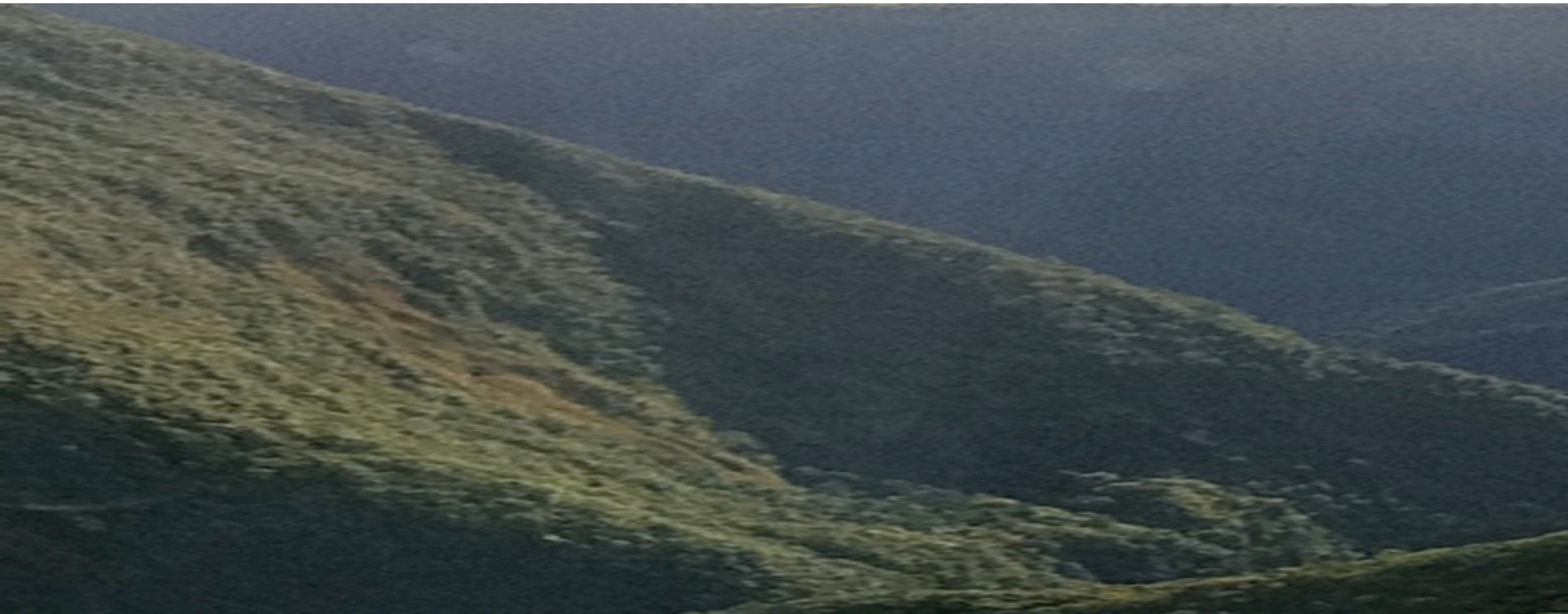
World Aquarium and Ma Cherie Innovation, Ltd

THE BIG PICTURE: CONNECTING LAND TO SEA WITH ECOSYSTEM BASED ANALYSIS & IMPROVING PRODUCTIVITY



History

- Since 1996 we have been looking closely at the effects of micronutrients on ocean systems and agricultural production. We have seen direct nutrient correlations to certain growth coefficients with corals, marine alga, and fisheries productivity. We have also studied downstream effects of feedlot production systems on stream/river ecology. In 2014 we looked at the micronutrient effect on crop production under greenhouse conditions and in the field to further develop through independent laboratory analysis, methodologies to increase crop production and improve the protein and vitamin content. It is our intent to further understand using an ecosystem based approach for linkage between what happens on the land and how it affects the ocean and develop mechanisms for additional preservation and production mechanisms.

How things are being changed by the effects of climate change

Relating individuals and area -wide activities as productive systems to innovative solutions

Engaging youth for future sustainability:
How to encourage youths from more traditional backgrounds & rural areas from leaving their homelands creating a production and preservation void

Some Recent Data:
Demonstrating Crop production improvements

Crop Research

Improving Crop Nutritional Values and Production

Testing improved cellular activities in plants using controlled greenhouse conditions has led to new understandings about reducing fertilizer use, increasing crop production and nutritional qualities and decreasing Nitrogen Effluents.

Improving Aquaculture Feed by decreasing costs and increasing fish growth

- "Fish meal and Fish Oils amount to approximately 1/3 of the cost of Aquaculture Feed."

Nutrition and Utilization Technology in Aquaculture
Chhorn E. Lim and David J. Sessa, Editors. AOCS Press, 1995.

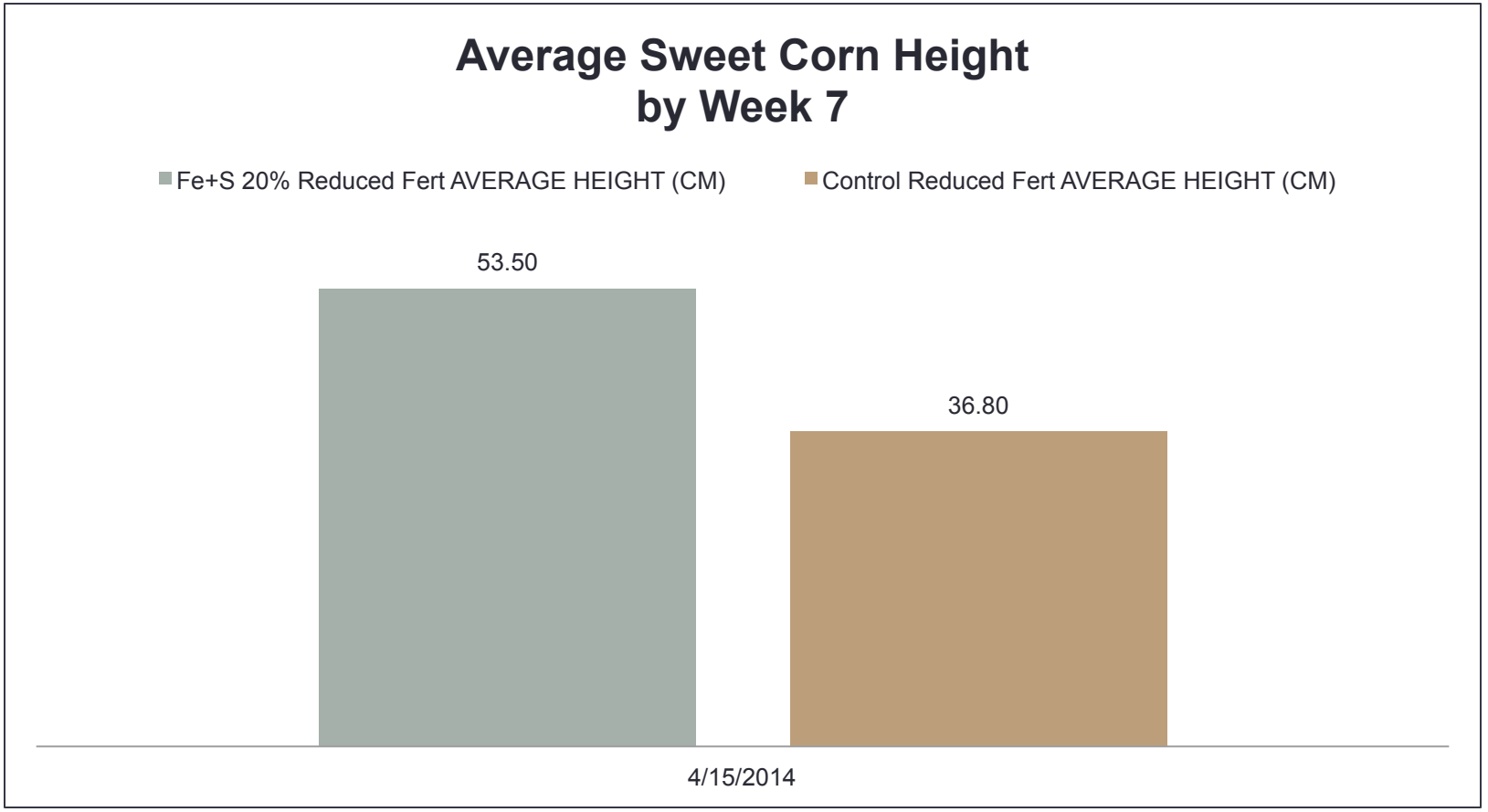
- Protein Level Comparison — Fish Growth

