A Preliminary Investigation of Groundwater and Surface Water Impacts on Nearshore Biological Communities in Saipan Lagoon

CNMI Watershed Working Group – July 21, 2016

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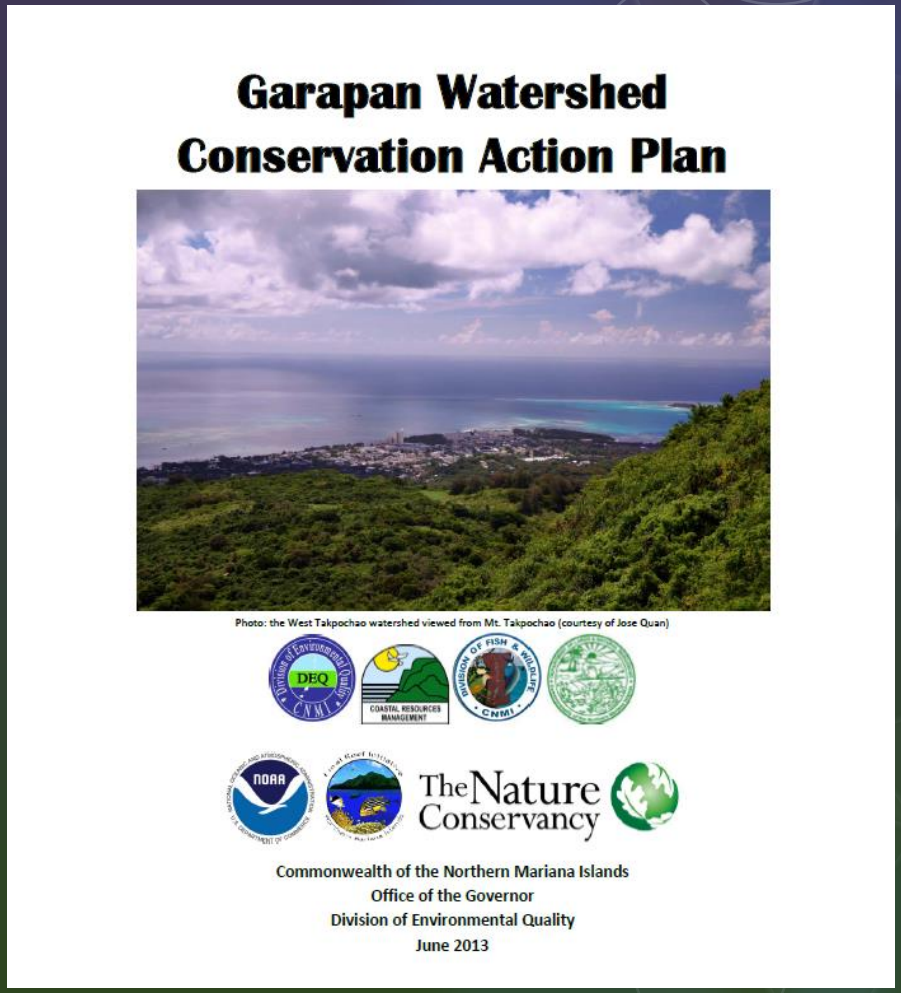
Garapan CAP

- Strategy F: Research and Monitoring
  - OBJECTIVE F1: By the end of FY2016, all high priority water quality problem areas within the watershed have been identified
  - OBJECTIVE F2: By 2016, the Climate Change Adaptation Plan will be finished and data used for informing regulations
  - OBJECTIVE F3: By FY2018, funding is secured and capacity identified to support long-term ecological monitoring within the watershed



Funding

Coral Reef Conservation Program FY14 funding:

Preliminary Investigation of Groundwater and Surface Water Impacts on Near Shore Biological Communities in Saipan Lagoon

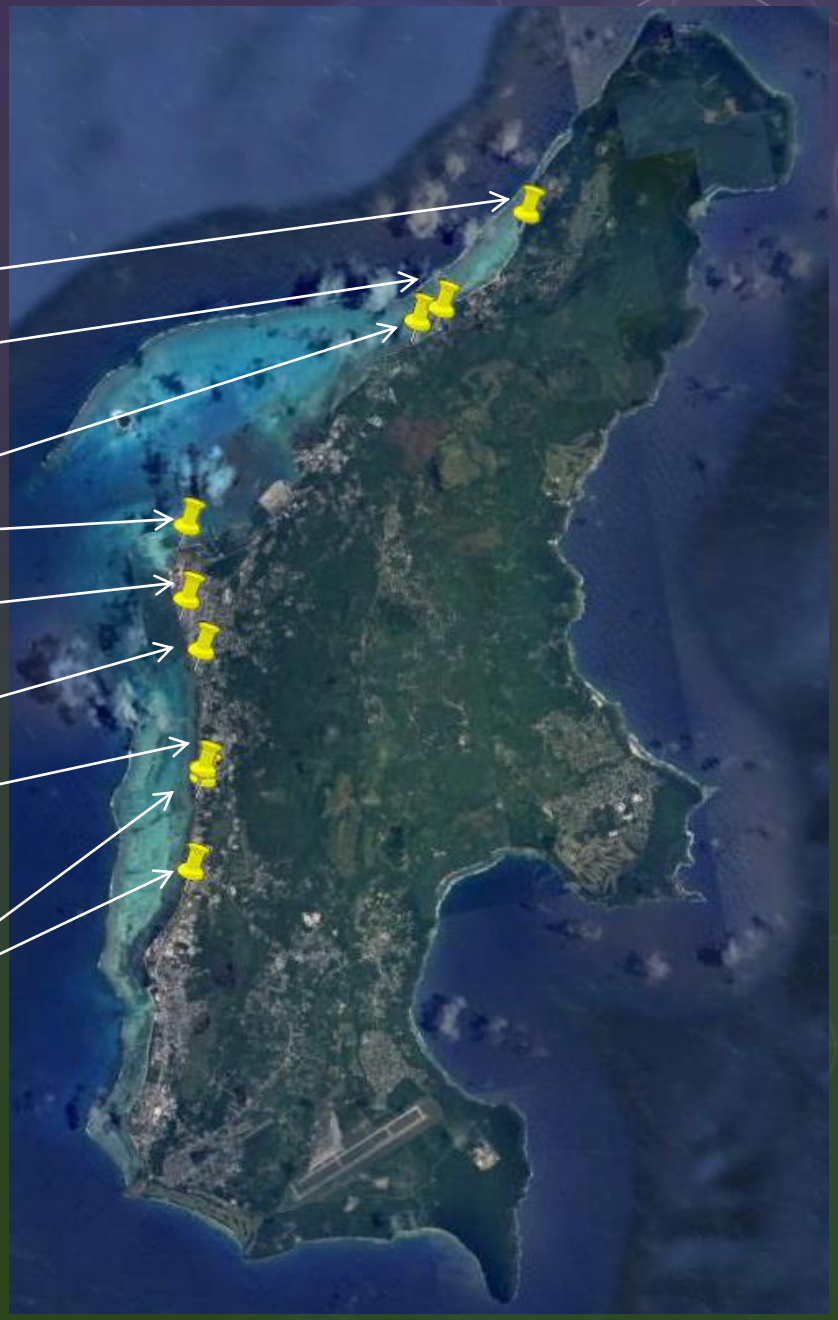
NOAA
CORAL REEF
CONSERVATION PROGRAM

Site Selection

- Saipan lagoon coastline divided in three sections (north, mid, south)
  - A groundwater, surface-water, and reference site was selected for each section
- Three Groundwater
  - Referenced APEC groundwater study
  - Surveyed Saipan lagoon for areas of high groundwater input
- Three Surface-water
  - Consulted experts for areas of high surface-water input
  - Surveyed Saipan lagoon for areas of high surface-water input
- Three Reference
  - Randomly selected

