

IMPLEMENTATION OF TECHNICAL SOLUTIONS THAT SUPPORT SUITABLE CONDITIONS FOR THE *Artemia* POPULATION ON GREAT SALT LAKE IN THE FACE OF DECLINING LAKE LEVELS.

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A Two-Pronged Approach

Maintaining suitable conditions for Artemia on Great Salt Lake

Unprecedented Action

Technical Solutions that
support the Artemia
population



Policy and Legislative Action

- Structural changes to Water Laws in Utah
- Water conservation measures
- Funding

Presentation by Representative Timothy Hawkes

Active Management of Key Factors affecting Artemia Population Health on Great Salt Lake

- Sustainable harvest management
- Nutrient inflow Management
- Salinity Management

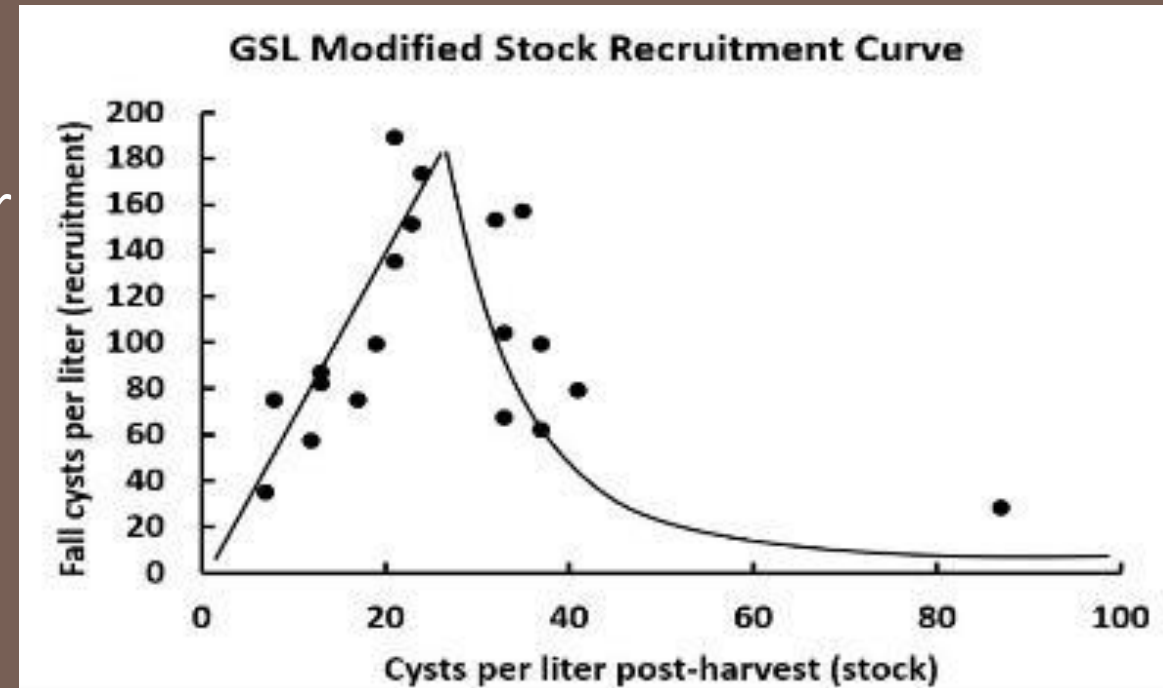


Sustainable Adaptive Harvest Management



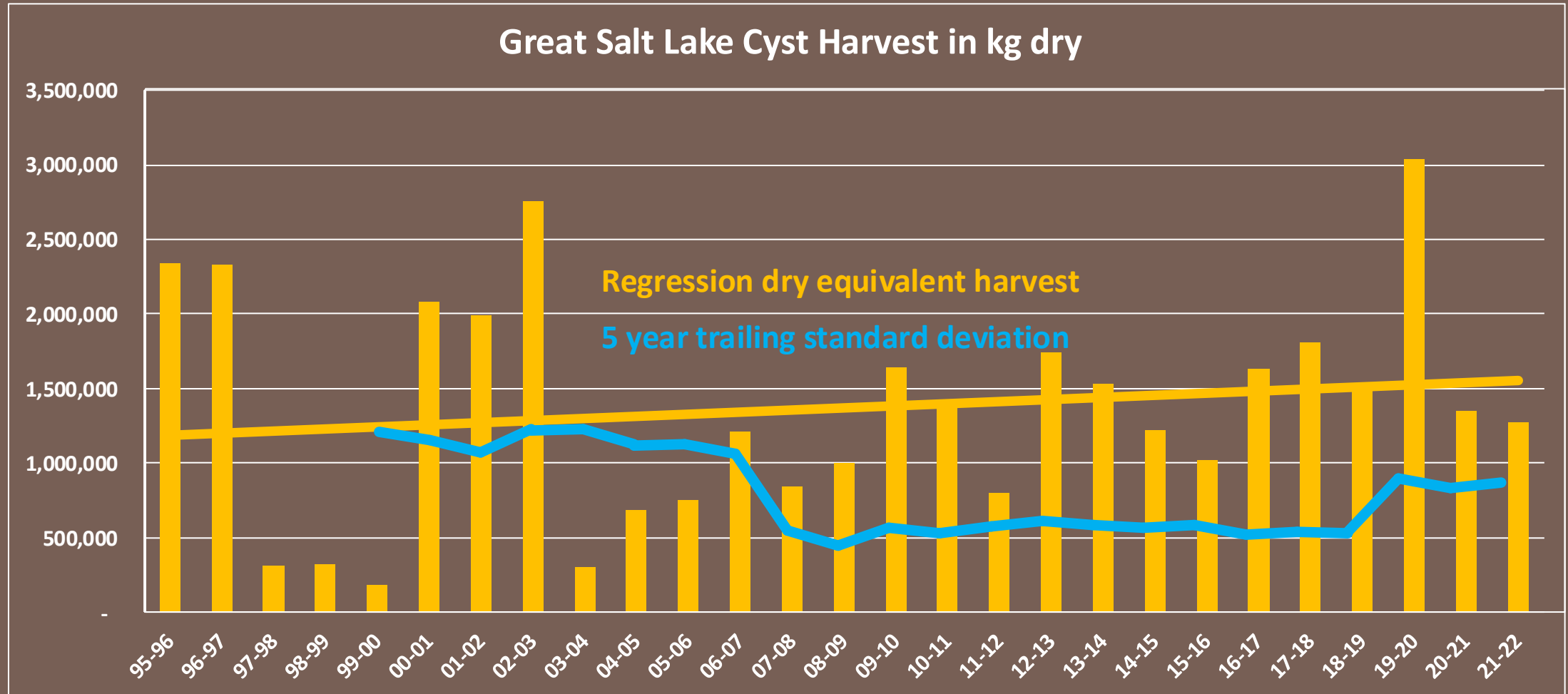
Sustainable Harvest Management

- Initiated in 1996 by the Utah Division of Wildlife Resources in Cooperation with the Artemia harvesting industry initiated Artemia harvest management
 - Formation of the Great Salt Lake Ecosystem Project
 - Technical Advisory Group (Experts from the Academic field, State Agencies and the Industry)
- Introduction in 1997 of harvest management based on a stock recruitment curve, a modified Ricker Curve
 - Optimal escapement stock of 21 cysts per liter
 - Adaptive
- Has been researched for more than 25 years
 - Described in detail in Belovsky et al. 2011 and in Belovsky and Perchon, 2019

