

assignment is hazarded. Its short, stocky proportions and concave anterior profile at once suggest the surf ducks and separate it from the geese. Comparison was made with *Arctonetta fischeri*, *Somateria v-nigra*, *Oidemia deglandi*, and *Oidemia perspicillata*. The closest resemblance is with *Oidemia perspicillata*. From this species it differs in the greater relative thickness of the shaft, the less elevated outer margin of the anterior face, and the greater concavity of this profile longitudinally. At the proximal end the bone shows a different ratio of transverse to sagittal diameter, the sagittal diameter being relatively less. In an uncorroded bone of the fossil species this disparity would be even greater. When viewed from the rear, the fossil shows a degree of flattening in marked contrast with the Recent bird, which has the inner margin much elevated and the plane of the posterior face much inclined toward the outer side. This character of the fossil is due only in part to corrosion. The inner trochlea is raised and is slightly separated from the middle trochlea, as compared with the Recent bird.

A single vertebra in the collection represents an anserine species about the size of *Branta canadensis*. It may properly have come from an individual of the species under discussion.

This species is named in honor of Mr. J. Eugene Law, whose continued efforts, both biological and administrative, have materially advanced the cause of ornithology in the western United States.

Phalacrocorax auritus (Lesson)

There are two fragmentary tarsi in the collection that are not distinguishable from the surviving Farallon Cormorant. The material represents both proximal and distal extremities of the bone and the greater portion of the shaft in each case, so that, despite much corrosion before entombment, the specimens are considered determinable.

Los Angeles, California, April 15, 1925.

PELICANS VERSUS FISHES IN PYRAMID LAKE *

By E. RAYMOND HALL

THE PYRAMID LAKE region of Nevada has acquired great popularity of recent years on account of the excellent trout fishing there. The trout grow to great size. Of the several hundred individuals seen by the writer as taken from Pyramid Lake during the summer of 1924, none weighed less than three pounds, and several were seen that weighed 22 pounds; there are authentic records of much larger ones.

During the past few years, however, the trout have been decreasing in the lakes of that region (Pyramid, Winnemucca and Walker); also, and more especially, in the streams which feed these lakes. Apart from the interest of the sportsman, the fishing industry is of considerable importance for the reason that Reno and the other towns in the region secure a large part of their supply of fresh fish from these waters. Most of this supply comes from Pyramid Lake itself. This lake is a part of the Piute Indian Reservation, and some of the Indians depend as a means of livelihood wholly, and many depend in part, upon the taking and marketing of these fish. Also the

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Indians depend in a great measure upon the trout that they dry for a winter food supply for themselves. Formerly the trout were taken thus late in the fall when they ascended the Truckee River to spawn.

The White Pelicans that nest numerously at Pyramid Lake are seen to catch fish; and many people believe that they destroy large numbers of trout. Local sportsmen and others interested in preserving the fish, especially the trout, have made numerous requests to the United States Department of Agriculture to have the relations of the pelicans to the fishing industry investigated. In answer to these requests the writer was delegated by the Bureau of Biological Survey of the United States Department of Agriculture to make a study of the food habits of both the young and old pelicans, and also to ascertain if possible what have been the causes of the decrease in the number of trout. The work, undertaken in the summer of 1924, was carried on under the supervision of Mr. W. L. McAtee of the Division of Food Habits Research of the Bureau of Biological Survey.

Pyramid Lake is known to have been a breeding place of the White Pelican (*Pelecanus erythrorhynchos*) from the time the first white man settled in the region until the present. According to Indian lore, the birds were there for countless years preceding the advent of white men. Pyramid Lake is situated thirty-three miles northeast of Reno, Nevada. The lake is thirty miles long and five to twelve miles wide. Its long axis extends in a north and south direction. High mountains rise abruptly on the east and west. Low terraced hills separate it on the north from Mud Flat Desert, a part of the Quaternary Lake Lahontan, of which Pyramid Lake is a remnant. On the south are the flats of the Truckee River Valley and low bordering foothills through which the Truckee River, the only stream flowing into the lake, descends. The lake has no outlet, the water being lost by evaporation. Although the water is brackish, and on this account unfit for human consumption except near the mouth of the river, it is not so alkaline as to prevent the existence of plentiful fish life; at least seven native and four introduced species of fish thrive there.

The pelicans of this entire region resort for nesting to Anaho Island, which lies in Pyramid Lake nine miles north of the mouth of the Truckee River and one mile from the east shore of the lake. In this region no other breeding ground is known. The body of this island is three-fourths of a mile in diameter; there is a low narrow peninsula one-half mile long, extending to the southeast, and another of less length extending to the northeast. The island is 400 feet high and flat topped. It has one large terrace 100 feet above the water and other smaller ones at different altitudes, all marking former shore lines. The original rock formations are largely concealed by curious and fantastic coatings of calcareous rock which is formed by the deposition from the lake water on algae. There is no water on the island and vegetation is scanty.