Sites

- 1 Paupau (north, groundwater)
- 2 Aqua (north, reference)
- 3 Iguel Ranch (north, surface-water)
- 4 AMP (mid, reference)
- 5 Hafa (mid, surface-water)
- 6 Fishing Base (mid, groundwater)
- 7 Quartermaster (south, surface-water)
- 8 Pump Station 12 (south, reference)
- 9 Oleai (south, groundwater)



Methods
Water Quality

- 9 sites – monthly samples for 12 months
- In situ measurements (YSI)
  - temperature, salinity, pH, and dissolved oxygen
- Turbidimeter
  - Turbidity
- DEQ Lab
  - TSS and Enterococci
- UOG WERI
  - nitrite/nitrate, ammonium, total nitrogen, orthophosphorus, total phosphorus

Methods Biological

- Seagrass and Intertidal
- Summer (June-July 2015)
- Winter (February 2016)

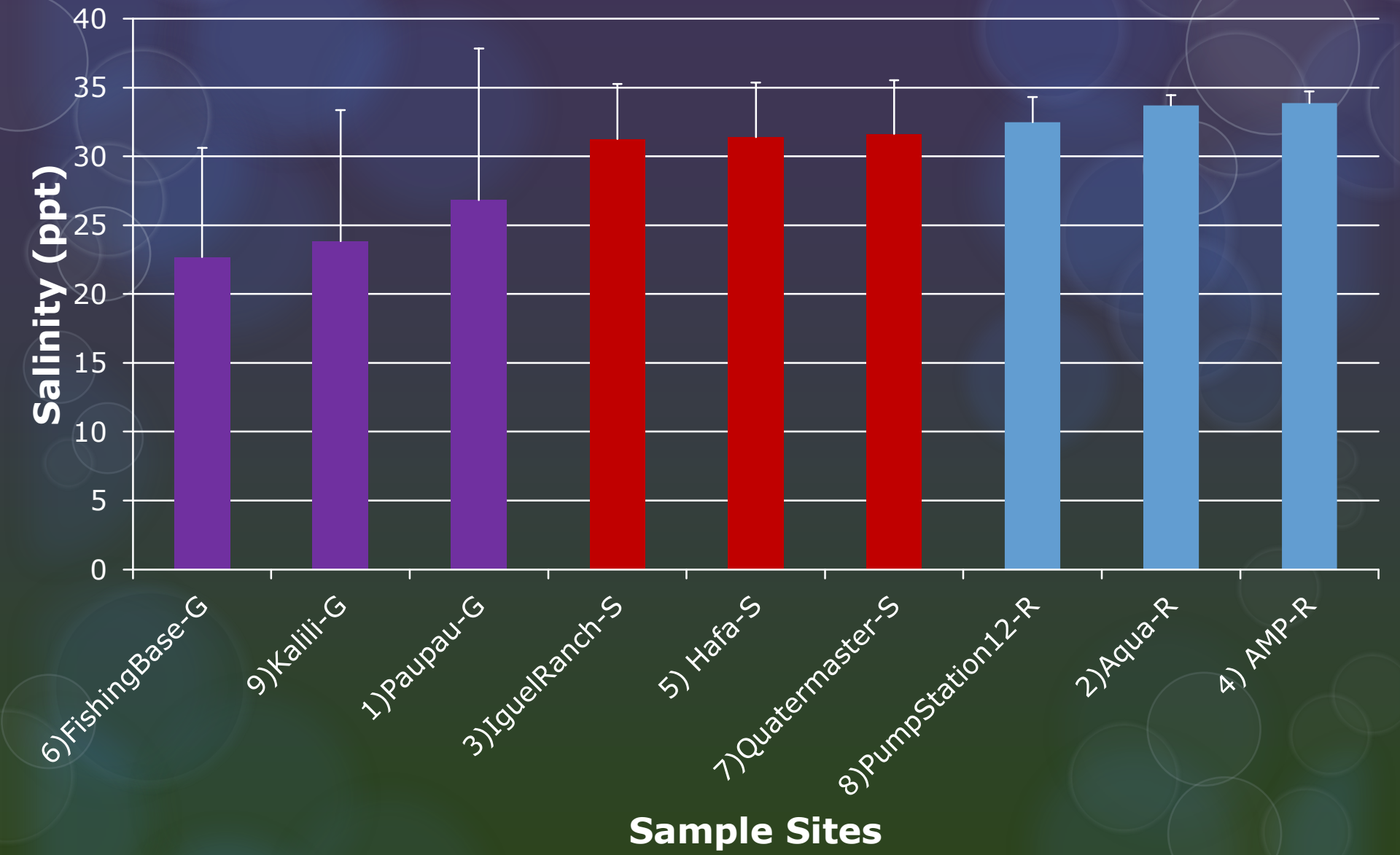
Methods Biological

- Five 10m transects per site
- Percent Cover
  - 0.25 m^2 quadrat at each meter
  - Species under 10 points identified per quadrat
- Diversity
  - 1 m^2 quadrat, three within each transect
  - All species identified within quadrat
- Macro Invertebrates
  - 1 m^2 quadrat, three within each transect
  - All macro invertebrates counted within each quadrat

