Eulachon— A difficult road to recovery

By Susan McDougall

Climate Change

Many factors play a role in the dynamics of a fish species' population. In recent years, the increasing awareness of climate change has become a subject of public accord and disagreement alike. One outcome of this awareness is the expansion of research efforts (and money) into this unprecedented phenomenon of a rapidly warming planet. For although natural climate cycles are a part of Earth's past, sometimes driven by catastrophic physical events, as far as we know the impact of a single species has never been so great. Humans are altering their own environment in a way that our ancestors could not have imagined.

"Climate change." It is a simple phrase with profound implications. More than an altered cycle of annual weather patterns, the inexorable rise in temperature affects physical and biological processes in ways whose outcome is difficult to predict. For the ocean, research into factors such as changing currents and their impact on nutrient production, alterations in water column dynamics, movements of warm water species into more northerly habitats, predation alterations, freshwater flows — the list goes on — is an acknowledgement of the magnitude of the problem.

In other words, study of climate changes implies that you are looking at an entire system, and, in the case of a particular species, at the outcome of alterations to its environment that includes one of the most difficult subjects to predict — flexibility in a rapidly changing world. It is not easy, but when a species is listed as 'threatened,' a combination of science, directives, rules, studies, and expertise must of necessity coalesce into a partnership with the goal of recovery.

Scientists have placed climate change at the top of the list for a continued role in the precipitous decline of the Eulachon. Yet there are many other factors to consider, and specifying not only those of the past but their potential role in the future is challenging. It is an interdisciplinary science, a new world in which the physical effects of rising temperatures on so many species are unprecedented.

Published by the National Marine Fisheries Service, the Eulachon Recovery Plan relies heavily on the studies and recommendations of a Biological Review Team (BRT). Noting that the southern distinct population segment (DPS) of Eulachon experienced its most precipitous decline in 1994, with other significant reductions in 2008 and 2017 (the second after Eulachon was listed as "Threatened") the BRT concluded that the most significant threat to Eulachon recovery is climate change. Dividing the Threatened population into four subpopulations — the Klamath, Columbia, Fraser, and British Columbia (to the Nass River, the northern extent of the listed Eulachon) — the team designated a "high" severity of climate change on each. In part, the reasoning behind this placement at the top of the list was an admitted *lack of knowledge* about the impacts of temperature rise, as well as a paucity of information about the Eulachon itself. At the time of the publication of the southern DPS Eulachon Recovery Plan in 2017, when 16 factors were prioritized, it was believed that climate change impact had increased since listing.

The placement of climate change as the most significant factor for its role in Eulachon fluctuations was based in part on the observation that it appeared to correlate with population declines. In particular, a review of the weather cycles that included the Pacific Decadal Oscillation (PDO), as well as the EL Niño Southern Oscillation (ENSO,) and the NOI (Northern Oscillation Index), among others, were implicated in the decline.

For researchers, the observation of increased sea temperatures and the drivers that influence it, such as the PDO, drive cyclical changes on many parameters. These include (but are not limited to) higher sea level, alterations in freshwater flows, increased riverine temperatures, fluctuations in phytoplankton and zooplankton populations, sediment dynamics, acidification, upwelling and its role in bringing nutrient-rich waters to the surface, and movements of species.

With the listing of a species, research expands into many of these factors, and along with it a hoped-for increase in understanding. But prediction is difficult, while the need for funds is always pressing, as researchers and managers alike work in a world where support may disappear as quickly as it becomes available. And short-term effects as well as long-term understanding depend not only on theory and investigation, but data as well. This implies increased surveying; it is insufficient to examine the fall-out of changes poorly understood. It is in part the incomplete understanding of atmospheric dynamics that places climate change at the top of the list.

Scientists investigating climate change find themselves in the position of not only applying knowledge of their own field but incorporating an interdisciplinary approach as well. Biologists may specialize in studying the impacts of various factors on a species, while atmospheric scientists investigate the dynamics of climatic cycles on ocean processes. Yet the two must come together for a fuller understanding. Studying the coupling of atmosphere and water may be the job description for atmospheric scientists, but understanding the influence of climate on water is a necessity for biologists.