Study of the food habits of the White Pelicans in this region was carried on between May 15 and August 3, 1924. At regular intervals during this time nine visits of one to three days duration were made to Anaho Island to study the food habits of the young. On June 5, thirteen colonies were located, which ranged in size from 11 to 791 nests. No correlation was found between the situation of the colonies and intensity of sunshine, direction of prevailing wind, elevation, occupancy of former colonies, or time of hatching. The colonies were distributed on all sides of the island. In vertical distribution they varied from four feet above water level to the top of the island. One colony was on ground showing no signs of having been occupied in former years. The others were on old nesting sites, as attested by bleached bones of pelicans of varying ages, egg shells, old nest mounds, and dead shrubbery. Several

clearly marked nesting sites of previous years were unoccupied. The two colonies on top of the island hatched at the same time as did one only eight feet above the water.

On this island the two positive distributional factors for location of nesting colonies seem to be level or slightly sloping ground and some loose top-soil. Slight excavations made at all points where these conditions obtained, revealed bones and egg shells of former colonies, except on the newly formed beach from which the water had receded only within the last two years. There are, then, more suitable nesting sites, of various sizes, than there are birds to occupy them, and some changes are made in nesting sites from year to year. One factor possibly determining this choice of different nesting sites from year to year, is the size of each flock as it arrives in the spring, if, as Evermann (1923, p. 18) suggests, the flocks that arrive together nest together.

Even when unoccupied by the white birds, the colonies are discernible at a great distance. This is due to the white excrement that covers the ground and to the paucity of vegetation most of which is killed by occupancy of the birds.

The nests consist of gravel and any rubbish present, which the birds rake into piles. Such piles were found not to exceed 8 inches in height and 2½ feet in diameter. The eggs are laid in the concave tops of these mounds. In the smaller colonies the nests are spaced the distance of the combined lengths of two birds' necks (see Grinnell, 1908, p. 189), but in the larger colonies they are often spaced two feet or less apart.

On June 5 and 6, 4534 nests containing 816 young and 6234 eggs, or a total of 7050 eggs and young, were counted in the 13 colonies, and some eggs were known to have been taken from the colonies before this date. The numbers of nests classified by content were as follows:

Nests with 1 egg.....	1851	Nests with 2 eggs and 1 young.....	1
Nests with 2 eggs.....	2075	Nests with 1 young.....	197
Nests with 3 eggs.....	19	Nests with 2 young.....	214
Nests with 1 egg and 1 young.....	184	Nests with 3 young.....	2

The two colonies on top of the island suffered less than the others from interference by men, both before and after June 6, hence they were better indexes of conditions under natural factors than the others. June 6 most of the eggs in these two colonies were pipped, and all hatched within the next few days; the laying period thus had passed. At this time the two colonies together contained 862 nests with 102 young and 1367 eggs, or a total of 1469 eggs and young. The numbers of nests classified by contents were as follows:

Nests with 1 egg.....	231	Nests with 2 young.....	9
Nests with 2 eggs.....	528	Nests with 1 young and 1 egg.....	70
Nests with 1 young.....	24		

From 607 out of 862 nests having 2 or a potentiality of 2 young, a mode of 2 and mean of 1.72 is obtained. Three was the greatest potentiality found in any one nest. Bendire (1882, p. 130) in speaking of the numbers of eggs found in the nests of this species at Malheur Lake, Oregon, says: "Each of these contained generally two eggs, although three and four to a nest were by no means rare, and occasionally I found as many as five, all evidently laid by the same bird." At Pyramid Lake my observations of nests containing more than two eggs led me to believe, in most cases, that additions to the usual number had come from other nearby nests. Eggs were often found lying about between the nests, and in many cases the shape of one egg in a nest of three suggested that this egg had not been laid by the same bird that had laid the other two.

Early in June single eggs were several times found in the water about low-lying rocks where the pelicans were in the habit of sitting during the day. This habit of occasionally dropping an egg wherever the bird happens to be is known to be common to many species. Hanford (1903, p. 50) in speaking of the White Pelicans at Washoe Lake, Nevada, says: "Three eggs were found a foot under water in June, but no nests have been found for a number of years."

But little is known with respect to the length of the incubation period. In different colonies, several nests containing one egg each on May 29 and two eggs each on June 5 were marked for the purpose of determining the length of the incubation period. Unfortunately all the colonies in which such nests were selected were destroyed by reason of interference by man. Bendire (1882, p. 130) states: "Eggs placed under a domestic hen hatched in twenty-nine days . . .".

From actual counts of 8500 adults made on the island between 12 A. M. and 4 P. M., June 21 and again June 22, and the estimate of 1500 at other places away from the island, based on the average of actual counts previously made at these various other places at the same time of day, the total number of adult pelicans present in the Pyramid Lake region was placed at 10,000. This is, therefore, the largest colony of White Pelicans known to be in existence today.

