragments not identifiable. Presence of alewife scales may indicate that the fish bones also are of alewife.
Ring-billed Gull 63-261, organ undesignated Mason Co. 11-16-63	1 alewife, 5". Insect remains (Coleoptera).	Hyomandibular, opercular, and cleithrum of alewife. Abdomen and leg of insect. Rest of contents composed of fragmented vertebrae, ribs, and other bones not readily identifiable.
Herring Gull 63-262, stomach Mason Co. 11-16-63	Fish bones. 1 nematelmith (Nematoda).	Bones very fragmented and not readily identifiable. The nematode (1/2") entire.

¹ Occurrences of stones, sand, and feathers omitted.

Table D. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Herring Gull 63-262, intestine	Fish bones. 1 nematode, 1".	Few vertebrae and other fragmented bones. The nematode was entire and not digested; I believe the animal was a parasite of the bird and not the fish.
Herring Gull 63-298, organ undesignated Van Buren Co. 12-8-63	1 yellow perch, 5"-6". 4 nemathelminths, probably of the class Nematoda. Much plant material: roots, stems, and leaves.	Opercular bones, parasphenoid, scales, etc. of perch. The nematodes complete, indicating them to be parasites of the bird.
Herring Gull 63-300, stomach Lake Michigan 12-8-63	4 alewives, 6"-7". Bird bones. Some green plant material.	Parasphenoid, cleithrum, preopercular, dentary, maxillary, and scales of alewives. Ribs uscnate processes, and other bones of a bird.
Gull 63-311, organ undesignated Ottawa Co. 12-8-63	2 yellow perch, one 6"-7", and the other 5". Trace of plant material.	Opercular, dentary, and maxillary bones of perch.
Ring-billed Gull 64-5, stomach Crawford Co. 7-31-63	2 yellow perch, one about 6" and the other 4". 2 floatoblasts or statoblasts of Bryozoa. Insect remains (Coleoptera and Hemiptera). Moderate amount of plant material.	The larger perch was entire except for the head. Identification based on parasphenoid, dentary, and opercular bones. Legs, heads, thorax, and abdomens of insects.
Ring-billed Gull 64-6, stomach Muskegon Co. 9-16-63	1 alewife, 6"-7". Insect remains.	Dentary, articular, opercular, and scales of the alewife. Parts of insect exoskeleton. Rest of contents badly fragmented.

Table D. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Gull 64-7, stomach Muskegon Co. 9-16-63	Fish bones. Insect (adult) remains. 2 insect larvae. A few eggs. Moderate amount of plant material. Moderate amount of red, blue, green, and white stringy material, microscopic in size. Large number of unidentified dark objects.	Moderate number of vertebrae, fragments of finrays, and bones not identifiable. Parts of body and wing of an insect. Eggs were encountered before, in a loon stomach.
Herring Gull 64-29E, stomach Allegan Co. (shot) 2-5-64	Fish bones. 1 alewife (?).	Many fragments of vertebrae, fin rays, ribs, and other bones. A fragment of an articular possibly of an alewife.
Herring Gull 64-162, stomach Berrien Co. 11-13-63	3 alewives, two about 5" and one 8"-9". Fragmented bones (not fish). Trace of bird feathers.	Preopercular, opercular, dentary, and quadrate of alewives. Fragmented bones of either bird or mammal.
Bonaparte's Gull 64-163, gizzard Berrien Co. 11-13-63	1 alewife. Small amount of shredded plant material.	Preopercle, post temporal, etc. of alewife. Rest of contents very fragmented.
Herring Gull 64-203, stomach Delta Co. 8-11-64	3 alewives. 1 mottled sculpin. Insects.	Parasphenoid, dentary, cleithrum, and opercular of alewives. Cleithrum, frontal, and articular of the cottid. Two heads with large jaws, of insects.
Herring Gull 64-204, organ undesignated Delta Co. 8-11-64	1 alewife, 5".	Cleithrum, dentary, maxillary, post temporal and scales of alewife. Rest of contents very fragmented.