Data Analysis

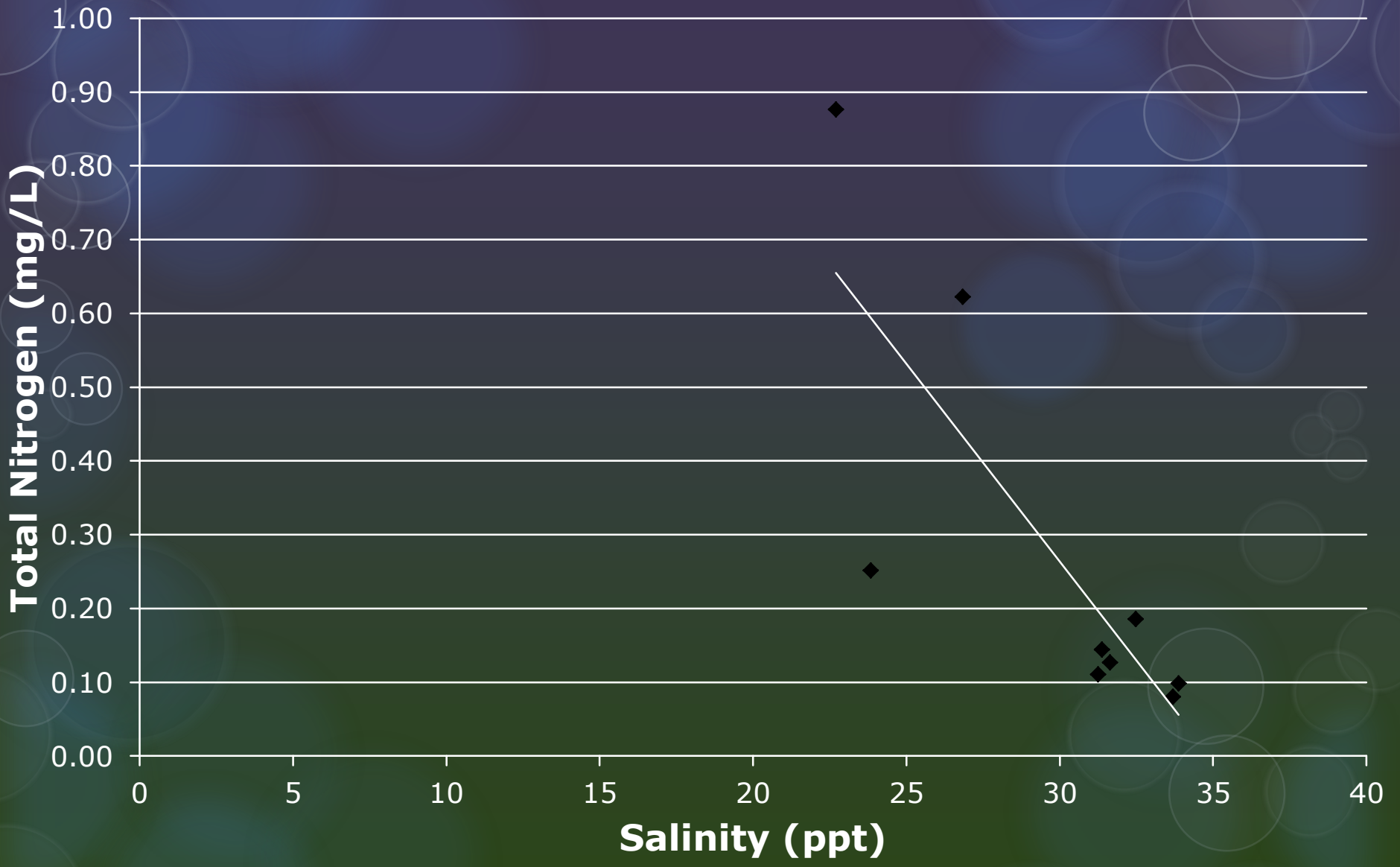
- Prior to data analysis seagrass percent cover data was converted into a ratio (seagrass/macroalgae)
- ANOVA's and Regressions were used to establish relationships within and between water quality, biology, site type, and lagoon section
- If data was normal we proceeded with an ANOVA
- If data was not normal data was ranked prior to an ANOVA
- no transformation prior to carrying out a regression
- Analyzed with SigmaPlot

Average Salinity Values at Sample Sites



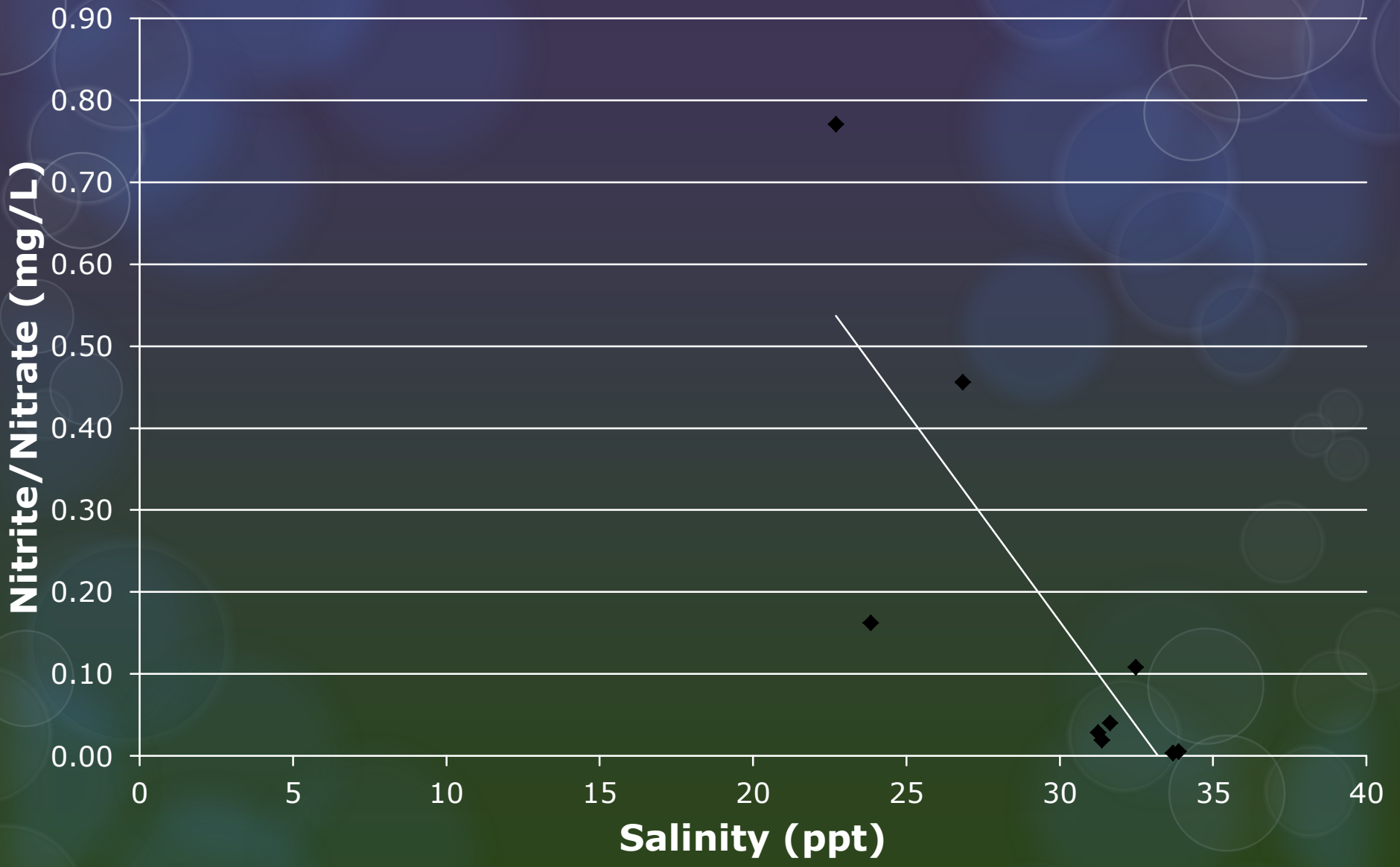
Sites of groundwater input have lower salinity than surface-water and reference sites

