



**Olivia Loeffler | Olivia Snow**

**SUST 739: Biomimicry Methodology | Savannah College of Art and Design | Spring 2022**



**Olivia Loeffler | Olivia Snow | Jacqueline Perez-Rubio | Frannie Levy**  
**SUST 739: Biomimicry Methodology | Savannah College of Art and Design | Spring 2022**





**Special thanks to  
Cathy Sakas and Scott Boylston**

*for illuminating a world of biomimetic innovation and guiding our journey to fruition*

**Additional thanks to Avelino Rodriguez**

*for sharing invaluable insights on the fishing market  
and his personal experiences with fishing equipment*



# CONTENTS

01

## Project Overview

p. 06

02

## Initial Discovery

p. 09

03

## Opportunity Area

p. 16

04

## Our Innovation

p. 36

05

## In Context

p. 51

06

## References

p. 59



M.A. Design for Sustainability



Olivia Loeffler

MFA Design for Sustainability



Olivia Snow

team  
**PANASEA**



# Project Overview

*"The more we care for the fish swimming today, the more fish there will be to catch in the future."*

**– Avelino Rodriguez, Sports Fisherman**

Today's oceans, lakes, and rivers are inundated with plastic waste. Plastics are harmful, both to aquatic life and to humans. Floating on the water's surface and sinking into its depths, these plastics are a man-made problem swept up in the natural ebb and flow of underwater ecosystems.

Plastics besetting aquatic environments represent a human error, a drastic oversight from initial production to disposal. Our current plastic lifecycles overlook *where* this waste goes at end-of-life. Escaping from waste management infrastructure, "leaked plastics [degrade] natural systems... and induce direct economic costs." (76, The New Plastic Economy).

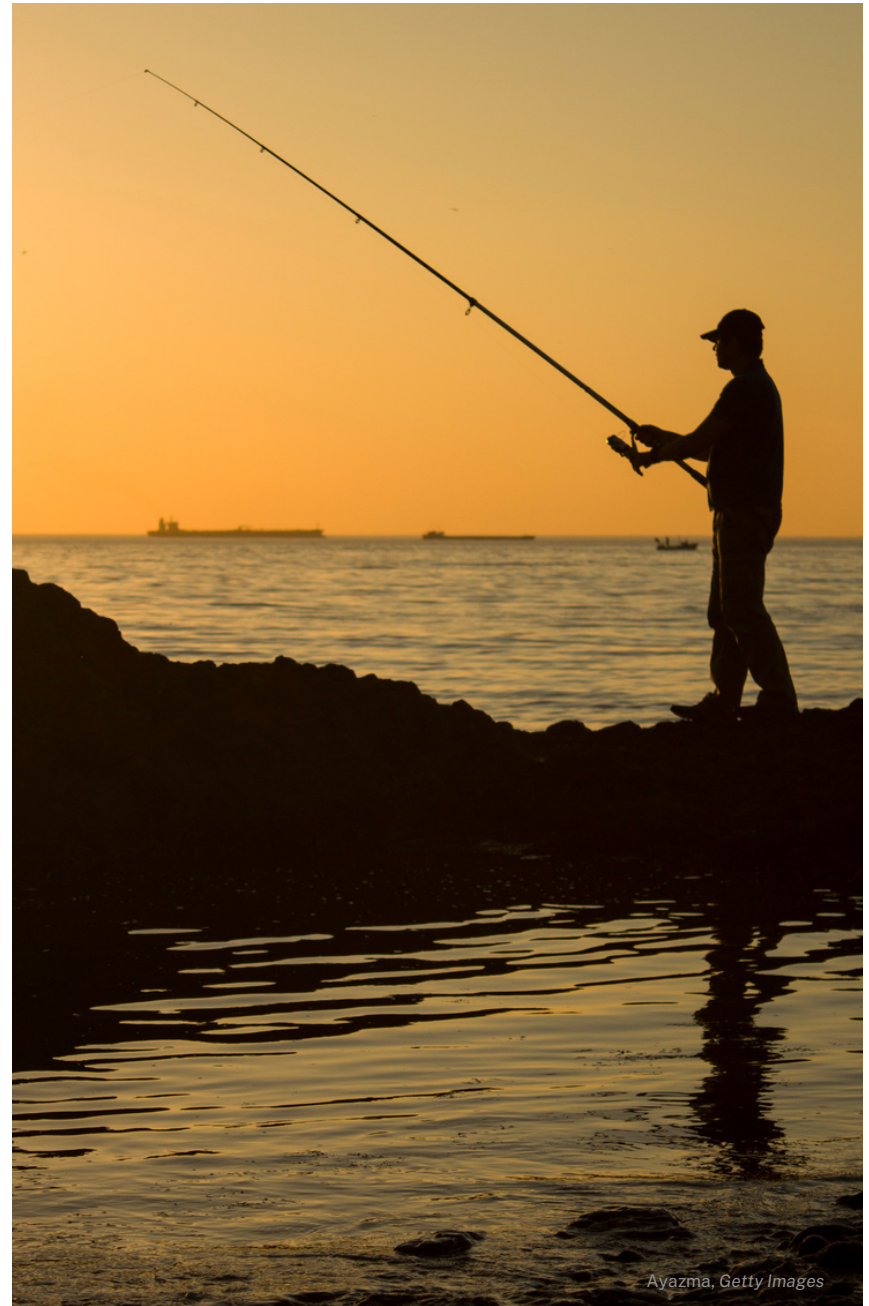
While plastic waste occupying waterways originate from many sources, seventy percent of macro-plastics floating on the ocean's surface are composed of fishing equipment by weight (Ghostgear, 2019). This figure does not account for the additional quantity of fishing equipment polluting rivers, lakes, and other bodies of freshwater. Nor does it quantify the impact of other lost fishing tackle, such as lead weights or metal hooks. Fishing equipment pollution in the water has an impact, both environmentally and economically.

“Costs of the negative externalities of plastics in the oceans [is estimated] at over USD \$13 billion” (Valuing Plastic, 2014). With this conservative deduction, we can assume that fishing gear significantly impacts both the aquatic health and economic vitality of the earth's waters. How do we tackle this problem of fishing waste, particularly the input of fishing gear plastic into waterways? How might we start a movement in the fishing industry to change the materials we use from toxic to beneficial for underwater life?

In the early phases of our process, our team began at the site of this issue and learned from two teachers: the natural world and the fishers regularly interacting with this environment. Together, they served as our primary stakeholders and informed the basis of our research. After synthesizing biomimetic strategies inspired by underwater species, we discovered a design function opportunity inspired by the staghorn coral. This colonial organism's survival strategy provided us with a solution space to address the problem of fishing equipment waste.

Emulating the genius of the staghorn coral's evolutionary tactic, our design innovation was derived from the very aquatic environment we aim to nurture. While we performed primary and secondary market analyses and charted through the unfamiliar territories of design iteration, we reminded ourselves of the enduring tenet which grounds our work: with more fish comes more fishing.

Our applied design solution aligns closely with this principle and paves the way to revolutionizing both the sports fishing market and the industrial fishing paradigm of the future.



Ayazma, Getty Images





# Initial Discovery



**01** Introduction to  
Biomimicry

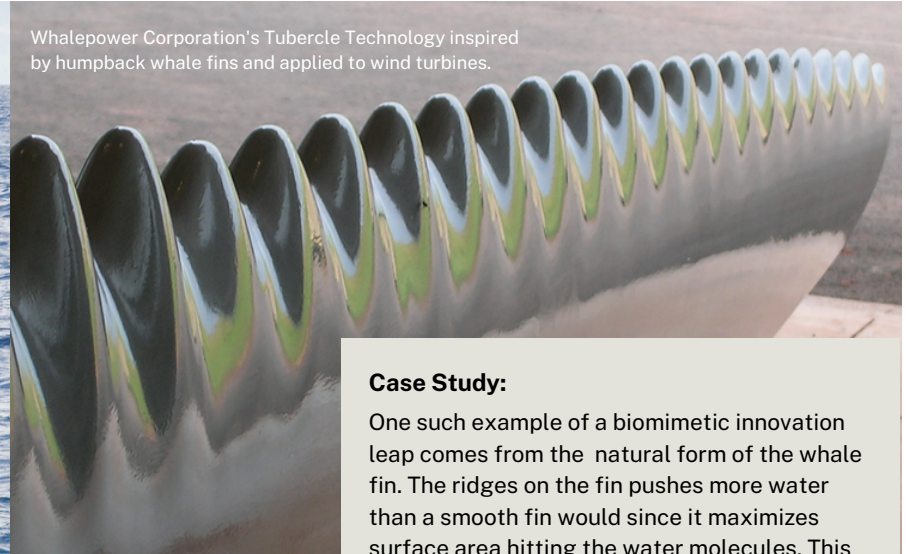
**02** Species  
Exploration

**03** Chosen Species  
Analysis





Whalepower Corporation's Tubercle Technology inspired by humpback whale fins and applied to wind turbines.



**Case Study:**

One such example of a biomimetic innovation leap comes from the natural form of the whale fin. The ridges on the fin push more water than a smooth fin would since it maximizes surface area hitting the water molecules. This inspired the design of this wind turbine, which generates more energy through better capturing wind energy.

# An Introduction to Biomimicry

**Biomimicry is a practice that learns from and mimics the strategies found in nature to solve human design challenges—and find hope.**

- Biomimicry Institute

Human beings are part of a much larger system, one that has existed long before our species first walked the earth. The strides in technological advancements we have made often mar this truism. However, with the rising frequency of environmental challenges brought on by our rapid industrialization as a species, our limitations begin to show, ever-growing fissures in our façade of human cleverness.

Taking a step away from our hubris and our own individual perspectives, one can truly observe our limitations, the temporal boundaries of the human lifespan and the gaps in knowledge we can glean from the natural world as our teacher.

This is the most basic tenet of biomimicry. It is an act of faith, an emulation of nature's genius, through a deeply mindful and provocative immersion in the workings of individual species, nested communities, and ecosystems. This meditation is predicated on our prioritization of listening to the quieted, yet boundless voice of the natural world.

It is about asking questions, discovering what might be by first asking what could be.



In order to conduct a biomimetic analysis, one must engage with an organism or system on three levels: ethos, emulation, and (re)connection.

**Ethos** requires us to see the interconnections, the natural forces at work beyond the ordinary scope of a human glance. We have much to learn from these interactions and flows of information and energy.

