FRIENDS OF GREAT SALT LAKE

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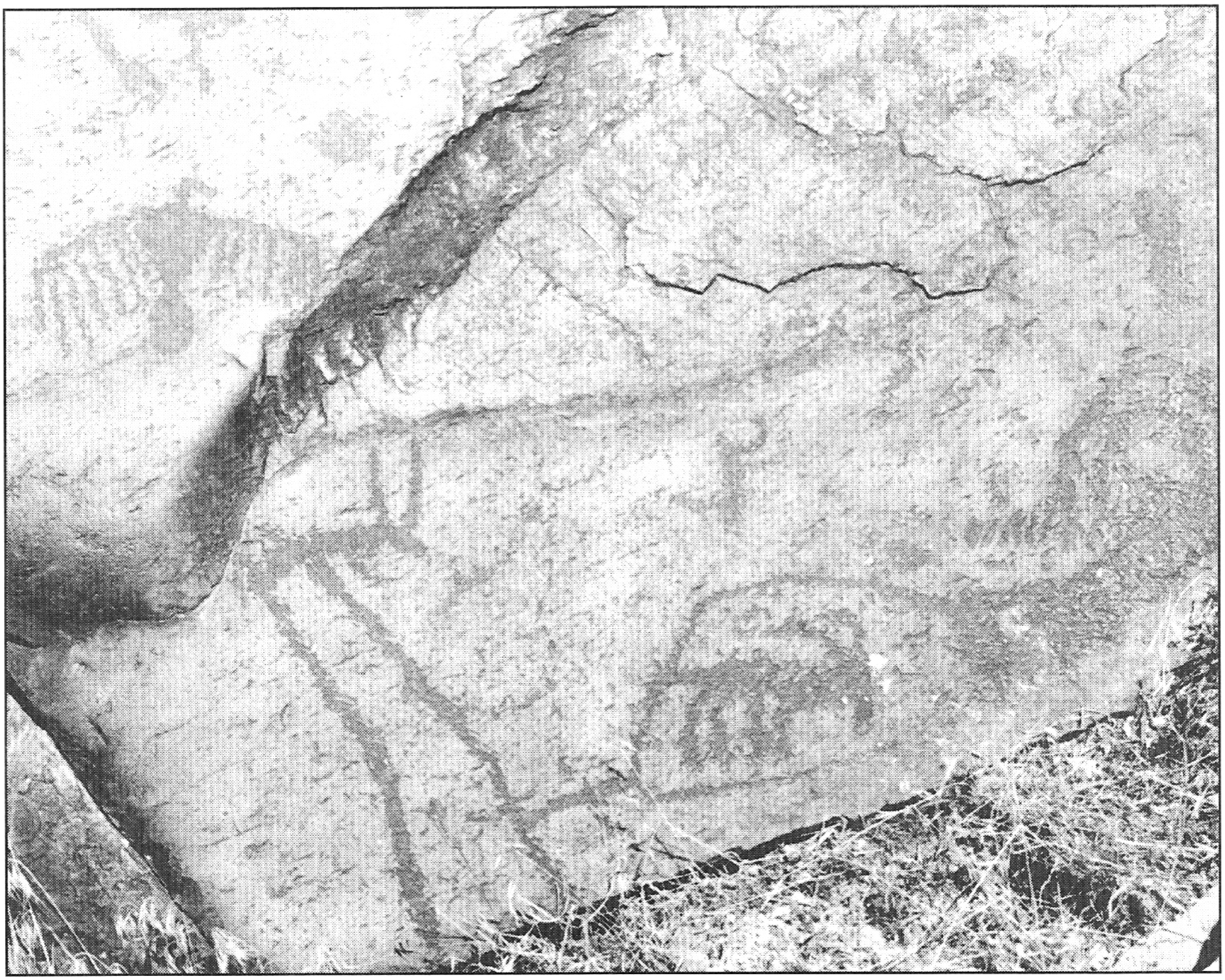

The mission of Friends of Great Salt Lake is to preserve and protect the Great Salt Lake ecosystem and to increase public awareness and appreciation of the Lake through education, research, and advocacy.

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MagCorp Emissions to be Discussed at the next General Meeting

Join Friends of Great Salt Lake on **Tuesday, January 26, 1999 @ 7:00 p.m.** to learn the latest about **regulation of the Magnesium Corporation of America (MagCorp) by the Utah Department of Environmental Quality (UDEQ) and the U.S. Environmental Protection Agency**. As regular readers of this newsletter know, MagCorp is located on the southwest shore of Great Salt Lake. Their facility produces magnesium from lake brines and is also the largest polluter in the U.S., emitting more than 65 million pounds annually of chlorine and hydrochloric acid emissions into the atmosphere. Recent testing conducted by UDEQ discovered high levels of dioxin in sediments near MagCorp. The Citizens Against Chlorine Contamination (CACC) have been very active in the last two and a half years lobbying UDEQ and the EPA to more stringently regulate emissions from MagCorp. FOGSL has invited **representatives of UDEQ, MagCorp, and CACC** to discuss efforts to identify and reduce pollution emissions from MagCorp. See article on page 11.

Winter 1999 Calender of Events

January 7, Thursday	**Board Meeting 7 p.m.**
January 26, Tuesday	**General Meeting 7 p.m. MagCorp Emissions Discussion (see above)**
January 30, Saturday	**Annual Board Retreat 9a.m. to 5 p.m.**
February 4, Thursday	**Board Meeting 7 p.m.**
February 23, Tuesday	**General Meeting 7 p.m. -Topic to be announced**
March 4, Thursday	**Board Meeting 7 p.m.**
March 23, Tuesday	**General Meeting 7 p.m. -Topic to be announced**
April 1, Thursday	**Board Meeting 7 p.m.**
April 27, Tuesday	**General Meeting 7 p.m. -Topic to be announced**

NOTE: General Meetings are held at the Sugarhouse Garden Center, located in the northeast corner of Sugarhouse Park 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: From the Lakeside Range a boulder engraved with petroglyphs depicting a eagle-dancer, and surreal combination of long-legged male and pregnant female big horn mountain sheep. By Ken Sassen.
The editor regrets the ommission of credit to Kathlyn Collins for the Fall 1998 cover art.

President's Message

We met out at the end of the old Saltair dike on a sunny, clear, slightly brisk late fall day. Tom Hougaard, a senior news photographer from Fox 13, aimed his camera at Bruce Thompson and me for this on site interview. Tom is working on a series of programs to be aired beginning in early January about Great Salt Lake. He wanted to discover what Friends of Great Salt Lake was up to.

This was an excellent opportunity for Bruce and I to bend his ear about a "sense of place" and the importance of the Lake in that role. Standing at the far tip of the dike provided a wonderful visual vantage point to support our position that the physical connection we have with the Lake is obvious. It's the appreciation and awareness of the Lake that is the weakness in the relationship-- that's why we are working to develop quality educational opportunities for the regional community. Our goal is to bring people closer to the Lake both in their hearts and in their minds.

Part of realizing that goal is to get the cash to do it! And I am delighted to say that we have had tremendous success in fundraising for our educational programs.

I am thrilled and honored by the quick and generous response to our fundraising efforts. Since our letter went out to our membership in October, sixty-five Friends have committed $3,805 toward education about the Lake. This has exceeded our anticipation -- and we're still getting responses. It clearly shows how important the mission of Friends is to its members.

As added good news, we will be able to put all Friends' membership contributions directly to work toward the development of our Great Salt Lake Curriculum Project. Our next series of presentations of "The Lake Affect" has already been fully funded by generous donations from the Dr. Ezekiel R. and Edna Wattis Dumke Foundation, the Utah Wetlands Foundation, the Patagonia Outlet, and the George S. and Dolores Dore Eccles Foundation.

I am also pleased to report that the Walbridge Fund has donated $5,000 to Friends to use "where it will do the most good." Could this be the start of a Friends' Endowment?

