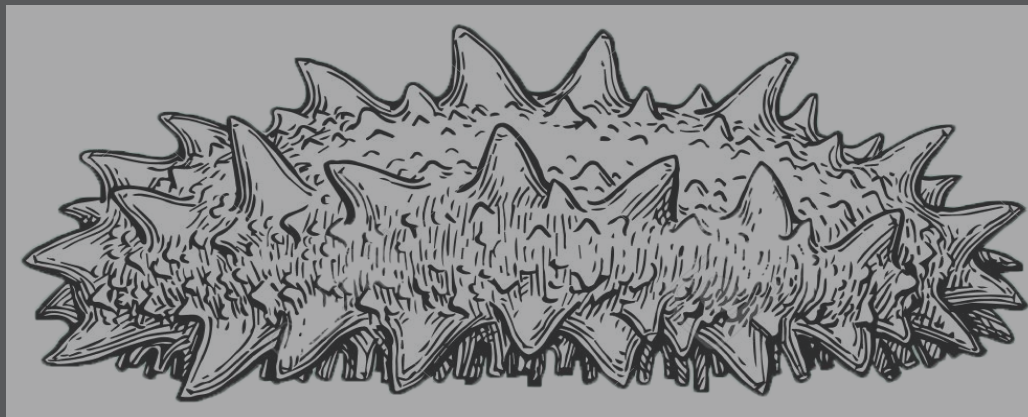




IMPACT OVERVIEW



Profitable Restoration of Caribbean Fisheries

How do subsistence fishers restore their own depleted Caribbean fisheries? By raising millions of native, regenerative, nutrient recyclers with high market value – sea cucumbers.

Sea cucumber cultivation provides an ideal opportunity for Caribbean coastal fishing communities to sustainably transition out of poverty. The work builds upon fishers' existing knowledge and produces a high-value product while restoring the marine ecosystem. Production of sea cucumbers is, by far, the most economically productive aquaculture endeavor in the world and, crucially, the process is environmentally regenerative rather than destructive. The economic opportunities and ecological restoration impacts that sea cucumber ranches along the Caribbean Coast would provide for coastal communities are potentially transformational and Panama is the ideal place to start.

Aquaculture production of sea cucumbers, as opposed to wild harvesting, involves breeding and farming them in a controlled area. The use of coastal ocean waters for raising sea cucumbers from juveniles to adulthood is known as sea ranching.

The first
commercial sea
cucumber hatchery
in the western
hemisphere



A 2016 study of Panama's economy conducted by Harvard's Center for International Development identified fishing as the top-ranked activity for industrial diversification in Colón Province – the ideal location for PanaSea's aquaculture facility.¹

Coasts in Peril

Though the oceans are Earth's largest ecosystem, covering more than two-thirds of the planet's surface and hosting 80% of its biodiversity¹, more than 99% of that area is sparsely populated with life—on par with tundras and deserts on land.²

Rather, marine life is concentrated along coastlines, especially in coral reefs and algae beds, roughly 0.1% of the planet's surface.³ Coastal ecosystems are some of the most productive on Earth. They provide us with essential ecosystem services, such as coastal protection from storms and nursery grounds for fish.

Compared to the biologically unproductive open ocean, coral reefs can sustainably produce 5-15 tons of fish, crustaceans, mollusks, and other invertebrates per square kilometer per year.⁴ Today, the majority of Earth's substantially-sized coral reefs are 5,000 to 10,000 years old.⁵ To sustain this long-term growth, coral reefs must accumulate calcium carbonate faster than erosion wears them down.⁶