- Normal Feed 28%
- Yeast 40%
- Fly Larvae 45%

Yeast + Fly Larvae
= 22% increase in Catfish Weight

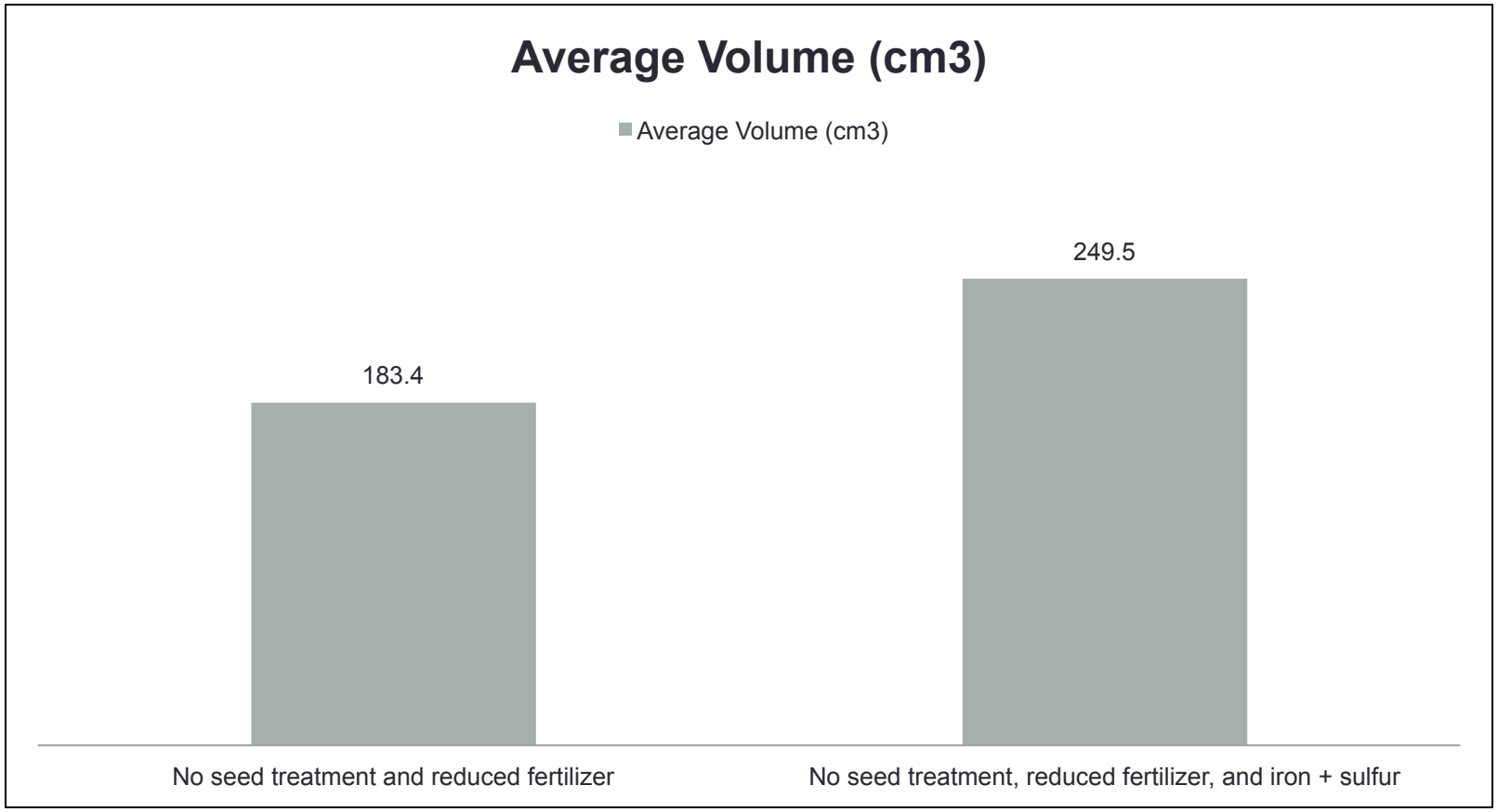
- Yeast and Fly Larvae are produced through nutrient recycling programs that have little to no production expenses.