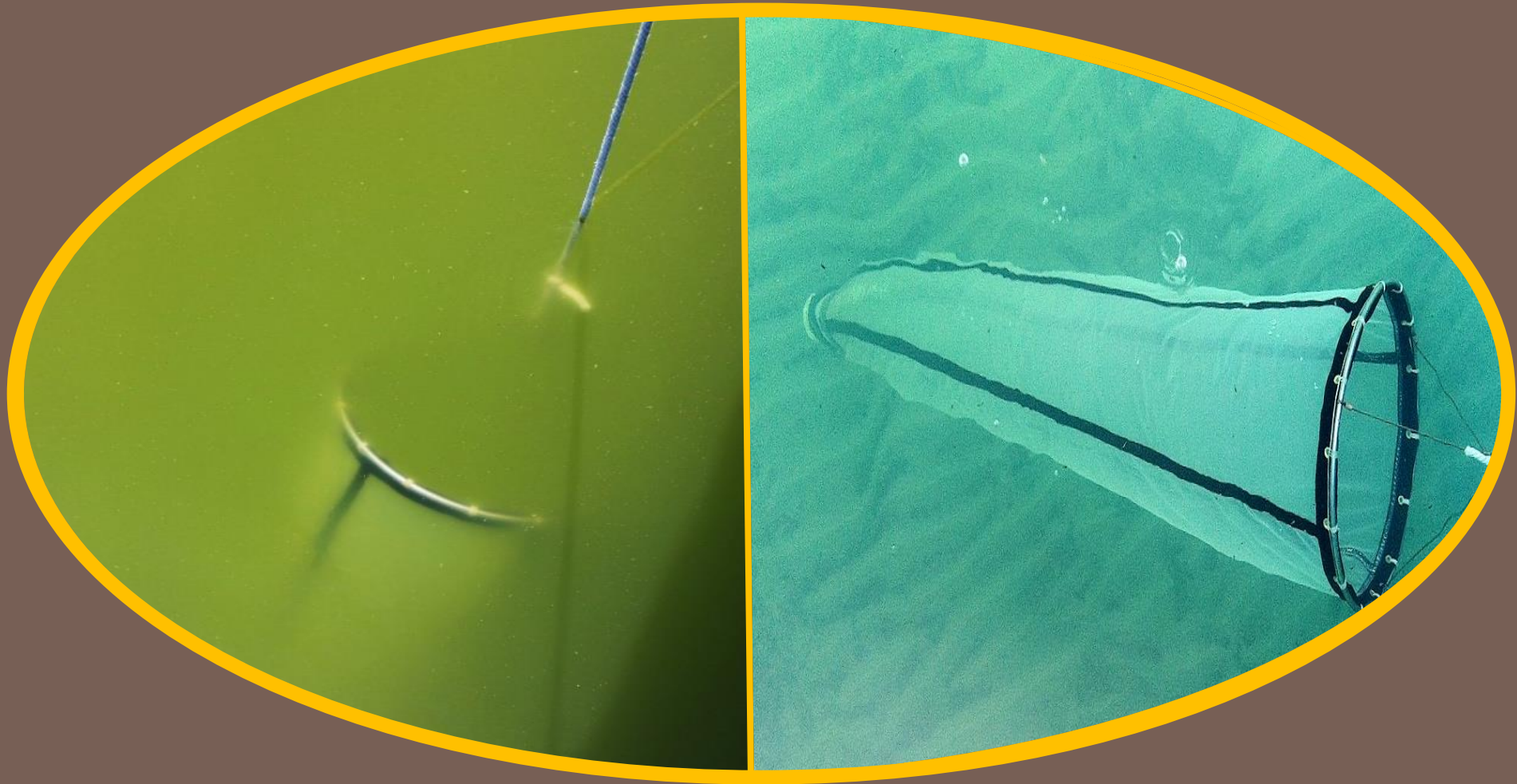


Sustainable Harvest Management

- Sustainable harvest management implemented in 1996 has resulted in a stable Artemia population on Great Salt Lake



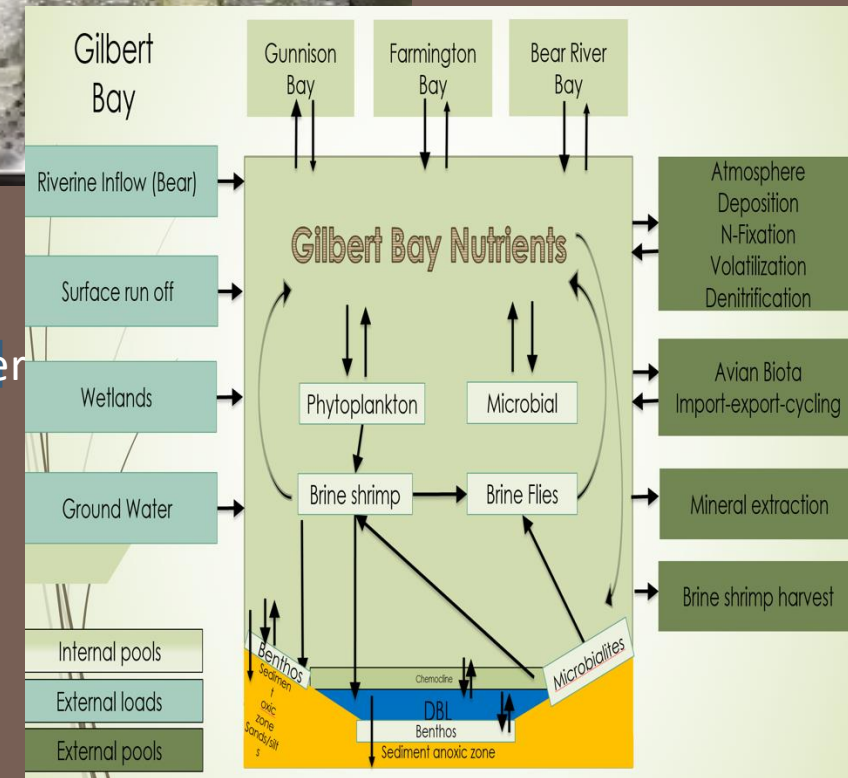
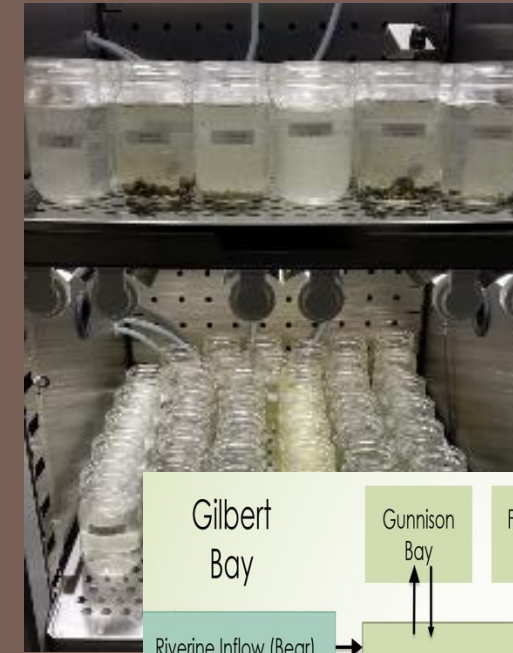
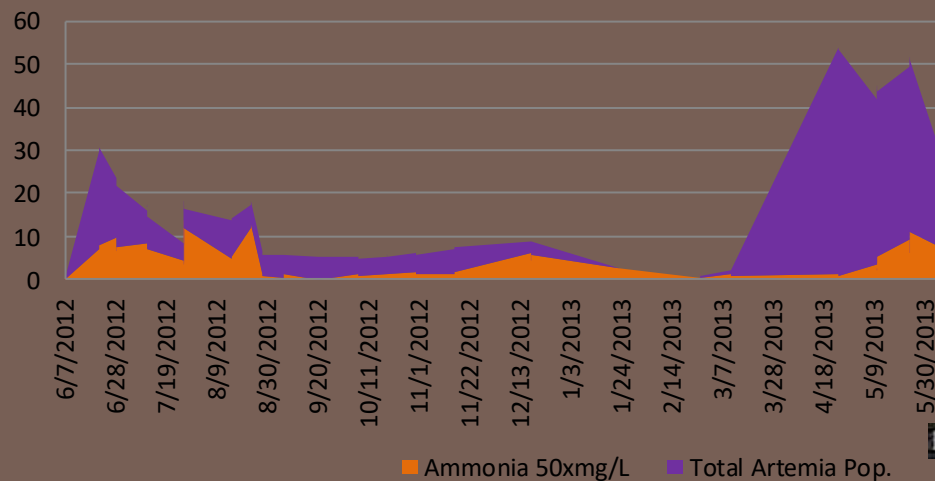
Nutrient Management on Great Salt Lake



