AN ABSTRACT OF THE THESIS OF

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A water bird census was taken at three points on Upper Klamath Lake at weekly intervals extending over a period from September 9, 1936 to May 29, 1937. A total of 24,319 birds was recorded in field records and included thirty-two species. Totals of birds by weekly field trips show the following maxima: October 3 produced by pintail, December 24 produced by golden eye, January 16 by ruddy and golden eye, March 6 by ruddy, and May 1 by greater scaup together with western and eared grebe.

During the winter months while the lake is frozen over, the birds are concentrated in open water near hot springs or where a strong water current is present. They consist of bottom feeding or diving birds during this time; principally merganser, bufflehead, pied-billed grebe, ruddy, golden eye, coot and greater scaup.

The fall migrants consisted largely of widgeons while the spring influx was composed mostly of greater scaup, western and eared grebe.

The most abundant species were the ruddy, golden eye, widgeon, coot and greater scaup, constituting 23%, 21%, 16%, 11% and 10% respectively of the total number of all birds observed. In frequency of appearance in field records, the greater scaup and coot were recorded on more than 80% of the field trips while the ruddy and golden eye were present in from 70% to 80% of the trips.

Availability of feeding areas appears to be the principal factor causing fluctuation in number during the winter season.

The temperature and precipitation conditions during the period of the census were not average. The dry fall characteristic of this region prevailed extremely late. The first precipitation of any consequence and in the form of snow occurred in late December. An extremely cold period during January and February followed this dry fall season. The spring season was later than usual, the temperature failing to moderate until late March.

These variations from the average weather conditions produced three effects: first, a delayed fall migration; second, limited feeding area for the wintering birds due to restricted areas of open water while the lake surface was frozen; third, a delayed spring migration which was concentrated and of short duration.

A CENSUS OF WATER BIRD LIFE ON UPPER KLAMATH LAKE

by

RAYMOND WALDEMAR COOPEY

A THESIS

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A CENSUS OF WATER BIRD LIFE ON UPPER KLAMATH LAKE

INTRODUCTION

Most of the problems concerning bird habits are incompletely solved at present. These problems may be grouped into two divisions on the basis of their nearness to solution. The first group includes those which have a number of plausible explanations offered based on personal interpretations and lacking entirely in collected data for proof. The second includes those which have a body of evidence accumulated from conducted experiments or observations upon which quite valid conclusions may be based. None, however, is at a stage of complete explanation with a check over a wide variety of types and situations. This condition is not due so much to a lack of qualified investigators in the field, as it is to a lack of background of recorded observations upon which to base conclusions and against which to check them. The study of bird habits is in its infancy, relatively speaking, as compared with other phases of ornithology; for example, taxonomy. It would appear that the study has now progressed to a stage where little advancement in explaining the many intricacies of bird

life can be hoped for until a reinforcement of data collected by trained and accurate observers throughout the world, makes possible a selection of theories based on correct premises from those which are untenable.

As examples of the above, some of the larger and more common problems may be mentioned in connection with water bird life. Possibly of most urgent importance at present, at least to the conservationist, is data from all over North America on the migration routes followed, the numbers and types of birds present in a locality at various times of the year, and finally more complete banding and trapping records. Data from these three phases alone, aside from its practical value to the conservationist, would go far toward straightening out the muddle of conflicting opinions on questions of migration which exist in the literature today. The present state of our knowledge on certain phases of migration is well summed up by Wetmore (23) as follows:

> "Some have attributed the underlying cause of migration to changes in food supply, others to seasonal change in temperature, to a crowding that has driven birds from their original homes to which they have an inherited desire to return, for the nesting season, to a reaction to seasonal change in intensity of light, to shifting of range due to changes in the environment in past geological ages, to seasonal physiological changes in the birds themselves, and so on.

> "The factor that initiates or starts the present annual migrations of birds is, without much question, certain physiological changes in the bird itself that have synchronized the season of the year and the life cycle of the individual--
>
> "The original basic reasons for migration have unquestionably been different in the many different species concerned so that the underlying cause for migration as we see it today must be considered as due to a number of factors, some affecting one group of the species and some another."

Additional problems needing solution include tabulation of numbers and types of ducks shot by sportsmen, more detailed data on feeding habits, census of breeding birds in various localities, surveys of prospective localities for game preserves, quantitative information on importance of predators in killing water birds--young and adult, surveys of food resources, of breeding and wintering grounds, and, finally, a more thorough investigation of the conditions causing disease fatalities with experimentation to find efficient methods of cure or prevention.

Methods of investigation

Two methods of investigation are utilized at present to gain data for the solution of these problems. The first and probably the oldest method is that of bird banding, which, according to Lincoln (15), originated in

Germany in 1710. This method, which is possibly the more fruitful of the two in the investigation of migration routes and bird movements, was introduced into this country by the American Bird Banding Association in 1909, and in 1920 was taken over by the United States Biological Survey.

In order that the bird banding method work effectively, it involves, first, immediate and full reports of recaptured birds in other trapping stations which at present are not very numerous--being largely governmentally operated, and second, complete reports from sportsmen shooting banded birds which, from all indications, is very haphazardly done at present.

A second method of widespread use is that of making a bird count or census. In practice, this consists of a tabulation of types and numbers of birds present in a locality. It may be taken only once for a particular area to determine concentration areas of breeding or wintering or--which is more valuable--it may be extended over a period of time in order to obtain the fluctuation in numbers. Also, various special phases may be investigated, such as a census of breeding birds, number of young birds, and the proportion of males to females. Cooke (8) in discussing the usefulness of the information

from bird census states the following:

> "Memory of past abundance, usually impression rather than accurate count, is a poor basis for scientific work, particularly since recollection of numbers frequently magnifies the facts. Lack of material desired should make ornithologists of today only more willing to collect it for the benefit of those who come after them; for the work must be done now, not left until some future time. Numerical data relating to birds continue to increase in value, the farther we get from the conditions to which they relate."

The census method has an advantage over bird banding in that it requires less elaborate equipment and can be done by the average person with proper training. It also has the advantage of being more complete in its results. Pirnie (19) for example, finds the returns from banding work seldom run higher than 20 per cent. The United States Biological Survey (22) promoted the widespread making of bird counts at one time but no reference in literature has ever been made to the data so accumulated.

Bird population of Klamath Lake region

The bird population of the Klamath Lake region today is considerably depleted as compared to the abundance of some twenty to forty years ago. Forbush (10) quotes an observer who states that previous to 1909 two hunters could kill a sufficient number of Mallards in a

few hours of shooting to fill a wagon. Similar reports for other birds stand in distinct contrast to conditions as they appear today when limit bags are the exception rather than the rule with the average hunter.

