FRIENDS of *Great Salt Lake*

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Volume 7 Number 4 Summer 2001

The mission of Friends of Great Salt Lake is to preserve and protect the Great Salt Lake ecosystem and to increase public awareness and appreciation of the Lake through education, research, and advocacy.

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Doyle W. Stephens Research Assistance Scholarship

Friends of Great Salt Lake has established a fund in memory of Doyle W. Stephens, one of the finest scientists dedicated to understanding Great Salt Lake and its systems. Income from the fund, administered by the FOGSL research committee, will be awarded to supplement undergraduate and graduate level research projects that are investigating Great Salt Lake systems. We need your help building the fund. Please send your check to payable to Friends of Great Salt Lake indicating that it is a contribution for the Doyle W. Stephens research assistance scholarship. When developed, guidelines for the scholarship will be posted on our website and appear in subsequent newsletters. Thank you!

Summer 2001 Calendar of Events

September	6	Thursday	Board Meeting 7 PM
September	15	Saturday	Great Salt Lake Cruise (see info on page 4)
September	25	Tuesday	General Meeting 7 PM - Sue Thiros and Kidd Waddell
			The Great Salt Lake Basin's National Water Quality Assessment (NAWQA) Study (see page 7)
October	4	Thursday	Board Meeting 7 PM
October	23	Tuesday	General Membership Meeting/Elections 7PM
November	1	Thursday	Board Meeting 7 PM
November	27	Tuesday	General Meeting 7 PM - Dr. Bryan Brown, Ornithologist, will be presenting

Watch the local papers for announcements of speakers and topics at our General Meetings, or call our hot-line at 801/583-5593, and press 1 for monthly activities. NOTE: General Meetings are held at the Sugarhouse Garden Center, located in the northeast corner of Sugarhouse Park, 2100 South 1300 East in Salt Lake City. Board Meetings are held at the Salt Lake County Complex on State Street and 2100 South in Salt Lake City. Room S3009

Cover: Buffalo Point, Antelope Island painting by Dale Bryner

President's Message:
The Gift of Enlightenment

We live along the Great Salt Lake, one of the most extraordinary natural features in North America. I do not believe we, as a community, have honored its rarity. Our lack of intimacy toward this inland sea is not out of neglect, but of ignorance. We do not know the nature of this vast body of water that sparkles and sings. If we did, the shores of the Great Salt Lake would look different.

— Terry Tempest Williams, *FOGSL Advisory Board*

A string of educational pearls is forming along Great Salt Lake's shores. These pearls of enlightenment will provide opportunities for all of us to become better acquainted with our big, salty neighbor.

The Bear River Migratory Bird Refuge, Farmington Bay, TNC's Layton Wetlands Preserve, and Kennecott Utah Copper's Inland Sea Shorebird Reserve, among others, will soon be places where residents and visitors to the state can discover the significance of wetlands, the importance of fluctuating lake levels, and the impacts of increasing urbanization on an ecosystem that deserves wise decisions about its future.

In keeping with this, on June 20th, Friends submitted a proposal to the Division of Forestry, Fire and State Lands to lease 1.25 miles of sovereign land on the south shoreline beach area of Great Salt Lake. The property lies between the "new" Saltair and the old Saltair dike. With access from the I-80 frontage road, it's close to the population centers in the Salt Lake and Tooele Valleys. The shoreline exhibits wonderful examples of the successional stages of vegetation development and excellent views of the old Lake Bonneville shorelines. And the historic Saltair dike holds many secrets about past Lake activities and provides a delicious opportunity for people to leave the shore and move out into the lake.

Our proposal received strong endorsement by a number of other organizations that are eager to see an education center established there. Westminster College, Utah Society for Environmental Education, National Audubon, The Nature Conservancy of Utah and the University of Utah Museum of Natural History already use that venue for workshops and field trips.

If our proposal is accepted, we will begin working cooperatively with our neighbors along the south shore. We all know the need to increase our appreciation and awareness of the Lake. Adding another pearl of enlightenment will be a great step in that direction.

Yours in saline,

Lynn de Freitas

Lake Fact:
How long do adult brine flies live?

Join Friends of Great Salt Lake for The 2001 Great Salt Lake Cruise

Ranked 'The Best Lake Tour' by Salt Lake City Weekly

Come join Friends for our annual charter cruise of the Great Salt Lake , Saturday, September 15, 2001 from 9:30 AM to 3:00 PM. The cruise is a great adventure for first time visitors as well as regular lake enthusiasts. Enjoy stunning vistas as the Island Serenade passes through the islands of the Gilbert Bay area offering a rare side of GSL few people ever get to experience. The day offers opportunities to meet and visit with lake experts about its unique aspects as well as witness its raw beauty first hand.

Our cruise is with Salt Island Adventures on the 65 foot Island Serenade excursion liner. The boat offers comfortable seating, as needed heated or air conditioned main deck, and large vista windows. Open-air areas on the bow, aft, and upper decks allow a unique lake experience. The cruise round trip departs from the Great Salt Lake State Park Marina.

COST:

$35 for Friends of Great Salt Lake members
$55 for non-members (this includes a one-year membership)
$35 for each additional person in household

RESERVATIONS:

To reserve your space, send your check by September 5th 2001 to:

Lake Cruise
Friends of Great Salt Lake
P.O. Box 2655
Salt Lake City, UT 84110-2655
(make checks payable to FOGSL)

This tour is a very popular Friends of Great Salt Lake event and fills up very quickly. Reservations are made on a first come first serve basis, so plan early.

