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Publication Date
2019-06-01

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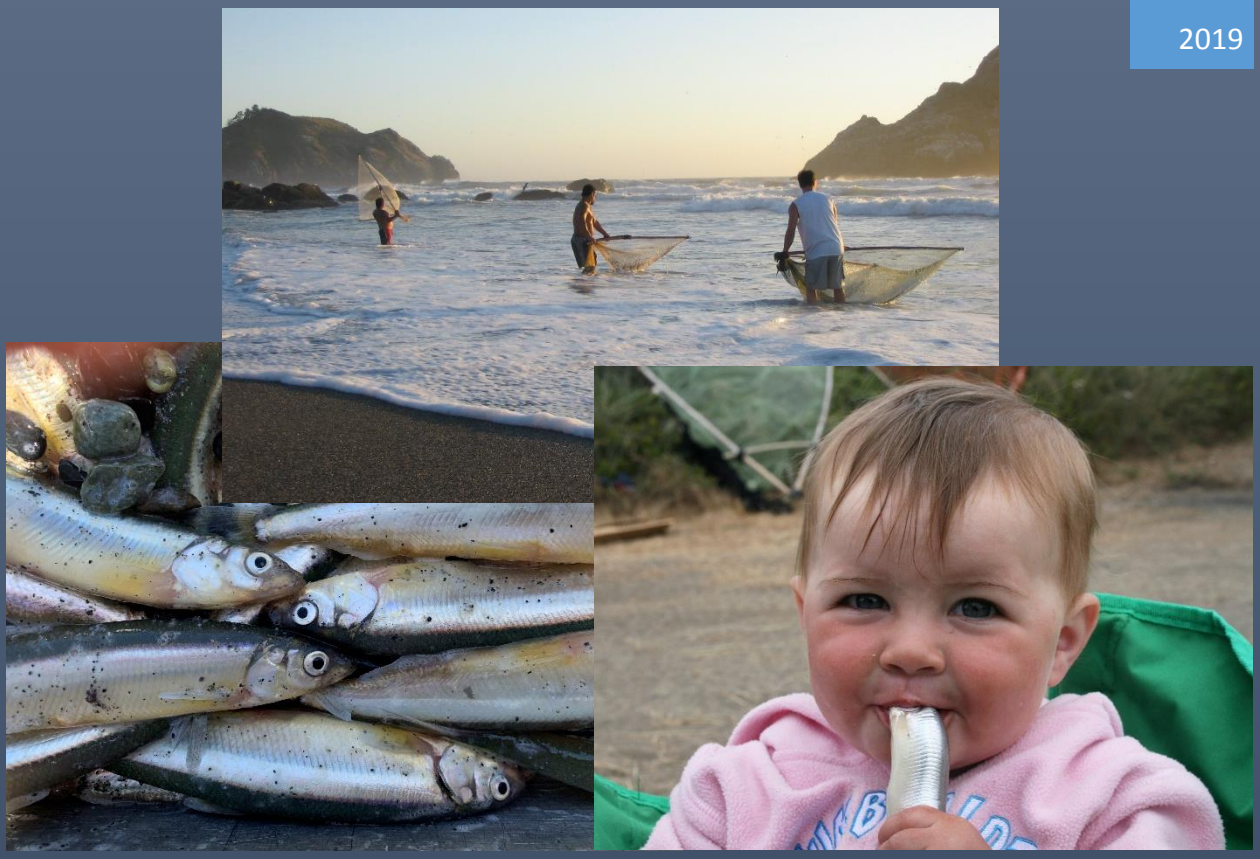

