Managing the Artemia population on Great Salt Lake

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

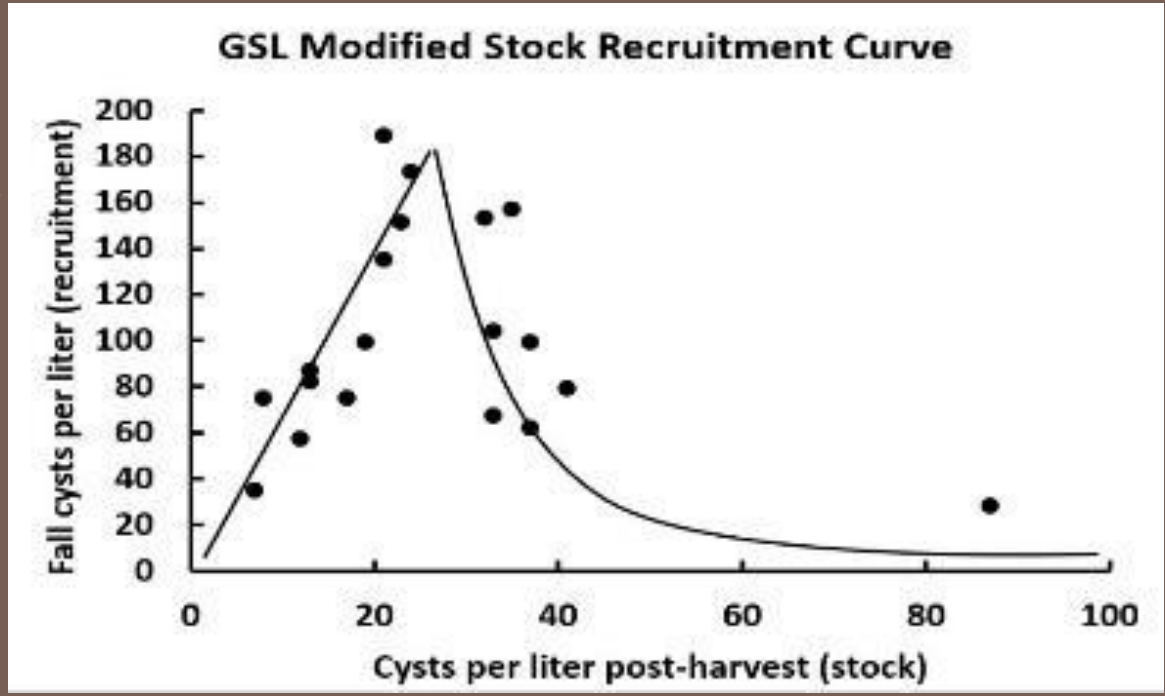
Sustainable Adaptive Harvest Management

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)

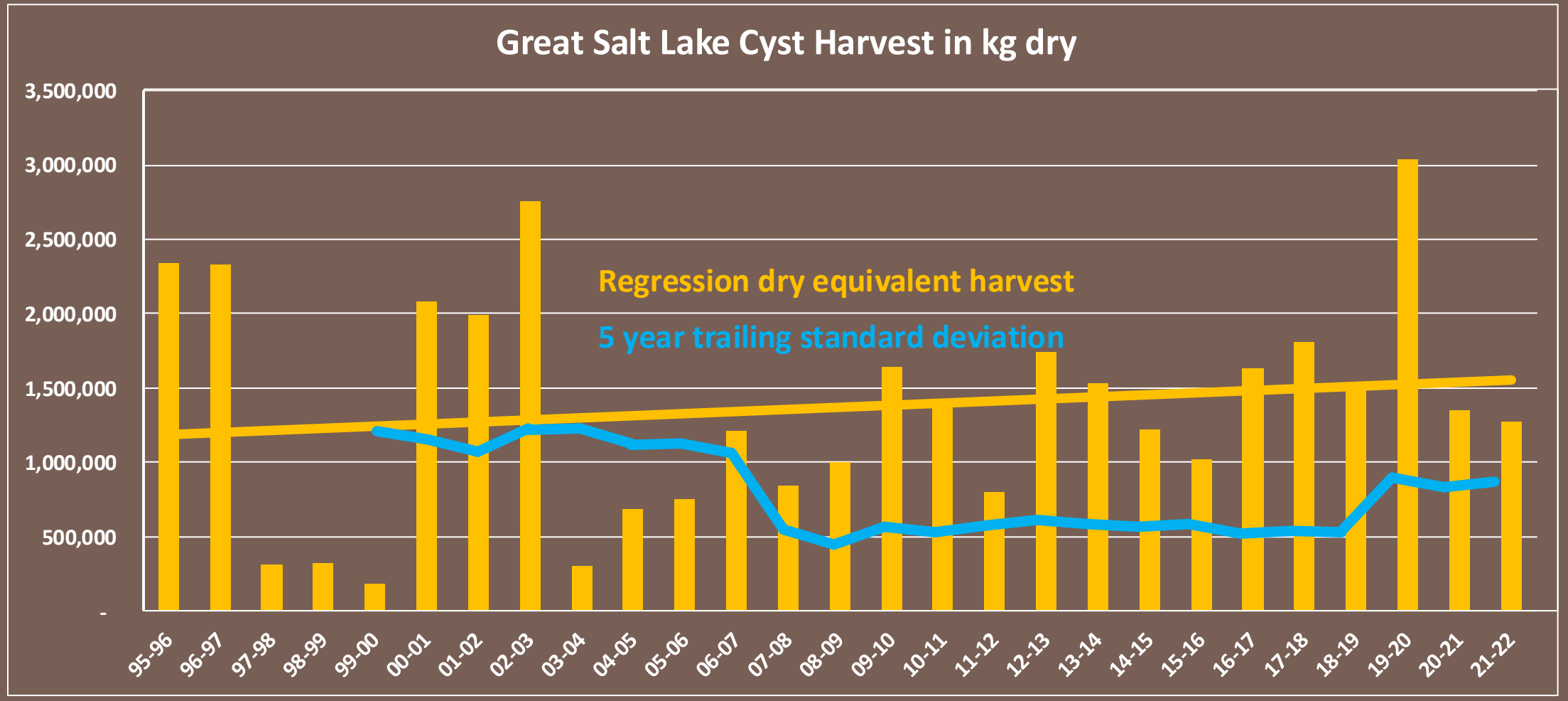
- Introduction in 1997 of harvest management based on a stock recruitment curve, a modified Ricker Curve
  - Optimal escapement stock of 21 cysts per liter
  - Adaptive

