

POPULATION STUDIES OF WATER
BIRDS AT TULE LAKE AND
LOWER KLAMATH LAKE,
CALIFORNIA

by

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A THESIS

Submitted to


OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

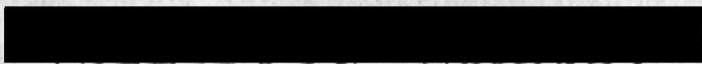
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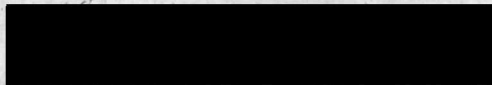


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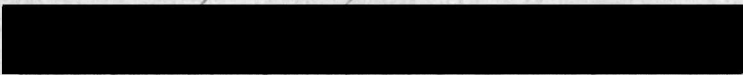
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Date thesis is presented April 25, 1950

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I wish to take this opportunity to express my sincere appreciation to Dr. Robert M. Storm for his assistance in the preparation of this thesis and for his interest and encouragement throughout my career as graduate student.

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AT TULE LAKE AND LOWER KLAMATH LAKE, CALIFORNIA

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POPULATION STUDIES OF WATER BIRDS
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Chapter 1

Historical Summary

Since early times the Klamath Basin of southern Oregon and northern California, including, with other waters, Tule Lake and Lower Klamath Lake, has been famous for its wildlife. Jewett (8,p.2) cites Fremont's report of his visit in December, 1843, as the first published account of the region. Trappers came soon after Fremont's trip and reaped a rich harvest of beaver, otter, and other furs. The vast marshes also teemed with ducks, geese, and swans, and this feature from this time on attracted many hunters.

Even in prehistoric times the region evidently had considerable importance to man. A cinder cone on the east side of Tule Lake contains two caves with smoke-blackened walls, indicating that they once served as human habitations. Like nearly all such caves in the interior plateau region of the West, their mouths are largely filled with soil formed from dust and debris blown into the caves as well as what has been formed from animal matter left by generations of wild

mountain sheep, now extinct in the region, as they spent the days lying in caves as a retreat from the sun. It can be seen on inspection that, with this material removed, the caves were once quite large. A third cave, blocked by a rock slide, is at present barred from entry.

The walls of the cinder cone to the left of the caves are covered with ancient writings carved into the soft rock. These are usually simple. Some are short, straight lines in series as though intended for a tally of some sort or to mark the passage of time. Others are irregular, connected lines as though outlining a trail through the mountains. A few figures suggest human beings caricatured as herons, but other carvings can hardly be connected to any purpose. The whole thing brings to mind rude carvings that boys make with their pocket-knives in the smooth, clay walls of railroad cuts near centers of population. The carvings at Tule Lake, likely the idle occupation of many long summer days, convey but in small measure an artistic striving for expression.

Further survey of the area reveals that Tule Lake once lapped the base of the cinder cone. Its waters evidently came to a narrow beach almost directly in front of the cave mouths. Imagination supplies the rest. A picture takes shape of naked or partially clad brown-skinned people coming in from the lake on rude rafts piled with geese trapped in primitive, tule-made net or stockade-type traps. Perhaps

some are landing and are being met with wives and children hurrying from the caves for eager inspection of the catch. The time would be in August when geese and other wildfowl are temporarily flightless because of complete loss of the flight feathers in the annual fall molt. An account from Kortright (12,p.116), describing capture of Emperor geese by Eskimos in Arctic Alaska, supports this view. It follows:

"Generally the natives go to the same spot each year for their drives, which are made about the end of the first week in August." They make "a practice of setting up long lines of strong fishnets on the tundras to form pound traps, or inclosures with wide wings leading into them, into which thousands were driven and killed for food."

According to the same source (12,p.121), Indians on the Barren Grounds in Canada also toll flightless white-fronted and other geese onto land where most of them easily fall prey to the hunters. These Indians and Eskimos evidently made their captures in land-based stockades, but the rough, lava-strewn borders of Tule Lake supports the conjecture that the early-day cave-dwellers of the region set their traps in waterways through the tule beds.

Tule Lake at this early time covered almost 40,000 acres. Lower Klamath Lake at the same time was a vast, marshy lake of more than 80,000 acres. It, as well as Tule Lake, was a biological wonderland. William L. Finley, photographer-naturalist, described the lake in terms of its

bird life, as follows (4,p.97):

"Lower Klamath Lake is a body of water about 25 miles long by 10 or 12 miles wide. About its sides are great marshes of tules. The whole border is a veritable jungle, extending out for several miles from the main shore in an almost endless area of floating tule islands, between which is a network of channels. Here, where we found the nesting colony of western grebes, we had good chances to study the habits of these birds.

"About one of these islands we found the floating grebe nests every few feet apart, and counted over 60 in a short distance. We rowed up to one end and landed and then waded along just inside the thick growth of tules that grew along the edge. From this place, partly concealed as we were, we could look through the tules and see the grebes swimming and diving near their nests. Across the channel along the edge of the opposite island were many more grebe nests, and some of the birds were sitting on their eggs."

Finley also found a colony of California and ring-billed gulls. His account follows (3,p.12):

"From a full mile away, with our field glass, we could see the gulls rising and circling over the low-lying islands. As we rowed nearer the birds came out to meet us, cackling excitedly at the dubious-looking craft approaching so near to their homes. They swam about on all sides, curiously following in the wake of our boat. Cormorants flapped along over the surface, pelicans rose heavily from the water, and gulls and terns got thicker and thicker, until when the nose of the boat pushed in at the edge of the island, the air seemed completely filled with a crying, chaotic swarm. We stepped out among the reeds, but had to tread cautiously to keep from breaking eggs or killing young birds."

At the time of Finley's visit the lakes in the Klamath Basin were a profitable field for plume hunters (2,p.4). Plumages of gulls, terns, grebes, egrets, and other birds

were at this time in great demand for the millinery trade. For twenty cents apiece hunters stripped the breasts from grebes, dried them, and shipped them to New York. During the height of the breeding season they made twenty to thirty dollars a day, killing several thousand birds each week. Jewett (8,p.5) also made the general observation that market hunters killed ducks and geese by the wagon-load for city markets.

Finley protested the slaughter and enlisted the aid of the Audubon Societies. They secured President Theodore Roosevelt's attention, and an Executive Order followed. On August 8, 1908, largely through Finley's efforts (5,p.11, p.133) the area became established as Lower Klamath National Wildlife Refuge.

The refuge did not remain inviolate (8,pp.5-7). Up to 1916 the lake waters were deep enough for fair-sized power boats, and visitors commonly made the boat trip from Klamath Falls down the Klamath River to the upper end of the lake and on to Laird's Landing at its lower end. The ever-increasing demand for farm lands changed this situation. The principal source of water came from overflow from the Klamath River when in annual flood. A dam built across the channel between Klamath River and Lower Klamath Lake cut off this supply, and in four years the lake had dried up almost entirely. Efforts to cultivate the lake bed failed in most parts, and the lowered water table made some of the

neighboring ranches worthless.

Tule Lake was also reclaimed for agriculture at about the same time (8,pp.5-7; 5,pp.183-186). The waters of Lost River, which flowed into the lake, were diverted. Much of the lake bed, through a highly developed irrigation system, became profitable farm land. A sump, or storage reservoir filled by surplus irrigation water, remained as Tule Lake. This area was established by an Executive Order, effective October 4, 1928, as Tule Lake National Wildlife Refuge. Another sump became necessary to take care of the irrigation water, and subsequent Executive Orders in 1932 and 1936 enlarged the refuge to 37,340 acres. This took in practically all the cultivated lands on the old lake bed as well as the two sumps, these comprising about 13,000 acres of marsh and open-water area.

At about this point, as a result of increased use of irrigation waters on lands above Tule Lake, the sumps proved inadequate. When some dikes broke, flooding several thousand acres of good cropland, a tunnel was built through an intervening ridge of hills to Lower Klamath Lake. Excess water was then pumped through the tunnel from Tule Lake and released into Lower Klamath. A dike along the Oregon-California boundary impounded the released waters and restored approximately 20,000 acres of the old lake bed. As part of the development artificial nesting islands were built in Tule Lake of coarse gravel and rocks and planted

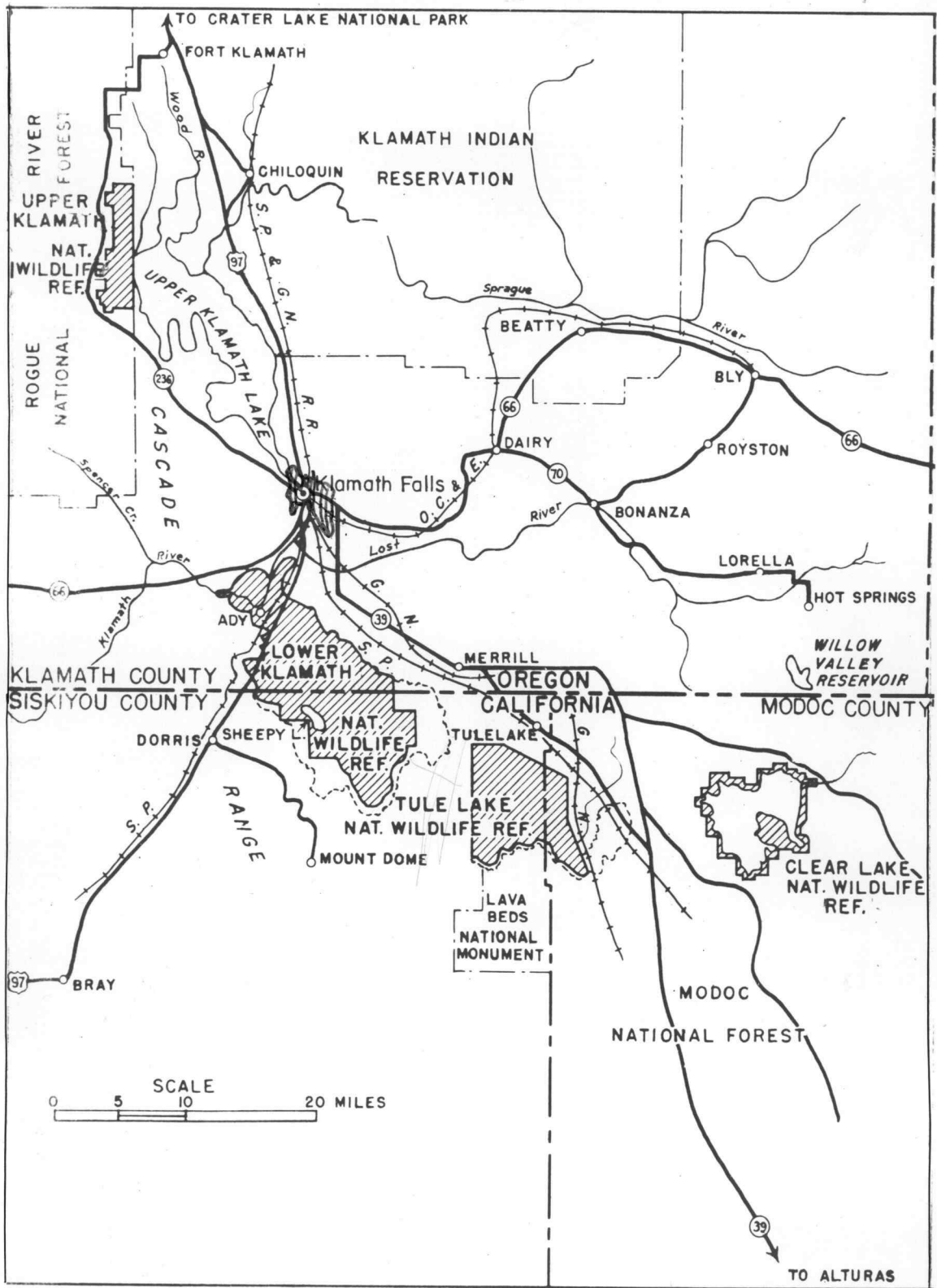
with tules and grasses, and in Lower Klamath Lake a series of dikes were constructed dividing the area into units. These intercommunicated by means of channels for the sake of water control.

