



AN ANALYSIS OF SYNTHETIC SEA WATER MIXES

BY AQUARIUMWATERTESTING.COM 12/07 - 02/08

ABSTRACT

It was our hope that by analyzing a selection of popular synthetic sea salt mixes, as specified by Reef Central members, that we could contribute some meaningful information to the ever-present discussions of which salt is best. We did not endeavor to interpret the data we collected or to suggest that one mix was superior to another in any way. We prepared the samples like a diligent hobbyist and then tested them in our professional laboratory facilities just as if they were AWT client submissions.

INTRODUCTION

Available information on the makeup of synthetic sea salts pertains primarily to the presence of toxic metals and there are no recent studies on the constituent components of freshly-mixed synthetic sea water. Much of the information available is based upon the claims of the salt manufacturers themselves, and many of the elements and compounds that are of interest to advanced hobbyists have been largely ignored. Furthermore, since exacting scientific analysis of the various salts requires very expensive equipment, such as ICP (mass) spectrometers, it is unlikely that an examination of synthetic salts at this level and across a broad range of elements/compounds will soon be undertaken.

The purpose of this study is to independently examine those elements and compounds that are of interest to aquarists, using methods and equipment that are widely recognized as adequate for the task. The results of this examination are intended to offer some data to enrich the discussions and debates that surround the process for selecting a salt mix. This data was gathered and is being shared in the spirit of community and is not meant to be a definitive scientific paper on this subject nor was this meant to promote or detract from any brand represented in this study.



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METHODS

AQUISITION OF SALT SAMPLES

A list of 14 salts was submitted by members of Reef Central to be considered in this study. AquariumWaterTesting.com purchased all salts from normal distributors in common quantities. No salt manufacturers were contacted for samples, nor were they informed of the study. Two samples of each salt were purchased in December 2007, one each from different distributors. We chose distributors from geographically distant locations to increase the chances of seeing samples from different manufacturing runs. The only exceptions were Crystal Sea, Crystal Sea Bioassay, and Marine Environment, of which we were only able to obtain samples from a single source. We therefore chose to analyze only one sample of these 3 products. As we wished to conduct this study without any possibility of bias, each salt was given a unique number for the purpose of tracking the results. At no time did the technicians conducting these tests know which salt they were testing.

We considered thoroughly mixing each salt prior to samples being taken, because we realize that settling during shipping and storage will produce a less than homogenous mixture. While thorough stirring may have produced more accurate results for the entire container, the effort and equipment required to do this is beyond the means of the average aquarist, who makes up water in batches smaller than the entire container. We therefore chose to only nominally stir each salt mix. We felt like the results produced by this methodology would be more useful, as it more closely approximates what the aquarist would do in the home environment. The water was of a quality commonly available to aquarium hobbyists, RO/DI water. The water filter was a Spectrapure, four-stage, RO/ DI unit that was purchased expressly for use in this study. The water was produced in one batch, and all make-up water was drawn from this batch. The water was stored in a normal, polyethylene barrel that had been pre-cleaned and acid washed to remove any possible sources of contamination. The resulting seawater samples were stirred and aerated for 24 hours prior to testing using new Rio 600 water pumps with aeration attachments in new, unused, polypropylene buckets. Approximately 200mL of each sample were taken in cleaned beakers to be tested.



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TESTING OF SEA WATER SAMPLES

We tested the 14 parameters on each of the seawater samples that comprise the standard panel for AquariumWaterTesting.com clients: Ammonia, Nitrite, Nitrate, Phosphate, Iodine, Copper, Silica, Calcium, Potassium, Magnesium, Strontium, Molybdenum, Alkalinity, and Boron. In response to a special request, Bromine was also tested in this panel. Additionally, we performed a yield test for each of the salt samples.

A variety of methods were used to test for these parameters. We used a DR series spectrophotometer and digital titrator from the Hach Company. The Ion Specific Electrodes (ISEs) used were obtained from Denver Instruments. All equipment was pre-tested and calibrated prior to use. Standards were obtained and tested to ensure accuracy as part of routine AWT procedure. In the case of Nitrate tests, a special standard is used to account for the interference of Chloride in the testing process. The standard is made with a background Chloride concentration of 19,000mg/L. Other possible interferences were checked for using a process called Standard Additions, (spiking). No interferences were found in any parameter, with most of the percent recoveries falling within 95% to 105%.

The spectrophotometer methods used are standard Hach methods, and can be examined on their website, www.hach.com. The methods for the digital titrator can be found in the Hach Digital Titrator Users manual, June 2006, Edition 24. The ISE's are double junction types, and are read using a series 200 Ion Meter, all from Denver Instruments. Procedural audits, advice and recommendations on testing procedures had been previously obtained from outside chemists at Hach, Denver Instruments, and Cole-Parmer. Testing procedures were found to be sound, within the limitations of the involved chemistry. All glassware used in these procedures was subjected to our rigorous cleaning procedures and acid washed using a 0.1N solution of HCL to eliminate any possible sources of contamination.



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TESTING OF SEA WATER SAMPLES (CONT.)

The yield test was performed by weighing the equivalent of 35 grams of the salt mix into 1 liter of water. In the interest of reducing required space and mixing equipment, we reduced these values by 4/5th, so that 7 grams of salt were mixed into 200mL of water. The scale used was a Digiweigh Laboratory balance, and the salt water solution was mixed using magnetic stirrers.

The actual testing was performed in January 2008. A two staff member team was assigned to the testing to reduce the possibility of technique bias in the results. The tests were run on consecutive days, and the results were recorded by hand prior to being collated for this paper. No statistical analysis was run on the results of the tests.

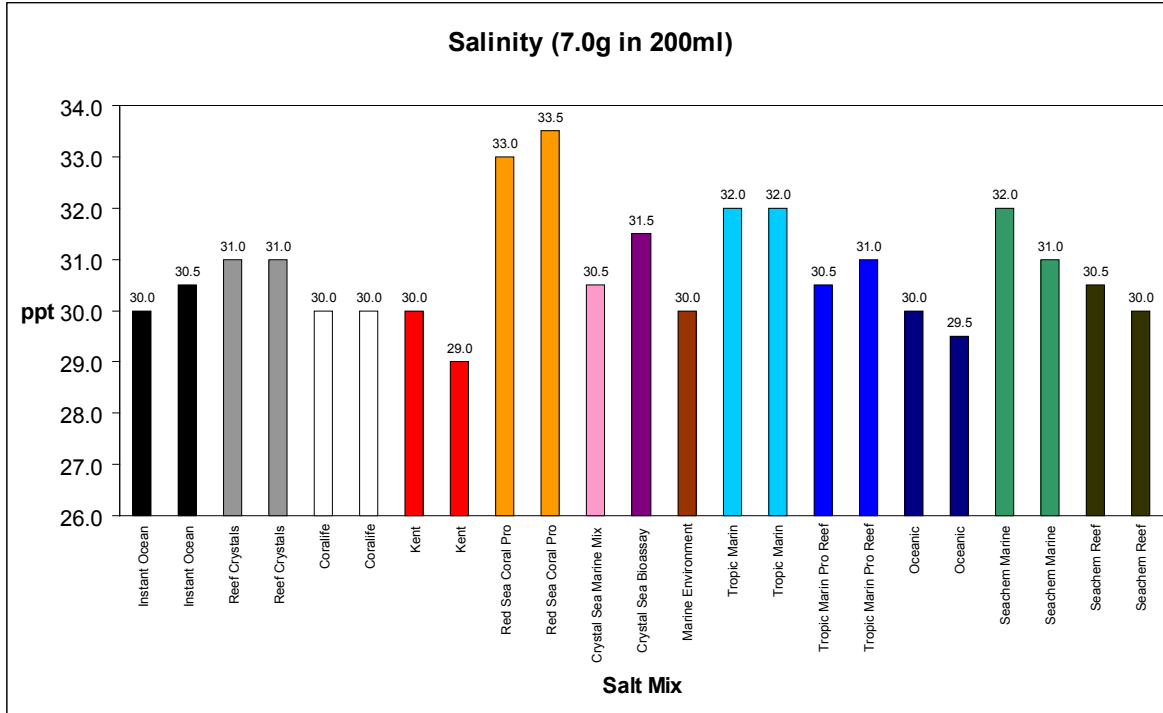
The following synthetic salt mixes were used in this study. We believe that they represent the vast majority of salt mixes currently being used in the hobby: Oceanic, Instant Ocean, Red Sea Coral Pro, Tropic Marin, Tropic Marin Pro Reef, Coralife, Reef Crystals, Crystal Sea, Crystal Sea Bioassay, Kent, Seachem, Seachem Reef and Red Sea. The following products were received in 50 gallon bags: Instant Ocean, Reef Crystals, Coralife, Kent, Crystal Sea Marine Mix and Bioassay, Marine Environment, and Seachem Marine and Reef. Red Sea Coral Pro came in a bucket, both Tropic Marin varieties came in boxes and Oceanic came in a jug.

RESULTS

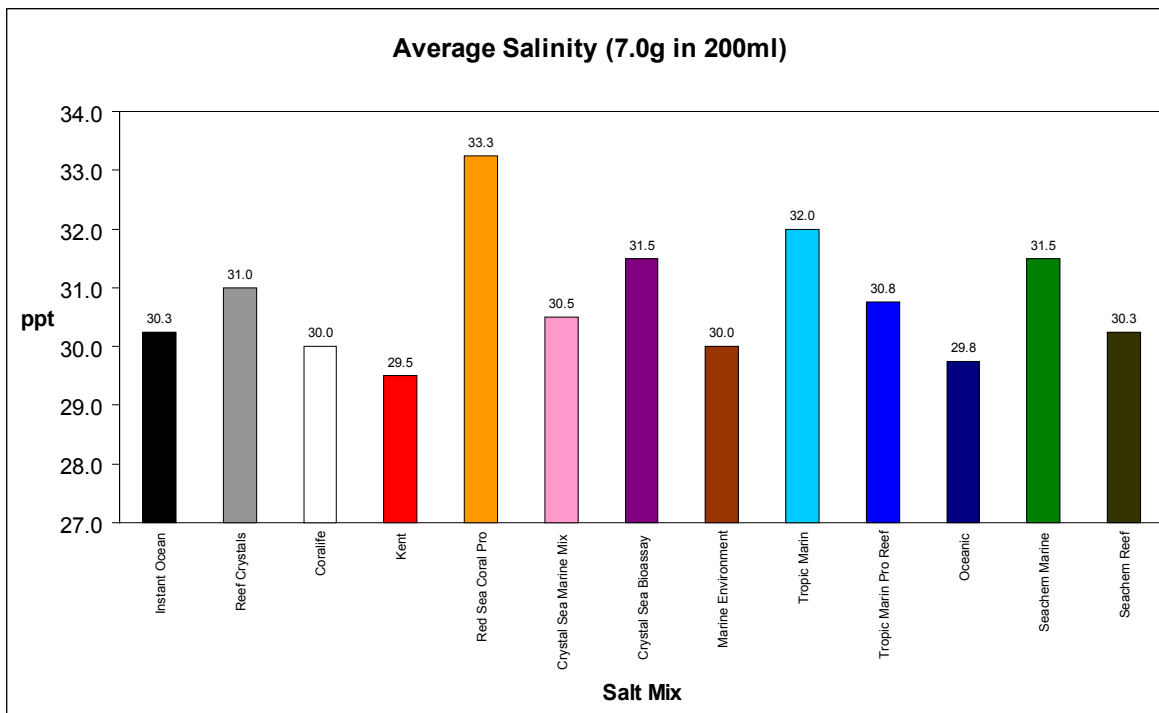
The data from the results of the testing can be seen on the following charts. We have broken up the data by parameter instead of by salt brand to make comparison easier. The greatest variability between identical samples is in those salts packaged in buckets or boxes, presumably due to settling during storage and the difficulty of manually mixing the entire volume of those containers.