Seven of the thirteen colonies hatched the first and second weeks in June. All the eggs, with the exception of infertile ones, in each of the colonies hatched within a few days of one another. One colony on May 29 had nests in all stages of development from one nest with one young over half grown and four other nests the eggs in which had hatched, to nests with one fresh egg. The colony in question thus would have shown a more prolonged hatching period than any of the others that did hatch had it not later been destroyed. In five other colonies no eggs at all hatched by reason of interference by man.

The young remained in the nest until they had attained a weight of 3 or 4 pounds. At this stage they were approximately one-third grown. Thereafter, young so marked that they could be identified left the nest during the day but returned to the original nest mound at night, where they were covered by one of the adults. This continued until the young attained a weight of 6 pounds, being then nearly half grown. After this time they would huddle together in "pods" during the night. All old birds would then be congregated along the lake shore. The young also collected in pods during the day, when intruders entered the colony. The birds farthest away showed little fear, and progress was made by those in the rear scrambling both over and around those in front. When the flock came to rest, the heads of the birds were held high and the yellow pouches that fluttered with every breath resembled leaves in a breeze.

Loss of the horny growth on the bills of adults began at the time the eggs commenced to hatch and was practically completed throughout the adult population within a month. Early in June while observing a nesting colony I noted that the birds incubating eggs lacked the horny growth on the bill, while nearly all of those birds that were merely resting about the borders of the colony, not on the nests, possessed the horny growth on the bill. At that time I assumed that the horny growth was present in the males only. However, it appears to be well established that both sexes possess the horny growth on the bill in the breeding season (see Ridgway, 1877, pp. 633-634). If, as seems to be the case, both sexes possess this horny growth during the breeding season, my observation suggests either that the horny growth is retained longer by one sex than by the other, or that it is retained longer by non-nesting birds than by those incubating eggs. Both suggestions might be found to be true. However that may be, this is an interesting point for future observers to determine. The same

is true of the care of the young. Three adults that had just returned to the colony with food for the young were secured and all were females. Two young in one nest and one in another nest were marked with paint and were never observed to have been fed other than by similarly besmeared adults. According to Skinner (1917, p. 180): "Both sexes share in the incubation duties, nest relief taking place near noon each day, and, I have reason to believe, again at midnight." If both sexes share in the duties of incubation it would seem likely that they should also assist in feeding the young, but this is apparently not definitely known.

Practically all the young in the two colonies on top of the island hatched June 7 and 8, and, with the exception of a few runts, remained uniform in size throughout their development. On July 11 an average young one weighed 7 pounds, being half grown; and when I last visited the colony, which was on July 30, the young weighed 11 pounds and could not yet fly. On July 30, young in a colony which hatched May 27 to 29, weighed $12\frac{1}{2}$ to 13 pounds. They were 62 to 64 days old at this time, weighed 1 to 4 pounds less than adults, and were making their first flights. When three-fourths grown the young start stretching and flapping their wings. In this manner these young are soon able to lift themselves a few inches off the ground. Thus by running and flapping the wings they gradually develop the power of flight until the time comes when they start down some steep incline to the water, as the impulse seizes them, or when frightened by intruders, and their flapping wings carry them into the air. They flap awkwardly for a distance, slipping from side to side, and seem always on the verge of crashing to earth, when they at last set their wings more or less firmly and volplane some distance out in the current of air rising against the side of the island. By alternately sailing and flapping they reach the lake and tumble into the water with a huge splash. In such cases the well-wishing observer does, and well can, become a sigh of relief, for not all maiden flights end so well. If the young birds become frightened at the observer, he is a misplaced intruder and causes many precocious attempts at flight that result in young not maintaining the air but plunging to their death down some steep incline or cliff.

Young, in the colonies near the water, descended to the lake when two-thirds grown and swam near shore during the day but returned to the colonies at night. They were enticed to the lake shore by the old birds that fed them. I never observed that the young were led down from the colony directly to the water, but I did see many of the old birds alight some distance from the colony toward the lake when bringing in food, and the young descend to them. In this way the colony would be led a considerable distance in a short time, since, though the adults fed only their own young as indicated by the behavior of the adults and young that I marked, all the young hastened to any adult landing in, or near, the colony. After a few days on the water and along shore the young remained there for the night. However, they soon wandered to other parts of the lake. Young, easily recognized by their short bills, were seen on the west lake shore August 2, fully five miles from the island. They were still being fed by the old birds.

Feces were voided anywhere in the colony. The young birds became more or less covered by it as a result of their habit of collecting in pods. In no place, however, did I find guano in sufficient amounts to be of any commercial importance. Large numbers of dead young and some fish in various states of decay were found at all the colonies. All these combined to produce a characteristically disagreeable odor.

