

ONE FISH, TWO FISH, RED FISH, BLUE FISH
Presented to the SPHEX Club by
George Dawson
January 23, 2020

Genesis 1: 26-28

²⁶ Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals,^[a] and over all the creatures that move along the ground."

²⁷ So God created mankind in his own image,
in the image of God he created them;
male and female he created them.

²⁸ God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish in the sea and the birds in the sky and over every living creature that moves on the ground." (Genesis 1:26-28, New International Version)

Dr. Seuss

"One fish
two fish
red fish
blue fish.
Black fish
blue fish
old fish
new fish."

Red Fish

They are called "Reds". And they are also called Sockeye salmon - from a rough translation of the name Suk-Kegh, meaning red fish. The name originated from the Pacific Northwest's native coast Salish language dating back as far as 6,000 years ago. It refers to the bright red/orange color of their flesh which comes from the krill they consume during their Pacific saltwater years – and also to the bright red color their bodies take on as they return up freshwater rivers to their individual spawning grounds. Sockeye is one of five species of wild salmon caught in the Pacific Ocean today.

About half of all Sockeye salmon in the world start and finish their lives in the watershed that spills into Alaska's Bristol Bay. The Bristol Bay fishery is one of only two last great wild salmon fisheries remaining – the other being the wilds of eastern Russia. The 2019 Bristol Bay sockeye salmon run of 56.5 million fish was the fourth largest, and also the fifth consecutive year that in-shore runs topped 50 million fish. That year the commercial harvest was about 43 million fish. (Source: <https://www.nationalfisherman.com/alaska/bristol-bay-sets-record-value-for-2019-salmon-harvest/>). Bristol Bay Sockeye generate \$1.5 billion a year and provide nearly 20,000

jobs throughout the United States. (<https://www.worldwildlife.org/stories/why-is-bristol-bay-important-for-salmon-and-seven-other-bristol-bay-facts>)

All five species of Pacific salmon—Sockeye (Reds), Chinook (King), Coho (Silvers), chum (dog) and pink (humpback)—spawn and rear in the Bristol Bay watershed – but the Sockeye rules in Bristol.

New York Oysters, Louisiana Shrimp, and the Atlantic Salmon

Ten years ago, lifelong fisherman and New York Times bestselling author and winner of the James Beard Award for Writing, Paul Greenberg, wrote, “ three decades ago, nearly everything we ate from the sea was wild. Today, rampant overfishing and an unprecedented biotech revolution have brought us to a point where wild and farmed fish occupy equal parts of a complex marketplace.” Now in 2020, make that two-thirds or more farm raised. Greenberg points out that the complex interplay of global economic forces, lack of protection for wild fisheries, global population explosion, advancing genetic engineering and changing climate conditions all have and will continue to come into play. (*Four Fish: The Future of the last Wild Food*, Paul Greenberg (2010) Penguin Books and *American Catch: The Fight for Our Local Seafood* Paul Greenberg (2014) Penguin Books).

While the US controls more ocean than any other country on earth. more than two-thirds of the fish we eat is imported – and when you include the fish that are caught here and sent overseas to be processed and then sent back – the imports go up to 90%. In 2017 we imported 6 billion pounds most of it farm raised. The same year we exported 3.6 billion pounds essentially all of it wild caught. When it comes to aquaculture – farming fish – we rank 16th in the world with filter feeders like mussels, clams, and oysters as our leading crops. We have strict federal and state laws dealing with aquaculture safety and ecology – but lose import inspections. Less than 2 % of imported fish are ever inspected. On top of that repeated studies have uncovered a persistent (<https://www.foodandwine.com/news/seafood-fraud-study-2019>) mislabeling of seafood by species and source. Oceana sampling of retail and restaurant DNA samples puts it at 20 % or greater. There’s more than a 50 % chance that your sea bass or red snapper are some other species. And that wild Alaska salmon may well be farm raised.

Speaking of farm raised, in 2017 the average American ate about 16 lbs. of seafood compared to 216 lbs. of red meat and poultry. It was virtually all farm raised – and with what impact to our health, antibiotic resistance, and environment. Maybe our son Nick is right - become a vegan.

In his 2014 book, *American Catch*, Greenberg focus on the importance of habitat as one - but far from the only, - factor determining our relationship with the sea and seafood. He reels us in using three remarkable fish as bait – oysters, shrimp, and salmon. They each have their story to tell.

