BENEATH THE GULF OF ALASKA

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ALASKA IS ALSO KNOWN AS "ALYESKA",

an Aleut word meaning "great land".

ITS NAME CONVEYS GRANDEUR.

It is derived from the same root as the Aleut term, "alaxsxaq" which can be literally translated into

"THAT WHICH THE SEA BREAKS AGAINST".

A few months ago, and much more north of now, I touched down in Alaska, the biggest state in the USA. It is the size of the next three biggest states put together, and accounts for more than 17 percent of the landmass of the United States. America's tallest mountain peak, Denali, as well as our highest tides, can both be found in the 49th state in the Union. Five different biomes make up this gigantic area, and some of the most charismatic megafauna in the world call its lands and waters home. From orcas and humpback whales, to grizzly bears and moose, Alaska and its fauna are recognized for their size.

Even its name conveys grandeur. Alaska is also known as "Alyeska", an Aleut word meaning "great land". It is derived from the same root as the Aleut term, "alaxsxaq" which can be literally translated into "that which the sea breaks against". And this it most certainly does. Through a unique combination of hydrology and geography, South-central Alaska sees gigantic tidal fluctuations of nearly 40 feet (12 metres) that can produce breaking waves that rush in twice daily at speeds of up to 24 miles per hour (38 kilometres per hour). The raw power of the ocean is regularly on full display.

I could easily spend a lifetime taking in the sprawling glaciers, powerful waves, majestic mountains, and peaceful valleys of this land. It was a challenge not to let myself get lost in the expansive beauty of the Alaskan wilderness, but as in awe of this place as I was, I had work to do.

In total, I spent almost a month up north, with my time split primarily between Anchorage and Seward. My friend and colleague, Michele Hoffman, invited me to join her to work on a film project for the University of Alaska Fairbanks (UAF) and I jumped at the opportunity. We spent several days in Anchorage at the beginning of the assignment to build up a stock footage library of landscapes and native animals, and then trekked down to Seward on the southern Alaskan coast to spend 18 days aboard an 80-metre, ice capable research vessel called R/V *Sikuliaq*. Nearly three weeks and 5TB of footage later, we were overwhelmed, but on track.

The purpose of the project was two-fold. The primary and most urgent assignment was to create a video that would serve as a "site review" for the National Science Foundation (NSF). The scientific operations happening aboard R/V *Sikuliaq* are all part of an ongoing, multifaceted project called Northern Gulf of Alaska Long Term Ecological Research, or NGA LTER for short. The research is funded in no small part by NSF grants, and every five years, the Foundation conducts what they call a site review to evaluate the work being done and the need for continued financial support. This site review was meant to be conducted in 2020, but since pandemic restrictions made that impossible, it was up to us to produce a short video that would serve in its place.

The second part of the project involved the creation of a series of short, educational videos detailing the complexities of the Gulf of Alaska food web. These will be used by UAF on the NGA LTER website to illustrate the complex relationships between the vast array of marine creatures that inhabit these waters, as well as our human connection to them.