Many factors have been at work in causing this decrease. Commercial hunting of some birds for their plumes was formerly practiced. One report by the Audubon Society (2) of more than $30,000 worth of pelts piled near Klamath Falls with each pelt worth less than one dollar gives some idea of the magnitude of the slaughter that has been going on. Western and Eared grebes suffered most, but, fortunately, this practice of wholesale slaughter is now prohibited by federal law.

A second effect is the destruction of breeding and feeding grounds by drainage as a part of reclamation projects. A noteworthy example of this is the drainage for agricultural purposes of Lower Klamath Lake. This region to the south and east of Klamath Falls formerly containing hundreds of acres of the finest types of breeding grounds for the various kinds of ducks and geese is now under cultivation. The land so reclaimed is of doubtful agricultural value, due to the peculiar character of the soil which has allowed the watertable to drop so far that no amount of irrigation will provide

the necessary water supply for plant growth. Agitation in recent years for the re-flooding of this district may sometime restore this breeding ground to its original position. As further evidence of the decrease in the productivity of this area, Bell and Preble (3) list the Klamath Lakes as a former breeding ground for the following birds, but now practically unused: Canada, lesser Canada, and cackling goose, mallard, gadwall, pintail, or "sprig", green-winged teal, blue-winged teal, shoveler-spoonbill, redhead, canvas back and ruddy duck.

Bell and Preble (3) reporting on a recent survey of the large breeding grounds in the Prairie Provinces of Canada, found that the number of ducks breeding in 1934, as compared to the normal carrying capacity of the grounds, ranged from seventy per cent to as low as ten per cent. On the basis of this report, it would appear that the crux of the situation lies not so much at present in the decrease of breeding areas, but in the lack of sufficient breeders to replenish the stock. This problem brings us to the third and fourth causes for depletion of the waterfowl resources--namely, shooting by sportsmen, and killing by disease and predators.

The number of ducks killed annually by sportsmen is placed between eight and nine millions by Phillips and Lincoln (18) or about thirty per cent of the total number. This figure, added to the infant mortality in the breeding grounds, and the numbers killed by disease and predators, would bring the total well toward sixty per cent.

The death toll of diseases has already been mentioned. One of the worst scourges which has occurred at intervals since first being noted in 1891, is the disease formerly known as "alkali poisoning" but lately shown by Kalmback (11) to be a form of botulism. The disease is called "limberneck" when it occurs in domesticated birds. It periodically takes a toll of thousands of wildfowl, particularly in the vicinity of Klamath, Tule, and Malheur lakes in Oregon and the Bear Marshes of Utah. Other diseases and parasites taking lesser numbers, include lead poisoning, aspergillosis, tuberculosis, coccidiosis, cholera, pneumonia, flukes, tapeworms, nematodes, and protozoa. Predators include the horned owl, duck hawk, and various carnivorous mammals.

According to Phillips and Lincoln (18) Klamath Lake, together with Tule and Malheur lakes, Bear River

Marsh of Utah, and the Sacramento and San Joaquin valleys of California, are included in the southwestern division of the breeding area. The Klamath lakes formerly were an important breeding region for several specie of ducks, as was previously mentioned, but drainage and agriculture have ruined it along with most of the internal valleys of California from this standpoint. It probably never did rank of importance as a wintering ground excepting for the small brant--the cackling goose--which winters at or near Tule lake.

The Pacific Fly-way

Lincoln (16) asserts that three primary routes of the Pacific fly-way contribute to furnish the migratory wildfowl population on Klamath Lake. One route followed by the cackling goose, black brant, and Ross's goose originates at the breeding grounds in Alaska, follows down the coast line to the vicinity of the mouth of the Columbia, then turns inward to the region of The Dalles where it again swings southward. The second principal route bringing the greatest share of the other ducks and geese with the exception of the redheads originates in the interior valleys of Alaska and the prairie provinces. It courses southward to the region of the

international boundary, where it turns southwestward cutting across Montana and Idaho, then follows the Columbia down to a juncture with the previously mentioned coast contingent. A common route for both groups runs southward from here over central Oregon to the Klamath Lake region. In the Klamath Lake vicinity they are joined by one contingent of the redhead migration from the Bear River Marsh of Utah. These birds fly north-westward from the marsh through Utah and southeastern Oregon to the Klamath lakes, then continue southward with the other species to the interior valleys and coastal region of California. The shoveller-spoonbill and pintail or "sprig" usually start their migration in the late summer followed by other types as the cold weather drives them out of the north.

The practical applications of results from an investigation of a census problem will be principally in the field of conservation, of which it is a phase, and of life habits--particularly those problems previously mentioned concerning migration.

The former has just been discussed briefly, the history and present status of the latter now follows as an approach to the results of the investigation.

The migration problem

The problem of the movement of birds over long distances at periodic times resolves itself into three main phases; a) the probable origin of the migratory instinct, b) the mechanism which initiates and regulates the two major movements in the northern hemisphere, one to the north in the spring and the other to the south in fall, and c) the routes followed by the birds.

Concerning the first of these problems, much has been written of an inconclusive nature. Today the question remains in a somewhat debatable status with a lack of unanimity among writers on the theories advanced.

Allen (1), who was one of the first important contributors on the subject of the migratory instinct, proposed the origin during the critical evolutionary period of glacial or post-glacial times when many new species originated and developed. The winters in post-glacial times were undoubtedly more severe than at present, tending to force a southward migration when weather and lack of food prompted. The reverse movement in spring, he believed, was an urge to return to the breeding ground, and was intimately connected with the

reproductive cycle. Chapman (5) adds that the desire of birds in general to seek seclusion during breeding might have influenced the return northward. Taverner (21) proposed that both migrations might be explained on the basis of lack of food. The northward trend would be necessitated by the increase in the number of birds after the new brood would hatch and the consequent need for larger feeding areas. The southward trend would come as a result of the failing food supply producing a crowding in the southern regions and bringing about the elimination of many of the less fit before the start of the northward spreading the following spring. Recent writers add to this another possible cause of the southward migration in the necessity for sufficient vitamin A production in the body for proper functioning. A lack of ultra-violet radiation during the winter months results in insufficient vitamin A production in the body and makes a southward migration imperative to the successful reproduction the following year.

The second phase of the migration problem--namely that of the mechanism which produces the migratory impulse in recurring cycles, has been more conclusively explored.