Tolowa Dee-ni' Nation Lhvmsr Habitat Assessment

ESTABLISHING BASELINE DATA FOR SPAWNING RUNS OF SURF SMELT

KEIGHLEY E LANE

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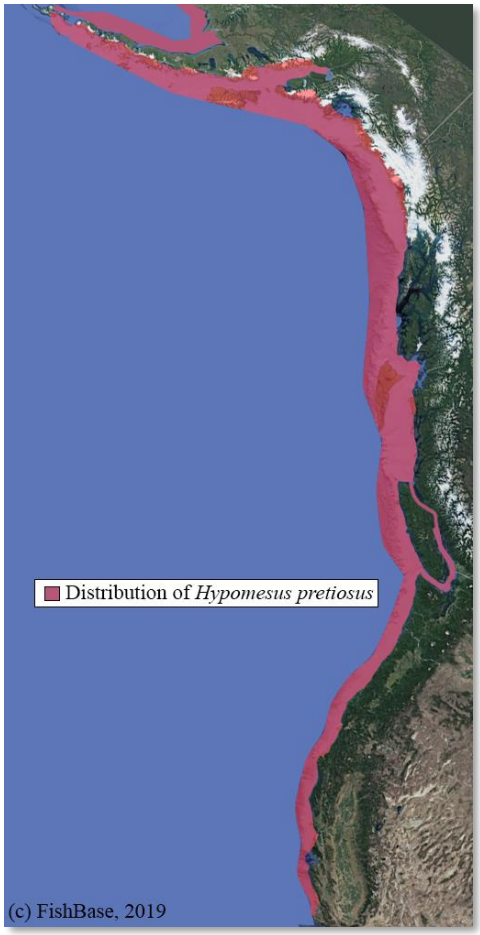
Surf Smelt Drying, Tolowa Dee-ni' Nation, 2009.

Project Goals

The status of surf smelt (*Hypomesus pretiosus)* populations have historically been overlooked by the Western scientific community, despite fervent commercial, tribal, and recreational supporters. Recent population declines within multiple forage fish species and smelt research based in Puget Sound have finally galvanized a trickle of interest around the species, in addition to research into what might be driving declines. The Tolowa Dee-ni' Nation (TDN) of California's North Coast has long understood the significance of surf smelt, called *lhvmsr,* utilizing it for both its subsistence and cultural value. Only a small number of Tribal families continue the traditional practice of "fish camp" in the lower Pacific Northwest, and native knowledge of this species is integrated in a complex understanding of natural systems. However, only in the last few decades has the traditional ecological knowledge (TEK) of indigenous people been elevated as hard data in scientific circles. In 2017, TDN partnered in a groundbreaking TEK study in which almost 90% of tribal interviewees ranked the current quantity of surf smelt as *worse or significantly worse* than when they were children. These results complement spotty commercial and recreational landings data estimates that may suggest catches have decreased.

Until now, there has never been an assessment conducted in the Lower Pacific Northwest or California on surf smelt habitat by a federal or state agency, tribe, or other entity. It is vital that possible environmental and anthropogenic impacts to surf smelt populations on the North Coast be characterized, and baseline data established. The following report not only visualizes and assesses six years of spatial surf smelt habitat data collected by TDN, but also evaluates a range of other data sources in order to compensate for the current "data gap" that exists for both this species and the greater North Coast region. This includes available habitat, erosion, visitation, construction, and more. Each avenue of investigation and its methods will be discussed by section. Hopefully these analyses will not only shed light onto the oft-neglected field of surf smelt study, but can also inform tribal and local management practices, and provide a basis for future study.

Lhvmsr Background



Lhvmsr, or Surf smelt, are a member of the Osmerid family of true smelts, and historically ranged from Monterey Bay, CA to Prince William Sound, AK. Their latin name, *Hypomesus pretiosus,* translates to "hypo" more than, "mesus" a half, and "pretiosus" meaning precious or valuable, paying tribute to the delicate nature of their mild meat.[1] They are also called day fish, due to their habit of spawning during the day, and also silver smelt. Surf smelt are one of seven true smelts native to California waters, an important species delineation as surf smelt have historically been misreported or combined with other species by nontribal entities.