Salinity and Total Nitrogen (r=-0.807, p=0.009**)



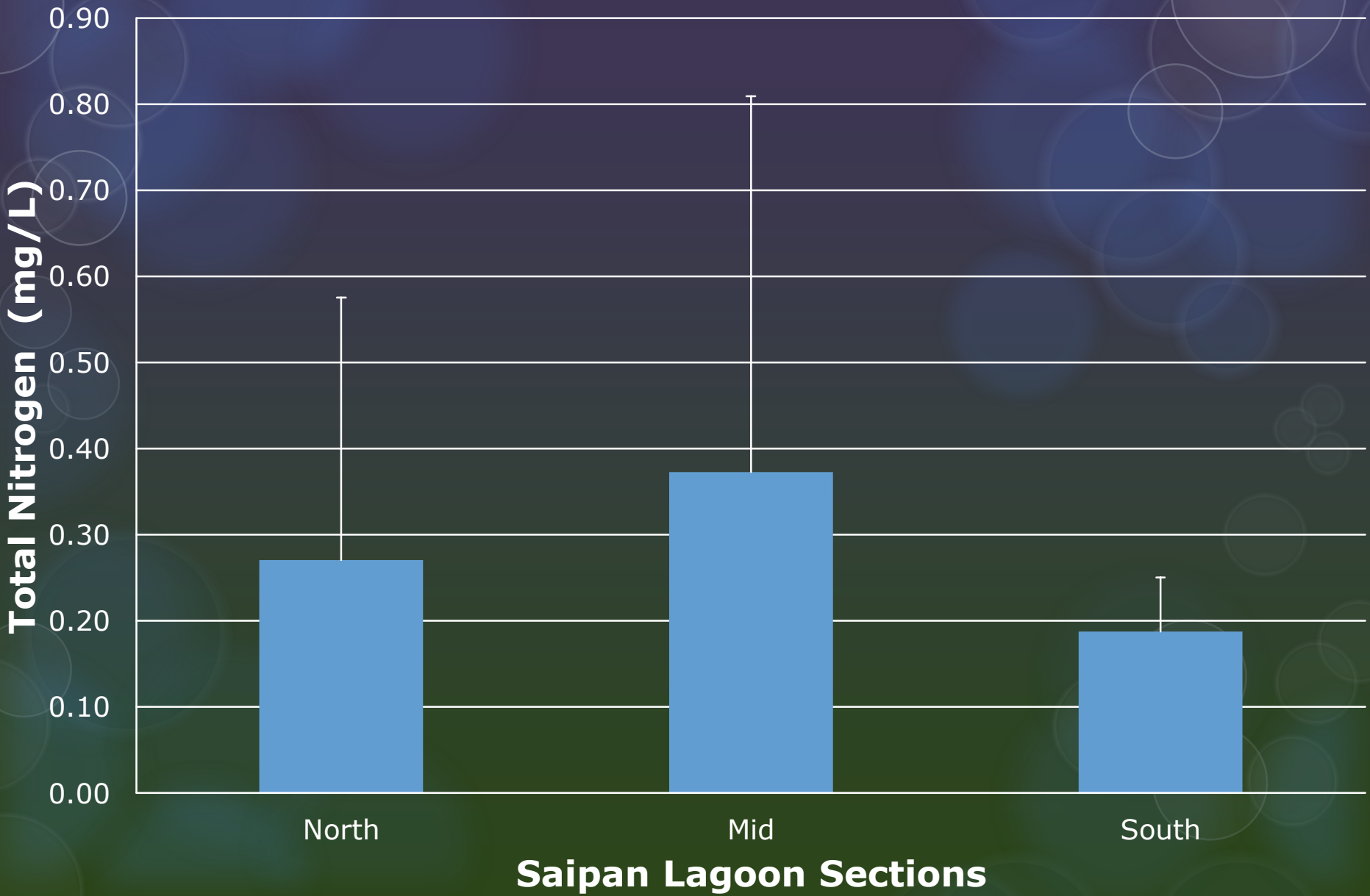
Sites with lower salinity have greater total nitrogen concentrations

Salinity and Nitrite/Nitrate (r=-0.812, p=0.008**)