DIRECTIONS:

Take Interstate 80 to the Saltair Exit (approximately 15 miles west of Salt Lake City). Turn Left on the frontage road and follow the paved road to the marina. The Island Serenade is docked at the farthest end of the parking lot.

LUNCH:

Remember to bring a sack lunch, and water. There will be a cash bar for juices, soft drinks, and alcoholic beverages. No coolers, please.

DON'T FORGET:

Binoculars, field guides, sun protection, and sack lunch.

FOR MORE INFORMATION:

Call FOGSL's activities hotline at (801)583-5593 Ext.1 or check out the FOGSL website at www.fogsl.org
Sponsored in part by Salt Island Adventures

PHOTO BY L. DE FREITAS

Don Paul "prepared for action" during a May field trip to Gunnison Island.

Ecosystem Services and Great Salt Lake

By Robert W. Adler

In her preface to *Nature's Services, Societal Dependence on Natural Ecosystems*, Stanford ecologist Gretchen Daily wrote of the "near total lack of public appreciation of societal dependence upon natural ecosystems." "This ignorance," she continued, "represents but one of a complex of interacting factors responsible for today's array of anthropocentric disruptions of the biosphere" (Daily 1997). In others words, we often destroy what we don't understand.

The quote reminded me of the reaction of a colleague to a slide show I gave at a law school brown bag lunch several years ago. The slides (courtesy of Friends of Great Salt Lake Advisory Board member Ella Sorenson) featured the remarkable bird life Great Salt Lake. My colleague was born and raised in Salt Lake City, and has spent most of his life here. Astonished by what he had seen, he told me that he had been to the lake exactly twice (not counting fleeting glimpses from the interstate), and only for the novelty of floating in the brines. For the lake's biological treasures he had a "near total lack of appreciation."

Earlier this summer I gave a short presentation on "Ecosystem Services and Great Salt Lake." Although I had written (e.g., Adler 1999) and spoken extensively about the need to protect Great Salt Lake and its watershed, in large part based on its remarkable biological treasures, my view of the lake through this new lens was revealing. By cataloguing the ecosystem services provided by Great Salt Lake-even in a very preliminary way-I developed an even greater appreciation of what the lake does for us, and why it deserves better protection.

What Are Ecosystem Services (and Goods)?

Daily defines ecosystem services as:

> ... the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of *ecosystem goods*, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors. ... In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well.

Examples of ecosystem services include "purifying air and water, detoxifying and decomposing waste, renewing soil fertility, regulating climate, mitigating droughts and floods, controlling pests, and pollinating plants." (Salzman, et al. 2001) In the public dialogue about environmental issues we often focus on *ecosystem goods* to the exclusion of *ecosystem services*. Both, of course, are important in our overall accounting of natural resources and their values.

For better or for worse, economists have begun to translate ecosystem goods and services into economic terms. In a pioneering but controversial effort, economist Robert Costanza and colleagues estimated the economic value of the earth's ecosystem services at $33 trillion per year (with a confidence interval of $16 trillion to $54 trillion). (Costanza et al. 1997; critiqued in Pearce 1998) While any effort to translate ecosystem value to monetary value is necessarily difficult, these researchers clearly did not intend to suggest that their estimates were "correct" as opposed to indicative. And some natural resource economists properly advise us that traditional methods of economics ignore the value of this "natural capital" in measuring human well-being. (Repetto 1990). Likewise, the values of Great Salt Lake cannot be converted into monetary terms with any degree of precision, and any such effort misses intangible and intrinsic "values" that are impossible to quantify. Nevertheless, an effort to identify those services, goods, and their values is useful to the public discourse about the lake and its future.

The Ecosystem Services (and Goods) of Great Salt Lake

Historically, our realization that Great Salt Lake provides any ecosystem services came slowly. "No living thing of any kind lives in the lake," reported Scientific American in 1861. Prominent Great Salt Lake historian Dale Morgan wrote that "Great Salt Lake is an ironical joke of nature-water that is itself more desert than a desert." (Morgan 1947) Even Wallace Stegner got it wrong when he wrote that the lake "provides not a single oasis; it offers little recreation or refreshment" (Stegner 1957). Now, thanks to Friends of Great Salt Lake and others, we are developing a much better appreciation of what the lake offers.

Of course, even to this day many people would probably say that what the lake has to offer is salt. As a provider of this traditional economic good, the lake does provide us significant service. Because it is a closed basin, Great Salt

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The Great Salt Lake Doesn't Stink...
But Farmington Bay Does

The continuation of the Spring 2001 newsletter article.

By Amy M. Marcarelli, Michael D. Mills, and Wayne A. Wurtsbaugh[1]

The next question to ask is what can be done to improve the water quality in Farmington Bay so that it is more similar to that of the lake. Currently there are no numeric criteria used by the State to govern water quality in the lake; it is one of the only bodies of water in the country without such regulation. The Great Salt Lake is a unique system, and numeric water quality standards should be established to permit greater enjoyment of the lake. Reduced nutrient input into Farmington Bay will help reduce the productivity levels and cyanobacterial dominance in the system. Currently, the treated sewage effluent from approximately 500 thousand people flows or is piped into the shallow, contained Farmington Bay, thus greatly increasing the concentration of nutrients and causing the algae to flourish. Total phosphorus concentrations in Farmington Bay always exceed the State's suggested level of 25 mg P L-1 set for freshwater, and they often exceed 100 mg P L-1. Total nitrogen concentrations are also in the eutrophic range (UWRL 1988). Wastewater reused to fertilize golf courses, parks and crops could divert the nutrients causing problems in Farmington Bay. Tertiary treatment of the sewage could be done to remove the nutrients, but this would be extremely costly.