Under the finished set-up, Clear Lake, at the head of Lost River, serves as storage reservoir for the entire system. Clear Lake fills in winter and spring, and water is drawn from it as needed. As nearly as possible, a constant water level is maintained for Tule Lake and Lower Klamath Lake. In Lower Klamath Lake water in the various units may be raised or lowered independently by means of water-gates in the intercommunicating channels, an important measure in combating outbreaks of botulism.

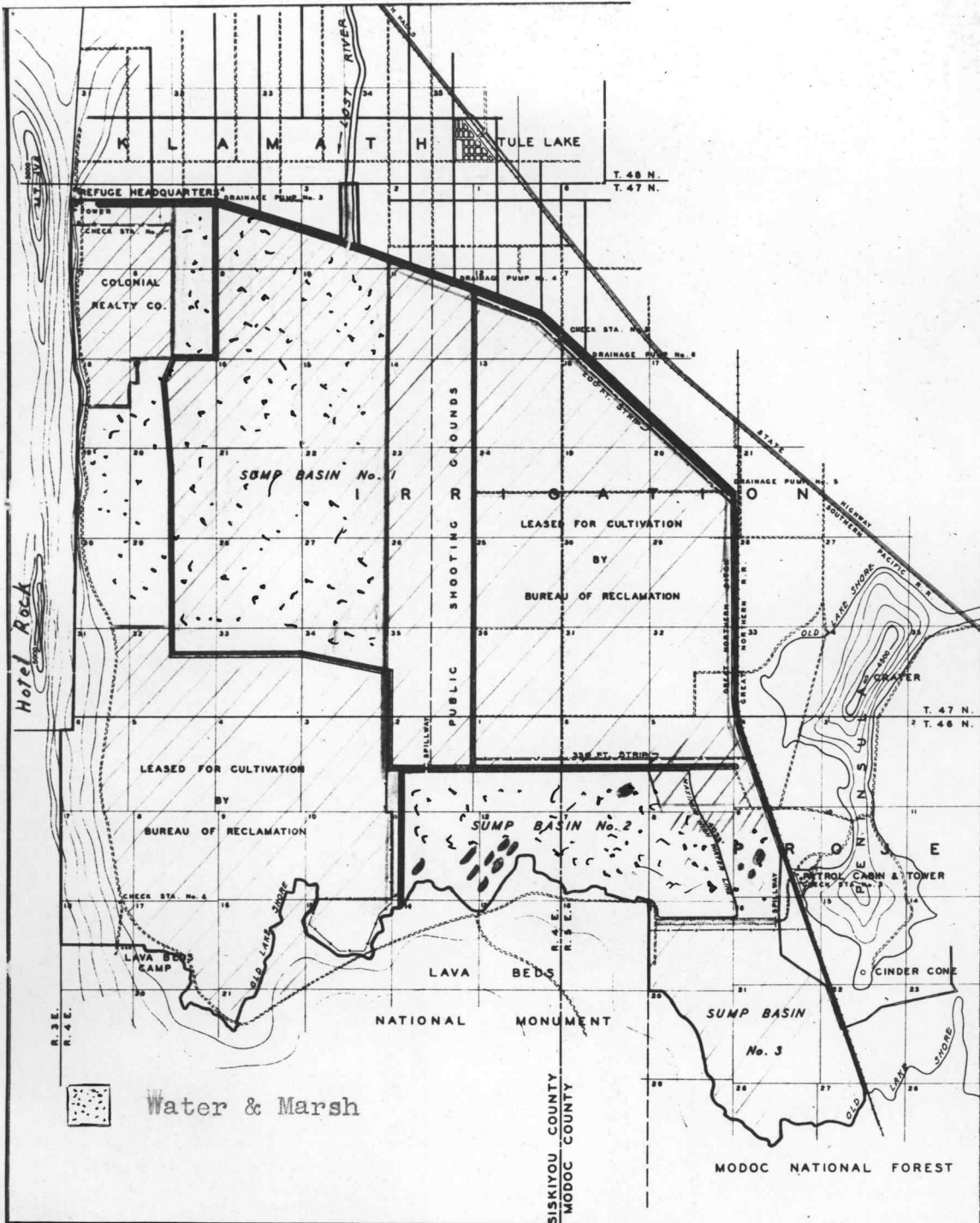
During the war maintenance was neglected because of shortage of manpower. Winter storms over the shallow waters produced wave action that damaged and, in many places, washed out the dikes. Repair of this damage began in 1946 and continued through 1947. The restored lakes are now surrounded by richly producing farm lands, with barley as the principal crop. The watery areas support an abundant growth of aquatic plants, including sedges (Carex), tules or bulrushes (Scirpus americanus nevadensis) and (S. occidentalis), coontail (Ceratophyllum), pondweed (Potamogeton), smartweed (Polygonum), widgeongrass (Ruppia), duckweed (Lemna), cattail (Typha), and many others that produce food and cover for ducks, geese, and other species of marsh birds.

Maps of the region under discussion are presented as follows:

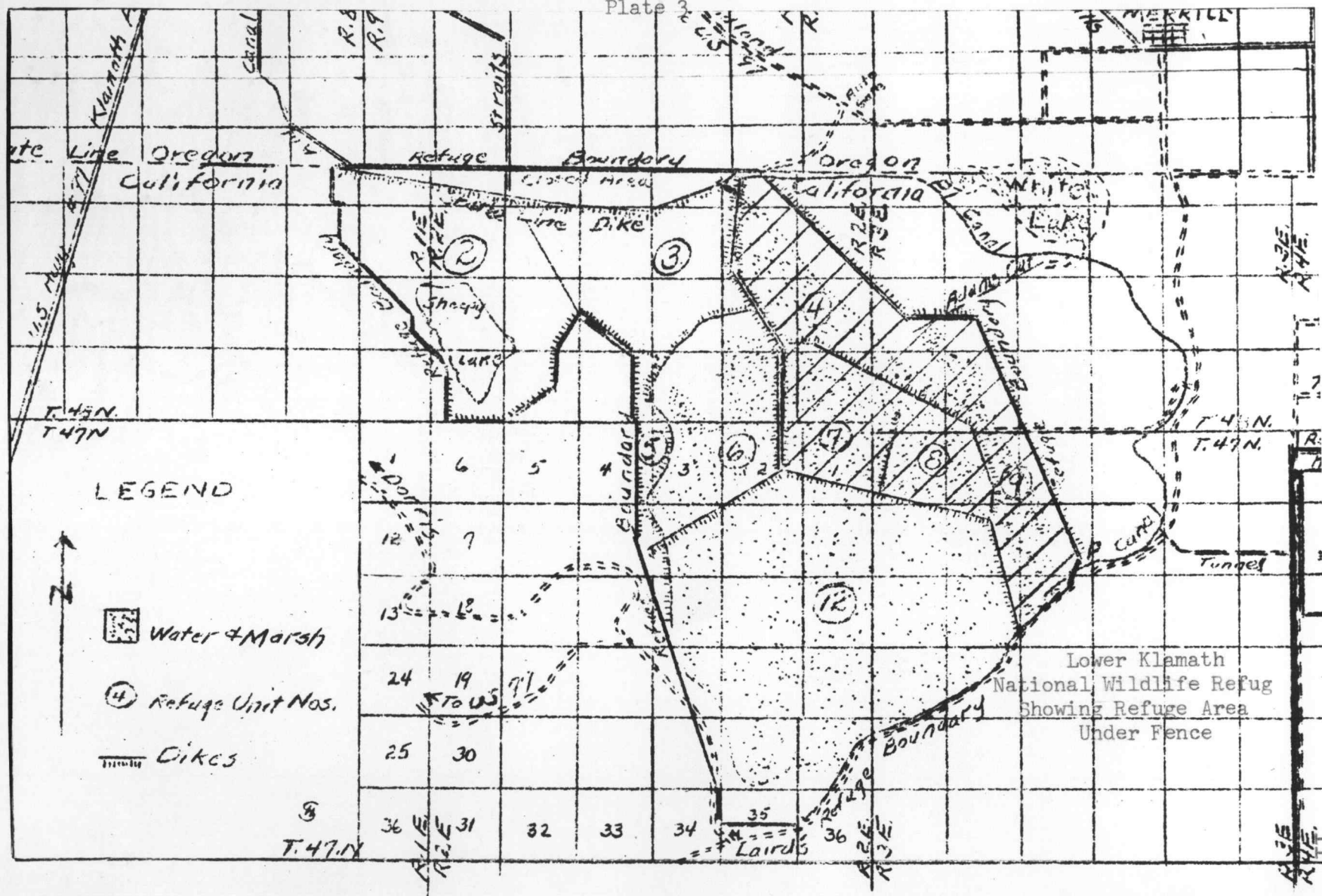
- Plate 1 - Klamath Basin, Showing National Wildlife Refuges
- Plate 2 - Tule Lake National Wildlife Refuge
- Plate 3 - Lower Klamath National Wildlife Refuge



Klamath Basin, Showing National Wildlife Refuges



Tule Lake National Wildlife Refuge



Chapter 2

Brood Counts - Ducks

The Migratory Bird Treaty with Great Britain, effective July 3, 1918, put the United States Government to the task of counting its birds. The treaty called for governmental regulations under which waterfowl and other migratory game birds could be hunted. As these regulations were based primarily on the principle that the kill should not exceed the annual increase (5,p.137), it became necessary to have some measure of production. For that reason annual surveys of the breeding grounds were made. Although most of the work was concentrated in Canada and Alaska, where the bulk of waterfowl shot for sport was raised, it was also realized that a considerable portion was produced on refuges in the United States. Apart from the surveys of northern breeding areas, it was felt desirable to appraise refuge breeding populations during the breeding season.