Nutrient Management on Great Salt Lake

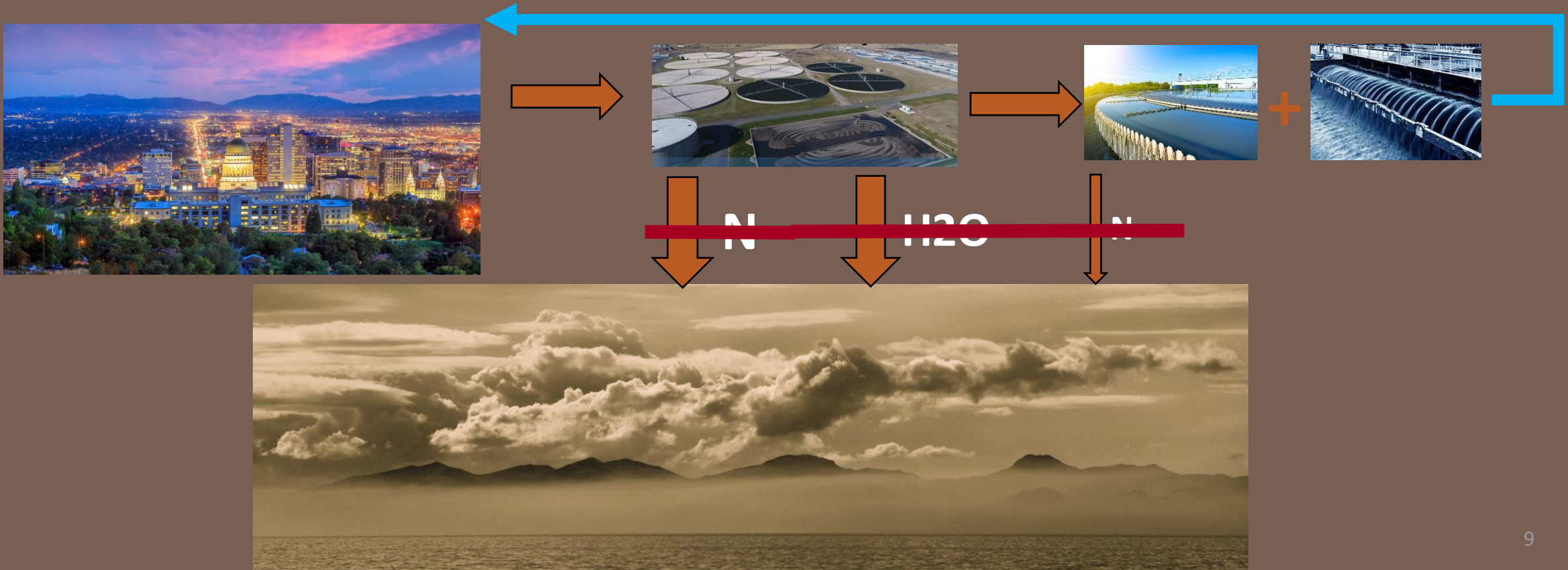
Nutrient research shows

- Great Salt Lake is Nitrogen Limited
- There is a predominance of Nitrogen cycling, which is consistent with endhoreic lakes, approximately 8 % of the soluble Nitrogen pool is replenished on an annual basis
- A majority of these inputs come from natural inflow of nutrients through tributaries



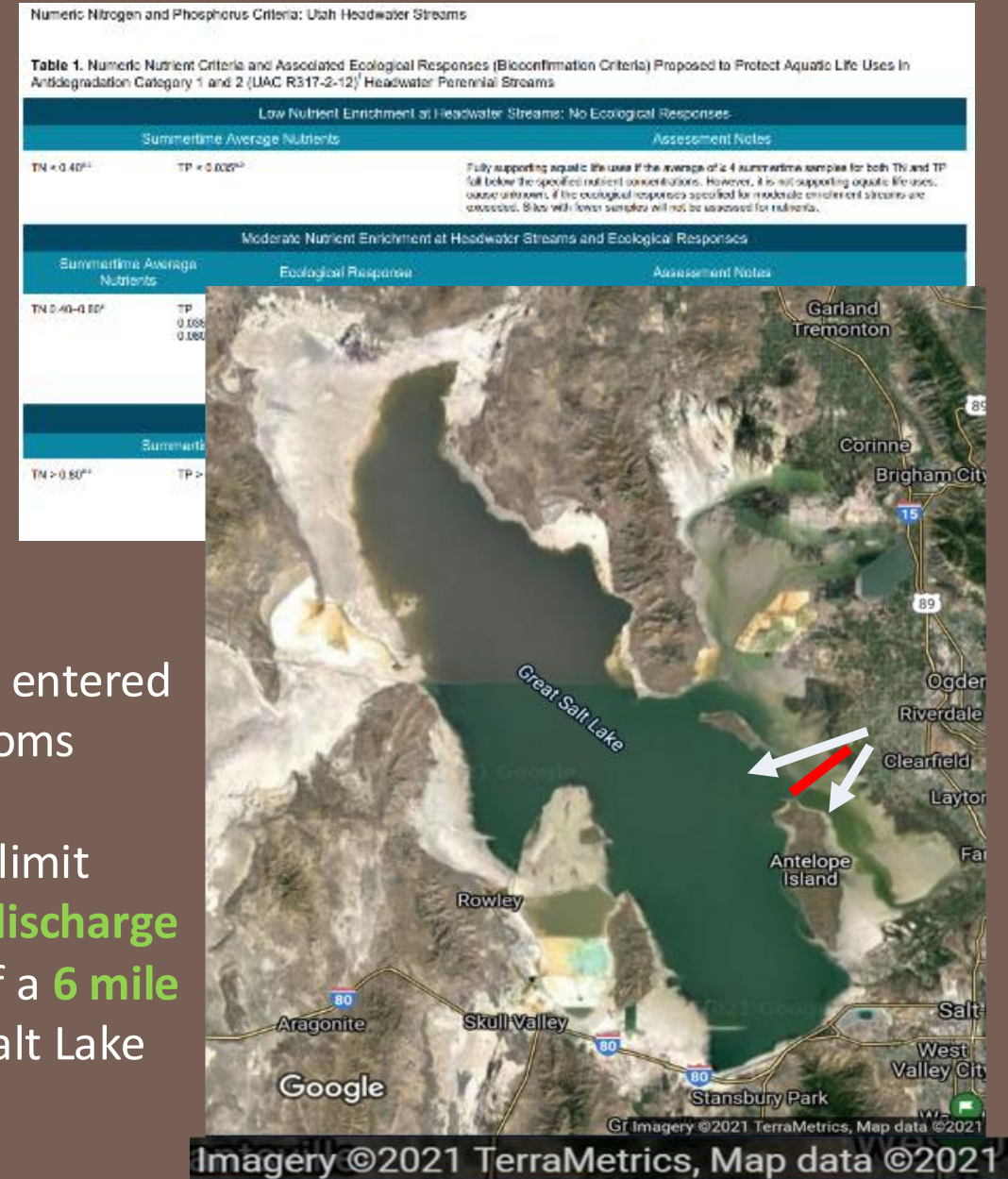
Nutrient Management and Water are Inter-twined