Cooke (7) suggested temperature as the primary influence, other writers in turn have postulated barometric pressure, change in the color of trees, ultraviolet radiation, and, as noted with some of the previously mentioned authors, the failure of food supply. Rowan (20), by applying an experimental technique, has been able to accelerate or inhibit the migratory impulse in juncos and crows merely by increasing or decreasing the length of time of activity each day which is dependent on the length of daylight. He found this produced a physiological change in the gonads of the birds which was directly proportional to the amount of inhibition or acceleration of the migrating impulse. Eifrig (9) suggested in 1924 that this might be investigated as a possible source of the starting impulse. Wing (25) recently states that a check-up of the date of first arrivals in the spring migration with the sun spot and environment cycles shows a rather close relationship over a period of twenty-five years, suggesting an influence from this source. Cartwright (4) also suggests that the photo-chemical effect of light in changing plumage color may produce a similar internal physiological effect which might have a bearing on migration.

The study of migration routes is another phase of investigation into which the personal element has entered prominently in past observations. Some objective evidence is available at present in the form of bird banding records and this method will no doubt yield more fruitful evidence as records become more complete. Observations of the concentration of migrating birds in their southern and northern flights has, according to Phillips and Lincoln (18), resulted in the division of North America into four established fly-ways, namely: Atlantic, Mississippi, Central, and Pacific. Records of bandings have revealed that the same birds frequent the same fly-ways year after year, even though their wintering or breeding areas may be far to the east or west of these established north-south routes. It is evident that some force attracts or leads them to their ancestral fly-way in the same uncanny manner that it leads them to breed and winter in definite regions of the globe.

Attempts have been made to explain this phenomenon on the basis of the homing instinct, but obviously, one of the migrations would be away from the breeding spot and hence opposite to homing. MacKay (17) attributes

minor changes in direction of migrating birds from day to day to a shrinking from elements such as wind or rain direction. Clark (6) considers this to be the determining factor in the long distance migration of shore birds particularly the plover, the tendency being to fly diagonally to wind which he claims would account for the change in route on the northern migration of the plover. Undoubtedly the birds follow natural geographic "troughs" on their routes, but an experiment by Lincoln (16) in which banded birds from their ancestral fly-way were liberated at great distances from and in proximity to another fly-way, showed that by the following season after liberation, these birds had returned to their original fly-way and wintering grounds. This utter disregard for climatic, geographical and distance factors, would seem to indicate, if not to point with some certainty, to an hereditary background as the basis for this ability. At least, as a temporary explanation, then, the habit of wildfowl to follow definite paths of migration may be explained on the presumption that they possess an instinct of "geographical location" combined with that of homing. Leopold (13) concurrs in this, but believes that

certain examples of the change in route followed by migrating birds would indicate that after a sufficient number of generations, the new route would be incorporated in the instinctive behaviour of the bird.

The greater portion of the bird population does its travelling at night, especially among the smaller birds, leaving the days free for feeding. Libby (14) found that the most intense migration activity took place in the first two or three hours after dark, the remainder of the night being spent in more varied movements partly for collecting fragments of the group and partly for selecting suitable feeding grounds. It would seem that a relatively small proportion of the time is spent in actual flying, inasmuch as the flying speed in general of ducks and geese is between forty and sixty miles per hour--in the smaller birds slightly less-- while the distance covered in a day's time is usually less than one hundred miles. In an exceptional case of speed quoted by Phillips and Lincoln (18), a bird travelled only three hundred miles in two days, or about three hours' flying time per day. This does not apply to some of the longer migrants, such as the

golden plover and the arctic tern, whose endurance is probably not excelled by any other living animal. Also, sudden extremes of temperature tend to speed the birds toward their destination--cases of extreme cold where the migrants have been trapped without food and eventually have perished, have been reported frequently. On the other hand, in the Pacific Coast region, some flights--largely spoonbills and pintails--commence very early in the season--often times reaching their wintering grounds by late August. As a general thing, the migration goes on in a leisurely fashion, particularly in the fall, the birds drifting southward as inclement weather pursues them out of the north.

STATEMENT OF PROBLEM

The object of this investigation is a census of bird life on a restricted area of Upper Klamath Lake carried on at weekly intervals during a period from September 9, 1936 to May 29, 1937. The results give a record of the fluctuations in numbers and types of birds present in this locality during the fall, winter and spring.

As previously pointed out, the census is vitally necessary as a fundamental step in any planned conservation program. This work, though perhaps not inclusive enough in scope for final conclusions, should be useful when added to results secured by such agencies as The Biological Survey, State Game Department, and others.

Acknowledgement for helpful aid in planning the problem and suggestions in carrying out the field investigations is given to Dr. Nathan Fasten, head department of zoology, Oregon State College, and to Dr. Alfred Taylor and Dr. Kenneth Gordon, zoology department, Oregon State College.

FIELD RECORDS

Materials and methods

The data recorded was gathered at weekly intervals over a period from September 9, 1936 to May 29, 1937. Thirty-seven census records were made, the weeks of December 19 and April 10 having been omitted due to unavoidable circumstances. The field trips were made between the hours of 10:00 A. M. and 2:00 P. M. to assure the maximum number of birds present at the census location. Night feeding on surrounding country was observed to attract the birds away from the location between 3:00 and 4:00 o'clock in the afternoon. All had apparently returned by 10:00 o'clock the following morning.

The locations where the census takes were made are as follows:

Buck Island--about five miles from city of Klamath Falls at southeastern end of lake directly in from Buck Island. Figures 5, 7, 9, 10, and 11.

Barclay-Sucker Springs--about ten miles north of Klamath Falls on east side of lake at southern boundary

of Klamath Indian reservation. Figures 6 and 7.

Shippington--at extreme southern end of lake within city limits of Klamath Falls. Figures 7 and 8.

Lake Ewauna--at lower end of Link River which leads out of south end of Upper Klamath Lake--within city limits of Klamath Falls. Figures 12 and 13.

The area covered at each location in the count was somewhat variable. In the case of the Buck Island location an area with a shoreline distance of three thousand feet and extending out fifteen hundred feet from shore was covered. In the case of the three other locations the area was dependent to a large degree on the amount of open water during the time the lake surface was frozen.