As partial fulfilment of this purpose, brood counts were made through the summer months of 1946 and 1947 at Tule Lake National Wildlife Refuge and Lower Klamath National Wildlife Refuge. The special aim was to get an

objective measurement of potential reproduction. Local production is modified by drought, outbreaks of botulism, and predation, and during progress of the brood counts the author made notes on these and other factors that came to his attention. The work was carried on until the crop was on the wing and was made to include water birds other than ducks and geese, especially as Lower Klamath Lake, of the two refuges, had been set aside primarily for the protection of non-game species.

The studies began July 9, 1946, with employment of the author as Student Assistant at the Administrative Headquarters, serving both areas, at Tule Lake National Wildlife Refuge. They ended for that year on September 8. In the interval twenty-one days were spent on brood counts on Lower Klamath Lake and eighteen and a half days on Tule Lake. A set route was followed, and distance covered in the car was taken from the speedometer reading. Where condition of the road or dike required observations on foot, the distance was estimated from the map. In this manner, the miles of shoreline covered in 1946 was set at 24 miles at Tule Lake and 16 miles at Lower Klamath Lake.

In 1947, the work began June 16 and ended August 26. In this year brood counts were made according to a schedule which called for two days each week at Tule Lake and three days at Lower Klamath. A specified area was to be covered each day, and when this was done, other tasks might

be undertaken. The route followed 28.6 miles of shoreline at Tule Lake and 21.6 miles at Lower Klamath Lake. The additional distance was made possible through repair work on damaged dikes since the close of the previous brood counting season.

Counts were made from a pick-up truck with the aid of eight-power field glasses. The broods as observed were counted and entered in field notes by species, number in brood, and appropriate age class. Age classes were as follows: I, downy young, probably not over two weeks old; II, ducklings from just above the downy young stage to about two-thirds grown; and III, nearly full grown ducks about ready to fly. In 1947 the definition of class I was changed to read as follows - downy young, probably not over one week old. It was felt that some broods would be counted more than once and that there might be an advantage in avoiding repeats in the youngest age class.

In practice, this distinction in age was difficult to observe. This may be realized from Hochbaum's description of the one to three weeks old canvasback (7,p.103): "The duckling remains clothed entirely in its natal down, the only marked plumage change being a gradual fading of down color." It was not believed that the changed definition made any appreciable differences in the tables presented at the end of this chapter, as follows:

Table 1 - Brood Counts of Ducks, 1946

Table 2 - Brood Counts of Ducks, 1947
Table 3 - Brood Count Totals, 1946
Table 4 - Brood Count Totals, 1947
Table 5 - Species Composition of Breeding Population
Table 6 - Combined Brood Counts
Table 7 - Estimated Production, 1946
Table 8 - Estimated Production, 1947
Table 9 - Revised Estimate of Production, 1946
Table 10 - Water Levels, Tule Lake and Lower Klamath Lake, 1946 & 1947

In addition to the species listed in the tables - mallard, gadwall, pintail, cinnamon teal, shoveller, redhead, ring-necked duck, canvasback, scaup, and ruddy duck - blue-winged teal were present on both lakes but were not separated from cinnamon teal because of the difficulty in distinguishing by field marks the females of the two species. In 1947, on the suggestion of Stanley G. Jewett, a watch was made for territorial blue-winged teal males. Several were located, and it was noted that hens, presumably blue-winged teal because of the earlier presence of a similarly colored female with the clearly distinguishable blue-winged teal male, would appear later at these places with broods of class I young. These observations indicated that the blue-winged teal was present as a breeding bird, but no separate counts were presented for this species.

The scaup, or lesser scaup duck, entered as breeding in fairly common numbers, had not been noted previously as a breeding species, and no specimens were collected in connection with the brood counts. According to Mr. Howard Sargeant, Refuge Superintendent, these ducks had been present

for several years, and their presence may reflect a recent extension of breeding range. The canvasback was confirmed by Stanley G. Jewett and published as a new record (9,p.126). The ring-necked duck has not been officially confirmed. One brood was seen on Tule Lake in 1946. In 1947, mated pairs were seen at several places on Lower Klamath Lake, and these places were watched for the later appearance of females with young. None were seen, and the ring-necked duck as a breeding species on the Klamath marshes must await further confirmation.

In line of further comment, the increased count in 1947, shown in comparing tables 3 and 4, cannot be taken as indicating an increased production. In 1947 the counts began three weeks earlier than in 1946, thus bringing into the study a portion of the brood season that was not available for the 1946 season. The increased count would also be explained in part by greater speed in field identification of the various female ducks.

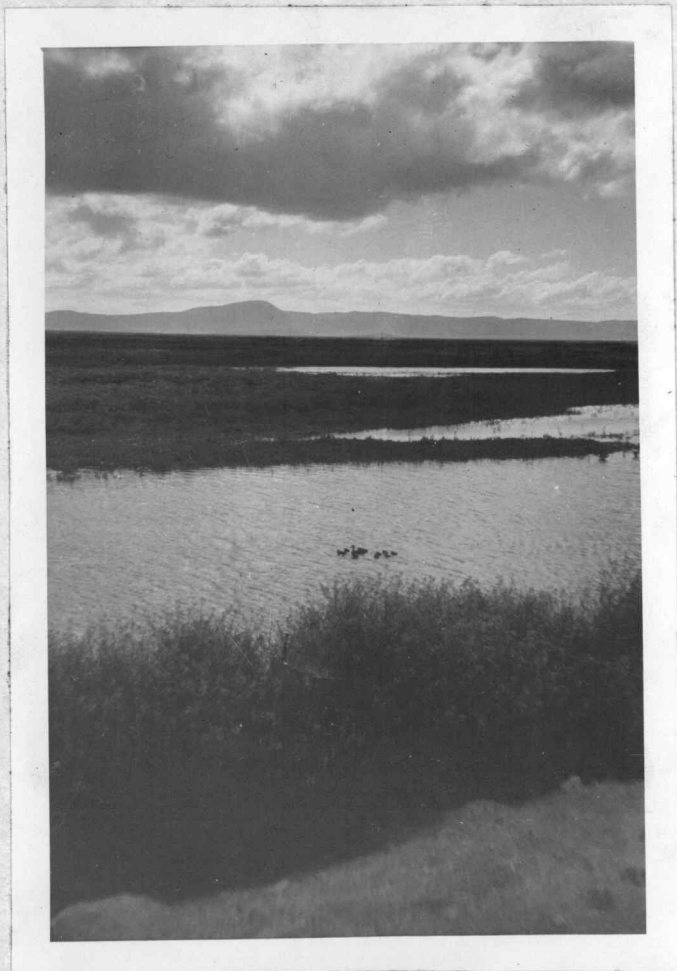
Another circumstance affecting the increased count applied to Lower Klamath Lake. Dragline operations when the dikes had first been built had left bordering channels of deeper water (Plate 4). These were not especially evident at normal water levels, but when the dragline was again used in repairing dikes damaged by wave action, as described earlier, the water was gradually lowered through the summer to make operation of the machinery possible. As

the water went down, broad expanses of shallow lake bottom came into view, and this caused a gradual concentration of birds in the deeper water bordering the dikes. The counts increased accordingly. Gauge readings of water level are given in Table 10.

It is also pertinent at this point to comment on brood sizes. Species differences were evident, and in the overall count the averages given for no. I broods - 7.7 for Tule Lake and 6.8 on Lower Klamath Lake in 1946 and 7.4 on Tule Lake and 6.7 on Lower Klamath Lake in 1947 - showed a slight differential in favor of Tule Lake. Broods of all species, in general, showed a decline in size with age. This might be explained on the basis of a gradual loosening of the brood organization with the young birds becoming progressively exposed to dangers they were not equipped through experience to meet.

Reference to table 5, Species Composition of Breeding Population, brings out the importance of Tule Lake as a red-head breeding area. Ruddy ducks, mallards, and gadwalls were also important breeding species with pintails, cinnamon teal, shovellers, and scaups occurring less commonly. On Lower Klamath Lake mallards and gadwalls were the principal species with others present in lesser numbers. The percentages also show that in 1947 redheads increased on Tule Lake but showed no change on Lower Klamath Lake. Mallards remained about the same on both lakes, but gadwalls decreased

Plate 4



A. Lower Klamath Lake,
Looking Eastward Across Unit 4



B. Lower Klamath Lake, Unit 6,
Showing Deep Water Channel Bordering Dike

on Tule Lake and increased on Lower Klamath Lake. The ruddy duck decreased on both lakes. So also did the scaup. Cinnamon teal increased on Tule Lake, and shovellers decreased on Lower Klamath Lake. In other respects the proportionate population remained the same.

Table 6 combines the brood count into yearly tables. Here the late nesting habit of the redhead is reflected in the preponderance of class I broods, and reference to tables 1A and 2A shows that most of them came in July. For ruddy ducks, also breeding in large numbers on Tule Lake, most of the broods came in August. In contrast, most of the mallard broods that entered into the counts were class III, illustrating the earlier nesting and longer brood season of that species (7,p.109). The gadwall, on the basis of preponderance of class II broods, held a position intermediate in this respect between mallard and redhead. The scaup, it will be noted, with three weeks earlier start in brood counting in 1947, showed a preponderance of class I broods in that year, whereas in the count of the previous year the greater number had been class II broods.

Table 7 presents an estimate of production for 1946. For this table an estimate was made of the probable number of resident adult birds. These figures, 25,000 for Tule Lake and 30,000 for Lower Klamath Lake, were taken as the respective populations at the beginning of the breeding season. It was considered that about 20% would be non-

breeding birds. This figure could be larger, for Hochbaum in Manitoba (7,p.15) noted a disparity between sexes in canvasback and scaup of about two to one, and this would result in about 33 1/3% non-breeding birds. The same author gave a sex ratio of 56:44 for redheads, which would make about 12% non-breeding males, but he also noted a small number of non-breeding females (7,p.85).

For nesting success, the figure of 60% was used, based on Kalmbach (11,p.597), and in this manner the total of successful nests became 6000 on Tule Lake and 7200 on Lower Klamath Lake. These were apportioned according to the percentages in table 5 and multiplied by the average of class III broods given in table 3. The final figures came to 35,415 young ducks produced on Tule Lake and 39,312 on Lower Klamath Lake. The method used in arriving at these totals was not considered satisfactory because the estimate of breeding population was largely subjective in nature and because the percentage used for nesting success would not necessarily apply to the Klamath Basin. It was further realized that the final figures represented class III young and not flying birds of the year.