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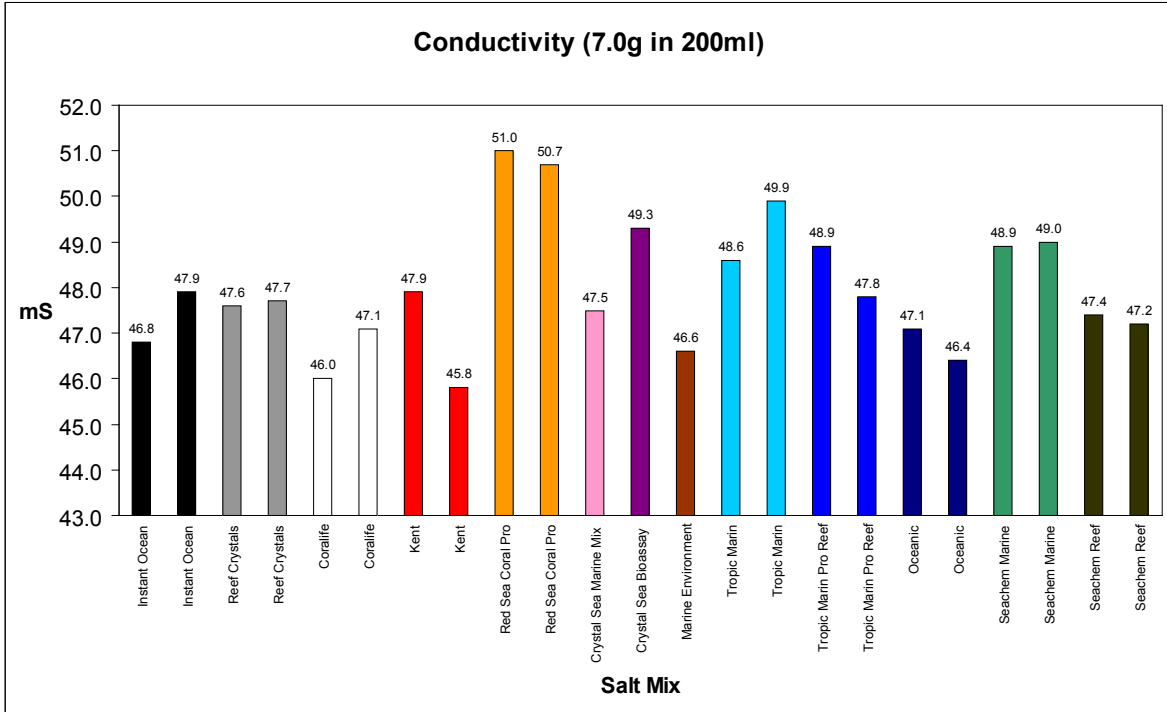


NSW salinity around coral reefs average 35 parts per thousand.

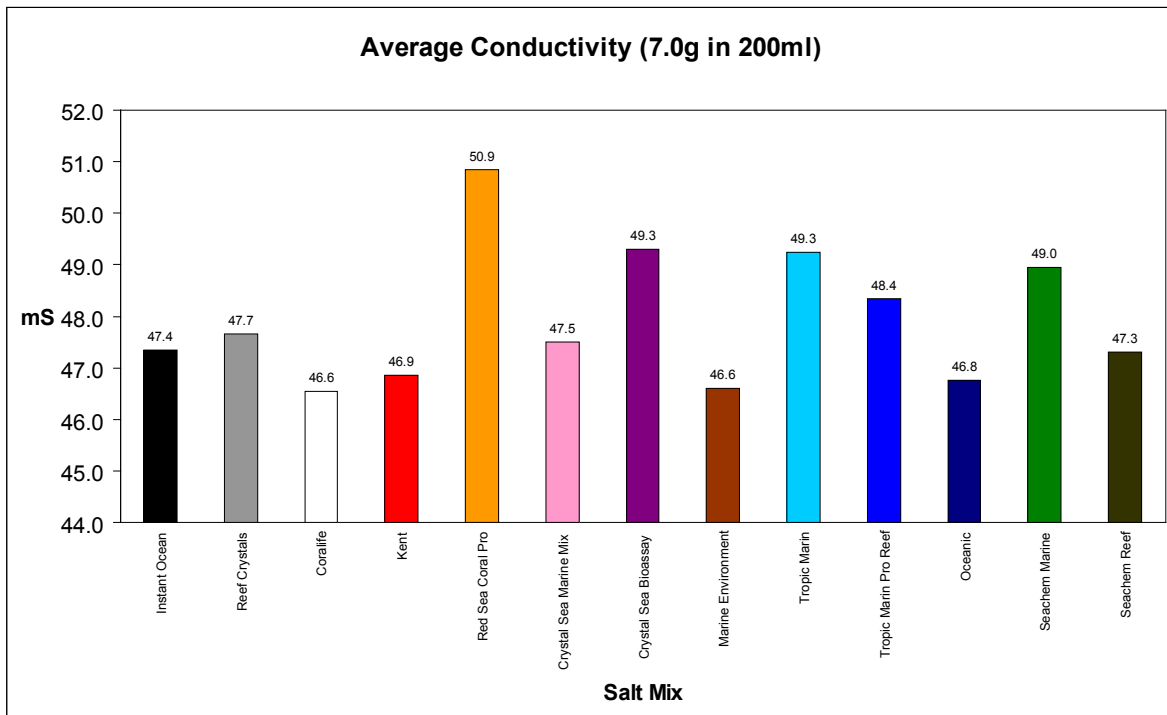


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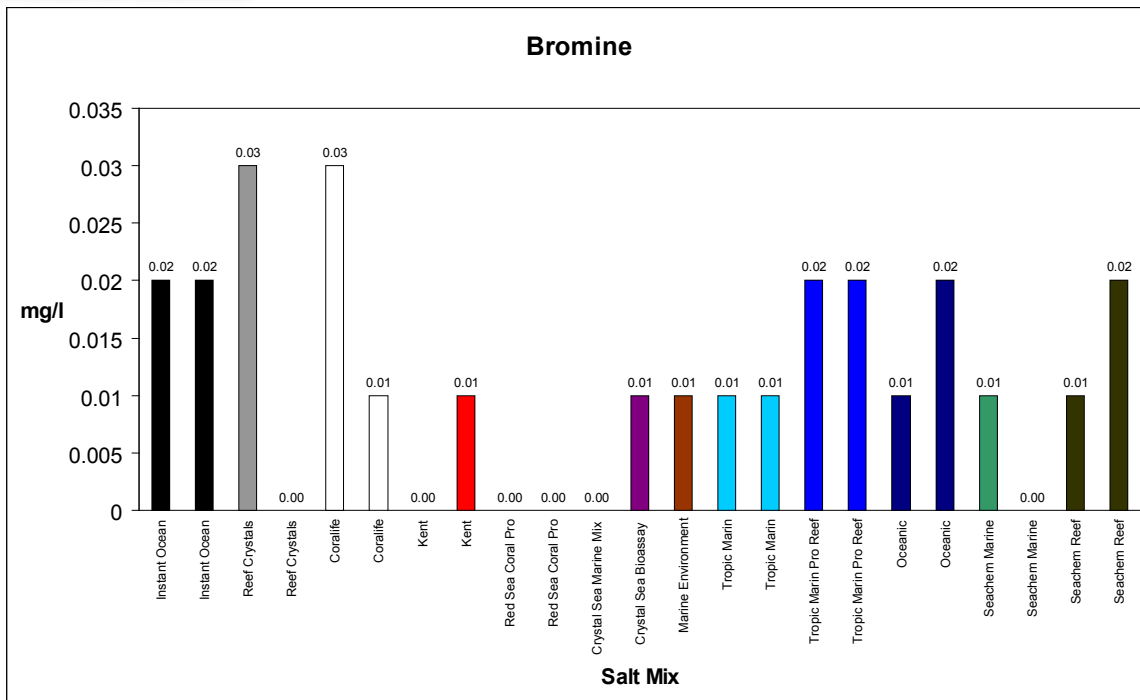


NSW conductivity around coral reefs average 53 mS.