They can reach 10 inches at total length, but are commonly caught at 5-7 inches.[2] Females typically grow the largest and live the longest (up to 5 years), while the males rarely live longer than three years. They are plankton feeders, relying on copepods, amphipods, crab larvae, marine worms, and larval fish.[3] During spawning, males will take on a rich golden hue, in contrast to the female's olive-blue back.

Surf smelt are a part of the forage fish niche, serving as lynchpin trophic links in nearshore food webs.[4] Surf smelt display many of the characteristics common to forage fish, including small body size, rapid growth, schooling behavior, and possibly strong population responses to environmental variability. Surf smelt are the dominant part of the diets of many fish, including Chinook salmon and Coho salmon (federally-listed threatened species), as well as seabirds and marine mammals; positive correlations between the decline of these forage fish and dependent species have been identified.[5][6]

Spawning Colors, (c) Discovery Passage Aquarium

Very little is known about surf smelt's life history, but the relative bulk of what is known centers around their

[1] Romero, P., 2002. An etymological dictionary of taxonomy. Madrid, unpublished.
[2] Hugg, D.O., 1996. MAPFISH georeferenced mapping database. Freshwater and estuarine fishes of North America. Life Science Software. Dennis O. and Steven Hugg, 1278 Turkey Point Road, Edgewater, Maryland, USA.
[3] Department of Fisheries and Oceans. 2002. Surf Smelt. DFO Can. Sci. Advis. Sec. Stock Status Rep. B6-09 (2002).
[4] Penttila, D.E. 2001. Effects of shading upland vegetation on egg survival for summer-spawning surf smelt, Hypomesus, on upper intertidal beaches in Northern Puget Sound. In: Proceedings of Puget Sound Research, 2001 Conference. Puget Sound Action Team, Olympia, WA.
[5] Springer, A., D. Roseneau, E. Murphy and M. Springer. 1984. Environmental controls of marine foodwebs: food habitats of seabirds in the eastern Chukchi Sea. Can J. Fish Aquat. Sci. 41: 1202-1215.
[6] Bargmann, G. 1998. Forage fish management plan. Washington Department of Fish and Wildlife, Olympia, WA.

spawning habits. It is during this time that they abandon the safety of the water to spawn at the water's edge, putting themselves at risk to both marine *and* terrestrial predators. Once in the upper intertidal zone, surf smelt deposit demersal eggs on coarse sand and gravel beaches during falling high tide. Studies in Puget Sound have concluded that surf smelt prefer "pea-sized gravel", a sand/gravel substrate mix ranging between widths of 1.0-7.0 mm[7], with some freshwater seepage. However, runs are highly variable even under the right tidal conditions, and they vary across the spawning season and even by individual beaches. Females are mature in one to two years and can produce 1,300 to 37,000 eggs. In California, most spawning occurs from June to September, especially during high tides and those high tides that occur in the late afternoon.[8]

Wave action, which averages at nine feet on the north coast, buries the eggs 0-6 inches in the gravel. The eggs have an adhesive coating which allows them to stick to the substrate and remain attached when the tide recedes. Eggs hatch in 2-5 weeks after spawning, however, they will hatch in less time during warmer conditions. Larvae are planktonic drifters for a number of weeks after hatching. Warmer temperatures cannot only delay the hatching of surf smelt eggs but also impede their survival. One Puget Sound study categorized embryos that overheated as having a 100% mortality rate, while ones that fell below freezing only suffered a 5% mortality rate.[9] Unlike Puget Sound surf smelt, those on the north coast do not seem to need the presence of overhanging vegetation to shade their eggs and maintain humidity.