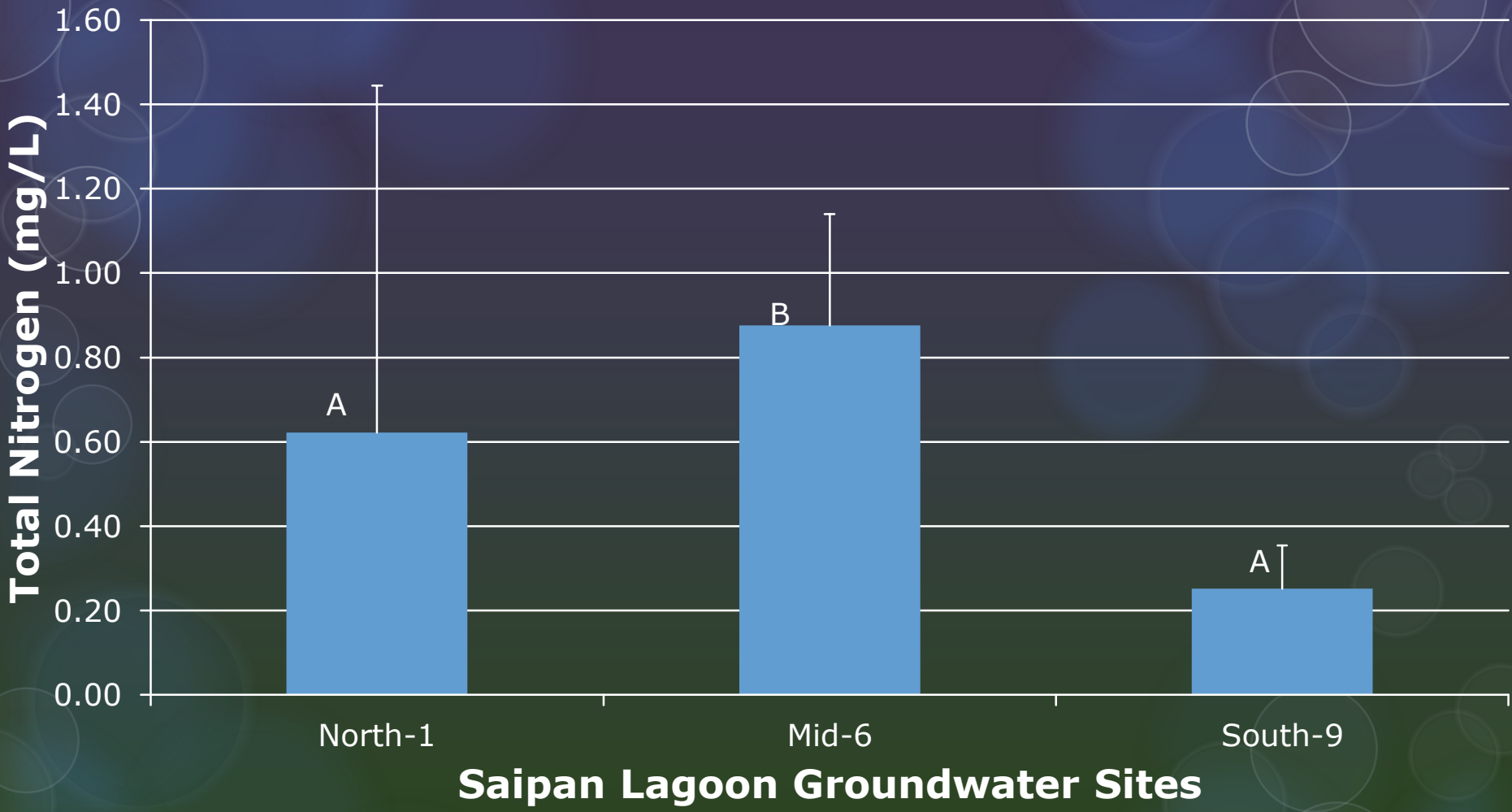


Sites with lower salinity have greater nitrate/nitrite concentrations

Total Nitrogen at Saipan Lagoon Sections (n=3, p=0.773)

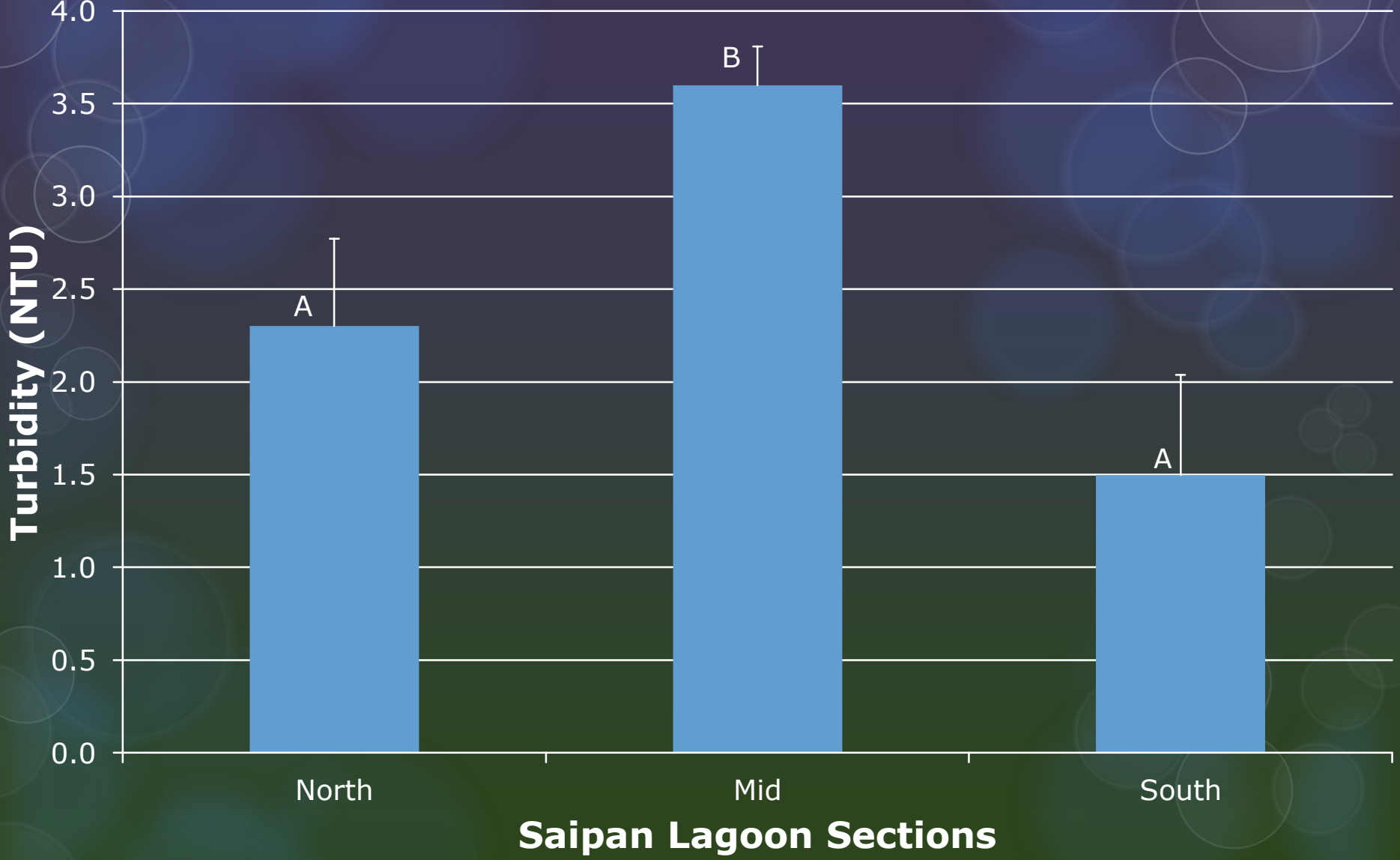


Total Nitrogen at Groundwater Sites (n=12, p=0.001**)



Trends show that total nitrogen was highest in the mid section, further analysis shows that groundwater sites are driving this trend, every sample from site 6 exceeded water quality standards for total nitrogen

Turbidity at Saipan Lagoon Sections (n=3, p=0.003**)



Turbidity is greatest in the mid section

Salinity and Winter Intertidal Algal Cover (r=-0.740, p=0.023**)

Intertidal Algal Cover

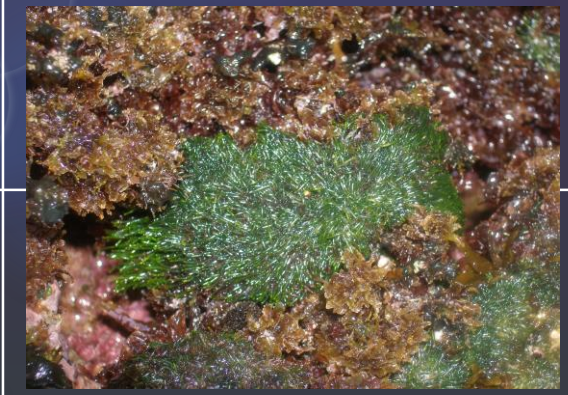
0 5 10 15 20 25 30 35 40 45 50

0 5 10 15 20 25 30 35 40

Salinity (ppt)