Lastly, it's important to me to acknowledge the collective efforts of academia, public and private agencies, and groups who do the day to day research and information gathering to enable us, as stewards of the Lake, to make better informed decisions. You will find reports on two such efforts in this issue. Tom Aldrich's article on the Avian Cholera outbreak last fall, and Doyle Stephens' piece on the reasons why the 1998 brine shrimp harvest was cut so short.

For the Lake and its myriad occupants.

Lynn de Freitas

Brine Shrimp in Great Salt Lake: The 1998 Population and Harvest

Doyle Stephens
USGS, Salt Lake City

The USGS in cooperation with Utah Division of Wildlife Resources, continued collection of limnological data, phytoplankton (algae), and shrimp from the lake at intervals of two to four weeks. As in the past four years, environmental variables and food availability interacted to produce a shrimp population that was unique and somewhat unpredictable. The lake elevation continued to rise and the salinity declined to about 9% by late June (Figure 1).

Phytoplankton in Great Salt Lake

Between January and May 1998, centric diatoms, a green alga tentatively identified as Dunaliella salina and an unidentified spherical green alga were dominant. There appears to have been another shift in lake phytoplankton at the start of the winter bloom in 1998. During 1995, in late 1996 and early 1997, the dominant phytoplankton consisted of green algae, primarily Dunaliella viridis. During much of 1997, large pennate diatoms predominated; but during much of 1998, centric diatoms, Dunaliella spp., and a small green alga dominated. The winter phytoplankton bloom in January 1998 was dominated by centric diatoms but a considerable number of pennate diatoms also were present. Dunaliella spp. was dominant in February and March. The majority of the spring phytoplankton bloom was due to an unidentified spherical green alga. During the winter and spring blooms, all dominant and co-dominant phytoplankton consisted of cells with a volume of less than 8,200 to 14,000 /m3. This cell size is well within the ingestible range of shrimp nauplii. (The relatively small number of nauplii reaching maturity and small quantity of cysts harvested in 1997 are believed due to the dominance of pennate diatoms that were too large to be ingested by nauplii.)

Concentrations of chlorophyll a during the winter bloom in January-February 1998 were smaller than in 1997. However, chlorophyll concentrations in late March and early April were much higher than in 1997 and were dominated by small green algae (Dunaliella and a spherical chlorophyte). The availability of suitably sized food resulted in survival of a large number of nauplii and by June 1998, the average number of nauplii was 36 percent greater than in 1996 and 13 percent greater than in 1997. Chlorophyll concentrations continued to be slightly higher through June 1998 compared to June 1998. A favorable food base appeared to be present for Artemia development.

Artemia in Great Salt Lake

The number of shrimp cysts available to start the population cycle in March 1998 was about 11,600/m3 with a 95 % confidence interval of plus or minus 5,700. The first appearance of nauplii was early February when the water temperature was 4? Celsius and nauplii increased to a mean concentration of about 13,000/m3 by mid May, a month later than in previous years. Water temperatures during the winter of 1998 were not as cold as in the previous two years and never dropped below 2 deg. C at 1 meter depth at a deepwater mid-lake site. However, water temperatures were slower to warm in 1998, with a slope of 0.13 for annual minimum to annual maximum temperature compared to a slope of 0.15 in both 1996 and 1997. Water temperatures from early May to early July 1998 were as much as 5 deg. C colder than the equivalent period in 1997. The cold temperatures slowed the

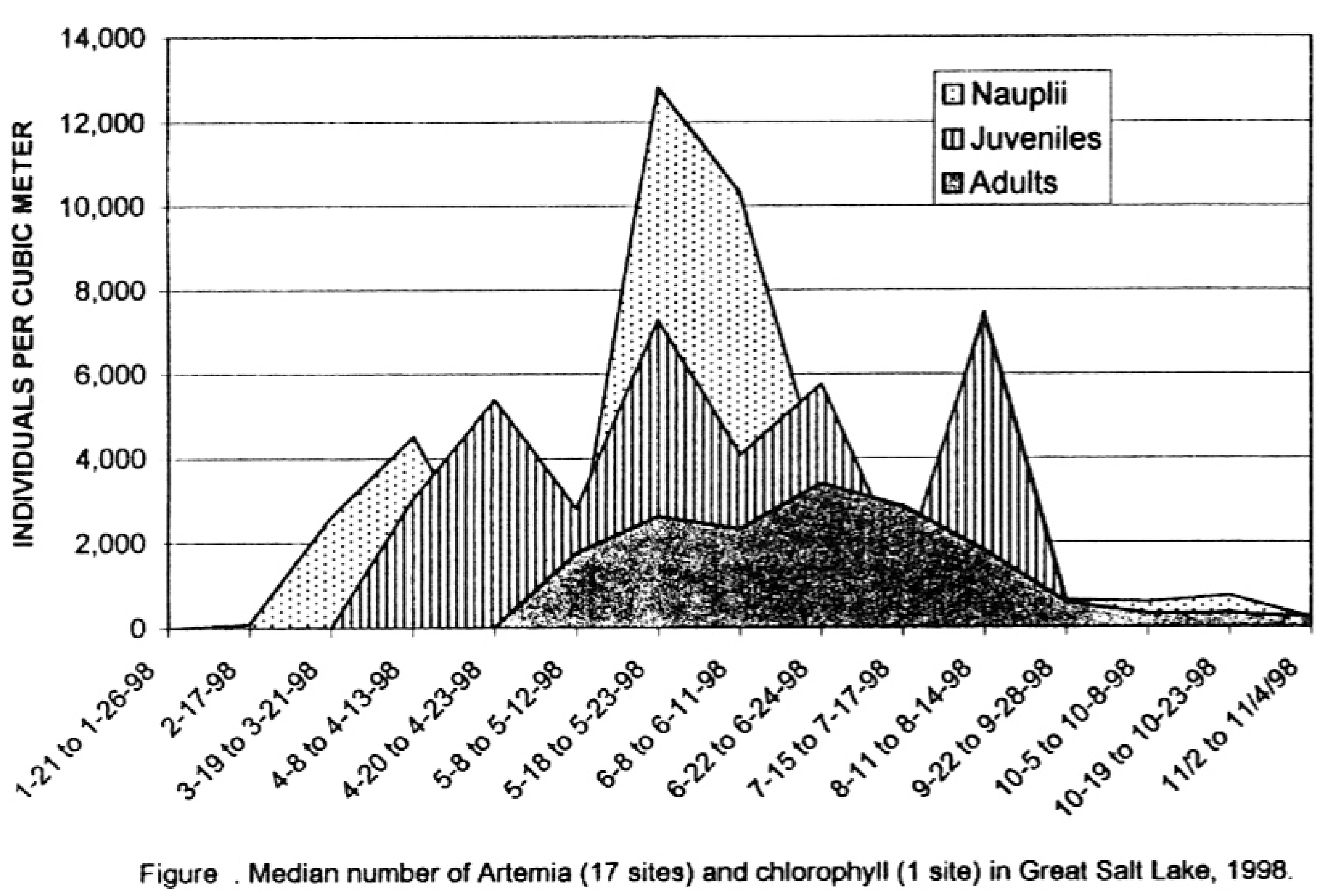

Figure . Median number of Artemia (17 sites) and chlorophyll (1 site) in Great Salt Lake, 1998.

maturation of the Artemia and offset the population about 4 to 6 weeks behind normal. The initial hatch of nauplii in March did not reach adult status until May (Figure 2). A second large hatch of nauplii, from ovoviparous eggs, occurred in late May and moderate numbers of nauplii were also present in late June. There was a large ratio of number of juveniles to number of nauplii in April and May 1998. Large ratios of juveniles to nauplii suggest high survival of the nauplius stage and recruitment into juveniles. By June, numbers of adults (especially females) were larger than in the previous two years, indicating high survival and recruitment likely due to sufficient food resource during springtime.