Man is the most destructive enemy of the White Pelican, and, though unintentionally so in most cases, the results of his activities are none the less disastrous. Most of the eggs in one colony, as evidenced by my finding the fresh nest mounds without

eggs, and the tracks of the marauder, had been taken by man. These were probably used for food, since shells were found at a deserted Indian camp on the east lake shore opposite the island, at a later date. Pyramid Lake is annually becoming more and more popular as a fishing and summer resort, and people often visit the pelican colonies as one of the main points of interest at the lake. Winds sometimes arise that prevent these people from leaving the island, and fires are kept burning throughout the night for warmth, which causes all the pelicans on the side of the island on which the fire is built, to remain off their nests. The low temperature at night kills the developing embryos and newly hatched young. In 1924, marooned pleasure seekers were less disastrous in this respect than the Indian fishermen who made two camps near the colonies that, as a result, failed to hatch. In all, 7 colonies of 2609 nests containing 3977 eggs and 6 young were destroyed in this way. In addition, 1250 of these nests contained only one egg, a large proportion of which, when broken, proved to be fresh; thus the laying period was not over. Assuming that when laying was completed, the same relative number of nests with one egg would remain as in the colonies on the top of the island, where the laying period had passed, there would have been only 539 instead of 1250 nests of 1 egg, or a total of 4694 eggs and young, instead of 3983 eggs and young as counted. The old birds are wary and do not return to the nests for some time after being frightened off. This results in many of the young during the day succumbing to the intense heat. Young 1 to 5 days old appear to be more seriously affected when left unprotected in the heat of midday than do those just emerging from the egg, or those more than 5 days old. When frightened off the nests the old birds strike the ground with the feet several times before getting into the air, and in so doing they break large numbers of eggs and cut and mutilate many small young. After the young leave the nests, intruders do harm by causing the young to collect in pods, the smallest and weakest birds being trampled upon and left lying upon the ground completely exhausted and sometimes with broken wings or legs. Later, when the young are two-thirds or more grown, sight of an intruder may cause them to rush over some cliff or precipice, with a high percentage of fatality. Frightening the old birds away from the eggs leaves the latter at the mercy of the California Gulls, large numbers of which are always hovering about.

Considerable mortality is also due to the fact that one egg in a nest of two practically always hatches one to three days before the other, and the larger of the two young pecks, sometimes partially swallows, and otherwise continually persecutes, the smaller. The head and especially the eyes of the smaller young one often become raw from this persecution, and in these extreme cases death always results.

Both young and adults are heavily infested by insect parasites. One kind of Mallophaga parasitizes them externally and another lives attached to the inside of the pouch and roof of the mouth. The latter parasite, with mention of its habitat, was described by Leidy in 1878 (pp. 100-101) under the name *Menopon perale*. Leidy at that time had specimens of this louse from the pouches of White Pelicans taken both in Florida and on the Red River of the North. Inhabitants of the region assert that birds badly infested with lice remain apart from the others. This may be so, but all the adults that I secured had a goodly share. Careful investigation of many trout failed to show any *Dibothrium*, a parasite of trout to which the White Pelican is said to be an intermediate host in some regions.

The potentiality of 7050 young, which excludes eggs known to have been taken by Indians, and eggs that probably would have been laid in incomplete sets, resolved itself by actual counts into 1562 young June 21 and 22, 1404 July 5, and 1048 young July 29. Of these 1048 live young, enough were sick and possessed of broken wings

to prevent probably no more than 950 from leaving the lake. The potentiality of 3067, from the colonies that did hatch, then, produced 950 young able to leave the island. Had the same relative number of young been produced from the potentiality of 3983 in those colonies that did not hatch, as was produced from the colonies that did hatch, 1233 more young would have been able to leave the island. Considering the percentage of nests in these destroyed colonies that would have had one more egg, the number is increased from 1233 to 1453. This, then, holds man responsible for the destruction of 60 percent of the young, and does not take into account eggs taken by Indians for food, eggs broken and young killed by the old birds when frightened off the nests, young killed by collecting in pods or by plunging over cliffs upon the approach of intruders, or destruction of eggs by gulls when the adult pelicans are frightened away from the colonies or by other "natural" causes. My estimate, based in so far as possible upon actual statistics, assigns to the different factors mentioned the following percentage values of total destructiveness to young: man, directly and indirectly, 75 per cent; infertile eggs, annoyance of smaller of two young by larger, insects, gulls and all other natural causes, 25 per cent.

It is interesting to compare the present condition of the pelican colony on Anaho Island with conditions noted by others in earlier years. Ridgway (1877, pp. 627-635) furnishes much interesting information regarding this colony, which he visited in May, 1868. At that time California Gulls also nested on Anaho Island. In 1924 one nest with a single egg, that was subsequently deserted, was the only nest of the California Gull found on this island. While Ridgway makes no estimate of the numbers of pelicans present in 1868, he mentions finding only one colony. This colony was located on the northeast arm of the island and on a site still used for nesting by the pelicans. In 1924 the colony on this point was among those destroyed before they hatched. Ridgway's visit was made in the middle of May and it is probable that not nearly all of the birds had yet begun to nest. At least all had not begun to nest by this time in 1924. In speaking of his visit at this time, Ridgway (1877, p. 630) says: "In May, 1868, the lake was again repaired to, and at this time we found the Pelicans in as great abundance as during our visit the summer previous; . . .". The visit in the summer previous was in August, 1867, and in giving an account of this visit he mentions *thousands* of pelicans being present.