- Has been researched for more than 25 years
  - Described in detail in Belovsky et al. 2011 and in Belovsky and Perchon, 2019

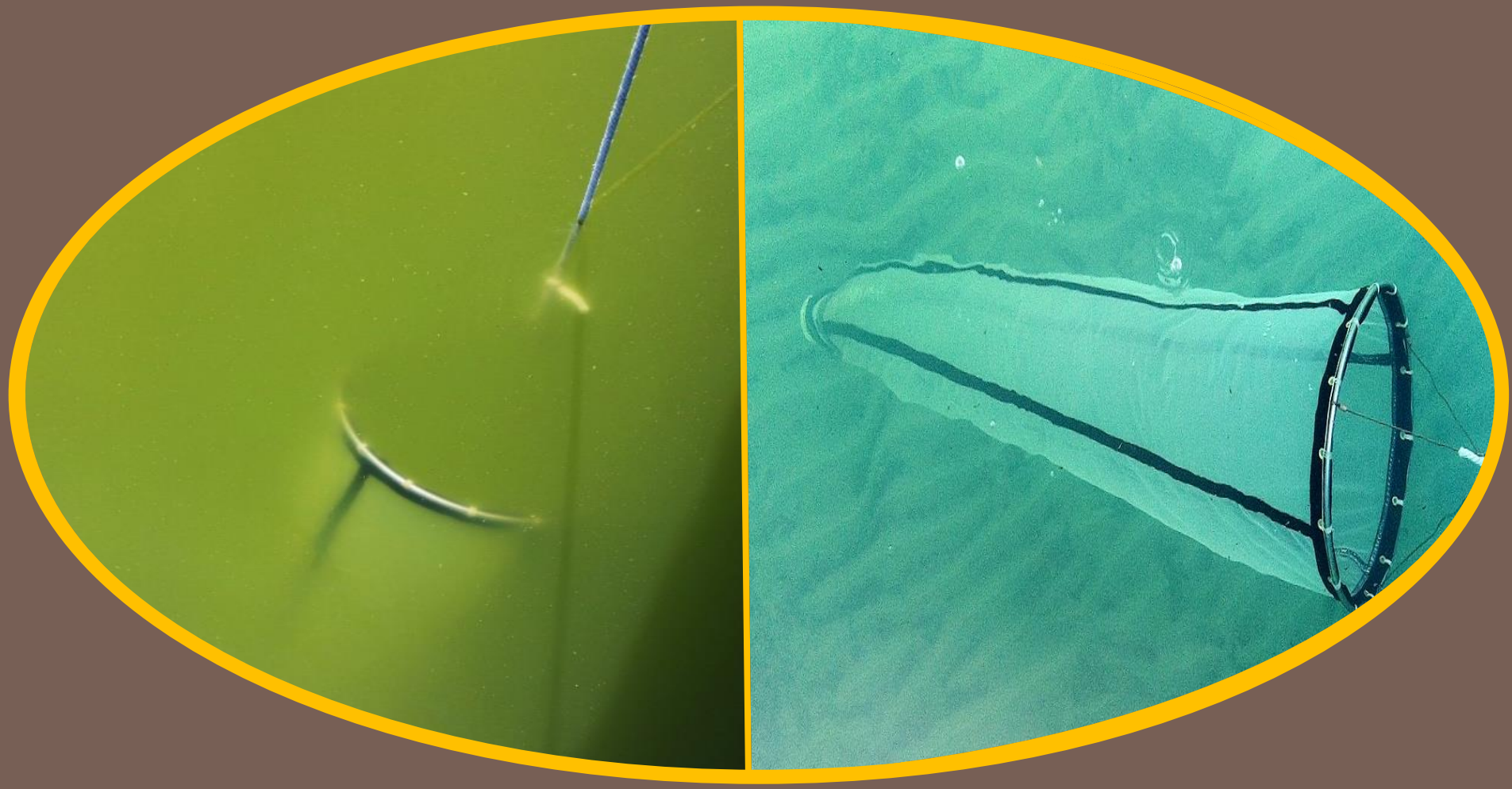


Sustainable Harvest Management

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



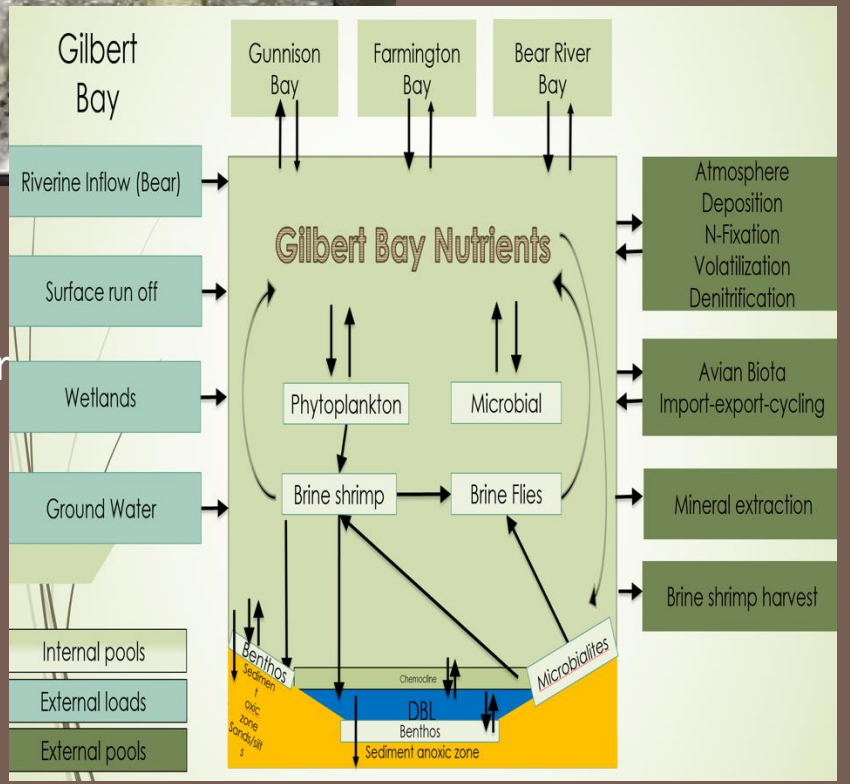
Nutrient Management on Great Salt Lake

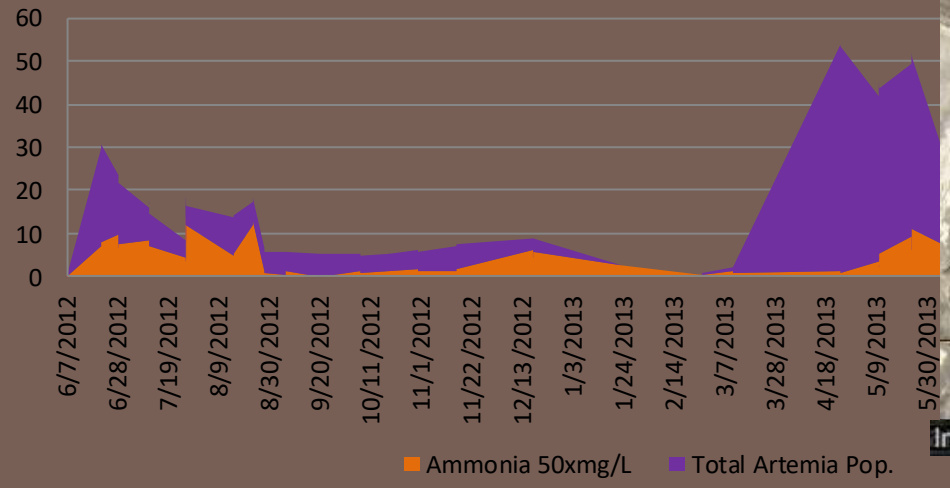


Nutrient Management on Great Salt Lake

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

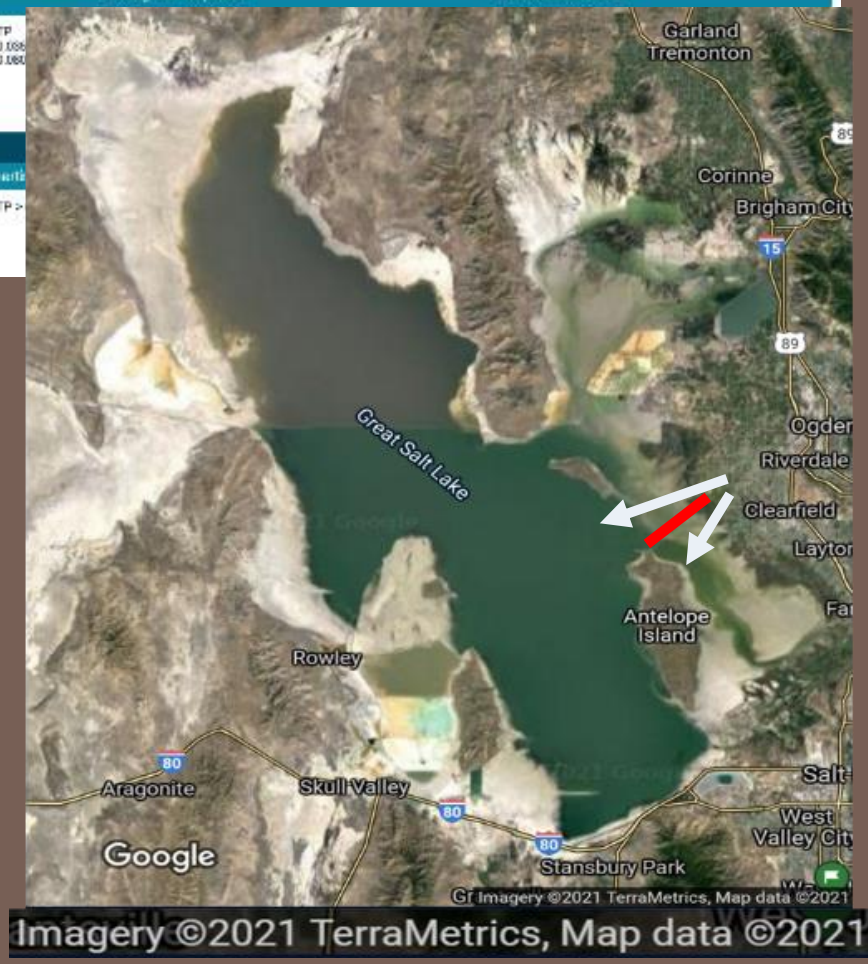
- The Utah, **Division of Water Quality,** with the involvement of multiple stake holders helped **create a unique and balanced approach to nutrient criteria** development based on a combination of numeric criteria and ecologic responses.
- This **protects the beneficial uses** of Utah streams while considering the **needs of all aquatic ecosystems** including **Great Salt Lake**


Numeric Nitrogen and Phosphorus Criteria: Utah Headwater Streams

Table 1. Numeric Nutrient Criteria and Associated Ecological Responses (Bioconfirmation Criteria) Proposed to Protect Aquatic Life Uses in Antidegradation Category 1 and 2 (UAC R317-2-12)[1] Headwater Perennial Streams

Low Nutrient Enrichment at Headwater Streams: No Ecological Responses		
Summertime Average Nutrients		Assessment Notes
TN < 0.40[2]	TP < 0.025[2]	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 is not supporting aquatic life uses, cause unknown, if the ecological responses specified for moderate enrichment streams are exceeded. Sites with fewer samples will not be assessed 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 0.025–0.060[2]	
TN > 0.80[2]	TP >	