- In addition, GSL also relies on inputs from water treatment plants for nutrient and water supply
- Up to 10% of water and nutrients are supplied by water treatment plants which are under active management



Nutrient Management – Creative Solutions

- The Utah, **Division of Water Quality**, with the involvement of multiple stake holders helped **create a unique and balanced approach to nutrient criteria** development based on a combination of numeric criteria and ecologic responses.
- This **protects the beneficial uses** of Utah streams while considering the **needs of all aquatic ecosystems** including **Great Salt Lake**
- Nutrient rich water from North Davis public water treatment entered a brackish Farmington Bay and created unfavorable algal blooms
- Rather than requiring excessive water treatment that would limit nutrient inflow, DWQ negotiated a **transfer of nutrient rich discharge from Farmington Bay to Gilbert Bay** with the construction of a **6 mile long pipeline**, thus maintaining nutrient inflows into Great Salt Lake

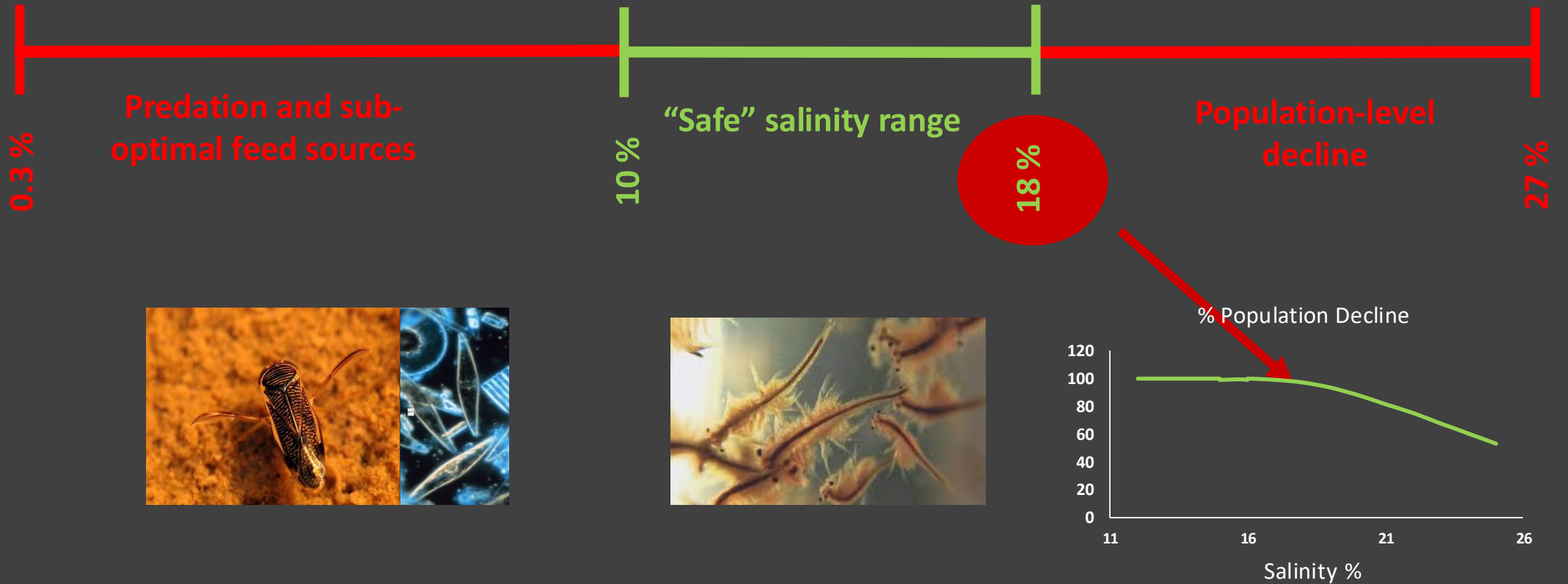


Active Management of Salinity on Great Salt Lake

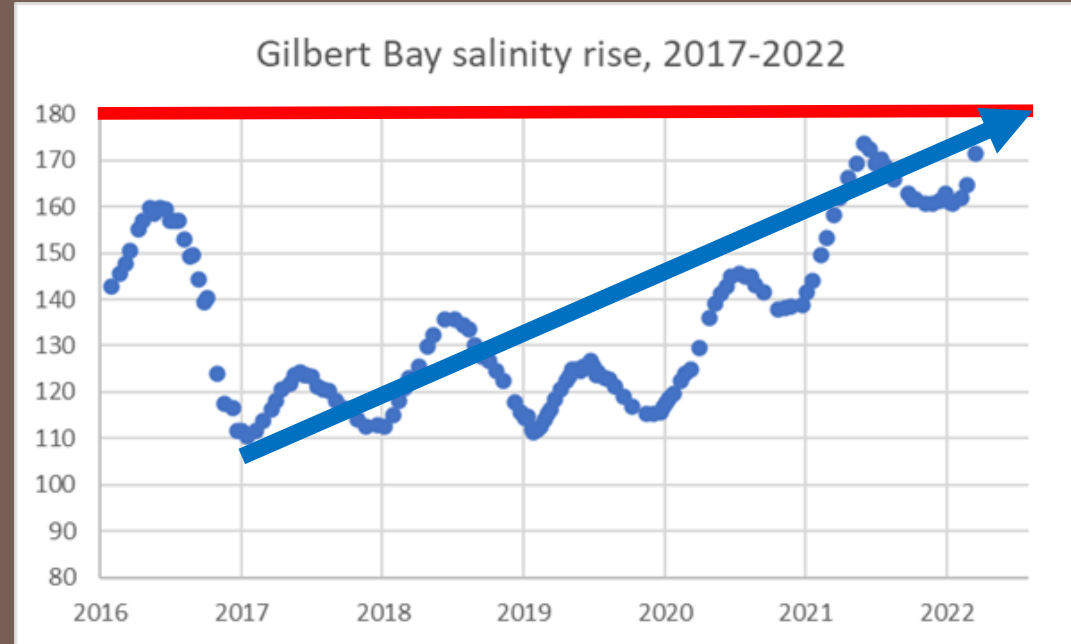
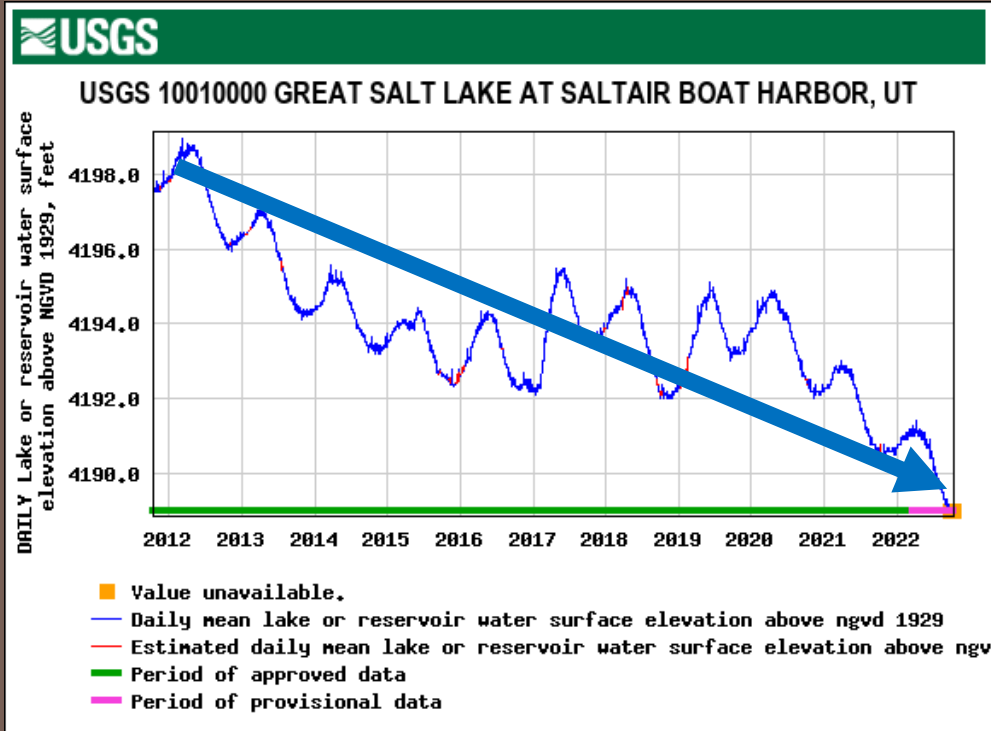
100 to 180 PPT