Russell (1885, p. 63) states: "During our visit to Anaho Island in August, 1882, there were two large pelican 'rookeries,' in each of which there were 600 or 800 young birds." In August, 1882, there were, then, 200 to 600 more young pelicans on Anaho Island than there were in late July of 1924. However, considering also the number of young that would have come from the colonies that were destroyed before they hatched in 1924, the number of young in August, 1924, could have been greater by 1000 than the number reported by Russell in August, 1882. We, of course, do not know that colonies were not also destroyed before they hatched in 1882. Very probably they were, if the Indians camped on the island to fish in the surrounding waters. According to statements made by the Indians themselves they have always taken eggs of the pelicans for food and within recent years have practiced this habit less than in former years. On July 7, 1903, Chapman (1908, p. 378) found eight distinct colonies ". . . containing in all, 4000 young Pelicans and one hundred and eighty-nine eggs." Two days earlier in the month, in 1924, only 1404 young pelicans were found on the island. The suggestion may be made that several of the colonies present earlier in the season may not have been noted by Chapman. In 1924 by July the young of many of the smaller colonies had migrated to larger nearby colonies and the number of colonies had been considerably reduced.

Evermann (1923, p. 18) who visited Anaho Island in June, 1917, and on June 3, 1921, found on the latter date thirteen colonies with a total of 2381 nests and estimated the total number of nests on the island at 4181. The number by actual count on June 5 and 6, 1924, was 4534. Evermann (1923, p. 18) estimated that the number breeding on Anaho Island in 1921 was 20 to 30 per cent less than the number that bred there in 1917. Were there 20 per cent more in 1917, the number of nests, based on Evermann's estimate for 1921, would have exceeded 5000. If this be correct, there were more pelicans at Anaho Island in 1917 than in 1924. Figuring on a basis of the colonies that did hatch, there could have been, had not man destroyed part of the colonies, 3561 young pelicans on July 5, 1924. Even this is 439 less than the number found by Chapman on July 7, 1903. While several probable chances of error, which, possibly, may offset one another to some extent, are present in making comparisons between the numbers of pelicans present in 1924 and in previous years, the comparable data that is available tends to show that there has been a decrease in numbers within recent times. Certainly, fewer young were reared in 1924 than in previous years if we may accept the statements of Russell, Chapman, and Evermann.

The adult pelicans are slow on land. They throw the body from side to side as they walk. The young are extremely clumsy, and tumble over any small obstacle that happens to be in their path, and often when there is none, when they try in the least to hurry. The birds are graceful in the air, having great soaring powers and a fairly rapid flight. They seldom demonstrate their swimming powers, usually flying from, instead of swimming from, an intruder. Some young, able to fly only a little, were pursued by me in a motor boat and their maximum swimming speed was estimated at three miles per hour. They did not seem greatly frightened and were perhaps not making their best efforts.

The species is decidedly gregarious, nesting, roosting, and feeding in flocks. The birds are apparently a social lot, adults seldom manifesting hostility toward one another. They are not particularly courageous or curious, taking wing at some distance when approached, and readily deserting their nests during the day. One can, however, with a spot-light, approach them on their nests at night, and here they show considerable courage, striking viciously with their formidable bills when molested; and they often suffer no small amount of annoyance before deserting their nests. They manifest considerable intelligence both in avoiding their enemies and in securing their food. They apparently have a poorly developed system of communication, but are keen observers of the actions of one another, which may, in many ways, compensate for their lack of communication by voice. They post no lookouts about the colonies.

The pelicans prey on various species of fish and in turn furnish considerable food to the California Gulls, large numbers of which are usually to be found about the colonies waiting to dodge in at every opportunity and snatch up fish, as well as, in the earlier part of the season, eggs. Turkey Vultures feed on the carcasses of the young pelicans that die. Three lizards, *Uta stansburiana stansburiana*, *Sceloporus magister* and *Cnemidophorus tessellatus tessellatus*, are found in greater abundance about the pelican colonies than elsewhere on the island, perhaps because insect food is more abundant there.

The adult pelicans begin their daily foraging soon after the first streaks of light appear in the east. Some are to be seen foraging throughout all hours of the day during the incubation period, but many collect in flocks and remain at the sides of the colonies of sitting birds throughout the middle of the day. Others collect on the long southeast arm of the island, on the lake shore, and on low rocks in various parts of the lake. The sitting birds usually leave the nests only in the early morning or late

afternoon or evening. After the young hatch, most of the old birds remain away from the colonies throughout the day, but apparently all return in the evening to the shores of the island to roost. As soon as the young are a few days old, the old birds spend their entire time foraging for their young and themselves, and were to be seen fishing at all hours of the day. Also pelicans were often heard fishing along the shores of the lake in the early hours of the night. Many of the pelicans do not return to the island until well after dark, sometimes returning in flocks of more than a hundred each.