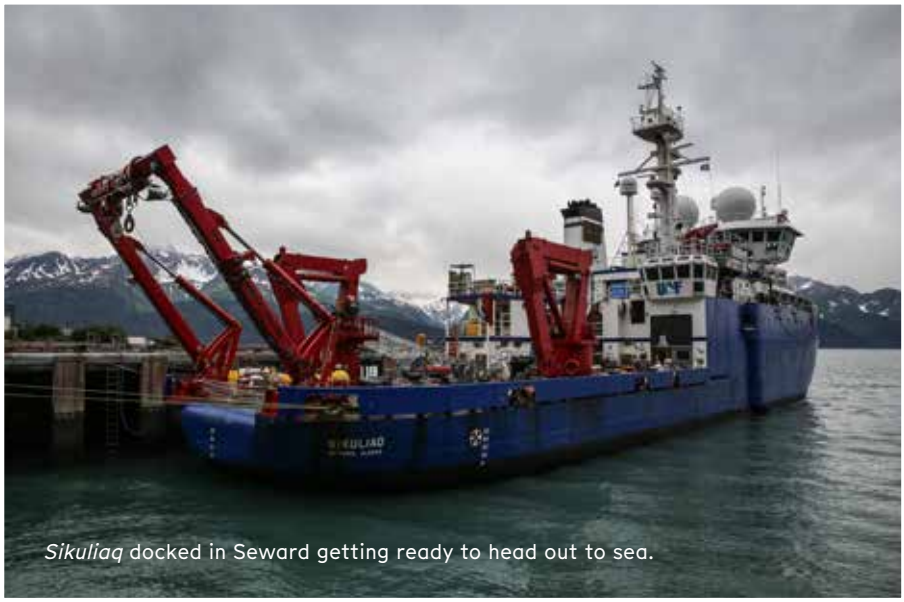
THE NORTHERN GULF OF ALASKA IS A SUBARCTIC MARINE BIOME

that occupies the deep (200-300 metres) continental shelf there. Inshore, fjords and sounds link the NGA to steep snow- and ice-clad mountains, and the shelf transitions offshore to deep canyons leading to an oceanic trench.

It took some time and effort, but once I got accustomed to saying that extra-long initialism, I was better able to focus on all the important research being done under the umbrella of NGA LTER. According to their official statement: "We provide educational resources, research, and data about the ecosystems

of the Northern Gulf of Alaska for teachers, students, and the community at large. Our research team creates information for our resources through sustained data collection and experimentation within our study area. This is a long-term ecological research program that investigates the features, mechanisms, and processes that drive the Northern Gulf of Alaska ecosystem production and foster its resilience."

Long-term, uninterrupted data sets are extremely valuable because it allows us to track trends and form insights, which help us understand the differences between natural cycles, abnormal occurrences, and shifting baselines. Some of the hydrographic sampling stations in Resurrection Bay, the fjord that connects Seward, Alaska, to the Northern Pacific, have been established for more than 45 years, which means that for almost every month starting in 1970, there exist snapshots of the water parameters in the NGA that tell the ongoing story of this region.



Sikuliaq docked in Seward getting ready to head out to sea.

The scientific operations happening aboard R/V *Sikuliaq* are all part of an on-going, multifaceted project called

NORTHERN GULF OF ALASKA LONG TERM ECOLOGICAL RESEARCH.

The Northern Gulf of Alaska is a subarctic marine biome that occupies the deep (200-300 metres) continental shelf there. Inshore, fjords and sounds link the NGA to steep snow- and ice-clad mountains, and the shelf transitions offshore to deep canyons leading to an oceanic trench. Environmental drivers in the NGA include strongly seasonal conditions such as heat, winds, freshwater input, and light.

In Situ Ichthyoplankton Imaging System or ISIIS is an underwater imaging system aimed at capturing in situ, real time images of marine zooplankton of relatively low abundance such as fish larvae and fragile gelatinous organisms.

Since the marine environment of the NGA is relatively inaccessible, fieldwork is restricted to tri-annual research cruises and moored instruments that can remotely collect data. Specific topics of interest include determining the drivers of spring algae blooms, examining the role of freshwater inputs in structuring the ecosystem, understanding what factors generate hot spots of primary and secondary production during the summer months, and analysing the distribution and composition of biological communities.

Studying these complex topics involves the use of a wide variety of impressive sampling instruments. The Conductivity, Temperature, and Depth, a primary tool for determining essential physical properties of sea water (CTD) sustained the heaviest use and was deployed at every sampling site to measure conductivity, temperature, and depth (pressure). The CTD is essentially a cylindrical cage rigged with an array of large sampling bottles referred to as a carousel or rosette. These bottles are triggered to close by a computer at a number of predefined depths so that water parameters can be measured at a range of vertical ocean points. We actually had two CTDs on board *Sikuliaq*: a large one capable of collecting 24 samples during each cast, and a smaller trace metal CTD with 12 ultra clean collection bottles on it tasked solely with measuring trace amounts of iron. These samples are used to measure what kind of iron is being introduced to the Gulf of Alaska from different terrestrial sources and how this impacts primary production, in this particular case, the ability of phytoplankton to grow.