Safe Salinity Range For Brine Shrimp *Artemia franciscana*



How do lake levels affect Brine Shrimp Resource



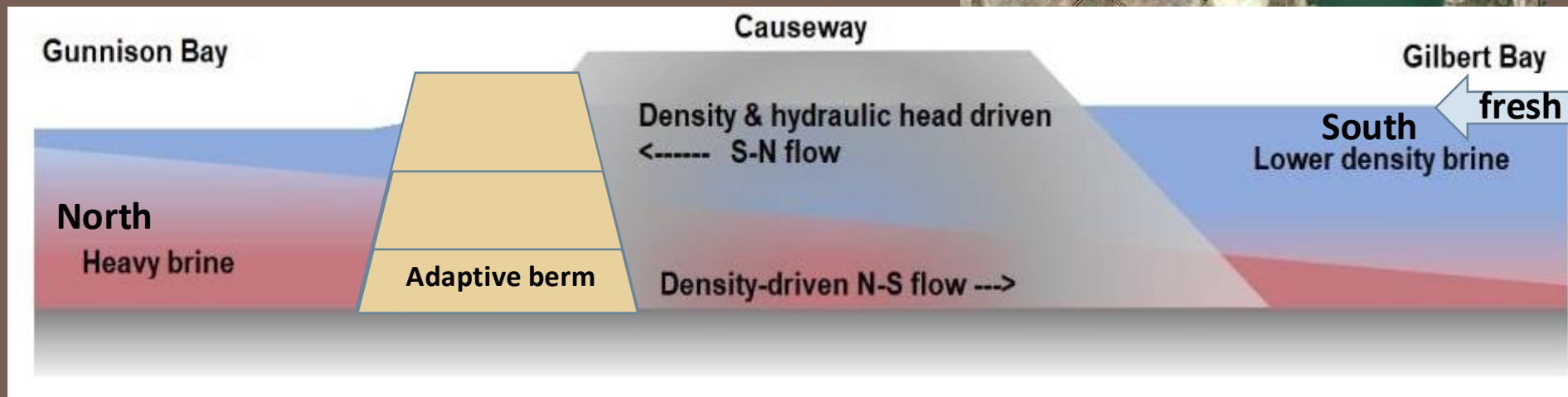
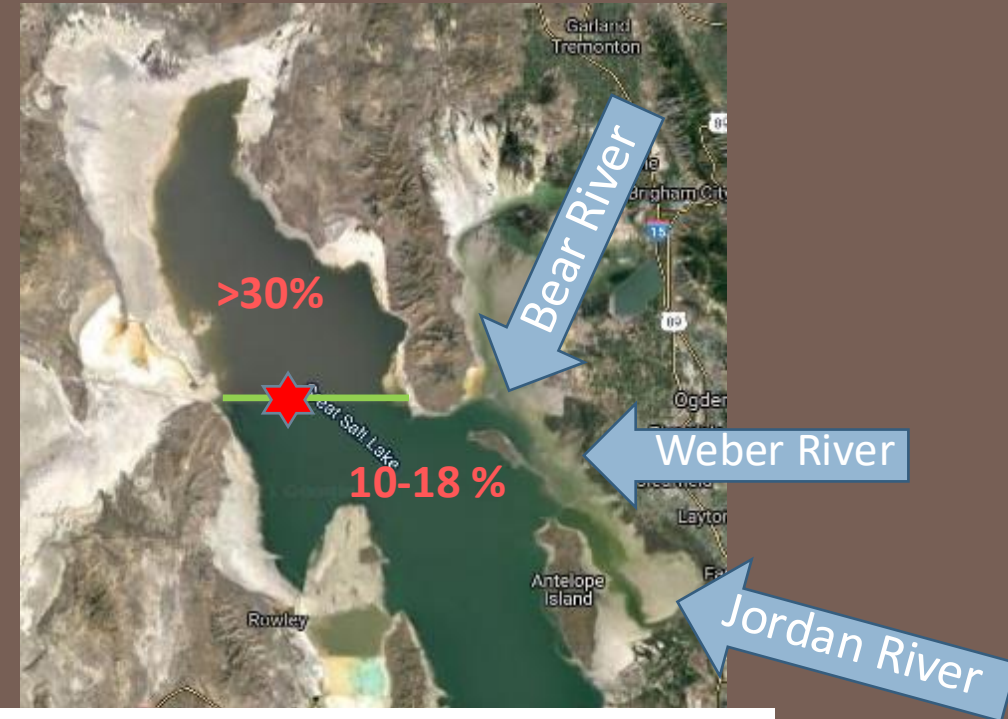
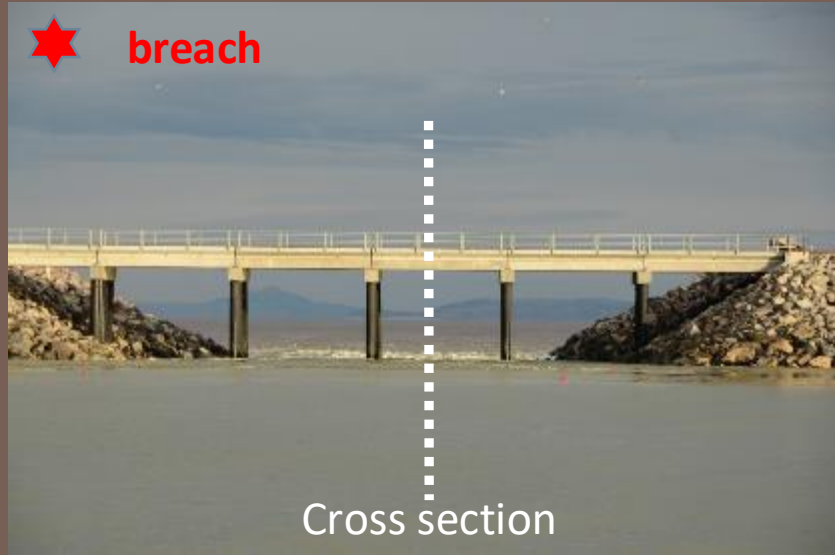
18 %

What is the Solution?