Effects of Iron + Sulfur Addition on Sweet Corn Growth



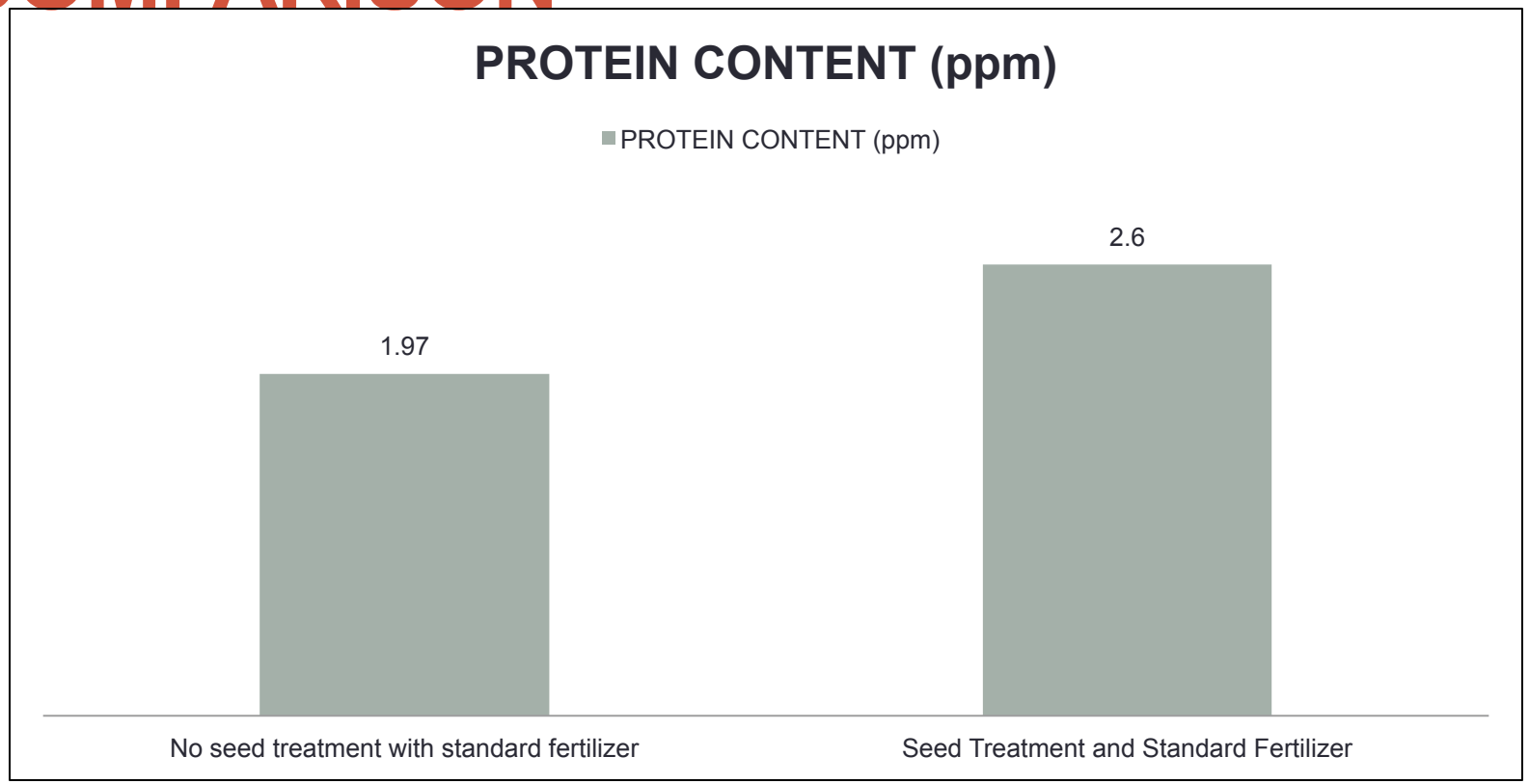
45% INCREASE IN HEIGHT

UNTREATED SEED SWEET CORN COB VOLUME COMPARISON



36% INCREASE IN VOLUME

PRETREATED & UNTREATED SEED SWEET CORN COB PROTEIN COMPARISON

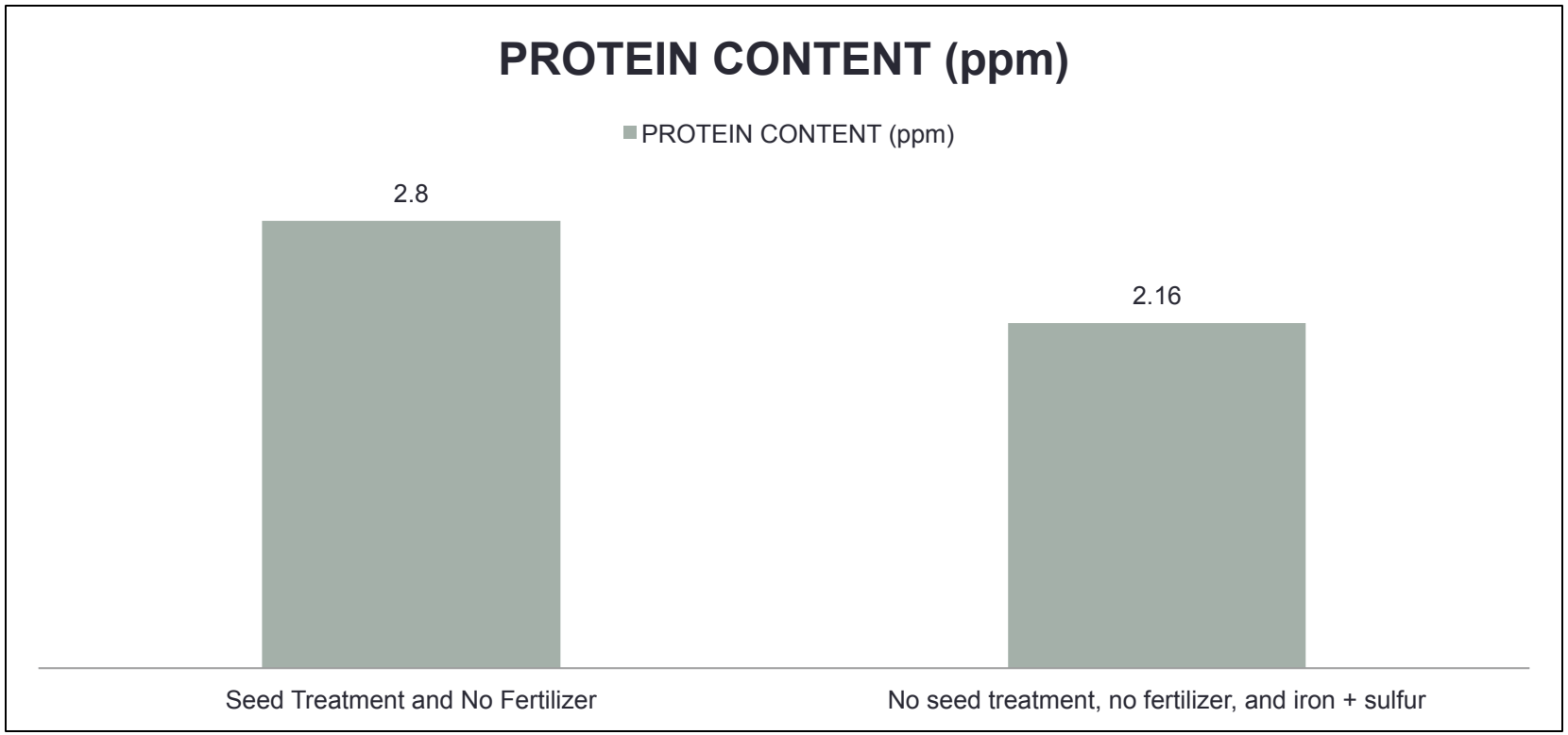


Independent evaluation by

N·PAL
N·P ANALYTICAL LABORATORIES

32% INCREASE IN PROTEIN CONTENT

SWEET CORN COB PROTEIN COMPARISON

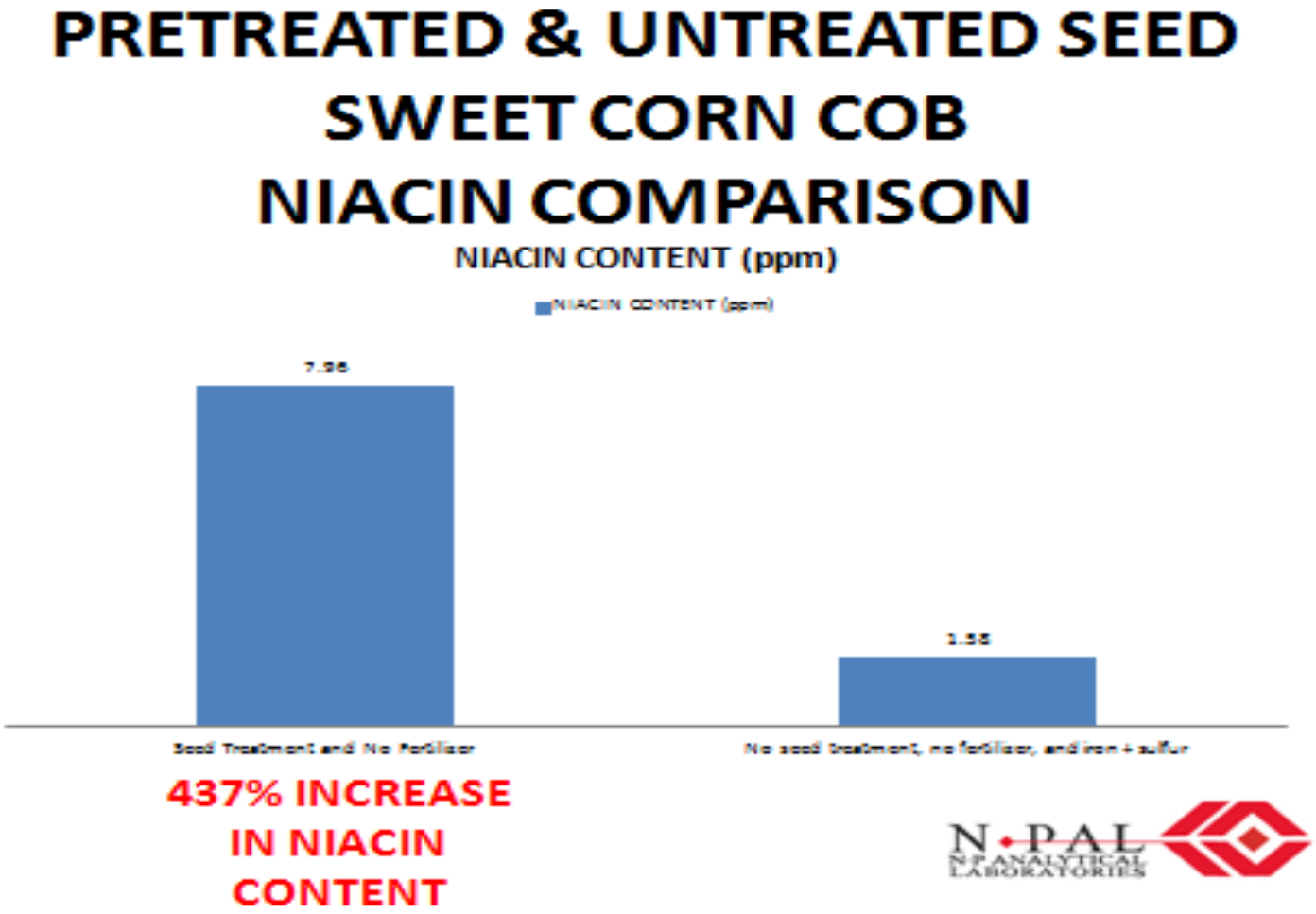