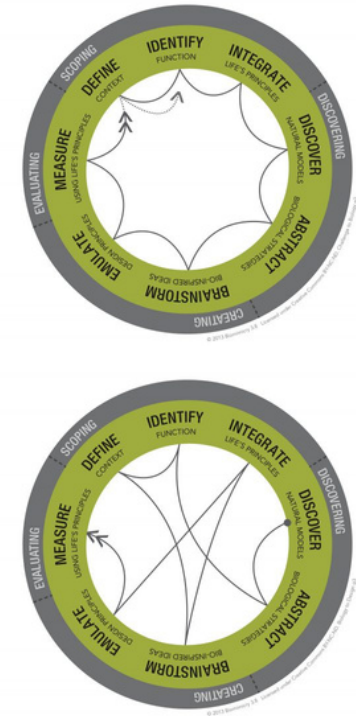
**(Re)connection** is all about rediscovering where we came from. It is about hearing from other human voices, other cultures that have maintained a closeness to the earth and re-engaging the environment with a childlike wonder.

Lastly, **emulation** allows us to truly engage with, learn, and apply these connections to design principles. With these principles, we can make innovative leaps to actualize real change and solve human-created issues.

In this journey of emulation, we engaged with the **natural form** of organisms (their characteristics), **natural processes** (how something functions or is made) and **natural ecosystems**, where we look at design as part of larger community and model it from the functioning of that ecosystem.

In this biomimetic journey, we performed a biology-to-design practice. First, we analyzed the fascinating and inspiring characteristics and survival strategies of various organisms and derived inspiration and potential opportunities from that analysis.

We formed abstracted design principles from the debiologized functions inspired by the organisms themselves, bridging function to application. The design principle served as our compass to strategize a solution. For us, this function bridge offered the chance to address the problem of lost fishing gear polluting the world's waterways and innovate an exciting solution, one that made us fall back in love with the organism that inspired us in the first place! Our human design solution thus remains deeply rooted in the biomimetic process.



# Species Exploration

In the beginning of our biomimicry learning journey, we learned how to evaluate species based on how their certain properties or mechanisms could be applied in the field of design. To do this, one must start with exploration. Over the first few weeks, we discovered many different species via our numerous field trips, iSite Journal exercises, and investigations on asknature.com.

Each member of our team was assigned to choose a species that we thought was interesting and conduct further research that would help us narrow down the final chosen species for our whole group.

One of the most important aspects of researching a species for biomimetic applications is to

distill the species into its mechanism, strategy function, and design principle. The mechanism is the aspect of the species that you want to hone in on for your biomimicry application. The description of the mechanism

**Biomimicry is about valuing nature for what we can learn, not what we can extract, harvest, or domesticate. In the process, we learn about ourselves, our purpose, and our connection to each other and our home on earth.**

- Biomimicry Institute

should be highly scientific and detailed. The strategy is a description of that mechanism, but in casual conversational terms. The function is the mechanism distilled down to its simplest form. Finally, the design principle is a conversion of the function into terms that you could give any designer to work with. We utilized this process in studying four organisms.



## Mushroom Anemone

*Discosoma*

**Mechanism:** The Mushroom Anemone has a protein chromophore that has a unique configuration which allows it to absorb a photon from the sun and use that energy to produce a pulse of red light. The beta barrels shield the chromophore from other molecules that could steal the energy before the chromophore can use it to create the fluorescent protein's signature glow.

**Strategy:** Proteins made by *Discosoma* Mushroom Anemones produce color by using the sun's energy to generate specific wavelengths of light.

**Function:** Structure converts light energy into visible color.

**Design Principle:** Unit absorbs energy and converts into visible light form.





**Whirligig Beetle**  
*Gyrinidae*

**Mechanism:** The Whirligig Beetle has two sets of eyes for simultaneous viewing: the "surface" set of eyes remain on the top of the water while the "submerged" set allows it to see underwater. The surfaces of each set of eyes are completely different and which aid them in performing in their respective environments.

**Strategy:** Nano-structures on the upper "surface" eyes refract light to match the reflective index of the surrounding air while the surface of the "submerged" eyes are smooth.

**Function:** Dual units adapted for simultaneous function.

**Design Principle:** Dual environment-specific attributes allow for simultaneous use.



**Sea Pansy**  
*Renilla reniformis*

**Mechanism:** When disturbed, a chemical reaction takes place within the zooid tissues of the Sea Pansy. Three key compounds: luciferin, luciferase, and oxygen interact and give off light. The photoreceptors found in surrounding zooids detect the flash and respond with light.

**Strategy:** When the unit is physically disturbed, it pulses with light. Individual zooids protect themselves by emitting a flash of light, triggering neighboring zooids to perform the flashing mechanism, via photic signaling.

**Function:** Localized reception of physical stimuli distributed through a decentralized network reaction.

**Design Principle:** Localized reception, decentralized reaction.



**Staghorn Coral**  
*Acropora cervicornis*

**Mechanism:** The long skinny branches of the Staghorn Coral are made of a brittle material that breaks under pressure. Instead of harming the organism, the programmed breakage helps the coral asexually reproduce, as the broken pieces regrow.

**Strategy:** The thin branches of the coral easily break off when met with abundant water flow which disperses the fragments and allows new colonies to grow from them.

**Function:** Planned breakage can help eliminate external stress on the organism and aids in reproduction.

**Design Principle:** Propagation through fragmentation.\*

\*Proc Natl Acad Sci U S A. 1981 Apr; 78(4): 2427-2431

# Staghorn Coral

*Acropora cervicornis*

## Scientific Classification

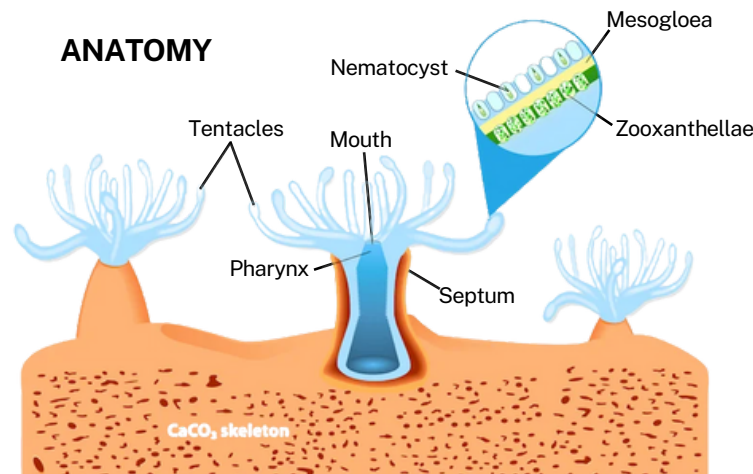
**Kingdom:** Animalia  
**Phylum:** Cnidaria  
**Class:** Anthozoa  
**Order:** Scleractinia  
**Family:** Acroporidae  
**Genus:** *Acropora*  
**Species:** *cervicornis*

## Environment

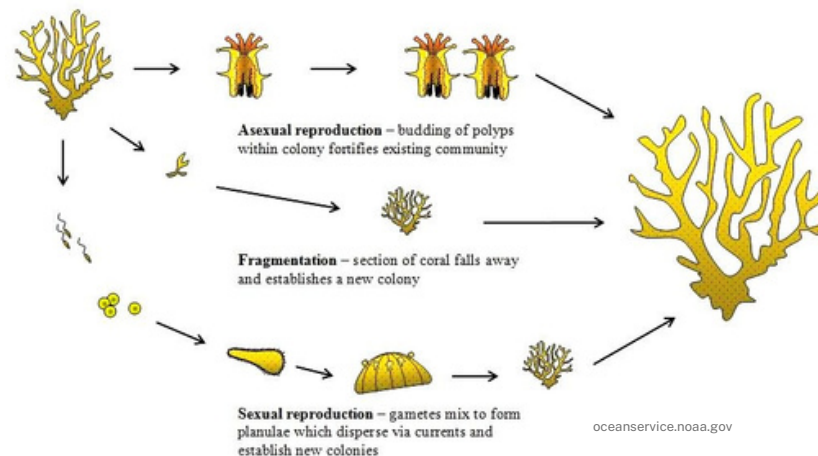
Staghorn Coral (*Acropora cervicornis*) provide a habitat for fish and sea organisms. This species is located in the warm coastal waters of the Caribbean and along the Floridian coast.

## Nutrition

Staghorn coral obtain their food from photosynthetic algae (zooxanthellae) that live inside the coral's cells. They also feed by capturing plankton. This is why the coral are considered a colonial (or compound) species. The algal organisms cohabitate the corals' cells in a symbiotic relationship.



NOAA, Extant Coverage & Staghorn Coral Anatomy



oceanservice.noaa.gov

## Biology to Design

This species first captured our interest when we learned about its unique growth and asexual reproduction strategy. The staghorn purposefully grows its branches rapidly to outgrow competitors, and because of this faster growth rate, the branches are weaker and likely to break off in heavy currents caused by hurricanes.

However, the staghorn uses this weakness as its hidden strength. Branches easily break off from the main structure, protecting the base, and the fragmented pieces are transferred through the water to new areas they can start colonies anew from. Thus, this propagation from fragmentation formed the basis our design function.

"The fragments that broke off, dropping in a favorable place, would become the germ of another coral plant, its base cementing by means of new coral secretions to the rock on which it might rest."

(Dana, *Coral and Coral Islands*, 1890)