In an effort to work out a more objective measurement of production, the method described above was abandoned the following year. For the 1947 estimate of production a multiple called, for want of a better term, the habitat-ratio, was devised. This consisted of two parts. For one, the

brood season of each species was evaluated in relation to the brood count season. This, taken from table 6, was as follows:

Mallard, pintail, cinnamon teal, and shoveller	3
(on basis of preponderance of class III broods)	
Gadwall (on basis of preponderance of class II broods)	2
Redhead, scaup, and ruddy duck	1
(on basis of preponderance of class I broods)	

The count sample, the other component of the habitat-ratio, was arrived at by taking the route followed in making the counts, 28.6 miles on Tule Lake and 21.6 miles on Lower Klamath Lake, as a transect extending $1/8$ mile out over the water, the area under observation. This transect, translated into acreage, was divided into the areas of the respective lakes, 13,000 acres in Tule Lake and 20,000 in Lower Klamath Lake. The count sample, arrived at in this manner, was multiplied by the brood season evaluation to give the habitat-ratio.

The final figures of production, given in table 8, were reached by multiplying the number of class I broods by the habitat-ratio and multiplying the product by the average class III brood. The concentration described on Lower Klamath Lake caused by lowering water levels was allowed for by halving the count of class I broods. This, a special condition, was called a habitat factor. For the sake of comparison, a revised estimate of production was worked out for 1946 by use of the habitat-ratio and presented in table 9.

The totals for the two years were very similar, and the species totals in general followed the shifts in population shown in table 5. For example, the increased redhead population on Tule Lake was brought out in figures. This was also true in showing the decrease in scaups and ruddy ducks and the shifts in population involving the gadwall.

Other correspondence may be noted, as the increase in cinnamon teal on Tule Lake, but this of itself does not establish the validity of the method. Further study is needed, and comparisons should be made in the field with other methods of estimating production. Bennett, for instance (1,p.122-124), with the entire nesting and brood season under observation, had estimated the production of blue-winged teal in Iowa. He summarized his procedure, as follows:

- "1. Determine the total number of nests in area.
2. Determine the percentage of successful nests.
3. Multiply the number of successful nests by the average number of eggs in successful nests to determine the number of hatched ducklings.
4. Juvenile counts, August 10-17, indicated the number of young reaching the migratory stage. Multiply the average number of young observed with adult females with the total successful nesting population of females to arrive at the year's production."

The same author (1,p.106-108) noted the relationship of shoreline to nesting population, and Hochbaum (7,p.78-79) used the term 'shore-line:nesting population ratio' in his discussion of distribution of territorial populations.

Their findings suggest that, in further studies of production of ducks and other marsh-breeding birds, habitat-ratio might be determined from total length of shoreline rather than from acreage of water area.

Table 1
Brood Counts of Ducks, 1946,
A. Tule Lake

Species	July			August			September			Total		
	*I	*II	*III	I	II	III	I	II	III	I	II	III
	**											
Mallard	24/224 9.3	21/132 6.3	36/201 5.5	1/8	--	5/27 5.4	--	--	--	25/232 9.2	21/132 6.3	41/228 5.5
Gadwall	27/239 8.8	39/302 7.7	8/55 7.9	8/81 10	9/68 7.5	6/36 6	--	--	--	35/320 9	48/370 7.7	14/91 6.5
Pintail	--	3/16 5.3	2/11 5.5	1/7	--	3/22 7.3	--	--	--	1/7	3/16 5.3	5/33 6.6
Cinnamon Teal	--	2/19 9.5	3/26 8.7	--	2/16 8	6/41 6.8	--	--	--	--	4/35 8.7	9/67 7.4
Shoveller	2/18 9	--	1/5	--	--	3/12 4	--	--	--	2/18 9	--	4/17 4.2
Redhead	68/551 8.1	26/199 7.6	--	43/321 7.4	44/343 7.8	29/208 7.1	--	1/6	--	111/872 7.8	71/548 7.7	29/208 7.1
Ring-Necked	--	1/6	--	--	--	--	--	--	--	--	1/6	--
Canvasback	--	--	--	1/9	1/6	--	--	--	--	--	1/9	1/6
Geaup	12/105 8.7	10/85 8.5	2/9 4.5	--	--	--	--	--	--	12/105 8.7	10/85 8.5	2/9 4.5
Ruddy	16/75 4.7	14/75 5.3	1/3	48/310 6.4	26/145 5.5	9/38 4.2	9/55 6.1	10/64 6.4	--	73/440 6.0	50/284 5.7	10/41 4.1

*Age classes I, II, and III.

I - Downy young, probably not over two weeks old.

II - Ducklings from just above the downy young stage to about two-thirds grown.

III - Nearly full grown ducks and about ready to fly.

**The first figure represents the number of broods, the figure following the diagonal line the number of young, and the figure below these two gives the average number of young per brood.

Table 1
Brood Counts of Ducks, 1946,
B. Lower Klamath Lake

Species	July			August			September			Total		
	I	II	III	I	II	III	I	II	III	I	II	III
Mallard	53/407 7.7	*63/480 7.7	74/392 5.3	1/6	2/8 4	11/78 7	--	--	--	54/413 7.6	*65/488 7.5	85/470 5.5
Gadwall	31/228 7.3	69/493 7.0	28/167 6.0	10/66 6.6	6/30 5.0	11/66 6	--	--	--	41/294 7.1	75/527 7.0	39/233 6.0
Pintail	8/58 7.2	12/88 7.3	6/29 4.8	1/5	--	7/41 5.9	--	--	--	9/63 7	12/88 7.3	13/70 5.4
Cinnamon Teal	9/51 5.7	10/55 5.5	22/111 5	3/17 5.7	3/10 3.3	13/86 6.6	--	--	--	12/68 5.7	13/65 5.0	35/197 5.6
Shoveller	11/57 5.2	13/53 4.1	31/140 4.5	1/6	4/18 4.5	4/18 4.5	--	--	--	12/63 5.2	17/71 4.2	35/158 4.5
Redhead	11/55 5	30/260 8.7	--	5/26 5.2	9/63 7.0	12/67 5.6	--	--	1/10	16/81 5.0	39/323 8.3	13/77 6.0
Scaup	10/64 6.4	*18/143 8.0	*3/96 32	1/9	1/2	2/10 5	--	--	--	11/73 6.6	19/145 7.6	21/106 5
Ruddy	4/24 6	15/85 5.7	5/17 3.4	2/9 4.5	1/3	--	--	--	--	6/33 5.5	16/88 5.5	5/17 3.4

The same explanation as to age classes and arrangement of figures applies to this table.

Table 2
Brood Counts of Ducks, 1947,
A. Tule Lake

Species	June			July			August			Total		
	*I	*II	*III	I	II	III	I	II	III	I	II	III
Mallard	*16/92 6.1	19/133 7.0	6/39 6.5	7/45 6.5	14/77 5.5	48/270 5.6	-	1/6	53/268 5.0	23/137 6.0	34/216 6.3	107/577 5.4
Gadwall	3/22 7.3	3/15 5.0	-	8/55 7.0	10/59 5.9	15/82 5.3	1/9	5/35 7.0	15/82 5.3	12/88 7.0	18/109 6.0	30/164 5.3
Pintail	-	-	-	-	-	1/3	-	1/9	13/55 4.2	-	1/9	14/58 4.2
Cinnamon Teal	-	-	-	10/75 7.5	9/50 5.5	7/52 7.5	2/14 7.0	9/51 5.7	31/160 5.1	12/89 7.4	18/101 5.6	38/212 5.6
Shoveller	-	-	-	-	4/33 8.2	1/6	-	5/24 4.8	5/26 5.2	-	9/57 6.3	6/32 5.3
Redhead	6/38 6.3	4/17 4.2	-	180/1333 7.4	108/600 5.5	19/97 5.1	64/515 8.0	84/490 5.8	51/292 5.7	250/1886 7.5	196/1107 5.7	70/389 5.5
Scaup	2/23 11.5	-	-	1/7	3/16 5.3	-	-	1/5	-	3/30 10.0	4/21 5.2	-
Ruddy	-	-	-	14/84 6.0	5/26 5.2	-	103/775 7.5	48/281 5.8	5/22 4.4	117/859 7.3	53/307 5.8	5/22 4.4

*Age classes I, II, and III -

I - Downy young, probably not over one week old.

II - From approximately one week old to about two-thirds grown.

III - Nearly full grown ducks and about ready to fly.

**The first figure represents the number of broods, the figure following the diagonal line the number of young, and the figure below these two the average number of young per brood.

Table 2
Brood Counts of Ducks, 1947,
B. Lower Klamath Lake

Species	June			July			August			Total		
	*I	*II	*III	I	II	III	I	II	III	I	II	III
Mallard	51/348 6.8	72/364 5.0	11/78 7.0	64/424 6.6	106/652 6.1	111/643 5.8	1/8	2/10 5.0	60/259 4.3	116/780 6.7	180/1026 5.7	182/980 5.4
Gadwall	55/415 7.8	29/206 7.1	-	115/729 6.3	220/1416 6.4	58/332 5.7	4/12 3.0	27/120 4.4	31/165 5.3	172/1156 6.7	276/1744 6.3	89/497 5.6
Pintail	4/23 5.7	4/35 8.7	1/6	2/7 3.5	23/106 4.6	16/97 6.0	-	-	33/166 5.0	6/30 5.0	27/141 5.2	50/269 5.4
Cinnamon Teal	2/23 11.5	-	-	23/128 5.6	29/163 5.6	38/216 5.7	2/14 7.0	3/14 4.7	36/159 4.4	27/165 6.1	32/177 5.5	74/375 5.0
Shoveller	3/26 8.6	1/10	-	5/23 4.6	10/79 7.9	11/60 5.5	-	-	6/30 5.0	8/49 6.1	11/89 8.0	17/90 5.3
Redhead	17/98 5.8	5/20 4.0	-	27/169 7.0	50/319 6.4	7/27 3.9	-	14/86 6.1	35/210 6.0	44/287 6.5	69/425 6.2	42/237 5.6
Canvasback	1/11	-	-	1/8	-	2/6	-	-	-	2/19	-	2/6
Scaup	5/46 9.2	2/7 3.5	-	16/128 8.0	10/50 5.0	1/4	2/18 9.0	4/26 6.5	7/42 6.0	23/192 8.3	16/83 5.2	8/46 5.7
Ruddy	-	1/7	-	1/7	1/7	-	-	-	1/11	1/7	2/14	1/11

*Age classes I, II, III -

I - Downy young, probably not over one week old.

II - From approximately one week old to about two-thirds grown.

III - Nearly full grown ducks and about ready to fly.

**The first figure gives the number of broods, the figure following the diagonal line the number of young, and the figure below these two the average number of young per brood.