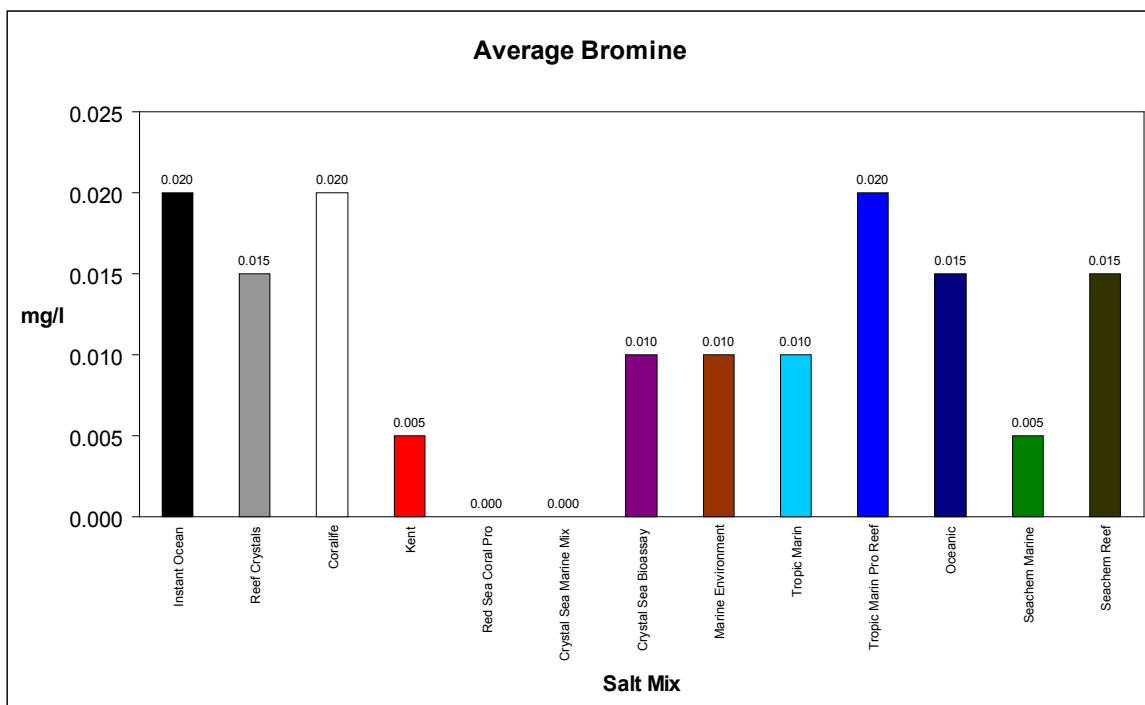


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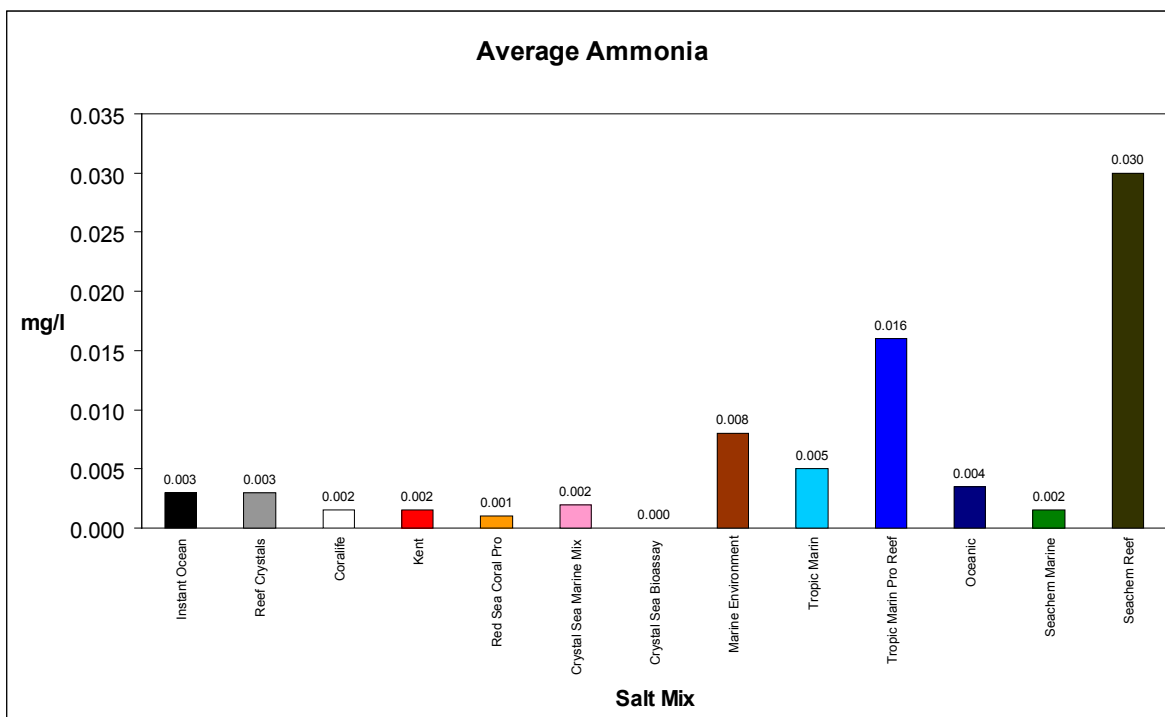
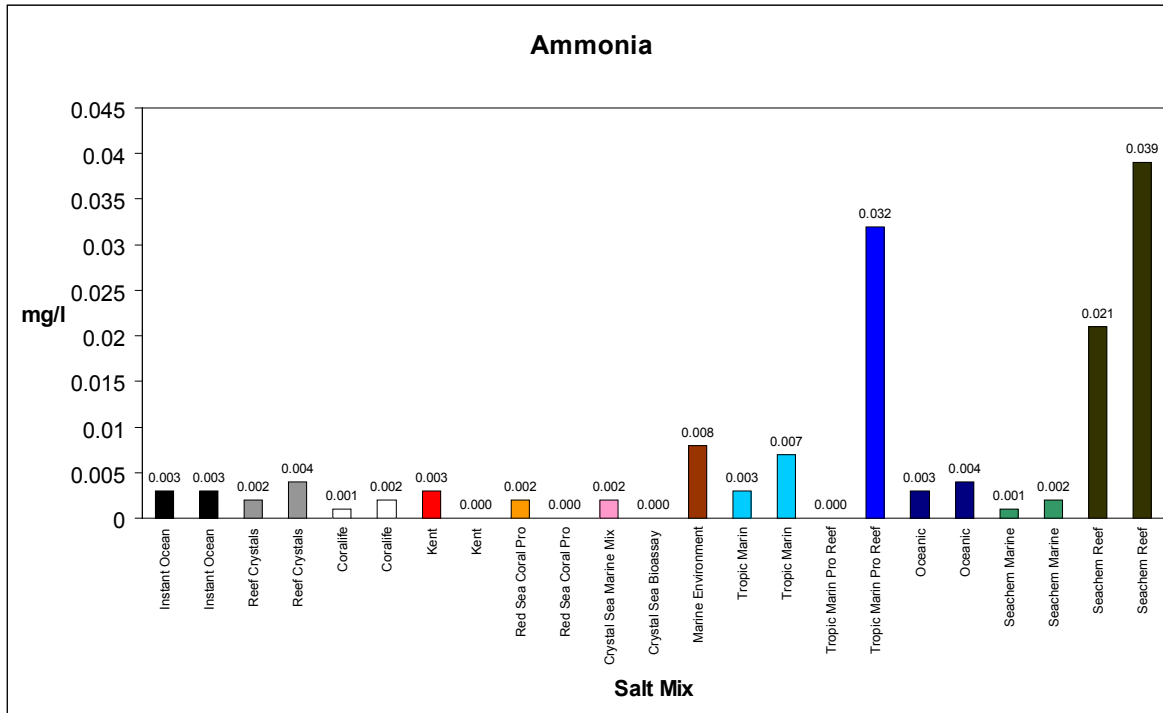


Bromine is normally found in sea water at a concentration of around 85 ppm. Although there is no evidence that bromine performs any biological functions, it was included in this test panel. We tried a variety of techniques, based on recommendations from the chemists at Hach, to bring out bromine in these tests. As you can see from the results, one of two possibilities is true. Either there is no bromine in the salt samples, or the presence of bromine is being masked by the presence of other ions. Based on the data from previous salt assays, we believe that bromine is present, but the only way to confirm this may be through the use of ICP mass spectroscopy.