# Propagation Through Fragmentation



National Geographic



# Opportunity Area



**01** Market Analysis

**02** Primary & Secondary Research

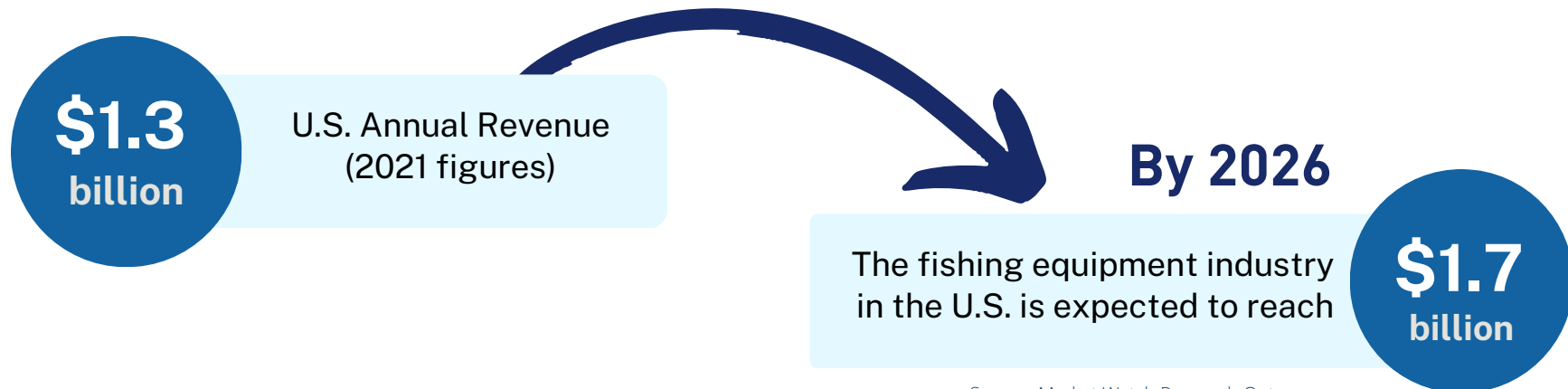
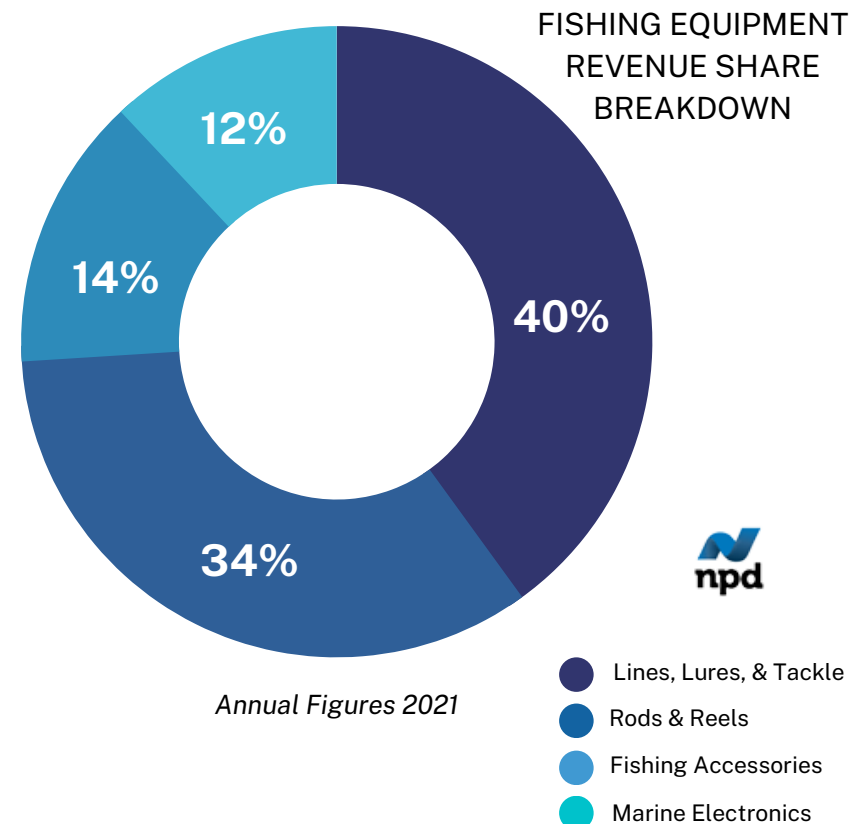
**03** Mission & Vision

# The Fishing Tackle Market

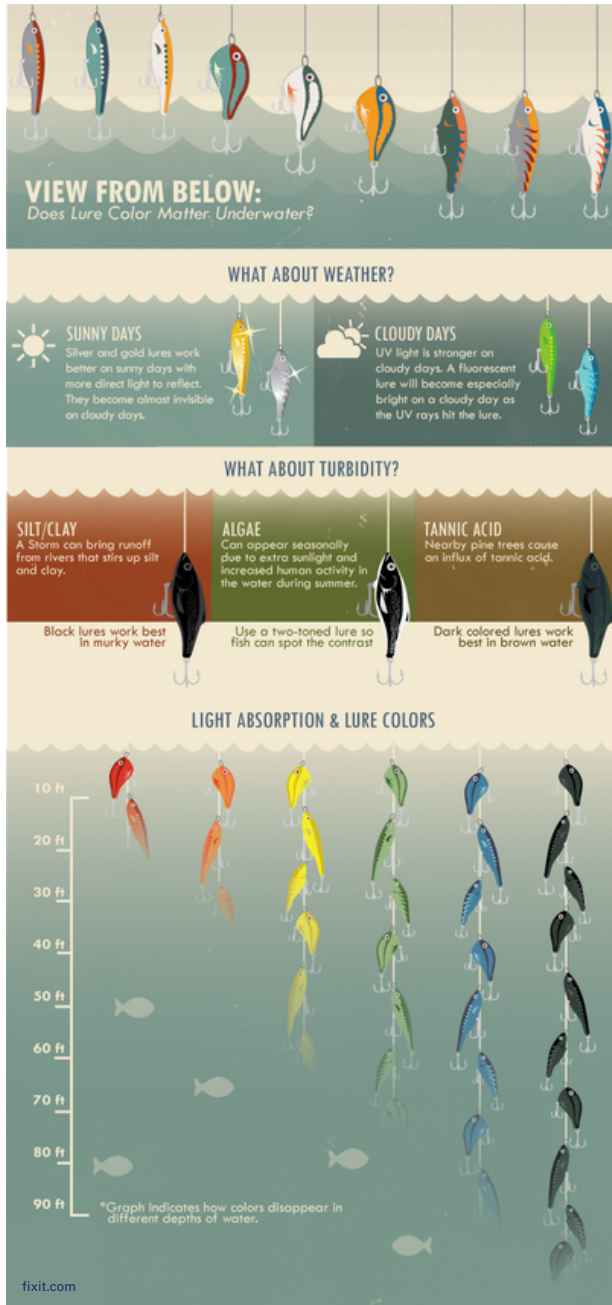
Presently, the fishing market for hobby and sports tackle is popular and shows a large potential for growth in upcoming years. Due to consistent and growing needs for a wide range of fishing tackle styles that align with the characteristics of prey in the location the fisher intends to use them, this market continues to require a diverse and durable set of products. Additionally, because a large portion of fishing equipment is often lost during the act of fishing, this market represents a continued need and a strong profit trajectory.

US annual revenue figures for 2021 demonstrated that lines, lures, and terminal tackle accounted for the largest portion of revenues in the market. The market itself is rapidly growing.

The future growth of the market will depend on how well existing businesses and fishers operating in marine environment connect with the Panasea tackle line.



Source: [Market Watch Research Outcomes](#)



# Deciding Purchase Factors

We deduced customer priorities as follows:

- **Durability**  
How long will the tackle hold up in the water, to fish bites, and to repeated hooking by fishers?
- **Efficacy (maximizing catch)**  
What colors, vibrancy, smells, food products attract the most fish?
- **Ease of use**  
Do fishers know how to use the tackle well? Is the design intuitive?





# Environmental Impact of the Fishing Industry

Within the infrastructure and product life cycle outline in the market today, plastics and toxic chemicals continue to cause devastating environmental impacts.

Unequipped to break down the altered petroleum and chemical additives in plastic tackle, the earth's waters house these materials indefinitely. Plastics take centuries to break down and even longer to biodegrade, irrevocably damaging life in the water.

Plastic waste leaches out toxic chemicals, including carcinogens. It snags and entangles organisms, drowning them. Mistaken for prey, it is consumed by at least 260 species (STAP, 2011) whose digestive systems are unable to dissolve or expel the foreign waste. It bioaccumulates as microplastics in the food chain, eventually making its way back to our stomachs as we bite into the catch-of-the-day on our plates.

We see the reinforcing feedback loop caused by fishing equipment damage to aquatic ecosystems as an opportunity. After analysis of current market options, we got to work on a solution entirely new to the fishing market.

**640,000** tonnes of fishing gear enter the world's oceans annually



John Gollop, Getty Images

of all ocean plastic, fishing gear comprises **10%**

By weight, fishing equipment composes

**70%** of macroplastics floating on the ocean's surface

[Green Peace Report \(ECO WATCH\)](#)  
[The Guardian - NOAA Findings](#)

# Plastic Bait Lifecycle



Oil is extracted from the earth.



The oil is refined and processed.



Additives are incorporated and lures are injection molded.



Lures are packaged in more plastic and internationally distributed to stores.



The lures are then purchased and usually kept in a tackle box for use.



Lures are attached to hooks and used to catch fish.



Lures are lost or thrown overboard and remain in the body of water.

## Key Takeaways

- Current bait and lures are filled with carcinogenic paints, chemicals, additives, and plastic components. This has negative health impacts on humans and fish alike.
- Bait is easily snagged or lost underwater, and often used only a handful of times. Its impact is eternal.

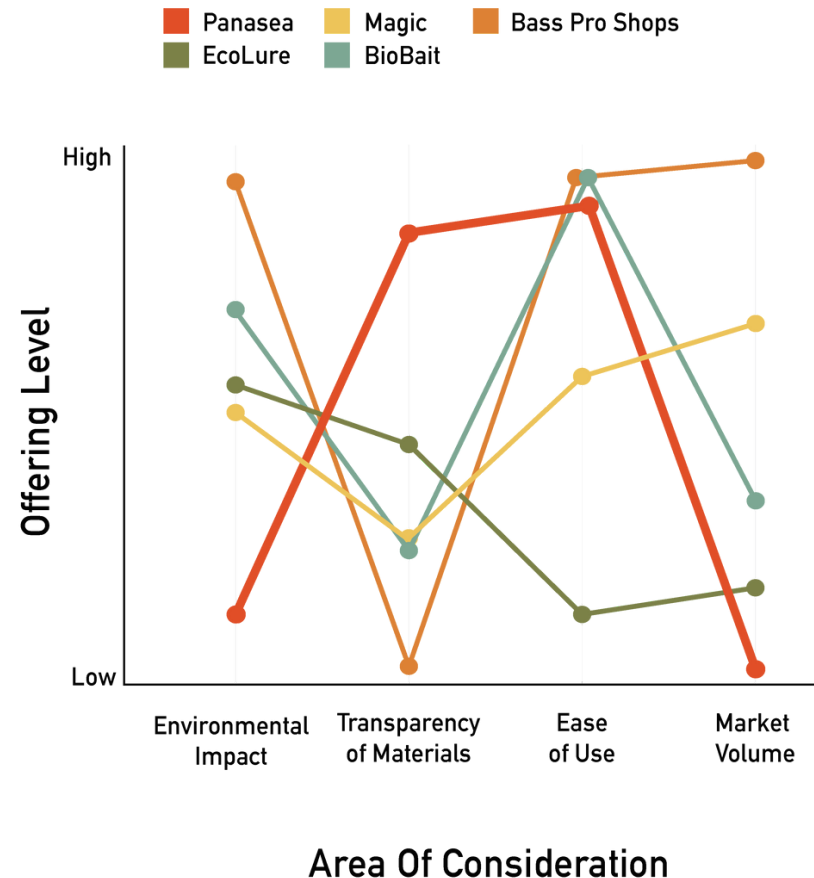
# Strategy Canvas

While the fishing market currently has a very large gap when it comes to sustainable products and options, there are a few soft bait companies that are attempting to close in on friendlier choices. Below is a strategy canvas that shows each company in comparison to the rest in the aspects of environmental impact, their transparency of materials, ease of use, and overall market volume. This canvas shows where we think that we are in within the current market.

**Bass Pro Shops** is one of the largest retailers for fishing and outdoor gear. For the purpose of this canvas, we are only analyzing their line of soft baits which are 100% plastic and represent the conventional soft plastic bait.