- 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

Safe Salinity Range For Brine Shrimp *Artemia franciscana*

0.3 %

Predation and sub-optimal feed sources

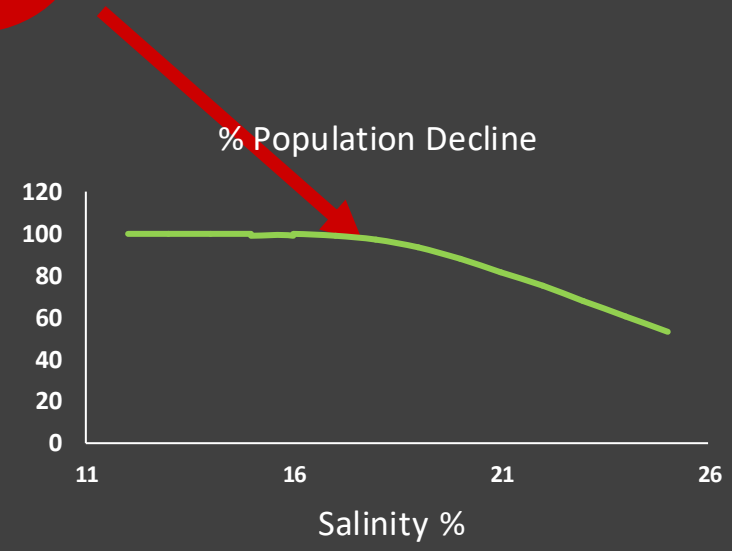
10 %

"Safe" salinity range

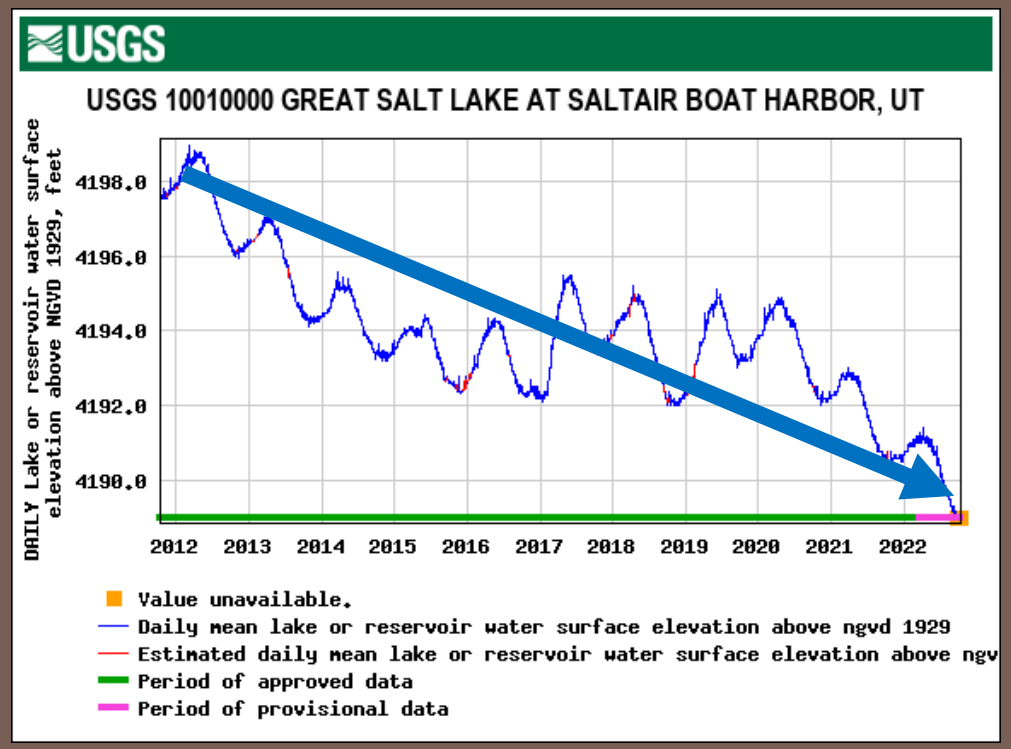
18 %