Continuing on from these measurements were incubation experiments, which consisted of bottles filled with phytoplankton and seawater containing varying concentrations of micronutrients all contained within Plexiglas incubator boxes kept cold by a constant inflow of fresh ocean water. Samples were then collected daily to measure what kinds of plankton communities grew during the course of the experiment. Analyses of the results can help improve system models that predict how nutrients are moving around the Gulf of Alaska.

Then there was the sediment trap. This was a device

Two engineers, Charles and Cederic, make some last minute adjustments to the ISIIS before her first flight.

THOUGH OF ALL THESE INCREDIBLE CREATURES,

one by far was the strangest. I was introduced to *Phronima*, a transparent, predatory, deep-sea hyperiid amphipod that I came to learn

WAS THE INSPIRATION FOR THE FILM *ALIEN*!

equipped with sampling tubes mounted to a sturdy metal frame; these tubes catch particles falling toward the ocean floor by physically intercepting them during their downward transit. They collect fine sediment as well as larger accumulations such as marine snow, which is made up of organic matter, dead sea creatures, tiny shells, dust and minerals.

Of course, we cannot forget about the newest and most expensive sampling tool on board: the In Situ Ichthyoplankton Imaging System (ISIIS). The ISIIS is a type of DPI (Deep Plankton Imager) that was developed in collaboration between the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) and the subsea engineering company, Bellamare, LLC. According to Charles, one of the ISIIS engineers on the Alaska cruise, "ISIIS is an underwater imaging system aimed at capturing in situ, real time images of marine zooplankton of relatively low abundance such as fish larvae and fragile gelatinous organisms. The system utilizes a high-resolution line-scanning camera with a Light Emitting Diode (LED) light source, modified by plano-convex optics, to create a collimated light field to backlight a parcel of water. The imaged parcel of water passes between the forward portions of two streamlined pods [UW housings],

This *Phronima sedentaria* has consumed and carved away the insides of a salp, making the empty barrel structure its nest. In this picture, she has laid her eggs inside the barrel and extend her legs outside and pushed it around hence the nickname "pram bug". Though it seems a bit creepy, taking over another species' body, it is an intelligent way for *phronima* to travel, meet potential mates, have sex and raise children in the cold deep-sea environment. | Picture by Michael AW

Dr Hopcroft rinses plankton down the net into the cod end for collection and preservation.

and thereby remains unaffected by turbulence. The resulting very high-resolution image is of plankton in their natural position and orientation. When a sufficient volume of water is imaged this way, quantification of density and fine-scale distribution is possible." In far fewer terms, it's essentially like making a photocopy of a slice of the ocean.

In addition to this imaging marvel now in the modern arsenal of very lucky and well-funded physical oceanography programs, there is also an assortment of collecting nets used to sample planktonic communities. Upon initial consideration, it seems that the sophistication of the DPI would render collecting nets obsolete, but it turns out they provide the best data when used in tandem. As explained by Dr Ross Hopcroft, the Chair of the Oceanography Department at UAF and a lead scientist on *Sikuliaq*, "While the DPI gives us higher spatial resolution at a lower taxonomic level, the net sampling provides us with lower spatial resolution at a higher taxonomic level. Together they give us the best possible look at the ocean's planktonic communities."