**Magic Bait** makes some interesting bait, including real fish such as shad and minnows that have been preserved and enhanced with certain colors and flavors. Although these lures are made of a natural base ingredient, the fish is highly processed and preserved by mystery chemicals and processes.

**BioBait** describes their products as revolutionary, patented, water soluble, safer alternatives, to traditional fishing lures. However when looking into the specifics of their patents, there was not enough evidence that their product was biodegradable. No where on their website or packaging do they say that their products are biodegradable and on their website they explain that "Bio Bait is a giant step in the right direction of finding a 100% biodegradable fishing lure alternative to plastic". If it is still plastic, how is it safer.



**EcoLure** is an online company that sells "biodegradable" rubber and kits to make fishing lures with them. The rubber is still plastic. The product also is very low on the ease of use scale because it requires the customer to make each lure themselves.



# Personas

## Experienced Enthusiasts

Our hope is that we can create a product that is as good or better than what is currently on the market to sway those who already have their go-to tackle, to think about the impacts of their choices. From the experienced fishers that we have already chatted with, we can tell that there is definitely a want for a more sustainable tackle collection. If we can secure the experienced market, hopefully it will support more visibility to people newer to the activity.



## Recreational Hobbyists

By creating interesting and unique products, newer hobbyists will hopefully be more inclined to use our products. Because of the lighter environmental impact of our products, we can help introduce customers to our "guilt-free" approach to tackle. The sooner people can shift their perspectives on tackle, the sooner we can transform such a high polluting industry.

## The Next Generation

When walking down the fishing aisle at the local outdoor store, the thought popped into our head to envision all of thousands of pieces of tackle for sale ending up on the floor of a body of water. When you think of it that way, it is very clear that things in the fishing tackle industry need to change. It is our hope that we can inspire a new generation of conscious fishing enthusiasts who will strive to integrate conservation into all of their outdoor passions.



A background image showing a person's hands holding a small plastic bag of red bait over an open fishing tackle box. The tackle box is filled with various fishing gear, including lures and hooks. The scene is set outdoors on a sandy beach.

# **Interviews**

**01**      **Recreational fishers on Tybee Beach**

**02**      **Biologist-at-the-Design-Table, Cathy Sakas**

**03**      **Avid Sports Fisherman, Avelino Rodriguez**



# Tybee Recreational Fishers

## Main Takeaways

- Fishers in this group were highly aware of the weather conditions, tides, and other local factors that influence where and how they fish. Being locally attuned matters to them for this reason and thus they have a deep connection with the natural marine system on Tybee, even if it is an unspoken sense of being within the environment.
- Different kinds of bait and lures are used depending on the desired catch, time-of-year, lighting, tides, and other abiotic factors. Fishers take great pride in their collection of tackle and are knowledgeable about what circumstances predicate using a particular kind of bait. They spend time and money on fishing and it is a deep passion. Connecting with this passion will be important for us to enter in to the market with success.
- When relaying their preferred bait color and appearance, these fishers said that all colorful lures tend to work, but particularly orange baits, bobbers with rattles, and lures with some aspect of shine or sparkle are best. These all succeed in drawing attention by the species underwater.
- We must ensure that our products cater to a vast array of needs. Diversity is inherent throughout the market, which is why it is ironic that such a great quantity of bait is made solely of plastic. The fishers did say that local fresh bait is often the best to catch fish on Tybee's beaches. This is a perfect example of how the fishing community will rally around a more sustainable bait when it is effective in attracting the desired fish. Our business plan would have greater reach if we cater to that interest and share the benefits of Panasea tackle from an environmental perspective.





# Cathy Sakas, Expert Biologist

## Insights Gleaned

- Cathy provided us with invaluable information regarding the nutrient flows we needed to be aware of, both in coastal Georgia and inland to freshwater lakes, creeks, and swamps. Cathy let us know that the coast of Georgia exists in a dynamic state. Since the tidal amplitude in Georgia is so significant compared with other sections along the Atlantic coast, **tides are the great flushing mechanism that keeps salinity and nutrient levels in check within coastal marshes.** Particularly during the full and new moon, a tremendous amount of water flows into marsh that flushes out.
- On the infrequent occasion that high tides remain (12 + feet) for a long period, the saltwater gets pushed up quite too far into the coastal zone. When this water partially retreats, some evaporates and results hyper saline solutions. In drought periods, this hypersalinity causes marsh grass die-off. Over the last big drought, Cathy could remember going to Skidaway Island and seeing swathes extending into the distance of dead marsh.
- Despite this hypersaline issue, **the marshes and coastal environments are resilient.** As soon as the rains came back after the most recent drought, Cathy said that it took but one cycle for all of the dead marsh to regrow.
- When we asked Cathy about issues of nutrient deficits or overloads that are known plagues water catchments, she confirmed that these problems arise more frequently in static, rain-fed bodies of water. **This is an important factor** to keep in mind as we hope to eventually create niche lines of bait that serve the specific needs of the area where they are used (and often lost in).





## Cathy Sakas: Additional Insights

- The only nutrient deficit-prone areas in Georgia waters occur in inland ponds, as they do not have a direct source of nitrogen. However, Cathy cautioned us against adding nutrients to these systems, as they already have evolved to source missing nitrogen in creative ways. Carnivorous plants in these ecosystems supply the nitrogen by catching and absorbing chemicals from insects who consumed those nutrients in other locations.
- Cathy's advice: **let nature take its course. It has developed its own natural workarounds to allow for a thriving ecosystem.**
- She suggested we look at the act of fishing and what we want to impact. We should aim to allow for fishers to continue the act of fishing in a way that doesn't result in pollutants (line, tackle, etc.) entering the water and remaining there.
- **What we design needs to be neutral and inert if left in the water.** Lead is just one example of this. Fishing waste in its current forms leaches toxins into the natural environment. How can we alter this sequence?
- Cathy provided us with a final piece of wisdom that we can incorporate into our products: **consider glass cullet.** This is an inert substance mostly made of silica (a component of sand). If we included glass cullet in our fishing weights in coastal areas that do not need nutrients from iron filings like the deep sea does, we will have no negative impact when the tackle's external bioplastic shell breaks down. Furthermore, **we would be propagating new systems of recycling that are sorely missing for glass waste in most cities** (including Savannah), filling a gaping hole of reusable materials currently sent to landfill.

# Avelino Rodriguez, Avid Sports Fisherman

## Direct Interview Quotes

"The fishing tackle I use depends on what catch I am fishing for. Each lure is meant for a certain fish and has a purpose. In terms of recycling, the only recycling I can do as of now is that I donate my fishing line every year to my boat captain for our longer deep sea excursions. The captain then can reuse the line for other fishers on the boat.

Most often, I go deep sea fishing in the Caribbean Sea or Atlantic Ocean. In this context, I use a 15 pound, 30 pound, or 80 pound line to fish with, depending on how deep I want my line to go. For live bait we use squid, sardines, shrimp, flying fish, and ballyhoo. For artificial bait we most often use rubber (soft plastic) squid, and rapala floater lures, as they pop up and down by water's surface and get attention from the fish.

only tend to use weights when I am trying to do bottom fishing. I mainly go for yellowtails, red snappers, or sea bass. The five pound weight works for 900 feet, whereas the 4-6oz weight works for 100 foot depth. I mostly use the teardrop shape in terms of weight shape.

Most often, I tend to do trawl fishing with live bait. On a 4-8 hour trip you usually lose your tackle over the course of the day. Depending on the fish, the bait can last the whole day or only a few minutes. Dorados, or mahi mahi, or marlins go for the ballyhoo bait, but they don't often bite the bait off of the hook. In contrast, kingfish and tuna have sharp teeth and they cut the line quickly. For fishermen looking only to sport fish and not bring home their catch, I suggest using circle hooks so the fish don't swallow them and risk greater injury.

**I would love a sustainable bait. For trolling they used to use wood in the artificial lures, but now it's a hard plastic, for the covers, and the lures. That's all you can find.** If you go into the fishing section of Bass Pro Shop and you go for lures, or salt water fishing, or anything - you will find they all are plastic. **If you can make a plastic-alternative bait that degrades, fishermen wouldn't mind paying more for that. It would be a great change."**



Image courtesy of Dani Rodriguez



# Background

It was important to us to back up the context of our design choices with concrete research. Our Secondary research was comprised mostly of analyses of current market innovations, peer review scientific and academic articles, and patent searches.

## Form

During our research for our fishing weight and our soft lures, we realized that there were many positive reasons for sticking to some of the most popular designs: When keeping the form to a traditional design it remains recognizable which we hope will help in the early adoption process. Taking a page out of the biomimicry book, the natural evolution of which baits work best has been tested repeatedly over decades. As we are not avid fishers ourselves, it was best to rely on what already seems to work for fishing community instead of claiming that we know what is best.

Fishing weights vary by weight, shape, material, connection to the line, and movement. Keeping all of these variables in mind we wanted to only change what was necessary while showing that our innovations could be used in various applications.

Most rounded weights, such as the dropshot, barrel, banana, and ball sinkers, allow the weight to move across the bottom of the body of water it is being used in. This helps the fisher to control the bait in a way that mimics fish swimming. When the current is stronger, a weight that is able to anchor into the bottom is necessary -- these mechanisms are best shown in the pyramid and bar weights.



For our initial iterations and prototypes we decided to work with a moving weight and an anchoring weight example. We chose the dropshot for moving and the pyramid for anchoring.

Soft fishing lures vary in form based on what kind of fish it is aimed at catching. To keep things simple, we chose minimal forms that seemed to be popular across all brands.

## Materials

In our first trip to our local fishing store, we were alarmed at how many "Reproductive Harm" warnings we found on the back of most of the tackle that we encountered! After spending the afternoon browsing the fishing weights, we decided to look further into if the lead in fishing weights had the same level of harm that other -- more regulated-- products have like paints. A pamphlet from Contra Costa Health Services in California put our answer in simple terms: "Most fishing sinkers are made of solid lead. Lead in fishing sinkers can cause lead poisoning.

Lead dust from fishing sinkers can contaminate tackle boxes, tables, and other surfaces. Even small amounts of lead can hurt a young child's growth and development" (contracosta.org). The Center for Disease Control also confirms the toxicity of fishing sinkers by including them in a brief list of products found in the United States that may still contain lead and therefore could pose an exposure risk: "While lead is prohibited from many products in the United States, imported or pre-regulation products may still pose a risk. Lead is still used in commercial products and may be found in products such as [...] fishing tackle" (atsdr.cdc.gov).



Vladimir M. Getty Images





Elena Nichizhenova, Getty Images

It's almost as if lead has been so ingrained in the fishing tackle industry, that the potential harm doesn't even register because of how normalized it is.

As for the plastics used in fishing lures, it is safe to say that all plastic is harmful to the environment. When interviewing our biology specialist, Kathy Sakas, she wholeheartedly agreed and highlighted the fact that plastics do the most harm to organisms and ecosystems through leaching endocrine disruptors, such as BPA.