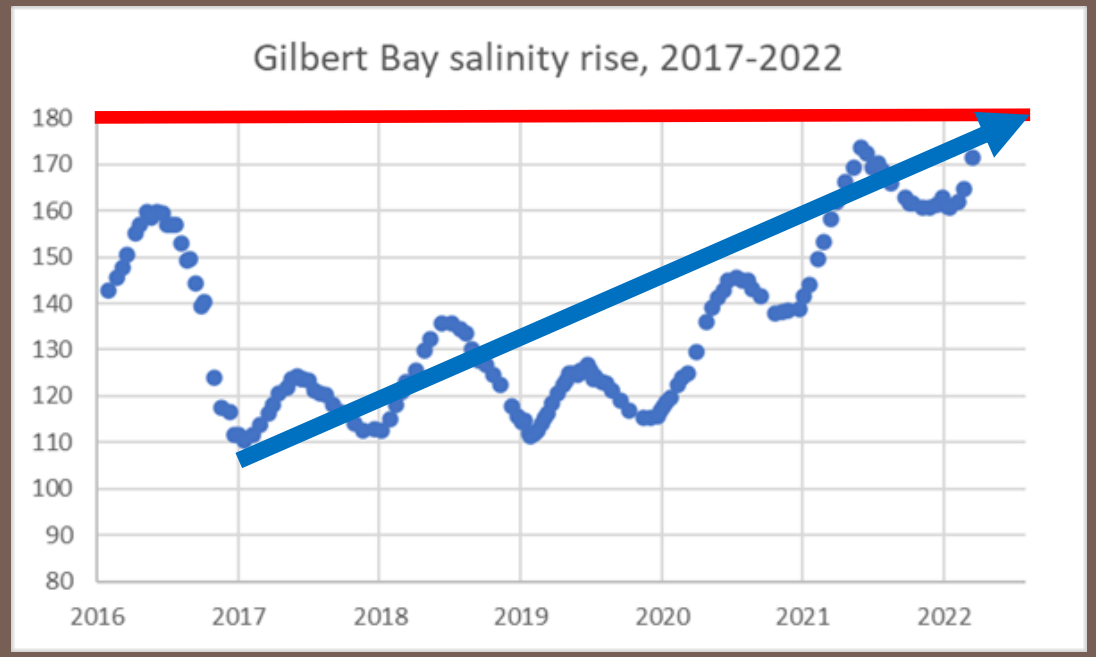
Population-level decline

27 %



How do lake levels affect Brine Shrimp Resource



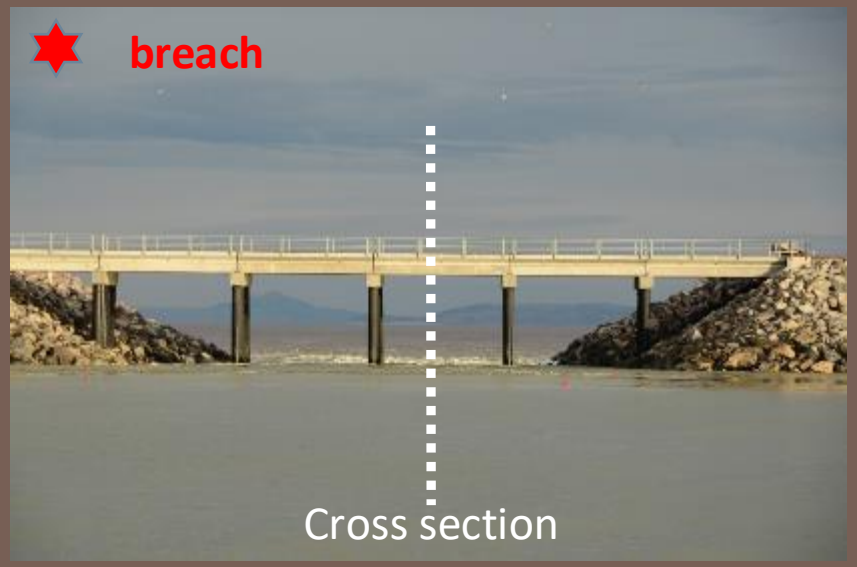


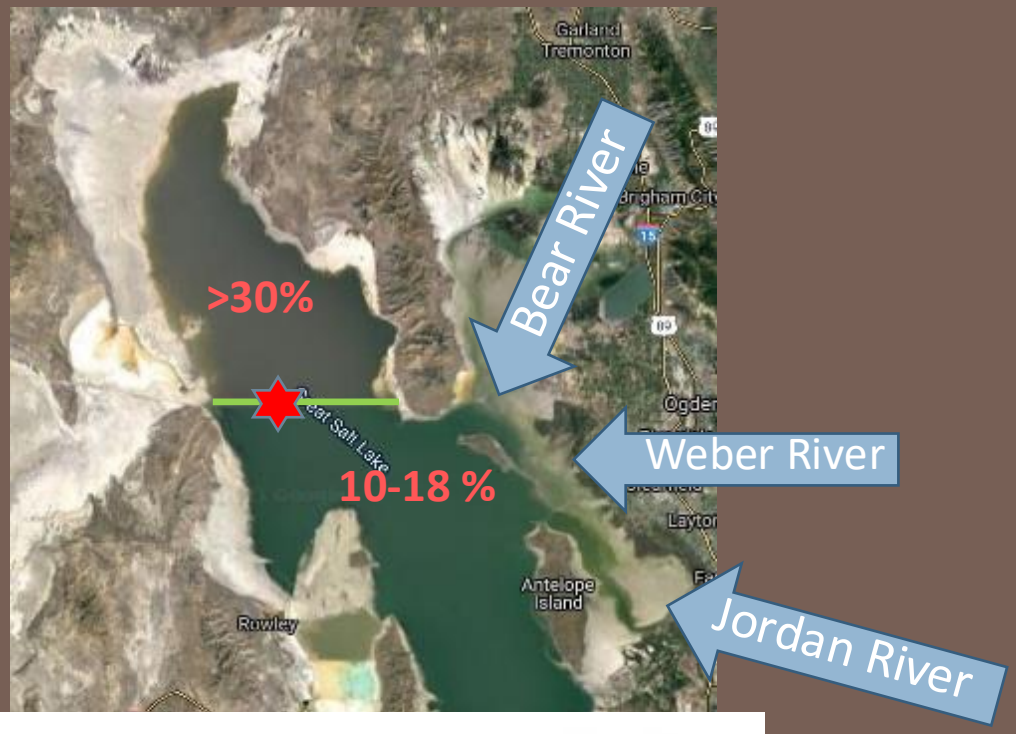
18 %

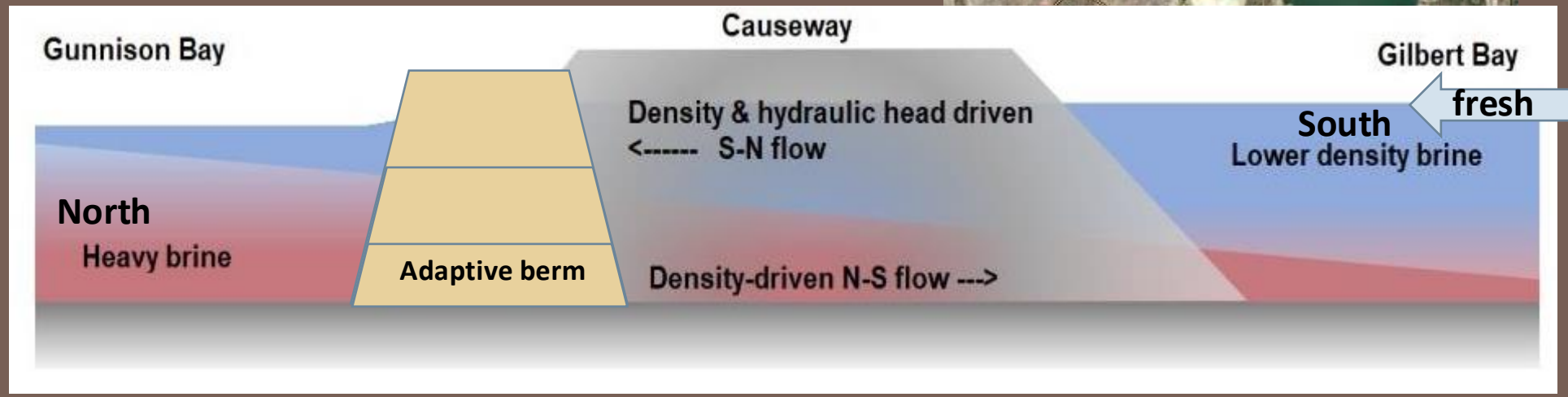
What is the Solution?