Table 3
Brood Count Totals, 1946,
A. Tule Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
Mald.	25	232	9	21	132	6.3	41	228	5.5	87	592
Gadw.	35	320	9	48	370	7.7	14	91	6.5	97	781
Pint.	1	7	7	3	16	5.3	5	33	6.6	9	56
C.Fl.	-	-	-	4	35	8.7	9	67	7.4	13	102
Shov.	2	18	9	-	-	-	4	17	4.2	6	35
Redh.	111	872	7.8	71	548	7.7	29	208	7.1	211	1628
R.Nk.	-	-	-	1	6	6	-	-	-	-	6
Canv.	-	-	-	1	9	9	1	6	6	2	15
Scaup	12	105	8.7	10	85	8.5	2	9	4.5	24	199
Ruddy	73	440	6	50	284	5.7	10	41	4.1	133	765
Tots.	259	1994	7.7	209	1485	7.1	115	700	6.1	583	4179

B. Lower Klamath Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
Mald.	54	413	7.6	65	488	7.5	85	470	5.5	204	1371
Gadw.	41	294	7.1	75	527	7	39	233	6	155	1054
Pint.	9	63	7	12	88	7.3	13	70	5.4	34	221
C.Fl.	12	68	5.7	13	65	5	35	197	5.6	60	330
Shov.	12	63	5.2	17	71	4.2	35	158	4.5	64	292
Redh.	16	81	5	39	323	8.3	13	77	6	68	481
R.Nk.	-	-	-	-	-	-	-	-	-	-	-
Canv.	-	-	-	-	-	-	-	-	-	-	-
Scaup	11	73	6.6	19	145	7.6	21	106	5	51	324
Ruddy	6	33	5.5	16	88	5.5	5	17	3.4	27	138
Tots.	161	1088	6.8	256	1795	7	246	1328	5.4	663	4211

Table 4

Brood Count Totals, 1947,
A. Tule Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
Mald.	23	137	6	34	216	6.3	107	577	5.4	164	930
Gadw.	12	86	7	18	109	6	30	164	5.3	60	359
Pint.	-	-	-	1	9	9	14	58	4.2	15	67
C.Tl.	12	89	7.2	18	101	5.6	38	212	5.6	68	402
Shov.	-	-	-	9	57	6.3	6	32	5.3	15	89
Redh.	250	1886	7.5	196	1107	5.7	70	389	5.5	516	3382
Canv.	-	-	-	-	-	-	-	-	-	-	-
Scaup	3	30	10	4	21	5.2	-	-	-	7	51
Ruddy	117	859	7.3	53	307	5.8	5	22	4.4	175	1188
Tots.	417	3087	7.4	333	1927	5.8	270	1454	5.4	1020	6468

B. Lower Klamath Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
Mald.	116	780	6.7	180	1026	5.7	182	980	5.4	478	2786
Gadw.	172	1156	6.7	276	1744	6.3	89	497	5.5	537	3397
Pint.	6	30	5	27	141	5.2	50	269	5.4	83	440
C.Tl.	27	165	6.1	32	177	5.5	74	375	5	133	717
Shov.	8	49	6.1	11	89	8	17	90	5.3	36	228
Redh.	44	287	6.5	69	425	6.2	42	237	5.6	155	949
Canv.	2	19	9.5	-	-	-	2	6	3	4	25
Scaup	23	192	8	16	83	5.2	8	46	5.7	47	321
Ruddy	1	7	7	2	14	7	1	11	11	4	32
Tots.	399	2685	6.7	613	3699	6	465	2511	5.4	1477	8895

Table 5

Species Composition of Breeding Population
By Brood Percentage
A. Tule Lake

Species	1946		1947	
	Broods	%	Broods	%
Mallard	87	15.0	164	16.0
Gadwall	97	16.5	60	6.0
Pintail	9	1.5	15	1.5
Cin. Teal	13	2.5	68	6.5
Shoveller	6	1.0	15	1.5
Redhead	211	35.0	516	50.0
Ring-necked	1	0.16	-	-
Canvasback	2	0.34	-	-
Scaup	24	4.0	7	1.0
Ruddy	133	24.0	175	17.5
Totals	583	100.0	1020	100.0

B. Lower Klamath Lake

Species	1946		1947	
	Broods	%	Broods	%
Mallard	204	31.0	478	32.0
Gadwall	155	24.0	537	36.0
Pintail	34	5.0	83	6.0
Cin. Teal	60	9.0	133	9.0
Shoveller	64	9.0	36	2.5
Redhead	68	10.0	155	10.0
Canvasback	-	-	4	0.5
Scaup	51	8.0	47	3.5
Ruddy	27	4.0	4	0.5
Totals	663	100.0	1477	100.0

Table 6
Combined Brood Count,
A. 1946

Species	Class I	Class II	Class III	Totals
Mallard	79	86	126	291
Gadwall	76	123	53	252
Pintail	10	15	18	43
Cinnamon T.	12	17	44	73
Shoveller	14	17	39	70
Redhead	127	110	42	279
Ring-necked	-	1	-	1
Canvasback	-	1	1	2
Scaup	23	29	23	75
Ruddy	79	66	15	160
Totals	420	465	361	1246

B. 1947

Species	Class I	Class II	Class III	Totals
Mallard	139	214	289	642
Gadwall	184	294	119	597
Pintail	6	28	64	98
Cin. Teal	39	50	112	201
Shoveller	8	20	23	51
Redhead	294	265	112	671
Canvasback	2	-	2	4
Scaup	26	20	8	54
Ruddy	118	55	6	179
Totals	816	946	735	2497

Table 7
Estimated Production, 1946,
A. Tule Lake

Species	Spec. Comp. By Broods	Successful Nests (Est.)	Av. No. III Broods	Total Prod.
Mallard	15.0	900	x 5.5	4950
Gadwall	16.5	990	6.5	6435
Pintail	1.5	90	6.6	594
Cin. Teal	2.5	150	7.4	1110
Shoveller	1.0	60	4.2	252
Redhead	35.0	2100	7.1	14910
Ring-necked	0.16	10	6.0	60
Canvasback	0.34	20	6.0	120
Scaup	4.0	240	4.5	1080
Ruddy	24.0	1440	4.1	5904
Totals	100.0	6000		35415

B. Lower Klamath Lake

Species	Spec. Comp. By Broods	Successful Nests (Est.)	Av. No. III Broods	Total Prod.
Mallard	31.0	2232	x 5.5	12276
Gadwall	24.0	1728	6.0	10368
Pintail	5.0	360	5.4	1944
Cin. Teal	9.0	648	5.6	3629
Shoveller	9.0	648	4.5	2916
Redhead	10.0	720	6.0	4320
Ring-necked	-	-	-	-
Canvasback	-	-	-	-
Scaup	8.0	576	5.0	2880
Ruddy	4.0	288	3.4	979
Totals	100.0	7200		39312

Table 8

Estimated Production, 1947
A. Tule Lake

Species	No. I Broods	<u>Habitat-Ratio</u>		Av. No. III Broods	Totals
		Brood Season x	Count Sample		
Mallard	23	3	5.6	5.4	2086
Gadwall	12	2	5.6	5.3	725
Pintail	-	3	5.6	4.2	70
Cin. Teal	12	3	5.6	5.6	1130
Shoveller	-	3	5.6	5.3	90
Redhead	250	1	5.6	5.5	7700
Canvasback	-	-	5.6	5.5	30
Scaup	3	1	5.6	5.5	92
Ruddy	117	1	5.6	4.4	2882
Totals	417				14805

B. Lower Klamath Lake

Species	No. I Broods	<u>Habitat-Ratio</u>		Av. No. III Broods	Tot.
		<u>Habitat Factor x</u>	<u>Brood Season x</u> <u>Count Sample</u>		
Mallard	116	$\frac{1}{3}$	3	5.4	10711
Gadwall	172	$\frac{1}{3}$	2	5.5	10784
Pintail	6	$\frac{1}{3}$	3	5.5	564
Cin Teal	27	$\frac{1}{3}$	3	5.0	2308
Shoveller	8	$\frac{1}{3}$	3	5.3	725
Redhead	44	$\frac{1}{3}$	1	5.6	1404
Canvasback	2	$\frac{1}{3}$	-	3.0	35
Scaup	23	$\frac{1}{3}$	1	5.7	690
Ruddy	1	$\frac{1}{3}$	1	11.0	62
Totals	399				28030

Table 9

Revised Estimate of Production, 1946
A. Tule Lake

Species	No. 1 Broods	<u>Habitat-Ratio</u>		No. III Broods	Totals
		Brood Season	Count x Sample		
Mallard	25	3	6.7	5.5	2763
Gadwall	35	2	6.7	6.5	3048
Pintail	1	3	6.7	6.6	132
Cin. Teal	-	3	6.7	7.4	148
Shoveller	2	3	6.7	4.2	168
Redhead	111	1	6.7	7.1	5280
Ring-necked	-	-	6.7	-	6
Canvasback	-	-	6.7	6.0	40
Scaup	12	2	6.7	4.5	678
Ruddy	73	1	6.7	4.1	2005
Totals	259				14268

B. Lower Klamath Lake

Species	No. 1 Broods	<u>Habitat-Ratio</u>		Av. No. III Broods	Totals
		Brood Season	Count x Sample		
Mallard	54	3	15	5.5	13365
Gadwall	41	2	15	6.0	7380
Pintail	9	3	15	5.4	2187
Cin. Teal	12	3	15	5.6	2968
Shoveller	12	3	15	4.5	2385
Redhead	16	1	15	6.0	840
Ring-necked	-	-	-	-	-
Canvasback	-	-	-	-	-
Scaup	11	2	15	5.0	1650
Ruddy	6	1	15	3.4	306
Totals	161				31081

Table 10

Water Levels,
in feet above sea level*

Tule Lake

1946		1947	
July	9 - 4033.69 feet	June	16 - 4034.08 feet
	16 - 4033.78 feet		23 - 4033.94 feet
	23 - 4033.79 feet		30 - 4033.81 feet
	30 - 4033.81 feet	July	7 - 4033.82 feet
Aug.	6 - 4033.93 feet		14 - 4033.78 feet
	13 - 4033.93 feet		21 - 4033.67 feet
	20 - 4034.02 feet		28 - 4033.75 feet
	27 - 4033.98 feet	Aug.	4 - 4033.74 feet
Sept.	3 - 4034.05 feet		11 - 4033.77 feet
	10 - 4034.01 feet		18 - 4033.67 feet
	17 - 4033.83 feet		25 - 4033.65 feet
	24 - 4033.83 feet		31 - 4033.63 feet

Lower Klamath Lake

1946		1947	
July	12 - 4077.22 feet	June	18 - 4076.80 feet
	15 - 4077.24 feet		21 - 4076.75 feet
	19 - 4077.10 feet		25 - 4076.62 feet
	22 - 4077.08 feet	July	2 - 4076.42 feet
	29 - 4076.98 feet		10 - 4076.18 feet
	31 - 4076.90 feet		16 - 4076.04 feet
Aug.	6 - 4076.66 feet		23 - 4075.78 feet
	12 - 4076.54 feet		30 - 4075.70 feet
	15 - 4076.46 feet	Aug.	6 - 4075.42 feet
	22 - 4076.36 feet		13 - 4075.14 feet
	28 - 4076.36 feet		20 - 4074.86 feet
	30 - 4076.34 feet		27 - 4074.58 feet
Sept.	9 - 4076.34 feet		

* Readings for Tule Lake from U. S. Bureau of Reclamation;
for Lower Klamath Lake from gauge in Unit 4.
Readings made by author.

