USE OF STABLE ISOTOPES TO DETERMINE *ARTEMIA* NUTRIENT SOURCES, GREAT SALT LAKE, UTAH

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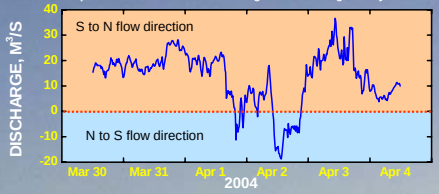
N inputs to GSL vary spatially and seasonally

Acoustic techniques used to quantify nutrient inputs

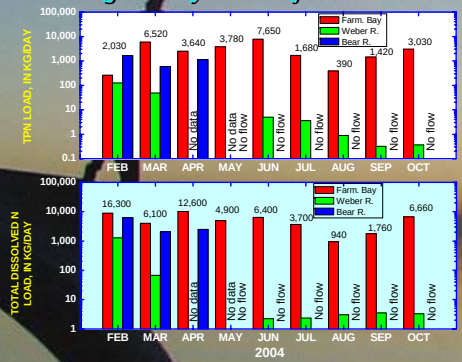
Determination of nutrient loadings to the open water of GSL requires accurate measurement of water flow. Continuous measurement of flow into the open water of GSL was not possible until development of hydroacoustic technology. Because of low gradient conditions along inlet areas of GSL, the relationship between river stage and discharge is poor. Instead, discharge is controlled by lake level, combined with the interaction between wind direction, river stage, and water-density gradients. Hydroacoustic equipment allows for the continuous measurement of both the direction and velocity of water entering GSL. Detailed vertical velocity profiles can also be determined to measure density-driven flow.

Hydroacoustic equipment used at Farmington Bay outlet

Example of effects of wind on discharge from Farmington Bay to GSL



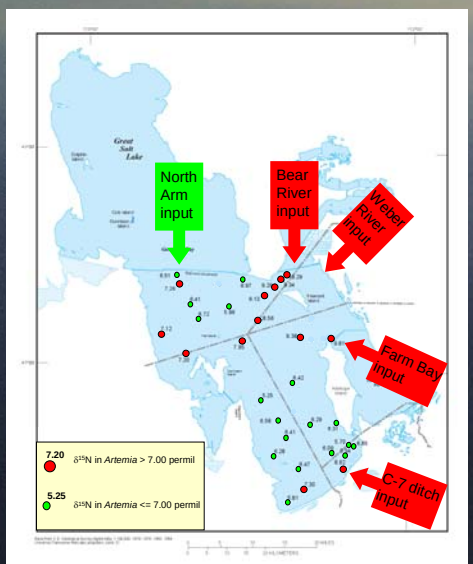
Farmington Bay is a major dissolved and particulate nitrogen source



Nitrogen (N) loads to GSL from Farmington Bay, Weber River, and Bear River were measured during 2004. During late winter and spring, substantial inputs of dissolved (up to 6,500 kg/day) and particulate N (up to 1,700 kg/day) were contributed by the Bear River; however, drought conditions during 2004 resulted in near zero nutrient loadings from Bear River during May through October. During the monitoring period, the majority of dissolved and particulate N load to GSL was from Farmington Bay. The unique seasonal changes in particulate organic matter (POM) $\delta^{15}N$ values from Farmington Bay were found to influence the Artemia $\delta^{15}N$ values throughout the south arm of GSL.

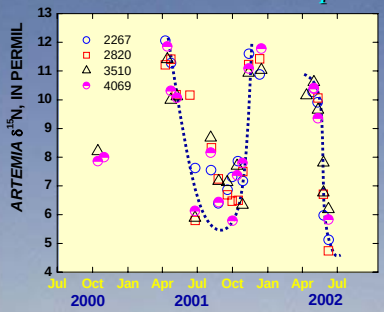
Variation of $\delta^{15}N$ values in *Artemia* reflect currents

During November and early December 2002, *Artemia* samples from throughout the south arm of GSL (0 to 1.0 m) were collected and $\delta^{15}N$ was determined on each sample composite. The $\delta^{15}N$ values of the *Artemia* indicate distinct spatial trends that appear to be related to temporally consistent currents from major inflow sources to GSL. *Artemia* with relatively enriched $\delta^{15}N$ values (+8.62 to +9.81 permil) are found at inflow sources including the Bear River and Farmington Bay causeway breach and input from wetlands along the southern margins of GSL. The isotopically enriched *Artemia* extend west and southwest of the Bear River and Farmington Bay inflow sources to sample sites west and north of Carrington Island. The data indicate that synoptic sampling and $\delta^{15}N$ analysis of *Artemia* during specific time periods may give insight into water currents as well as *Artemia* nutrient sources.