The following is a list of the thirty-two species observed during the course of the census:

Whistler, golden eye -- Glaucionetta clangula americana
Widgion, pintail -- Dafila acuta tzitzihoa
Caspian Tern -- Sterna caspia imperator
Blue-winged Teal -- Querquedula discors
Green-winged Teal -- Nettion carolinense
Wilson Snipe -- Gallinago delicata
Lesser Scaup -- Marila affinis
Greater Scaup -- Marila marila
Ruddy -- Erismatura jamaicensis
Redhead -- Marila americana

White Pelican -- Pelicanus erythrorhynchos
American Merganser -- Mergus americanus
Mallard -- Anas platyrhynchos
Belted Kingfisher -- Ceryle alcyon
Killdeer -- Oxyechus vociferus
Great Blue Heron -- Ardea herodias
Anthony Green Heron -- Butorides virescens anthonyi
Marsh Hawk -- Circus hudsonius
Western Gull -- Larus occidentalis
Western Grebe -- AEchmorphorus occidentalis
Pied-billed Grebe -- Podilymbus podiceps
Eared Grebe -- Colymbus nigricollis californicus
White Fronted Goose -- Anser albifrons
Snow Goose -- Chen hyperboreus hyperboreus
Lesser Canada Goose -- Branta canadensis leucopareia
Canada Goose -- Branta canadensis canadensis
Baird Cormorant -- Phalacrocorax pelagicus resplendens
Coot -- Fulica americana
Canvasback -- Marila valisneria
Bufflehead -- Charitonetta albeola
Bald pate -- Mareca americana
Whistling Swan -- Cygnus columianus (5 were observed on 12/12/36 but are not included in field record)

Blue and green winged teal are grouped together in field records due to difficulty in distinguishing them at a distance on field trips.

Willett (24) lists a group of fifty-eight species noted on Malheur and Harney lakes during a period from April to August 27. His list agrees with the species noted in this study, but includes a larger number of

shore birds which may be accounted for on the basis of the difference in the season of observation.

The freezing of the lake surface over most of its area by December 28 necessitated a change in census location from Buck Island. The Lake Ewauna location was chosen because the current from Link River emptying into it maintained an open channel free from ice throughout the winter. The Barclay-Sucker Springs location is restricted in area but also open throughout the winter because of warm springs emptying into the lake at this point. An overlapping in records at these locations occurred as may be seen from the field records and graphs, however the increase in the total of birds observed on each field trip was not materially affected because the birds deserted one location for another whenever physical conditions necessitated and the field trips were changed correspondingly. This will be mentioned again later and explained more in detail.

Golden Eye					300	270	200	200	20	175	100	195	50	100
Widgeon	810	250	600	700	600	200	195	105	3	5	4	55	5	25
Caspian Tern														
B & G Teal														
Wilson Snipe		1												
Lesser Scaup														
Greater Scaup					40	20	50	50		12		60		20
Ruddy							100	190		125	50	50		
Redhead														
White Pelican		1												
Am. Merganser														
Mallard														
B. Kingfisher										1				
Killdeer		2											2	
Great B. Heron				1										
Anthony G. Heron														
Marsh Hawk													1	
Western Gull			4							1				
Western Grebe	25	5	24	4										
P.-billed Grebe	30	4	12		50	100	150	205	5	10	4	5		
Eared Grebe														
White F. Goose														100
Snow Goose								2						
L. C. Goose													175	300
Canada Goose					2							75	25	
B. Cormorant														
Coot	125	75	100	50	100	95	125	110	50	5	50	25	20	
Canvasback														
Bufflehead														
Baldpate														
Time	3PM	11AM	11AM	2PM	2PM	11AM	11AM	11AM	2PM	1PM	11AM	11AM	11AM	2PM
Temperature F	80	50	75	65	75	70	70	65	60	70	50	65	40	35
Day	9	12	19	26	3	10	17	24	1	7	14	21	28	5
Month	September				October				November					

TABLE I FIELD RECORD BUCK ISLAND LOCATION

Golden Eye	60		295	500	500	125		15					5					4
Widgeon	100		50															
Caspian Tern													50					
B & G Winged Teal			50															
Wilson Snipe																		
Lesser Scaup																		
Greater Scaup	25		75	100	70	160	25	25		250	230	75	75	25				
Ruddy	50		75	2000	100	75												
Redhead						2	1	2										
White Pelican										2	3			m 30				
Am. Merganser				75						50	30		25					
Mallard						5						1	5					
B. Kingfisher																		
Killdeer																		
Great B. Heron																		
Anthony G. Heron														2				
Marsh Hawk	1				3	1		1			1							
Western Gull					3	3		3										
Western Grebe										3	40	50	150	75				
R.-billed Grebe																		
Eared Grebe											30	85	50	25				
White F. Goose				25			25					200						
Snow Goose																		
L. C. Goose	100		145	25		75						300						
Canada Goose	200		50										15	10				
B. Cormorant											4	5	5	10				
Coot				50	60	60	10	20		50	55	50	100	110				
Canvasback											3							
Bufflehead					55	20	4	10					2					
Baldpate						2												
Time	2PM	3PM	11AM	2PM	2PM	3PM	2PM	3PM		2PM	10AM	9AM	9AM	11AM				
Temperature F	38	30	40	48	50	40	40	43		55	66	75	50	60				
Day	12	19	24	6	14	20	27	3	10	17	24	1	8	15				
Month	December			March				April				May						

TABLE II BUCK ISLAND LOCATION (Cont'd)

Golden Eye						5	2	2	15	16				
Widgeon						25								
Caspian Tern														
B & G Winged Teal														
Wilson Snipe														
Lesser Scaup														
Greater Scaup	15	10									110	125	50	5
Ruddy		2				10	16	3	10	10				
Redhead		5					1				1			
White Pelican	50	60												
Am. Merganser														
Mallard		3				3								
B. Kingfisher							1							
Killdeer														
Great B. Heron						1	4							
Anthony G. Heron		3												
Marsh Hawk														
Western Gull														
Western Grebe	50	50										40	20	25
P.-billed Grebe														
Eared Grebe	15	10										20	10	5
White F. Goose														
Snow Goose														
L. C. Goose														
Canada Goose	5													
B. Cormorant	6													
Coot	125	150				28	9	5	5	6	10		25	30
Canvasback						5								
Bufflehead						3		1						
Baldpate														
Time	10AM	11AM				2PM	11AM	9AM	2PM	11AM	2PM	10AM	9AM	9AM
Temperature F	70	60				15	10	18	38	38	40	66	75	50
Day	22	29				2	9	16	20	27	27	24	1	8
Month	May					January			Feb		Mar	Apr	May	