Sometimes, "the solution to pollution is dilution." In this case, larger breaches could be made in the causeway separating the two basins to allow greater mixing of the water and dilution of the nutrients from Farmington Bay into the main lake. Pipes or canals could also be used to deliver the nutrients to the much larger main lake. Because brine shrimp production in the main lake is likely limited by nutrient-dependent algal production (Wurtsbaugh 1988), it is conceivable that this resource, and the birds that are dependent on the shrimp, could benefit by moving the nutrients into the main lake. Such an action would obviously need to be approached with extreme caution, as it would not be wise to simply shift the problems in Farmington Bay to the rest of the lake, particularly when fluctuating salinity conditions throughout the system complicate the biological responses (Stephens 1990). The sediments of Farmington Bay also contain toxicants from past water quality abuses (UWRL 1988), and any remediation must insure that their impacts are minimized. Breaching or water diversions would increase salinity levels in Farmington Bay, and this could have consequences for the marshlands surrounding the bay. Clearly, more work is needed to determine the best and most cost-effective alternatives to solve this serious problem.

Our surveys and earlier studies in the Great Salt Lake highlight the dramatic differences between the two basins. Extreme nutrient loading to the relatively contained Farmington Bay is primarily responsible for these differences. Water quality criteria must be established for Farmington Bay and the main lake, and steps taken to meet them. The lake is too valuable to be used as a dumping ground for the Wasatch Front's wastes. With sufficient commitment, conditions in Farmington Bay can improve to a point where algal densities will decrease, and the bay will become a friendlier place. Who knows, perhaps one day we will be able to enjoy the beauty of Antelope Island and the lake without being assaulted by the odor that is now considered typical of the Great Salt Lake.

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We would like to acknowledge the support of the Department of Fisheries and Wildlife and the College of Natural Resources, and the Aquatic Ecology Laboratory class at USU, whose hard work resulted in the 2000 data. The students who contributed to this work were Eric Anderson, Quinn Cannon, Rob Curtis, Jon Flinders, Alex Gardiner, Alex Gouley, Ryan Hillyard, Martin Schjif and Tim Ricks. R. Adler, T. Miller, J. Pitkin and M. Reichert provided many useful suggestions on an earlier version of the manuscript.

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Water Quality Assessment of Great Salt Lake Basins

By Sue Thiros and Kidd Waddell

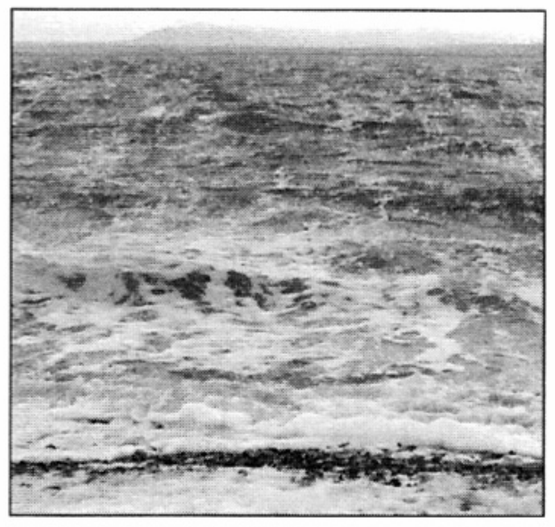

PHOTO BY ANNA WELLER

The protection and enhancement of the quality of the Nation's ground-water and surface-water resources are high priority concerns of the public. The Great Salt Lake Basins NAWQA is one of the 59 study units that are part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program. The long-term goals of this program are to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources, and to provide a sound, scientific understanding of the primary factors affecting the quality of these resources. The program will employ a multi-disciplinary approach using physical, chemical and biological measurements to provide multiple lines of evidence with which to evaluate water quality. Information on the study can be found on the internet at http://ut.water.usgs.gov/nawqa.

Kidd Waddell and Susan Thiros, hydrologists with the U.S. Geological Survey, will present data and findings from the Great Salt Lake Basins NAWQA study. Kidd Waddell is the project chief and has studied Great Salt Lake, ground-water flow and quality in Salt Lake Valley and at Hill Air Force Base, and surface-water quality in the Bear River drainage. Susan Thiros is the projects ground-water specialist and has studied ground-water flow and quality in Salt Lake Valley and at Hill Air Force Base and ground-water/surface-water relations in the upper Sevier River Basin.

Most of the 14,500 square miles of the Great Salt Lake Basins study unit is in Utah but some areas in Idaho and Wyoming also are included. The study area covers the 3 major river systems that discharge into Great Salt Lake: the Bear, the Weber, and the Provo/Jordan. The study unit contains Utah's three largest cities (Salt Lake City, Ogden, and Provo) and about 1.6 million people, or 85 percent of the population of the State. Surface- and ground-water quality along the Wasatch Front is most affected by urban and industrial land uses and wastewater treatment. Farming and livestock grazing on irrigated land most affect the water quality in the Bear River basin.

The following water-quality issues have been identified in the Great Salt Lake Basins:

- Effects of stormwater runoff into streams from residential and commercial urban areas on water quality and aquatic biological communities
- Effects of urban and agricultural land use in ground-water recharge areas on ground-water quality
- Changes in aquatic biological communities as a result of changing land use and non-point pollution
- High concentrations of nutrients from livestock grazing, feedlots, and natural factors that cause eutrophication, the process by which surface waters increase in biological productivity in response to nutrient enrichment.