Combination of active Salinity Management and increased Water Supply

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

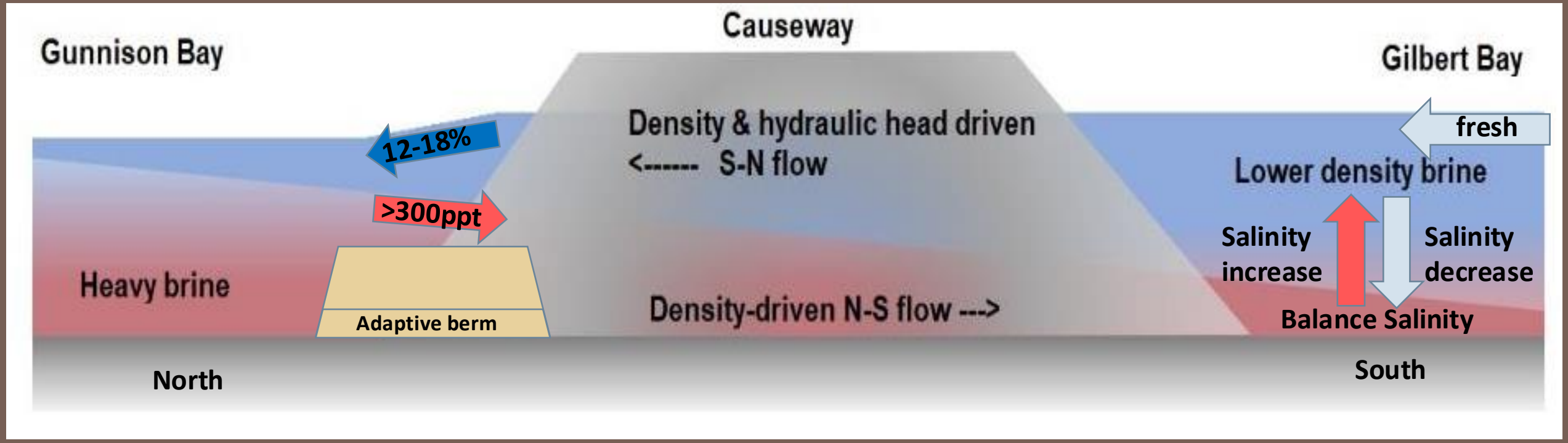




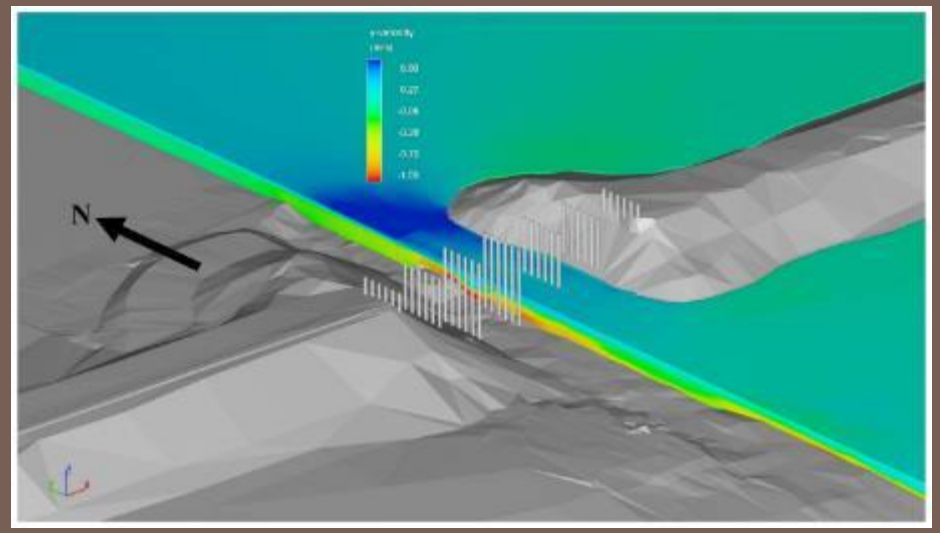


Salinity Management under different conditions of precipitation and inflow

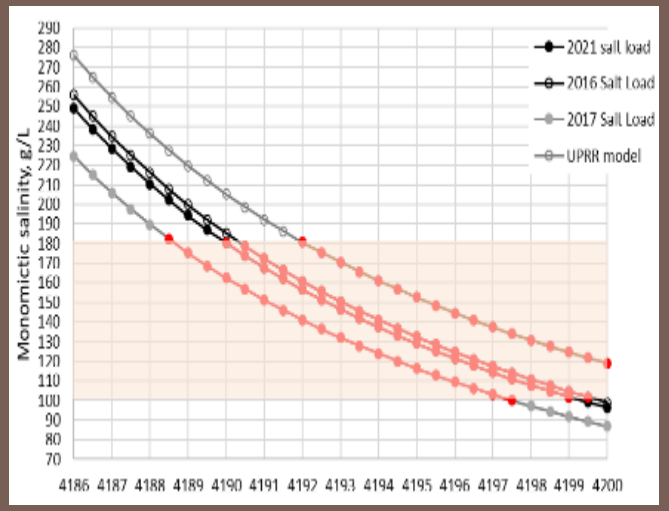
Adaptive Management Berm – example of management

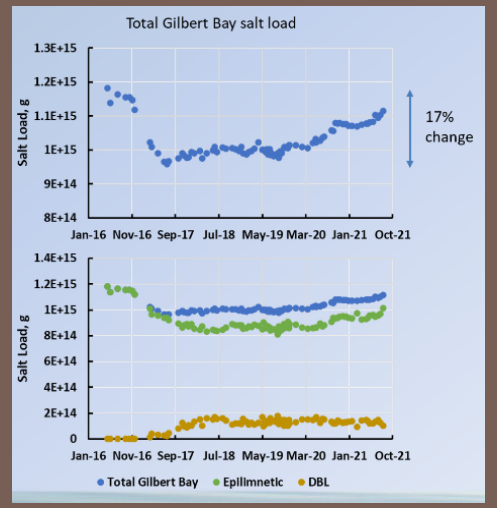


2022 – Adaptive management Berm modifications



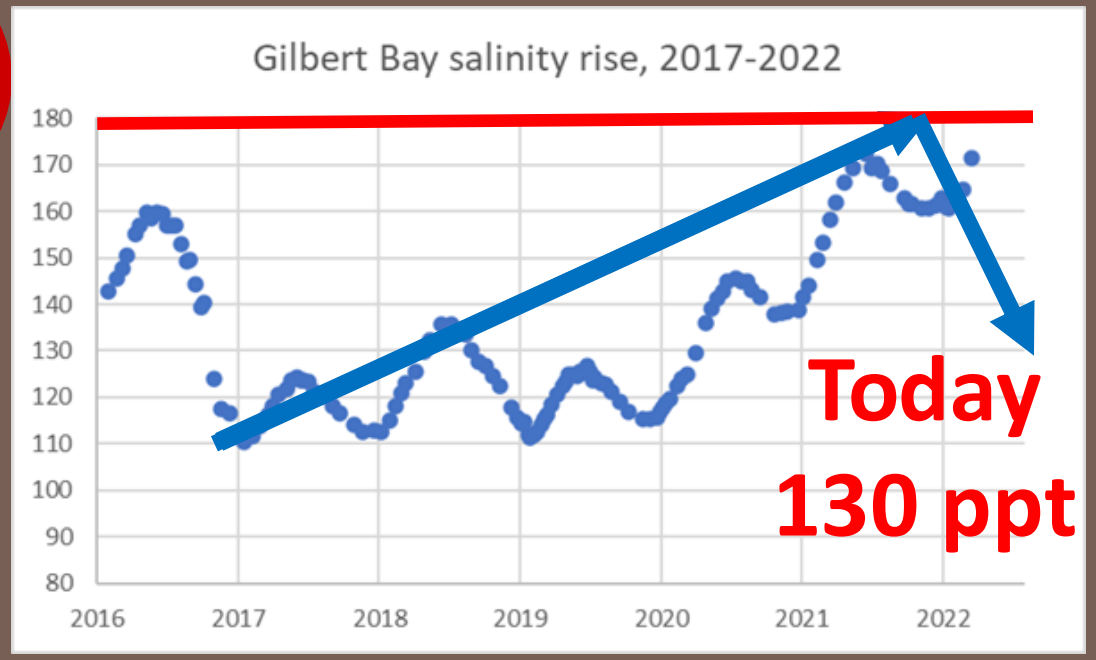
Rasmussen, M.; Dutta, S.; Neilson, B.T.; Crookston, B.M. CFD Model of the Density-Driven Bidirectional Flows through the West Crack Breach in the Great Salt Lake Causeway. *Water* **2021**, *13*, 2423. https://doi.org/10.3390/w13172423