Sites with lower salinity have greater intertidal algal cover

Salinity and Winter Intertidal Algal Richness (r=-0.870, p=0.002**)



Winter Intertidal Algal Richness (ave sp per sq m)

0 1 2 3 4

0 5 10 15 20 25 30 35 40

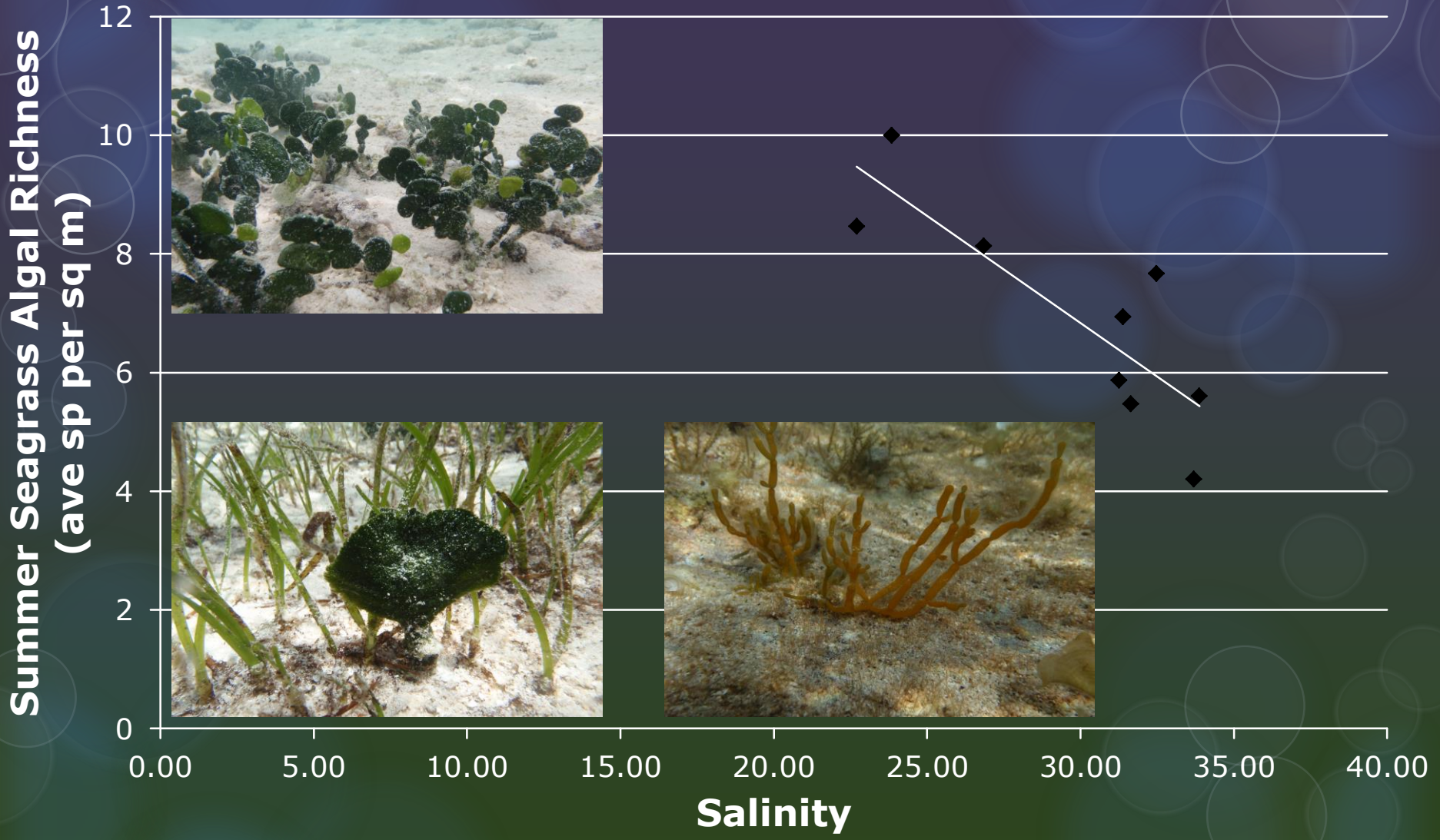
Salinity (ppt)

Sites with lower salinity have greater diversity

Salinity and Winter Seagrass:Algae Cover Ratio (r=0.627, p=0.071*)

Sites with lower salinity have lower seagrass:algae ratio

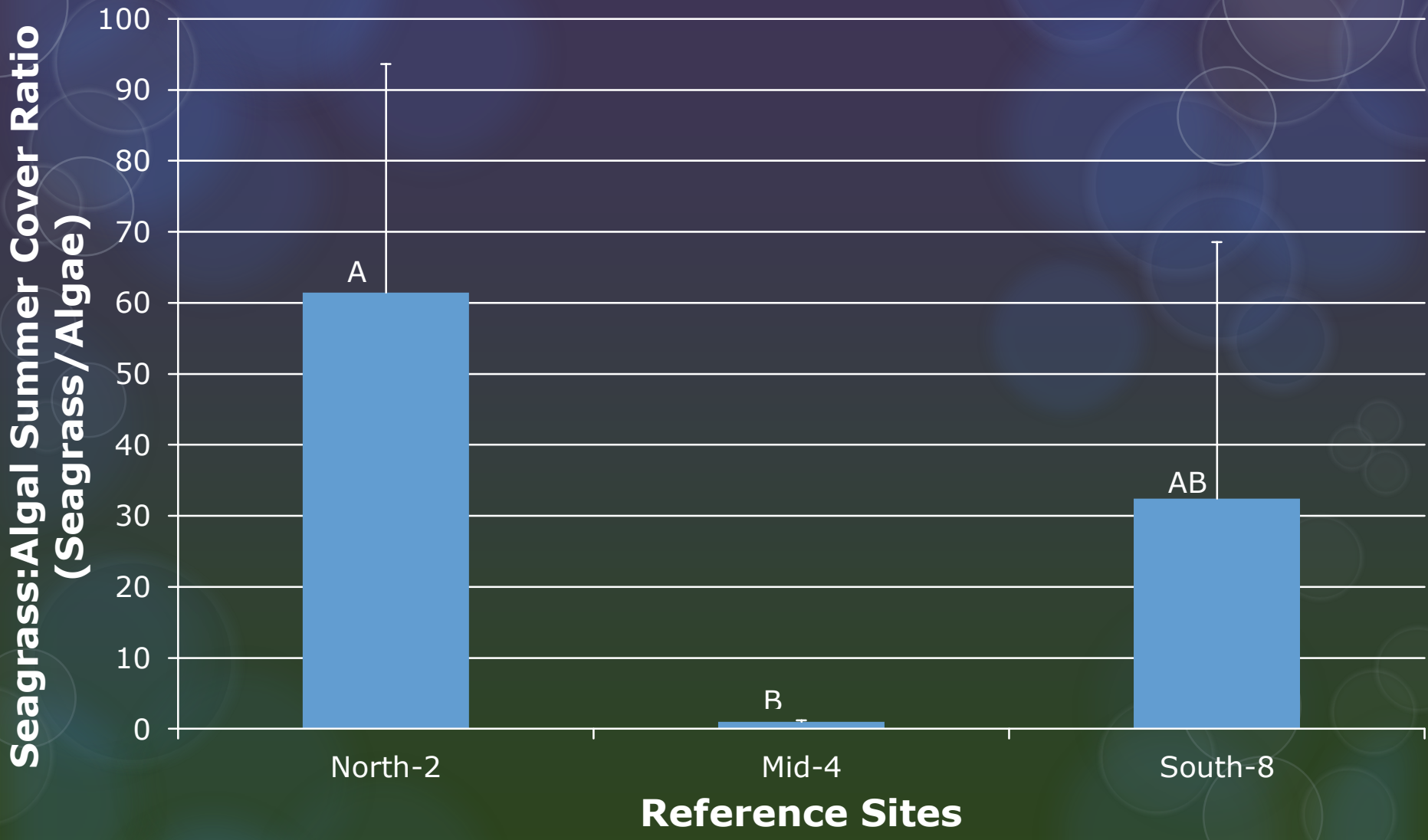
Salinity and Summer Seagrass Algal Richness (r=-0.838, p=0.005**)