The adults collect where schools of fish are located. When these are some distance out in the lake the fishing is done individually, each bird making quick thrusts of the bill, when the fish of their own accord come to the surface or when driven to the surface by trout that dash through the schools. When the fish are found in shallow water near shore, groups of pelicans align themselves in a semicircle and work toward shore, beating the water with the wings and feet. When they reach shallow water near shore, a general melee results as the birds scoop up the fish.

When pelicans fish individually, several fish are sometimes secured at one scoop of the bill. Generally, however, only one fish is secured at a time and this is accomplished by a quick thrust of the bill. The fish is grasped between the upper and lower mandibles, the point of the bill is raised upward, and the fish slides down the capacious gullet. Fish are not retained in the pouch while more are being secured, but pass directly to the stomach, or to the esophagus if the stomach is filled. Pelicans frequently fish until the esophagus up to the mouth is filled and greatly distended. This condition makes it difficult for the birds to rise from the water.

A clear and simple conception of the way in which this food securing and storing apparatus functions is to imagine an extremely distensible tube widening out at either end, anteriorly into the pouch, and posteriorly into the stomach. The pouch is not a separate receptacle. When food is placed in the pouch and the head is slightly raised the food slides down the gullet. The skin of the pouch, however, being highly elastic, permits the holding of fish in it while the bill is directed downward, and this greatly assists in the capture of a large fish. A mechanical arrangement in the articulation of the lower jaw with the quadrate bone spreads the rami of the lower mandible as the mouth is opened, facilitating the scooping up of fish and the handling of a large one. Sharp longitudinal ridges on the upper mandible also facilitate the holding of fish when grasped between the two mandibles. Some of the adults have the bill decurved. The Indians ascribe this to hard battles with large fish, but I do not see how this could cause the upper mandible to become bent downward.

Only once out of the hundreds of times I saw pelicans attempt to catch fish did I see one do so by diving. In this particular case the pelican was describing a horizontal flight-line fifteen feet above the water, when it suddenly dived head foremost and was completely submerged. In all other cases when I saw pelicans after fish they struck the water with quite a splash and oftentimes extended the feet forward as skids. Skinner (1925, p. 140) also records an instance of a White Pelican diving. This, however, was from a position on the water and not from the air. Another habit, explicable on a basis of seeking food, but noted only after July 15, was that of 12 to 25 birds flying low over the water in single file, with the leader now and then rising and immediately descending to the original level. All the other birds followed the leader's path, making it appear as though they were hurdling an invisible obstacle. The connection between this behavior and fishing was suggested as a possibility by my observing the birds to descend into the water on a school of fish directly after one of these rises as though they had been aloft to better inspect what lay below.

When feeding small young, the old one lays its bill on the ground sidewise and regurgitates food into the pouch for the young one to help itself to. When over half grown the young one thrusts its head down the old one's throat. When they have reached this stage of development all the young of a colony rush to any adult which happens to alight among or near them and attempt to thrust their bills down the old one's throat. The old one is more discriminating, however, as I determined by marking individuals. An adult looks about among the milling group until its own young reaches it, whereupon the young is allowed to thrust its head down the old one's throat. Young, three-fourths grown, in two cases kept the head down the old one's throat 2 minutes, and in a third case $2\frac{1}{2}$ minutes. When this large, the young one thrusts the head as far down the old one's throat as possible, and from the length of its bill and neck it would seem that it must reach the stomach of the old bird. One female was shot immediately after she had finished feeding her two young and the stomach proved entirely empty.

Though as many young as can, crowd around and attempt to thrust their bills down the old one's throat, the latter quickly disposes of them with a few passes of the bill. Even when untouched, they grovel upon the ground and flap the wings in a most ludicrous manner, now and then raising the head slightly as though to steal a glance to see whether their supplications had caused the old one to relent. Young, with the bill in the old one's throat, are loth to cease probing for food and have literally to be thrown and jerked loose by the old bird. They invariably try for more, but one pass of the old bird's bill sets them to groveling on the ground.

After feeding, the young are often so full that they can hardly move about. They readily disgorge their food when molested, after becoming about one-fourth grown, but less readily before this time. When the intruder walks in the opposite direction from the young, they often follow back and pick up this disgorged food.

I did not find that adults left piles of fish about the colonies for the young to feed upon as needed, as some observers have described. The piles so observed were probably the stomach contents of several young pelicans, disgorged in one place. Such a communistic scheme seems improbable, furthermore, since marked individuals fed only their own young, the young seem always to be hungry, and the old birds feeding young proved to be quite lean when shot and appeared to have their entire time fully occupied in securing enough food for their own young.