New York Bight Oysters

The 400,000 acres of water surrounding the New York/New Jersey inlet were once paved with oyster reefs. Oysters were a major food source for the natives of the area. With the first European settlers in the 1600's, things started to change. The shells were burned for the production of lime rather than returned to the water to serve as anchors for free swimming new larvae. Sewage fouled the beds - development overtook tidal basins. Even so consumption and production increased as farmed oyster beds were introduced in the New York harbor – often adjacent to effluent outlets. BY 1910, New York City produced 1.4 billion oysters a year. (Forber.com, oysters are back in NYC). In 1921 it all came to an end as cholera, typhoid, and hepatitis all were found to be present in oysters from the polluted waters. As oyster beds became unimportant and commerce more important, the result was dredging of progressively deeper channels and shoreline filling and development. A 20 foot harbor depth became 50 feet with dredging. Flats and marshes were filled and developed. As a result, the New York/ New Jersey basin is especially vulnerable. (<https://www.jcronline.org/doi/full/10.2112/JCOASTRES-D-13-00183.1>).

On October 29, 2012, Hurricane Sandy had its say. “It made landfall just off the southern tip of New Jersey and followed a path that closely marked the ancestral footprint of the eastern oyster.” (Geenberg, page 80-81.). Intertidal filled areas had sea walls breached. Dredged shipping lanes served as express lanes for cresting seawater. Without the drag of oyster beds and the benefit of calming marshes and beach areas, neighborhoods were flooded with washed mud, sewage and waste from the harbor floor.

Gulf Coast Shrimp

More than two years before Sandy a different kind of man-made disaster was getting ready to strike in the Gulf of Mexico. On the night of April 20, 2010, the alarm on the Deepwater Horizon, located 41 miles off the Louisiana coast, started sounding. Before it was over, more than 5 million barrels of oil would be spilled in the Gulf impacting 1,100 miles of shoreline and thousands of square miles in the Gulf. (<https://www.britannica.com/event/Deepwater-Horizon-oil-spill>). In truth, the alarm came at least 85 years too late. The destruction of the Mississippi River delta and the Gulf of Mexico began as far back as 1924 – the year oil was discovered in Louisiana.

- Dredging shorter channels to facilitate shipping and refineries soon followed, negatively impacting the beneficial cleaning action of flood waters sheeting across the marshes. As salinity increased marsh grasses died and erosion increased. Land began to erode into the Gulf.
- Development of the Mississippi River floodplain led to further soil erosion and fertilizer wash down the river and into the Bay.
- In the 1930's and 1940's, the Army Corps of Engineers completed massive projects to straighten the Mississippi River by bypassing large sections of the Greenville Bends eventually shortening the river by 150 miles.
- The final complete deforestation of the 24 million acres of “bottomland” forest that had once bordered the Mississippi River banks, The last 2 million acres were cleared for

agriculture in delta forests in Louisiana, Arkansas, and Mississippi between 1930 and 1976 with 80% of it to be planted in soy beans benefiting from Federal price support. (Technical Report SE- 14, January 24 – 26 1978 Workshop)

- Faster waterflow meant marshland and soil washed into the Gulf. Excess nitrogen and nutrients meant massive algae blooms in the Gulf producing a large dead spot of oxygen deficient water.
- In 2017 the National Oceanic and Atmospheric Administration (NOAA) estimated the size of the dead spot to be 8,776 square miles or about the size of the state of New Jersey. (<https://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured>).

No seafood better illustrates the paradox of American production and consumption than does shrimp. It has replaced tuna as the leading seafood consumed in the US – 4.4lbs per capita annually. It makes up a quarter of the average American seafood diet. US per capita consumption is growing rapidly from 2 lbs. in 1985 to 4.4 in 2017. And “all you can eat shrimp” appears on fast food menus across the country.

Sixty years ago, 70% of our shrimp was wild – much of it from the Gulf of Mexico. Today 90 % of US shrimp consumption is imported largely China, India, Indonesia, and Viet Nam shrimp farming operations. (<https://www.st.nmfs.noaa.gov>). Imports exceed 1.4 billion lbs. per year - 15 times the annual Gulf coast wild catch. (<https://www.nationalfisherman.com>).