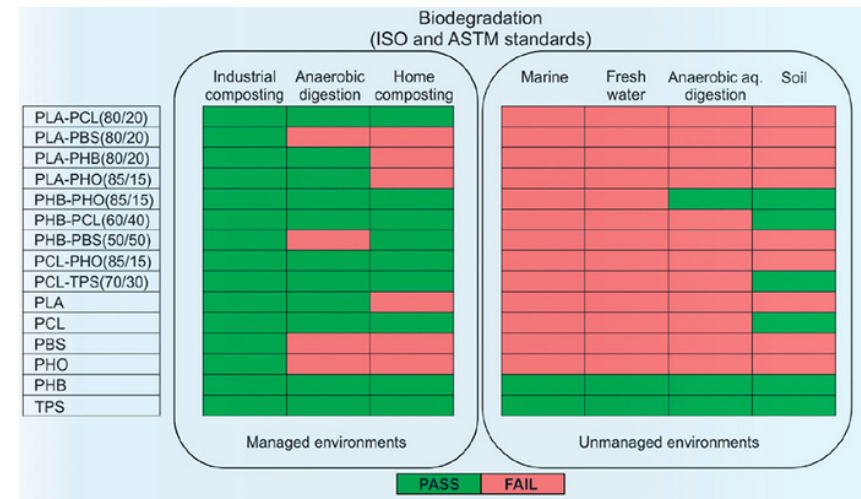
Plastics are notorious for taking a very long time to break down; recent research has shown that when they do, they can actually cause more harm in the form of microplastics and nanoplastics. As a study published in the international peer-reviewed journal *Environmental Pollution* states: "Microplastics are prevalent; they interfere with nutrient productivity and cycling, cause physiological stress in organisms (e.g., behavioral alterations, immune responses, abnormal metabolism, and changes to energy budgets), and threaten the ecosystem composition and stability" (Ma et. al., 2020). From the biological and sustainability perspectives, it was clear from the beginning that we should try our best to take plastic out of the equation whenever we could.

This ended up being easier in some applications than in others. For the soft lures, we were able to figure out a recipe that requires no plastic (a material breakdown can be found in the *Our Innovation* section. After our interviews with fishing enthusiasts, we learned that lures seemed to be more disposable than the weights and bobbers, this was another key factor in us being able to evade plastic in our lures. Weights and bobbers are reused more, meaning that they need to be able to be in contact with water-- including salt water-- and also be stored for multiple reuses.





This brought us to the realization that we would probably need to use plastic in these instances. Originally, we planned on using PLA as we had heard that it was a compostable plastic. Upon our research, we learned that this was not the case in aquatic environments. A study published in Journal of Environmental Technology in 2018 analyzed how different plastics and mixtures of plastics broke down in different environments.



★

★

★

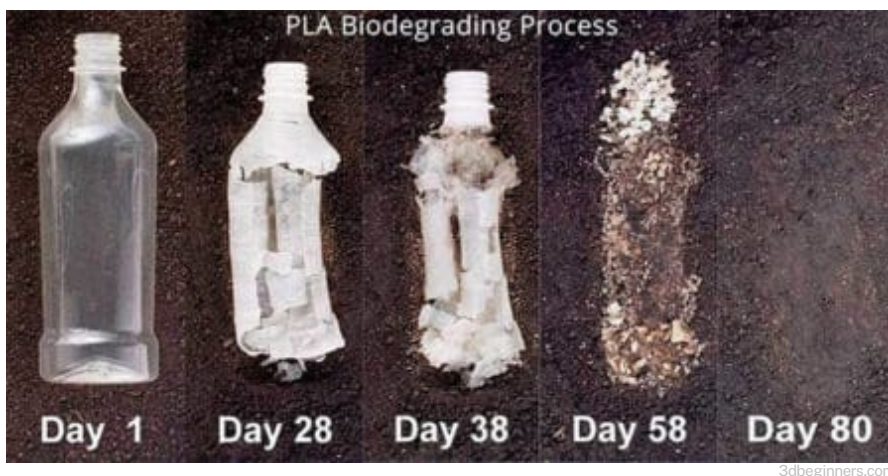
★

Ghosh and Jones, 2021

Polyhydroxybutyrate (PHB) is a plastic made from natural materials, mainly starches derived from vegetables, and breaks down in both marine and freshwater environments. Panasea uses PHB whenever plastic is absolutely needed. In the current case, we only use it in our bobbers and weights. We are also currently looking at just using PHB as a coating to protect an algal plastic layer to use less plastic.

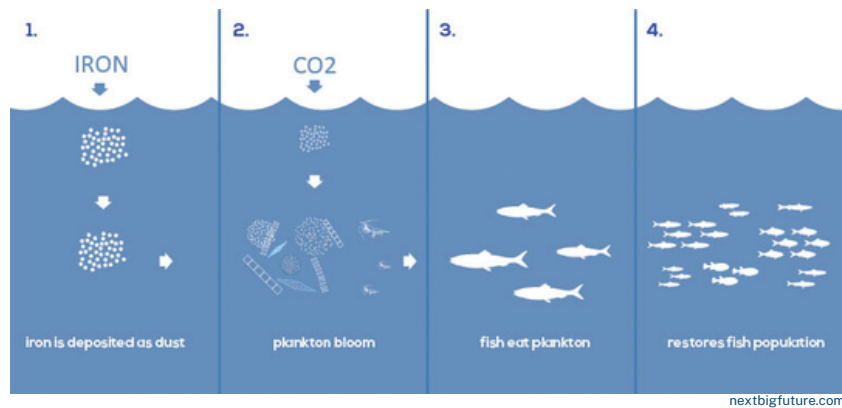


When it came to what to fill the plastic shells with, we looked back to our design principle: propagation through fragmentation. As our products break don we want them not just be benign in the environment where they are left behind, but we want them to improve that environment in order to allow fish to multiply as well as build a robust environment for them to thrive in.





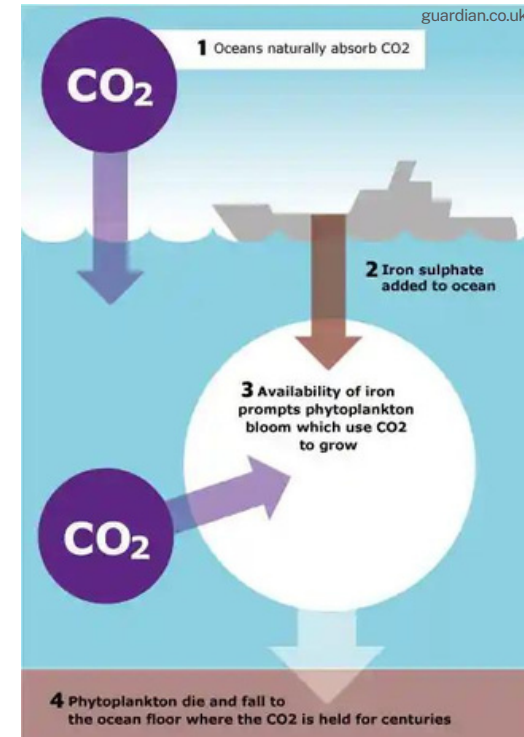
## Iron's Impact



Looking to what could be added to the ecosystems, we learned that iron is an essential micronutrient that phytoplankton need to reproduce and in most environments it is the limiting factor for phytoplankton reproduction.

As corroborated by many scientific publications: "Iron (Fe) is an important component of phytoplankton enzymes and catalytic sites, and is an essential element for phytoplankton growth in the photosynthetic and respiratory electron transport chain, carbon and nitrogen fixation, chlorophyll synthesis, and detoxification of reactive oxygen species" (Mills et al., 2004, Sandmann, 1985, Schuback et al., 2016, Sunda and Huntsman, 1995).

In addition to improving the ecosystem, adding iron filings to deep sea environments actually helps capture carbon. Another sustainability win! In the 2004 research project entitled the European Iron Fertilization Experiment (EIFEX), researchers were able to fertilize 167 square kilometers of the Southern Ocean with iron sulphate (Schiermeier, 2012).



According to a study of this experiment that was conducted in 2012, they found that "Each atom of iron added pulled at least 13,000 atoms of carbon out of the atmosphere by encouraging algal growth which, via photosynthesis, captures carbon. In a paper in Nature today the team reports that much of the captured carbon was transported to the deep ocean where it will remain sequestered for centuries" (Schiermeier, 2012).

During our discussion with Kathy, she informed us that it would be best to only use the iron filings in specific applications where phytoplankton growth is known to be low. In general, Fe concentrations are low in open oceans (Yuan et. al. 2021).



With this new information, we decided to keep the iron filings for deep sea fishing applications and use recycled glass cullets that are a mostly a waste product of the beverage industry. Since most recycling centers do not separate the glass by color before crushing it, the reuses are limited based on aesthetic reasonings. However, this off-cast is perfect for our application because it will never be seen and the glass fragments will simply degrade over time and turn into more sand.



CD Enviro

## Innovations

One of the main issues with soft bait that all of our interviewees mentioned was that the hook tends to destroy the bait faster than the fish do. In order to overcome this we decided to add to the forms that we have already seen by adding an interior supporting structure to stop the hook from splitting the bait.



After many iterations and prototyping, we settled on a crocheted loop system for the hook to go through which offers great strength. Using jute twine allowed us to retain our biodegradability and also pushed us to use a regenerative material. When jute is grown, it is a great carbon sequester and improves the soil that it is grown in!



Malcolm Manners via Wikipedia

# From Our Perspective

## Mission

To create high quality fishing equipment that offer durability, ease of use, and success in attracting desired catch that improve the environments they perform in. Our belief is simple: more fish, more fishing.

## Vision

We want to create tangible change within the fishing market. Fishing equipment must improve the aquatic environment in order to enable future generations to experience the joys of fishing.





# Our Innovations



**01** Product  
Descriptions

**02** Material  
Transparency

**03** The Future  
of the Brand



# Our Products

*"You have a strong grasp of potential materials. Now the real fun begins in exploring opportunities for your products and how the materials can facilitate a better outcome."*

**– Professor Saty Sharma, Materials Expert**

In our pursuit of biodegradable, ecosystem-enhancing tackle, we first leaned into the design principle we debiologized from the staghorn corals' function of fragmentation and propagation to create our items anew. The discoveries made from our earliest sketches allowed our team to consider fishing tackle in new ways and assess the important factors we needed to prioritize in later iterations. We dove into a world of exciting, brand-new materials, from starch-based bioplastics with partial-hydrophobic properties, to algal plastics that regrow and form live colonies when immersed in water. While several of these materials did not suit all of our functional requirements, they informed our process, understanding of the market, and our base of knowledge for the future.