Such is the case with the PDO, whose impacts are acknowledged in the southern DPS Eulachon recovery plan. This large-scale oscillation was “discovered” in 1996 at the University of Washington by atmospheric scientists involved with fish research. A cycle of cool and warm temperatures in the North Pacific that affects both land and sea weather patterns, the PDO is measured as an average of monthly sea temperatures north of the 20 degrees North Latitude with the global average anomaly subtracted.

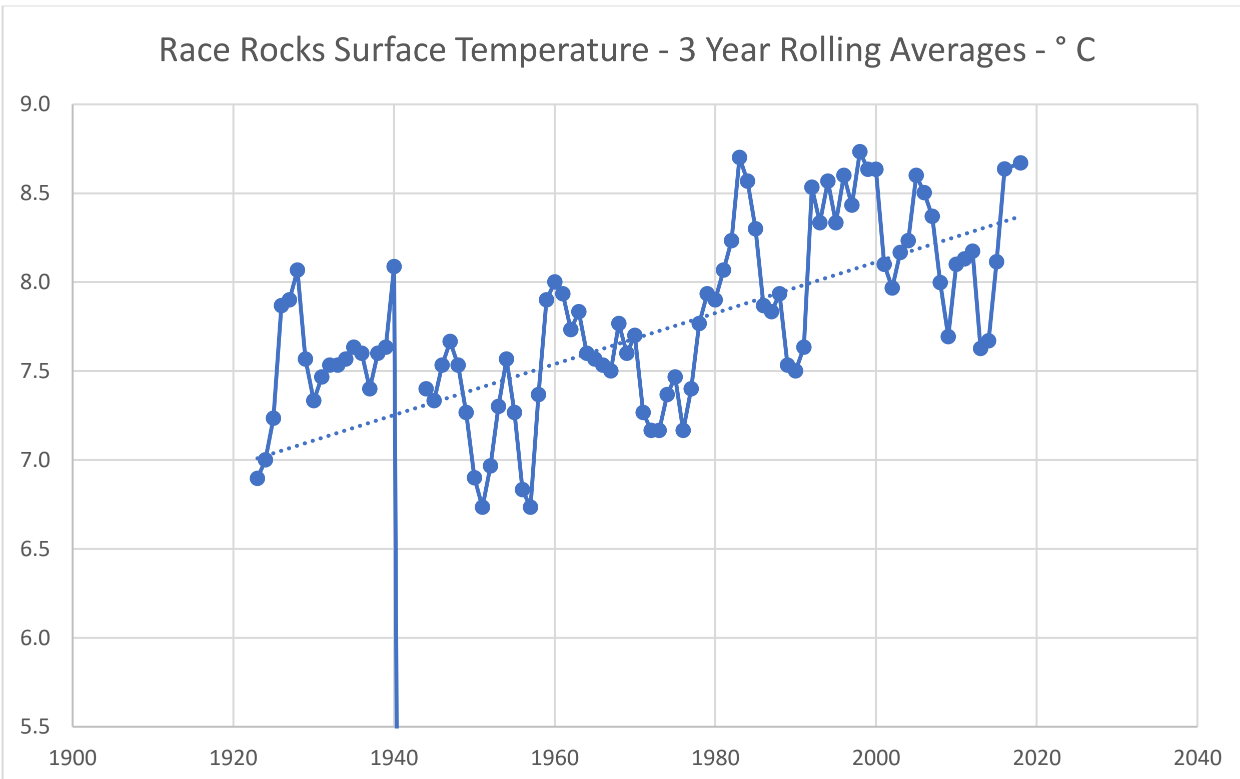
Connected with the more well-known ENSO (El Niño Southern Oscillation) and other cyclical patterns such as the North Pacific Gyre Oscillation (NPGO), the PDO may be responsible for delays in upwelling, affecting the arrival times of nutrient-rich waters of miniature plants and animals so vital to the entire oceanic food chain. The swings between warm El Niño conditions and the cooling trends of La Niña affect sea and land alike, and the temperature spikes and declines can be dramatic.