And as Greenberg notes, when it comes to shrimp, the America been decoupled “ from the American coast and reattached us to ever more distant shores.” (Greenberg, Four Fish, page 92.). It doesn’t matter how things go in the Mississippi delta and Gulf of Mexico – we can still get “all the shrimp we can eat.” But must that mean killing mangrove forests in Viet Nam, antibiotic overuse and contamination Thailand , and bycatch damage to sea turtles and penguins?

Bristol Bay Sockeye Salmon

From the co-pilot seat of the DeHavilland Beaver seaplane I had a birds-eye view of a very different American coastline. Louisiana was 3,400 miles to the southeast. The Cook Inlet spread out before me. We had just taken off from Anchorage, Alaska - destination Twin Lakes 100 to the southwest in the Clark National Park and Preserve where my sister and her friend and I would spend the week in a remote cabin on the 6 mile upper Twin Lake. When the pilot navigated the mountain pass and left us on the floating dock, we were alone in the wilderness. That week we caught and ate lake trout and grayling, hiked and picked blue berries and dodged a few bears.

Twin lakes flows westward into the Chelicerata River and eventually into the Mulchatna and Nushagak Rivers and Nushagak Bay which opens into Bristol Bay. To the south is Lake Clark and Iliamna Lake and between them the proposed Pebble Mine site. In 2013, I was already getting emails about saving Bristol Bay.

In June and July mature Sockeye begin returning from the Pacific Ocean into Bristol Bay and then up the Nushagak and Kvichak rivers and into and their tributaries as well as the half dozen

other rivers which feed the Bay. It is the watershed where half of the world's Sockeye population spawns. Research suggests that a single species of salmon, such as the Sockeye, is made up of many different strains which each exhibit genetic differences. Individual strains relate back to specific spawning areas to which the salmon return. Salmon leave the saltwater of the Bay in "bursts" of salmon all a bound for a specific spawning area within the vast watershed.

When they reach the shallow spawning grounds the females use their tails to build small cavities in the sand and gravel which are called "redds". Each female deposits 2,000 to 5,000 eggs into the their redd which are then fertilized as males swim over them. Both the males and females die in early Fall within a few weeks of spawning.

(<https://www.adfg.alaska.gov/index.cfm?adfg=sockeyesalmon.printerfriendly>)

The eggs hatch during the winter and the young alevians remain in the gravel feeding from their yolk sacks. As they mature into small "fry" in the spring, they emerge from the gravel and move into freshwater lake "rearing areas" where they live for up to 3 years feeding on zooplankton and small crustaceans. (Where there are no lakes, they juveniles will move into saltwater immediately.). As they become smolts weighing several ounces, they are ready to make their springtime journey to saltwater where they grow quickly in the saltwater environment. They spend the next 2 to 5 years travelling thousands of miles in the counterclockwise current of the Gulf of Alaska. Eventually they return to spawn in the same exact freshwater location where they were hatched. An adult sockeye can range between 18 and 31 inches and weigh 4 to 15 pounds. (Source: Ibid).

This multi-stage life cycle has important implications for the future and sustainability of wild Salmon.

- Wild Salmon seem adapted to their specific micro ecosystem. To quote Greenberg, "Every salmon river has its own unique set of challenges to which the fish must adapt. Some rivers are very long...and require animals that can build up tremendous fat reserves in order to survive the extended journey. Others are very far North, with only a short season of warmer temperatures and require a fish that can maximize growth, particularly during its juvenile phase." (Greenberg, Four Fish, page 41.)
- Thus, the loss of a particular spawning ground likely means the loss of biodiversity, even though it does not result in the loss of the entire species. "Young salmon become particularly sensitive to the unique chemical odors of their locale when they enter the smolt period (when they begin their downstream migration to the sea). Odors that the smolts experience during this time of heightened sensitivity are stored in the brain and become important direction-finding cues years later, when adults attempt to return to their home streams."
<https://www.scientificamerican.com/article/how-do-spawning-fish-navigate-back/>
- Because of the multi-year and multi-stage lifecycle , the impact of environmental changing conditions is potentially delayed or masked. This makes it much harder to understand what is causing the populations to decrease or increase.