TABLE III BUCK ISLAND

TABLE IV BARCLAY-SUCKER SPRINGS

Golden Eye	250	275	300	300	285	325	200	50	300		75	35			
Widgeon				5											
Caspian Tern															
B & G Winged Teal															
Wilson Snipe															
Lesser Scaup	23	15	10	25	30	25	25								
Greater Scaup	150	100	100	90	110	75	25								
Ruddy	350	375	400	350	375	375	75	200	100		50	25			
Redhead															
White Pelican															
Am. Merganser	125	75	50	60	55	100	50	20	50			10			
Mallard															
B. Kingfisher															
Killdeer															
Great B. Heron															
Anthony G. Heron															
Marsh Hawk															
Western Gull															
Western Grebe															
P.-billed Grebe	25	10	10	12	15	20	20				20				
Eared Grebe															
White F. Goose															
Snow Goose															
L. C. Goose															
Canada Goose															
B. Cormorant															
Coot	75	55	60	50	55	50	40	50	75		60	50			25
Canvasback															
Bufflehead	125	100	110	115	115										
Baldpate															
Time	9AM	11AM	11AM	10AM	2PM	2PM	11AM	2PM	2PM	3PM	2PM	3PM			2PM
Temperature F	18	20	25	20	35	38	38	48	50	40	40	43			55
Day	16	23	30	6	13	20	27	6	14	20	27	3	10		17
Month	January			February				March				April			