Sites with lower salinity greater algal diversity within nearshore seagrass beds

Seagrass:Algae Summer Cover Ratio at Saipan Lagoon Sections (n=3, p=0.382)

Seagrass:Algal Summer Cover Ratio at Reference Sites (n=5, p=0.017**)

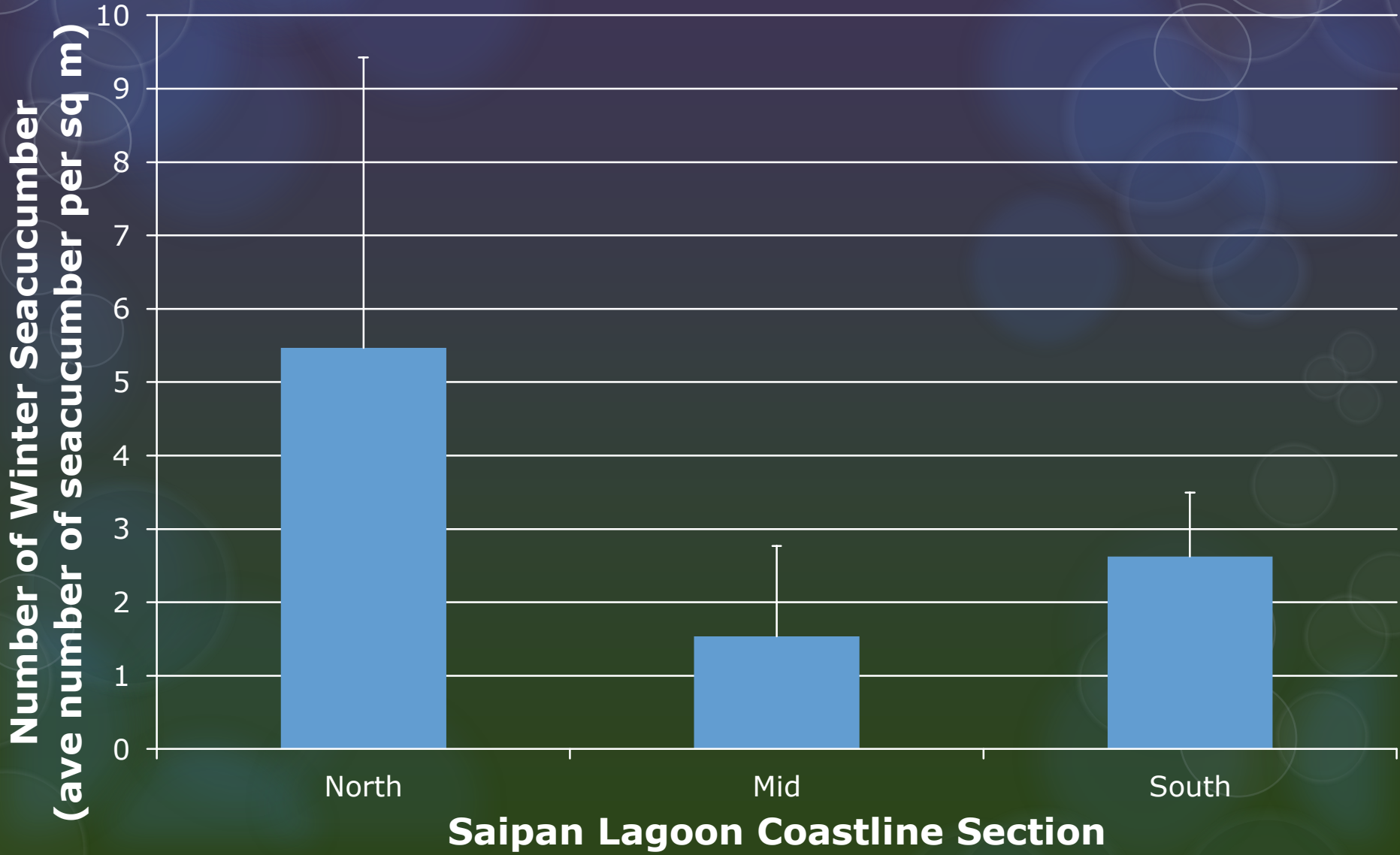


Trends show that seagrass:algae ratio was lowest in the mid section, further analysis shows this is highly significant at the reference sites