Then there is “the Blob,” a large warm water phenomena in the northern Pacific that began in late 2013 and spread to the Pacific Northwest coast by September 2014. The Blob persisted until 2016 and ultimately reached a breadth of more than 2,000 miles (3,200 km). Water temperatures ranged as much as 4.5° F (2.5° C) above normal. The effects across the animal kingdom were profound, with northward movements of several warm water oceanic species of particular interest. For the Eulachon, the Blob may have contributed significantly to the decline in 2018 when the count in the Columbia River reached its lowest since the 2010 listing.

Currently the PDO cycle off the Washington Coast is negative and La Niña conditions have prevailed for more than a year. The cooler PDO began in 2020, and it is predicted that the reduced temperatures will have a positive impact on Eulachon numbers. And indeed, the highest count in 2022 since 2011 was estimated at 18.6 million pounds. At the present time this is good news for the scientists who study the species, the regulators who set fishing quotas, and of course for the Eulachon itself.

Given the fluctuating nature of the various cycles and the overall effect of increasing temperatures, it seems prudent to look beyond the current season in forecast fish populations. Today, at the beginning of 2023, NOAA and several other sources report that La Niña “officially” ended in March. The ENSO oscillation suggests (and studies forecast) a high probability of a return warm El Niño event beginning in autumn. It is hoped that those with the responsibility of bringing about Eulachon recovery will consider all impacts, including the driving climate factor, in at the very least specifying the fishing regulations for this species.

Although it is not as simple as an annual cycle, processes that influence the Eulachon will continue to include perturbations such as ENSO, the PDO, and ENSO, in concert with the overall warming of land and sea alike from increasing CO_2 and other atmospheric components. A graph of sea surface temperatures (SST) at Race Rocks, British Columbia, a station off Vancouver Island with a long record of SSTs (today taken by satellite), visually demonstrates the overall increase over the past century (data from 1940-1941 is not available).



Coupled with the steady rise in sea surface temperatures, oscillations may exacerbate impacts on the Eulachon. Considered a cold-water species with an upper tolerance limit of 50° F (10° C), additionally this species is anadromous, making it sensitive to both oceanic and freshwater environments, although teasing out the relationships between the fish and its two habitats is difficult. As an example of a possible temperature-driven impact, a short-lived but strong El Niño took place in 1991-1992. Given that the spawning cycle of the Eulachon is typically three years, could this warming have been a factor in the precipitous decline in 1994?

Not all scientists agree with the emphasis placed on the effects of oscillations such as the PDO and the ENSO. At least one paper questions the relevancy of such indices to predicting fish population fluctuations. And complicating the analysis, recent research reveals that ecological variables and their relationship to climate indices such as those of ENSO and the PDO will change over time.

The second factor implicated in Eulachan decline and future health of the species is more quantified, although accurate data only became available at the beginning of the 21st century. Nevertheless, the growth of the Pink Shrimp (*Pandalus jordani*) industry in the 1950s would place additional stress on the Eulachon. Unfortunately, by the time accurate surveys began, the Eulachon had already undergone its collapse. However, the magnitude of the decline and the Eulachon listing in 2010 would focus attention on a saltwater species caught in nearly uncountable millions.

Unfortunately, along with this bonanza came an unexpected phenomenon, and within a few years the Pink Shrimp fishery would raise the alarm of "bycatch" to public awareness, researchers, and regulatory authorities alike. Bycatch referred then and now to the haul of unintended species, including the Eulachon, into the long nets that were designed to only reap the bounty of a tasty little shrimp.

And the bycatch number was enormous.

The Pink Shrimp Fishery

Although not recognized at the time, in retrospect 1949 was a momentous year in the history of the Pacific coast Pink Shrimp industry. In Louisiana, an inventive young man who was employed in his father's shrimp processing plant, repurposed the household washing machine into an automatic peeler. Perhaps a curiosity at the time, this machine would expand a fishery limited by meticulous hand processing, to one with unprecedented speed. Now shrimp would be caught in unprecedented numbers and quickly prepared for the market. The result was a fishery worth that was worth millions. Coupled with increased public demand, promoted by the industry, in the 1950s, within the confines of sleepy Grays Harbor on the Washington coast, the Pink Shrimp fishery was transformed.