30% INCREASE IN PROTEIN CONTENT

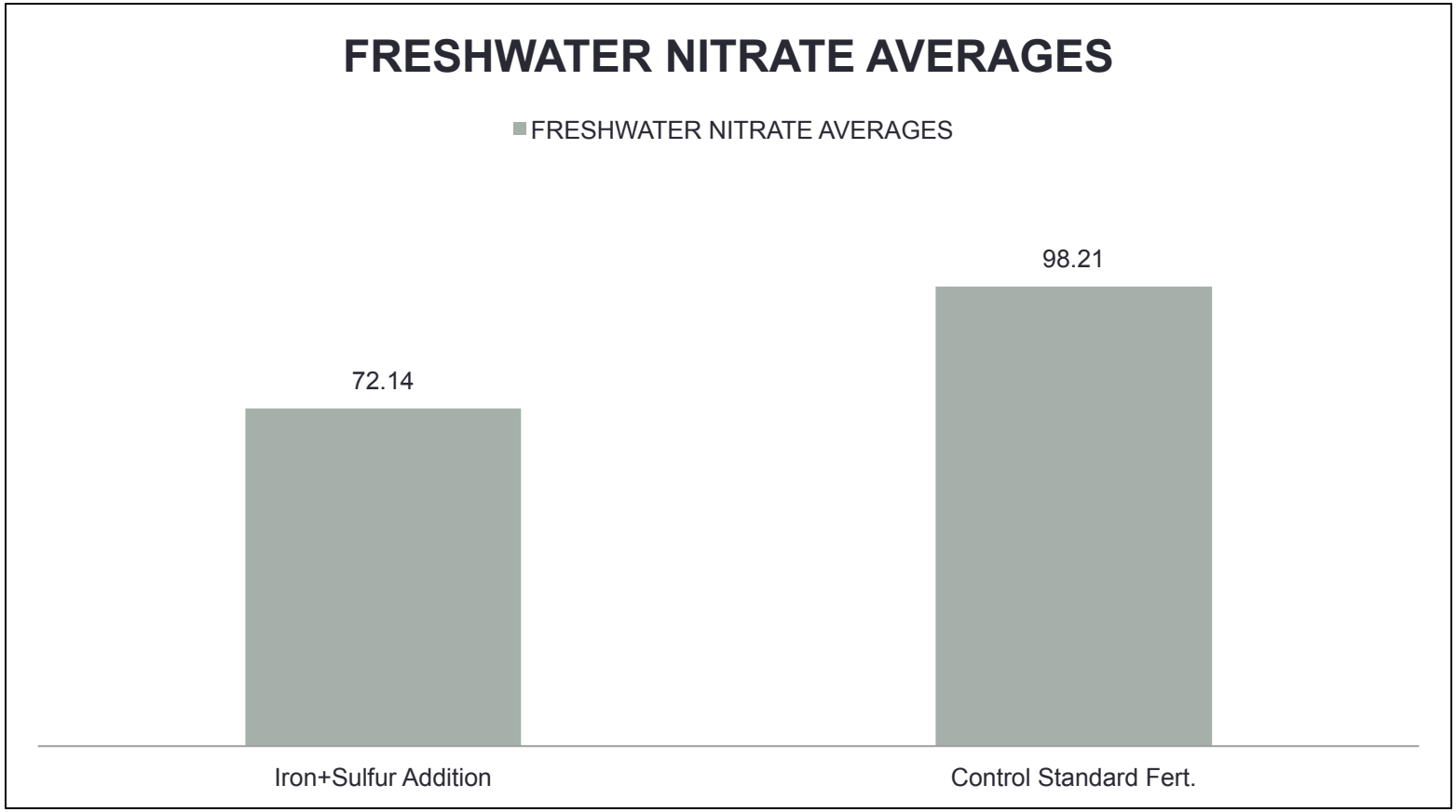
Independent evaluation by

N·PAL
N·P ANALYTICAL LABORATORIES

Improving Vitamin Content without Fertilizer

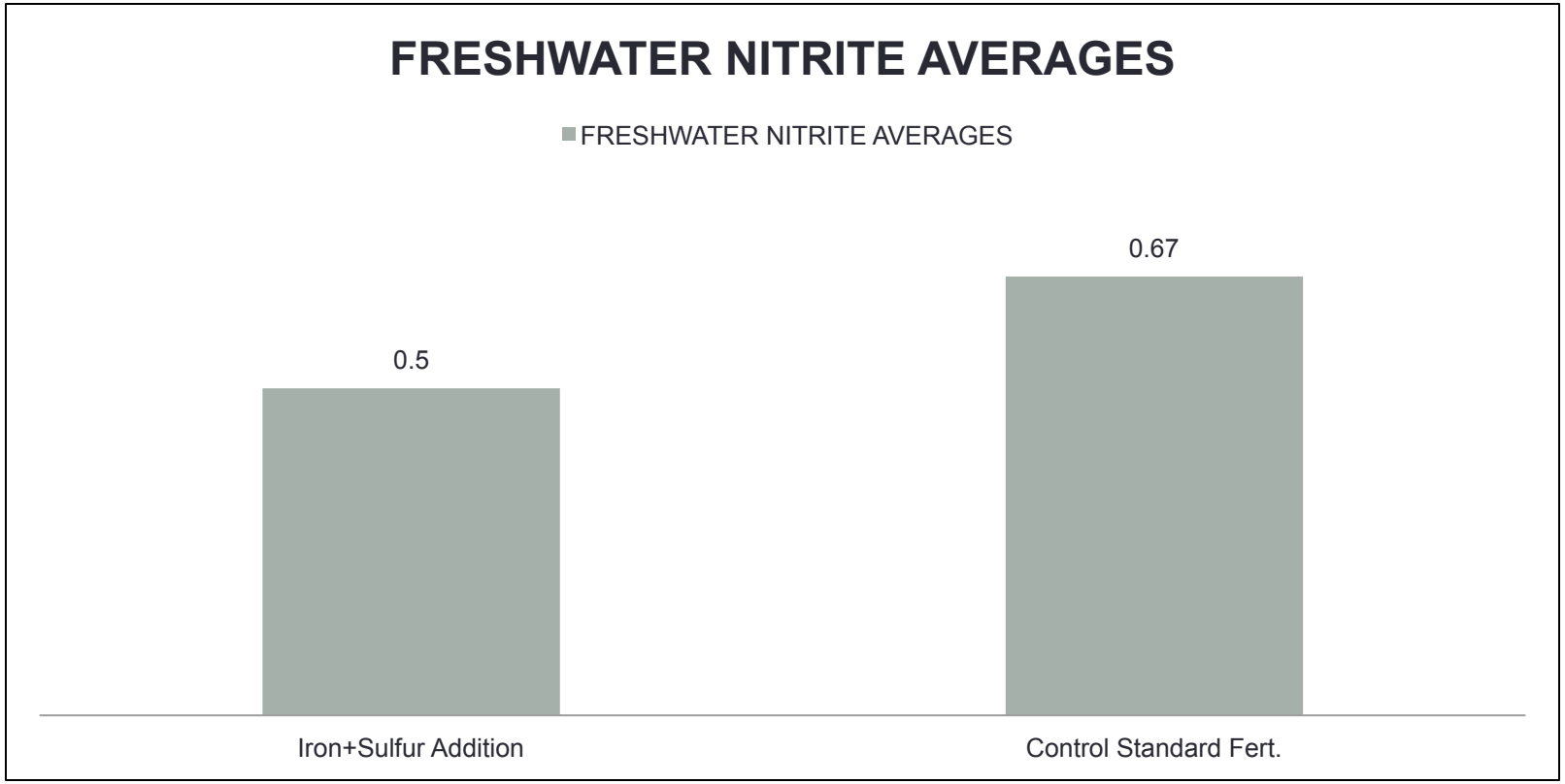


Downstream Effects From Fertilizer Use: Water Runoff Analyses- FRESHWATER



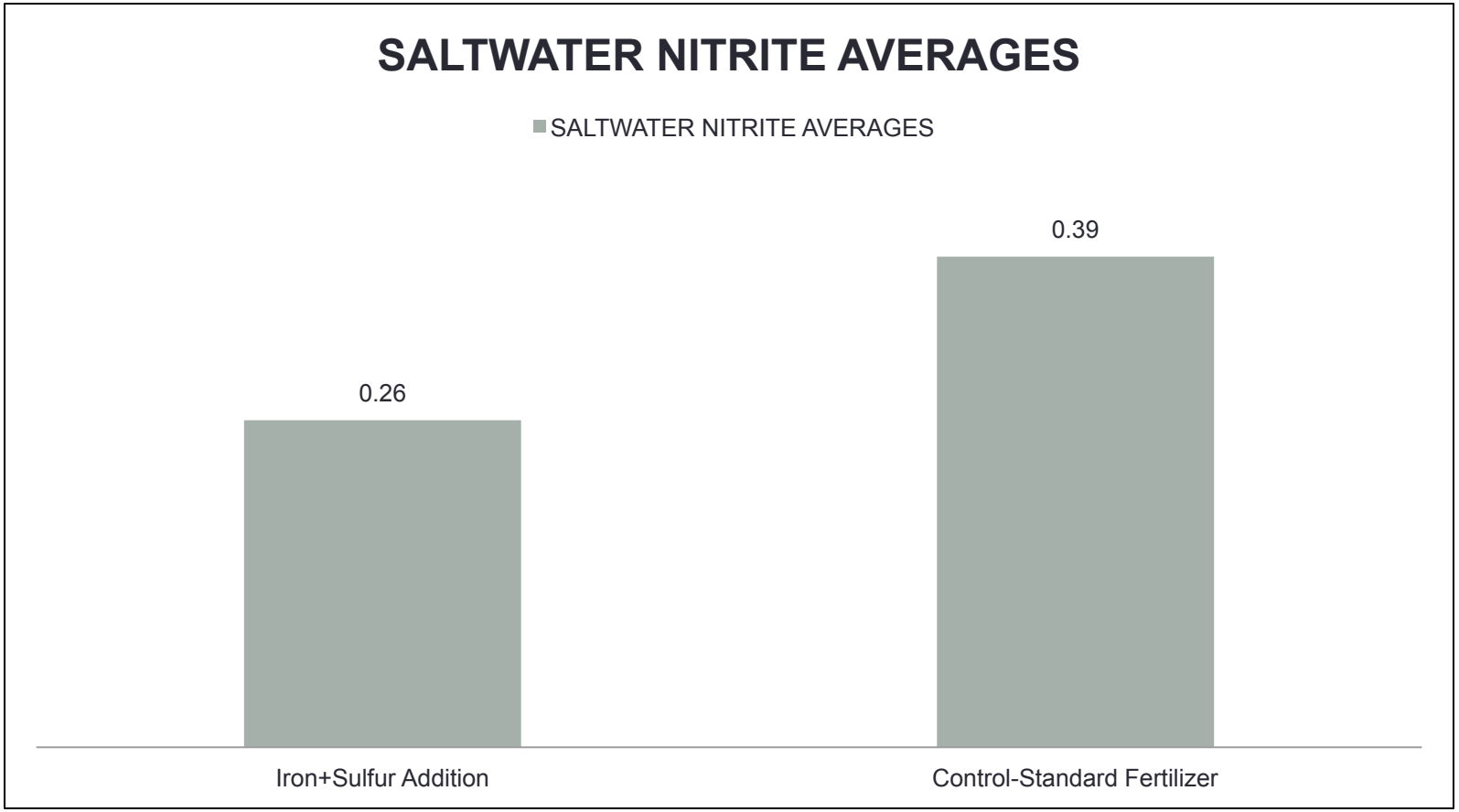
17% DECREASE IN NITRATE

WATER RUNOFF ANALYSIS – FRESHWATER



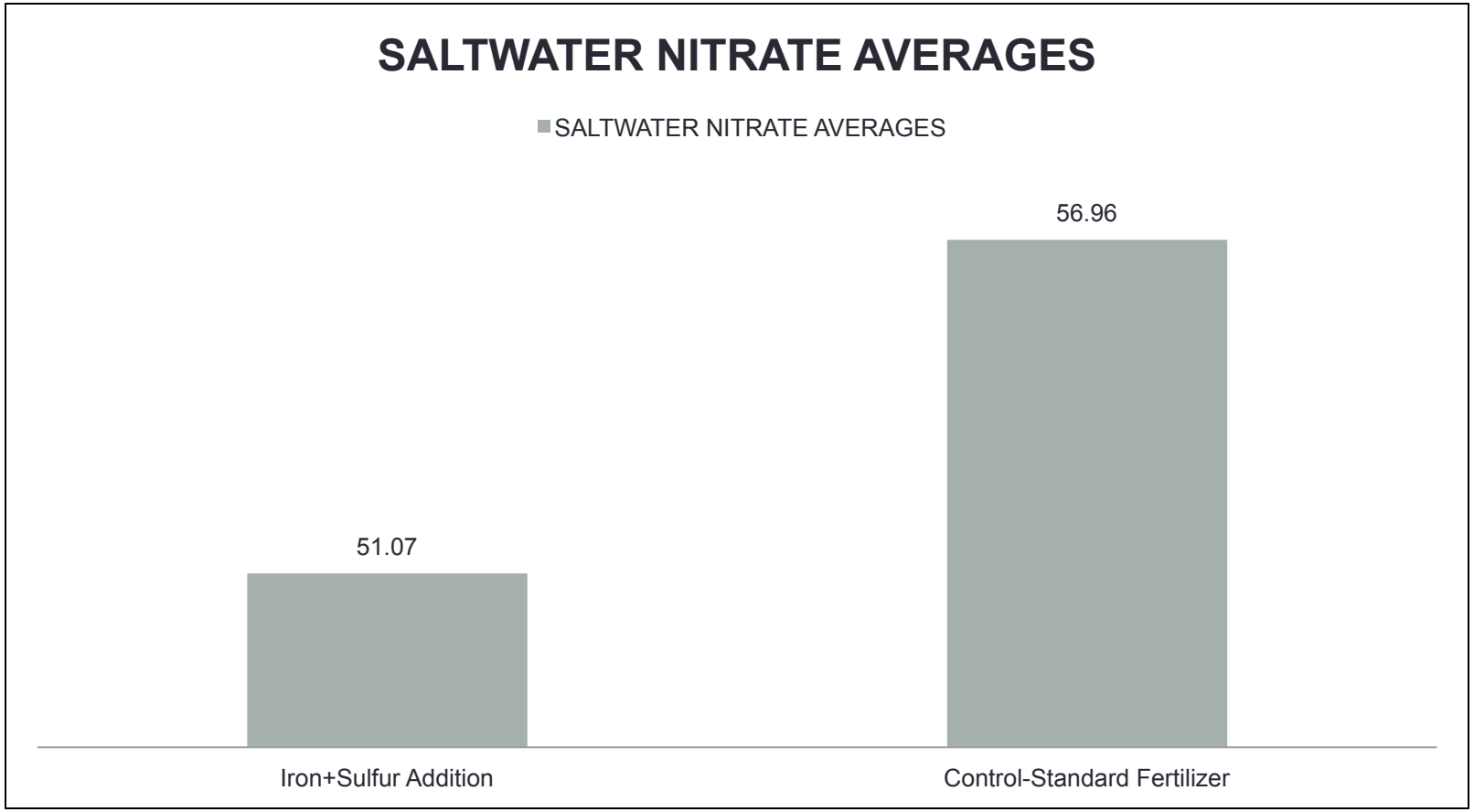