Ocean Acidification

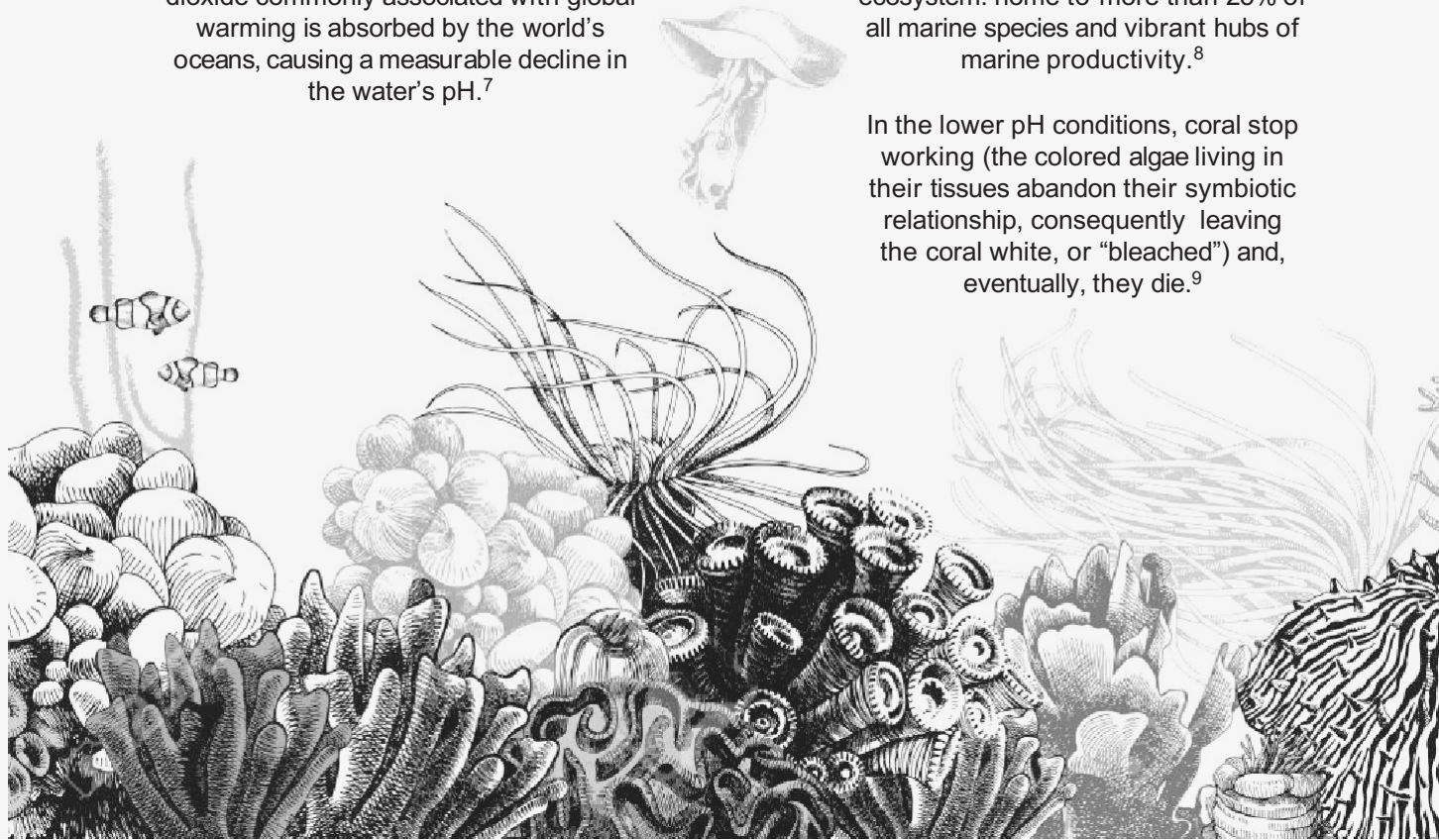
A quarter of the atmospheric carbon dioxide commonly associated with global warming is absorbed by the world's oceans, causing a measurable decline in the water's pH.⁷



Coral Reef Decline

Coral reefs are the "cities" of the marine ecosystem: home to more than 25% of all marine species and vibrant hubs of marine productivity.⁸

In the lower pH conditions, coral stop working (the colored algae living in their tissues abandon their symbiotic relationship, consequently leaving the coral white, or "bleached") and, eventually, they die.⁹





Fisheries Depletion

Fishery declines happen when species are taken from the sea faster than they can replace themselves. Growing demand, poor fishery management, and declining ecosystem health each play a role.