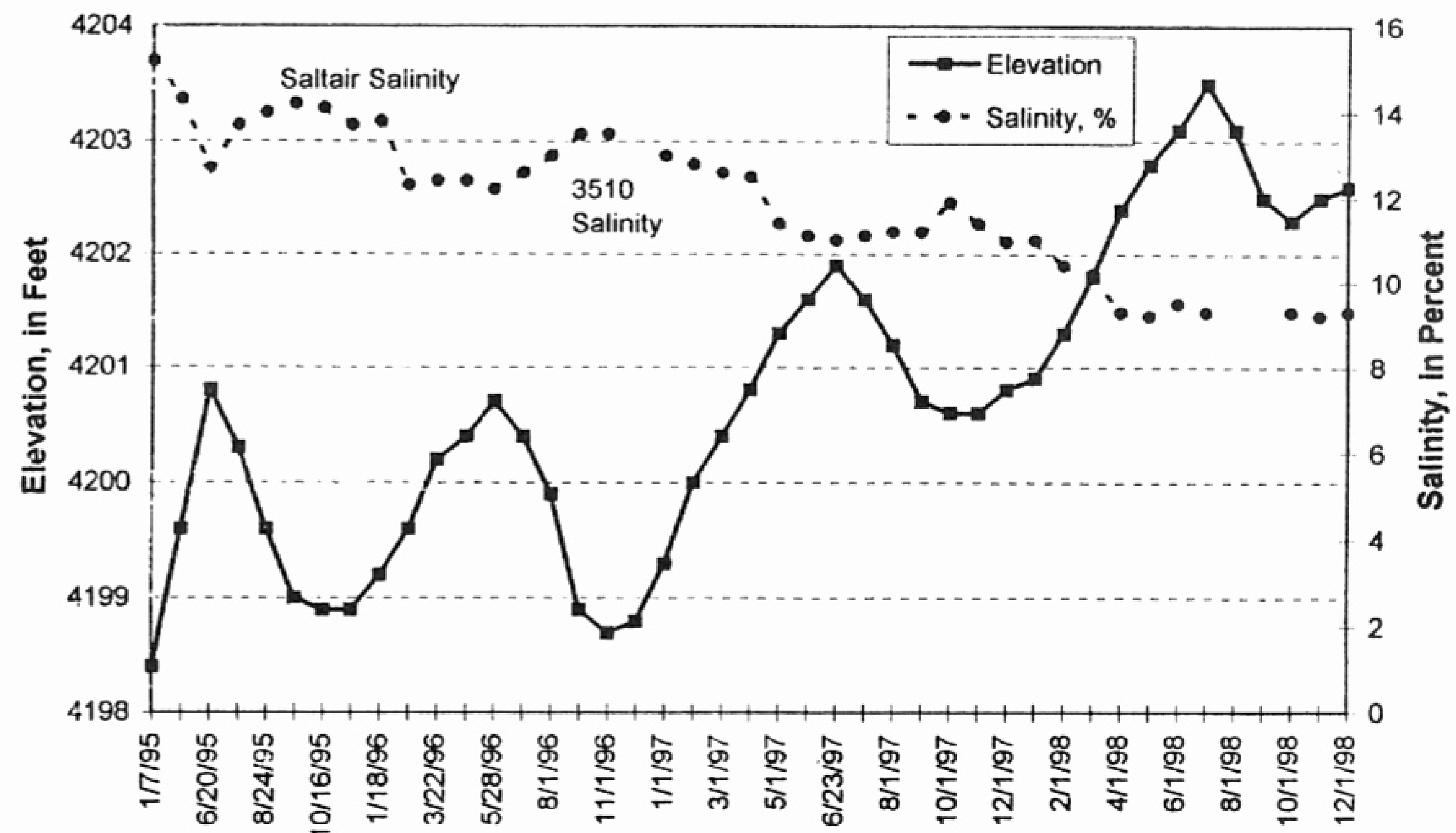

Figure 2. Elevation of Great Salt Lake at Saltair gage and salinity at Saltair gage and at 1 m at site 3510.

However, the percentage of females carrying eggs or cysts was considerably lower in 1997-98 than in previous years. In early May, less than 1 % of females carried ovoviparous eggs (these produce "live birth") compared to 30 % in 1997. By the end of June, only 1 % of females carried cysts and the average number of cysts per female had dropped to 14. Free cysts in the water averaged 1,973/m3 but had a 95 % confidence interval of 13,400/m3 indicating large variability between sites.

Cyst production finally began increasing in late July and by the end of September, over 30% of the females carried cysts. A third group of nauplii produced primarily from cysts in August successfully recruited to juvenile stage but adult populations continued to decline through the late summer. The commercial shrimp harvest started October 1 and there were over 30,000 cysts/m3 present in the water. At the start of the harvest in 1997, there were only 19,000 cysts/m3 but in 1996 there were over 65,000/m3. Obviously, the shrimp population has very large annual variations.

The Division of Wildlife Resources (DWR) set the harvest quota of biomass (adult shrimp, cysts, and debris) at 7.3 million pounds prior to the opening of the season in 1998. The numbers of cysts in the water were closely monitored weekly during the season, and by mid October, the number of free cysts in the water had dropped to about 15,000/m3. The DWR revised their harvest limit downward and halted the season with an emergency closure designed to protect the resource for coming years. The total harvest for 1998 was estimated between 4.6 and 5.2 million pounds of total biomass.

Plans are underway for addition work by USGS, DWR, and Utah State University for the coming year. As in the past, the lake either will expand or contract, become fresher or more saline, and there will be few or many brine shrimp.

Additional information about brine shrimp and Great Salt Lake is available through the USGS web site at wwwdutslc.wr.usgs.gov . Information about regulation of shrimp harvest and the Great Salt Lake Ecosystem Project is available at the DWR web site at www.nr.state.ut.us . The USGS has an education poster (17 by 30 inches) about brine shrimp that is available free to the public by email to stephens@usgs.gov or by calling the USGS at 801-975-3354.

Our Rock Art Legacy
Along the Shores of the Great Salt Lake

Ken Sassen

The archeological evidence from the classic cave excavations conducted earlier in this century suggests that ancient indigenous peoples witnessed Lake Bonneville recede, and exploited the shores of the new Great Salt Lake (GSL) for a variety of foodstuffs starting about 11,000 years ago. We can surmise that at the end of the last Ice Age a spiritual reorientation was necessitated by the changing lifeway, as the rituals of the big game hunters of the Pleistocene gave way to the different concerns of the hunter-gatherers of the Archaic Period. Although it is unclear how far back in time the native American traditions of pecking and painting images on stone extend, the oldest rock art preserved along the GSL margins may have been a manifestation of these new world views. The predominantly abstract (circular and curvilinear design) Archaic rock art style eventually blended with the more representational Fremont style perhaps starting as early as 1,500 years ago, which featured mountain sheep (and other zoomorphs), rainbows and lightening bolts, and eerie broad-shouldered anthropomorphs. It has also been suggested that external stylistic influences from the Great Plains are also represented in this areas rock art. Finally, a few modern horse figures establish that Ute visitors left their mark during the Historic Period, after contact was established with the Spanish well to the south.

Having widely photographed and studied rock art from many cultures, I have no doubt that the rock art sites surrounding the GSL represent a unique heritage: the diversity of styles shows this to be an area of mixing communication lines and cultures, and the apparent great age at some sites implies unusual antiquity for North American rock art. Moreover, as hinted at here photographically, there are a number of exceptional ceremonial sites involving bizarre settings and mythical panel illustrations that are perhaps not sufficiently appreciated by the scientific community. Some of these sites are essentially unknown, and you will forgive me if no specific directions to them are provided-- rather, go and explore in order to locate these, and as yet other undiscovered rock art sites. (Besides the Antiquities Act makes me hesitant to do so, in view of evidence for criminal vandalism and even "legitimate" rock art boulder "acquisitions" by our local Universities.)

Fig. 1. Fremont-style rock art panel from a rocky outcrop along the southeastern shore of Stansbury Island, depicting a line of burden-carrying figures, until quite recently unknown and hidden behind a rock slab. Ken Sassen.