Chapter 3

Brood Counts - Geese, Grebes, Coots, and Shorebirds

When brood counts began in 1946, the young Canada geese had reached class III age, and no younger birds were seen. Further, the goslings had gathered in large groups, especially on Tule Lake. Mr. Sargeant took advantage of this "bunching" and censused the groups, and it was believed that the total presented a fairly accurate picture of the year's production on Tule Lake. His figures follow:

Sump Basin No. 1	400
Sump Basin No. 2	400
Water area adjacent to Winema farms	500
Channel between Sump Basins No. 1 and 2	600
Total	1900

In addition, seven broods of Canada geese with 38 young were counted on Tule Lake, giving an average of 5.4 per brood, and a pair of lesser snow geese raised a brood of three young (9,p.126).

On Lower Klamath Lake, 85 Canada goose broods with 445 young entered into the counts. This gave an average of 5.2 per brood. Field observations indicated that there were fewer geese here than on Tule Lake, and on a comparative basis the estimated production was set at 1300.

Brood counts on other birds were not representative, and because of insufficient data, no estimate of production was presented for these birds for 1946. These miscellaneous counts follow:

Table 11

Miscellaneous Brood Counts, 1946,
A. Tule Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
E. Grebe	40	77	1.9	47	82	1.7	7	8	1.1	94	167
P.B. Grebe	7	13	1.9	4	7	1.7	-	-	-	11	20
Coot	6	15	2.8	24	81	3.4	12	56	4.6	42	152
Totals	53	105		75	170		19	64		147	339

B. Lower Klamath Lake

Coot	10	23	2.3	17	69	4.1	15	57	3.8	42	149
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In 1947, brood counts were made on geese, coots, grebes, and shorebirds, and estimates of production were made for geese, grebes, and coots. These findings are given in tables at the end of this chapter, as follows:

- Table 12 - Brood Counts, Grebes, Geese, Coots and Shorebirds, 1947
- Table 13 - Total Brood Counts, Grebes, Geese, and Coots
- Table 14 - Estimate of Production, All Species, 1947
- Table 15 - Species Composition of Breeding Population, All Species, 1947

In giving brood sizes for grebes, tables 12 and 13 present matter worthy of further research. Bent (2,p.5; p.30-31) gives three or four eggs as the usual clutch size for the western grebe and four or five for the eared grebe,

while on the two lakes under consideration class I grebe broods were usually two chicks and less frequently three. The average was 2.2 for the eared grebe and 2.5 for the western grebe in counts made by refuge personnel and 2.1 in counts made by the author. While low incubation temperatures will probably be the rule for these species, it may be that wet nesting materials and exposure of the under surface of the eggs to cold water result in a high loss of embryos. It will be seen, also, that losses after hatching were minor and that the average class III brood allowed only for maintenance of the species. As a balance to this last factor, the bird's remarkable aquatic ability probably holds down post-breeding losses and may be combined with a comparatively long adult life.

Brood sizes for Canada geese, in the same tables, contrast with those for ducks in that the average class I brood is somewhat smaller, 6.8 and 7.4 respectively (Table 4), while the average class III brood is practically the same. The greater size of the bird evidently has value in saving lives of the young. With coots, the small size of class I broods is worthy of note. It probably means that the time was well past their normal breeding season and raises the question as to whether clutch sizes were smaller or viability was lowered.

In the estimate of production in table 14, the figures for Canada geese and western grebes on Tule Lake were based

largely on counts made by refuge personnel. These were made at the height of the breeding season for the two species, whereas the author's counts on these early-nesting birds began so late as to furnish insufficient material. For Lower Klamath Lake, the estimate of production for Canada geese was made on a comparative basis. Field observations showed that geese had decreased on Tule Lake since 1946 but had increased on Lower Klamath Lake and were more numerous there than on Tule Lake. It represented a shift in population. Grebes, although not shown in counts, also formed part of the breeding population on Lower Klamath Lake. Although present in lesser numbers than on Tule Lake, they were found mainly in unit 12 whose deeper waters were less affected by the general lowering of the water level. Only a fringe of this portion of the lake was sampled in the counts.

Of the shorebirds, avocets and black-necked stilts were present, especially on Lower Klamath Lake, and in noise and numbers constituted a distinctive portion of the breeding population. A small breeding population of Wilson's phalaropes was found on Lower Klamath Lake, and a few western willets were noted as breeding on Tule Lake. Adult killdeer with young were also seen on Lower Klamath Lake. No estimates of production are presented for these birds nor for any of the colony-nesting birds - herons, cormorants, and pelicans - that also were present in large numbers.

In table 15 the percentages for species composition of breeding population agreed in general with field observations. In addition, they bring out that it took a large number of grebes to raise the same number of young as did ducks. They emphasize, further, the fact that Lower Klamath Lake was predominantly a duck producing lake, appealing especially to puddle or marsh ducks like the mallard and gadwall. Tule Lake, on the other hand, attracted diving birds. The figures in table 15 showed its acceptability as a grebe habitat, and those in table 5 showed that it furnished a favorable environment for redheads and ruddy ducks, both diving species.

Table 12
Brood Count - Grebes,
Geese, Coots, and Shorebirds, 1947,
A. Tule Lake

Species	June			July			August			Total		
	I	II	III	I	II	III	I	II	III	I	II	III
Eared grebe	-	-	-	298/641	182/383	-	156/354	1213/2553	50/100	454/995	1395/2936	50/100
				2.2	2.1		2.3	2.1	2.0	2.2	2.1	2.0
Western grebe	*300/750	150/300	50/100							300/750	150/300	50/100
	14/28	28/60	1/2	3/8	37/77	55/114	-	1/2	126/260	17/36	66/139	182/376
	2.5	2.0	2.0	2.7	2.1	2.1			2.0	2.5	2.0	2.0
Pied-billed grebe	3/6	-	-	2/2	6/12	2/3	1/2	-	-	6/10	8/12	2/3
	2.0			1.0	2.0	1.5				1.6	2.0	1.5
Canada goose	*54/367	25/142	15/90							54/367	25/142	15/90
	-	1/3	38/208	-	-	129/651	-	-	33/188	-	1/3	200/1047
	6.8	5.6	5.6			5.0			5.7	6.8	5.6	5.3
	47/127	34/110	-	23/70	128/512	17/70	22/69	79/342	391/161	892/266	241/984	408/1688
Coot	2.7	3.2		3.0	4.0	4.1	3.1	4.3	4.1	2.9	4.0	4.1
	1/2	1/1	-	-	-	1/3	-	-	-	1/2	1/1	1/3
Willet												
	-	-	1/1	1/1	2/5					1/1	2/3	1/1
Avocet												
Bl.-n. stilt	-	1/3	-	2/2	-	3/11	-	-	-	2/2	1/2	3/11
												3.7

*Counts by refuge personnel.

The same explanation as to age classes and arrangement of figures applies to this table as to tables 1 and 2.

Table 12
Brood Count - Grebes,
Geese, Coots, and Shorebirds, 1947,
B. Lower Klamath Lake

Species	June			July			August			Total		
	I	II	III	I	II	III	I	II	III	I	II	III
<u>Eared grebe</u>												
<u>Western grebe</u>												
<u>grebe</u>												
<u>Pied-billed</u>												
Canada goose	-	1/2	20/125	-	-	213/1077	-	-	95/517	-	1/2	328/1719
			6.2			5.0			5.4			5.2
Coot	-	-	-	4/9	16/63	9/34	-	-	2/16	4/9	16/63	11/50
				2.2	4.0	3.8			8.0	2.2	4.0	4.5
Killdeer	-	3/8	-	-	2/4	-	-	-	-	-	5/12	-
											2.4	
<u>Willet</u>												
Avocet	5/10	53/55	2/4	3/5	12/25	39/99	-	-	2/7	8/15	45/80	43/110
	2.0	1.7	2.0	1.7	2.1	2.6			2.5	1.9	1.8	2.5
Bl.-n. stilt	2/3	-	1/3	1/1	5/10	18/46	-	-	-	3/4	5/10	19/49
	1.5				2.0	2.5				1.3	2.0	2.5
phalarope	-	-	-	1/1	1/2	-	-	-	-	1/1	1/2	
<u>Wilson's</u>												

The same explanation as to age classes and arrangement of figures applies to this table as in tables 1 and 2.

Table 13

Total Brood Counts,
Grebes, Geese, and Coots,
1947

A. Tule Lake

Species	Class I			Class II			Class III			Totals	
	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.	Av.	Brds.	Yng.
E.Grebe	454	955	2.2	1395	2936	2.1	50	100	2.0	1899	3991
W.Grebe*	300	750	2.5	150	300	2.0	50	100	2.0	500	1150
W.Grebe	17	36	2.1	66	139	2.1	182	376	2.0	265	551
P-B.Grebe	6	10	1.7	6	12	2.0	2	3	1.5	14	25
Can.Goose*	54	367	6.8	25	142	5.6	15	90	6.0	94	599
Can.Goose	-	-	-	1	3	3.0	200	1047	5.2	201	1050
Coot	92	266	2.9	241	964	4.0	408	1688	4.1	741	2918
Totals	923	2384		1884	4496		907	3404		3714	10284

B. Lower Klamath Lake

E.Grebe	-	-	-	-	-	-	-	-	-	-	-
W.Grebe	-	-	-	-	-	-	-	-	-	-	-
P-B.Grebe	-	-	-	-	-	-	-	-	-	-	-
Can.Goose	-	-	-	1	2	2.0	328	1719	5.2	329	1721
Coot	4	9	2.2	16	63	3.8	11	50	4.1	31	122
Totals	4	9		17	65		339	1769		360	1843

*Brood counts made by refuge personnel prior to June 15.

Table 14

Estimate of Production,
All Species, 1947
A. Tule Lake

Species	Habitat-Ratio				Brd.Tot.
	Cl. I Brds.	Brd.Seas.	x Count	Sam. Av.Cl.III	
E.Grebe	454	1	5.6	2.0	5085
W.Grebe	317	1	5.6	2.0	3550
P-B.Grebe	6	3	5.6	1.5	150
Can.Goose	54	1	5.6	5.3	1603
Coot	92	3	5.6	4.1	6337
Totals	923				16725
Ducks	417	(Table 8)			14805
Totals	1340				31530

B. Lower Klamath Lake

Can. Goose					2500
Coot	4	3	11.5	4.5	621
Totals	4				3121
Ducks	399	(Table 8)			28030
Totals	403				31151

Table 15

Species Composition of Breeding Population,
All Species, 1947
A. Tule Lake

Species	Broods Counted	Percentage
Eared Grebe	1899	40.1
Western Grebe	765	16.2
Pied-billed Grebe	14	0.3
Canada Goose	295	6.2
Ducks, All Species	1020	21.1
Coots	741	16.1
Totals	4734	100.0

B. Lower Klamath Lake

Eared Grebe	-	-
Western Grebe	-	-
Pied-billed Grebe	-	-
Canada Goose	329	17.9
Ducks, All Species	1477	80.4
Coot	31	1.7
Totals	1837	100.0

Chapter 4

Adult Populations

Censuses supplementary to the brood counts had value in shedding light on composition and movements of adult populations. In 1946, a census by direct count on August 5 on Tule Lake gave the following figures:

Ducks, grebes, and coots	9861
Canada geese	540
Lesser snow geese	14
White-fronted geese	6
White pelicans	102
American and snowy egrets	51
Shorebirds (sandpipers, phalaropes, dowitchers)	55
Terns	34
Totals	10663

In addition to these birds, four swans spent the summer on Tule Lake but were not seen on this particular day. Local movements involving birds raised in the immediate general area had a day-by-day effect of swelling the figures almost from the beginning. A count made on September 3 over the same route gave a total of 18,992.