Today, nearly 90% of the world's marine fish stocks are fully exploited, overexploited or depleted.¹



Sea Cucumber Decimation

As the “earthworms of the sea”, they are essential nutrient recyclers that release calcium carbonate needed for coral growth into the sea water and increase the water's pH, counteracting acidification.²

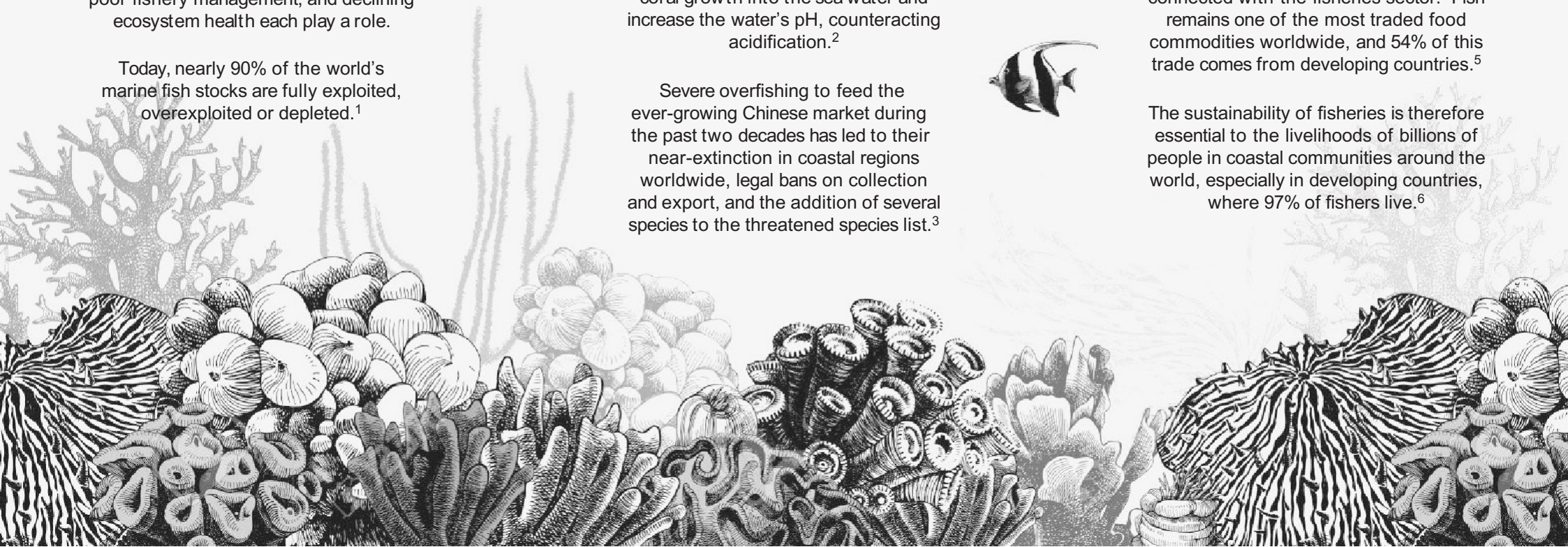
Severe overfishing to feed the ever-growing Chinese market during the past two decades has led to their near-extinction in coastal regions worldwide, legal bans on collection and export, and the addition of several species to the threatened species list.³