Surf smelt eggs in gravel, (c) Friends of Skagit Beaches

It can be inferred from surf smelt's ability to survive freezing temperatures, direct sunlight, and the dynamic intertidal zone that they are a very hardy fish, unlike those found in Puget Sound. However, their biological distance remains to be established, although it is surmised that they may even be different subspecies. Unlike the recently unglaciated waters of the Salish Sea, Northern California surf smelt spawning sites might conceivably been quasi-stable for millions, not thousands, of years.[10] This makes it all the more critical that key north coast spawning grounds be identified, and the rest of the surf smelt life cycle in Northern California be understood. Uncertainty about the ecology and life history of surf smelt will make it difficult for managers to adequately protect them. There are currently no population size estimates for

[7] Shaffer, A. 2013. Nearshore Drift-Cell Sediments Processes and Ecological Function for Forage Fish: Implications for Ecological Restoration of Impaired Pacific Northwest Marine Ecosystems. Journal of Coastal Research 29:4, 984-997.
[8] California Department of Fish and Game. 2001. California's Living Marine Resources: A Status Report. Sacramento, CA.
[9] Lee, C.G. 2007. The effects of temperature and desiccation on surf smelt (*Hypomesus pretiosus*) embryo development and hatching success: Preliminary field and laboratory observations. Northwest Science, 81:2, 166-171.
[10] Personal correspondence with surf smelt biologist, Daniel Penttila, 2019.

most smelt species, including surf smelt, although these are among the dominant pelagic schooling fishes caught in research surveys in the Oregon-Washington region.[11]

[11] Brodeur, R. D., J .P. Fisher, D. Teel, T. Miller, and R.L. Emmett. 2003. Juvenile salmonid distribution, growth, condition, origin, and environmental and species associations in the Northern California Current. NMFS Fish. Bull 102:25–46.

Traditional Ecological Knowledge

Much like their surf smelt, Tolowa Dee-ni' Nation have lived on the north coast since time immemorial. The Tolowa Dee-ni' Nation is a self-governing sovereign Tribal nation of Tolowa Dee-ni', with headquarters on their Reservation in Smith River, California. The Reservation lands of the Tolowa Dee-ni' Nation are located directly on the Pacific Ocean coast. TDN have always stood up for the importance of traditional harvest in marine planning, most notably during the Marine Life Protection Act implementation of 2009. Through a difficult and arduous three year process, the Tribe succeeded in ensuring that although a marine protected area (MPA) would be designated at what is now Pyramid Point MPA, the regulations would continue to allow for non-commercial "tribal take" by members of TDN.[12] This victory only strengthens the idea that it is essential that the Tribe continue to engage in traditional harvest and management of species like surf smelt. Indigenous nations in California have each developed a unique expertise as resource managers with inherent rights and responsibility to their ancestral lands and waters. Tribal citizens who continue traditional stewardship practices have an intimate understanding of coastal ecosystems built from millennia of practical application of traditional knowledge as adaptive management. It is no coincidence that while only 22% of the world's land surface is currently within territories held by Indigenous Peoples, these areas account for over 80% of global biodiversity.

Fish Camp, (c) Tolowa Dee-ni' Nation

Two years after Pyramid Point was designated, TDN Tribal Fish & Game Committee identified surf smelt as the *first* keystone species of extreme concern. Reports from Tribal members identified this decline as beginning in the late 1990s. In May of 2017, the Tolowa Dee-ni' Nation and four other tribes released a report titled "Informing the North Coast MPA Baseline: Traditional Ecological Knowledge of Keystone Marine Species and Ecosystems"[13] (which should be read in conjunction with this report). Results from this report indicated that almost 90% of tribal interviewees ranked the current quantity of surf smelt *somewhat* or *significantly worse* than when they were a child **(Table 1)**.

Table 1

Smelt: Quantity Last Year to Adulthood	
Significantly better	0
Somewhat better	0
Same	5
Somewhat worse	13
Significantly worse	34
n=	52

Smelt: Quantity Adult to Child	
Significantly better	1
Somewhat better	0
Same	5
Somewhat worse	7
Significantly worse	44
n=	57

This official data is critically important because Tribal citizens constitute a vital "front line" user group with extensive marine

[12] Smith River Rancheria Surf Smelt Habitat Assessment and Conservation Plan, 2012
[13] Informing the North Coast MPA Baseline: Traditional Ecological Knowledge of Keystone Marine Species and Ecosystems, 2017.