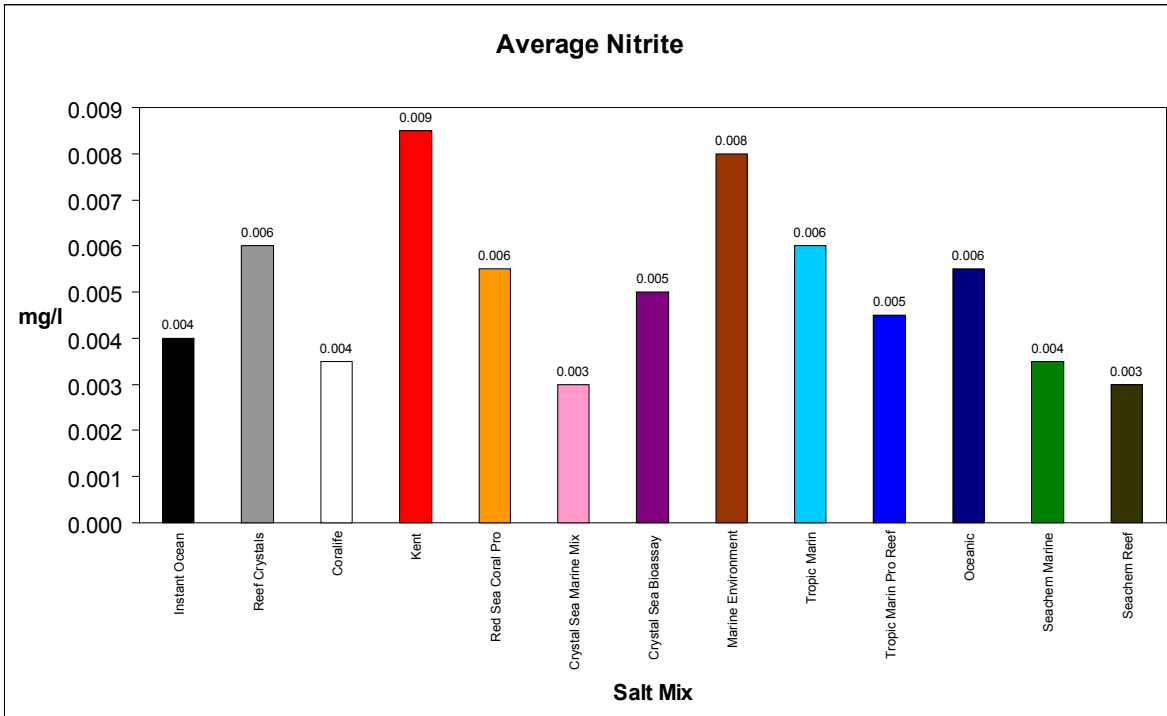
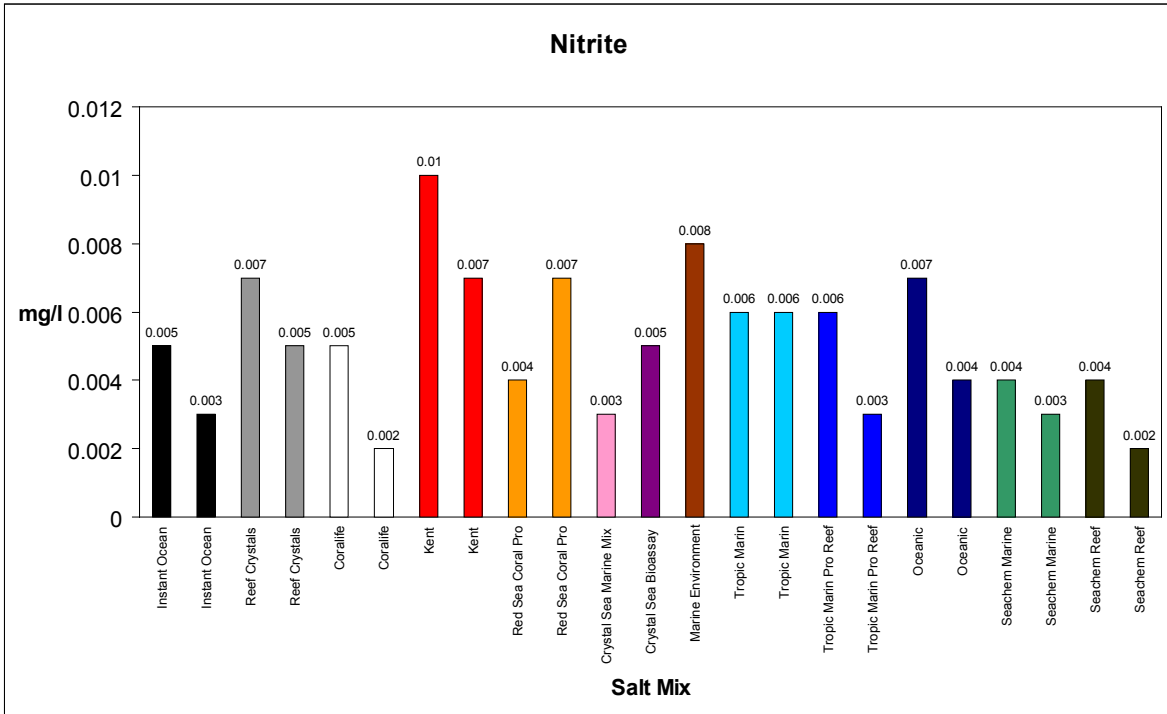
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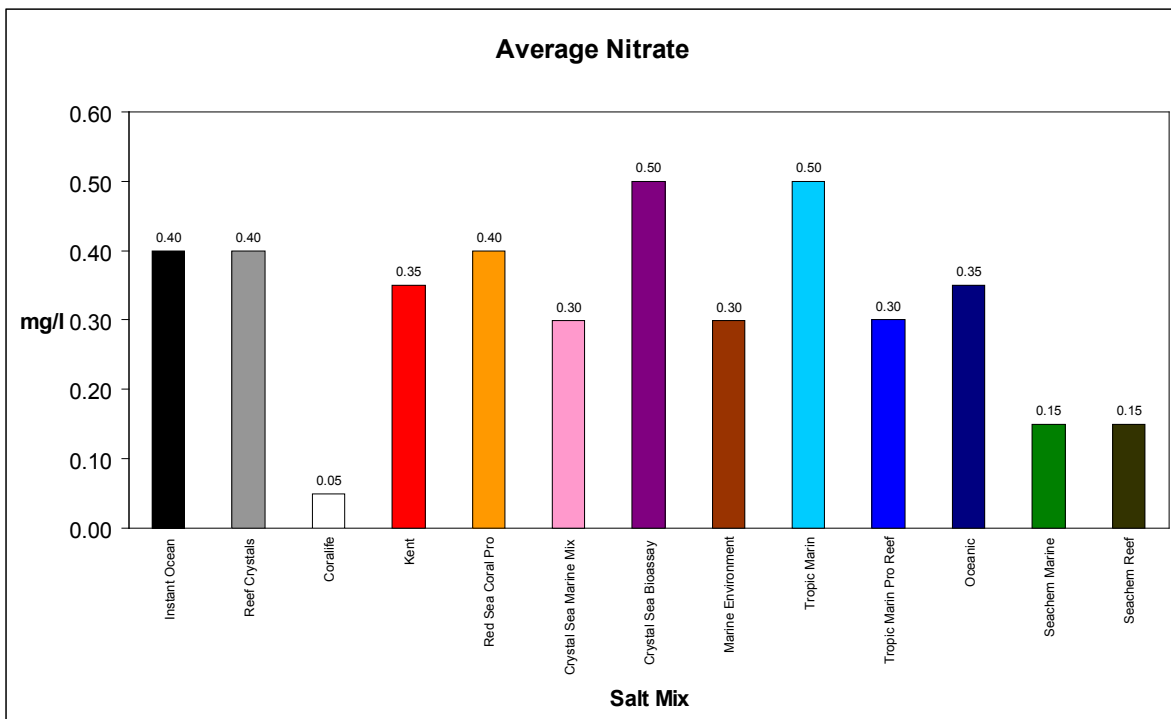
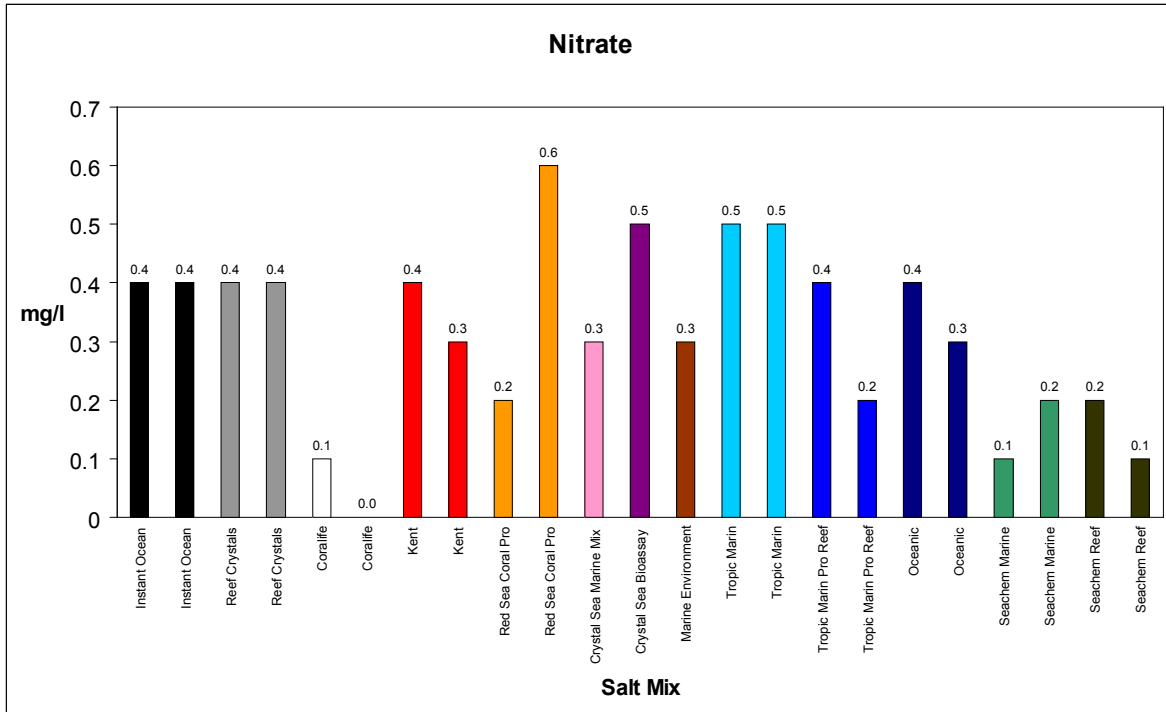
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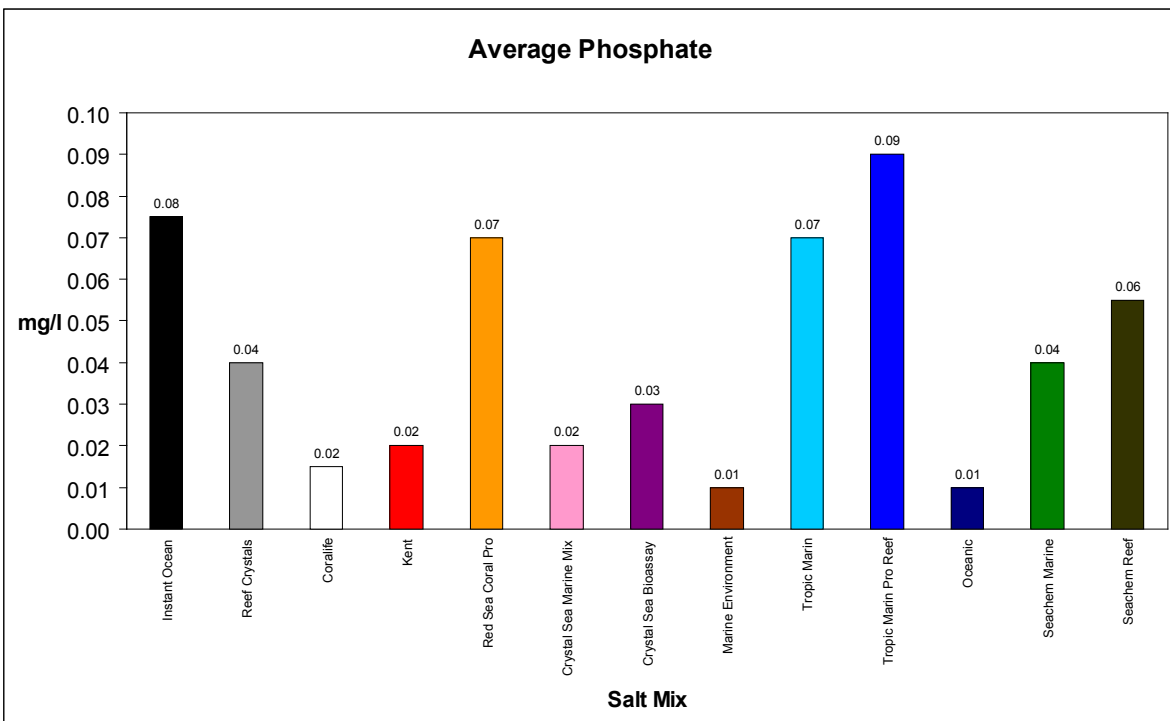
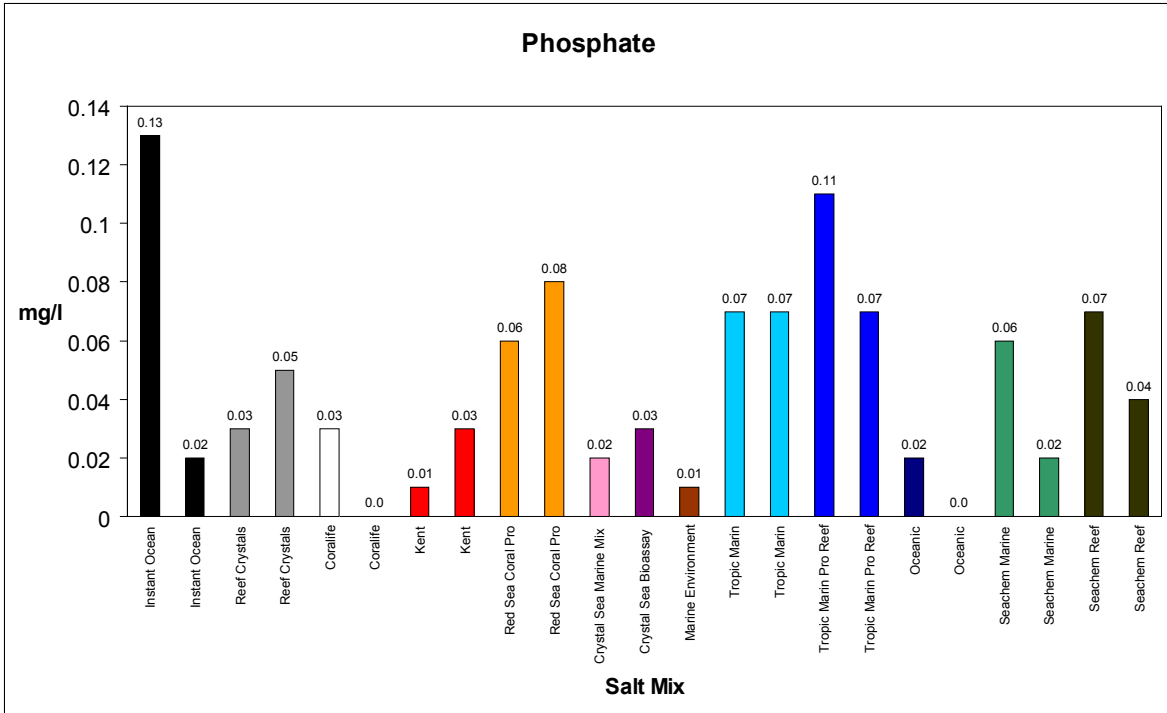
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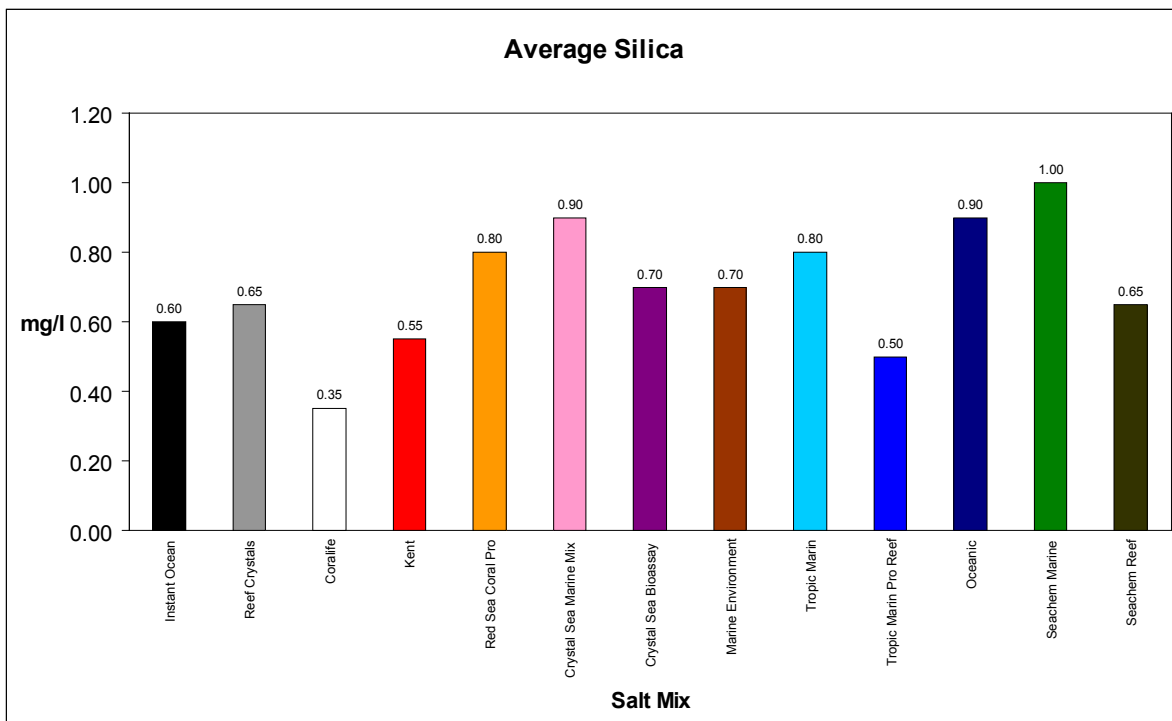