Starting northward from Salt Lake City and encircling the GSL in a counter clock-wise fashion, I have photographed painted Fremont bench cave and cliff sites all along the Wasatch front; a mixture of pictograph and petroglyph sites of various styles often at springs in the minor northeastern ranges and down the Promontory Range; a few significant transitional petroglyph Fremont and classic pictograph Fremont sites in the Lakeside Range; minor Archaic scratchings in the Cedar Range; Archaic petroglyph sites on both sides of the Oquirrh Range; and an outstanding accumulation of Archaic/early Fremont petroglyph sites on the southern half of Stansbury Island. In addition, there are numerous ancient petroglyph sites in the region to the south, particularly surrounding Utah Lake, an even a shallow cave with nice Fremont pictographs along the eastern edge of the Salt Lake Valley.

Let me briefly describe some of the best rock art sites in this region. The most intriguing is a minor petroglyph site on a rocky ridge just off the GSL shore of southeastern Stansbury Island. What makes this site unique in my experience is the fact that a large rock slab appears to have been purposely placed over a panel of representational figures-- to this day the hidden cliff surface shows little evidence of the discoloring patination process of the surrounding cliff face, which results from the exposure of many desert rocks to rain and sunlight. Hidden here are a line of figures (Fig. 1) that appear to be hump-backed, or more likely burden-carrying anthropomorphs, which are reminiscent of the Kokopeli figures of the Anasazi culture in the Four Corners Region. Nearby are classic Great Basin curvilinear boulder sites. Another unique site is close to Connor's Springs just to the north of the GSL, where a wide variety of figures reflecting various cultural affiliations, some quite mythical, are present; most interesting is an apparent birth scene with celestial overtones (Fig. 2), in which a female figure seems about to cut an umbilical chord attached to some strange orb-- at least this is a far-out interpretation! A small petroglyph site on the southeastern edge of the Lakeside Range contains other mythic creatures, including a winged anthropomorph similar to the so-called eagle-dancers or thunderbirds of later cultures, and surrealistic pregnant mountain sheep (Fig. 3). In this case, however, the repatination of the pecked rock surface is often so complete as to imply great antiquity. Finally, there is an unusually high elevation site involving petroglyphs and holes dug into a boulder scree slope on the upper flanks of the Oquirrh Mountains.

In many respects, these sites are unique to Utah and the Great Basin, and should be offered the highest degree of protection possible.

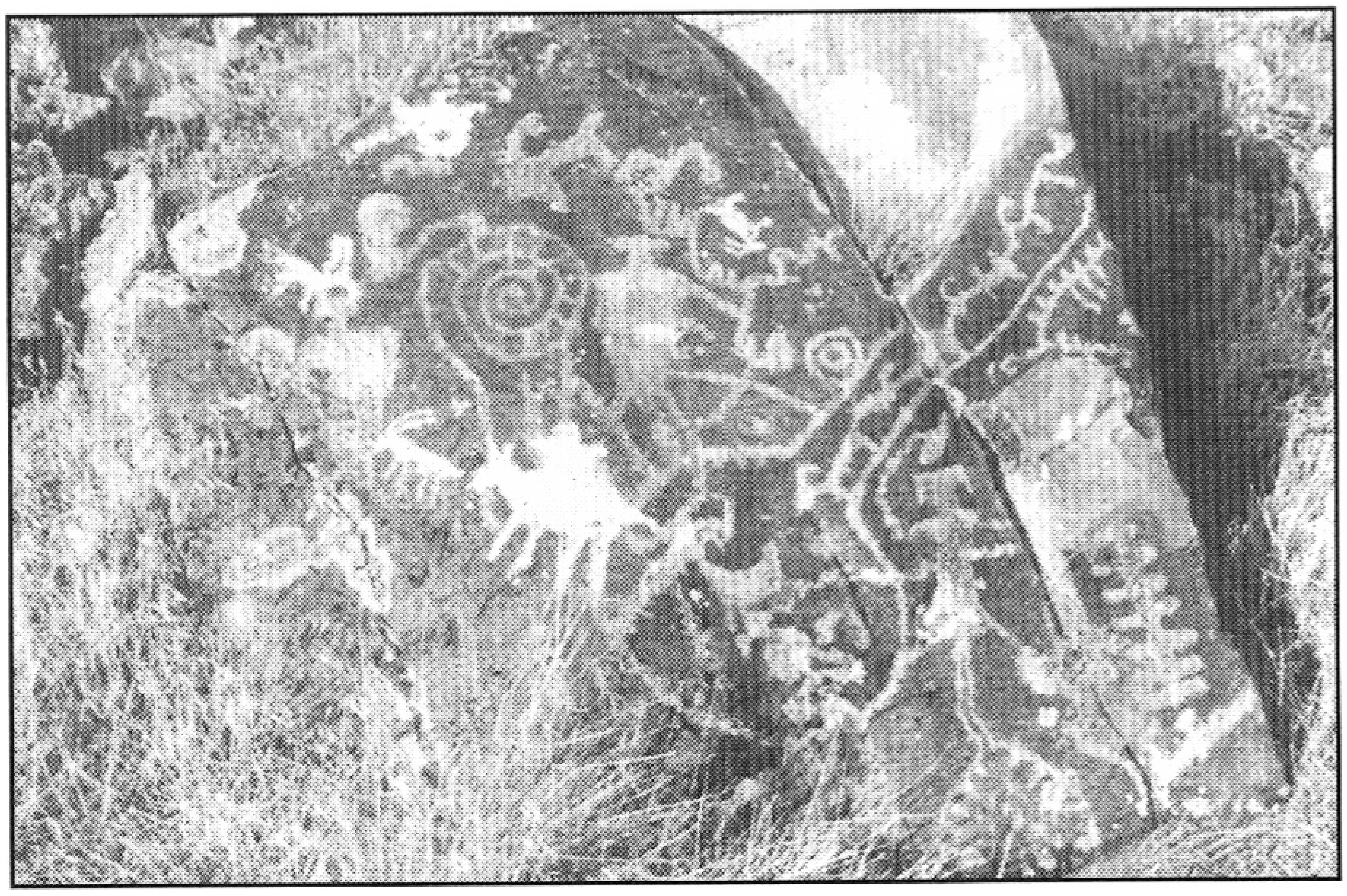

Fig. 2. Overlooking Connor's Springs, a petroglyph-covered boulder showing mythical images of fecundity and birth, as well as recent superimposed Ute nomadic horsemen. Ken Sassen.

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Ken Sassen, native of New York City, has been research faculty at the University of Utah Department of Meteorology since 1976. Although his professional research activities involve the sensing of cloud properties using lasers and radars, he has passionately studied rock art and published articles on their symbolic meteorological content.

Fig. 3. From the Lakeside Range a boulder engraved with a petroglyphic depiction of a eagle-dancer or thunderbird. Ken Sassen.

Avian Cholera on the Great Salt Lake

Tom Aldrich
Waterfowl Program Coordinator, UDWR

As of November 25, 1998, numerous volunteers, in cooperation with UDWR and the USFWS picked up approximately 35,000 dead birds on the south shore of the Great Salt Lake (GSL). Avian cholera was diagnosed as the cause of death from samples sent to the National Wildlife Health Center in Madison, Wisconsin. Among the dead were 32,500 grebes, 925 gulls, 1,060 ducks, and 474 shorebirds. A rare but notable loss was a snowy plover. As of December 7, losses are still occurring but at a much reduced rate from the initial outbreak. Cleanup efforts have ceased due to difficulties with snow cover and unacceptable safety risks associated with extremely low ambient temperatures. Sadly, these losses are in addition to more than 500,000 birds lost in 1997 to avian botulism.

The 1998 avian cholera outbreak marks the second confirmed episode of this disease in wild birds in Utah. The first occurred during the fall and winter of 1994-95, when at least 30,000 birds, mostly grebes and ducks, were lost along the Antelope Island causeway and south shore of the GSL. Estimates for the 1994 outbreak are imperfect because no cleanup activities were attempted.