25% DECREASE IN NITRITE

WATER RUNOFF ANALYSIS – SALTWATER



33% DECREASE IN NITRITE

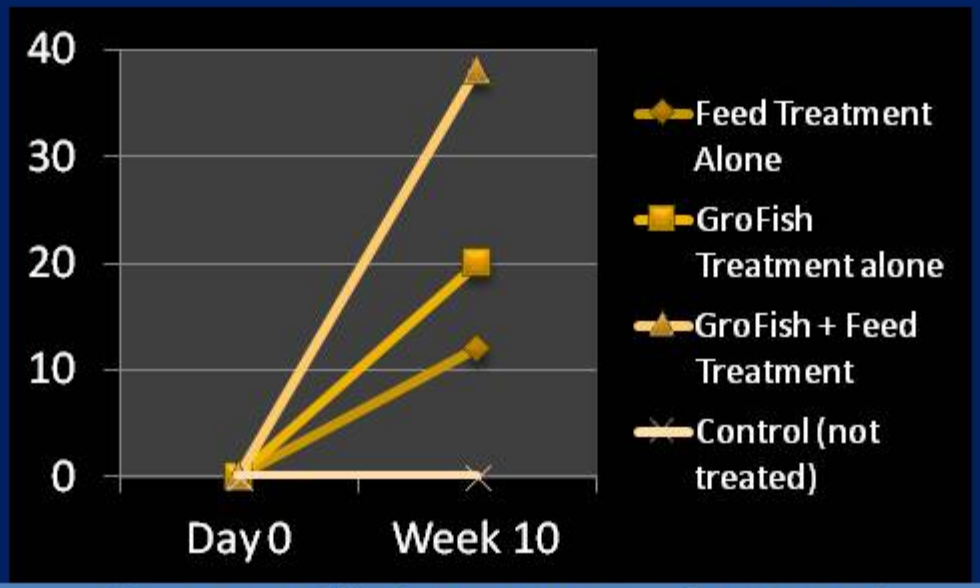
WATER RUNOFF ANALYSIS – SALTWATER



12% DECREASE IN NITRATE

GROFISH ™ Treatment & Feed Additive

Coho Salmon Smolt*
Growth Rate Graph

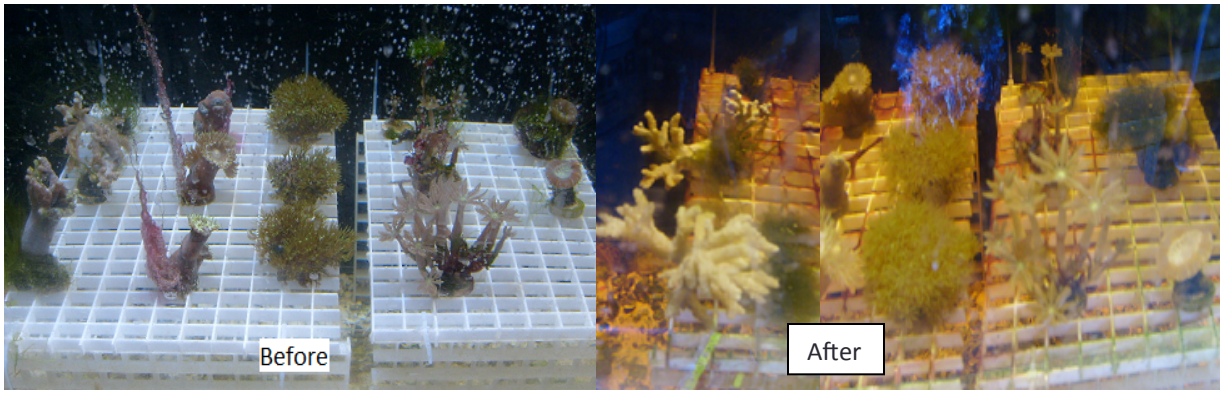


Percentage Size Larger Compared to Control

	Day 0	Week 10
Feed Treatment Alone	0	+12%
GroFish Treatment alone	0	+20%
GroFish + Feed Treatment	0	+38%
Control	0	+0%