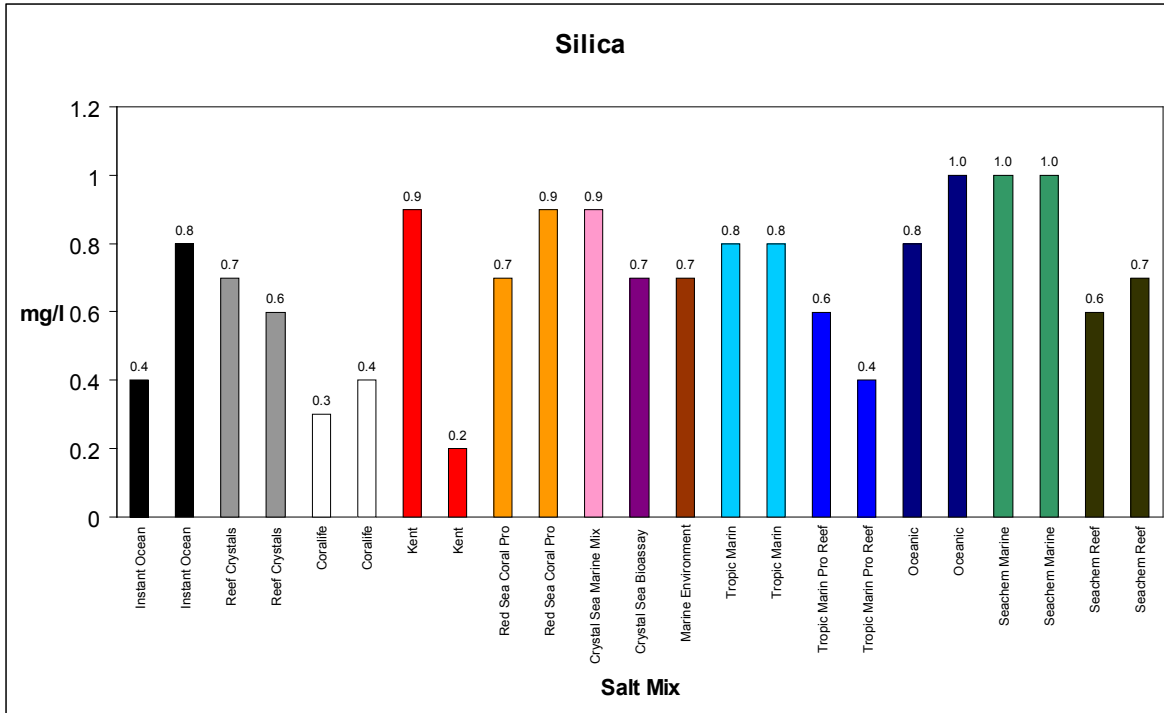
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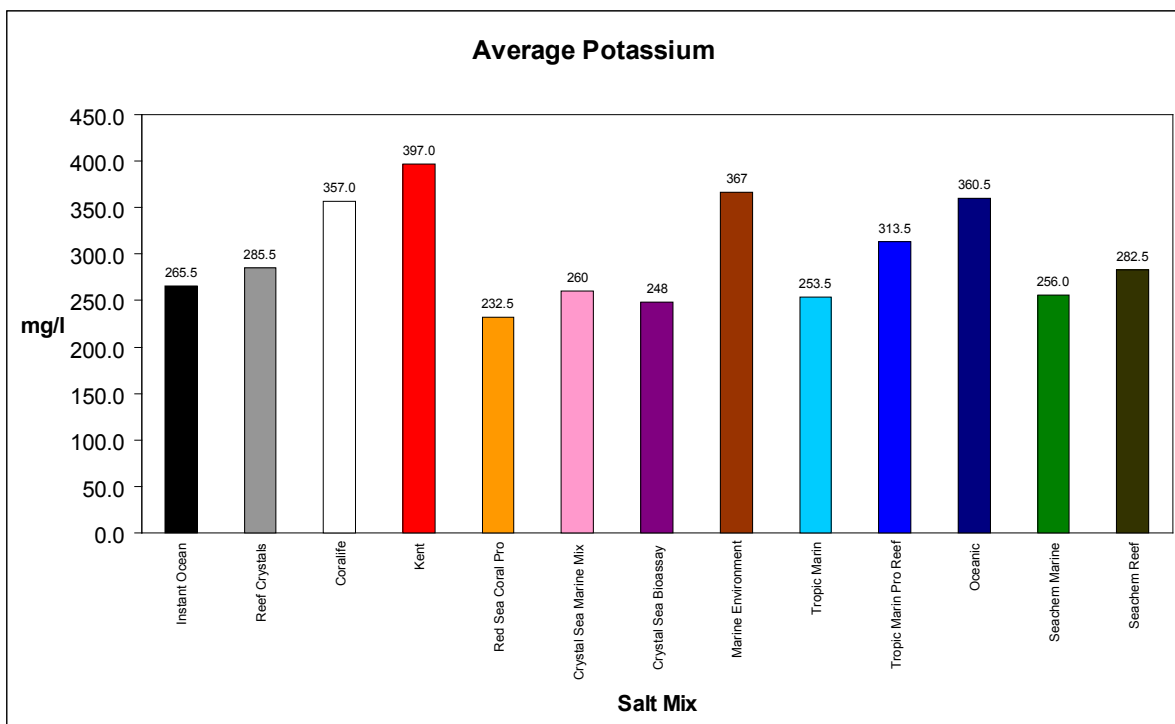
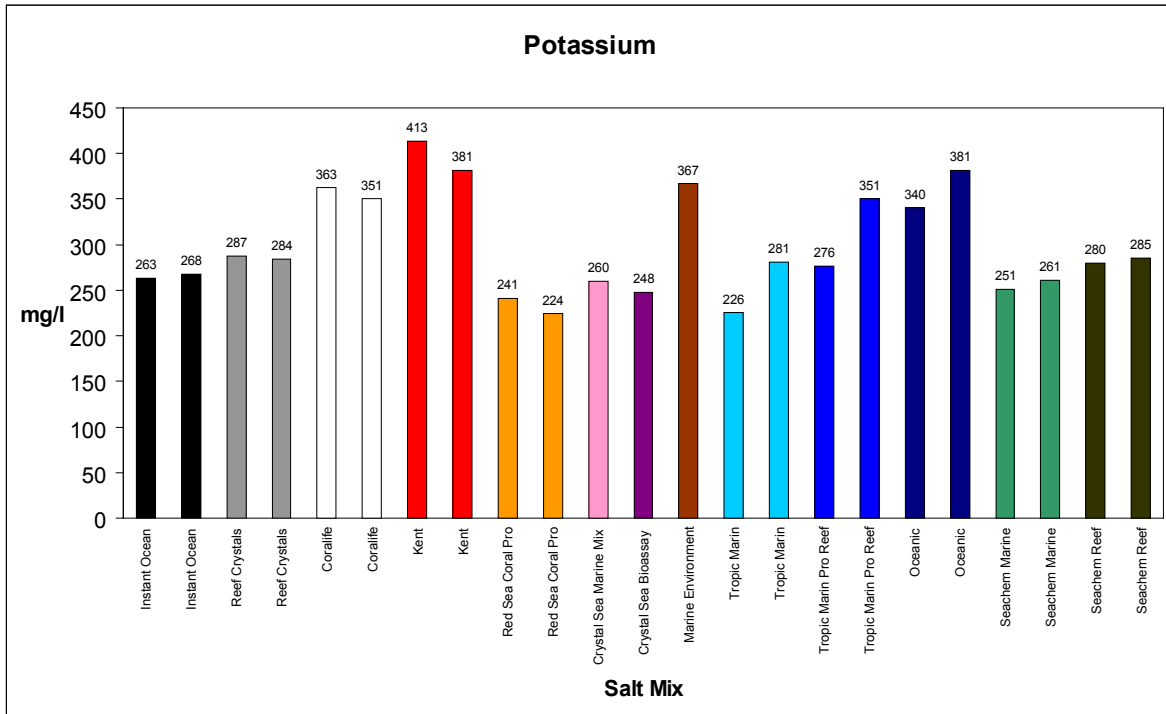
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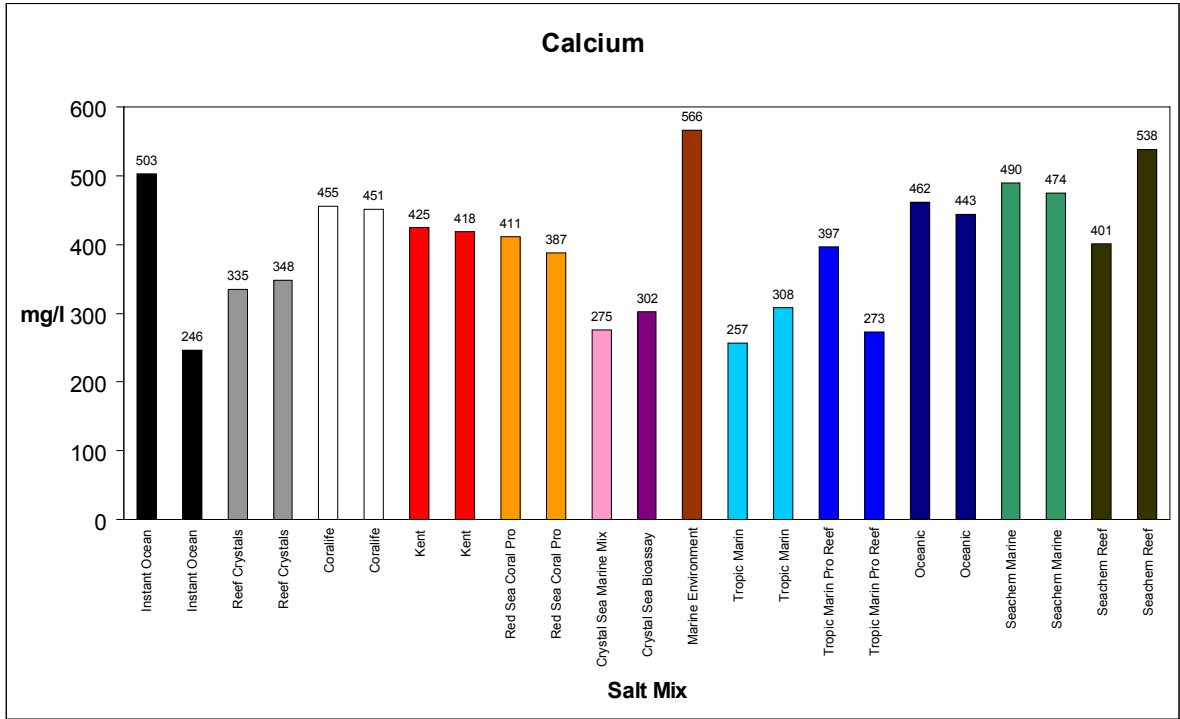
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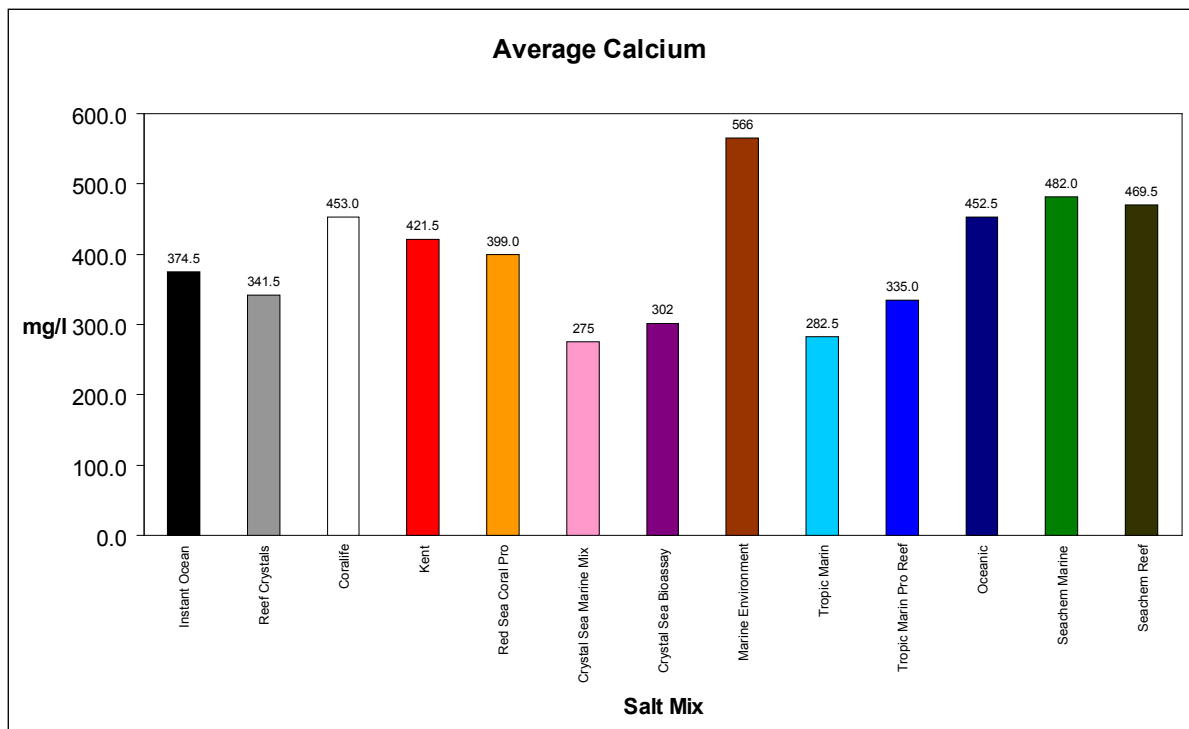