Although unknown in Utah until the 1990's, avian cholera has become one of the most common diseases in waterfowl in North America. It occurs regularly throughout the continent, and losses of more than 100,000 waterfowl have occurred during a single event. This, however, has not always been the case. Avian cholera was first seen in domestic birds in the 1880's. The first confirmed cholera outbreaks in wildfowl in North America occurred in key waterfowl wintering areas in the Texas Panhandle and in California during the winter of 1943-44. Because these outbreaks coincided in time and location with outbreaks in domestic ducks and chickens, some believe poultry may have been the disease source for the first outbreak in wild birds. In the 1950's, the frequency and severity of outbreaks increased in Texas and California but remained isolated in these two states. In the 1960's and 1970's, cholera events spread to numerous other states including key migration areas, most notably the Rainwater Basin in Nebraska. In the 1980's, cholera became established in snow goose breeding colonies in Canada. Today, cholera occurs annually across all four flyways, and it's recent debut in Utah appears to be another step in a very rapid pattern of expansion. Annual losses from cholera in the U.S. now rival those from avian botulism, posing a major management concern.

It is believed that most birds can be infected with cholera, but some species appear more regularly in die offs. It is unclear whether this is related to species sensitivity to the disease or to behavioral characteristics that enhance exposure. Because most research on the disease has occurred with waterfowl in fresh water environments, what we know may not apply to Utah where grebes in a hyper saline environment seem to be the vehicle for the outbreak.

Managers are not certain what initiates a cholera event. Although cholera bacteria can live up to a year in water under optimal conditions, most studies show a life span of 2-4 weeks after bird mortality has ceased in natural settings. This evidence suggests that the reservoir for the disease is in bird hosts that do not die, but act as carriers for the disease. Recent research on snow geese supports this hypothesis, and might explain the coincidence of cholera outbreaks along major snow goose migration routes. Gulls also may act as carriers.

What turns a low level outbreak into an epizootic of the magnitude witnessed this year is unclear. Age, sex, nutritional stress, and previous disease exposure have all been postulated to impact susceptibility of individual birds, but these relationships are inconsistent among species and situations.

Once an outbreak is initiated, transmission of bacteria among birds occurs through ingestion and inhalation of bacteria. Dead birds secrete a nasal discharge rich in bacteria, which can infect birds nearby, especially while feeding. Inhalation of bacteria laden aerosols from birds splashing and preening in infected water is also believed to be a mechanism for cholera transmission. Overcrowding, surface feeding strategies, water quality that facilitates persistence of free-living bacteria, and the presence of organic materials all favor enhanced transmission of cholera among hosts and potentially can increase the severity of the outbreak.

The impact of cholera losses on bird populations is another aspect of cholera that is poorly understood. Although more than 30,000 eared grebes died in this years outbreak, approximately 1.5 million grebes stage at the GSL. Losses therefore represent 2% or less of the population and is likely a relative small proportion of annual mortality from all causes. Cholera may have a greater impact on bird populations that are hunted. Some researchers believe cholera losses in waterfowl equal or exceed hunting losses in some areas. Recent work on snow geese demonstrated a decline in annual survival rates in response to cholera, suggesting a population-level effect. If the trend toward larger and more frequent cholera events in Utah and North America continues, avian populations may be severely impacted and harvest strategies for hunted populations may need to be modified.

Methods of prevention and control of cholera center around early detection and thorough cleanup of carcasses, although the efficacy of cleanup has never been tested. Carcasses left in the environment may serve as bacteria reservoirs, as well as decoys for other live birds. Carcasses can also be scavenged and distributed to new locations by predators. Small scale control strategies with limited application in our setting include disinfecting impacted areas, hazing and disturbance to prevent bird use of infected areas, and immunization.

Ultimately, prevention and management of outbreaks will depend on a better understanding of cholera ecology and effectiveness of control strategies. Management actions to date have failed to control the dramatic increase in cholera events over the past 50 years. Left unchecked, cholera could become one of the major migratory bird issues for managers in the 21st century.

Ode to a Grebe 10/30/98

Lynn de Freitas

A Capulet and a Montague, lying dead
on the shore of the Great Salt Lake.
Neither one knowing why or how, but victims
of their mutual love for the paradise
into which they both wandered.

She was small, and surprisingly heavy.
Her limp body, lying chest up
with the whiteness of her breast
commanding my attention.
I knelt down respectfully to retrieve
the grebe from the smooth rocks
and green loamy residue on the shore.

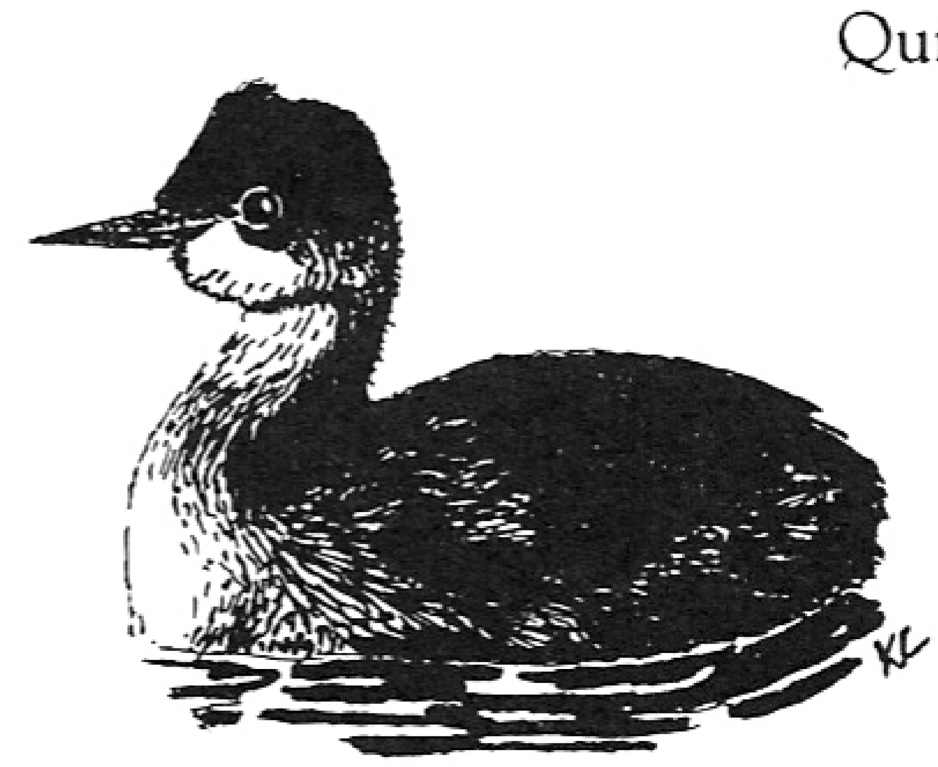
It was as though she had just fallen into her final sleep.
As I scooped her body into my glove,
her delicate neck, with its curve of distinction,
to the finely chiseled head and bill,
extended beyond my fingers.
Such grace, even in death.

The once fiery, crimson eye of vision and knowing,
now milky and vacant. What was your last thought?
What were you planning to do in preparation for your flight?
Were you consumed with your passion
for the depths of nourishment and strength,
providing the sustenance of power
to free you from this place for another, even more exotic?

And there, practically by her side, lay a gull; regal and still.
His commanding size and striking contrast
of crisp gray, black and white caught my eye.
Humbled from his high place of jaunt and aloofness,
his flight took him to the ground beside her.

He had fallen from grace by his will
to consume her in a simple act of nature.
A given right and act of kindness for which he died.

Quickly? Like she did?
I can only hope so.



Pure Joy

Kirsten Shields
Manager/Librarian
South Jordan Library

The Monday morning rush was over, the clouds were grey, the wind was strong, and the promise of white moisture was in the air. As I was daydreaming during a rare mid morning lull in activity, I looked out the glass doors of the South Jordan Library and saw strange black lines in the sky far to the south. I went outside to investigate. To my delight, the black lines were formations of geese heading towards the library. Instead of passing overhead, as they arrived over the library, they broke formation, circled numerous times going higher and higher until thousands of geese were circling above me. I ran inside to let everyone know. We came out to watch. As soon as they reached cloud level, they reassembled into their V formations and headed north towards the lake.