These last figures also showed the beginnings of the fall migration but are incomplete in not presenting a breakdown of resident birds as was done in the August census. The first flock of migrant white-fronted geese had been

noted as passing over Tule Lake Headquarters on August 23, and the September 3 count had included 1470 white-fronted geese and 925 cackling geese, all recent arrivals. The next few days brought a torrent of ducks and geese. A count made on September 6 of birds reasonably recognizable as new arrivals listed 10,965 white-fronted geese, 949 Canada geese, 475 cackling geese, one lesser snow goose, and five swans. On this same day Mr. Sargeant made a field survey of Tule Lake and estimated the birds present as 22,000 white-fronted geese, 3000 other geese, and 250,000 ducks.

Corresponding censuses on Lower Klamath Lake gave the following results:

Birds	August 6	September 4
Ducks, grebes and coots	11283	8426
Canada geese	870	357
Cackling geese	-	361
White-fronted geese	-	5
Pelicans and cormorants	432	-
Heron and egrets	652	172
Shorebirds	2411	1658
(avocets, stilts, dowitchers)		
Gulls and terns	719	325
Totals	16367	11304

The decrease in ducks, grebes, and coots may be explainable in part on the basis of local migration to Tule Lake. Comparison of the September 4 figures with those of the day before at Tule Lake shows that apparently the newly arrived white-fronted and cackling geese preferred Tule Lake over Lower Klamath Lake, and perhaps the resident

birds also found something at Tule Lake that was lacking at Lower Klamath. A possible repellent effect of a botulism outbreak, then in full swing on Lower Klamath Lake, might have played a part. The decrease in herons and egrets, shorebirds, and gulls and terns may have been from a beginning movement of these birds to their wintering grounds.

Pelicans were not seen in the course of the census of September 4. Earlier they had been present in large numbers. The following quotation, corrected from a grammatical standpoint, is taken from the author's report (unpublished) at the conclusion of the 1946 brood counting season.

"White pelicans were present on Lower Klamath Lake in such numbers as to suggest what Will L. Finley might have seen when he made his famous visit many years ago. One of the refuge men on the south shore of the lake saw on July 9 a flock that he estimated at 2000 birds. Later, following the dike between units 9 and 12, I saw these birds fishing." They had found a school of fishes sufficient in size to attract the entire flock and, in flock formation, were driving them in the shallow water.

"They (the birds) extended in a great, long line with the ends incurved like horns. Birds in the front rank fished with vigorous plunging of beaks and with wing-splashed water showering themselves and their neighbors. Those falling to the rear added to the confusion by taking wing in leapfrog fashion to regain their place in front in the place of advantage. The noise of threshing wings and splashing water was bewildering. Finally the school of fish escaped, and the flock gradually took wing, breaking up as they did so into long lines that settled onto the partially-washed out dikes well to the north. There, resting in the sunshine, the white flock looked like a snow bank on the lake's rim. I estimated that I saw 2000 to 3000 pelicans fishing at that one time."

Possibilities inherent in censusing were not clearly

appreciated, and the census figures preceding the quotation, taken from field notes, were not included in the 1946 report. In 1947, only one census was made through the course of the season. In this, direct counts were almost entirely abandoned, and the effort was directed mainly toward finding concentrations of birds and getting an estimate of their numbers. These gatherings were largely composed of ducks, both adults freshly molted into their fall plumage and flying young of the year broken away from the brood organization. A census made in this manner on July 30 on Lower Klamath Lake revealed 81,600 birds, and another made on August 12 on Tule Lake gave 67,000 birds.

Chapter 5

Disease and Predation

An outbreak of botulism on Lower Klamath Lake in 1946 has been mentioned as exerting a possible repellent effect and thus causing an influx of birds to Tule Lake. The presence of numerous dead ducks suggests itself as arousing a degree of apprehension, but this would be difficult to prove. The living ducks might not be able to recognize the dead ones as such. Other factors need be considered.

This disease outbreak on Lower Klamath Lake centered in units 4, 5, and 7. The count of sick and dead ducks that follows included only those birds whose condition indicated that they probably had died during the preceding twenty-four hours and those so sick that recovery was hopeless. This count was as follows:

Date - Sick and dead birds		
July	29	12 (unit 6)
July	31	1 (unit 12)
August	1	9 (units 4 and 9)
August	6	23 (units 4 and 7)
August	12	69 (units 4 and 7)
August	15	32 (units 5 and 6)
August	19	122 (units 4 and 7)
August	27	25 (units 4 and 9)
August	28	218 (units 4 and 7)
Totals		511

Field work ended on Lower Klamath Lake on the last day given, and the disease was showing little or no signs of diminishing in intensity. During the same interval of time, July 29 to August 28, thirteen sick and dead ducks were counted on Tule Lake.

The next year Tule Lake witnessed an outbreak of botulism, while Lower Klamath Lake was relatively free of the disease. Bodies that could be reached from shore by means of a long-handled rake and others lying along the shoreline were hauled away and destroyed. Between July 28 and August 28 the following birds were disposed of in this fashion:

Mallards	104
Pintails	81
Balpate	1
Green-winged teal	9
Cinnamon teal	1
Shoveller	2
Redhead	3
Ruddy duck	1
Unidentified ducks	7
Coot	1
Killdeer	2
Avocet	5
Black-necked stilt	1
Western sandpiper	1
Ring-billed gull	1
California gull	1
Black-crowned night heron	1
Total	222

It will be seen that the Tule Lake outbreak was much less severe than that on Lower Klamath Lake the year before. One of the birds on the Tule Lake list, a pintail, was thought to have probably died of lead poisoning because of its extreme emaciation. Between the same dates, July 28 to

August 28, the following sick birds were noticed on Lower Klamath Lake:

Mallards	6
Pintail	1
Redhead (extreme emaciation, probably lead poisoning)	1
Ring-billed gull	1

Predation by sea gulls, involving downy young, placed another drain on the population. The following is quoted from the author's 1946 report (unpublished):

"On July 17 a California gull took advantage of a mallard brood that had become slightly scattered. The gull had been resting on the water nearby. When it had its chance, it seized a duckling and took wing, swallowing it in mid-air. It returned and circled overhead while the distracted hen splashed through and around her brood. The gull seized another, was forced to drop it when the hen attacked, then followed the duckling as it dived, and took it again as it came to the surface.

"On the same day three gulls attacked a brood of ruddies and took four young. Their cooperation was not conscious. The hen made a dash at a gull, and another that came by ... swooped. Then the third gull, attracted by the commotion, came. Later, I saw one duckling taken from a redhead brood and an unsuccessful attack on a coot brood. In this case both parents defended their young."

Another item from the same report went as follows:

"Ducks with broods frequently showed concern when gulls were nearby. Sometimes they made threatening motions or, if the gull was swimming, kept between it and the brood."

Further material on this subject was included in the 1947 report (unpublished). The following observations, referring to Tule Lake, are taken from this source:

"While making brood counts, I noticed some predation by California gulls. The attacks, three in number, were all on Redhead broods and all took place in the channel between the two sumps. The gull succeeded in two cases, getting one duckling each time. In the third attack I could not be sure if the gull had caught a duckling. This (the attack) took place on the water, and the hen duck managed to seize the gull by the feathers and beat it a time or two with her wings, thus repelling further attack."

The same report contained the following observations made on Lower Klamath Lake. They follow:

"I saw nine attacks by California gulls on duck broods. In five successful attacks, the gulls got eight ducklings. In some cases one or more gulls were attracted to the scene, resulting in the loss of three ducklings in one case and two in another. Of defense reactions noted, twice I saw gadwall hens come to help broods under attack. I also saw that under persistent attack broods tended to combine into groups of thirty or more ducklings under charge of several hens. Apparently gulls had no success with these larger groups; all the successful attacks were on single broods."

These notes point to a need for further study on the subject. On the basis of field observations, ducklings were most vulnerable to attacks by gulls from the time they first took to the water until they were three or four days old. Most of the no. 1 broods entering into the counts were older than three days and were therefore at or near a size that would make them safe from further molestation. The average brood size given in Tables 3 and 4 for no. 1 ducklings - 7.7 on Tule Lake and 6.8 on Lower Klamath Lake in 1946 and 7.4 on Tule Lake and 6.7 on Lower Klamath Lake in 1947 - presents a gap in knowledge covering those first

three or four days. Fertility is high among ducks, and clutch sizes commonly range from eight to fifteen eggs. The inference is that predation by gulls had a deleterious effect on duck populations on both Tule Lake and Lower Klamath Lake. This possibility is emphasized by comparing clutch size as given by Gabrielson and Jewett (7,p.123) for the Canada goose - "4 to 10, usually 5 or 6" - with the 6.8 average given in Table 12 for no. 1 broods on Tule Lake in 1947. Protected by its larger size, the Canada goose evidently realized a reproductive potentiality denied the smaller ducks.

The 1947 also contained a notation on destruction of nests and eggs (Plate 5). This, referring to Lower Klamath Lake, follows:

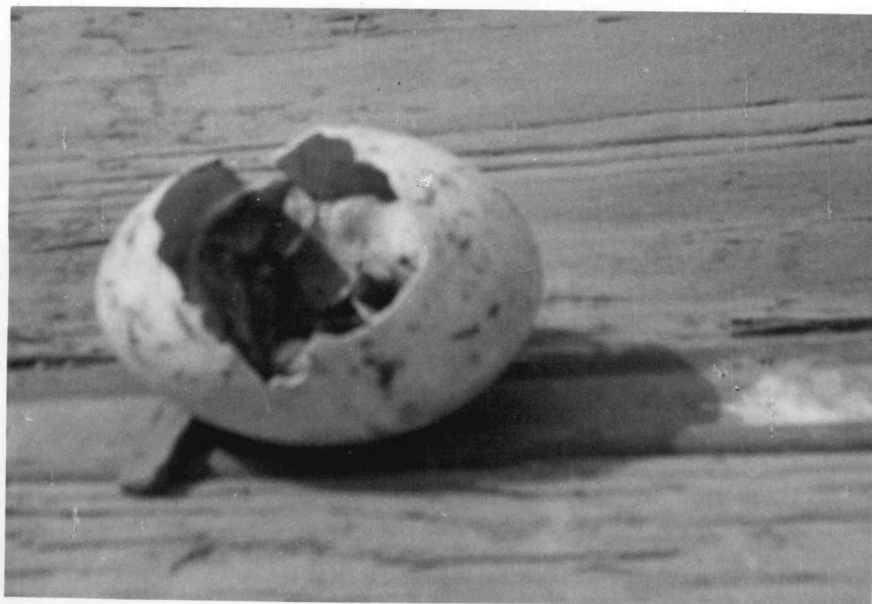
"In respect to nest destruction, I found 68 duck eggs that had been opened by some predator, probably weasel, on the dikes between units 9 and 12 and units 9 and 4, The eggs, all carried from the nests up to the top of the dike, had been opened on the side. I also found one goose egg and one stilt egg opened in the same way. On the dikes between units 4 and 7 I also found six duck eggs destroyed in the same fashion."