Consider the Chinook (king) population in the famed Yukon River which stretches more than 2,000 miles thru Canada and Alaska before dumping into the northern Bering Sea. Runs were strong during the 1980s and 1990s often upwards of 200,000 fish. By 2008, the harvest dropped below 50,000 fish, while many Chinook runs elsewhere in Alaska remained strong. Near record low fish count years have occurred over the past decade as well. In the Yukon River, catches were strictly limited so that enough Chinooks would survive to spawn in the tributaries.

There's an abundance of theories but no consensus on the reason(s) for the decline in Yukon River Chinook. One focus of attention is the incidental take of adult seagoing Chinooks by deep-water trawlers, but stricter by-catch limits haven't solved the problem. Many biologists suspect there are multiple causes " including overfishing, low freshwater survival, poor marine conditions, and climate change. A prominent suspect is the famous El Nino (or Pacific Decadal Oscillation), which causes ocean-wide shifts in temperature and storm patterns.

(Source: <https://medium.com/@aksalmonworld/the-longest-migration-yukon-river-king-salmon-f0357e55ed44>). Another possibility is the impact of declining sea ice and its effect of the salinity gradient that forms at the mouth of Yukon as it dumps into the Bering Sea.

But the message is clear. Salmon have a complicated lifecycle with multiple exposures. Some of these are in the ocean where they spend their adult phase. But exposure is great in the streams and lakes where they spawn, hatch, and develop from larvae to juveniles. The health ecosystem that determines the chemistry and properties of the watershed is critical to their survival.

The Pebble Mine

The ore deposits containing copper, gold, and molybdenum at the Pebble site were first discovered in the late 1980's on property owned by the State of Alaska and designated as a resource area. In 2001 the mineral rights were acquired by a Canadian company, Northern Dynasty Minerals, Ltd, which today owns the mineral rights to a 186 square mile area including the Pebble deposits. Actual ownership is held by Northern Mineral's subsidiary, the Pebble Limited Partnership, LLC. (PLP). Source: https://en.wikipedia.org/wiki/Pebble_Mine.

The Pebble Mine site sits in remote Alaskan wilderness 150 miles from Bristol Bay, between the drainages of Upper Talarik Creek and the Koktuli River. In its presently proposed configuration, the PLP permit application proposes to mine 1/8th of the mineral deposit. Opponents call the application a "Trojan Horse." Even at the reduced scale, the mine site would include a suite of facilities over several square miles. The heart of the operation would be the mine pit: 6,500 feet long; 5,500 feet wide and up to 1,750 feet deep. It would generate four

times as much water as any other mine in Alaska. It would destroy 3,500 acres of wetlands and 80 miles of streams. The wastewater implications are tremendous with a plan that calls for storing potentially toxic wastewater on site forever – an estimated 61 billion gallons of it. By comparison the Dallas Cowboys stadium filled with water would be just over one billion gallons. one billion. (Source: Trout Unlimited.) A large 600 foot tall bulk tailings storage facility capable of holding 950 million tons of waste rock would collect most of the milled ore. Smaller, lined tailings storage cells designed to hold 135 million tons of potentially acid generating mine waste would be segregated from the bulk tailings but be behind the same series of tailings dams. The storage facilities are designed to handle mine waste generated over 20 years of operations, according to Pebble’s documents.

The plan details a project that is much more than a mine. According to Pebble’s plan documents filed with the Army Corps of Engineers, , its reach would stretch 187 miles from the mine site north of Iliamna Lake to the edge of the Sterling Highway on the southern Kenai Peninsula. In between would be a natural gas pipeline up to 12 inches wide traversing the Cook Inlet sea floor for 95 miles from the Anchor Point area to a deep-water port west of Augustine Island. From there, a two-lane, private road would run 35 miles northwest to a ferry terminal on the south shore of Iliamna Lake. An ice-breaking ferry would then shuttle materials 18 miles across roughly the midpoint of the massive Iliamna Lake, which is the largest in Alaska. (Source: <https://earthjustice.org/features/alaska-s-bristol-bay-the-pebble-mine> and <https://www.alaskajournal.com/2018-01-10/permit-application-reveals-size-scaled-down-pebble-project>)

Since first envisioned in 2001, the Pebble Mine project has followed a controversial and twisted path filled with opposing views, investor optimism and desertion, reworking of mine scale proportions and scale, and scientific projections, changing regulatory opinions and intense lobbying. A lot of big fish and small fish have definite opinion the proposed Pebble Mine and its impact on the Bristol Bay watershed. You probably can guess where the “blue fish” stand. It may surprise you to learn that red fish are on both sides of the question.