Were they congregating at the lake before their journey south? Were they gathering for a final snack before the trip? None of us knew for sure, but business stopped as staff and patrons looked skyward. Library work is always interesting but this experience was pure joy.

Thanks to You Our Education Programs Will Reach Many More in Our Community

Many thanks to the following members that generously responded to our first fundraising letter supporting our education programs.

William J. Adams, Kennecott Copper
Robert W. Adler
Christine Allred
Margaret K. Batson
Peter Behrens
Bob and Georgene Bond
Denise Brown
Mark and Cheryl Brunson
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Bruce Waddell
Emmett and Linda Ward
Andy White
Wayne Wurtsbaugh
Ron Younger
William J. Zwiebel

Citizens Against Chlorine Contamination Update

by Howard Gross

December 20, 1998 - As regular readers of this newsletter know, recent testing conducted by the Utah Department of Environmental Quality (UDEQ) in September 1998 discovered high levels of dioxin in sediments near the Magnesium Corporation of America (MagCorp) facility on the southwest shore of Great Salt Lake. In response, UDEQ stated in November 1998 that its goal is to pinpoint where in the plant's production process dioxins are being produced, and then take steps to reduce or eliminate the dioxin production. The Citizens Against Chlorine Contamination (CACC) , a group that has been lobbying the State for two and a half years to address these issues, supports these intentions by the State.

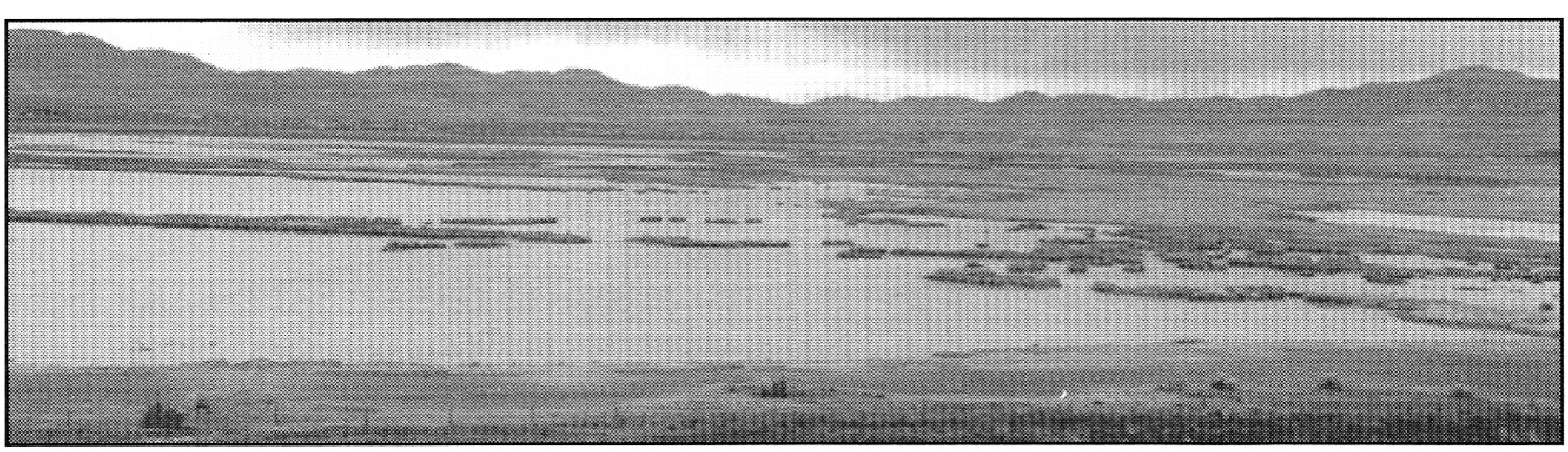
UDEQ appears to be following up on its November statements. In a meeting with CACC representatives in December 1998, UDEQ representatives stated that they and MagCorp were planning further testing for dioxins within and around the facility. Sampling of scrubber liquids from numerous locations within the plant was scheduled to occur in December. (CACC has requested such testing since February 1997.) In addition, MagCorp has proposed dioxin testing of soil samples collected from areas on surrounding BLM lands adjacent to MagCorp that are suspected, based on MagCorp air emission plume modeling, to be high impact sites. Division of Solid and Hazardous Waste (DSHW) representatives meeting with CACC stated that they have requested a characterization from MagCorp of their waste stream from point of generation, as well as a characterization of the waste stream leaving the plant.

CACC reiterated our longstanding position that UDEQ and MagCorp must determine the annual production rate and ultimate fate of MagCorp's dioxins. In addition, other key questions CACC has raised in the past were posed, such as: Where does the waste scrubber water go? Are there particle filters in the scrubber circuit? How much scrubber water is disposed of annually? Is the waste used to make any products for sale? We feel that UDEQ and MagCorp are now taking steps to answer these questions.

MagCorp is concerned about adverse public and business reactions to the dioxin findings and the publicity it has generated. Apparently, some of their clients have requested assurances that MagCorp's products are not contaminated. As a result, MagCorp now has a big budget for addressing these contaminant issues and has committed to paying for further collection and analysis of dioxin samples.

CACC supports the steps UDEQ and MagCorp are taking to address these serious issues of environmental contamination. We hope that by taking responsibility for the financial costs of the sample collection and testing, MagCorp is choosing cooperation over recalcitrance as the future path for addressing the agency and citizen concerns. CACC would support such an approach. Based on the recent demonstration of immense wealth by MagCorp's owner, Ira Rennert, it is obvious that MagCorp can afford such an approach, as well as afford to develop and install technology to drastically reduce their pollution emissions. As always, CACC will continue to monitor these issues and is committed to ensuring that UDEQ and the EPA more stringently regulate emissions from MagCorp.

Photo by Howard Gross



What About This Great Salt Lake?

This is the second in a continuing series on Great Salt Lake information compiled by Bruce Thompson, Education Director for Friends of Great Salt Lake.

Physical Features

LAKE LOCATION is within the Salt Lake Basin, in the northeast corner of the Great Basin and within North America's Basin & Range Province. The lake lies upon a trench filled with up to two miles of sediments accumulated over millions of years. It is the sixth largest lake in the US and fourth largest terminal lake in the world. It is the Western Hemisphere's largest saline lake, second largest worldwide.

LAKE SIZE at its average 4202' surface elevation is approximately 75 miles long, 30 miles wide, with 335 miles of shoreline. It occupies 1,680 square miles, or one million acres, and contains 15.4 million acre-feet, or five trillion gallons of water. Lake depth averages 15 feet, with the deepest part approximately 36 feet. During the past 150 years Great Salt Lake's size has fluctuated between 915 and 2425 square miles. 37% of the lake area lies in Gunnison Bay, which is the "North Arm" defined as the lake region west of Promontory Point, north of the Lucin Cutoff. The remaining 63% of the lake area comprises the region generally referred to as the "South Arm," and includes Bear River and Farmington Bays.

THE GREAT SALT LAKE WATERSHED drains 21,540 square miles in parts of three states. Inflow is primarily from the Bear (40%), Weber-Ogden (13%), and Jordan (13%) Rivers, supplemented by internal springs (3%) and direct precipitation (31%). 95% of all stream inflow enters, and because of the Lucin Cutoff causeway is largely confined to, the South Arm.

THE LUCIN CUTOFF is the name of the 12.6 mile rockfill causeway built in 1959. It dissects the lake east to west and serves as a Union Pacific Railroad shortcut. With only two built-in 15' culverts plus a 300' shallow flood-release breach added in 1984, this causeway inhibits water and nutrient exchange. It also accounts for differences in both surface elevation and increasing salinity between the North and South Arms.

