Owens Lake – From Dustbowl to Mosaic of Salt Water Habitats

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It's hard to call this a lake. The body of water that once covered this basin from shore to shore is gone, having dwindled to a hypersaline pool in the area where it was once deepest after the city of Los Angeles famously diverted the Owens River to support booming growth some 100 years ago. Along with the brine pool though, there is now a mosaic of about 40 square miles of ponded waters of varied extent, scattered across much of the ancient lakebed, maintained not by natural inflow but by a system of irrigation pipes and sprinklers.

The Owens Lake basin is located at the southern end of the Owens Valley, at about 1,080 m elevation, surrounded by the southern Sierra Nevada on the west and the Inyo Mountains to the east. Although located in an arid desert climate, the Sierra snowpack delivers many streams down its eastern slopes into the Owens River. During the late Pleistocene and Holocene, lake levels varied with climatic wet and dry periods, and were interconnected during high stands with rivers flowing from Mono Lake, through Owens into a chain of lakes in Searles, Panamint, and Death Valley (Bacon et al. 2006). Under drier climate regimes, a saline lake and sometimes desiccated playa existed during episodes of the past 20,000 years.

Streams of the eastern Sierra attracted the interest of the Los Angeles Department of Water and Power (LADWP) in the early 20th century. Employing sometimes deceitful land purchase practices to acquire 240,000 acres of Owens Valley and associated water rights, streams that would have flowed to Owens Lake eventually provided most of the water supply to the city (Reisner 1993). The first aqueduct to Los Angles was completed just over 100 years ago, in 1913, and captured all streams flowing east from the Sierra as far north as Bishop. It also cut off 62 miles of the Owens River channel above Owens Lake. Over the next decade or so Owens Lake dried down to a chain of small wetlands and mudflats along its shoreline. In 1969, a second aqueduct was completed and began pumping groundwater as well as diverting streams. Massive pumping began in 1970 causing the extinction of the largest natural springs in the Owens Valley as well as the destruction of many acres of wetlands.

Before Diversions

Early records of visits to pre-aqueduct Owens Lake indicate this was an expansive body of water and habitat to an abundance of aquatic life that supported large numbers of waterfowl and shorebirds. Reference was often made to the similarities of this body of water to Mono Lake to the north.

After the Civil War there were several major expeditions of geographic exploration and documentation undertaken in the western United States. At the same time Major John Wesley Powell was engaged in his famous ventures into the lower Colorado River and Grand Canyon, Lieutenant George M. Wheeler was conducting topographic and geologic surveys of the far west including eastern California. In 1876, Wheeler visited the region of Owens Lake and gave this superlative description, excerpted here in part because it is the earliest most complete account of the lake environs:

> *This lake is, next to Mono Lake in Mono County, California, certainly the most interesting lake on the North American Continent. Situated in a basin of about 4,000 feet above sea-level, its shores are bounded on the west side by the majestic Sierra Nevada, rising abruptly to towering peaks of 14,000 to 15,000 feet; and on the east side by the precipitous Inyo range, with the famous mines of Cerro Gordo and an altitude of 10,000 feet. Standing on the summit of this range, the panorama spread out in all directions is one of the grandest, most overwhelming views to behold, although there is no verdure to delight the eye and to support the ornamentation of the scenery. How far beneath us lies the Salinas Valley on one side, the Owens Valley on the other! How perpendicular the mountains, how diminutive the lake! How are we deluded by the optic refraction of the superposed strata of air of different temperature! Truly, to observe the setting sun on these heights, the changing tints of the sky, the spreading of darkness over peaks and valley, is a spectacle never to be forgotten.*
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> *The Owens Lake has no outlet and is fed by the Owens River. . . . as the level of the lake remains constant, there must be a perfect equilibrium between the amount of evaporation and the incoming water. The lake having 110 square miles surface, an evaporation of 4.6 feet per year would suffice to swallow up the annual volume of Owens River. Those who cannot appreciate the amount of evaporation have invented the hypothesis of a subterranean outlet, as in the case of Great Salt Lake in Utah. The water has a strong saline and alkaline taste, and is far-famed in Mono and Inyo Counties for its cleansing properties, surpassing those*

of soap. Neither fish nor mollusks can exist, but some forms of lower animal life are plentiful, as infusoriae, copepoda, and larvae of insects.