However, it was not only the shrimp that would be swept up by the voluminous nets. Eulachon and other fish species were captured as well. Unwanted, they were separated and cast back into the sea. In time, someone would notice the large numbers of unintended fish that were being dragged in. The "bycatch" was significant, and, additionally, many of the bycatch species were in decline.

Yet forty years passed before the relationship of the nascent shrimp industry and the schools of Eulachon attracted official attention. And not until 2016 would a Management Plan for the Pink Shrimp industry be put into place.

In 1956, a Pink Shrimp fishing boat steamed into Grays Harbor. Part of an expanding Pacific fleet, the vessel was equipped with a large trawl net, one which could scoop up thousands of the one-inch shrimp in a single sweep. These small invertebrates are mostly at home on the muddy bottom of the continental shelf. They are not alone there, as many species live and hunt on the shelf. These include the little Eulachon, a forage fish with a long human association.

In 1958, more than 6.5 million pounds of pink fresh were harvested. Followed by a decline during the 1960s and then an expansion, at the time the shrimp fishery numbered nearly 100 vessels on the west coast. In 1990, these boats landed nearly 15 million pounds of Pink Shrimp. A decline in abundance resulted in the departure of boats, and today the fishery typically supports fewer than 30 vessels in Washington. However, the magnitude of the catch turned around once again in the late 1990s when the harvest increased. In the 21st century, the shrimp catch has had its ups-and-downs, but in the second decade some very successful seasons have transpired.

The device used to catch the small Pink Shrimp is a bottom trawl net. About 10 feet long, it has a wide opening of 40 – 60 feet and tapers towards the closed end. The net is typically towed slowly on or above the ocean floor, the wide mouth scooping the shrimp. Often a boat is rigged with two nets, and fishing is done during daylight hours; Pink Shrimp are diurnal, moving from the bottom during the day to the surface where they feed at night. Trips are often 3 – 6 days in length, although shorter times are required when fishing is good.

As the nets are drawn into the boat the shrimp must be sorted before weighing and processing. Particularly in the earlier years of the industry, a significant proportion of the catch consisted of creatures that have backbones and a proper brain — fish.

It can be annoying at times, separating the thousands of fish from the shrimp. It takes time, and there is no financial gain in the process. Of no commercial interest, the unwanted fish are returned deceased to the dark sea. Here millions of Eulachon and other fish species contribute their bodies to the ocean's nutrient balance. Unfortunately, this beneficial influx is often countered by a decline that affects the viability for the species. Extinction is an ever-present reality for many creatures of the sea.

The Eulachon is not the only fish species that experienced significant loss as bycatch. Concern over Pacific Hake, several Rockfish species, and more would in time attract the attention of observers, regulators, scientists, and others concerned with diminished numbers of overfished species. And the Eulachon was heavily fished.

Previous studies had examined modifications to nets used in several fisheries with significant bycatch. One device that showed promise for the Eulachon was a rigid panel or grate, typically located on top of the trawl net, where it provided an escape passage. In the early years of its inclusion, grid spacing ranged from .89 – 1.13 inches (22.6 – 28.6 mm), and sometimes more, but as more data became available it was apparent that a smaller mesh size reduced the Eulachon bycatch significantly. In 2014, Washington state set the requirement of a maximum grid size of .75 inches (19 mm).

After the inclusion of the panel, studies of the placement of LED lights on the trawl net yielded excellent results in reducing bycatch; it is thought that such lights enable the Eulachon to distinguish between the net and the ocean floor. Tests of different types and numbers installed resulted in a new requirement for the shrimp fishery. By 2015, most nets were equipped with LEDs, and in 2018 Washington made the lights a requirement, including specification of what type could be installed. From the shrimp fisher's point of view, reducing the time devoted to separating bycatch was welcomed.

As implementation of BRDs became requirement and bycatch was reduced, the issue of how much was taken in the shrimp trawl nets remained. Although fisheries personnel knew the catch was large, and encouragement for its reduction was confirmed by research and inclusion of reduction hardware, a definitive statement of "how many" remained elusive. Data on bycatch numbers was not available, at least not from observers independent of the fishery itself. Not until 2010, after the "Threatened" listing, would observers be placed onboard shrimp fishery vessels. Unfortunately, by that time, 16 years had passed since the collapse of the southern DPS Eulachon, a crash that brought increased attention to a fish that at one time were nearly uncountable.