The following nets are the ones we used on our research cruise: CalVET net, multi-net, and Bongo net. All three are collecting nets attached to stainless steel frames, but each one is designed to sample for different kinds of plankton at various ocean depths. Some are towed horizontally across the surface while others are pulled up vertically through the water column. The majority of the sampling was done at night to take advantage of the diel vertical migration (DVM), the mass movement of planktonic communities from deep waters during the day to shallow waters at night to feed. Despite the near-constant light present during the height of the Alaskan summer, poor weather always seemed to coincide with the evening hours, so the vast majority of net tows were done at night in wind, rain, and rough waves. Sea science in the Gulf of Alaska is not for the faint of heart or weak of stomach!

While nocturnal plankton sampling made for a terrible sleep schedule, it yielded my favourite views. I was fortunate enough to have been gifted a space at a lab bench equipped with a beautiful Leica microscope specially outfitted with a 3D-printed attachment that fit the Canon 1DX Mark ii I was using, and I spent a massive amount of time glued to the scope. Every night as plankton samples arrived in our nets, the graduate students would kindly save me "all the cool stuff" to film and photograph under the microscope. Copepods, pteropods, cephalopods, amphipods, mysids, and all manner of tiny marine aliens graced my field of view on a nightly basis.

A young pacific krill, *Euphausia pacifica*, a key species in northern marine food webs.

NET SAMPLING PROVIDES LOWER SPATIAL RESOLUTION AT A HIGHER TAXONOMIC LEVEL.

CalVET nets, multi-nets, and Bongo nets are used to sample for different kinds of plankton at various ocean depths. Some are towed horizontally across the surface while others are pulled up vertically through the water column.

Each time a net came up, there was something fabulous to film. One night, a bunch of kelp got caught in our net, and it was covered in hundreds of little skeleton shrimps, genus *Caprella*. Another cast yielded a collection of tiny octopuses no bigger than my thumb nail. The next night we got a baby Lion's

Tiny juvenile octopus under our miscoscope.

The pelagic sea slug, *Clione limacina*, is fondly called a sea angel .

THAT CONTINUAL PROCESS OF LEARNING, QUESTIONING,

testing, and improving is what makes science so infinitely appealing to me, and having the chance to be part of

RESEARCH AT SEA IS INCREDIBLY FULFILLING.

mane jellyfish (*Cyanea capillata*) that was small enough to fit under the microscope. Then we had a net pull that was full of crab larvae of a range of different developmental stages: zoea, megalopa, and immature adult. A different net gave us a few *Clione limacina*, a pelagic sea slug fondly referred to as the sea angel. Another night still, we got a handful of newly hatched squids in one net, and a couple of scale worms in the next. Even our passive data collection buoys were covered in life, providing us with scallops, barnacles, anemones, snails, and nudibranchs.

Though of all these incredible creatures, one by far was the strangest. I was introduced to *Phronima*, a transparent, predatory, deep-sea hyperiid amphipod, that I came to learn was the inspiration for the film *Alien*! *Phronima* seeks out a salp, a prominent member of the gelatinous zooplankton community, and proceeds to scoop out its guts and take up residence inside its hollowed-out carcass. *Phronima* females will then lay their eggs within the salp, creating a mobile nursery for their young. These fantastic little beasts are formidable parasites, and I am glad to report they do not exceed more than a few inches in length! If they were much larger, I might reconsider the amount of time I spend in the sea at night.

UAF grad student, Delaney Coleman, identifies amphipods down to species level under the microscope.

Our time on *Sikuliaq* eventually came to a close, and I was not ready to leave either the ship or the state. I had learned so much in a relatively short period of time, and I knew I would miss that constant onslaught of exciting new information when I returned home. It seems that the more we learn, the more we realize we do not know. That continual process of learning, questioning, testing, and improving is what makes science so infinitely appealing to me, and having the chance to be part of research at sea is incredibly fulfilling. From swift waterfalls to expansive landscapes to amazing plankton, all of it was unforgettable. How fitting then that the State flower of Alaska is the forget-me-not. For as long as I have my mind, I will remember my first trip to Alaska, and hope to return soon for another heavy dose of adventure OG.