As to predation by hawks and owls, one instance was noted of a bald eagle feeding on a freshly killed coot. It was perched on a dike tearing out pieces of flesh while a great number of coots in a tight semicircle all faced the eagle, watching the proceedings. They were apparently drawn together through fear of the common danger and at the same time emboldened by numbers. No other such predation

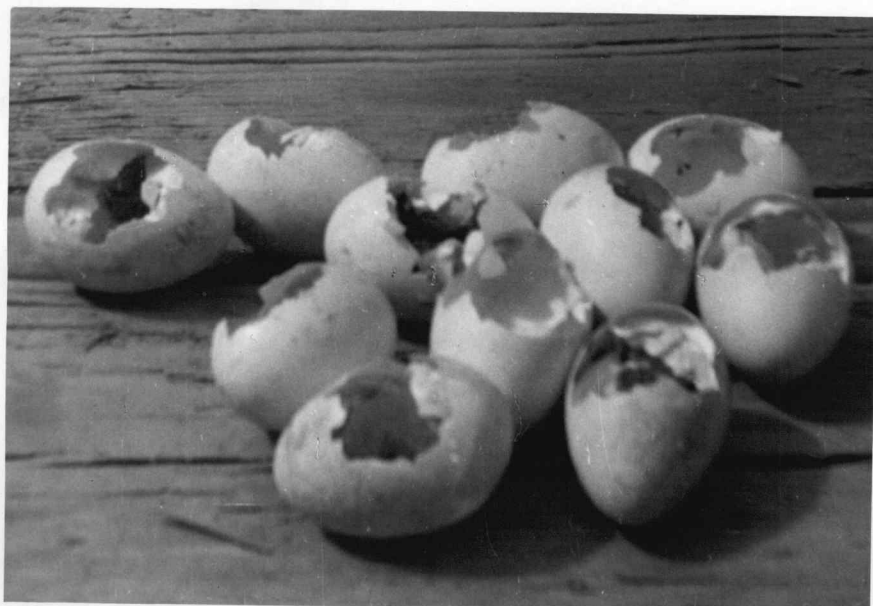
was noted. Marsh hawks were common, but no instances were seen where the presence of this hawk appeared to arouse concern on the part of ducks or other birds with broods.

Of hawks preying especially on birds, a duck hawk was seen on September 4, 1946, at Lower Klamath Lake. It was partially paralyzed and had evidently contracted botulism. On the next day, September 5, a gyrfalcon was seen at Lower Klamath Lake. This sight record, noted in the author's 1946 report, was considered as extremely improbable, but two years later, on October 23, 1948, it received unexpected support through collection of a specimen about two miles west of Lower Klamath Lake (11,p.233).

Plate 5



A. Canada Goose Egg Destroyed by Predator



B. Gadwall Eggs, Nest Destroyed by Predator

Chapter 6

Summary

The Klamath Basin of southern Oregon and northern California, containing Lower Klamath Lake and Tule Lake, has long been famous for its wildlife. Of the two refuges at these lakes, Lower Klamath National Wildlife Refuge now contains about 20,000 acres of marsh and water area, and Tule Lake National Wildlife Refuge about 13,000 acres. The United States Fish and Wildlife Service, administering the refuges, wished to get some measure of their productivity. Accordingly, the author was assigned to the administrative headquarters at Tule Lake on July 9, 1946, with the purpose of making brood counts of various water birds and using these counts in arriving at an estimate of young birds produced. As his work, terminating in September, continued through the brood season, he kept notes on factors, such as disease and predation, that would affect population. The following year the work began June 16 and again terminated in September.

Counting in both years was done by car and on foot and with the aid of eight-power field glasses. Broods were

counted by species, number in brood, and approximate age. Age was indicated as class I, class II, or class III. Results were presented in tables. Common species were noted as well as those occurring less frequently. The number of broods counted, in terms of percentage, gave the species composition of the breeding population. Comparison of these percentages for the two years showed shifts in population. Other tables, based on preponderance in the counts of one or the other of the age classes into which the ducklings were divided, reflected comparative lengths of the brood seasons.

An estimate of production for 1946 was then presented. The final figures were reached by estimating the breeding population at the beginning of the nesting season and using these figures with sex ratios and percentages of nesting success obtained from other studies. This method was abandoned in 1947 in favor of what was considered a more objective approach. Habitat-ratio, based on environmental and other factors, was multiplied by the number of class I broods to give the number of broods produced. This, multiplied by the average class III brood, gave the final figures.

Of other birds, the figure for production of geese for 1946 was based on direct count on Tule Lake and established for Lower Klamath Lake on a comparative basis. No estimate of production was prepared for other birds in that year,

but in 1947 an estimate was made for all species of water birds. Censuses were taken during progress of the work. The California gull was noted as a predator on ducklings in the downy young stage, and destruction of eggs was commented upon.

In conclusion, the method of estimating production used in 1947 was considered an improvement over that used in 1946. It was a more objective method, and the final figures were felt to be more representative of the true picture. Further work is needed to bring out the value in using those factors included under the term, habitat-ratio, in reaching an accurate estimate of production on any water area.

Common and Scientific Names of Birds

Included in Study

The following birds were included in the census categories or seen during progress of the brood counts. Among them are some, as noted, seen by refuge personnel and others not specifically mentioned in the text. The names are according to the A.O.U. Check-List of North American Birds, 1931 edition, and supplements to the check-list issued subsequent to this edition.

Holboell's grebe (Colymbus grisgena holboellii), one adult in changing plumage was seen on Lower Klamath Lake on August 15, 1946.

Eared grebe (Colymbus nigricollis californicus)

Western grebe (Aechmophorus occidentalis)

Pied-billed grebe (Podilymbus podiceps podiceps)

White pelican (Pelecanus erythrorhynchos)

Farallon Cormorant (Phalacrocorax auritus albociliatus)

Treganza's blue heron (Ardea herodias treganzai)

American egret (Casmerodius albus egretta)

Brester's egret (Leucophoryx thula brewsteri)

Black-crowned night heron (Nycticorax nycticorax hoactli)

American bittern (Botaurus lentiginosus)

Western least bittern (Ixobrychus exilis hesperis), an adult with a broken wing was seen by refuge personnel on Lower Klamath Lake, June 10, 1946.

White-faced glossy ibis (Plegadis guarauna), three were seen by the author on Tule Lake in September, 1947.

Whistling swan (Cygnus columbianus)

Common Canada goose (Branta canadensis canadensis)

Cackling goose (Branta canadensis minima)

Black brant (Branta bernicla nigricans), a few were seen by Mr. Sargeant on several occasions during the summer of 1947 on Lower Klamath Lake.

White-fronted goose (Anser albifrons albifrons)

Lesser snow goose (Chen hyperborea hyperborea)

Common mallard (Anas platyrhynchos platyrhynchos)

Gadwall (Anas strepera)

Baldpate (Mareca americana), these birds appeared as early migrants each year and in the botulism outbreak on Lower Klamath Lake in 1946 were a common victim.

American pintail (Anas acuta tzitzihua), another early migrant and also numerous among the 1946 botulism victims.

Green-winged teal (Anas carolinensis), the same can be said for this bird as for the pintail and baldpate.

Blue-winged teal (Anas discors)

Cinnamon teal (Anas cyanoptera cyanoptera)

Shoveller (Spatula clypeata)

Redhead (Aythya americana)

Ring-necked duck (Aythya collaris)

Canvasback (Aythya valisneria)

Lesser scaup duck (Aythya affinis nearctica)

Bufflehead (Bucephala albeola), one female seen on Lower Klamath Lake on August 6, 1946.

White-winged scoter (Melanitta fusca deglandi), one male seen on Tule Lake on August 13, 1946.

Ruddy duck (Oxyura jamaicensis rubida)

Hooded merganser (Lophodytes cucullatus), one adult female and one immature well able to fly was seen on Tule Lake on September 3, 1946.

Western turkey vulture (Cathartes aura teter)

Swainson's hawk (Buteo swainsoni)

American rough-legged hawk (Buteo lagopus sancto-johannis)

Northern bald eagle (Haleitus leucocephus washingtonii)

Marsh hawk (Circus syaneus hudsonius)

Duck hawk (Falco peregrinus anatum)

Gyrffalcon (Falco rusticolus)

Sandhill crane (Grus canadensis tabida)

Little brown crane (Grus canadensis canadensis), six birds were seen several different times during September, 1946, on Lower Klamath Lake, and on the basis of comparative size two were considered as sandhill cranes and four as little brown cranes. In 1947, two cranes stayed throughout the summer in the same general area where the others had

been seen the year before.

American coot (Fulica americana americana)

Killdeer (Charadrius vociferus vociferus)

Long-billed curlew (Numenius americanus americanus),

a few migrants were seen in August in both seasons.

Western solitary sandpiper (Tringa solitarius cinnomomea), one was seen on Tule Lake, August 5, 1946.

Western willet (Catoptrophorus semipalmatus inornatus)

Greater yellow-legs (Totanus melanoleus)

Lesser Yellow-legs (Totanus flavipes), these birds were seen in small, scattered flocks. It was sometimes difficult to tell if they belonged to this species or to the preceding, but two adults with two young seen on Lower Klamath Lake on July 17, 1946, were probably lesser yellow-legs.

Least sandpiper (Erolia minutilla)

Long-billed dowitcher (Limnodromus griseus scolopaceus), these birds appeared as mid-July migrants in spectacular numbers, especially in 1946.

Western sandpiper (Ereunetes mauri), these were seen in mixed flocks with least sandpipers.

Avocet (Recurvirostra americana)

Black-necked stilt (Himantopus mexicanus)

Wilson's phalarope (Steganopus tricolor)

California gull (Larus californicus)

Ring-billed gull (Larus delewarensis)

Foster's tern (Sterna forsteri forsteri)

Caspian tern (Hydroprogne caspia imperator)

Black tern (Chlidonias niger surinamensis)

Barn owl (Tyto alba pratincola)

Short-eared owl (Asio flammeus flammeus)

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