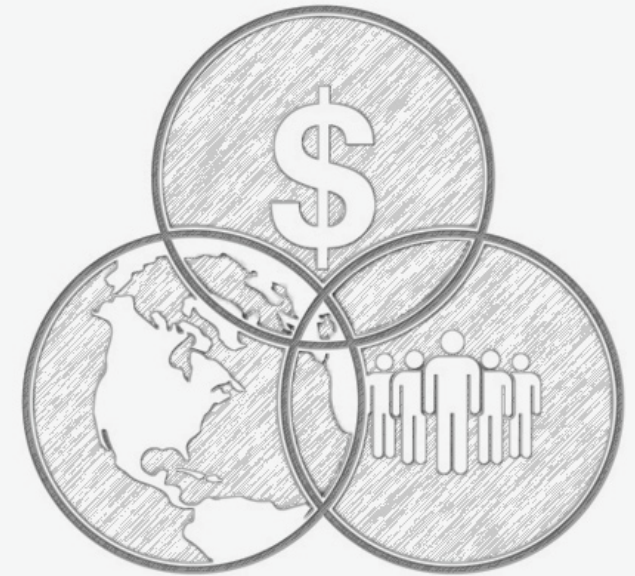
Grim Economic Prospects

Nearly 60 million people work in fisheries and aquaculture, and an estimated 200 million jobs are directly or indirectly connected with the fisheries sector.⁴ Fish remains one of the most traded food commodities worldwide, and 54% of this trade comes from developing countries.⁵

The sustainability of fisheries is therefore essential to the livelihoods of billions of people in coastal communities around the world, especially in developing countries, where 97% of fishers live.⁶



A Triple Bottom Line Opportunity



Planet

Restore depleted fisheries

People

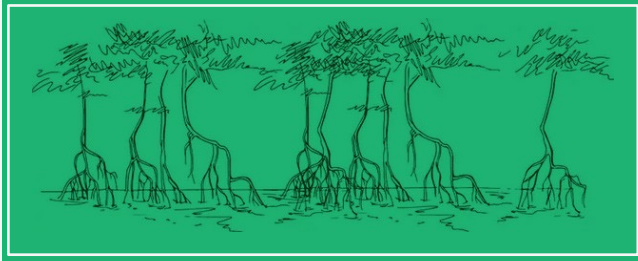
Cash crop for communities

Profit

Highest ROI in aquaculture

Despite Panama's economic boom since the country regained sovereignty of the Panama Canal in 2000, career opportunities for Panama's workforce remain largely unchanged, having simply traded subsistence fishing and farming for unskilled construction work in Panama City.⁴ Numerous studies have been conducted to identify the optimal paths for transitioning the fading construction growth boom into sustainable economic growth by promoting more complex economic activities.⁵ These studies confirm that a diversified economy is a strong economy and that diversification is achieved through building upon the capabilities already possessed by the population.⁶ Fishing has been identified by Harvard University's Center for International Development as the top-ranked activity for industrial diversification in Colón Province – the ideal location for PanaSea's aquaculture facility.⁷

Sea cucumbers are a delicacy in many parts of Asia, commanding surprisingly high market prices. Ever-increasing demand, fueled primarily by an expanding Chinese middle class, has led to severe overfishing of natural sea cucumber populations worldwide. Consequently, most countries have banned their collection and export. With increasing demand and decreasing supply, prices continue to rise and the transition to aquaculture farming of sea cucumbers, rather than wild-harvest fishing, becomes inevitable. Specifically, sea ranching —using coastal ocean areas to grow lab-produced juveniles into market-ready adults —allows for widespread cultivation along coastlines, minimizing crop threats like disease, maximizing environmental benefits, and diversifying work opportunities for coastal communities.



Environmental

Sea Cucumbers are **essential nutrient recyclers**, like earthworms are on land.¹

Their digestive processes increase the water's pH which **counteracts ocean acidification**.²

They **help buffer coastal ecosystems** from the impacts of global warming.³

They free up calcium carbonate into the seawater to **provide coral with what they need to grow**.⁴

They **prevent disruptive algal blooms** by breaking down organic matter.⁵

They maintain healthy seagrass beds that serve to **sequester vast quantities of carbon**.⁶

Unlike other food products, producing them **requires no precious fresh water**.