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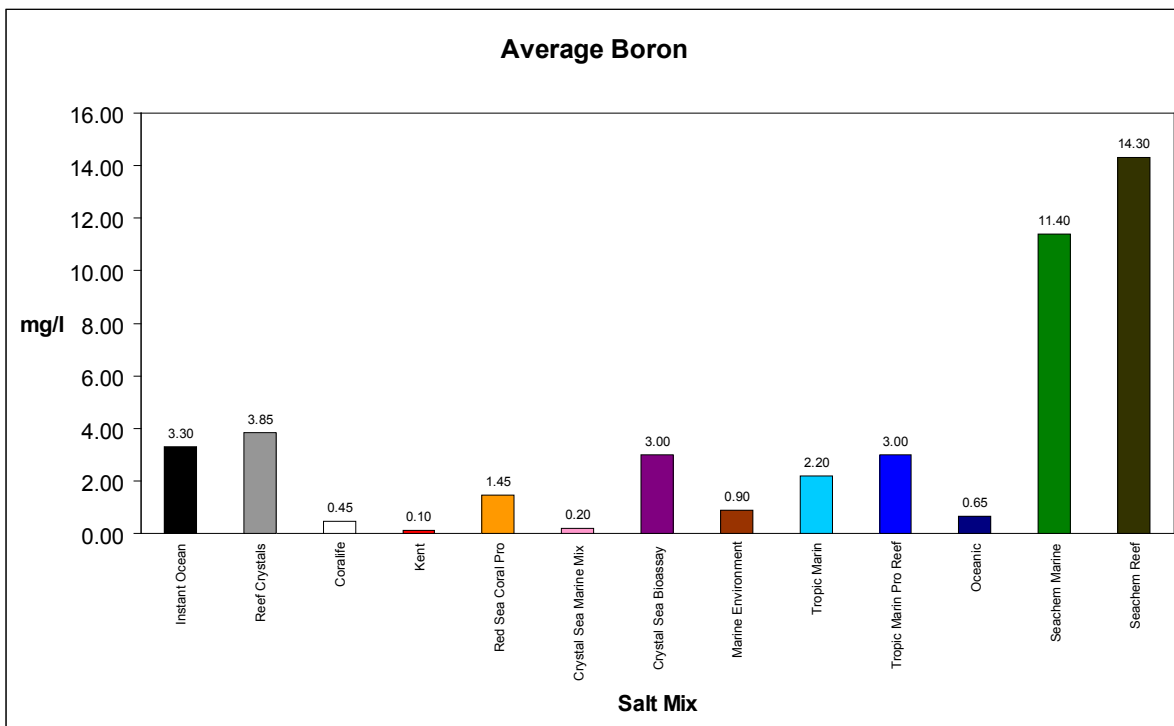
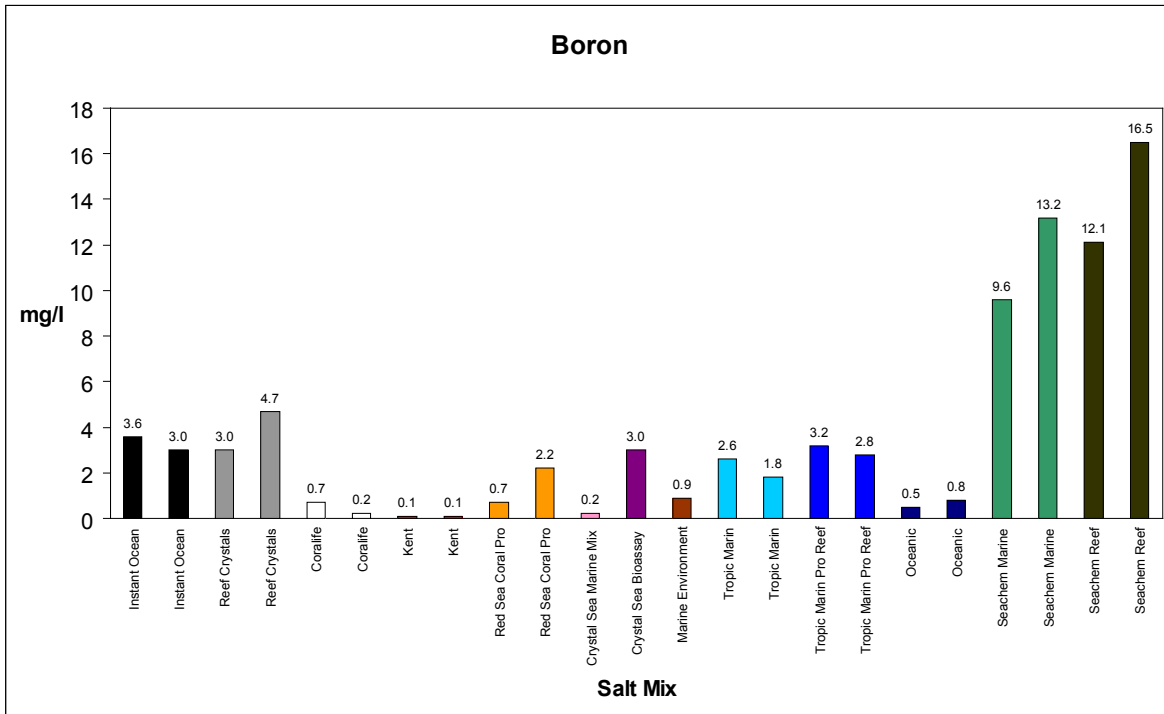