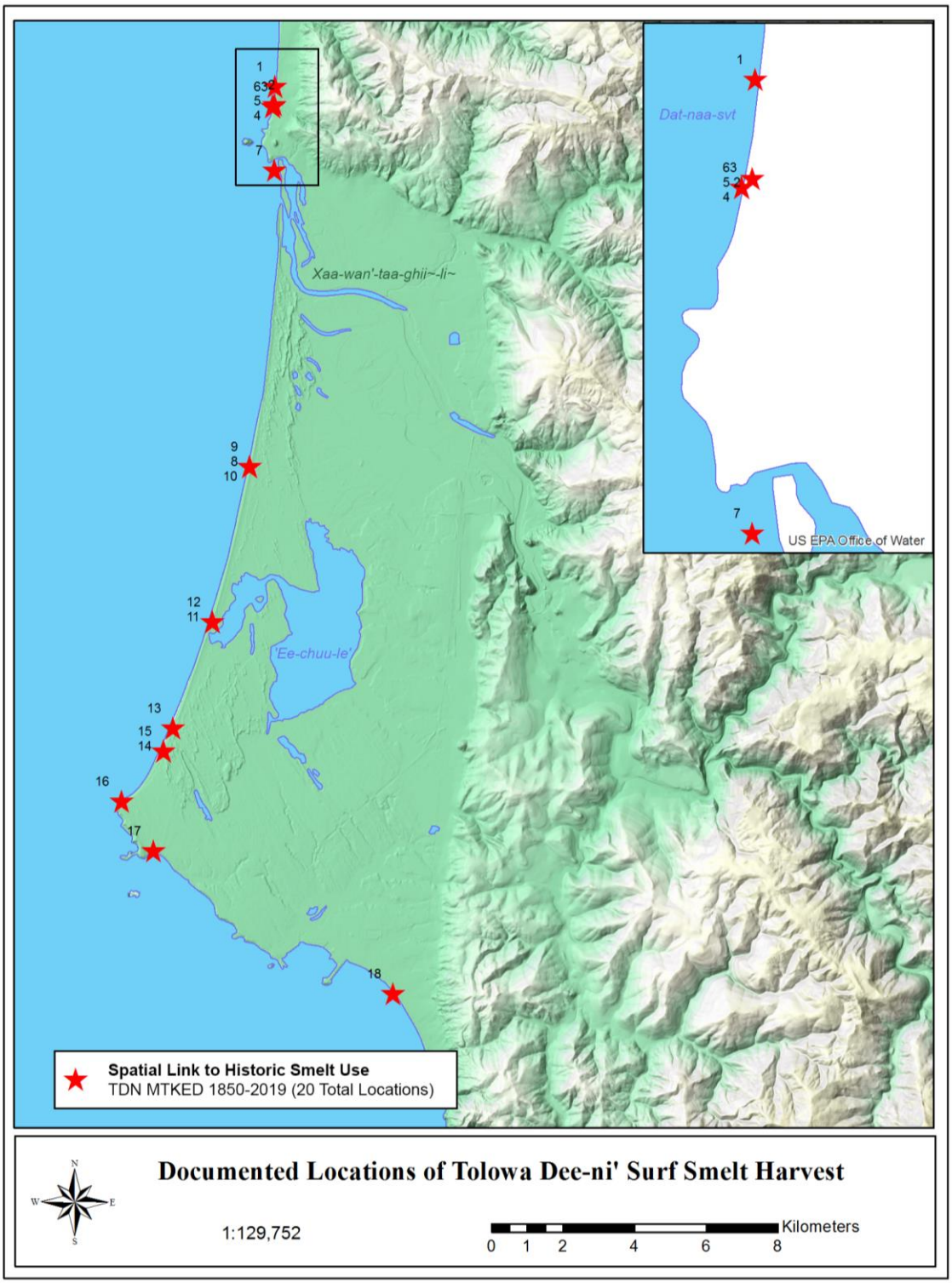
knowledge and stewardship practices that span countless generations. This frontline is magnified within the TDN community as fewer Tribal citizens participate in traditions. There are currently only two local families, the Steinruck/Bommelyns and the Browns, who continue the practice of "fish camp", also known as *lhvmsr xwee-ghatlh-ghelh*. Tribal families seasonally migrate to beaches within Tolowa lands to set up temporary housing on the beach to fish, camp, and traditionally process the surf smelt throughout the months of July to September. Surf smelt is harvested with a traditional A-frame net by the men of the society and then processed by the family members who oversee the family camp unit. The Steinruck family has provided generous amounts of personal information regarding their experience with lhvmsr/surf smelt and the changes they have seen on their traditional surf smelt harvest beach of Dat-naa-svt, where this project took place.