We honed in on our non-negotiable deliverables as this process continued. This meant ensuring the utility of our tackle for all stakeholders - the fishers and the natural ecosystems we aim to serve.



While the interests of these two main stakeholders overlap, we also paid close attention to the motivations of potential early adopters of our product. By fitting form to our intended function for our tackle, both during and post-consumer use, we can address the needs of the fisher and the environment.

Furthermore, we sought to quiet our own human cleverness and look to the needs of aquatic ecosystems before assuming that we grasped their needs. After extensive research and interviews with our expert Biologist-at-the-Design-Table, Cathy Sakas, we made several alterations to our initial designs in an effort to do no harm. Cathy reminded us of that capabilities of natural systems to serve their own needs, and we wanted to make sure our tackle did not interfere with or negatively impact those processes. Our designs were also heavily influenced by fishers. In order to allow for the best exposure and influence of our tackle within the insular market of sports and hobby fishing, we knew we needed to stick with what worked.

Reinventing the wheel in this case would not have solved the problem, and thus we decided as a team to fit the constraints of the current fishing industry paradigm. That way, we will have greater leverage to initiate change and gain traction in the future. Through additional primary and secondary market research, we challenged and reinforced our learnings, resulting in tackle designs that we are excited about on a personal level and believe in from a standpoint of environmental stewardship and deep ecology. From early ideation to actualized modeling to refined products, we hope you will follow along in our journey and join us in looking to the future of Panasea and the industry as a whole.



# Applied Concepts Brainstorm

## LINE

- Biodegradable submerged in water within 3 months (testing for variability with pressure/salinity)

## BOBBER & LURE

- Releases spirulina when hydrophobic casing dissolves
- Recoil mechanism to secure line post-break to avoid entangling sea life

## WEIGHT

- Outer shell with interior iron filings instead of lead - designed dispersal

## HOOK

- Cajeput oil-infused to promote healing
- Designed to biodegrade

## NETTING

- R&D for fragmentation induced by localized pressure after extended submersion
- Nutrient casing model (outer shell biodegrades, inner nutrients released)

## Deliverable Focus

### FEASIBLE

INNOVATIVE LEAP CAN BE APPLIED TO EXISTING SPORTS / HOBBY FISHING MARKET

- LURES
- WEIGHTS
- BOBBERS

### NOT FEASIBLE

MARKET CONDITIONS & SCIENTIFIC INNOVATIONS NOT READY FOR APPLICATION

- FISHING LINE
- FISHING NETS (INDUSTRIAL)
- FISHING POLES
- HOOKS



# Concept Ideation

## WEIGHT DESIGN

- Do we need to design for aerodynamics?
- How do the weights operate underwater?
- What are desirable qualities within the market function?

**Biomimetic Inspiration:** Aerodynamic vents on the sand dollar

## BOBBER DESIGN

- How do we ensure buoyancy?
- Are the spirulina (blue algae) pellets helpful for the environment? Or not?
- What other opportunities exist?

**Biomimetic Inspiration:** Bony fish swim / air bladder used to shift to higher and lower altitudes in the water. Control of buoyancy.

## HOOK DESIGN

- Are there any hooks on the market that help in fish recovery? Or prevent the damage that regular hooks can have?

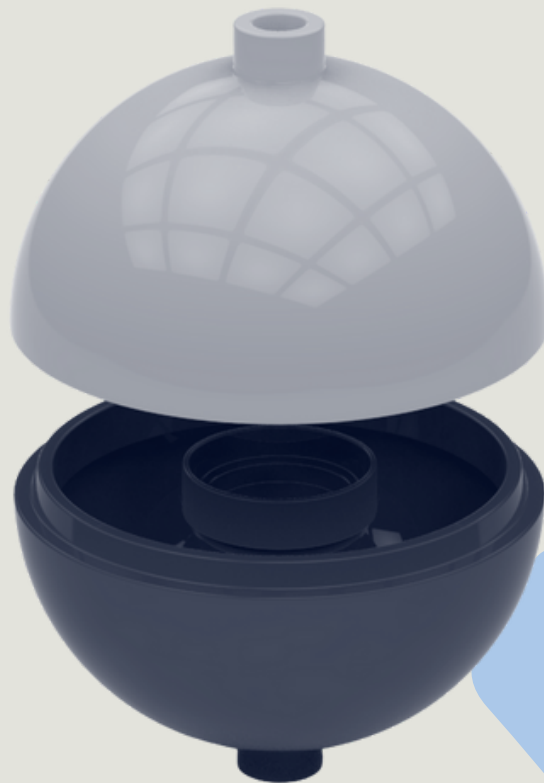
**Biomimetic Inspiration:** Density and added support where needed in horse pedal bone (also called the coffin bone)



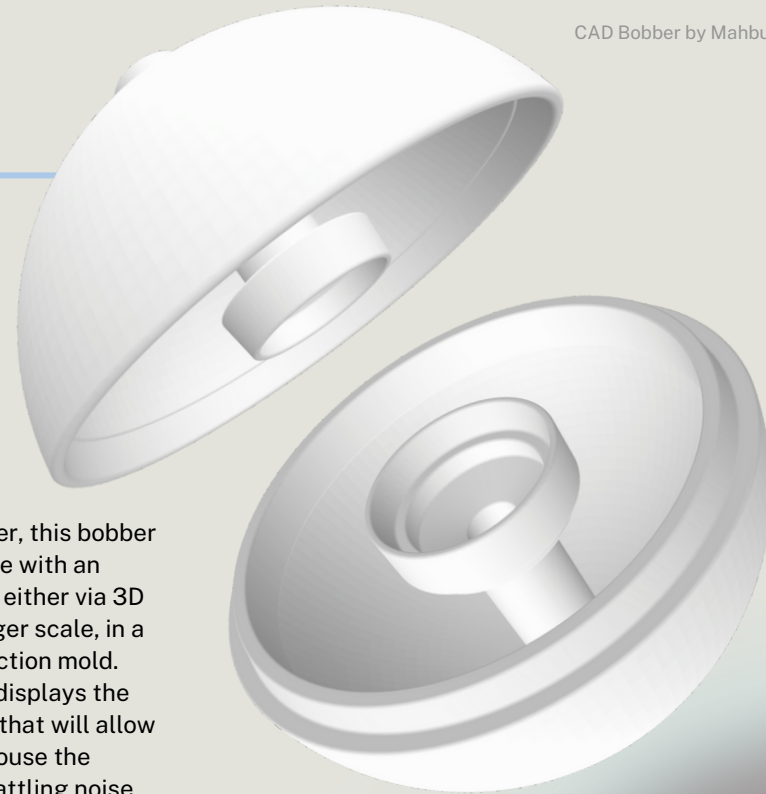
# Bobber

**Wire spring fishing bobber cross section shows central cavity that will house cullet pellets for rattling effect.**

CAD Bobber by Mahbub, Grab CAD



Much like the sinker, this bobber casing will be made with an exterior bioplastic either via 3D printer or, on a larger scale, in a thermoplastic injection mold. The cross section displays the interior air pocket that will allow for flotation and house the cullet pellets for rattling noise effect that attracts catch.



This cullet (recycled glass) will be melted into small pellets and used for all bobbers.



# Plans for Prototyping Our Bobber

Once we are able to get the 3D models of our bobbers printed, we will perform environmental stressor tests to determine durability and work on balancing the ratio of cullet pellets to empty space within the bobber before it is sealed. We aim to:

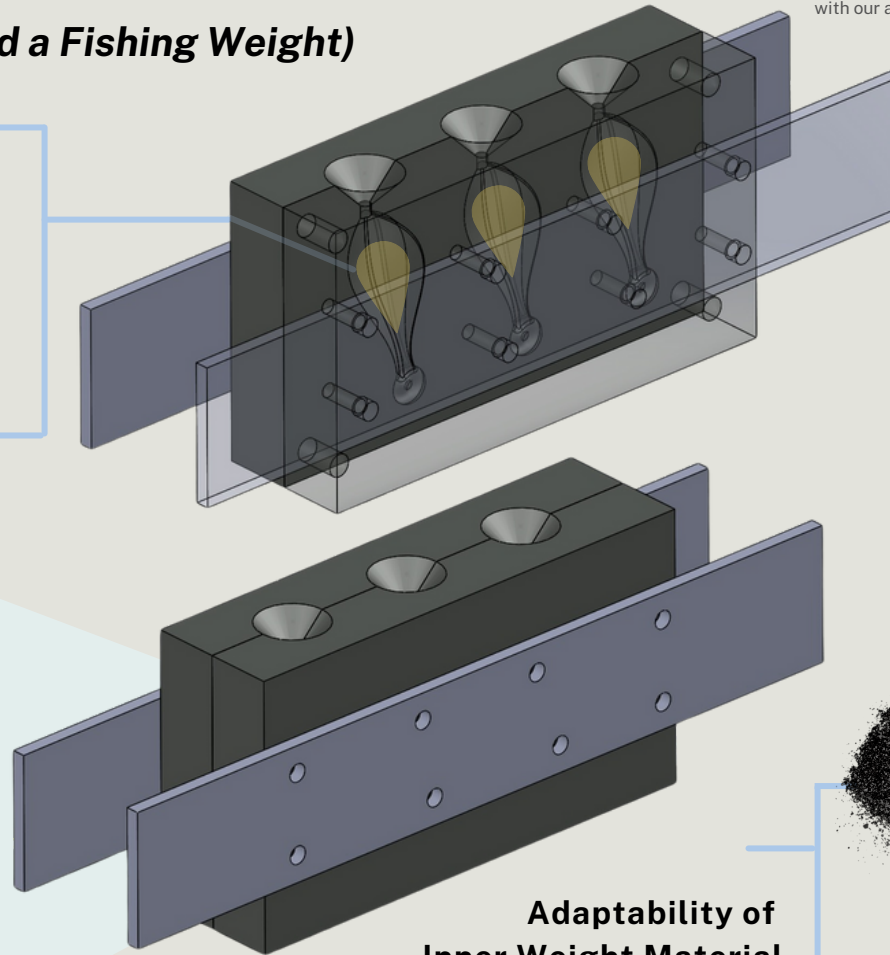
- Determine the best ratio system to use when adding internal components.
- Testing sealant methods to maximize efficacy and prevent water entering the inner chamber while in use.
- Test for decomposition timeline. Since it will likely not be fully immersed in the water, what impact do air, sun, and wind exposure have?



# Sinker *(Also Called a Fishing Weight)*

## Thermoplastic injection mold for external body of sinker

Similar to plastic bottle production, starch bioplastic is heated and injected into the mold in a liquid state. The inner core of the mold allows for the bioplastic to dry with an empty body cavity for iron filings or glass cullet to be siphoned into for weight.