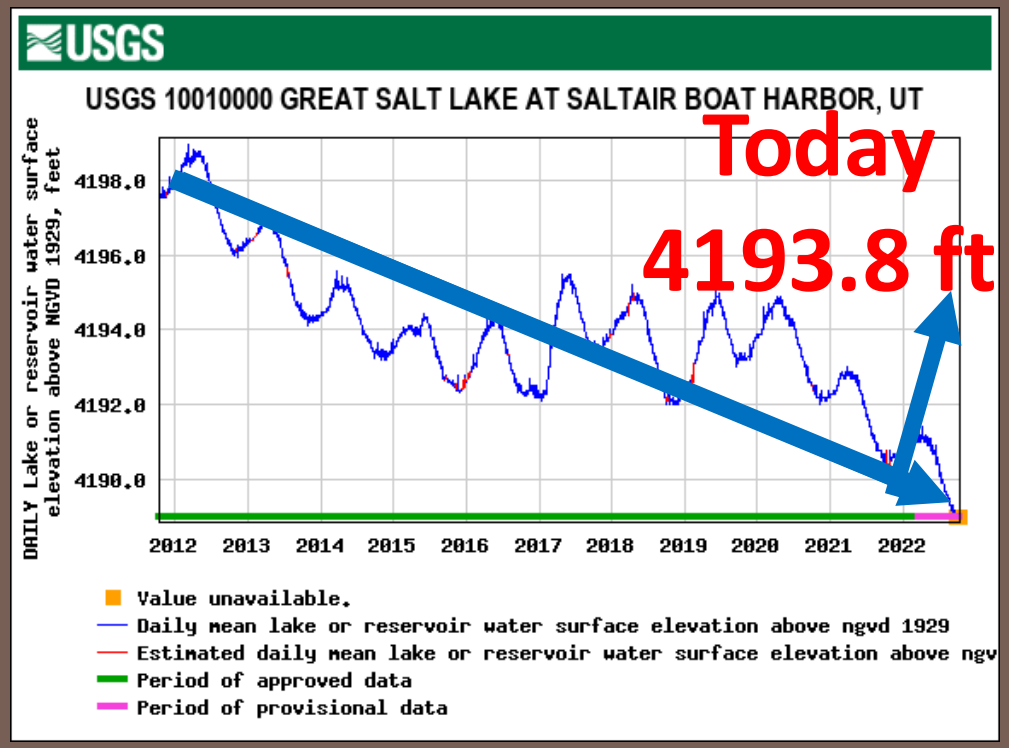




How do lake levels affect Brine Shrimp Resource

18 %





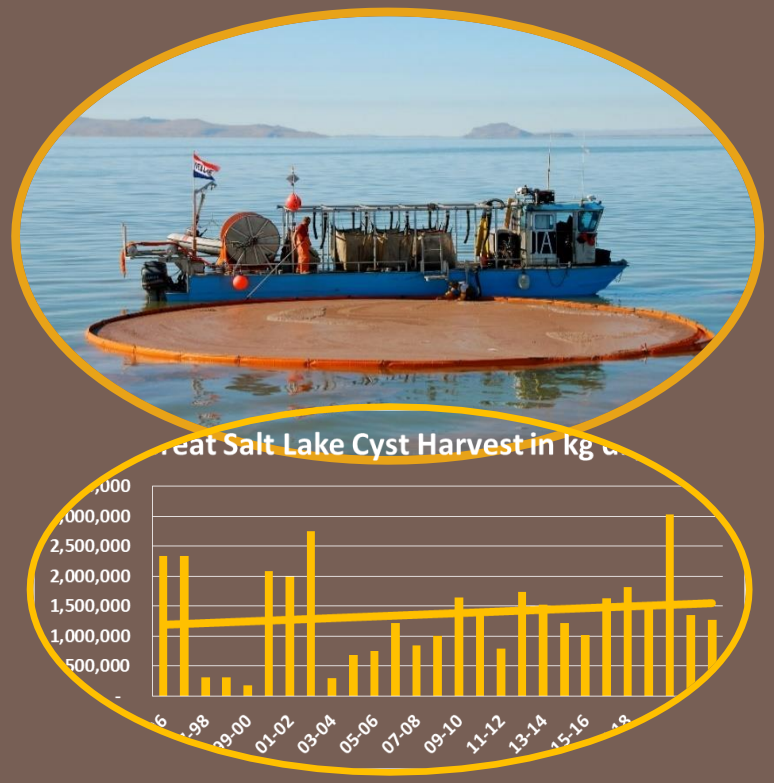
To date, modelling is showing that:

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?



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

External & Regulatory Affairs

Brine Shrimp Resource Management → DWR Technical Advisory Group (Thomas Bosteels)

Water Quality / Nutrient Availability → DWQ Nutrient Core Team (Don Leonard)
& Science Advisory Committee (Thomas Bosteels)

Salinity Management → Salinity Advisory Committee (Thomas Bosteels)