*6,000 treated

Iron Significantly Enhances Coral Growth



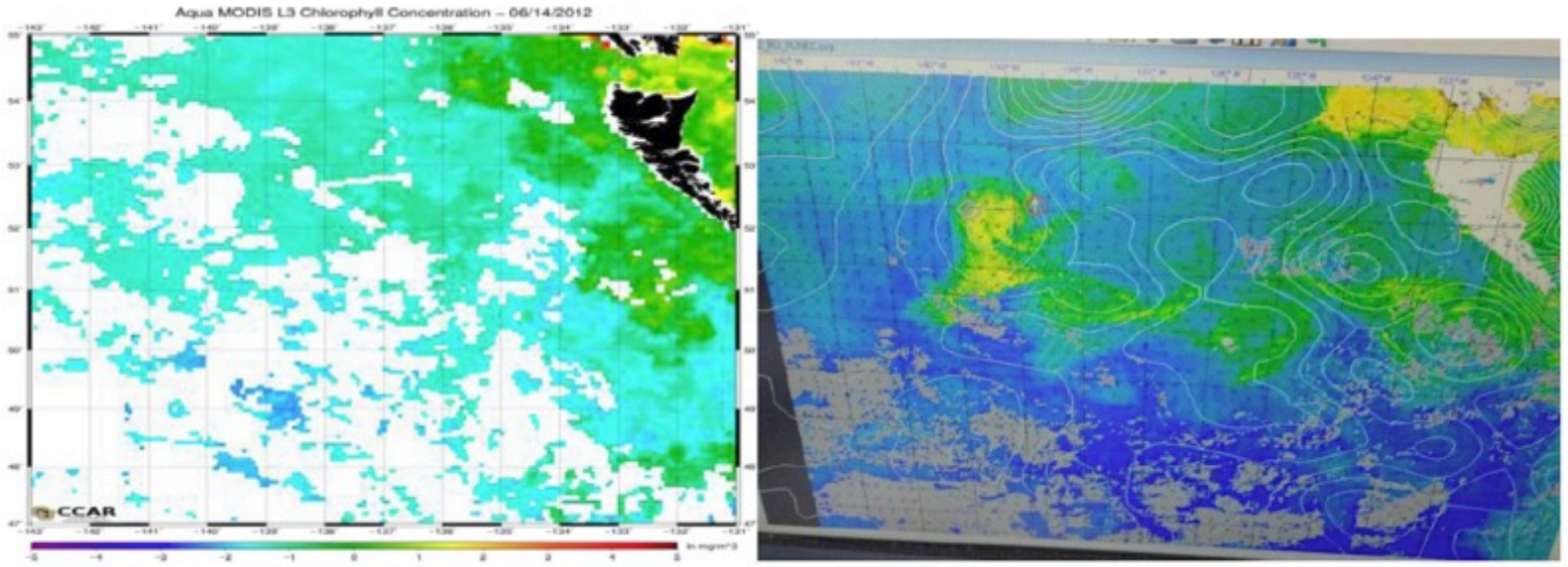
(2.0 g iron): Photo of all 5 species of corals on the first day (left) and last day (right) of the 3-week experimental period.

Coral Species	Change in peripheral living area (mm^2)	Percent change (%)		Change in number of polyps	Percent change (%)
Sinularia flexbilis	+262.5***	+52.5***		+56***	+114***
Duncanopsammia axifuga	+250***	+58***			
Green Briarium	+75	+10.3			
Clavaria sp.	+256.25***	+33.6***		+7***	+41.2***

* significant at $p < .05$; ** very significant at $p < .01$; *** extremely significant at $p < .001$.

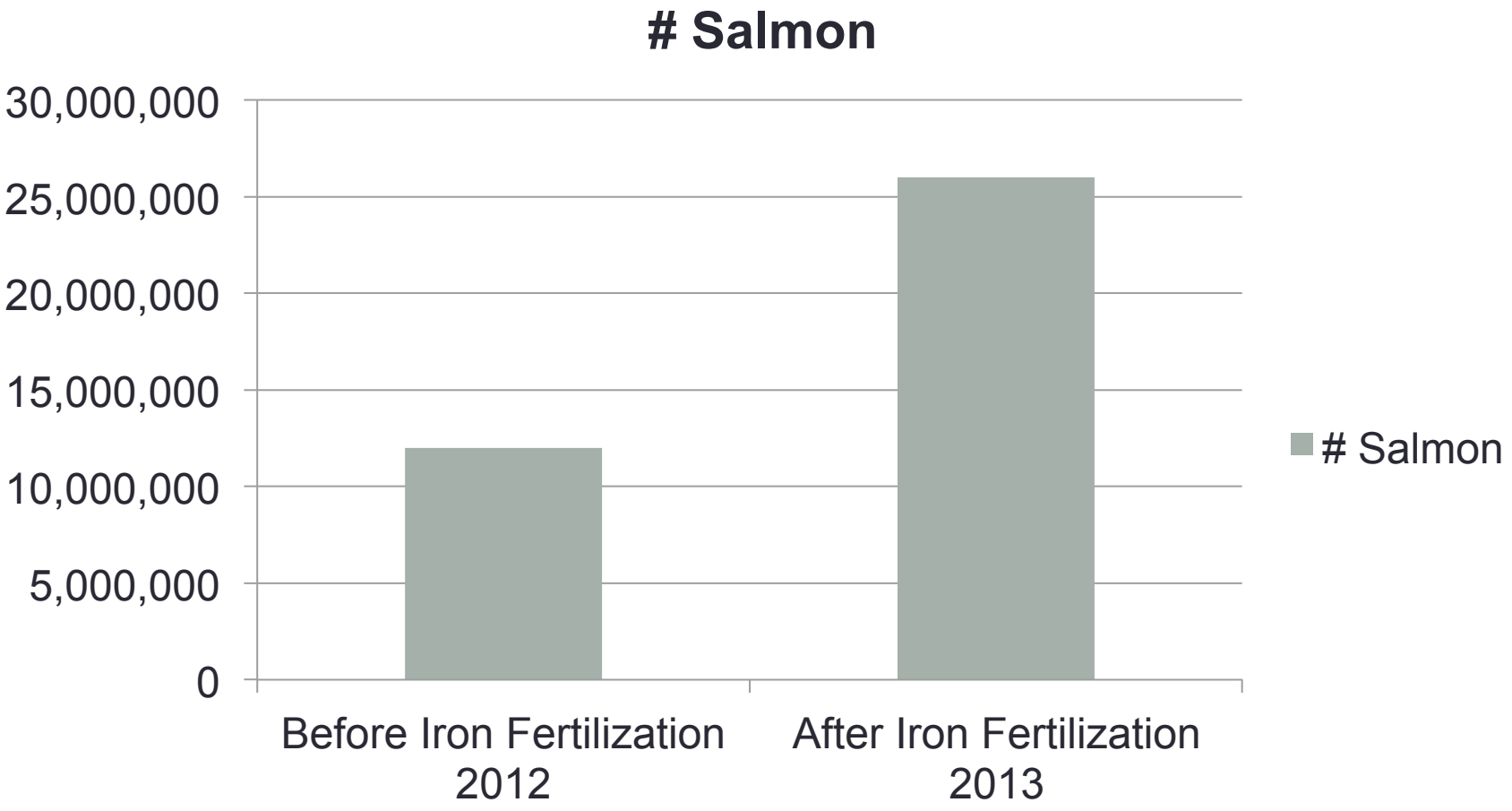
Iron Fertilization

- Our research has shown iron promotes phytoplankton growth, increases coral metabolism, improves fisheries production and removes excess carbon dioxide through sequestration in the ocean.