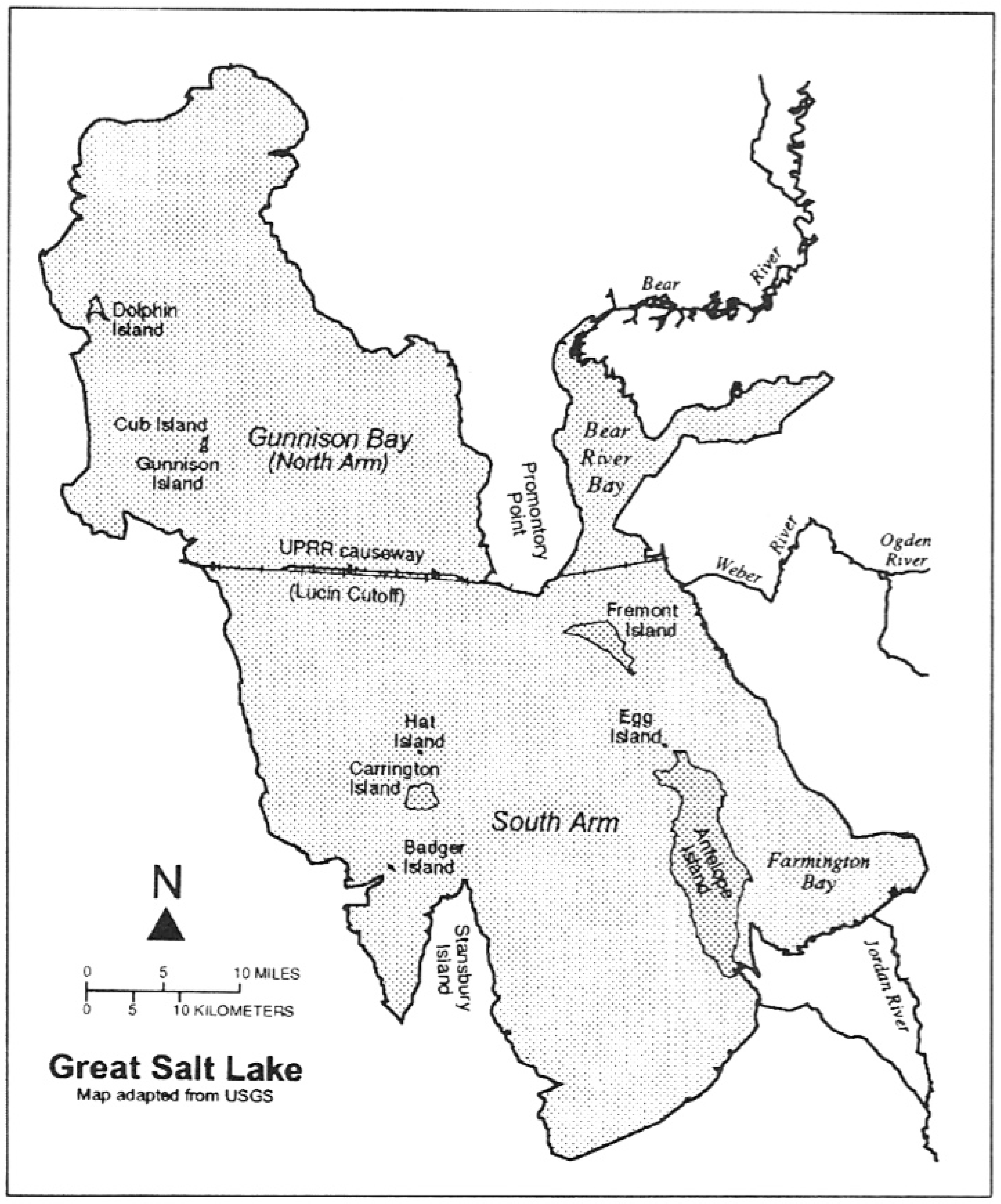
LAKE SALINITY averages 12% in Bridger Bay (the "South Arm") and 25% in Gunnison Bay (the "North Arm"). Overall salinization results from water transportation of minerals water entering the basin. Water is constantly evaporating from the basin, but chemicals remain trapped.

LAKE LEVEL has varied historically from a record low (4191') in 1963 to record highs (nearly 4212') in 1873 and 1987. The lake may have reached up to 4225' in the early 1700s. The size of Great Salt Lake at any time results from the equilibrium between water input (+) and evaporation (–). A self-adjusting mechanism exists whereby lowering lake levels cause progressively diminished water loss from evaporation, both because of the reduced surface area and the lowered evaporation rate of saline water. Conversely, water loss through evaporation increases disproportionately as the lake's surface area increases and salinity decreases. The lake's typical evaporation rate is estimated to be approximately 2.9 million acre-feet, or nearly 4 feet of depth, per year. Diversions and development on the lake's tributary system have reduced the average lake level by 4.8 feet in the past 150 years.

LAKE BONNEVILLE was the fresh water predecessor to Great Salt Lake 30,000–10,000 years ago. Roughly 15,500 years ago its size reached approximately 346 miles long, 145 miles wide and 1050 feet deep. At its peak, Bonneville occupied over 20,000 square miles of what are now western Utah and parts of Idaho and Nevada. Outpouring from a break at its northeastern edge at today's Red Rock Pass in Idaho, followed by subsequent periods of drier climate, has revealed over fifty shoreline levels today marked as terraces on the hills and mountains surrounding the Salt Lake Basin. Four major shorelines thus evident are: Bonneville Level (el. 5085'), Provo Level (4860'), Stansbury Level (4470'), and Gilbert Level (4275'). Because of "crustal rebound," both the Bonneville and Provo shorelines today appear at higher elevations in central parts of the lake basin than around the edges. Today's Great Salt Lake is a Bonneville remnant, in fluctuating existence for the past 10,000 years.

ISLANDS OF GREAT SALT LAKE include from largest to smallest: Antelope, Stansbury, Fremont, Carrington, Dolphin, Gunnison, Hat (or Bird), Cub, Badger, and Egg. The first four have historically served as livestock ranges, the first three plus Gunnison have also served as homes to settlers.

OOIDS AND OOLITIC SAND are names given to the tiny pearl-like particles that make up many of the lake's beaches. High salt concentrations combined with warm water and wave action result in a process of "reverse solubility," whereupon chemicals precipitate out of solution around small mineral or organic nuclei. This concretion process continues to build the off-white ooids. Ooids sometimes bond with carbonates of calcium and magnesium to form rock called aragonite ($CaCO_3$).



Great Salt Lake
Map adapted from USGS

WEST DESERT PUMPS, located west of the Newfoundland Mountains, were activated in 1987 in response to rising lake levels. The pumping station was built in 9-1/2 months at a cost of $71,700,000. Three pumps with 10' diameter impellers are each powered by a 16 cylinder natural gas powered engine. Pump output reaches a combined 1.2–1.6 million gallons/minute into a 4.2 mile outlet canal. Between April 1987 and June 1989, 500,000 acre feet of water were discharged, creating a 320,000 acre evaporation "lake" 500 square miles in size with an average depth of 2.5 feet. During this process, 700 million tons of lake salt were ultimately transferred to the West Desert. The pumps are served by 25 miles of dikes, a 37 mile natural gas pipeline and a ten mile access road. The pumps are not operational at this time. Great Salt Lake otherwise outflows naturally into the West Desert at 4217', an elevation that is higher than present airport runways and other roads and developments.

GREAT SALT CHEMISTRY includes 15 natural salts, such as chlorides and sulfates of sodium, magnesium, potassium, and calcium. On any given day, nearly 4-1/2 billion tons of different lake salts are in solution. In an average year, 2.2 Million additional tons of dissolved minerals flow into the lake —the equivalent of 70,000 railroad boxcars.