Sarah Palin, whose daughter is named for the Bristol Bay, characteristically has tried to play both sides of the street. (While campaigning for governor in 2006, Sarah Palin said, “I am a commercial fisherman; my daughter’s name is Bristol,” and “I could not support a project that risks one resource that we know is a given, and that is the world’s richest spawning grounds, over another resource.” But two years later, she said she opposed a state ballot measure to restrict the discharge of toxic waste from new mining operations, which might have stopped the Pebble project from developing further. Some Alaskans took this as a betrayal of her promise to protect Alaska’s fisheries. The measure was defeated.

Source:<https://www.theatlantic.com/politics/archive/2014/03/is-alaskas-pebble-mine-the-next-keystone-xl/284251/>).

2001 – Norther Dynasty Mining acquires mineral rights to Pebble deposit

May 2010 – Tribes ask EPA to block Pebble Mine under Clean Water Act

July 2014 – Proposed 404 Determination ruling issued by Obama EPA after a 3 year scientific study

In July of 2014, following 3-year peer reviewed scientific study, the Obama administration EPA proposed limiting mining in the Bristol Bay watershed under section 404 of the Clean Water Act citing a finding that a pit mine would cause "complete loss of fish habitat due to elimination, dewatering, and fragmentation of streams, wetlands, and other aquatic resources" in some areas of Bristol Bay. The agency invoked a rarely used provision of the Clean Water Act that works like a veto, effectively banning mining on the site. (<https://www.cnn.com/2019/08/09/us/epa-alaska-pebble-mine-salmon-invs/index.html>)

This move was labeled a pre-emptive strike against the Pebble mine which had never filed a permit application for the project and the preemptive action was called a precedent setting step by Sen. Lisa Murkowski and other prominent Alaskan Republican elected officials who also considered it a precedent setting decision on Alaska's development of resources.

November 2014 – Pebble Limited Partnership suit filed by Tom Collier, CEO of PLP,LLC.

Tom Collier, who served as Chief of Staff, for former Republican Senator and Secretary of the Interior Bruce Babbitt during the Clinton administration, did not hesitate. Collier who was now CEO of the Pebble Project in 20xx, quickly filed suit in federal court against the EPA claiming federal overreach. In response, a Federal judge issued a preliminary injunction in November of 2014, pausing the EPA's efforts to finalize a preemptive mining veto.

Jan 2016 – IG clears EPA of bias charge

May 1, 2017 – EPA head, Pruitt, meets with Collier – directs staff to stand down on 404 Determination

With President Trump's election in 2016, things changed. On May 1, 2017 Trumps EPA head, Scott Pruitt, met with Tom Collier. That same morning his acting General Counsel sent an email to EPA staff "directing the agency to withdraw an Obama-era proposal to protect the ecologically valuable wetland in southwest Alaska from certain mining activities." (Source: <https://www.cnn.com/2017/09/22/politics/pebble-epa-bristol-bay-invs/index.html>). The Obama era lawsuit was settled on May 11.

May 11, 2017 – Collier/ EPA settle suit

July 2017 - EPA proposes to withdraw Proposed 404 Determination issues in 2014

Dec 2017 - PLP submits Permit Request to Army Corps of Engineers

Dec 12, 2017 – Ruckelshaus, Reilly, Babbitt, Whitman and multiple Republican former EPA Heads issue full page Washington Post Editorial – "Wrong Mine in the Wrong Place".

By the Fall of 2017, Ruckelshaus had seen enough, and he agreed to endorse a bipartisan public statement, drafted largely by former Interior Secretary Bruce Babbitt and ultimately joined by former Republican EPA Administrators William Reilly and Christine Todd Whitman, condemning the Pebble Mine. In 500 words published in the Washington Post in December 2017, these unimpeachable national leaders in environmental protection and conservation—including EPA Administrators from the Presidencies of Nixon, Reagan, George H. W. Bush, and George W. Bush—left no doubt about their strong opposition to the Pebble Mine. Source: <https://www.nrdc.org/experts/joel-reynolds/thanking-bill-ruckelshaus-father-epa-foe-pebble-mine>

January 2018 – Pruitt “mining likely pose a risk” – suspends proposal to withdraw Proposed Determination thereby stalling permitting by Army Corps of Engineers

In a surprise and unexpected announcement In January of 2018, Pruitt announced, "it is my judgment at this time that any mining projects in the region likely pose a risk to the abundant natural resources that exist there. Until we know the full extent of that risk, those natural resources and world-class fisheries deserve the utmost protection."