While around the lake the vegetation consists of two salt plants, Bryzopyrum and Halostrachys, the vegetation in the lake is confined to an algous or fundgoid plant, floating in small globular masses, of whitish or yellowish-green color in the water. These accumulate on certain localities of the lake-bottom and near the shore and undergo decay, emitting a feces-like odor, as observed also in the treatment of albuminous matters with caustic alkalies.

One of the most striking phenomena is the occurrence of a singular fly, that covers the shore of the lake in a stratum 2 feet in width and 2 inches in thickness, and occurs nowhere else in the county; only at Mono Lake, another alkaline lake, is it seen again. The insect is inseparable from the alkaline water, and feeds upon the organic matter of the above-named alga that is washed in masses upon the shore. In the larva state it inhabits the alkaline lake, in especially great numbers in August and September, and the squaws congregate here to fish with baskets for them. Dried in the sun and mixed with flour, they serve as a sort of bread of great delicacy for the Indians (Annual Report 1876).

The reference to floating algae in the lake no doubt indicates the presence of the salt-tolerant filamentous green alga *Ctenocladus circinnatus* (Herbst and Castenholz 1994), often found as floating balls washed on beaches or settled in shallow waters near shores. The fly is *Ephydra hians*, also known from Mono Lake, and the copepoda may refer to the brine shrimp *Artemia* (copepods are not found in hypersaline conditions). The abundance of ducks and other water birds is evidence of the productivity and importance of Owens Lake as a wildlife habitat during this era.

Chemical analysis of a water sample taken during the Wheeler visit yielded a total salt content of 63.6 g/L, dominated by sodium carbonate salts, and having a specific gravity of 1.051. Another water sample taken in 1886 showed a salinity of 72.7 during a time of little change in lake volume. Agricultural development in the Owens Valley during the late part of the 19th century was enabled through irrigation withdrawals from the Owens River and severely limited inflows to Owens Lake. During the 1890s the lake elevation declined and salinities rose to around 200 g/L. Wet climatic conditions reversed this trend for a time but by 1913 the Owens Valley aqueduct was completed and farming water rights had been bought out, diverting the flow of the Owens River and resulting in drying of the main body of the lake by about 1926. Since then, except for a few isolated wet years of inflow, the only remnant of the lake had been a pool of saturated brine in the western portion of the lakebed (Figure 1). Scarce aquatic habitat also remained as marginal seeps, springs, wild wells, and their outflows onto salt flats and shallow ponds.

The great naturalist Joseph Grinnell visited Owens Lake in 1917 and his field notes provide a picture of Owens Lake prior to the impacts of the Los Angeles aqueduct:

Great numbers of water birds are in sight along the shore – Avocets, Phalaropes and Ducks. Large flocks of shorebirds in flight over the water

Figure 1. Red-colored water of heavy salt-saturated brine support halobacteria in a remnant pool in the western portion of the lakebed.

in the distance, wheeling about show en masse, now silvery now dark, against the gray-blue of the water. There must literally be thousands of birds within sight of this spot. En route around the south end of Owens Lake to Olancha saw water birds almost continuously. . . . The shore shallows are thronged with water birds. Avocets predominate; I estimated one bird every four feet of shoreline, which would make 1300 per mile!

By some accounts Owens Lake has been a dead habitat since it became dry. Known now primarily for the plumes of alkali dust that periodically blow off the playa surface during windstorms, the ecological values of the saline lake ecosystem had been ignored or forgotten but are now being considered. While there is considerable public attention to the human health concern related to fine dust particles that, when breathed, may cause respiratory ailments, the health of the lake as a habitat had been widely regarded as a lost cause. Contrary to this view, the existence of fringing habitats in the form of spring and seep outflows around the edges of the playa represent habitat refuges and potential colonization sources for the renewal of an interconnected aquatic ecosystem in the Owens Lake basin. Owens Lake is not a dead habitat, only dormant. Growing again these days like you might water a lawn.

Figure 2. Ponds at moderate salinity levels (25 to 75 g/L) are ideal for the growth of mats of benthic algae (mostly diatoms) that provide food for different species of brine fly larvae. Adults emerge and congregate along the pond margins, seen as the dark bands in this photo.

Rehydration

As the early accounts of the lake and its life attest, Owens had been a productive body of water. The sprinklers and flood irrigation ponds and channels now provide a revival of lost ecological values in a mosaic of saline water habitats that sustain a great variety of microbial, algae, and invertebrate life that attract hundreds of thousands of birds of many species. Some areas are fresh enough to support sheltering aquatic vegetation to waterfowl and diverse invertebrate inhabitants, others are hypersaline pools suitable only red-tinged halobacteria, but shallow pools at moderate salinity levels provide conditions that grow dense mats of algae that are consumed by prolific populations of salt flies and in turn by shorebirds in the thousands (Figure 2).