MINERAL EXTRACTION at Great Salt Lake is conducted by six mining companies, extracting nearly 2 million tons of chemicals per year. To get the chemicals out of the lake, water is removed from diked ponds by evaporation, which on a hot summer's day occurs at the rate of 200 tons of water per minute. There are over 85,000 acres of diked evaporation ponds in Great Salt Lake—comprising an area twice that of San Francisco. The lake contains 32 mineable minerals. *Potassium Sulfate* (K_2SO_4) is one of the more profitable minerals, shipped domestically and abroad for fertilizers. Other mined minerals include *Common Salt* ($NaCl$), used for cattle feed, food processing, water softeners, highway salt; *Magnesium Chloride* ($MgCl$), used for highway de-icing, road dust suppression, industrial use; *Magnesium Metal* (Mg), used for lightweight structural metal alloys, flares, pharmaceuticals; *Chlorine Gas* (Cl), used for bleaches, water treatment; *Sodium Sulfate* ($NaSO_4$), used for paper production, glass, ceramics, detergents; and *Calcium Sulfate* or gypsum ($CaSO_4$), used for plasters, wallboard, fertilizers. *Oil* extraction has been minimal, with none occurring now. *Sand* and *gravel* are mined at numerous locations, particularly along the remnant deltas and Provo Shoreline of ancient Lake Bonneville.

To learn more about Great Salt Lake, and for a listing of publications from which much of this information was derived, please see our Resource List in the Fall 1998 newsletter issue.

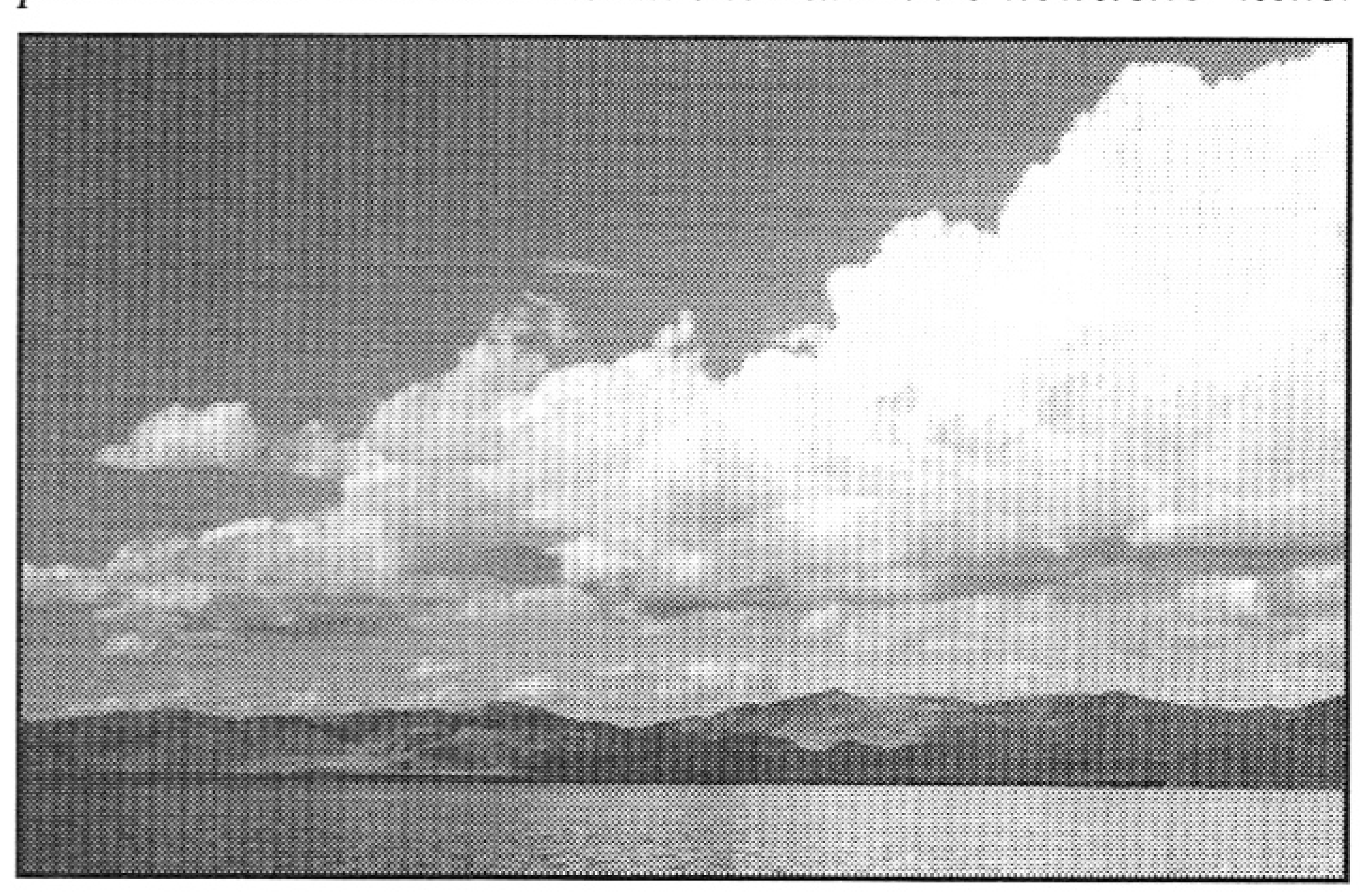


Photo by Lynn de Freitas

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RECYCLE ALUMINUM CANS FOR FRIENDS

Please consider donating aluminum cans to Friends. Can donations will be accepted at 1176 2nd. Avenue Saturdays between 9 a.m. and 2 p.m. All proceeds will go to the FOGSL general fund. Cans must be contained in plastic garbage bags. If you have cans to donate, but can't transport them, please call Margie Paul-Hus and arrangements will be made for a pick-up. If you don't recycle aluminum, please consider starting!! This will greatly benefit Friends. Volunteers are needed for accepting aluminum cans in your neighborhood and/or taking cans to the recycling center.

Questions, please call **Margie Paul-Hus at 355-7174.**

SUBMITTING MATERIAL FOR PUBLICATION

1. **What to Submit:** original articles (historical, geological, geographical, biographical, political, fiction, poetry, etc.) or art work (sketches, photographs, etc.) which pertain to Great Salt Lake.
2. **Submitting Material:** Mail or deliver to 1117 E. 600 S., Salt Lake City, UT, 84102. Or email to: ldefreitas@earthlink.net
3. **Please call (801)582-1496** to confirm receipt of email or with any other questions, suggestions, comments, or ideas.
4. **Deadlines:** The deadlines for submittals are Sept. 16 (Fall), Dec. 16 (Winter), Mar. 16 (Spring), and June 16 (Summer).

Friends of Great Salt Lake wishes to thank Xmission.com for its generous donation of services to support Friends of Great Salt Lake on the World Wide Web at **www.xmission.com/~fogsl**
Kevin Landis is our webmaster.

1999
Great Salt Lake Waterbird Survey Volunteers Needed

Project Objective: To determine the species, numbers and habitat use of waterbirds using the GSL and associated wetlands.

Survey Period: April through September 1999

Time Frame: Generally one morning every 10 days

If ever in the world you wanted to learn the intimacies of the GSL and make a contribution to the Lake's conservation and avian data, then here is your chance! Some waterbird ID skills helpful. Please call Don Paul, DWR Biologist for more info. At 721-9780

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Yes! I want to join FRIENDS ***of Great Salt Lake***

Here are my membership dues in the amount of:
(check one)

☐ $10 Student "Brine Fly"
☐ $10 Senior "White Pelican"
☐ $20 Regular "Pickleweed"
☐ $30 Family "Wilson's Phalarope"

Contributing Memberships:

☐ $31-50 "Brine Shrimp"
☐ $51-100 "Eared Grebe"
☐ $101-250 "Pronghorn Antelope"
☐ $251-499 "Bald Eagle"
☐ $500 Sustaining "Ecosystem Protector"

Student - be at least half time
Senior - be 62 years or older
Sustaining - any corporation, institute, organization, or individuals interested in financially supporting activities of Friends of Great Salt Lake.

In addition to my dues, I would like **to make a tax deductable**

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☐ $25
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