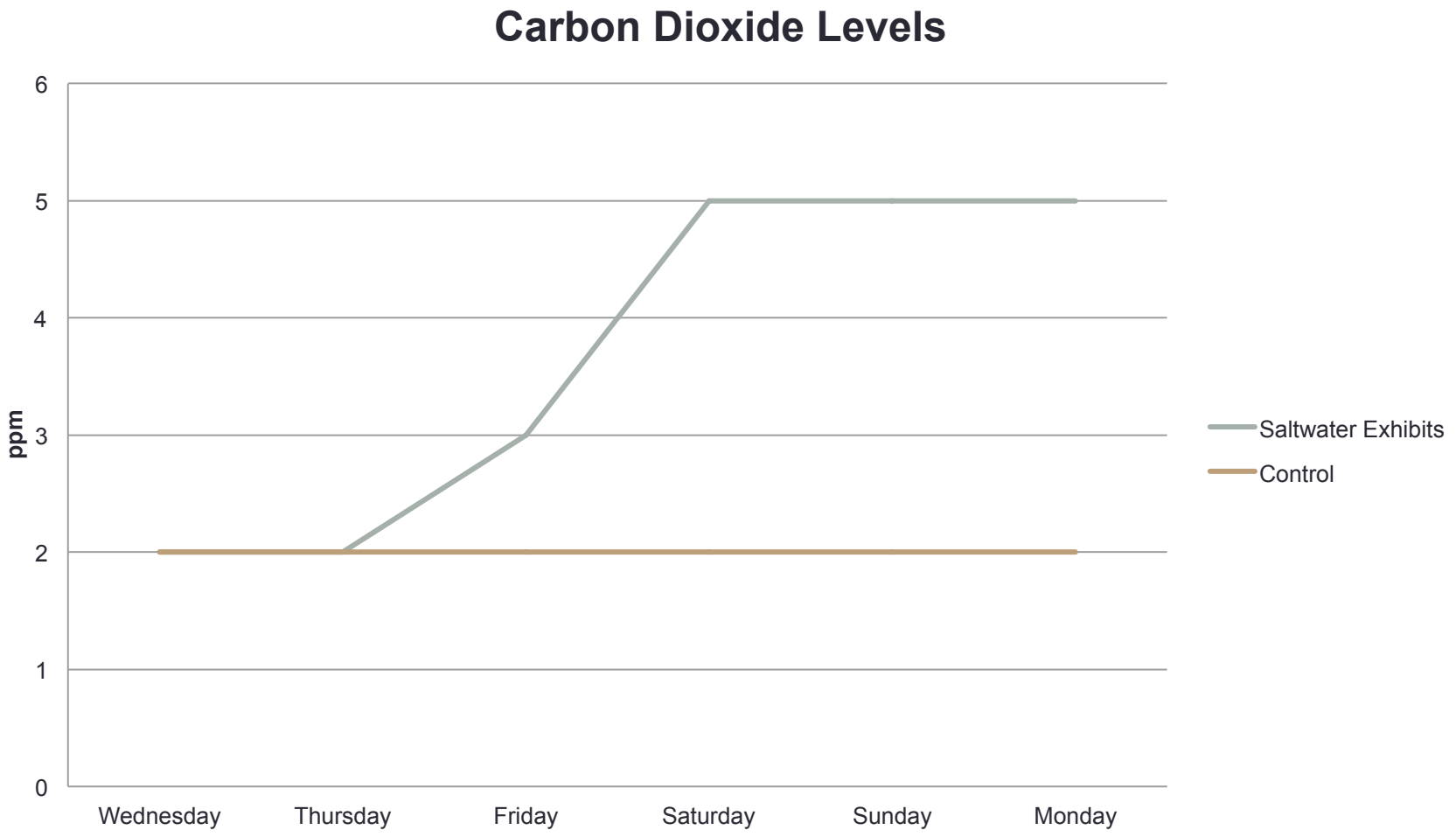


Before and after ocean restoration plankton bloom 200+ miles west of Haida Gwaii.

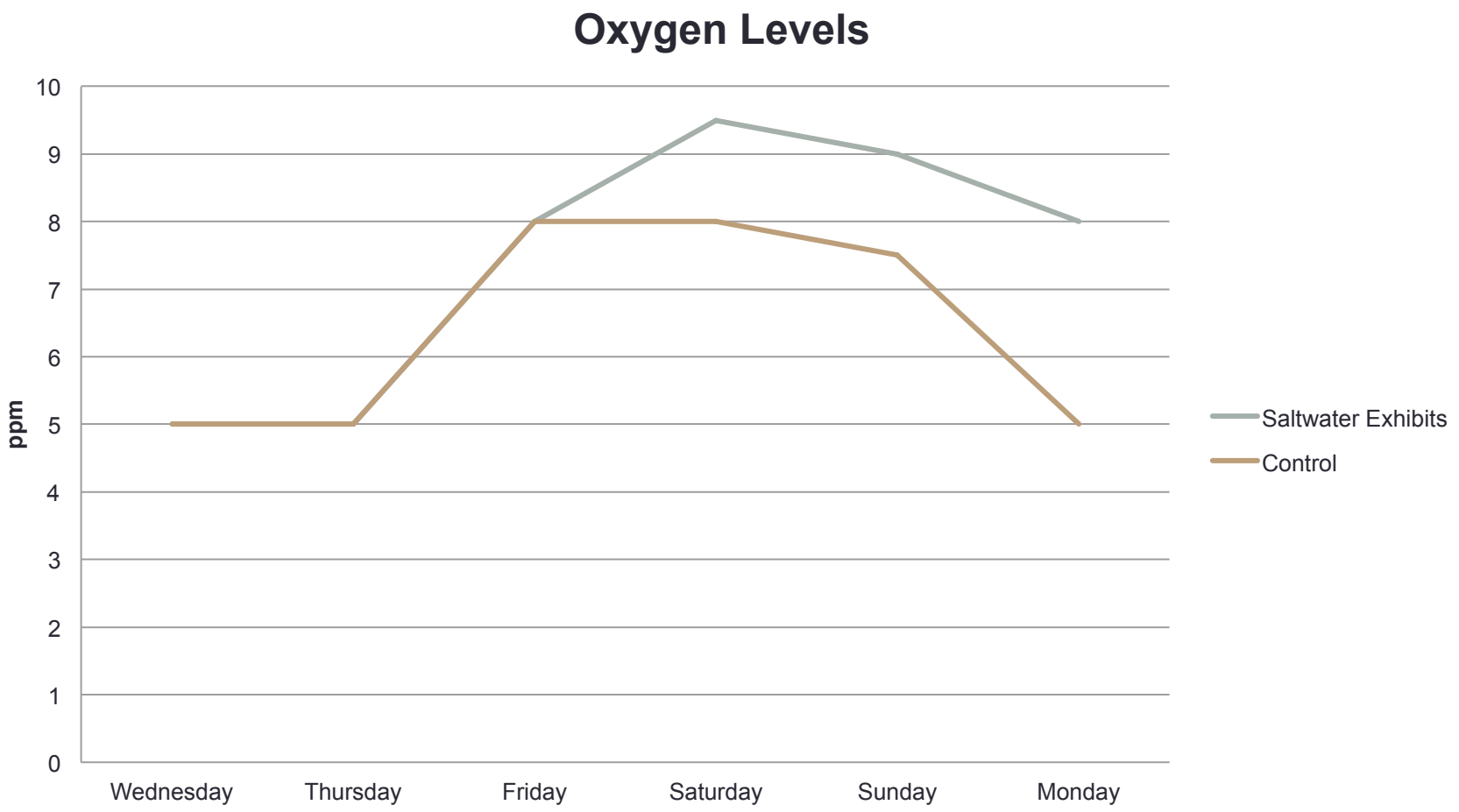
Iron Fertilization Results
Fraser River, Canada



Iron Fertilization Effects Upon Carbon Dioxide Levels



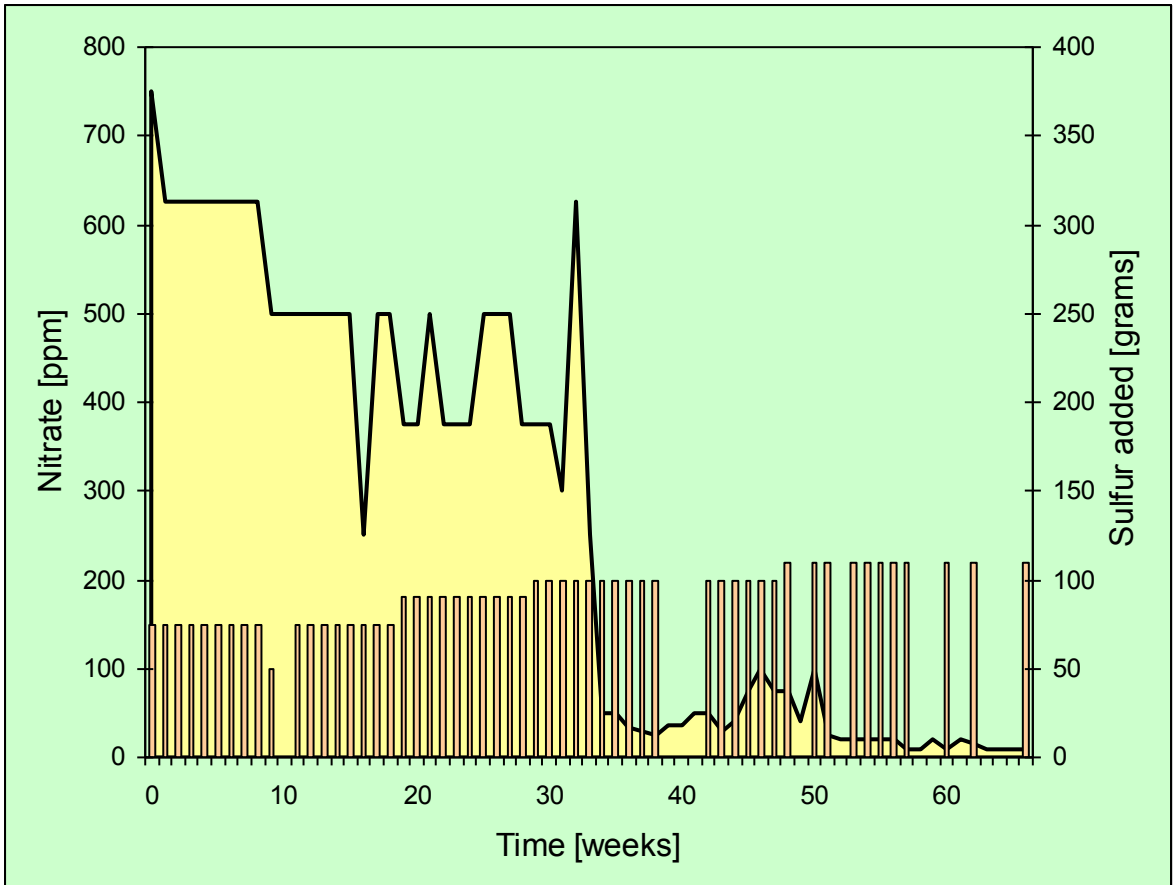
Iron Fertilization Effects Upon Oxygen Levels