In addition to the devastating effects diversions of the river had on the aquatic ecosystem, bird and wildlife habitat, the dry playa created a tremendous air pollution hazard, as dust blown from the exposed lakebed into the atmosphere far exceeded national air quality standards. In 1998, after years of conflict, under order from the U.S. Environmental Protection Agency to address this air pollution, Los Angeles and the Great Basin Unified Air Pollution Control District signed a Memorandum of Understanding whereby the City of Los Angeles accepted responsibility for the creation of the largest single-source PM10 dust hazard in the country. They committed to remediating the dust emissions as per the California Clean Air Act. The environmental document for the dust control project allowed three approved methods – water (sheet flooding and ponding), gravel, and native vegetation.

To date LADWP has covered the lake bed with about 40 square miles of sheet flooded and ponded "cells" (Figures 3 and 4). Approximately 4 square miles have managed vegetation and 3 square miles are covered in gravel. Currently there is 90 percent attainment of the dust control compliance. The cost so far for the Los Angeles Owens Lake Dust Control Project is over $1.2 billion. Nearly half of the Los Angeles Aqueduct flow is now diverted back to Owens Lake for dust control. Water for dust control began flowing in November 2001. Migrating waterfowl and shorebirds began using all watered areas immediately. Through the efforts of the local Eastern Sierra Audubon Society chapter and Audubon-California the project has added habitat goals for various guilds of birds and for alkali meadows/seeps/springs. A lake-wide survey of birds in April of 2013 found 115,000 birds. This included 20 species of shorebirds totaling 63,000 birds. Each year Owens Lake is averaging 600-700 adult snowy plovers, a California Species of Special Concern. It is the largest nesting location for the species in California. Wildlife at Owens Lake is considered part of California's Public Trust law as a result of the 1983 Mono Lake California Supreme Court Decision. This decision ruled that wildlife is a public trust and must be balanced with the need for water of the City of Los Angeles. The primary goals of the Owens Lake Dust Control Project are to conserve water and to protect and enhance existing habitat values for waterfowl and shorebirds as well as alkali meadows, seeps and springs.

Responses of aquatic life to salinity vary from requiring near salt-saturated conditions for growth in the red halobacteria of the old lake brine pool, through moderate-salinity tolerant

Figure 3. Bubbler on the lake produces outflow into saline pond habitats.

Figure 4. Sprinklers on the lakebed can provide water for wetland marsh vegetation.

algae, brine flies, and shrimp, to requiring fresh water for varied species of aquatic invertebrates, birds, and plants. Red-colored water of heavy salt-saturated brines is produced by halobacteria, a form of primitive prokaryote cells with a purple protein pigment that uses sunlight to pump protons across membranes and release energy stored as ATP, and that also have protective red-orange pigments known as carotenoids (as in carrots). Brine shrimp and brine flies both must spend energy to keep salts from entering their body fluids and cells, so excess salinity can be intolerable but they thrive at moderate levels where they can avoid predators or competition from species that are not salt-adapted (Herbst 2001). Fresher water coming from springs, seeps, wild wells (uncontrolled outflows), and flood irrigation create wetlands supporting a diverse mix of aquatic life forms along a gradient of outflow evaporating onto the playa. Diversity of invertebrate food items is high at lower salinity but abundance is greatest at moderate salinity.

Different bird species take advantage of what amounts to a mosaic of habitat values suited to varied feeding types and habitat preferences (Figure 5). This has been the basis of management planning that is supposed to maintain suitable habitat conditions for breeding and migratory guilds of birds from diving ducks to shorebirds (LADWP 2013). Dust-control irrigation has provided the opportunity for rejuvenated aquatic environments of varied biological make-up and an area of productive shallow water habitat that meets or even exceeds that of the pre-diversion lake littoral region. LADWP now has plans to decrease water application under future management scenarios by over 50 percent and this leaves uncertain how the area and quality of aquatic habitat that has been created can be sustained while saving water. With less water, the cover of aquatic habitat must inevitably decline and/or salinity increase.

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Figure 5. Avocets, stilts and other shorebirds are attracted by the new pools.

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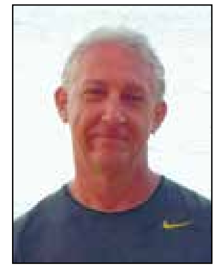

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