The EPA will continue to take public comment on the mine, and its announcement means the plan to withdraw the environmental protections is on hold while the EPA "receives more information on the potential mine's impact on the region's world-class fisheries and natural resources." (<https://www.cnn.com/2018/01/27/politics/epa-alaska-salmon-fishery/index.html>). Less than 6 months later he was gone.

June 2018 - Pruitt resigns

February 2019 – Army Corps of Engineers issues Draft Environmental Impact Statement on PLP proposed mine. Indicates final expected in 2020.

June 26, 2019 – Alaska Governor Dunleavy meets with Trump aboard Air Force One during Anchorage layover.

June 2019- EPA General Counsel orders Region 10 EPA administrator to resume consideration to withdraw 404 Proposed Determination

July 2019 – EPA submits comment on Army Corp of Engineer Draft Environmental Impact Study - “Likely understates impacts and risks”

July 30, 2019 - EPA withdraws 2014 Proposed Determination issued under section 404(c) of the Clean Water Act (CWA) for the use of the Pebble Deposit Area – clearing way for Army Corps of Engineer permitting process to continue.

September 2019 - Word spreads that Army Corp of Engineers will not hold public hearing on Pebble amended permit application Pebble amends

September 2019, - Alaska Republican Sen. Lisa Murkowski strongly criticizes Trump administration fast track handling of PLP permitting and says, “sound science must guide

federal decision making.” <http://midnightsunak.com/2019/09/27/committee-led-by-murkowski-rebukes-feds-on-pebble-mine-says-damage-to-fisheries-is-unacceptable/>)

October 2019 – Trout Unlimited files over its recent decision to withdraw protections for the Bristol Bay region of Alaska alleging that the EPA ignored science and the potential impacts of developing the mine when it withdrew the Bristol Bay Proposed Determination, and in doing so violated the Administrative Procedures Act and Clean Water Act. The U.S. Army Corps of Engineers cannot issue a permit to Pebble if the EPA’s decision on the Bristol Bay Proposed Determination is overturned.

October 2019 – Additional lawsuits filed against EPA from Native Alaskan coalition, Sierra Club, and a dozen other groups.

December 2019 - Senator Joe Manchin of West Virginia cited the Pebble Mine as “a perfect example” of a mining project that should not go forward.

January 2020, the fate of the Bristol Bay watershed and the Pebble Mine hang in the balance. And perhaps with it the fate of the Bristol Bay Sockeye salmon population.

Old Fish, New Fish

“Be fruitful, increase in number, fill and subdue the earth, and rule over the fish in the sea along with every living creature that moves on the ground.” Some would argue the Pebble project is about subduing the earth.

But when it comes to the part about being fruitful and increasing numbers, there is really no room for argument. World population has never been higher. The estimated 190 million people alive at the time of Christ became 990 million in 1800, 1.65 billion in 1900 and a 7.7 billion in 2019. The United Nations projects we will reach 8.6 billion in 2030 and 9.8 billion by 2050 (source: <https://ourworldindata.org/world-population-growth> and <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html>).

How does the world feed another one or two billion people – especially with sustainability about the sustainability of land based livestock? Not by catching wild fish. Worldwide – the wild fish harvest has plateaued for the past 4 decades at 80 million tons. (<http://www.fao.org/3/a-i5555e.pdf>). If fish are going to be part of the answer – it’s going to be from aquaculture – farmed raised seafood as compared to farm raised landfood. The United Nations 2016 Report on the State of Fisheries and Aquaculture Worldwide stated, “Whereas aquaculture provided only 7 percent of fish for human consumption in 1974, this share had increased to 26 percent in 1994 and 39 percent in 2004. “ In 2012 aquaculture surpassed the wild catch – with more than 90 million tons. (<https://ourworldindata.org/rise-of-aquaculture>) Meanwhile, the world’s wild fisheries are at or over capacity. Ninety percent were being fished at sustainable levels in 1976. By 2013 that had dropped to 69% - meaning that nearly a third were so over fished that their

future was in doubt. Less than 10 % of the fisheries in the world are considered to have additional capacity. (<http://www.fao.org/3/a-i5555e.pdf>).