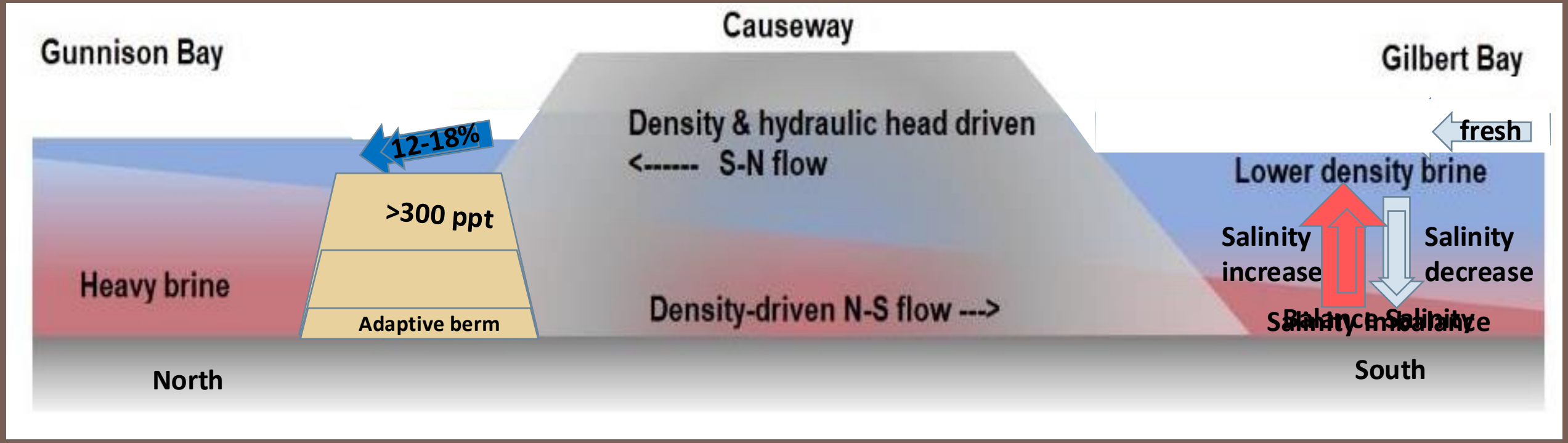
State DNR Research / GSL → Contractor Selection Committees (Tim Hawkes)

Legislation → Utah State Legislature (Tim Hawkes)

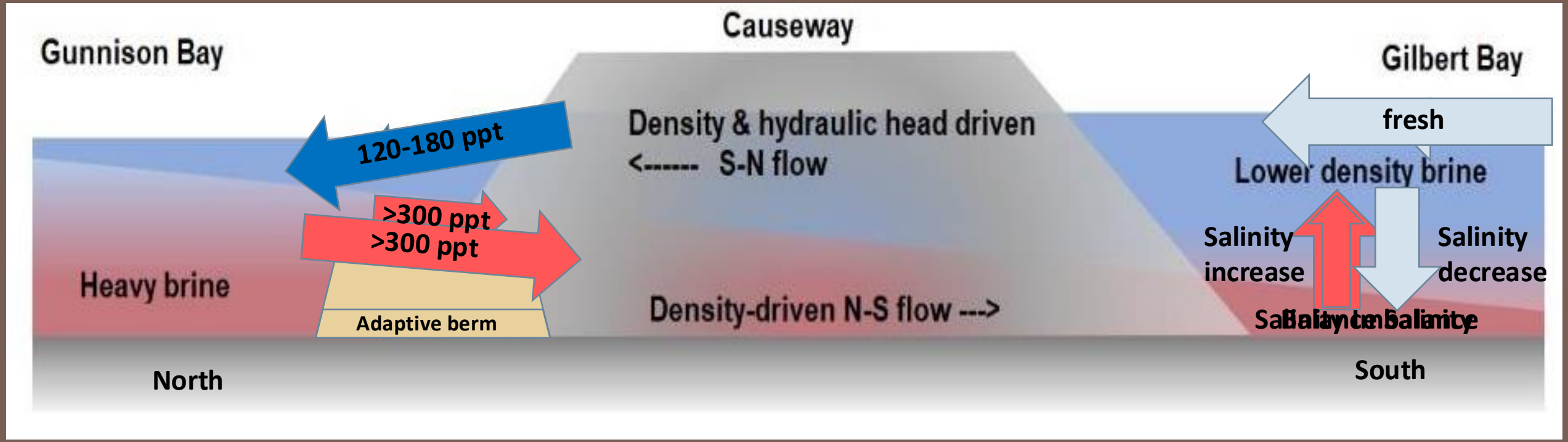
State Policy / GSL → Governor's Great Salt Lake Advisory Council (Don Leonard)

QUESTIONS

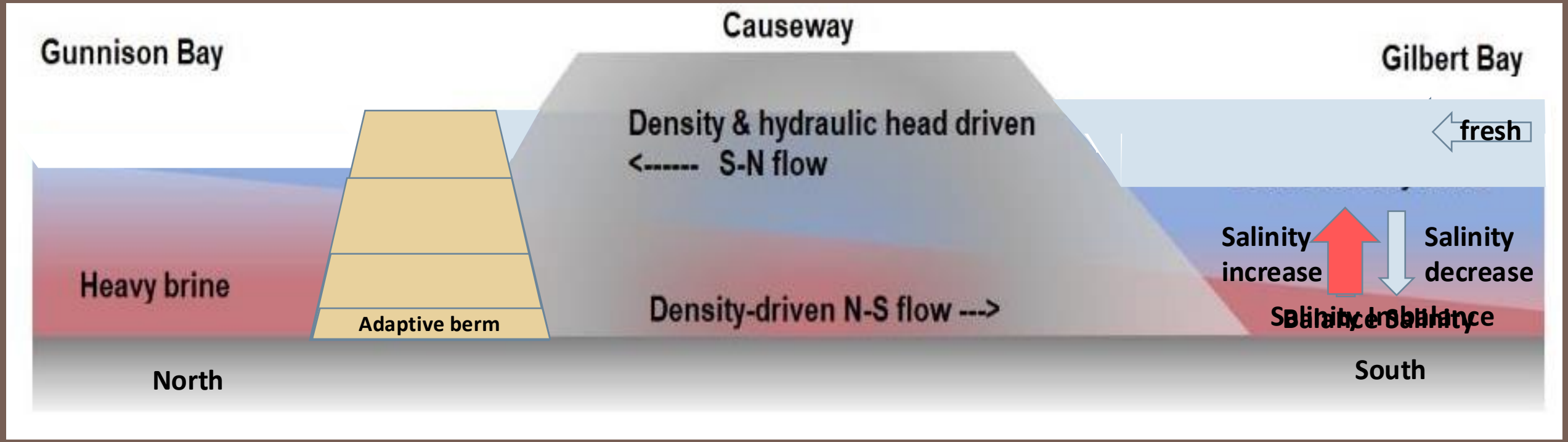
Adaptive Management Berm – Low Inflows and Precipitation



Adaptive Management Berm – High Inflows and Precipitation



Adaptive Management Berm – Extreme Drought



Salinity Imbalance