TABLE V LAKE EWAUNA LOCATION

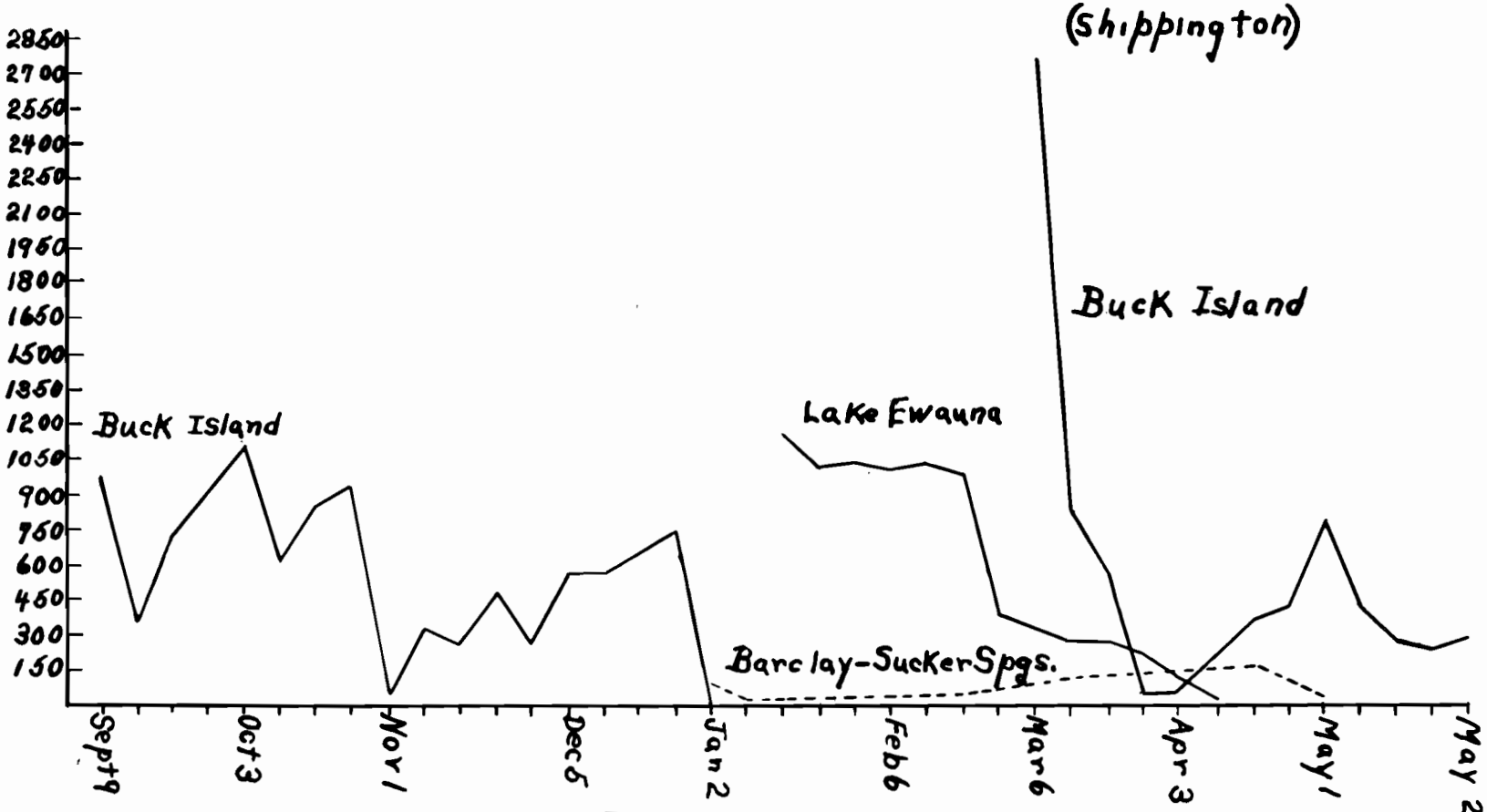


Figure 1

Total number of all species of birds observed on each field trip

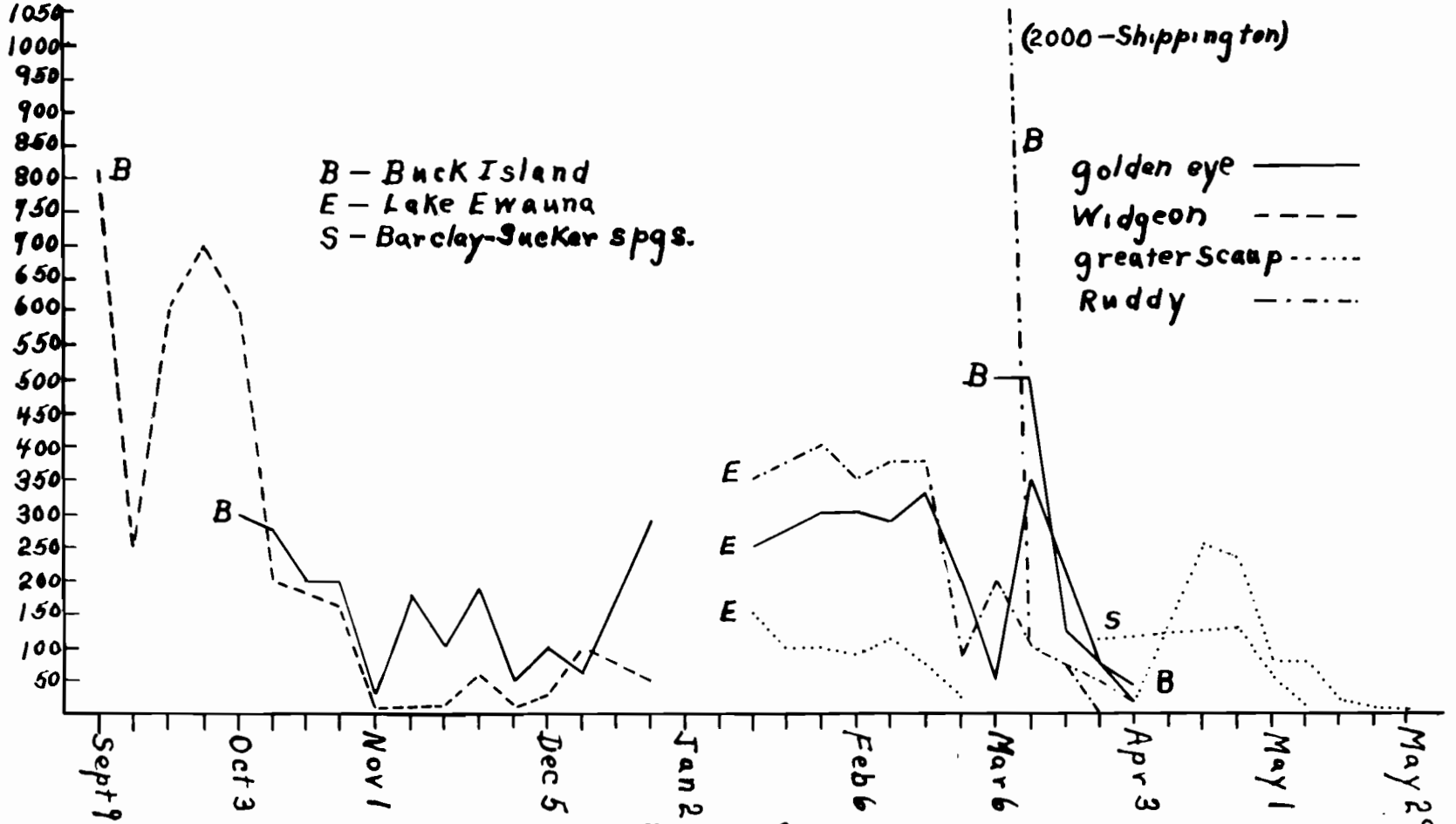


Figure 2

Numbers of four most important species by field trips

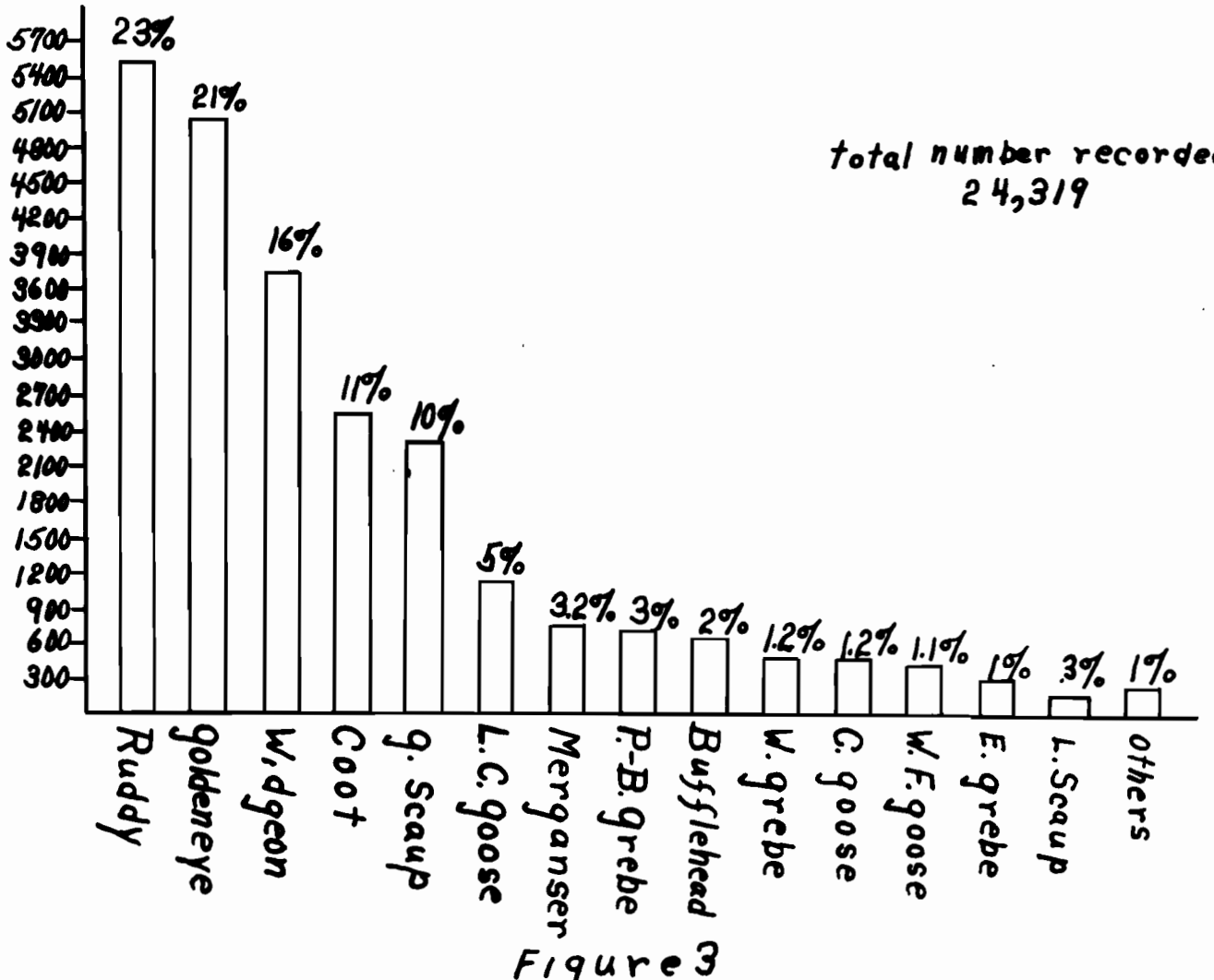
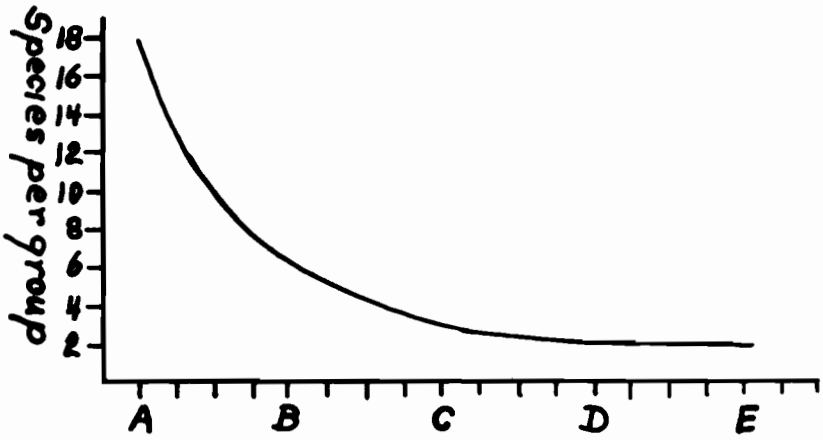