How does the US relate to this growing world dependence on aquaculture? We are the largest importer of seafood in the world, and some of Americans' favorites—including shrimp, salmon and tilapia—are predominantly farmed these days. Yet, we contribute less than 1 percent of the world's total aquaculture production. This means we rely heavily on other countries to satisfy our appetites for seafood. That includes about two-thirds of the salmon we eat in the United States with most of it mainly imported from Norway, Chile, and Canada. (<https://www.fisheries.noaa.gov/2011-top-10-favorite-seafoods-united-states>).

So, how's this for irony? In May of 2019, Don Young, the Republican congressman for Alaska, has introduced the Keep Fin Fish Free Act, which would specifically prohibit federal agencies from permitting marine finfish aquaculture facilities in federal ocean waters, unless and until Congress passes a future law authorizing such permits. <https://thefishsite.com/articles/us-faces-federal-fin-fish-moratorium>. (To give Young credit - he says he's still undecided on Pebble mining - but that science should be followed in making the decision). <https://www.ktoo.org/2019/10/25/youre-not-listening-to-the-science-pebble-mine-fight-aired-at-us-house-hearing/>)

To quote a 2019 editorial in Scientific American, "The narrative needs to move away from "wild versus farmed" and toward "wild and farmed." Let's have serious, informed conversations about the state of seafood and how the U.S. can both contribute to and benefit from sustainable Blue Growth." (<https://blogs.scientificamerican.com/observations/its-time-to-be-honest-about-seafood/>)

Farm raised fish have a bad reputation – much of it deserved. But all farm raised fish are not equal. Just as all farm raised chickens are not equal. Among the problems:

- Contaminants – PCB's and dioxins have been a problem in farmed raised fish. And also in some wild populations. Both feed on other fish and tend to concentrate contaminants. Levels are reduced in populations fed from less polluted waters – so source matters. Plant based diets for farm raised fish reduce the problem - but lower Omega 3 levels.

Counter argument: PCP levels have been lowered – and wild caught fish have higher mercury levels.

- Antibiotics - "The recent growth of aquaculture is contributing to the development of the same resistance mechanisms also seen in agricultural production," said a 2015 meta-analysis published by the American Association of Pharmaceutical Scientists. <https://journalistsresource.org/studies/environment/food-agriculture/farmed-versus-wild-salmon-research-explainer/>
- Sea lice – and the pesticides to deal with them have been a significant issue in Scotland, Norway, and elsewhere.

Counter: Many farm-raised fish have avoided pesticide use – and use sucker fish to reduce sea lice. And livestock protein sources have similar issues.

- Ecosystem degradation and genetic modification of wild fish is no minor issue as demonstrated by Norwegian multinational Marine Harvest, the largest producer of farmed salmon in the world, which had 690,000 salmon escape from a farm in southern Chile last year. (<https://www.undercurrentnews.com/2018/07/23/salmon-escape-at-marine-harvest-farm-causes-sanitary-crisis-in-chile/>)

Counter – 30 to 40 % of wild salmon caught are started in hatcheries and released into the environment – also introducing genetic modification.

- Habitat destruction has been especially severe in Asia where inland ponds are used to raise shrimp and other sea food. Once the target of agent orange from US aircraft, now the mangroves of Viet Nam are under siege from the US “all you can eat shrimp” market.

Avoid most shrimp from Vietnam and Thailand.

- Depletion of wild fish caused by the reliance of many farm raised fish on ground wild fish as a primary food source. By most reports 3 to 5 pounds of wild fish pellets are consumed for every pound of fish harvest.

Last Spring the Food and Drug Administration lifted an import restriction allowing AquaBounty, a biotech company with facilities in Canada and Panama, to start raising genetically engineered (GMO) salmon eggs in America, effectively clearing the way for the country’s first GMO seafood—and first commercially raised GMO animal—to come to the US market. They took this action over the objections of Alaska Sen. Lisa Murkowski who referred to it as a Frankenfish made from genetic splicing of two fish together. (<https://newfoodeconomy.org/fda-aquabounty-gmo-salmon-seafood-restriction-market/>).