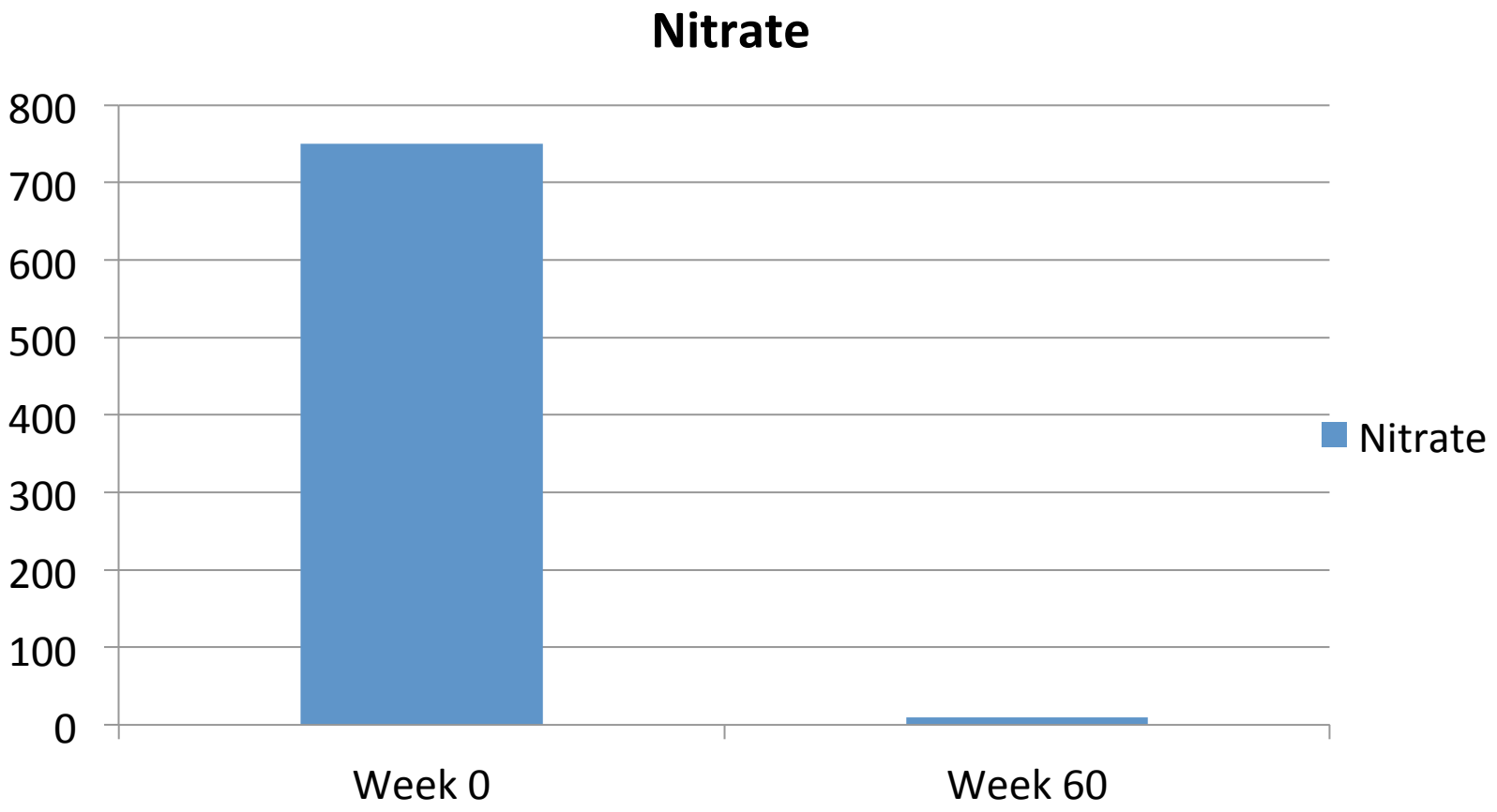
160% Increase

Sulfur Enrichment

As a result of our research, we have learned that sulfur facilitates the “denitrification” process – when added in very small quantities. When adequate time is allowed in the ecosystem, the chemical reactions resulting from the sulfur introductions proceed in a balanced and predictable manner such that sulfur oxidizes to sulfate ion, and the nitrate is reduced to nitrogen, in both dissolved and gaseous forms. 10,000 gallon ecosystem

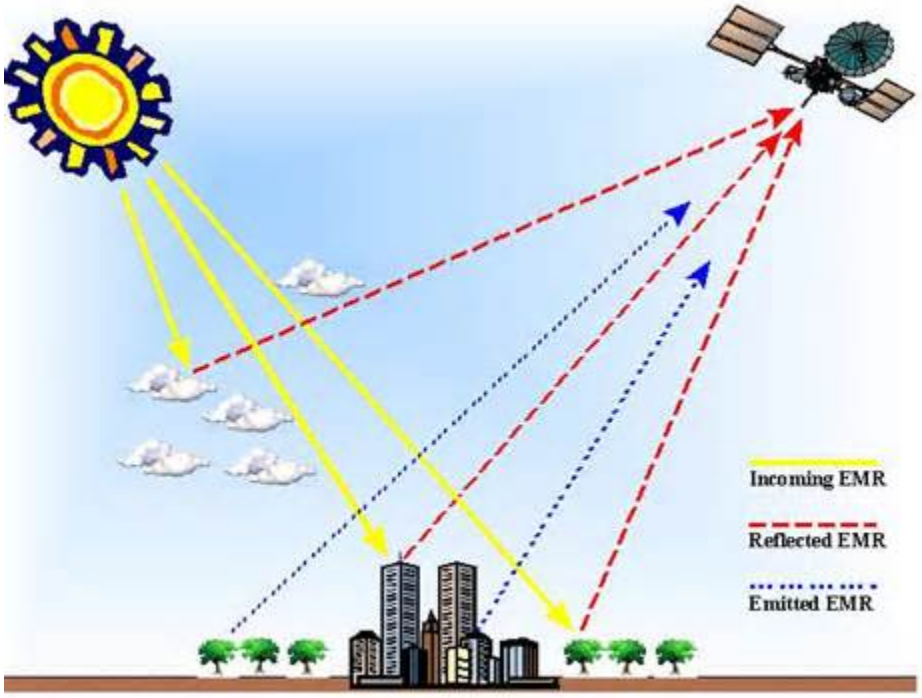


Sulfur Enrichment Results in 10,000 gallon closed ecosystem



Nitrates decreased by 99%

We are currently developing a method to track the flow of nutrients through the soils following the path of the hydrologic cycles on land and also monitor the relative crop and fisheries productivity through using GIS for soil analysis relative to nitrogen flow.



- Energizing local groups toward sustainable solutions by incorporating messaging platforms through non-biased religious affiliations.

- It is clear that the tradition of soil / land being a gift from God to the African people's transcends a particular religion and is widely held that why people are so protective of their land. This strong association with the reverence of the land in terms of protection, preservation and its inextricable relation to food security is a good handhold for future localized efforts that can be strengthened by religious ties to the community from a sustainability and instructional/educational standpoint.

- **Microfinancing Partner: MicrofinancingAfrica.org**

Engaging collateral community support

- Community surveys in several African countries have shown a need for creating a platform for local agricultural systems tied to these ecosystem based analytics not only to improve the productivity, but also being conscious of the potential downstream effects we are eager to get others involved to create a larger landscape for this research in order to improve food security as well as improve ecosystem productivity and sustainability by connecting local activities for productive solutions using innovative solutions.

Key Points

- Overall objective is to understand current issues
- with agricultural, aquacultural, ecosystem health i.e. Water, soil, forest and
- other ecosystem productive parameters and develop methodologies to improve
- productivity, nutritional quality and decrease pollution towards sustainability
- and provide resilience to climate change, previous unsustainable utilizations,
- and other local emergent and chronic issues as identified by initial community analyses.

Using multistakeholder survey methods

- Find out:
- 1. what they farm
- 2. Comments about farm production, e.g. Crop size,
- growth, problems, etc.
- 3. How they farm:
- a. with or without fertilizer,
- b.
- by hand,
- c. number of seeds per row,
- d. how many rows,
- e. what kind of
- seed,
- f. history of crop production,
- g. size and weights of products
- produced,
- h. is flavor a factor in what is produced?
- 4. Take photos of
- individual farmers for identification purposes with the plan to give them
- membership cards.
- 5. Take photos of the group as a whole and any farm photos
- could also be helpful.
- 6. Any other questions that you can think that will be
- helpful for survey purposes should be asked and recorded.

THANK YOU.

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