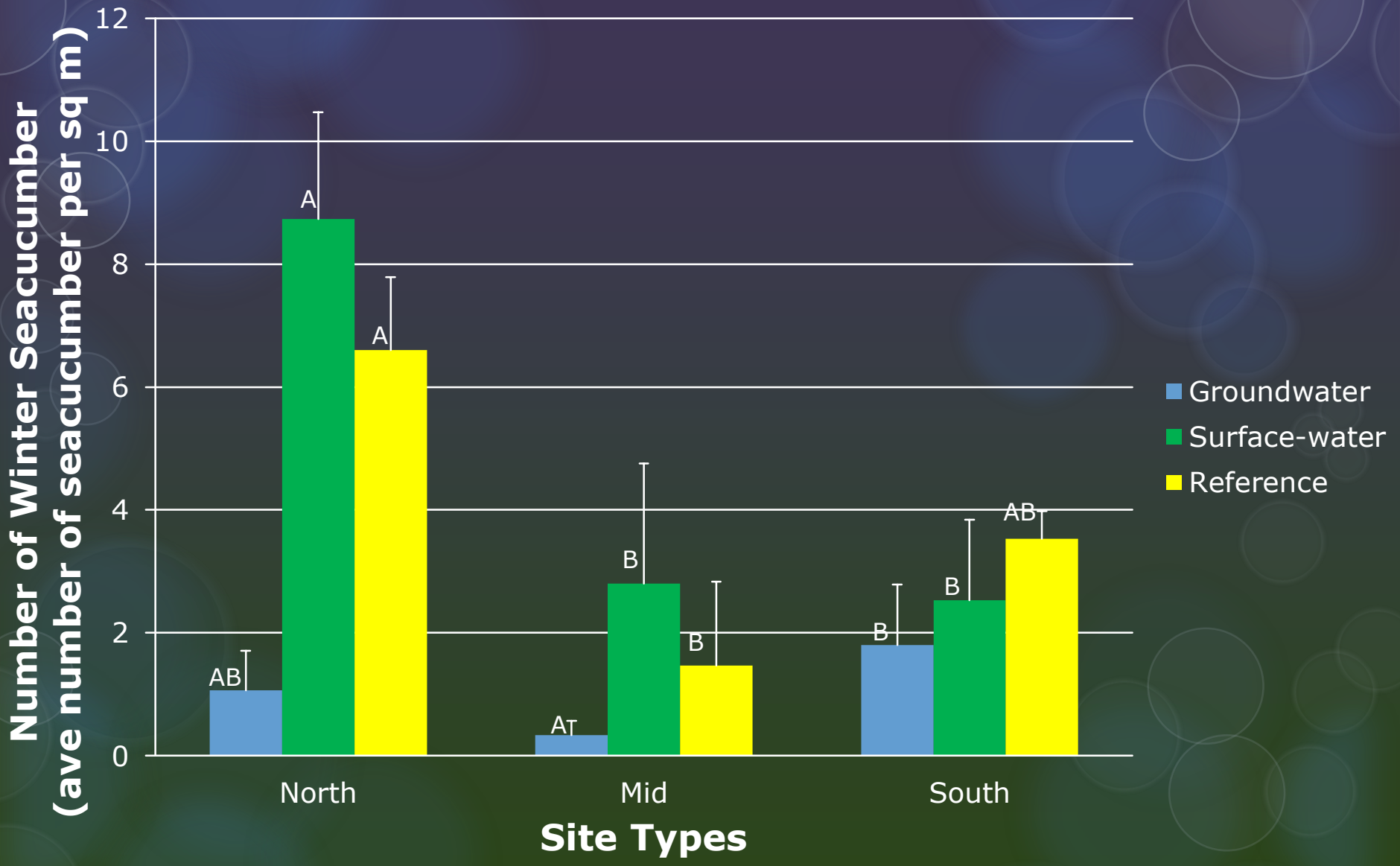
Number of Seacucumber at Each Site Type During Summer (n=3, p=0.081*)

Sea cucumber numbers are most abundant at surface water sites and least abundant at groundwater sites

Number of Seacucumber at Saipan Lagoon Sections During Winter (n=3, p=0.207)



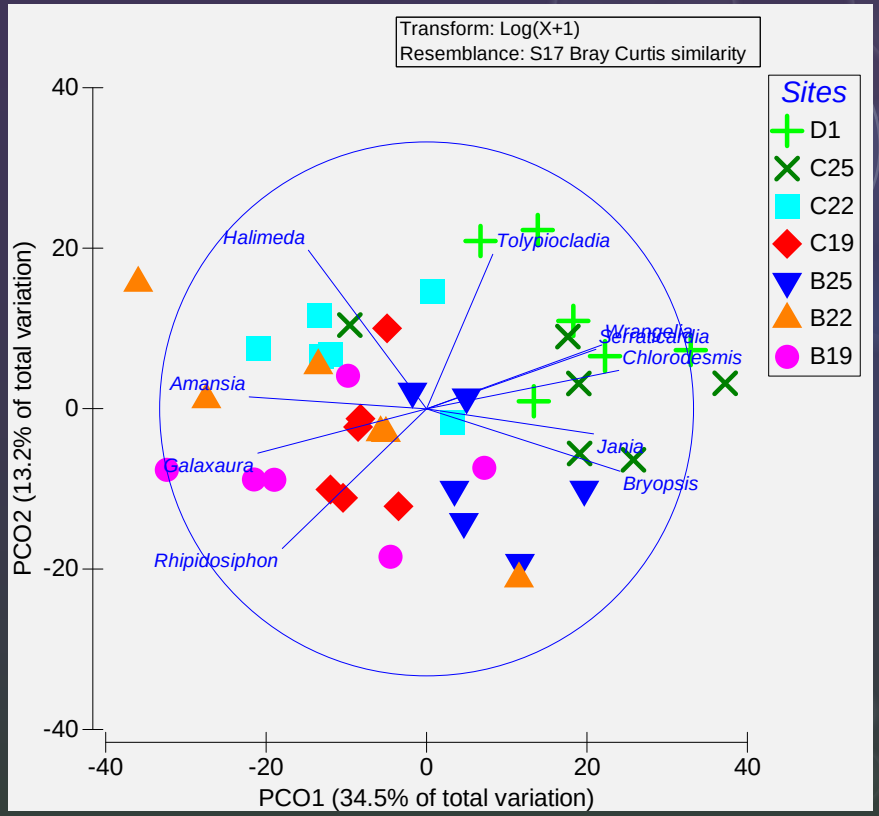
Number of Seacucumber at All Site Types During Winter



Trends show the lowest sea cucumber numbers are found in the mid section

Recommendations

- Assess the influence of season
- PRIMER
- N-isotope, QPCR, or other means of tracing sources of total nitrogen and nitrate/nitrite
- Influence of groundwater on other factors should be assessed (seagrass growth rate, fish counts, etc)
- Greater attention to groundwater for management action



Conclusion

- This study shows that groundwater has a greater influence on nearshore biological communities than surface water within Saipan Lagoon.
- This study shows the influence of groundwater results in compromised water quality and nearshore biological communities within Saipan Lagoon.
- The mid section has the poorest water quality relative to the north or south sections.

Mahalo

- NOAA Coral Reef Conservation Program
- UOG Water and Environmental Resources Institute
- BECQ Water Quality Surveillance / Non-point Source Branch, Laboratory Branch, and Marine Monitoring Team
- CRI Interns – Austin Piteg, Mary Fem Urena, and Julius Reyes

Bureau of Environmental & Coastal Quality
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