Seasonal variation of $\delta^{15}N$ in *Artemia*

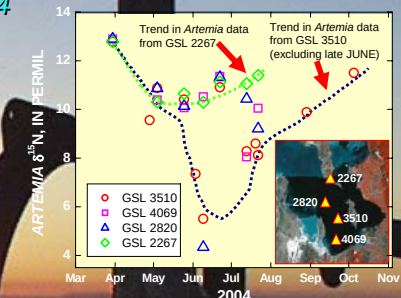
Archived Artemia samples



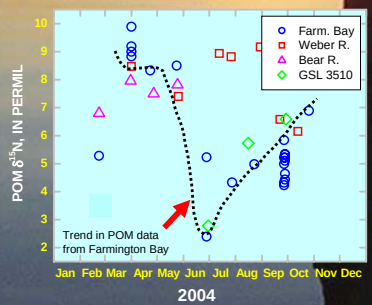
Archived *Artemia* samples from GSL collected during 2000 to 2002 and preserved in buffered formalin were analyzed for $\delta^{15}N$ composition. Previous work by Sarakinos et al. (2002) indicate limited effects of formalin on $\delta^{15}N$ of biota. Analysis of the archived samples indicate a 6 permil annual shift. Early season (Mar) *Artemia* have $\delta^{15}N$ values ranging from +12 to +13 permil, indicative of a food source supported by treated sewage or animal waste nutrient sources. Summer (Jun thru Aug) $\delta^{15}N$ values are progressively lower, (+6 to +5 permil), possibly indicative of higher proportions of nitrogen-fixing food sources. Late season *Artemia* (Sep thru Nov) return to higher $\delta^{15}N$ values, indicative of a food source supported by treated sewage nutrient inputs.

Artemia samples collected in 2004

In 2004, *Artemia* samples were collected from the same sites where archived *Artemia* samples were analyzed. Although similar shifts in $\delta^{15}N$ were observed in *Artemia* from sites 3510 and 2820, sites 2267 and 4069 exhibited smaller seasonal shifts in $\delta^{15}N$. The reason for these differences is unknown; however, they may be related to the disappearance of inflow from the Bear River to GSL in May 2004. The data suggest that the isotopically light food sources from Farmington Bay may be significant to selected areas of GSL during certain time periods. Both sites 3510 and 2820 are in proximity to outfall from Farmington Bay.

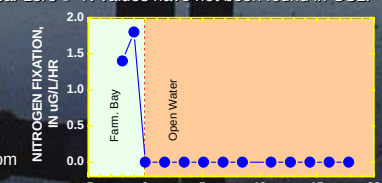


$\delta^{15}N$ of POM shows seasonal and spatial variance



Particulate organic matter (POM) collected at the outlet of FB to GSL shows a strong seasonal trend in $\delta^{15}N$ values. Decreasing trends in $\delta^{15}N$ values in the POM are probably reflective of increasing proportions of nitrogen fixation. Cyanobacteria that fix atmospheric nitrogen tend to have a tightly constrained isotopic composition near 0.0 permil. The strong seasonal correlation between POM $\delta^{15}N$ values collected at Farmington Bay and GSL 3510 indicates that nitrogen fixation in Farmington Bay may be an important food source to *Artemia* in the open-water system. To date, alternative food sources with near zero $\delta^{15}N$ values have not been found in GSL.

In September 2004, rates of nitrogen fixation measured in Farmington Bay approached 2 µg/L/hr compared to rates of near zero for the open water of GSL (J. Robinson, Utah State Univ., writ. commun., 2005). Seasonal variations of POM $\delta^{15}N$ values suggest that nitrogen-fixation rates may be higher from June through August. The predominance of isotopically light Artemia during the summer may be due to a change in the phytoplankton community composition attributed to inflow from Farmington Bay.



J. Robinson, USU, writ. commun., 2005

References and acknowledgements

Sarakinos, H.C., Johnson, M.L., and Vander Zanden, M.J., 2002, A synthesis of tissue-preservation effects on carbon and nitrogen stable isotope signatures: Can. J. Zool., vol. 80, p. 381-387.

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USGS

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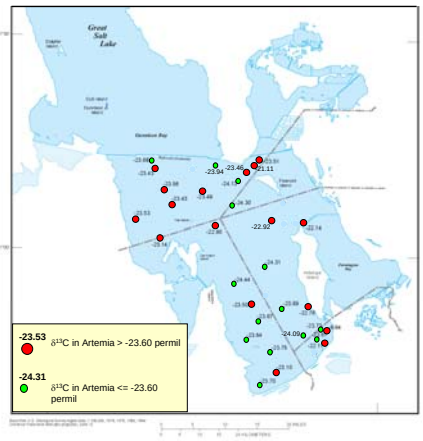
Great Salt Lake
-23.53
δ13C in Artemia > -23.60 permil
-24.31
δ13C in Artemia <= -23.60 permil