These values represent only the amount of free calcium ions present in the samples. According to Randy Holmes-Farley the total calcium concentration can be 10% to 20% higher.



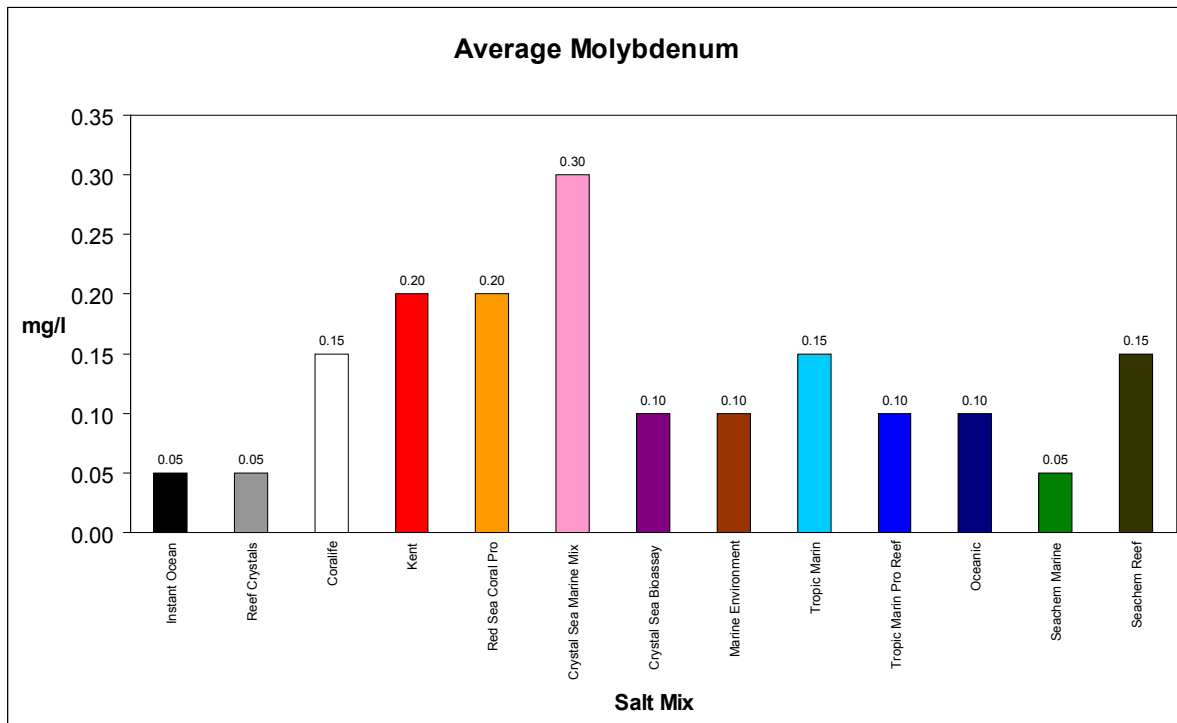
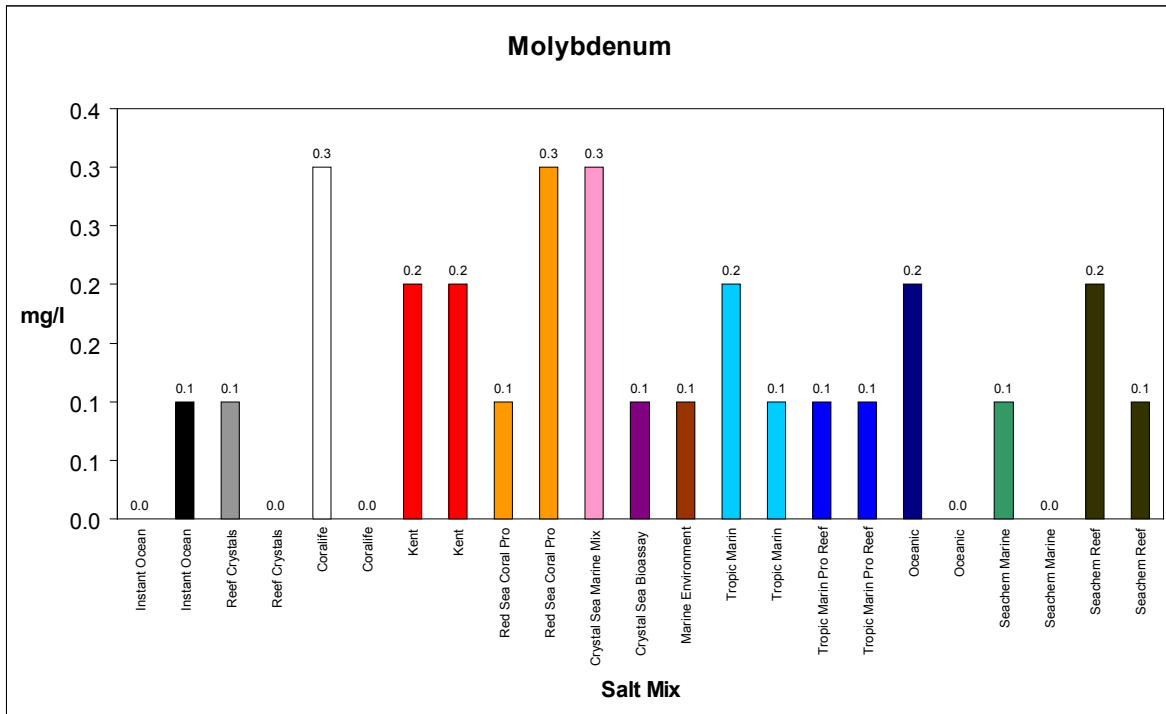
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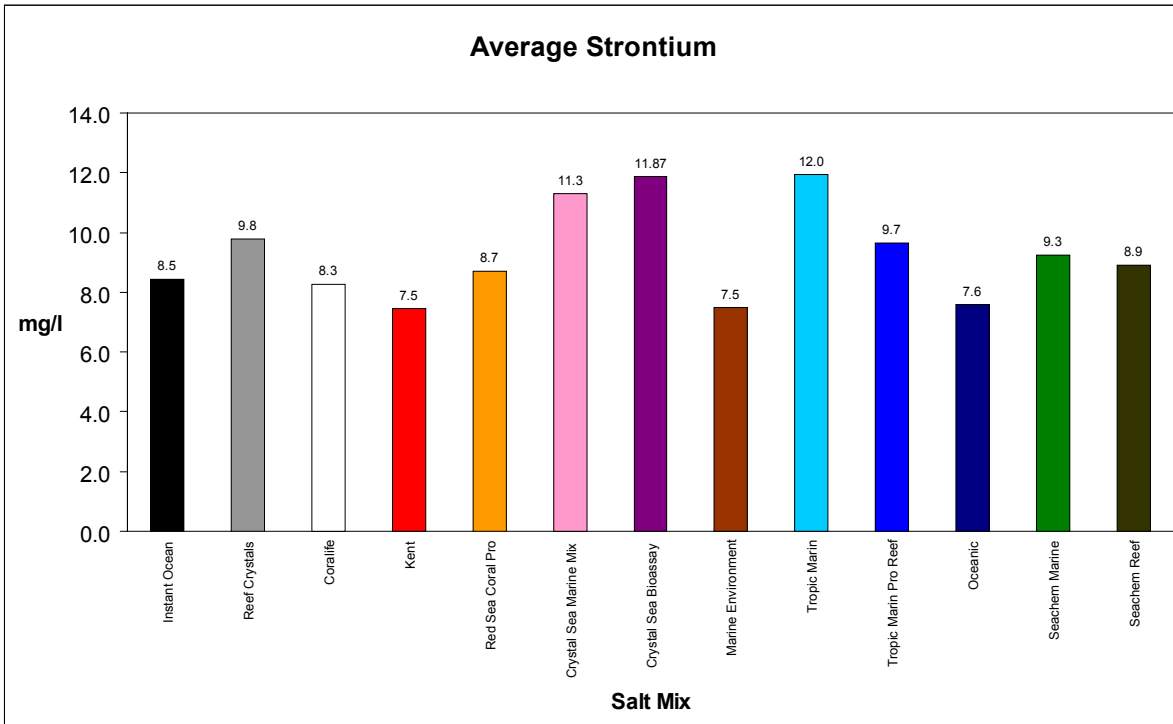
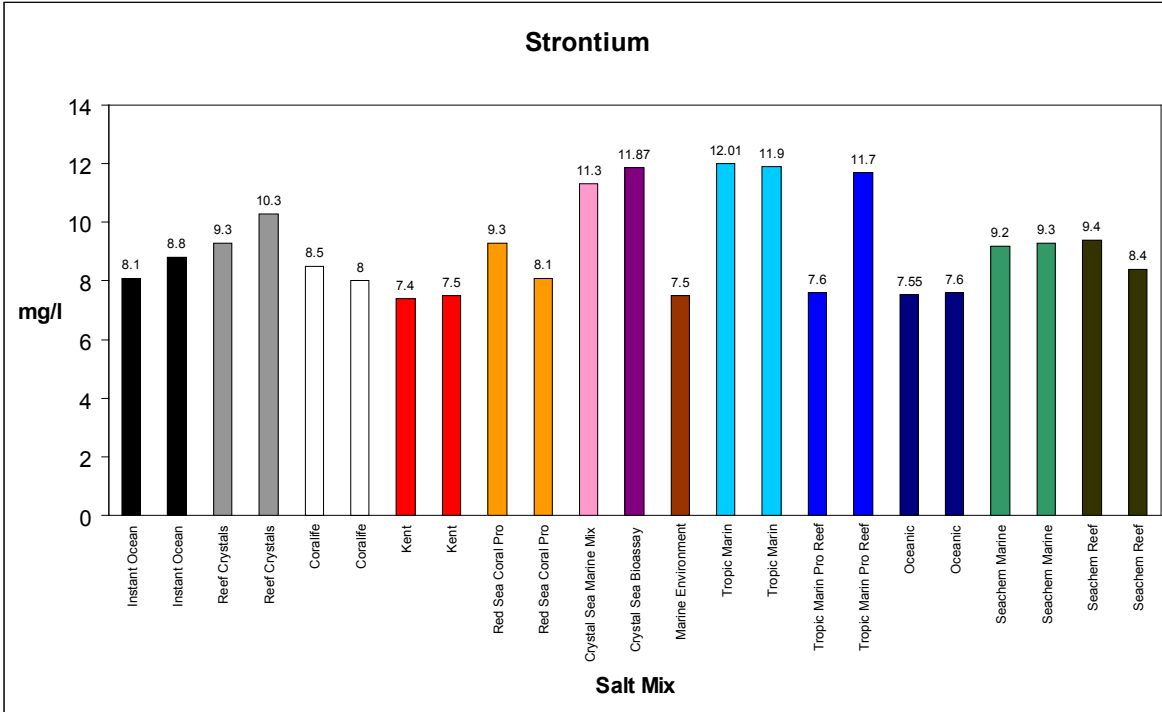
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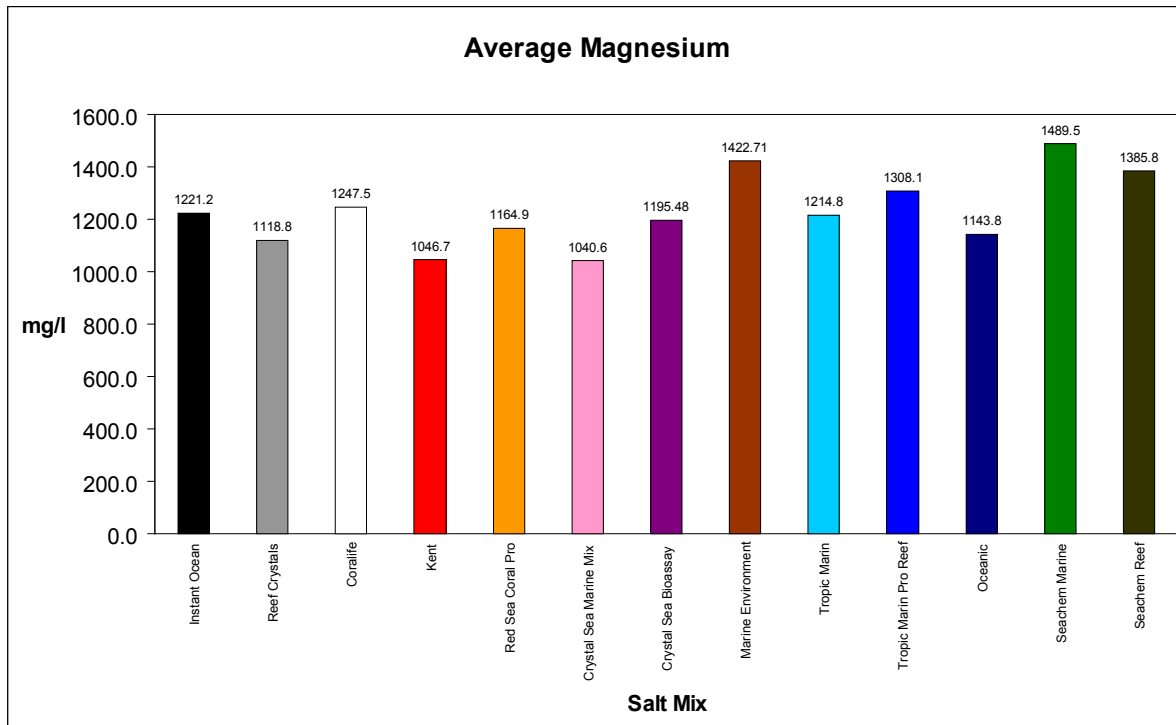
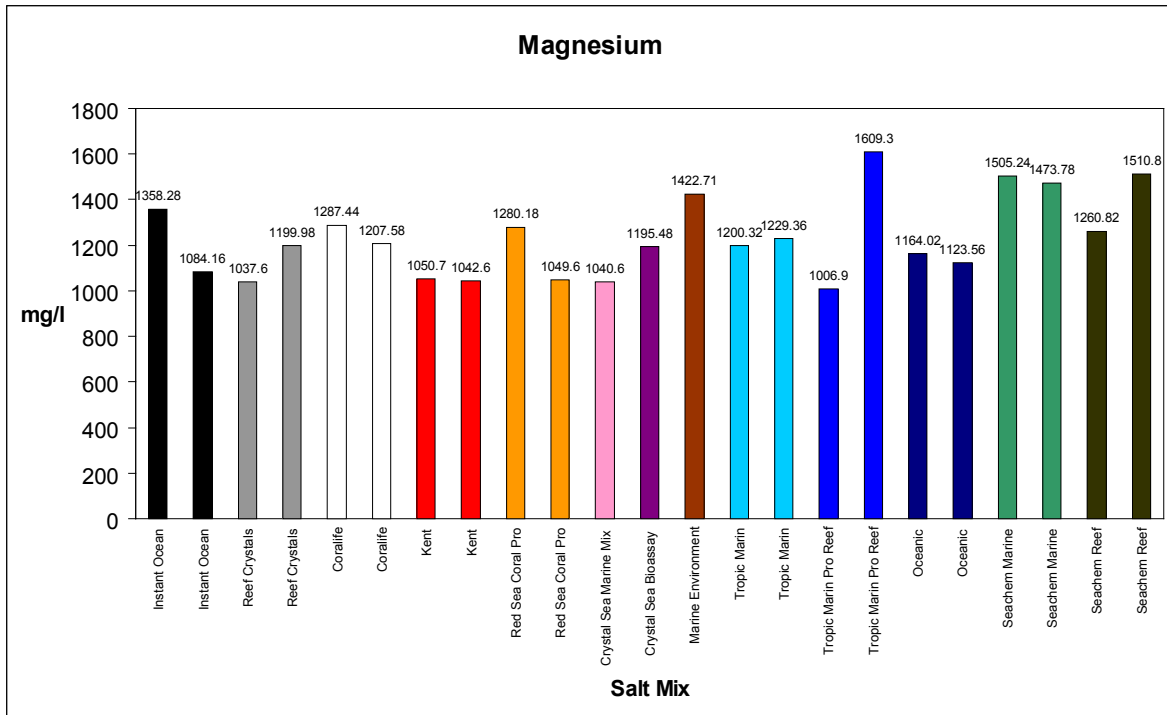
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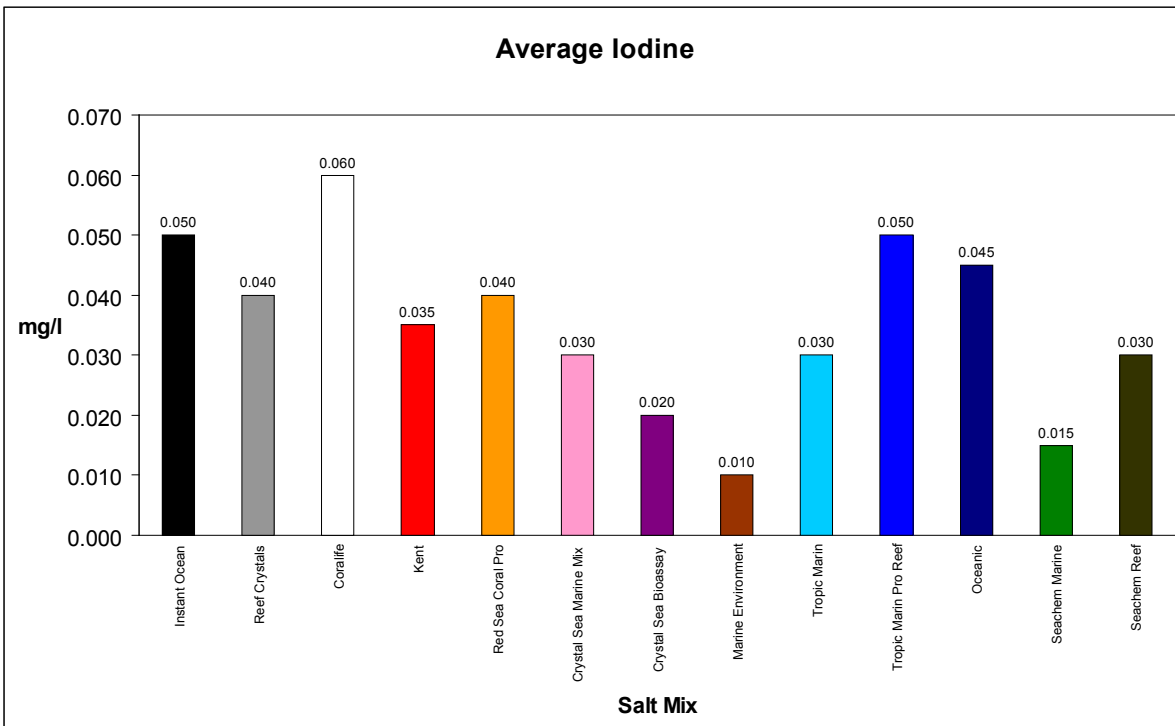