Table D. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Ring-billed Gull 64-206, stomach Delta Co. 8-11-64	1 alewife. 1 yellow perch. 1 unidentified fish. Insect remains. 3 statoblasts (<u>Pectinatella</u>).	Dentary bone and scales of alewife. Ctenoid scales, probably percid. One perch otolith. Cycloid scales indicate presence of another fish. The fish bones badly fragmented. Remains of one insect larva. A nematode found in the larva.
Bonaparte's Gull 64-215, stomach Lake Michigan 8-14-63	1 yellow perch (small). Filamentous plant material.	Parasphenoid, post temporal, frontal, and articular of a perch.
Ring-billed Gull 64-216, stomach Lake Mich., Ind. 8-14-63	1 alewife, 5".	Preopercle, dentary, articular, parasphenoid, and scales of alewife. Many unidentified fragments of vertebrae, and other bones.
Herring Gull 64-263, organ, location and date undesignated	Fish bones. Alewife scale.	Contents very fragmented.
Herring Gull 64-283, stomach Schoolcraft Co. 9-22-64	1 alewife. 1 smelt. 6 ear bones. 2 crustaceans, probably ostracods.	Parasphenoid, opercular, cleithrum and hyomandibular of alewife. Dentary and vomer of smelt.
Herring Gull 64-284, stomach Schoolcraft Co. 9-22-64	3 alewives, 5".	Cleithrum, preopercular, opercular, and maxillary identify the fish. Rest of contents very fragmented and unidentifiable.
Herring Gull 64-286, stomach Schoolcraft Co. 9-22-64	1 alewife. Insect remains. Plant material (stems and leaves).	Parasphenoid, maxillary, and cleithrum of alewife. Chitinous parts of exoskeleton, legs, and fragments of elytra of insect.

Table D. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Ring-billed Gull 64-287, stomach Delta Co. 9-22-64	1 alewife, 6".	Maxillary, cleithrum, and scales of alewife. Many vertebrae and other bones unidentifiable.
Ring-billed Gull 64-288, stomach Delta Co. 9-4-64	Fish bones. 1 alewife scale. 5 otoliths. 1 gastropod shell (1/16"), probably <u>Amnicola</u> . Tip of a claw. Unidentified, fragmented objects, hard and brown.	The claw fragment from an unidentified animal.
Herring Gull (unnumbered) stomach Charlevoix Co. (Beaver Id.) 10-16-64	1 alewife. 1 unidentified fish. Small amount of plant stems. 1 small piece of wood.	Articular bone of alewife. Large, thick vertebrae and other bones of an unidentified fish.
Herring Gull (unnumbered) undesignated organ with gizzards of 6 loons collected south of Gulliver, 11-64	Fish bones. Crayfish remains.	Many fish bone and crayfish fragments.

Table E. --Items found in digestive organs of 16 grebes

Specimen and number, organ, location, and date of collection	Items ¹	Remarks
Horned Grebe 64-299, organ undesignated Mackinac Co. 10-13-64	Fish bones. Moderate number of fish eggs. 4 ostracods. Statoblasts of a Bryozoan, probably <u>Pectinatella</u> . 4 crayfish, probably <u>Orconectes virilis</u> . Much stringy plant material.	Fish bones very fragmented and not identifiable. Crayfish chelipeds.
Horned Grebe 64-300, organ undesignated Mackinac Co. 10-13-64	2 mottled sculpins. Many fish eggs. Insect remains, possibly Coleoptera.	Articular, cleithrum, and parasphenoid of sculpins. Elytra and other body fragments of insects.
Red-necked Grebe 64-311, gizzard Mackinac Co. 10-8-64	1 mottled sculpin. Many fish eggs. Insect remains. Lamprey remains. Moderate amount of plant material.	Cleithrum, parasphenoid, and post temporal identify the fish. Teeth of sea lamprey. Fragment of a dipteran larva and some body fragments of a coleopteran.
Red-necked Grebe 64-312, gizzard Mackinac Co. 10-8-64	Fish bones. Many fish eggs. Insect remains. Much plant material. (shredded leaves, etc.). Many seeds.	Fish bones too fragmented for identification. Legs and parts of chitinous exoskeleton of a coleopteran. Wings of an insect also found.
Horned Grebe 64-315, gizzard Mackinac Co. 10-8-64	1 mottled sculpin. Many fish eggs. Crayfish remains. 4 statoblasts (<u>Pectinatella</u>).	Preopercle of a mottled sculpin. Fragments of crayfish.

¹ Occurrences of stones, sand, and feathers omitted.