Figure 3

Total number of each species recorded during census



A group 18 species
W. Swan
W. Snipe
Baldpate
S. goose
C. Tern
Teal
B. Kingfisher
Killdeer
A. green Heron
Canvasback
g. B. Heron
W. F. goose
W. Pelican
Mallard
W. gull
Redhead
Marsh Hawk
Eared grebe

B group 6 species
Cormorant
L. Scaup
L. C. goose
C. goose
Buffslehead
W. grebe

C group 3 species
A. Merganser
Widgeon
P.-B. grebe

D group 2 species
Ruddy
golden Eye

E group 2 species
g. Scaup
Coot

Figure 4
Raunkaier curve and frequency groups

DISCUSSION

Figures 1 to 4 inclusive give in graph form the fluctuations in bird numbers derived from the field records, tables 1 to 4 inclusive.

Kibbe (12) in a bird census on Lake Merritt, California, found a pintail maxima present on November 13, a canvas back maxima on December 25, and a scaup maxima on January 15.

In the present investigation, five rather well defined maxima were observed. Figure 1, giving the total number of all species recorded, shows these high points as follows: October 3, December 24, January 16, March 6, May 1. From figure 2, which gives the fluctuation in the four most important species, the widgeon or pintail duck appears largely responsible for the October 3 high point. For December 24, the golden eye, for January 16, the ruddy together with the golden eye, for March 6, the ruddy, for May 1 the greater scaup together with the western and eared grebe. The latter two are not plotted in the figure.

The ruddy, golden eye, widgeon, coot and greater scaup, as is shown in figure 3, are the dominant species present. These five alone constituting 81% of the total

with the remaining twenty-seven species making up the balance of 19%.

Figure 4, giving a frequency distribution of the number of times each species appeared in the weekly records, shows these same birds to be uppermost excepting that the pied-billed grebe is interposed between the ruddy and widgeon placing the latter sixth in the list.

The presence of so few of the other species comparatively speaking may be partially due to the weather conditions which prevailed during the census period.

The dry fall season characteristic of this region, prevailed extremely late with the first snow fall of any consequence in the latter part of December, thus probably retarding the southward migration of birds. The temperatures during January and early February were largely sub-zero at night--a minimum of minus eighteen Fahrenheit being recorded toward the end of January. This reduced the amount of open water available for feeding to a minimum and eliminated entirely any shore feeding conditions, Figure 13. The predominating waterfowl were of the diving or bottom feeding type during this period and gave the ruddy and golden eye the numerical advantage over the widgeon which predominated in the September,

October, November records. This period of temperature extremes also probably may have diverted the belated southward migration to the coastal route although no evidence is available to substantiate this.

The third effect was the retarded spring season which did not start until late in March, bringing about a concentrated migration northward with little stopping along the route and a resulting meager record during this period.

The conditions just discussed are perhaps characteristic of this area insofar as the predominance of the five species mentioned, but were not average as to temperature which undoubtedly influenced both the total numbers and the variety of types present.

Kibbe (12) in a bird census previously mentioned, finds several pronounced maxima at intervals that are not dependent on any observable change in environmental conditions.

The results of the present study seem to indicate that a supply of food is the determining influence causing the principal fluctuations, at least during the winter season. Figure 1 shows a gradual decline from

the high point of October 3 until the week of December 24 when the birds are driven out entirely by the frozen lake surface. The low points during the month of November being excepted because of hunters scaring the birds out of the counting location. The freezing of Upper Klamath Lake forced a great number of the birds to seek refuge away from this area and concentrated the remainder at the Lake Ewauna and Barclay-Sucker Springs location. The numbers remain almost constant here until February 27 when a moderation of temperatures melts the ice at the lower end of Upper Klamath and opens up a new feeding area. The birds now desert the Lake Ewauna location and, reinforced by a large number of ruddys coming in from elsewhere, swell the total at this point to two thousand seven hundred seventy-five for the high point in the census records. As the Upper Lake continues to thaw, the birds are dispersed over its area causing the number to decrease in the counting location. The final high point on May 1 is produced by an influx of greater scaup, probably as a part of the spring migration, which gradually declines, leaving the summer resident birds consisting mostly of brebes, coots, Canada and lesser

Canada geese, pelicans, and smaller numbers of the other species to continue in a uniform condition as respects total number present.

SUMMARY

The investigation shows five species--the ruddy, golden eye, coot, greater scaup, and widgeon-- to be the dominating types present during the census period from September 9 to May 29. The first four together with the merganser, bufflehead and pied-billed grebe constitute the winter population who, of necessity, must be bottom feeders during the period when the lake edge is frozen. The fall migrants consist largely of widgeons while the spring influx was composed principally of greater scaup, eared grebe, and western grebe. The greatest number of any single species counted on a single field trip was the ruddy ducks present on March 6. A total of thirty-two species were recorded in the field records.

Availability of feeding area appears to be the principal factor causing fluctuation in number during the winter season. The temperature and precipitation conditions during the period of the census were not average and may have influenced the results to some degree.

Figure 5

Figure 6

Figure 5 Buck Island location with island in center picture showing receding ice--March.

Figure 6 Barclay Springs, showing open water in vicinity of hot springs--January.