Unlike other meat products, growing them **requires no external food source**.



Social

Raising sea cucumbers is a work opportunity **equally accessible to men and women**.

It provides an employment opportunity in underdeveloped, **sparsely populated areas**.

The work **builds upon the existing knowledge** base of coastal fishing communities.

Seasonal reseedling with juveniles ensures **sustainable, year-round work** opportunities.

The low educational barrier to entry provides a **career opportunity for unskilled laborers**.

Farming sea cucumbers is **a lucrative alternative** to the diminishing trade of wild-harvest fishing.

Successfully engaging in aquaculture mandates an **increase in fishery management skills**.

As a burgeoning industry, there are countless **opportunities for academic collaboration**.



Economic

\$10 billion market worldwide for sea cucumbers with steady growth for the past four decades.⁷

Sharp decreases in available natural supply creates an **increasing need for aquaculture**.⁸

At more than \$180 per kilogram wholesale, they are **the highest value aquaculture crop**.⁹

After start-up costs are repayed, a commercial operation provides a **5:1 return on investment**.

Worldwide, no one else is commercially producing **desirable Caribbean-specific species**.

Start-up costs are low for sea cucumber aquaculture compared to fin-fish aquaculture.

Overfishing has resulted in widespread legal bans, creating a **high regulatory barrier to entry**.

Provides an opportunity to create much-needed **economic diversification** in Panama.¹⁰

The only sustainable sea cucumber fishing operations in the world are those which utilize aquaculture. These facilities are located primarily in China, Japan, Korea, and Taiwan. The key to their success lies in aquaculture. Aquaculture has progressed at such a pace in China that annual aquaculture production surpasses yields from capture fisheries. Localized pollution, however, has reduced the availability of additional farming areas throughout China. Consequently, supply levels of local sea cucumbers in the East Asian and Indo-Pacific islands has reached a critical stage and has reduced consumer confidence, driving the need to find foreign sources of supply from pristine environments like Panama's Caribbean coast.