Actually it’s from three fish – the genetic code is comprised of components from three fish: base DNA from an Atlantic salmon; a growth gene from a Pacific Chinook salmon; and a promoter, a kind of “on” switch for genes, from a knobby-headed eel-shaped creature called an ocean pout. The US version will be raised in land based tanks located near Muncie, Indiana. Its big advantage is growth rate – the GMO salmon grows twice as fast as a farm raised Atlantic salmon - coming to market faster and consuming 25 % less food than traditionally farmed salmon according to AquaBounty.

Whole Foods, Trader Joe’s, Safeway, Kroger’s, Red Lobster, and other chains, aware that their customers are touchy about genetic engineering, have preemptively said that the fish will not be welcome in their establishments. AquaBounty says it plans to introduce the fish initially thru restaurants, emphasizing the sustainability, freshness, predictability and consistency of the fish they will raise.

More Questions than Answers?

In researching and writing this paper I'll admit I fell down the proverbial "rabbit hole". Coming up out of it I was left with both answers and questions.

The Environment

- I come down on the side of protecting the environment. The Pebble Mine doesn't seem worth it to me. I am not sure who decide the future of Alaska's an irreplaceable natural resource. But it should not be a pawn in a political chess game? Today the Trump administrations EPA Administrator, Andrew Wheeler, announced the repeal of EPA's 2015 definition of "Water of the US" under section 404 of the Clean Water Act. The new language stands to have a major impact on wetlands and streams and the permitting process affecting their development under the Clean Water Act. This comes on the heels of last fall of revisions proposed to section 401 which if they stand will have the effect of impeding a state's permitting process over new developments affecting water quality.
- In an increasingly divided world, how do we How do we apply the common=sense practices that Greenberg advises? Among them: (1) Reducing overfishing by common sense measures like ending government subsidies, (2). Setting aside ocean space as sanctuary no-fishing areas – just like developed nations do for national parks. (3) Strict international efforts to protect endangered species that routinely cross national borders and /or live in international oceans. The bluefin tuna is a great place to start, and (4) better understanding protecting the bottom of the food chain – the forage fish that are increasingly caught as feed for farm raised fish and domestic livestock.
- All of this is coming at a time when we are starting to see success;
 - The New York Times (March 15, 2013, Michael Wines) reported that 1996 Magnuson-Stevens Fishery Conservation and Management Act had helped restore the health f 28 of the 44 targeted species in US costal fisheries.
 - The Baltimore Sun reported a 2019 rebound of Chesapeake Bay Blue Crabs.
 - NOAA reported Atlantic Sturgeon recoveries in the Chesapeake Bay.
 - The Associated Press reported a "Conservation Home Run" in the rebound and reopening of the rockfish fishery off the coast of California and Oregon

What You Should Do:

- Decide how you feel about the environment and advocate for that view. My view is that we only have a limited number of wild places left on this planet. One of them is the Bristol Bay watershed. It should not be a pawn in a political chess game. Whatever your view may be, it deserves a proactive response.
- Secondly, our diets should show more respect for wild caught fish by paying more attention to sustainability, eating more diversely and in moderation. As individuals we

should take the time to select from sustainable populations and buy wild caught fish closer to the sea. Boat to table is the equivalent of farm to table. In the email I will push out to all of you I have listed several sources for the direct or near direct purchase of fish from those who catch it. It will include boat direct sources for wild salmon, scallops, and other fish.

- After that we should intelligently purchase fish from the more responsible farm raised sources. All farm raised options are not the same - as is the case with all wild caught options. My email to you will include Seafood Watch, the official site of the Monterey Aquarium which rates different seafood sources and types by sustainability and ethical standards. It is instructive and helpful.
- Eat more fish from the bottom of the food chain - especially the filter feeders. Oysters, mussels, clams and kelp. These filter feeders actually improve the environment and are key to developing a multicultural approach to seafood farming whereby multiple species support each other in an ecosystem. In a nod to Michael Pollan and Polyface Farm,
- Greenberg put it this way:
“Eat American seafood.
A much greater variety than we currently do.
Mostly farmed filter feeders.
Some explanations are in order.”
 (“Three Simple Rules for Eating Seafood”, Paul Greenberg, an editorial in the New York Times, June 13,201)

Finally, as we think about our future relationship with fish and the sea, I would ask that you remember how Dr. Seuss ended his poem:

“Today is gone.
Today was fun.
Tomorrow is another one”.