Today, there is little doubt that BRDs reduce bycatch, certainly on an annual basis, but the question of how much reduction overall has been achieved is complicated, in part because of the advent of new methods for estimating Eulachon population numbers. As an example, spawning surveys potentially improve estimates, but their expansion makes comparison of Eulachon numbers before and after the surveys began difficult. The cessation of fishing for three years following the listing also complicates estimating numbers that might signify recovery, as does the resumption of fishing in 2014.

Given the observable fluctuations in the total population estimate, bycatch assessment is certainly improved with onboard observers. It is estimated that approximately 14% of shrimp fishery trips included observers, their work providing the first non-fishery attempt to estimate bycatch. And fluctuation in the shrimp count and number of vessels employed in the industry further muddies year-to-year comparisons, as does the number caught.

With these improvements in bycatch reduction, as well as the increase in spawning surveys and the inclusion of onboard shrimp fishery observers, the future for the Eulachon's recovery seems brighter, particularly beginning in the second decade of the 21st century. Yet there are forces that continue to impact the Eulachon that are not easy to quantify.

Climate Change, Bycatch, and Management

Climate change, the first factor listed by the BRT for its impact on Eulachon population dynamics, and as discussed above, is very difficult to assess. Even if scientists could more accurately predict temperature changes and the timing and magnitude of coupled oceanic oscillations, which are in all probability a simplification, the many other processes affected by temperature rise are not well understood. If an oscillation alters an ocean current, the outcome is observable, but the impact on phytoplankton, as an example, is difficult to assess. It is understood that fluctuations will be observed, but what will be the result of an overall decline in productivity for a species such as the Eulachon?

Given the difficulties of estimating the impact of climate changes alone, the nature of the Eulachon's anadromous life cycle further complicates recovery attempts. Such realities for researchers, field workers, and management as well emphasizes the advisability of a future-oriented management plan. Eulachon typically spawn when they are three years old. If a climate impact as severe as a strong El Niño is present, this implies that consideration must be directed not only to the present year, when sufficient prey may not be available, but also to three years in the future.

The second factor concerns the relationship between the Pink Shrimp fishery and the Eulachon. In the United States, this industry operates independently of Eulachon status. Whereas bycatch is to a great extent dependent upon the current number of fish, that value is not directly coupled with the shrimp catch. Just as the Eulachon catch will vary, so also will the shrimp, and although the two are affected by similar processes, such as temperature fluctuations, the relationship is not fully understood. So, once again, if an influx of warm water impacts spawning success three years in the future, that reality does not imply that shrimp will be impacted to the same degree or within a similar time scale. The shrimp population depends on other factors as well, including of course, the shrimp fishery itself.

A third factor to consider is the human management of the threatened Eulachon. A Management Plan is in place, and Recovery Reports are made public at five-year intervals. The fishery is subject to yearly quotas, and the data collected by this industry is considered important to quantifying Eulachon dynamics. Spawning surveys also contribute to more accurate estimates. Yet the understanding of this "data poor" species is arguably very incomplete. Like other forage fish, Eulachon numbers fluctuate "naturally," meaning in part, that they undoubtedly collapsed in the past. Indigenous people would have witnessed such oscillations. Yet these declines are not well understood, nor is the role of increased fishing in the 20th century. What is certain is that the management of all fished species rests in both federal and state agencies. And these organizations, particularly the state, wear more than one hat. "Management" implies a consideration of both fishing and recovery efforts, a marriage that at times seems to have opposed objectives. It is dynamic, not a fixed process.

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Some Numbers

Taking a closer look at the relationship between Eulachon numbers and estimated bycatch (beginning in 2010 when observers were present on shrimp vessels), some insights into both the impact of the Pink Shrimp fishery and the less quantifiable climate change itself are evident in the numbers.