Assessment of most types of water-quality issues for streams, such as nutrient enrichment or pesticides, requires the measurement of many characteristics, frequently in multiple media, such as water, sediment, and tissues. The Great Salt Lake Basins NAWQA is currently in its sample collection phase. Ten sites in the Jordan, Weber and Bear River drainage have been selected for the full suite of chemical, physical and biological sampling, which began in the late summer and fall of 1998. Sampling activities are guided by national protocols to ensure data can be compared at regional and national scales.

Ground water in the basin-fill deposits of the study area has a range in chemical quality that is affected by the sources of recharge, the aquifer material and properties, and the activities of people both at the land surface and through the use of wells. The deeper aquifers are used for public supply in urbanized areas and withdrawals must be managed to sustain the resource. More residential and commercial areas are being developed along the Wasatch Front, primarily at the expense of agricultural areas. A land-use study was done in Salt Lake Valley to better understand some of the effects of recently developed residential/commercial areas on the water quality of the underlying ground water. Chloroform, most likely from chlorinated drinking water that has recharged the shallow aquifer, was detected in 27 of 30 samples. Tetrachloroethene (PCE), usually used as a dry cleaning agent and solvent, was detected in 16 of 30 samples. There is also evidence of recently recharged ground water and of man made compounds occurring in water from deeper aquifers in the study area.

Great Salt Lake Ecosystem Studies:
How Simple Has Become Complex

By Gary E. Belovsky, Gillen Director and Professor, Hank Environmental Research Center, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556-0369, E-mail: Belovsky.1@nd.edu

PHOTO BY HEIDI HOVEN

I have been part of the Great Salt Lake Ecosystem Project and the Technical Advisory Group since their inception. When the Great Salt Lake Ecosystem Project was initiated in 1995 through the Utah Division of Wildlife Resources, there were two principal questions of concern: was the brine shrimp harvest sustainable and what impact might the harvest have on the birds that rely upon brine shrimp as food? I remember at our first meeting in Ogden, the participants, including the late Doyle Stephens from USGS, Don Archer from UDWR and myself, were amazed at how little scientific information was available on the Great Salt Lake, the fourth largest hypersaline lake in the world. Even though there existed a voluminous scientific literature on brine shrimp, almost all of it was based on aquaculture conditions, rather than the natural conditions that were our concern. However, given the sparse information available, we naively viewed the necessary research to provide scientific inputs to be appreciable, but not overwhelming, because the Great Salt Lake was a simple ecosystem. In the simplest construct from the literature, the ecosystem was composed of one abundant alga (Dunaliella viridis), the brine shrimp grazing on it (Artemia franciscana), two species of brine flies (Ephydra spp.) that consume particles of dead material, and many species of birds that consume shrimp and flies.

Also, at that time, the public that used the lake or were concerned with its future provided a variety of simple explanations of how the ecosystem operates or is threatened. These views ranged from a view that brine shrimp numbers were declining from predation by corixids (water boatmen), a view that commercial harvests were reducing brine shrimp and threatening the birds that consume them, and a claim that it was impossible to overharvest brine shrimp. Several management alternatives were advocated, including spraying insecticide over the lake to kill corixids, annually harvesting all of the brine shrimp cysts and aerially 'reseeding' the lake with cysts each spring, and either allowing unlimited harvesting of the shrimp or prohibiting harvesting altogether. The different perspectives were contradictory and based either on no scientific evidence or misapplication of the little information available. Furthermore, none of us had any idea of the emotions that research on the lake could invoke in others, ranging from derogatory references to one's intelligence and veracity, physical threats, and even offers of bribes. Nonetheless, research progressed and our knowledge increased.

We found that corixids do not reduce brine shrimp numbers, as long as salinity remains above 4.5%. We found that brine shrimp numbers are limited in some years by the abundance of different species of algae and in other years by the number of cysts surviving the winter that initiate the population in the spring. Our observation that spring cyst numbers in some years limit brine shrimp numbers indicates that shrimp can be commercially overharvested, especially when winters lead to low cyst survival. This has led UDWR to institute limits on the commercial harvest, so that sufficient numbers of cysts will remain in the spring after winter mortality. Lastly, we found that the lake ecosystem is much more complex than most scientists had thought or still consider. This is best illustrated by the dramatic shifts in the abundance of algae of different species within and between years, as water temperature, salinity and nutrient influxes vary. Furthermore, the consumption of different algal species by brine shrimp, as well as differences in water temperature and salinity, appear to have profound effects on shrimp survival and reproduction.

Our realization that the Great Salt Lake is not a simple ecosystem has forced us to reevaluate many common perceptions about the lake and many of our original hypotheses. Early on, the Great Salt Lake Ecosystem Project and Technical Advisory Group discussed the need for increased research support beyond what UDWR could provide. Unfortunately, additional funds sought from the Utah legislature and Federal government (EPA and NSF) have not been forthcoming. Currently, the Great Salt Lake is being considered for inclusion in the NOAA Sea Grant Program, which allows faculty at Sea Grant affiliated universities to submit grants to study authorized bodies of water.

It is humbling to consider how little we know about the Great Salt Lake, a world-renowned ecosystem, especially as the lake becomes engulfed by urbanization and economic demands increase for its resources and the resources of its watersheds.

Lake concentrates minerals with remarkable efficiency, although through a purely physical as opposed to ecological process. About 5 billion tons of salt are now concentrated in the Great Salt Lake system. Currently, these minerals are harvested at a considerable market value ($232 million in 1997) (UDNR 1998).