CAD 3 oz Sinker Mold by Ash, Grab CAD - with our added inner core design



## Adaptability of Inner Weight Material

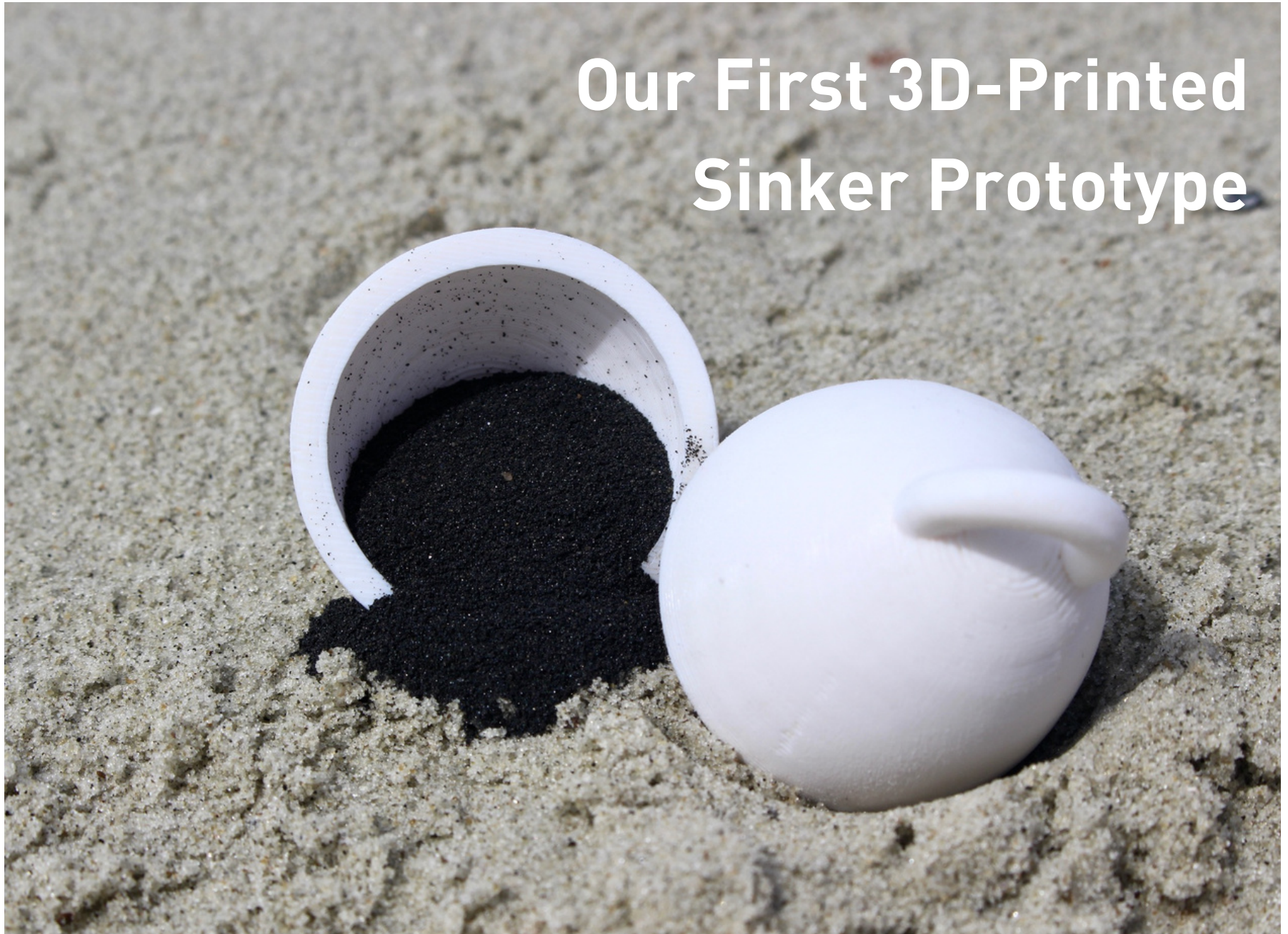
Based on the needs of the aquatic environment, we can change the inner material providing the weight in this product. For deep sea fishing, we opted for iron filings, whereas coastal or freshwater would use glass cullet, diverting glass waste from the Savannah landfill stream.



CAD 3 oz Iron Sinker, Magnacad LLC, Grab CAD



# Our First 3D-Printed Sinker Prototype



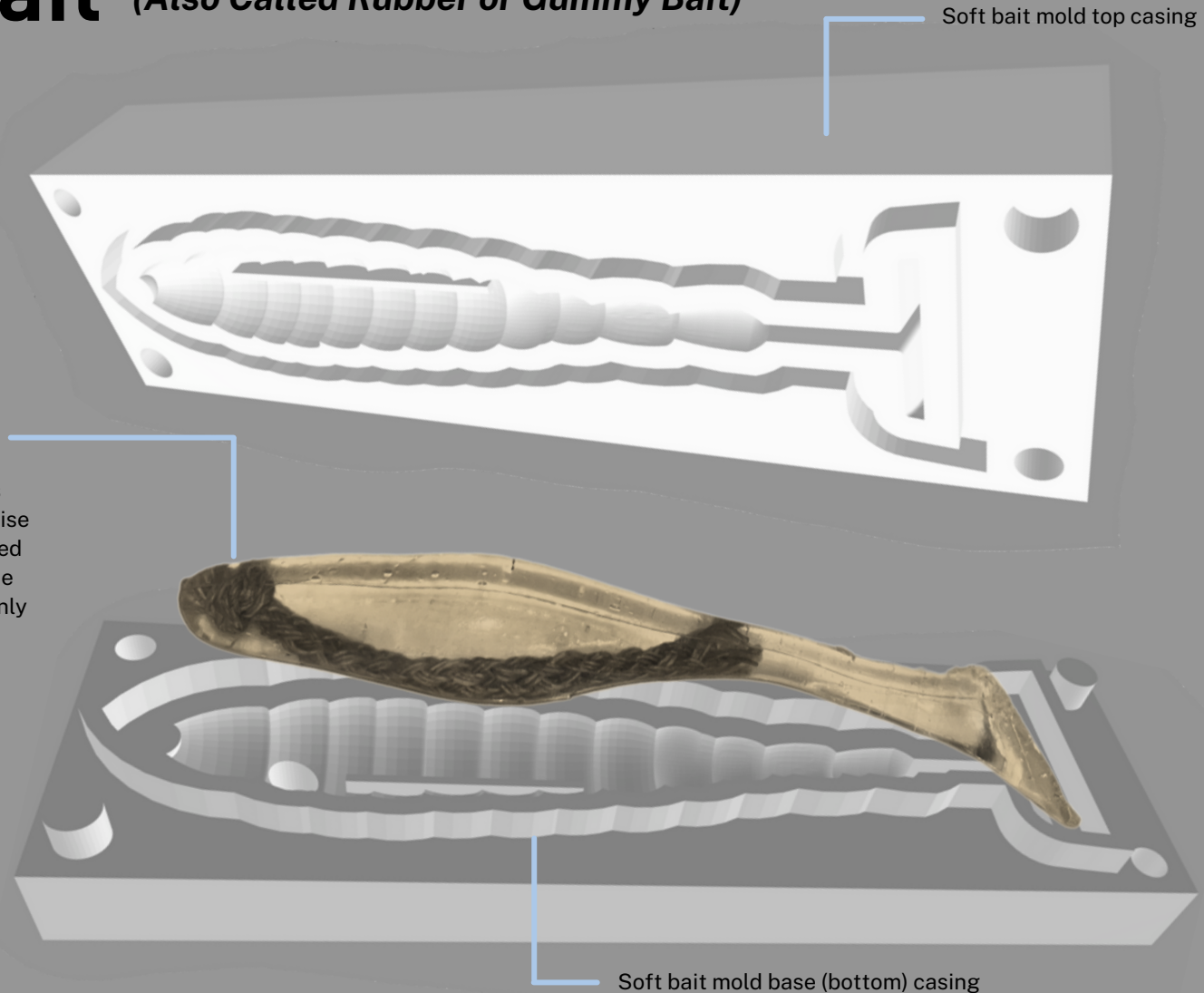




# Soft Bait *(Also Called Rubber or Gummy Bait)*

**This bait mold stabilizes and sets the curing soft bait as it dries into form.**

Our soft bait casing holds our casting mixture and jute twine hook anchoring point. Additives like ground dried fish flakes, anise essential oil, and garlic are added for enhanced fish attraction. The setting time for each batch is only about 10 minutes and then it is hung to cure.



CAD Soft Bait Mold  
by Chance Ott, Grab CAD



# Soft Bait Prototype Testing









# Material Transparency

Material transparency is at the heart of what we do. Not only do we want to use high-quality materials and ingredients, but it is our priority to ensure that we are as transparent as possible with our consumers about why we chose those ingredients and what purpose they serve.

The current transparency standards in the fishing tackle market incredibly low, and it is our hope that if we can prove that transparency is a positive aspect of a product in this insular market, that other brands will follow. It is our mission to change the industry for the better.

## Material Transparency Icons



Biodegradable



Regenerating



Made From  
Waste



Improves  
Its Environment



Compostable



Carbon  
Sequestering



Globally  
Available

## Jute Twine

Jute is a bast fiber used commonly in textiles and rope and is similar to hemp and linen.



## Fish Food

We use fish food as an attractant.



## PHB Plastic

PHB is a bioplastic produced by microorganisms that feed on starch.



## Gelatin

Gelatin is a byproduct of the livestock industry.



## Iron Filings

Iron filings are small particles left over from ironworking.



## Vegetable Glycerine

Glycerine is made from heating vegetable oils and treating them with a strong (natural) alkali such as NaOH.



## Glass Cullots

Glass Cullots are small particles of recycled glass.



## Spirulina Powder

Spirulina is a blue algae that is dried and converted to a powder.



# The Future of the Brand



Our long term goal is to be game changers within the fishing industry. With more time and resources for additional research, we would love dive back into further material analyses and field testing of our products. Eventually, we intent to expand the scope of the Panasea brand into more fishing and outdoor accessories as well as industrialized fishing products. Since ghost nets constitute one of the biggest polluters to marine ecosystems, we would love to use our powers for good and take a whole systems approach to such an immense issue. We are committed to being a catalyst for change in the outdoor activities realm as we believe that the outdoors can only truly be enjoyed if they are properly cared for.



# In Context



**01** Life's  
Principles

**02** Sustainable  
Development  
Goals

**03** Looking  
Forward

# Life's Principles

Biomimicry 3.8's Life's Principles are a distilled collection of strategies shared by the Earth's species. These principles helped today's organisms survive the 99.99% failure rate of 3.85 billion years' worth of evolutionary trial and error.

## Biomimicry 3.8's 6 Life's Principles



## Our Targeted Principles



We succeeded in meeting three targeted principles in our design. Analysis of these Life's Principles in relation to our innovative application provided a chance for us to rethink the motive behind certain decisions we made in the design process. In challenging those assumptions and choices, we both reinforced the strength of our design and adjusted aspects that were less sound. This allowed for a stronger design of our tackle products overall.