The White Pelican eats the fish food that is most easily secured. When I first reached the lake, May 13, the Red Sucker was spawning in the shallow water along shore and constituted a part of the food. Lake Minnows constituted a majority of the food items throughout the summer. Lake Chubs were taken in largest amounts early in June while spawning, and a few were secured throughout the season. In July, when hot weather came, Carp came up near the surface of the water and were taken in considerable numbers. Sacramento Perch were taken throughout the season. Catfish were found on three occasions only, June 5, July 18, and July 30. Trout were represented by flesh and mature eggs disgorged July 15 by two young birds. Ribs of these trout were found to correspond in size with those of trout weighing 8 pounds. The minimum and maximum lengths in inches of the other species of fish identified in the food of the pelicans were as follows: Catfish, 4-9; Sacramento Perch, 4-14; Lake Chub, 4-14; Lake Minnow, 3-13; Red Sucker, 8-15; Carp, 1-27.

It should be noted that several trout were found dead in the stagnant pools of water in the lower part of the Truckee River a few days before the trout remains were found on Anaho Island, and that these remains probably represented trout taken

under such conditions. That the White Pelican is a scavenger was demonstrated by their taking Sacramento Perch, Lake Minnows, and Badger flesh that I placed in the water. I doubt that trout are ever taken by pelicans in either of the two lakes, for the reason that trout are deep water fish and hence seldom come within reach of a pelican. I found no evidence of small trout living in the lake. Under conditions of normal water supply the larger individuals of *Salmo henshawi* are said to migrate up the river in the winter months to spawn and return early in the spring, during most of which time the pelicans are not present. These circumstances indicate that the trout found were accidental food items and for this reason they are not included in the table of fish eaten by the pelicans.

The results shown in the following table were arrived at by recording by length the different fish found, and by taking the average weight of the different lengths of each species from several specimens. Stomach contents of the pelicans were weighed to determine capacities. Young of different ages were marked and watched from concealment throughout the day to determine the number of times they were fed. This was usually twice daily. Adults were also marked, and while this resulted in definite data regarding the relation of adults to young, the adults could not be accounted for during most of the day, since they range widely. However, from having observed the activities of the birds as a whole, I feel no hesitancy in saying that the adults also fed themselves twice daily.

Account was kept of the age and weight of young in the colonies, and the amounts of food that they ate at different ages was recorded. For instance, when 10 days old they ate $\frac{1}{2}$ pound per day; 30 days old, 2 pounds per day; 55 days old, 4 pounds per day. Four pounds per day was also found to be the amount eaten by adults. It was concluded that a total of 150 pounds of fish was required to raise one young pelican to the age when it could fly, which was 62 to 64 days. Figuring from the counts made of live young at different dates, the total amount of fish eaten by the young during the summer of 1924, up to the time they could fly, was found to be 493,750 pounds, and 160,000 pounds more from that time to September 30, or 353,750 pounds in all. The 10,000 adult pelicans in the 180 days from April to September that they remained at the lake, consumed 7,200,000 pounds, bringing the total to 7,553,750 pounds or 3,776 tons per season. The fish recorded in the subjoined table are arranged in the order of their economic importance. Catfish are placed first because they are sometimes eaten by both the Indians and the white people of the region. Sacramento Perch are placed second because they are a potential food fish, though I know of only two fishing parties that took and saved them at Pyramid and Winnamucca lakes during the summer of my visit. Lake Chub and Lake Minnow are considered to be of equal rank, since both are seldom utilized by man as food and serve only as food for the trout and fish-eating birds. The Red Sucker apparently figures little in the food of the trout and fish-eating birds and not at all in the food of man. Carp are never eaten by the human inhabitants and are considered a serious detriment to the fishing industry of the region.

Two other fish known to inhabit Pyramid Lake but not recorded among the food items of the White Pelican are the Sand-bar Sucker, *Catostomus arenarius*, of no more economic value than the Red Sucker and less abundant, and the Cui-ui, *Chasmistes cujus*, second in importance only to the trout, since it is an important food fish of the Indians. The fact that the Cui-ui was not recorded among the food items of the pelican in 1924 was due to the low water which prevented it from ascending the river to spawn, at which place the pelicans usually secured it. In the lake it remains in deep water and is never seen.

Not included in the table are the dozens of instances when I have observed pelicans catching fish, which when I went to the spot in a boat, proved to be from schools of Lake Minnow.

FOOD OF WHITE PELICAN AT PYRAMID LAKE, NEVADA

Weights in pounds; percentages are of weight

	<i>Ameiurus nebulosus</i> (Catfish)	<i>Archopites interruptus</i> (Sacramento Perch)	<i>Siphateles obesus</i> (Lake Chub)	<i>Leucidius pectiniifer</i> (Lake Minnow)	<i>Catostomus tahoensis</i> (Red Sucker)	<i>Cyprinus carpio</i> (Carp)	Total	
adults	Number	0	5	7	50	3	7	72
	Weight	0	.7	1.4	11.3	1.4	5.6	20.4
	Per cent	0	3.6	6.7	55.4	7.0	27.2	99.9
young	Number	24	65	248	2370	5	185	289.7
	Weight	2.3	5.3	40.6	350.6	4.2	194.9	597.3
	Per cent4	.9	6.8	58.7	.7	32.6	100.1
total for ads. and yg.	Number	24	70	255	2420	8	192	2969
	Weight	2.3	6.1	42.0	361.9	5.6	200.5	618.4
	Per cent4	1.0	6.8	58.5	.9	32.4	100.0
	Weight for season	30,215	75,537	513,655	4,418,944	67,984	2,447,415	7,553,750