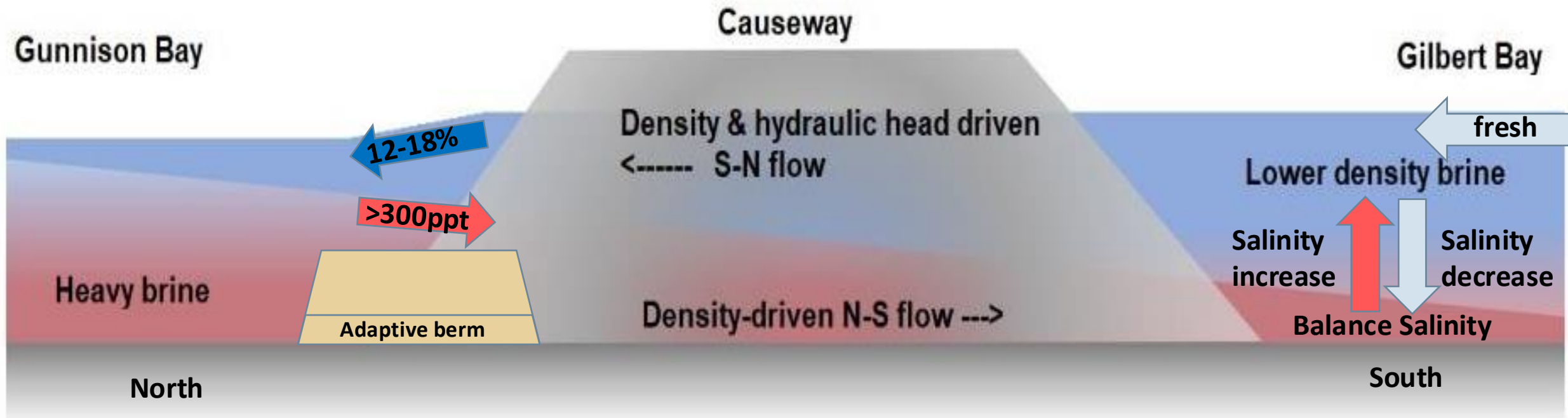
**Combination of active Salinity Management
and increased Water Supply**

Maintaining Salinity Within Acceptable Range for Artemia: an Adaptive Management Berm

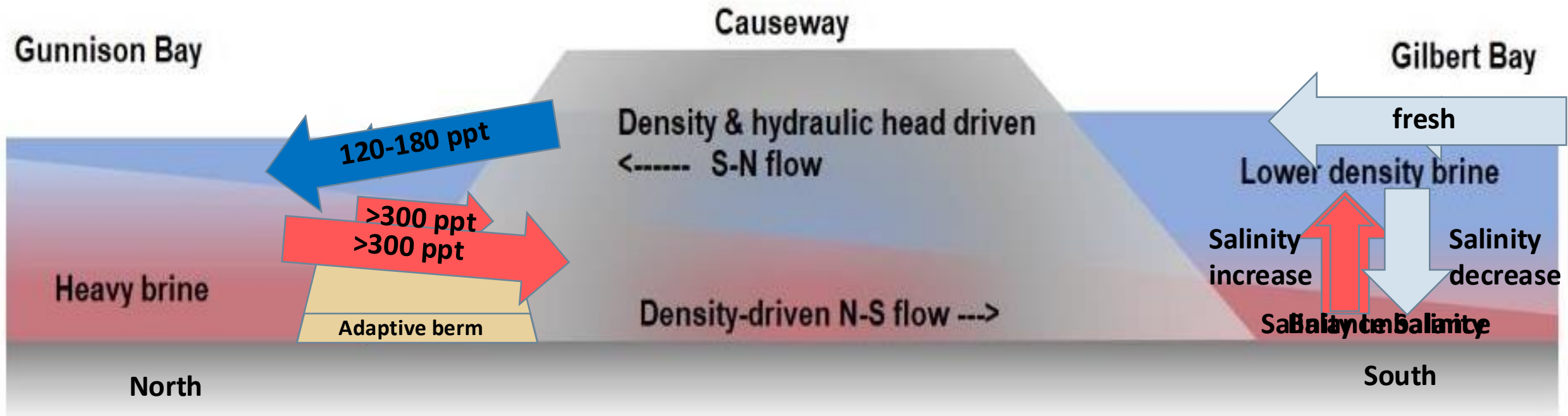


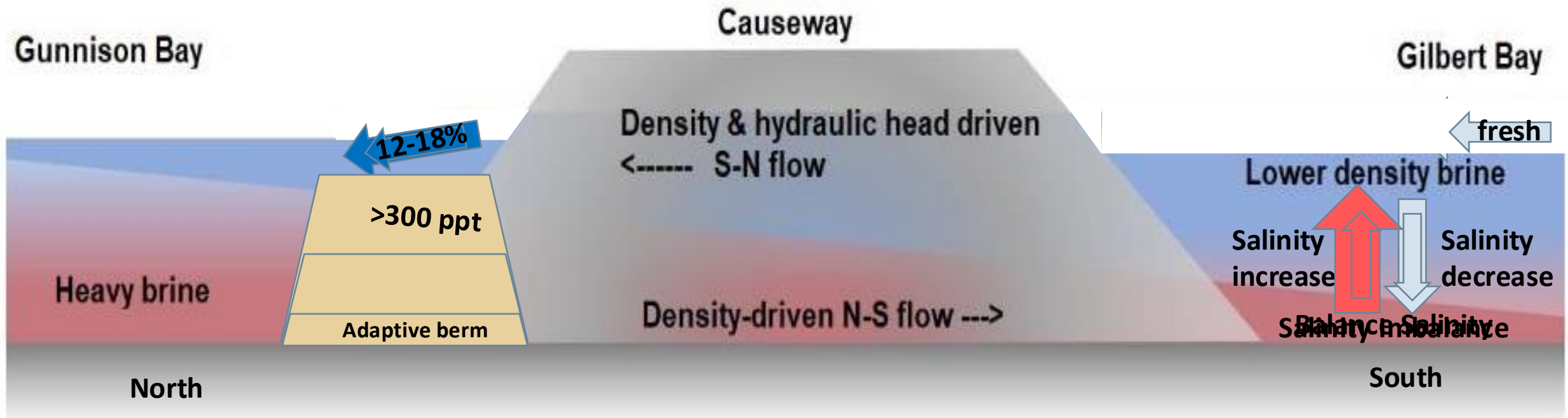
Salinity
Management
under different
conditions of
precipitation and
inflow