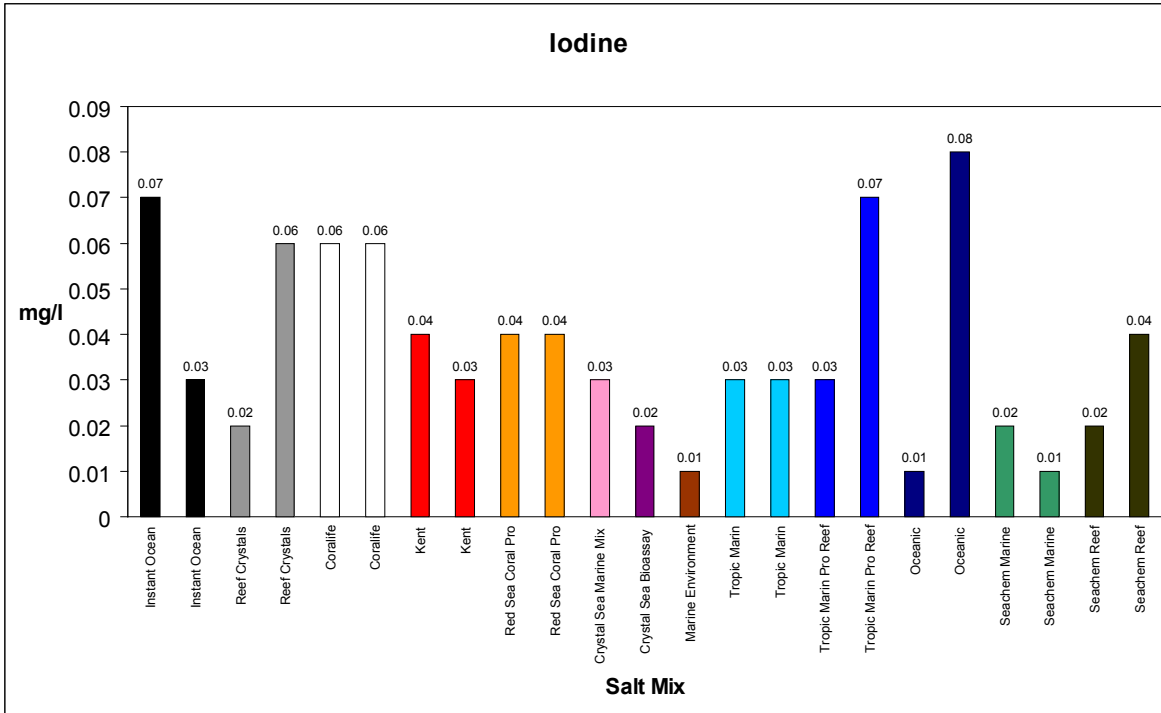
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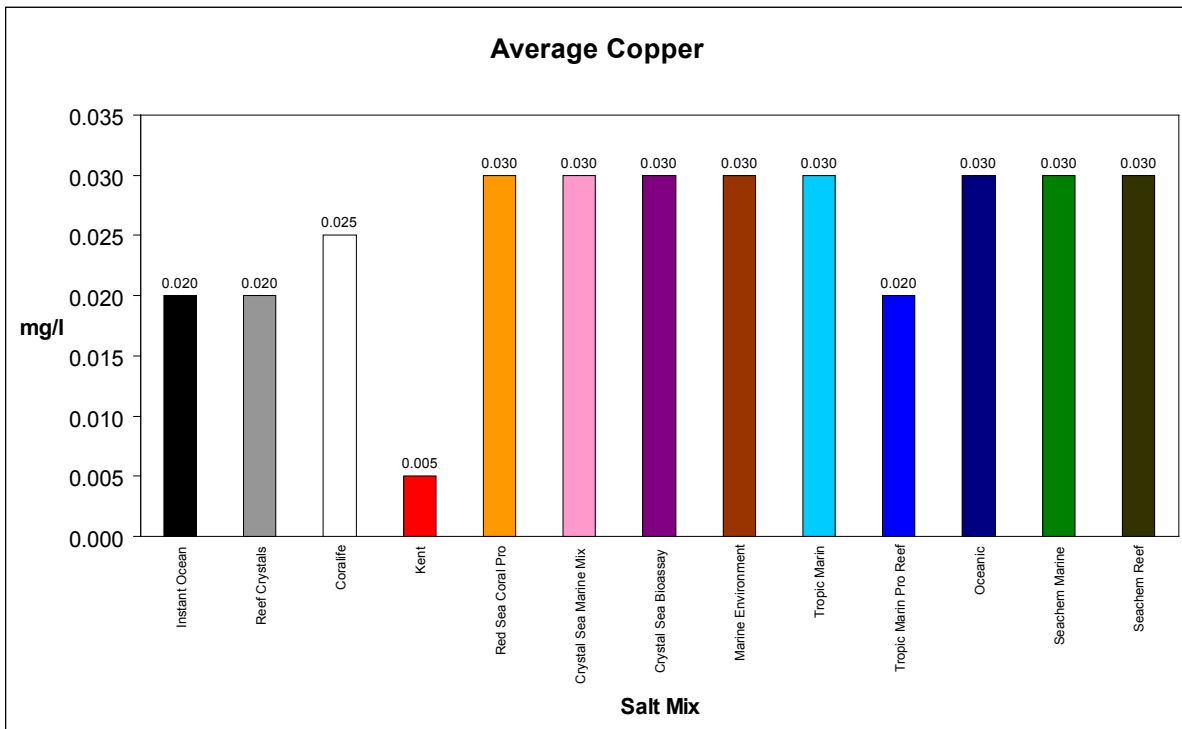
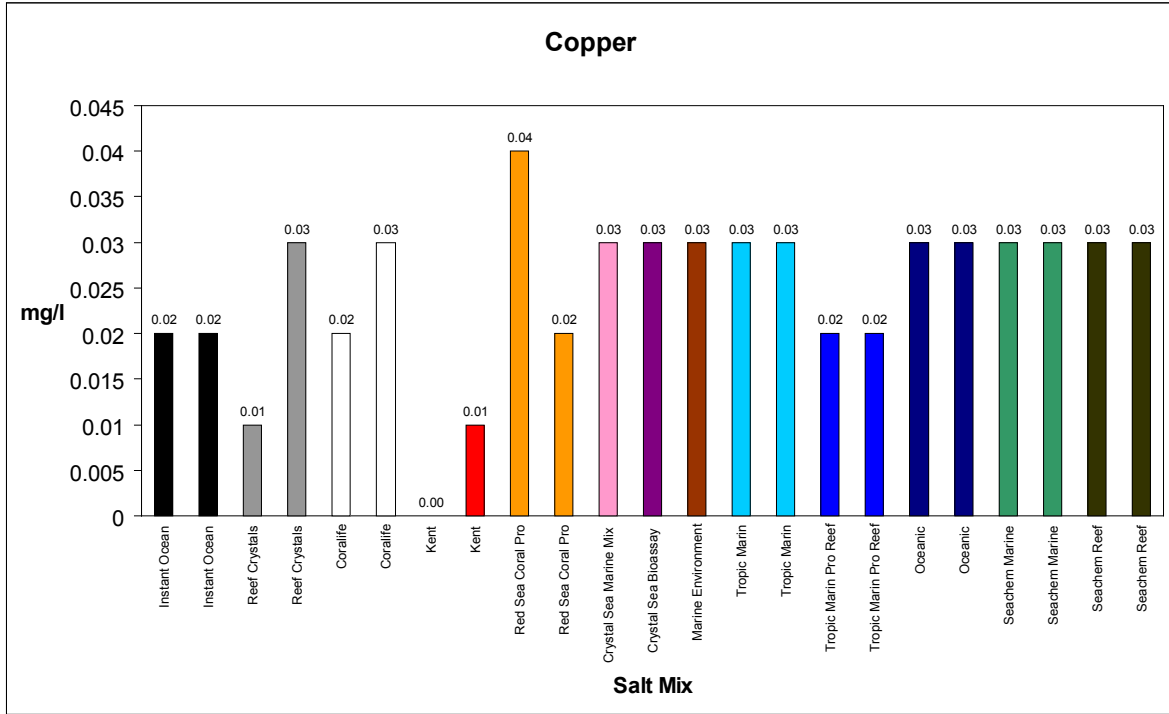
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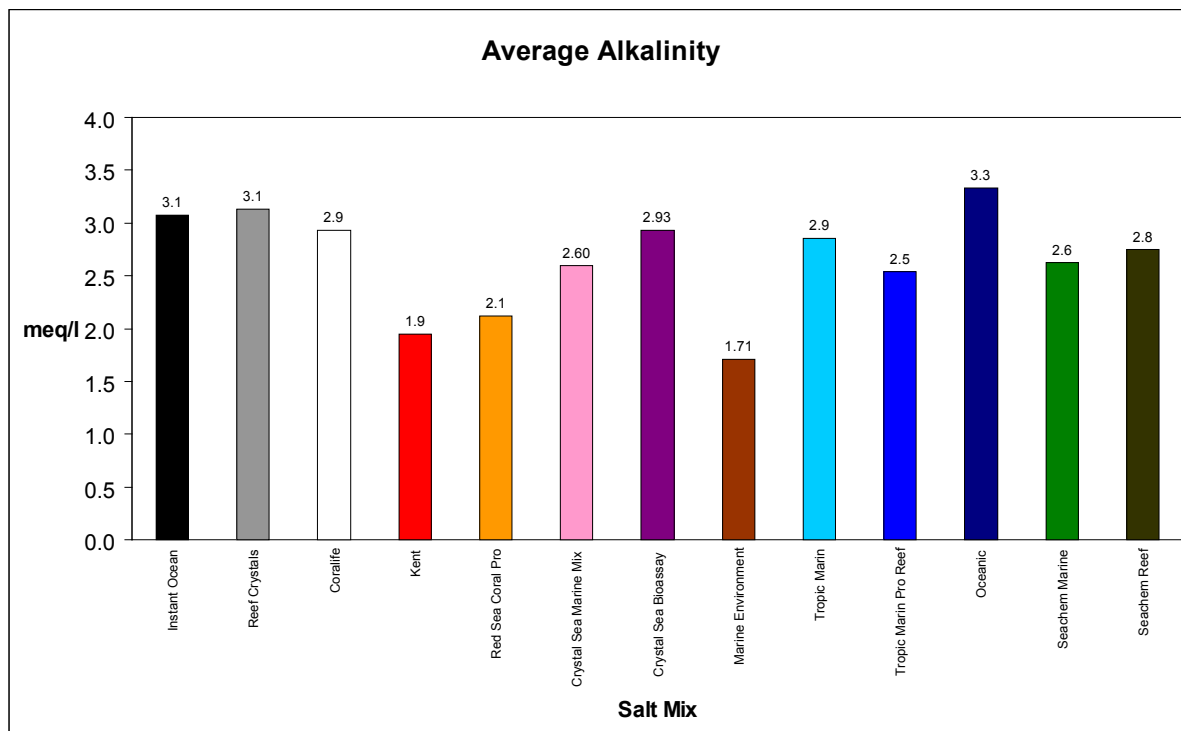
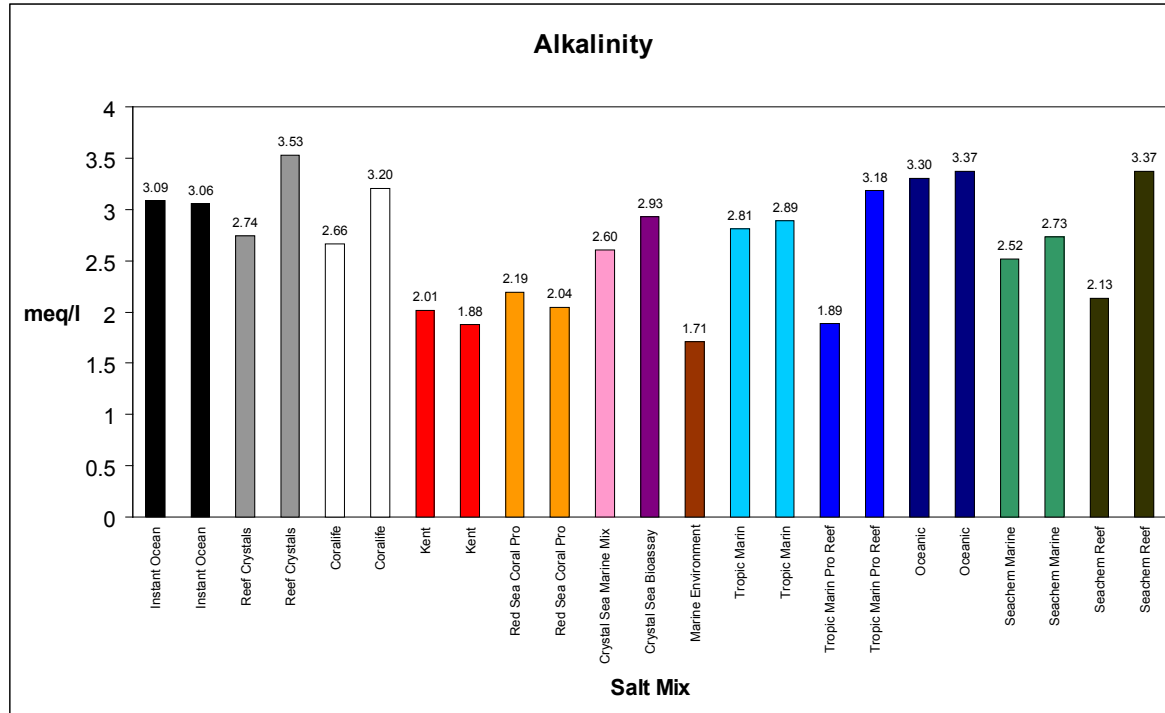
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DISCUSSION

Our intention was to deliver data to enrich your discussions so we will leave this to you!

This study ignited many great discussions among our staff here and we will plan on posting our thoughts on some of the more interesting topics in the FAQ section of AquariumWaterTesting.com.