The remarkable complex of wetlands along the shores of Great Salt Lake provides a much better example of ecosystem services. Especially for a lake that expands and contracts like a giant hydrological and ecological balloon in periodic natural cycles, these wetlands provide critical flood control functions, buffering lake waters as they reach their high points. As we fill more and more of those wetlands and move our homes and businesses ever closer to the lake's shorelines, the likelihood that human structures will be "flooded" increases. The temptation to "replace" the flood control services provided by Great Salt Lake wetlands with expensive concoctions like the West Desert Pumping Project is indicative of the value of those services. Great Salt Lake wetlands also provide essential water quality filtering services, processing nutrients, organic matter and other substances before they reach the lake itself. Again, these services are increasingly important as development creeps toward the lake, causing more and more polluted runoff from roads, parking lots, and other impervious surfaces. Finally, Great Salt Lake's wetlands provide essential habitat for numerous species, especially the amazing aggregations of birds that congregate in and around the lake every year (discussed below).

Which brings us to what is perhaps Great Salt Lake's most fundamental "ecosystem service," the conversion of sunlight, nutrients, and organic matter into usable biochemical forms. "Primary production," the transformation of the energy in sunlight into chemical form through photosynthesis, is the basic biochemical process by which life is made possible, and for this purpose Great Salt Lake is a veritable factory. Cyanobacteria and benthic algae in Great Salt Lake accomplish this conversion at the rate of 145 grams of carbon fixed per square meter per year (Stephens 1998). At the lake's average surface area of 1,700 square miles, this translates to 641 billion kilograms of carbon fixation annually.

The basic ecosystem service of photosynthesis is the foundation upon which many of the lake's other ecosystem services and goods are built. While the Great Salt Lake "food chain" is not very diverse at the bottom, its productivity supports immense amounts of life, and increasing diversity at the top. Bacteria and algae feed just two species of brine fly and one of brine shrimp, which feed birds and other larger species. These forms of life, in turn, provide additional ecosystem goods and services. Brine shrimp cysts are used as a traditional economic good by 32 companies at a value of around $20 million per year, providing over 1,000 year-round jobs and supplying the ornamental fish market and aquaculture industries from Indonesia to Ecuador (UDNR 1998).

To uninformed Great Salt visitors, it might be difficult to comprehend the ecosystem services provided by brine flies. As many as 5 thousand billion (5 quadrillion) of these unusual insects hatch each year (Wharton 1992), providing food for other species of birds. But brine flies also provide important ecosystem services as miniature sewage treatment plants, removing approximately 120,000 tons of organic matter from the lake each year. This is equivalent to the pollution control "service" provided by a large wastewater treatment plant processing 78 million gallons a day of sewage, coincidentally about the same size as the Salt Lake City sewage treatment plant (UDNR 1998). Without the ecological cleansing service provided by brine flies, Great Salt Lake would be a very polluted lake.

Many of the services identified above make possible one of the world's great avian mecca's (undoubtedly requiring little explanation for most readers of this newsletter). Great Salt Lake and its surrounding habitats are used by an estimated 3 to 5 million shorebirds and over 3 million waterfowl a year, including some of the most important assemblages for individual species anywhere: the largest staging area for Wilson's phalarope in the world; the most American avocets and Black-necked stilts in the Pacific flyway; the largest known assemblage of Snowy plovers in the world; the world's largest breeding populations of white-faced ibis and California gulls; one of the three largest breeding colonies of white pelicans in Western North America (UDNR 1998). The list of avian superlatives is seemingly endless. Whether viewed as providing ecosystem "goods" for consumptive users (hunters) and nonconsumptive users (birders and scientists) alike, or the ecosystem "service" of habitat support, Great Salt Lake ranks among the world's most important remaining wildlife ecosystems.

Some measure of the value of these ecosystem amenities is suggested by the growing use of Great Salt Lake for recreation, environmental education, and other public uses. Great Salt Lake marina receives almost a half million visitors a year. Antelope Island and Great Salt Lake State Parks boast almost a million. Others use state wildlife

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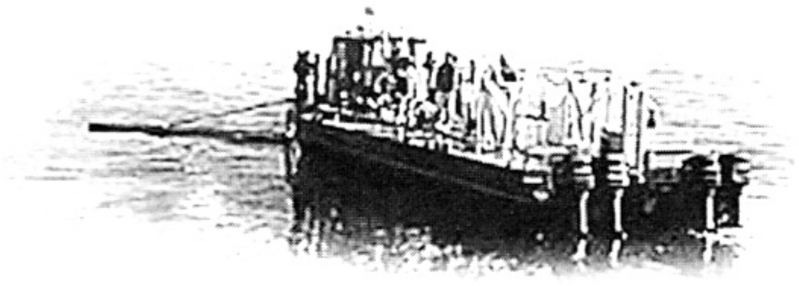
Understanding the 2000 Artemia Cyst Harvest



By Don Leonard, President, Utah Artemia Association

The Utah Artemia Association (UAA) appreciates this invitation to comment on the impact of the harvest of brine shrimp eggs during the recent 2000 harvest season and on the overall health of the Great Salt Lake (GSL) ecosystem. We commend the Friends of Great Salt Lake for its continuing efforts to increase public awareness of the Great Salt Lake and advocate support for preservation and protection of this unique resource.

Unfortunately, some confusion and concern surrounds the recent 2000 season harvest of brine shrimp eggs. The brine shrimp industry, environmental organizations and other GSL advocates have been warning about the ecological value and sensitivity of the GSL ecosystem (raising such issues as unnaturally low levels of salinity, shifts in algal population densities, and low populations of brine shrimp and brine shrimp cysts in some recent years). Yet, in the face of such advocacy, and following three successive years of declining harvests, the 2000 season yielded a possible record-level harvest. How could a threatened resource produce such an historically high harvest?