PLATE I

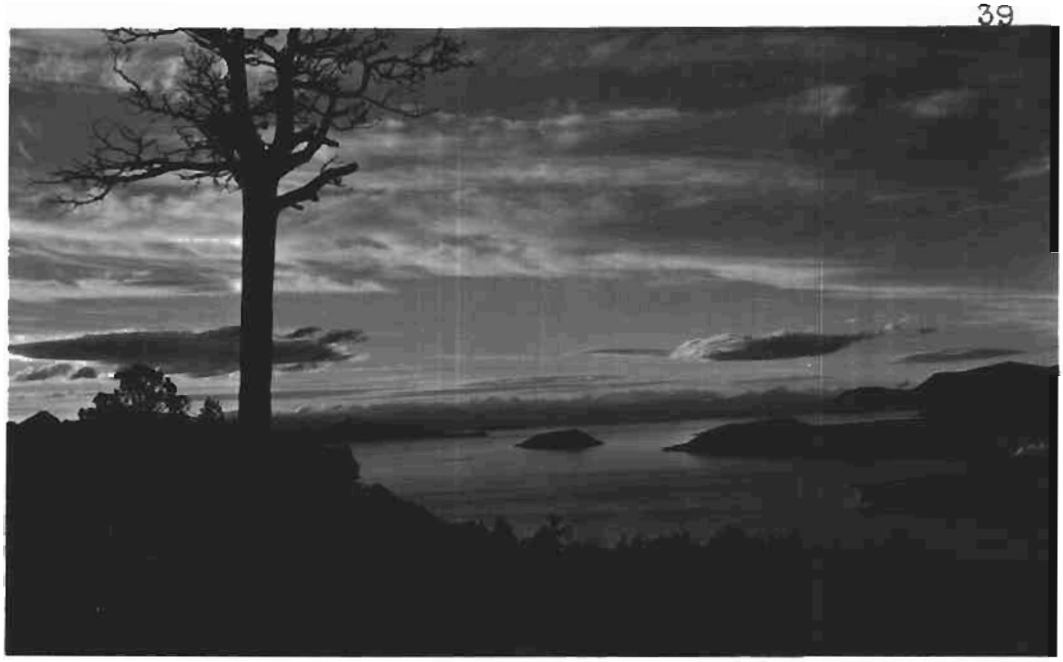


Figure 7

Figure 8

Figure 7 Upper Klamath Lake from south end. Buck Island in center foreground, Barclay Springs in right background, Shippington in lower right corner--June.

Figure 8 Shippington showing birds concentrated in open water at lower end of lake--December.

PLATE II

Figure 9

Figure 10

Figure 9 Buck Island shoreline showing frozen surface--December.

Figure 10 Buck Island location showing ice closing in from lake center--December.

PLATE III

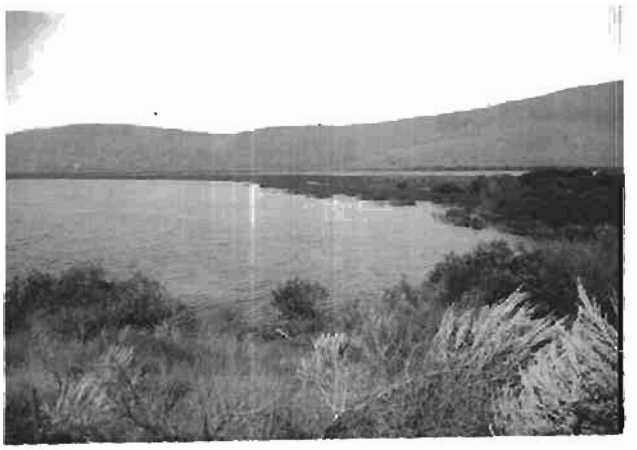


Figure 11

Figure 12

Figure 13

Figure 11 Buck Island shoreline--October.

Figure 12 Lake Ewauna location showing birds concentrated in open water--January.

Figure 13 Lake Ewauna location showing decreased open water area after prolonged sub-zero temperature--January.

PLATE IV

BIBLIOGRAPHY

1. Allen, J. A. The Geographical Origin and Distribution of North American Birds, Considered in Relation to Faunal Areas of North America. The Auk, 10:97, 1893.

2. Audubon Society Report of State Audubon Society for Oregon. Bird Lore, 7:336, 1905.

3. Bell, W. B., and Preble, E. A. Status of Waterfowl in 1934. U.S.D.A. Misc. Pub. No. 210, 1934.

4. Cartwright, B. W., and Harrold, C. C. An Outline of the Principles of Natural Selective Absorption of Radiant Energy. The Auk, 42:233, 1925.

5. Chapman, F. M. Remarks on the Origin of Bird Migration. The Auk, 11:12, 1894.

6. Clark, A. H. The Migrations of Certain Shore Birds. The Auk, 22:134, 1905.

7. Cooke, W. W. Variations in Bird Migration from Year to Year. The Wilson Bulletin, 25:1, 1913.

8. Cooke, May Thacher. How the Bird Census Solves Some Problems in Distribution. The Condor, 83:206-208, 1926.

9. Eifrig, G. Is Photoperiodism a Factor in the Migration of Birds. The Auk, 41:439-444, 1924.

10. Forbush, E. H. The Mallard. Bird Lore, 11:40,1909.

11. Kalmbach, E. R., and Gunderson, M. F. Western Duck Sickness a form of Botulism. U.S.D.A. Tech. Bulletin No. 411, 1934.

12. Kibbe, H. S. Aquatic Visitors to Lake Merritt, Oakland, California. The Condor, 27:55-58, 1925.

13. Leopold, Jr., N. F. Reason and Instinct in Bird Migration. The Auk, 40:409, 1923.

14. Libby, O. G. The Nocturnal Flight of Migrating Birds. The Auk, 16:140, 1899.

15. Lincoln, F. C. History and Purpees of Bird Banding. The Auk, 38:217-228, 1921.

16. Lincoln, F. C. The Waterfowl Flyways of North America. U.S.D.A. Circ. 342, 1935.

17. McKay, George H. Fly Lines. The Auk, 10:245, 1895.

18. Phillips, J. C., and Lincoln, F. C. American Waterfowl. Houghton Mifflin Company, New York, 1930.

19. Pirnie, Miles D. Michigan Waterfowl Management. Department of Conservation - Game Division - Lansing, Michigan, 1935.

20. Rowan, William. The Riddle of Migration. Williams and Wilkins, Company, Boston, 1931.

21. Taverner, P. A. A Discussion of the Origin of Migration. The Auk, 21:322, 1904.

22. U.S.D.A. Instructions for Making Bird Count. Bureau of Biological Survey, Documents 103,106, 1916.

23. Wetmore, Alexander. Bird Migration. Scientific Monthly, 34:459-462, 1932.

24. Willett, G. Bird Notes from South Eastern Oregon and Northeastern California. The Condor, 21:194-207, 1919.

25. Wing, L. W. Cycles of Migration. Wilson Bulletin, 46:150, 1934.