# Evolve to Survive

**Reshuffle  
Information**     *Exchange and alter information to  
create new options.*

As outsiders of the fishing community, we have a fresh take on tackle. We aim to bring an interdisciplinary approach to a very insulated market. It is important to us to prioritize balancing our innovative ideas with concepts that are proven within the current market.

**Replicate  
Strategies  
That Work**     *Repeat successful  
approaches.*

We have replicated the strategies used to make conventional lures, bobbers, and weights in our innovations. This being said, while the basic elements that make traditional tackle effective still remain in our iterations, we have revolutionized the materials used, and innovated some of the key functional issues that arise from soft bait, plastic bobbers, and lead weights. By incorporating knowledge from scientific experts and the fishing community, we aim to retain characteristics loved by the current market with a new dogmatic approach.

**Integrate the  
Unexpected**     *Incorporate mistakes in ways that can  
lead to new forms and functions.*

When we interviewed our Biologist at the Design Table, Cathy, we discovered an error in our original approach to conceptualizing the Staghorn Coral's propagation mechanism. Where we had incorporated blue algae pellets and iron filings in all bobbers and weights, Cathy saw potential for performance error. Depending on the aquatic environment, the nutrients offered by these material components could prove unnecessary or even harmful. Her main advice: these ecosystems have evolved to provide for themselves on a basic nutrient level. Don't mess with what works.

With this in mind, we discovered a new way to interpret propagation: via recycled glass cullet used in bobbers and weights. This brings a new life to Savannah's glass waste that would normally end up in landfill. Iron filings will still be incorporated in deep sea fishing tackle, as research has proven that small quantities deposited in these environments is beneficial.



## Use Life-Friendly Chemistry

### **Break Down Products Into Benign Constituents**

*Use chemistry in which decomposition results in no harmful by-products.*

All of our ingredients are natural from source to disposal. We have specifically worked with a biologist to ensure that our tackle won't harm the ecosystems that they enter or the wildlife that might end up eating them! Harking back to the propagation potential of the Staghorn Coral, we want the fragments of our tackle to enhance the aquatic ecosystems they enter.

### **Do Chemistry in Water**

*Use water as solvent.*

All of our ingredients use water as a solvent from their original state to our production, to their eventual end of life. Our products are intentionally designed to break down after a specific period of immersion and then benefit the environment that they are in.

### **Integrate the Unexpected**

*Incorporate mistakes in ways that can lead to new forms and functions.*

By reducing the quantity of materials used in the tackle items, we are able to not only control our environmental impact, but also easily communicate with the user what goes into our product in recognizable vocabulary.

### **Use Low Energy Processes**

*Minimize energy consumption by reducing requisite temperatures, pressures, and/or time for reactions.*

Unlike traditional plastics, our lures can be made with hot water and a little bit of time! Since our materials don't come from deep within the earth, we can drastically reduce the overall energy expended in production. Our weights use bioplastics, which are made by modifying starch. It's a lot easier to pick an ear of corn from a field than to dredge up a barrel of oil!





## Be Resource Efficient (Material and Energy)

### Use Multi- Functional Design

*Meet Multiple needs with  
one elegant solution.*

Our tackle meet the needs of the fisher, the fish, and the ecosystem. It is durable, intuitive to use, and effective in attracting desired catch for the fishing enthusiast. By keeping the base materials the same, we are able to customize each bait for a range of fish and ecosystem needs. Lastly, by replacing plastic and other toxic materials, such as lead and styrofoam, in the fishing market we can ensure that our product does not diminish the health of aquatic environments.

### Fit Form to Function

*Select for shape or pattern  
based on need.*

Instead of fitting form to function, we fit our function to the forms of tackle that already work. Our tackle mirrors the best options currently offered in a Trojan Horse paradigm. We know that in order for our product to gain traction within such an insular market, we must make the appearance and experience familiar to the sports fisher. By doing this, we are turning skeptics into early adopters.

### Recycle All Materials

*Keep all materials in a  
closed loop.*

Instead of ensuring that our materials are recyclable, which makes little difference if they end up in an ocean or bottom of a lake, the end-of-life for our tackle is merely a new beginning.





## Be Locally Attuned and Responsive

### Use Feedback Loops

*Engage in cyclic information flows to modify a reaction appropriately.*

By hacking the system, we have turned the reinforcing feedback loop of tackle pollution to damaged ecosystems to less fish into a positive, beneficial feedback loop. In our model, the more you fish with our bait, the more the ecosystem can improve, and therefore the more fish there will be to catch!

### Cultivate Cooperative Relationships

*Find value through win-win interactions.*

We often forget that when we interact with ecosystems, we are acting within ecosystems. By using biodegradable bait, you are in turn working with the ecosystem instead of against it. We like to put it in simple terms: **more fish, more fishing**. By this we mean that the less harm you cause, the greater potential for the fish population to thrive and therefore create more fish to catch! What's good for the fish will ultimately be good for the fishers.

### Use Readily Available Materials and Energy

*Build with abundant, accessible materials while harnessing freely available energy.*

When we starting thinking about the materials we wanted to use in our tackle, we aimed to go beyond solely biodegradable. Each of our ingredients serve different purposes when it comes to their environmental impact. Jute is a natural material that when grown actually helps to improve the soil. Gelatin is a natural byproduct of the livestock industry. and vegetable glycerin is made from vegetable fats via natural processes. In our weights, our bioplastic is made from processed starch and filled with post-consumer recycled glass and/or iron filings that help deep sea ecosystems. We also believe that in order to make an informed tackle purchase, we need to set a new ingredient transparency standard.

# Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a list of global goals for the entire planet to aspire to. The list was created by the United Nations in 2015, and have become a common language among sustainability experts. Panasea has narrowed down 5 key goals that we aim to strive for.



By reducing the amount of plastic lost in water due to fishing, the accumulated plastic within the cycle of consumption will be reduced and reduce the effect on human health.

Creating a more sustainable alternative for fishing gear will help an already thriving community to have a part in saving an environment that they value.

By providing an alternative that is just as good if not better quality that is also not harmful to humans, wildlife, and the environment from conceptualization to sales.

Creating products that are made of sustainable materials, benefit the environment its in, & has a function after being lost will help support marine life to develop.

By partnering with organizations that collect waste from oceans and waterways, we can collaborate & inform them of how our products work and they can inform us if it really does ease collection.



# Sustainability Wins

## 01: Achieving Full Biodegradability

Our fishing tackle works with the natural systems of aquatic environments instead of in opposition to them. Made with one hundred percent biodegradable materials derived from nature, we were mindful of ensuring our tackle not only does no harm, but enhances where it lands!



## 02: Full Material Transparency & Consumer Empowerment

we believe it is one thing to claim you have a 'green' product but we wanted to go several steps further and put our sustainability where our mouth is. Every product will proudly display its full list of ingredients to increase customer awareness and hold ourselves accountable for the safety of our customers and the fish they catch.



## 03: Initiating Real Change in an Untapped Market

Through our research, we have learned that the fishing market is ready to embrace change. It is our privilege to bring sustainability to such an enthusiastic market, one that is already deeply connected to the natural world. We see this as a partnership full of opportunity.



# References

**Please Note:** Photographs and images not directly cited were taken or made by the authors.

Ghosh and Jones. Roadmap to Biodegradable Plastics — Current State and Research Needs. ACS Sustainable Chemistry & Engineering 2021. DOI: 10.1021/acssuschemeng.1c00801.

Hui Ma, Shengyan Pu, Shibin Liu, Yingchen Bai, Sandip Mandal, Baoshan Xing, Microplastics in aquatic environments: Toxicity to trigger ecological consequences, Environmental Pollution, Volume 261, 2020, <https://doi.org/10.1016/j.envpol.2020.114089>.

Lordanskii, A., et. al. Current Status and Biomedical Application Spectrum of Poly (3-Hydroxybutyrate) as a Bacterial Biodegradable Polymer. Journal of Information, Intelligence and Knowledge Volume 6, (2015).

Narancic, T., et. al. Biodegradable Plastic Blends Create New Possibilities for End-of-Life Management of Plastics but They Are Not a Panacea for Plastic Pollution. Environmental Science & Technology 2018 52 (18), 10441-10452.

Schiermeier, Q.: The oresmen, Nature, 421, 109–110, <https://doi.org/10.1038/421109a>, 2003.

Yoon, J., Et. Al. Reviews and syntheses: Ocean iron fertilization experiments – past, present, and future looking to a future Korean Iron Fertilization Experiment in the Southern Ocean (KIFES) project. Biogeosciences, 15, 5847–5889, 2018

[https://cchealth.org/lead-poison/pdf/fishing\\_sinkers.pdf](https://cchealth.org/lead-poison/pdf/fishing_sinkers.pdf)

[https://www.atsdr.cdc.gov/csem/leadtoxicity/lead\\_found.html](https://www.atsdr.cdc.gov/csem/leadtoxicity/lead_found.html)

Ellen MacArthur Foundation. The New Plastics Economy. [https://plastics.ellenmacarthurfoundation.org/breaking-the-plastic-wave-perspective?gclid=Cj0KCQjwqPGUBhDwARIsANNwjV7k1DOr416k5e\\_OPkjsSOBNudCwid08WbTBtJlh47IE9CDpehceAlMaAiLEEALw\\_wcB#section5](https://plastics.ellenmacarthurfoundation.org/breaking-the-plastic-wave-perspective?gclid=Cj0KCQjwqPGUBhDwARIsANNwjV7k1DOr416k5e_OPkjsSOBNudCwid08WbTBtJlh47IE9CDpehceAlMaAiLEEALw_wcB#section5)

<https://www.marketwatch.com/press-release/sports-fishing-equipment-market-size-in-2022-31-cagr-with-top-countries-data-what-are-the-key-industry-trends-of-the-sports-fishing-equipment-market-in-depth-135-pages-report-2022-04-25#:~:text=The%20worldwide%20Market%20for%20Sports,3.1%25%20during%202021%2D2026.>

STAP, Marine debris as a global environmental problem (2011).

United Nations Environment Programme, Valuing Plastic: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry (2014).

Greenpeace Germany, Ghostgear: The Abandoned Fishing Nets Haunting Our Oceans (2019). [https://www.greenpeace.org/static/planet4-aotearoa-stateless/2019/11/b97726c9-ghost\\_fishing\\_gear\\_report\\_en\\_single-page\\_051119.pdf](https://www.greenpeace.org/static/planet4-aotearoa-stateless/2019/11/b97726c9-ghost_fishing_gear_report_en_single-page_051119.pdf)

6oz sinker CAD (by Ash) <https://grabcad.com/library/6oz-sinker-mold-1>

Fishing bobber CAD (by Mahbub) <https://grabcad.com/library/fishing-bobber-2>