In 2010, the year of the southern DPS Eulachon listing, estimates indicated that the bycatch numbers in Washington, Oregon, and California combined was over a million fish. The Eulachon total count (mean value of the high and low numbers) in the Columbia River was approximately 189,440 pounds or only 2,013,710 fish. In 2011, the bycatch was about 140,000 fish while in 2013 it numbered over 5,000,000 fish. Meanwhile, as these numbers imply, the Eulachon was increasing; in 2011, the Eulachon count in the Columbia River was estimated at a mean value of 36,775,900 fish, while in 2013 it was 107,794,000, nearly a threefold increase. However, the increase in bycatch was approximately 10 times that much, in part because the shrimp landed weighed in at 14,000,000 pounds in Washington. These three years that were instrumental in Eulachon recovery were also a time of increased Pink Shrimp catch. All Eulachon fishing was suspended during this time.

The high point for the Pink Shrimp fishery would come in 2015 when over 40,000,000 pounds were harvested. The bycatch was also nearing a maximum of approximately 5,362,000 Eulachon. That year the Eulachon numbers in the Columbia River were approximately 127,270,000 fish.

Thus, the increase in bycatch is in large part accounted for by more fish, but unfortunately the Eulachon population has exhibited large swings since listing. By 2017, the population was a tenth of the numbers estimated in 2014, and in 2018 it reached a low of 400,000 pounds, or approximately 4,910,400 fish. It was the lowest since the collapse of the early 1990s.

What was the bycatch at this time? In 2017, the bycatch was about 25,350 fish, a sharp decrease over the previous year; the shrimp fishery landings also decreased. in 2018, the inexorable rise began again, numbering 71,253 fish. Thus, while the shrimp fishery increased once again, the bycatch also began its unstoppable rise.

It is probable that this sharp decrease in the second decade of the 21st century of both the Eulachon and Pink Shrimp numbers was at least in part due to climatic factors. The "Blob," which was detected in 2013 in the northwest Pacific and had impacted coastal waters by 2014 did not dissipate until 2016. Beginning that year, the PDO was also positive. The impact on Eulachon numbers probably caught fisheries management by surprise. Following the listing and a three-year hiatus, commercial fishing resumed in 2014 with a modest catch of approximately 207,276 fish in the Columbia River. In 2019, declining numbers halted the fishery; in 2022, the fishery was back up to 305,780 fish.

Since its steep decline in the early 1990s and the subsequent listing of the species in 2010, much knowledge has been gained, thanks to increased quantification as spawning surveys have expanded, and bycatch observed and counted. Additionally, the two big factors of climate change and the Pink Shrimp fishery remain in the forefront of study as primary causes. Yet the future of the southern DPS Eulachon lies, as it does for all salt and freshwater creatures, in not only increased knowledge about ecosystems as a whole, but to the management practices that remain cognizant of both past impacts and future possibilities. Unfortunately, agencies responsible for so many fished species have a mixed record and are subject to fluctuations common to so many organizations — changes in personnel, political realities, and funding, to name just a few. And clearly the life cycle of the Eulachon is not understood well enough to predict the effects of warm water events such as those of El Niño, the Blob, and the general rise in temperatures due to increased atmospheric CO_2 and other compounds. These are nonconstant factors that are part of the reality of the 21st century.

While society seeks to understand climate change, the possibility of stopping rising temperatures seems very remote. Implementation of restrictions on emissions, alternative energy sources, land use, public awareness, and personal responsibility — all have their roles in attempts to slow the process. But the magnitude of the problem and the impact of the changes on species such as the Eulachon are part of the reality of a rapidly changing world. In the near term, there are limitations to what the individual can do, as well as the well-intentioned and committed personnel of organizations such as wildlife agencies and conservation associations. This alone places more emphasis on government regulation of industries such as the Pink Shrimp fishery. Restoration can play a significant role as well, if undertaken on a scale that has an observable positive effect. Fishing regulations should reflect the concern not only of the present but the future. Shoreline management, dams, changes in regulations; all should be scrutinized. It is a task for everyone.

Today, in 2023, the Eulachon population is increasing, a good sign for the fish, the fishing industry, managers, and the public as well. Yet what was acceptable in the past simply is not in the present. Hindsight is a luxury we can no longer afford. It is an uncertain time for the fish and for those who control its fate.