Adaptive Management Berm – Average Inflows and Precipitation

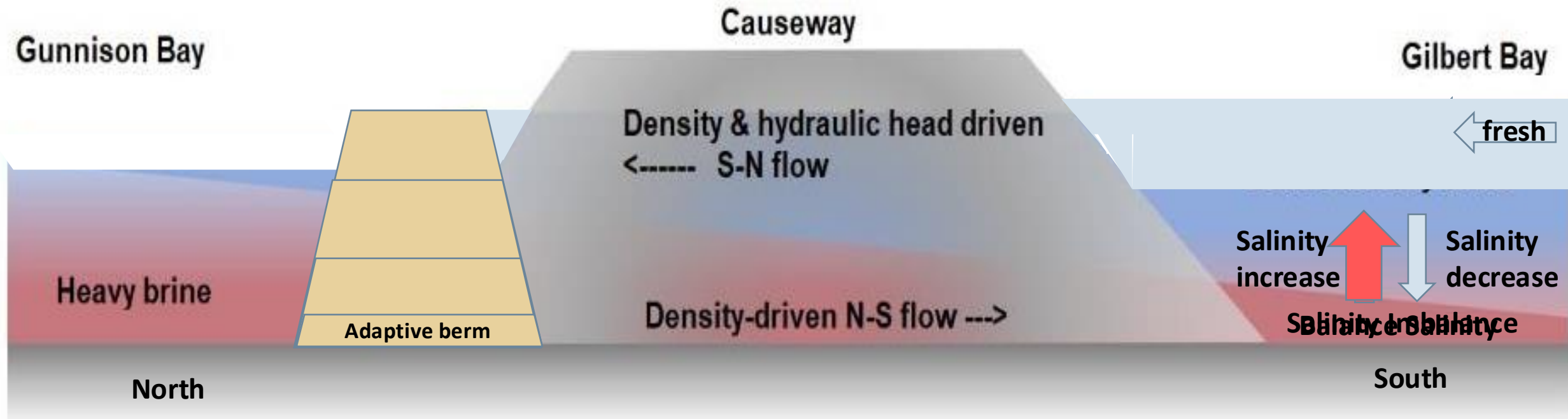


Adaptive Management Berm – High Inflows and Precipitation



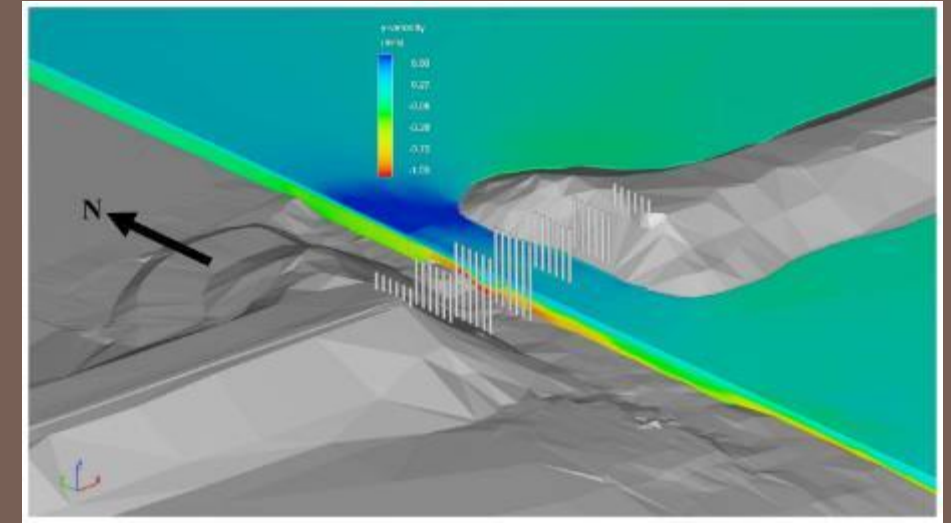


Adaptive Management Berm – Extreme Drought

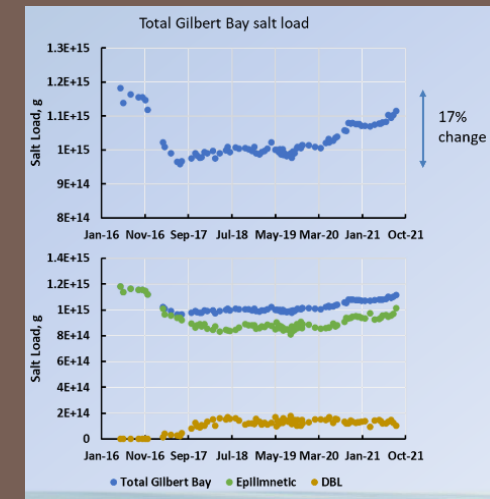
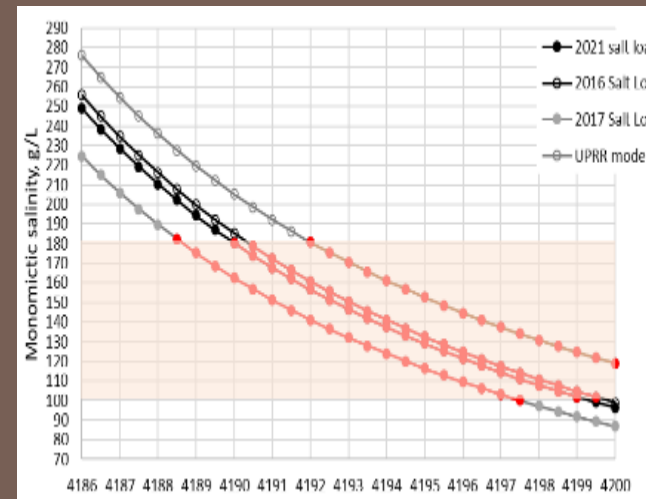