The pelicans wander far in search of food. Early in May large numbers were reported to have visited Washoe Lake, 50 miles southwest of Pyramid Lake, when a portion of the former lake dried up, and to have feasted upon the fish there. When I visited this lake July 9 and 10, only three pelicans were seen. In the latter part of July they began spreading to other parts of the country. Reliable reports of their occurrence at this time were had from Walker Lake, 80 miles southeast of Pyramid Lake. On August 4 a flock of 14, that may have come from Pyramid Lake, was noted on the Humboldt River, 10 miles west of Beowawe, Nevada, 170 miles northeast of Pyramid Lake; and a similar sized flock was seen at this same place again August 11. At these points different species of fish than those at Pyramid Lake would be taken, but there is nothing to indicate that a larger percent of trout or other fish of economic importance would be taken there than at Pyramid and Winnemucca lakes. In fact, the period spent at these two lakes, the breeding season, would seem, from what is known of the food habits of other fish-eating birds, to be the period during which the pelicans were most destructive to economically important fish.

The stomachs of several dozen trout that I examined contained only Lake Minnows and a few Lake Chubs. However, it cannot properly be maintained that pelicans are indirectly detrimental to the fishing industry by their destruction of fish-food of the trout, for, according to my observation, there is a superabundance of Lake Minnows. Schools many yards wide and approximately 100 yards in length have passed under my boat. Furthermore, the pelicans have bred here and presumably fed on the same kind of fish for many years past, during which time a balance seems likely to have been attained. At present certainly the trout and probably the pelicans are being reduced in number by man, so that the amount of the fish-food of these two animals is surely no less, and probably is more, than formerly, granting that other factors have remained the same.

SUMMARY

The White Pelican is not detrimental either directly or indirectly to the fishing industry of the Pyramid Lake region. However, local sentiment is in the main antagonistic toward this bird, because it is *believed* to eat large numbers of trout. With the increasing popularity of Pyramid Lake as a summer resort, and with the present lack of protection accorded this bird, the species will, in no great length of time, cease to breed there.

It is true that trout are decreasing in numbers, both in the lakes and in the rivers of the region. This is due to a multiplicity of causes. Most important of these is the depletion of water in the Truckee River. Formerly, between October and June, the common trout of Pyramid and Winnemucca lakes, *Salmo henshawi*, ascended the Truckee River to spawn. Fish culturists say that this, like some other species of trout, requires running water to insure fertilization of the eggs, hence it cannot reproduce in the lakes. Insufficient water in the Truckee River at the critical season not only prevents most of the fish from reaching their spawning grounds, but results in the death of those fish that do get into the river. On May 17, dozens of *Salmo henshawi*, weighing from 5 to 18 pounds each, were found dead in pools of the Truckee River just below the Indian Reservation Dam. Conditions of this kind have existed in previous years at other dams along the river (see Snyder, 1917, p. 42). The fish could not pass the Indian Reservation Dam because there was no water to flow through the fish ladder. Later in the year fish died along the river in great numbers because of the stagnant condition of what water there was. The stench from decaying fish is said to have become so offensive that, near Reno, men were employed to bury them. This lack of water is the result of dry seasons, construction of the Derby Dam (which is said to divert the water that naturally flowed down the Truckee River into the Carson River), and the general withdrawal of water for irrigation purposes.

Only one of the Nevada irrigation ditches taking water out of the Truckee River has a screen, according to persons familiar with the situation; and this screen was stated to be inadequate. None of the ditches that I examined had a screen. A heavy toll of trout is taken when the fry wander out into the smaller ditches and into the fields. The Derby Dam, the largest of the several dams in the river, has no adequate fish ladder by which the fish may ascend to their former spawning grounds.

Sewage from the several cities and refuse from saw mills and paper mills are emptied directly into the river, and are unquestionably detrimental to the fish life, especially at periods of low water. Some of this refuse is said to accumulate in pools and kill the spawn of the trout.

The critical factor in the welfare of the trout of Pyramid and Winnemucca lakes is the condition of the Truckee River which, for the reasons stated above, no longer permits of the fish ascending to their spawning grounds. Furthermore, the river is

no longer supplying the normal amount of water to the two lakes. Indeed, the level of these lakes goes down several feet each year. The development of other irrigation projects along the Truckee River now under consideration, including the construction of reservoirs, will no doubt further decrease the amount of water reaching Pyramid and Winnamucca lakes.

The White Pelican, then, is probably in no way responsible for the decrease which is so apparent in the number of trout. The causes of this decrease are man-made, and those which are believed to be the most salient have just been pointed out.

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