Those most familiar with the Great Salt Lake should not be surprised by this confusion or concern. Frankly, the lake is not well understood by most Utahns. This lack of understanding is complicated by the unique life cycle and sensitivities of the lake's brine shrimp species.

This article is intended: 1) to reiterate the role of the brine shrimp industry as one of the leading advocates for the health of the Great Salt Lake ecosystem; 2) to contribute to a better understanding of the brine shrimp resource in the Great Salt Lake ecosystem; 3) to help clarify any confusion about the relationship between the large harvest of the 2000 season and the still-fragile nature of the GSL ecosystem and its brine shrimp population; and, 4) to encourage continued support for protecting the Great Salt Lake ecosystem.

Lake Advocacy

The Utah Artemia Association is proud to be at the forefront of efforts to preserve and protect the Great Salt Lake and its unique brine shrimp species. The brine shrimp egg harvesting industry has a long history and a consistent and unwavering record of support for the resource and for the Great Salt Lake ecosystem.

That support is evidenced by many industry actions and positions, including but not limited to: the industry's support for a more than three-fold increase in the certificate of registration ('COR') fee in the early 1990's to fund a public brine shrimp research program; the industry alerting the Utah Division of Wildlife Resources to serious concerns about the brine shrimp resource in 1995 when some at that agency thought the resource was "inexhaustible"; industry support for significant restrictions on harvesting activity, including: reducing the season from seven months to five months to the current four months; the moratorium on issuance of additional CORs; emergency season closures; etc.; openly sharing with the state valuable industry sampling and research data and results; advocating a rigorous state management program that allows industry harvest of only 'surplus' eggs; advocating (and implementing) a zero harvest level from the south arm of the lake for the 1999 season; supporting a state-managed regulatory framework that has dictated significant capitol and human resource risks and investments; aggressively advocating measures to bring greater natural balance in salinity levels between the north and south arms of the lake, including obtaining an appropriation for recent modifications to the railroad causeway to increase bi-directional flows between the north and south arms; and others.

We have worked closely with the Utah Department of Natural Resources and its Division of Wildlife Resources ('DWR' or 'Agency') in support of the health of the Lake. We have supported the DWR's basic responsibilities to "protect, manage, and conserve the brine shrimp resource...and preserve the Great Salt Lake ecosystem while recognizing the economic value of allowing the harvest of...brine shrimp eggs and maintaining a sustainable brine shrimp population" [R657-14-1 (2)]. The industry remains committed to maintaining the long-term viability of the resource and to protection of the Great Salt Lake ecosystem.

Brine Shrimp in the Great Salt Lake

During the past decade, the Utah Division of Wildlife Resources, with the assistance of the brine shrimp industry, Utah State University, the U.S. Geological Survey, and others, has developed and implemented a plan for managing the Great Salt Lake's brine shrimp resource. That man-

agement plan is based upon the growing body of research and upon the experience of past years and seasons.

Research has resulted in a DWR determination that there needs to be "a minimum of 21 cysts per liter in the south arm" of the lake "at the end of the harvest season to fully reseed" the brine shrimp "population the following year." The number of 21 cysts per liter takes into account such factors as over-winter survival, and includes a liberal margin for caution or error. The excess above 21 cysts per liter is considered to be a harvestable surplus. Weekly and bi-weekly sampling during the season determines when the level of cysts in the lake approaches 21 cysts, at which time DWR issues an emergency closure order, typically providing no more than 24 hours notice to the industry to cease harvesting. The uncertainty and short notice inherent in such a management system imposes serious hardships on the industry. However, the industry continues to support the current management scenario as the best way to assure the health and viability of the lake ís brine shrimp species.

Great Salt Lake Brine Shrimp Industry

The Great Salt Lake brine shrimp industry emerged in the 1950s. At that time, a few companies and individuals harvested mostly live brine shrimp for the domestic aquatic hobbyist market. When declining natural fisheries spawned a growing commercial aquaculture industry, demand for natural feeds for prawns and other species fueled interest in artemia (brine shrimp). The Utah brine shrimp industry harvests artemia cysts (brine shrimp eggs), which are processed, packaged, and marketed internationally to the commercial aquaculture industry.

By 1995, the local industry feared undue pressure on GSL brine shrimp populations could threaten the health of the lake, prompting industry advocacy for state-imposed limits on harvest pressure. That advocacy was successful when the state capped the number of Certificates of Registration (i.e. harvest permits) it would issue at 79, beginning with the 1996 harvest season.

Declining harvests during the 1997, 1998 and 1999 seasons imposed great economic hardship on the industry, resulting in some contraction and consolidation within the industry. Brine shrimp populations and cyst counts in 1999 were so low that, despite the economic crisis then facing the industry, the Utah Artemia Association offered to the DWR Director that its members would voluntarily commit to no harvest from the south arm of the lake. Both the state and the industry have continued to strongly support limiting harvest pressure on the lake through the cap on the number of harvest permits and the rigorous enforcement of the management plan that requires a minimum of 21 cysts per liter to remain in the south arm of the lake at the end of each harvest season.

2000 Season Harvest: A Third Generation!

The simple answer to why the industry experienced such a large harvest in the midst of a lake and a resource that still faces serious ecological challenges and following several years of declining harvests is that the brine shrimp populations were able to produce an infrequent third (3rd) generation, and (importantly) that third generation survived to reach sexual maturity, resulting in more than doubling typical cyst production levels. Industry, state and university scientists are in agreement on this conclusion.

What factors contributed to the infrequent, productive third generation?

After several years of decline, salinity was elevated slightly above the danger zone in which competition and poor algal production become more probable.

Lake temperature increased steadily in the spring of 2000 and remained at a suitable temperature for artemia reproduction through November (i.e. an early, unseasonably warm spring followed by a record-setting warm fall, particularly in October).