Table E. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Horned Grebe 64-316, gizzard Mackinac Co. 10-8-64	1 mottled sculpin. Insect remains (Coleoptera). 1 statoblast of <u>Pectinatella</u> . Some shredded and stringy plant material.	Parasphenoid and preopercular identify the fish. Legs, jaws, fragments of elytra, and other body parts of insects. Two oval capsules, possibly the cocoons of leeches; also found in some loons and gulls.
Horned Grebe 64-317, gizzard Mackinac Co. 10-8-64	4 mottled sculpins. Insect remains (Coleoptera). 8 statoblasts of <u>Pectinatella</u> . Much shredded plant material.	Dentary and parasphenoid identify the sculpins. Some other bone fragments present but not identifiable. Legs, jaws, and body fragments of insect.
Horned Grebe 64-318, gizzard Mackinac Co. 10-8-64	2 smelt. Many fish eggs. Insect remains (Coleoptera). 3 statoblasts of Bryozoa.	Dentary, preopercular, and maxillary of smelt. Head of an insect found.
Horned Grebe 64-319, gizzard Mackinac Co. 10-8-64	1 mottled sculpin. Many fish eggs. Insect remains. Some stringy plant material.	Dentary, cleithrum identify the sculpin. Moderate amount of unidentified fragmented fish bones. An entire Tendipididae larva. Also some legs and jaws of insects, Coleoptera.
Horned Grebe 64-320, gizzard Mackinac Co. 10-8-64	Many fish eggs. Much stringy plant material.	

Table E. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Horned Grebe 64-321, gizzard Mackinac Co. 10-8-64	11-13 mottled sculpins of various sizes. Many fish eggs. 1 ostracod. Remains of insects, probably Coleoptera. 2 statoblasts of <u>Pectinatella</u> . 5 acanthocephalan parasites, 1/4". Moderate amount of stringy plant material.	Post temporal, cleithrum, dentaries, and parasphenoid identify the fish. Legs and elytra of insects. Plant material was matted together with feathers. The acanthocephalan parasites were entire and appeared to be parasites of the bird.
Horned Grebe 64-322, gizzard Mackinac Co. 10-8-64	Many fish eggs. Insect remains. 7 statoblasts of <u>Pectinatella</u> . Much shredded plant material.	Body parts of insects Plant material thick and matted with feathers.
Horned Grebe 64-323, gizzard Mackinac Co. 10-8-64	Many fish eggs, 1/32". Much shredded plant material.	Fish eggs found also in a loon and a gull.
Red-necked Grebe 64-341, gizzard Mackinac Co. 10-6-64	1 alewife. 1 mottled sculpin. Many fish eggs. Insect remains, order Coleoptera, family Dytisidae. 1 cycloid scale 1/32", probably from a minnow. Crayfish. 1 statoblast of <u>Pectinatella</u> . Some plant material. Long threads.	Parasphenoid identifies alewife. Articular and dentary identify the sculpin. Whole specimens and fragments of insects. One cheliped of a crayfish. Plant material thickly matted with feathers. Two unidentified objects, one half-moon shaped, black, 1/16", the other an oval, black structure.

Table E. --continued

Specimen and number, organ, location, and date of collection	Items	Remarks
Red-necked Grebe 64-342, gizzard Mackinac Co. 10-12-64	2-3 alewives. 1 mottled sculpin. Trace of fish eggs. Insect remains.	P reopercular, parasphenoid, and dentary of alewives. P reopercular of a mottled sculpin. Head, elytra, legs of insects, Coleoptera, also the head of an insect larva.
Horned Grebe (unnumbered) stomach Leelanau Co. 10-17-64	Fish bones. Many fish eggs. 7 statoblasts (P ectinatella). Insect remains. Shredded plant material.	Few fish bone fragments. Heads, elytra, and legs of insects, probably Coleoptera and Hemiptera.

Table F. --Items found in gizzards of two Red-breasted Mergansers

Specimen number, location, and date of collection	Items	Remarks
64-313 Mackinac Co. 10-8-64	1 smelt Plant material. (shredded). Moderate amount of coarse sand which grades into small stones.	Dentary and preopercular identify the smelt. Many other bone fragments not identifiable.
64-314 Mackinac Co. 10-8-64	Fish bones. 1 statoblast of <u>Pectinatella</u> . Much coarse sand which grades into small stones.	Many disarticulated vertebrae, other bones, and fin rays, not readily identifiable.