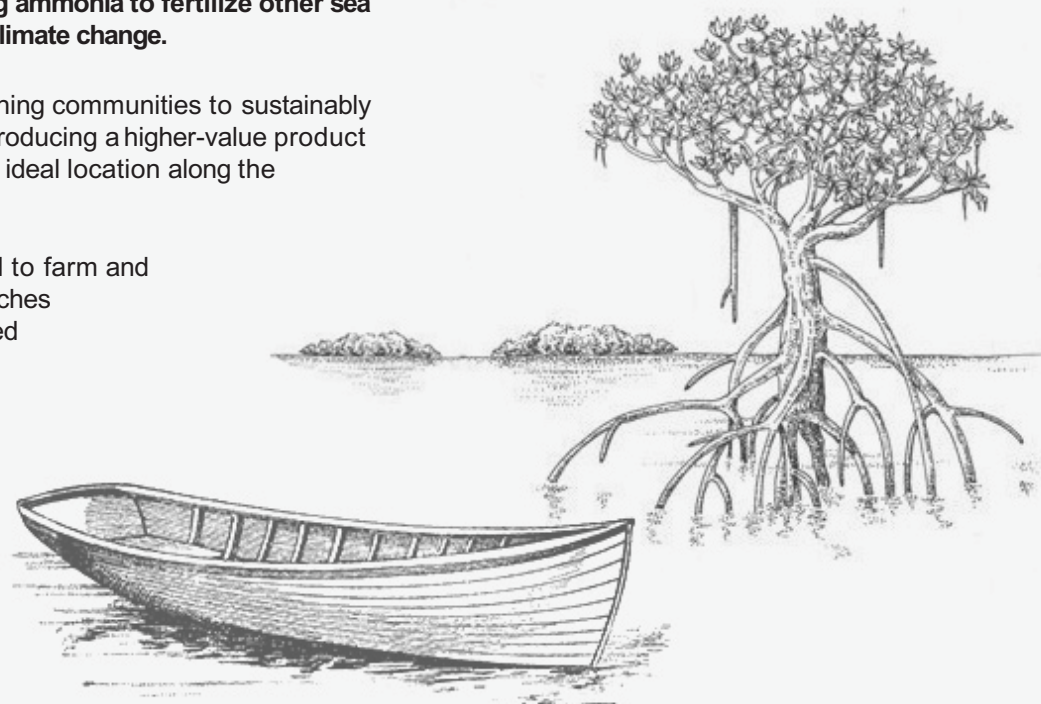
Our Sea Ranches are Far-reaching

Sea ranching—using coastal ocean for the grow-out area—allows for the cultivation of sea cucumbers as valuable food product while simultaneously improving the marine habitat by cleaning the sea floor of surplus organic detritus, preventing and consuming unhealthy algae blooms, distributing ammonia to fertilize other sea life and the calcium essential for coral, and combating the acidifying effects of climate change.

Sea cucumber cultivation provides an ideal opportunity for Caribbean coastal fishing communities to sustainably transition out of poverty by adding to workers' existing fishing knowledge and producing a higher-value product while restoring the marine ecosystem. And, the Colón Province of Panama is the ideal location along the Caribbean coast for initial development of sea cucumber aquaculture cultivation.

Essentially sedentary and self-sufficient, sea cucumbers are very straight-forward to farm and harvest, particularly in shallow water. The juveniles will be distributed to sea ranches throughout PanaSea's government concession areas where they will be maintained by local fishing cooperatives, entrepreneurial individuals or, where neither of those options are available, PanaSea's employees. After 18 months they will be ready for harvest and processing.

Our processing will use proprietary technology to produce the highest quality dried sea cucumber product for the Chinese market. Once they are dried and shelf stable, they are vacuum-sealed, boxed, and sent to our buyers in China. Panama recently signed a Bilateral Trade Agreement with China that permits product to be exported directly to mainland China.





In Linton Bay, we have the opportunity to occupy the same hatchery complex previously utilized by Open Blue, now the world's largest open ocean fish farm. Moreover, Linton Bay, and the neighboring village of Puerto Lindo, represent a perfect model of the challenges we seek to overcome—sea cucumbers were overfished seven years ago and the fishery has since collapsed.

Areas suitable for sea ranching run along the entire Caribbean coastline of Panama and, in some areas, extend out into water for many miles. Just a decade ago, these areas contained healthy populations of sea cucumbers, but they were subjected to drastic overfishing until the government banned all collection and export. PanaSea has worked with the government to secure a special permit for aquaculture production and harvest of sea cucumbers in Panamanian waters.

Our journey begins in the 100 hectares of Linton Bay, but it will soon expand into the boundless hectares of Panama's Caribbean coast. Looking further into the future, PanaSea's will seek out opportunities to expand into the rest of Caribbean Central America, where native sea cucumber populations have been similarly overfished.