Hatching of the over-wintering cysts occurred synchronously in the spring and generated a successful population that was able to produce a peak nauplii (baby brine shrimp) count in the third week of May.

The population cycle exhibited the "boom and crash" dynamic that we are beginning to associate with a healthy population on the GSL. In this cycle it is essential that after the initial population crash the GSL phytoplankton population is rapidly replenished with favorable species (namely the smelly chlorophytes). This did happen last summer.

In August we had a very important peak in nauplii numbers (19.0 per liter) versus 1.7 per liter in 1999. This nauplii cohort translated into counts of 0.3 females carrying cysts per liter and a mean brood sac size of 33 cysts per female. These numbers are quite robust in terms of the population dynamics and clearly resulted in a very substantial contribution to the standing crop of cysts;

Utah State University professor and researcher Gary Belovsky summarized these conclusions at a DWR Technical Advisory Group (TAG) meeting on March 15, 2001.

continues p. 12

Belovsky reported that the end result of all of these favorable factors was the uncommon appearance of a third generation of brine shrimp in September 2000, and the record-setting heat of October 2000 that allowed this third generation of brine shrimp to reach sexual maturity (because the lake remained warm).

We have had third generations in prior years. For example, state and industry biologists seem to agree that the last large harvest (prior to 2000) in 1996 was the result of a third generation of brine shrimp. In fact, a DWR official opined at the March 15, 2001 TAG meeting that the 1996 season harvest probably would have been a twenty million pound harvest, except that monthly sampling (as opposed to the weekly and bi-weekly sampling that occurs now during harvest seasons) failed to identify the emergence of the third generation, resulting in leaving a lot of surplus egg on the lake. (Unfortunately, that surplus egg contributed to the populations crash in 1997 because the excess spring population overgrazed the lake's algae, resulting in insufficient food for the lake ís excess brine shrimp population.)

Brine Shrimp Myths

When the industry experienced a 19,963,087 pound harvest in the 2000 season, some questioned the credibility of industry concerns about the health of the lake's ecosystem and our cries for continuing measures to address the salinity imbalance. These questions spawned two myths that merit discussion.

Myth–Salinity: The large harvest of 2000 proves that salinity is not an important factor in the health of the resource.

Fact: An important factor in the health of the brine shrimp populations in the lake is the abundance of brine shrimp populations preferred algal food source. That algal food source thrives in higher levels of salinity, but in lower salinity levels it is displaced by algal species that are difficult, if not impossible for the brine shrimp to ingest and/or digest. Record-setting heat in 2000 and measures to increase bi-directional flows between the north and south arms of the lake resulted in a modest increase in salinity in the south arm last year. However, south arm salinity remains dangerously low; and north arm salinity remains well above levels that could sustain meaningful, independent, producing populations of brine shrimp. It is important that salinity increased–it is obviously a critical aspect of the GSL ecosystem and the population dynamics of the brine shrimp and the brine flies. Had the trend of decreasing salinity continued, we could have seen both the artemia and the brine fly populations decrease dramatically. South arm salinity levels are still well below optimum levels for healthy, sustained brine shrimp populations.

Myth–Over-Harvest: The large harvest of 2000 threatens future brine shrimp populations.

Fact: In terms of harvest size, the industry continues to support the DWR method of managing the GSL and the artemia population. The industry has ceased harvesting each year when the cyst density approached the critical threshold of 21 cysts per liter. Sampling within one week of the 2000 season closure indicated cyst densities in excess of 32 cysts per liter, well above the DWR minimum density threshold. Recent experience seems to indicate that under harvesting is a greater threat to future populations than over harvest. As noted above, DWR believes that the low populations of 1997 were probably due, in great part, to spring cyst densities that were too high. (That surplus egg contributed to the populations crash in 1997 because the excess spring population overgrazed the lake ís algae, resulting in insufficient food for the lake ís summer and fall brine shrimp population.)

Conclusion

While most critical factors that impact brine shrimp cyst production lined up extremely favorably in 2000 (and factors that were not extremely favorable, such as salinity, experienced at least some positive movement), concerns persist about the long-term health of the Great Salt Lake ecosystem and its unique and valuable brine shrimp resource. The Great Salt Lake brine shrimp industry will continue to be at the forefront in advocating and implementing ecologically sound management of the lake ís brine shrimp resource.

The Utah Artemia Association appreciates this opportunity to share some of our views and concerns. Please contact the Association (801-908-5960) if you would like additional information about the industry or the lake.

SeasonHarvest (lbs.) **1991** 13,532,797; **1992** 10,172,399; **1993** 8,864,092; **1994** 6,485,954; **1995** 14,749,596; **1996** 14,679,498; **1997** 6,113,695; **1998** 4,606,352; **1999** 2,631,853; **2000** 19,963,087.

management areas, the Bear River Migratory Bird Refuge, private duck clubs, and other natural areas, all due to the ecosystem services provided by the lake. Another market indicator is the large acreage of land held in private ownership to protect the lake's ecosystem values as opposed to its economic development potential, with some 67,000 acres owned and managed by private duck clubs, and an additional 10,000 acres owned by private conservation organizations like The Nature Conservancy and Audubon (with more such acquisitions currently being planned) (UDNR 1998).