Salinity Imbalance

2022 – Adaptive management Berm modifications

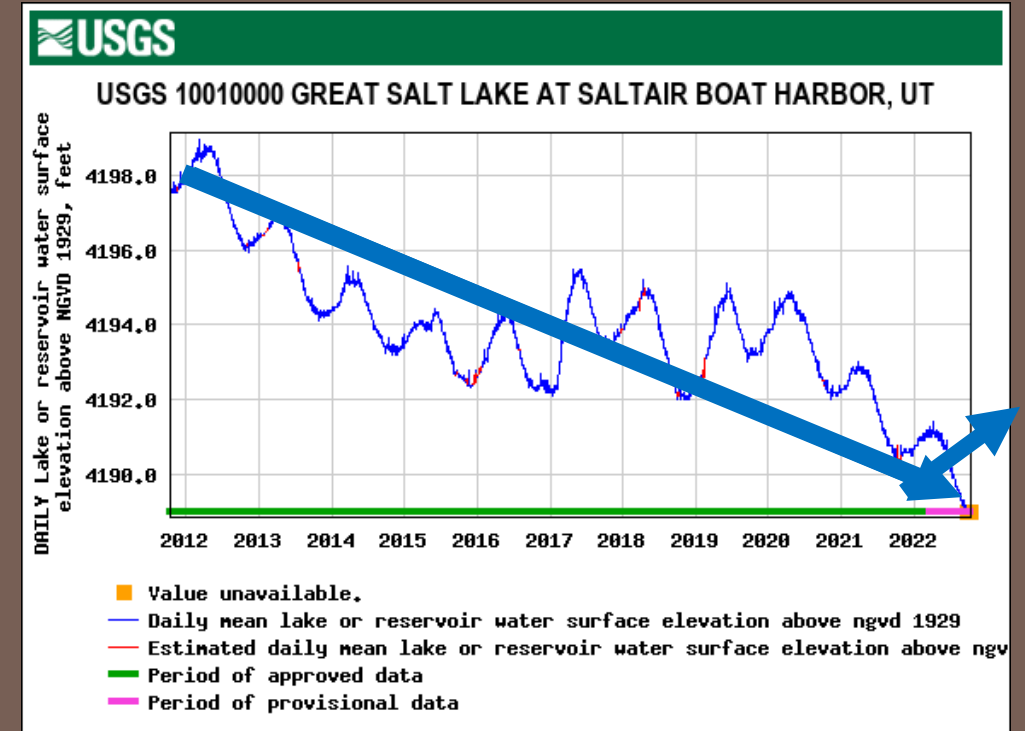
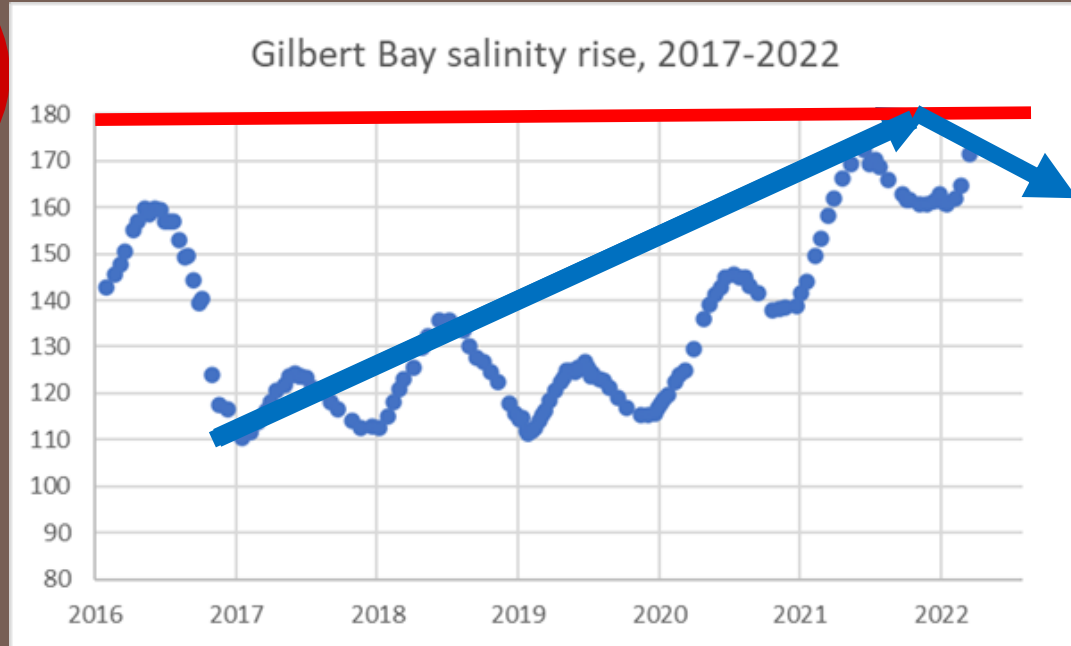


Rasmussen, M.; Dutta, S.; Neilson, B.T.; Crookston, B.M. CFD Model of the Density-Driven Bidirectional Flows through the West Crack Breach in the Great Salt Lake Causeway. *Water* **2021**, *13*, 2423. <https://doi.org/10.3390/w13172423>



How do lake levels affect Brine Shrimp Resource

18 %



To date, modelling is showing that:

Under the extreme drought of the past 10 years, the adaptive management berm will function to maintain an acceptable salinity range and acceptable lake levels, suitable to the Great Salt Lake Artemia Population

Have we succeeded?

➤ Sustainable harvest management



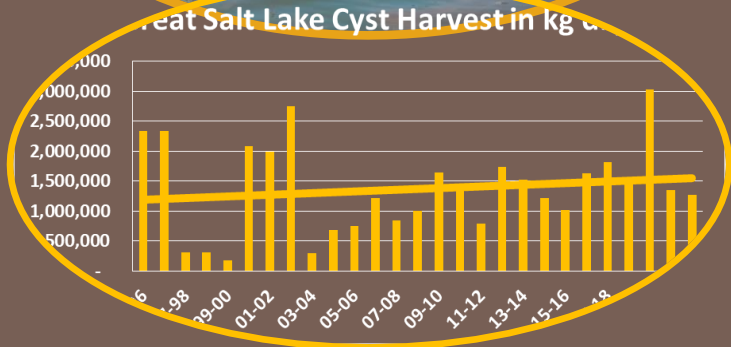
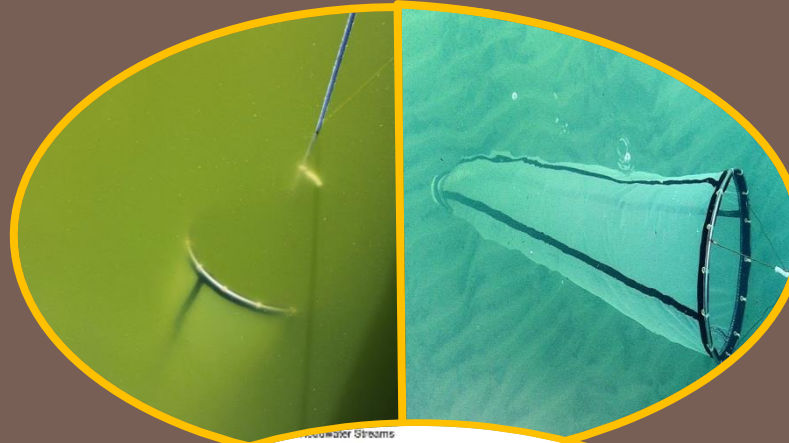
➤ Nutrient inflow Management



➤ Salinity Management



Have we succeeded?



Low Nutrient Enrichment at Headwater Streams: No Ecological Responses			
Summertime Average Nutrients	Ecological Response	Assessment Notes	
TP < 0.002 ¹	TP < 0.002 ¹	Fully supporting aquatic life uses if the average of 4 summertime samples for both TN and TP fall below the specified nutrient concentrations. However, if it is not supporting aquatic life uses, cause unknown, if the ecological response specified for moderate enrichment streams are exceeded, 8 hrs with lower samples will not be seawarded for nutrients.	
Moderate Nutrient Enrichment at Headwater Streams and Ecological Responses			
Summertime Average Nutrients	Ecological Response	Assessment Notes	
TN 0.40-0.80 ²	TP 0.005-0.007 ² Chlorophyll <i>a</i> > 1.0 or more GPP ³ of < 5 g O ₂ /m ² /day OR BPC < 5 g O ₂ /m ² /day	Headwater streams within this range of nutrient concentrations will be considered impaired (not supporting aquatic life uses) if any response exceeds defined thresholds. Streams without a response will be listed as having good status and prioritized for additional monitoring if either TN or TP fall within the specified range.	
High Nutrient Enrichment at Headwater Streams: No Ecological Responses ⁴			
Summertime Average Nutrients	Ecological Response	Assessment Notes	
TP > 0.007 ²		Streams over these thresholds will initially be placed on Utah's Best Management Practices list. Threatened streams will be further evaluated using additional biological, chemical, or nutrient-related data and in downstream waters.	



The combination of these technical solutions with policy efforts, will ensure a healthy *Artemia* population on Great Salt Lake for years to come



QUESTIONS