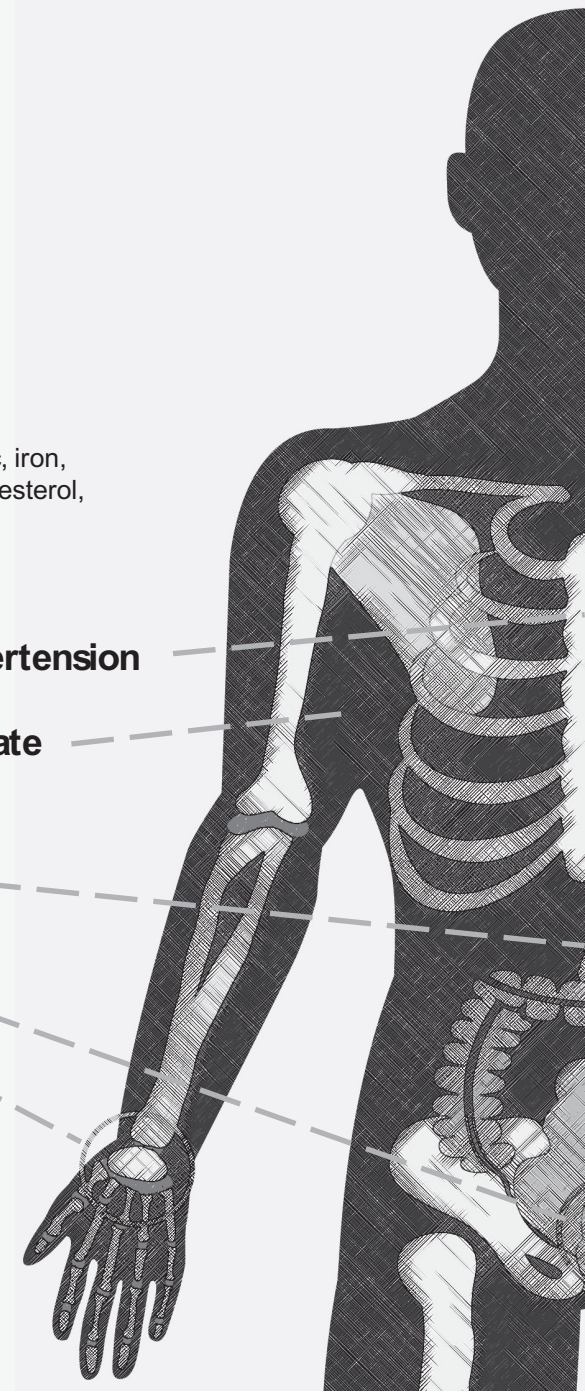
A Single, Centralized Hatchery Provides Widespread Sea Ranching Opportunities

Human Health Remedies & Research

High in protein and low in fat, sea cucumbers also contain valuable nutrients such as vitamin A, B1, B2, B3, magnesium, calcium, zinc, iron, and chondroitin sulfates. Research suggests that sea cucumbers can be effective to treat arthritis, hypertension, joint pain, high cholesterol, and erectile dysfunction.¹

A thousand years
of Eastern medicine
confirmed by
modern medicine.

- ✓ **Treats High Cholesterol and Hypertension**
- ✓ **Magnesium and Chondroitin Sulfate**
Promote Bone Health
- ✓ **Fights Pancreatic Cancer Cells**
- ✓ **Treats Erectile Dysfunction**
- ✓ **Treats Arthritis and Joint Pain**





Traditionally many drugs and other chemicals with biological activity have been discovered by studying allelopathy – chemicals that organisms create that affect the activity of other organisms in the fight for survival. Despite the rise of combinatorial chemistry as an integral part of lead discovery process, natural products still play a major role as starting material for drug discovery.¹ A 2007 report found that of the 974 small molecule new chemical entities developed between 1981 and 2006, 63% were natural derived or semisynthetic derivatives of natural products.² For certain therapy areas, such as antimicrobials, antineoplastics, antihypertensive and anti-inflammatory drugs, the numbers were higher. In many cases, these products have been used traditionally for many years.

Sea Cucumbers provide novel chemical structures for pharmaceutical drug research and development

Our knowledge of the effects of bioactive compounds isolated from sea cucumbers makes it possible to consider these marine invertebrates as a promising source of substances for development of pharmaceuticals with, at least, anticoagulant, antithrombotic (blood clot prevention), antitumor, antifungal and antileishmanial (anti-protozoa) activities.³ It is important to emphasize that the use of sea cucumbers as pharmaceutical raw materials would avoid the risk of contamination with pathogens like prions and viruses during isolation of pharmaceutical substances.⁴

Pharmaceutical extracts from the species we are cultivating, *I. Badionotus*, show promise for treatment of: blood clotting; cervical cancer and perhaps other cancers; HIV; malaria; and diabetes.⁵ Moreover, our Caribbean climate allows us the opportunity to raise most of the other species that top the pharmaceutical use-case list.

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