Finally, perhaps a surprise or two: one of the most important ecosystem services globally is the preservation of biodiversity, including the intrinsic diversity and value of nature's gene pools. In the case of Great Salt Lake, this includes an unusual assemblage of salt-tolerant plants (Wharton 1992). Just as we now harvest the genetic diversity of South American rainforests to provide ecosystem goods, particularly pharmaceuticals, the salt-tolerant plants of Great Salt Lake may in the future help to feed the world. A recent article in Scientific American identified the potential to grow food in places that lack adequate fresh water, and where desalination costs are prohibitive, with salt water (Glenn 1998). While we are unlikely to dine on such enticing species as greasewood, iodine bush, or inkweed (although pickleweed and salt grass at least sound more palatable), the genetic salt tolerance capabilities of those plants could yield breakthroughs in this field in the future. And last but not least, arguably the "greatest snow on earth" is the direct result of the Great Salt Lake ecosystem service known as the "lake effect." Warm, moist air rising from the lake mixes with cold air masses moving across the lake, causing the dry, powdery snow that feeds the Wasatch Mountain ski resorts. Some early Great Salt Lake planning documents actually proposed to drain the lake entirely, because its values were so poorly understood. Had we done so, one of the state's most thriving industries, may never have been born. And no, we probably would not have been awarded the 2002 Winter Olympics. But nothing is all good.

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How to get to Antelope Island

Travel North on I-15 to Exit 335 — the Syracuse exit. There is also a brown highway sign for Antelope Island just prior to the off ramp. Travel West from the light at the end of the off ramp (a Left) and continue several miles, all the way to the AISP entrance gate. Antelope Island is through the exit gate and across the causeway 7 miles. Entrance fee is $7.

PHOTO BY DIANA ALLISON

Bruce Thompson and friends during a spring Lakeside Learning Field Trip on Antelope Island

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2. **Submitting material:** Mail or deliver to 1117 E. 600 S. Salt Lake City, UT 84102. Or e-mail to: ldefreitas@earthlink.net
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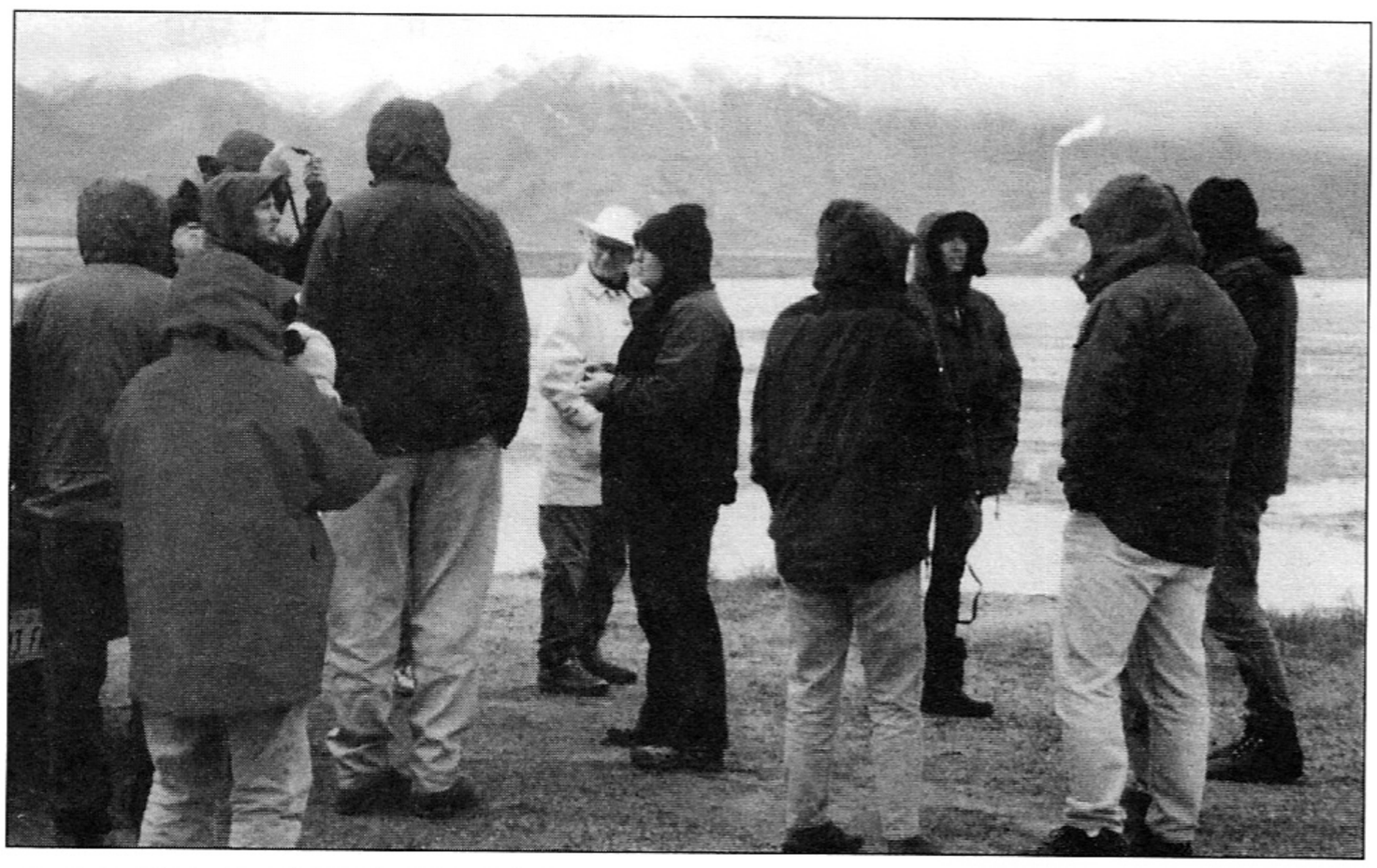

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April field trip to KUCC's ISSR Mitigation site

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