The North Coast MPA Baseline Report created a Marine Traditional Ecological Knowledge Database which covers 120 archival sources dating back to 1850, and 69 interviews with current tribal citizens. The project used community-based research to develop a baseline for ecological features and species observations, as well as to identify areas of concerns for long-term monitoring, one of those areas being surf smelt. One location can have multiple unique historic mentions. Additionally, an ancient Tolowa village, named "Sweetwater" in the scientific literature, has been the subject of significant archaeological interest and research documenting the excavation of many osmerid bones. It has even been proposed for listing on the National Register of Historic Places.[14] By visualizing all these points, this map serves to provide significant historical context for TDN's cultural ties to surf smelt within the California extent of their traditional lands, and characterize a baseline for where historic harvest occurred.

To understand the multiplicity of areas where the TDN used to find surf smelt, a map has been created from MTKED project points. Documented locations linked to traditional knowledge and/or harvest of surf smelt are visualized in **Figure 1**. Individual locations can have multiple links, and identifiers have been stripped to protect the confidentiality of the database.

[14] Tushingham, S. 2013.The Sweetwater site: archaeological recognition of surf fishing and temporary smelt camps on the north coast of California. Malki-Ballena Press.

Figure 1.



Keighley Lane, Scripps Institution of Oceanography, 2019

Dat-naa-svt Gravel Beds Assessment

I. BACKGROUND

Surf smelt research is a particularly small area of ichthyology and fisheries, especially outside of Puget Sound. Additionally, the bulk of the science that has been collected centers around the most visible part of the smelt life cycle- their beach spawning habits. The little certainty that has been gleaned from this small pool is surf smelt's preference for beaches with particular environmental factors conducive for spawning. Although it is possible that north coast smelt are a separate subspecies, for the purposes of this study it can be assumed the North coast surf smelt require a similar range of gravel substrate sizes, gravel bed temperatures, and beach elevation based on the established parameters for Puget Sound surf smelt. Establishing baseline data for individual spawning beaches like Dat-naa-svt is essential to future understanding. For example, only 10% of suitable beaches are utilized by surf smelt in Puget Sound.[15] Because a small proportion of sites appear to support most spawning activity, a conclusion consistent with year 2 egg counts, understanding what happens at relatively small individual beaches could greatly affect surf smelt production.

Gravel at DNS, 2019.

II. SURVEY METHODS

After determining that surf smelt were a culturally significant species in decline, TDN sought to analyze these factors for their traditional lhvmsr fish camp beaches: Dat-naa-svt (DNS) and Yan'naa-svt (YNS). Through grants provided by the USFWS's Tribal Wildlife Grants and the Administration for Native Americans, funds were secured to sample for suitable spawning habitat on DNS and YNS. Data at DNS was collected from 2013 to 2018, on a monthly basis. Yan'naa-svt collection began in 2016 and continued to 2018. This report primarily focuses on what was collected at DNS, as it had more total years of collection, three documented TEK points, and the only currently established family fish camp. A three mile stretch of DNS was surveyed by a team of two biologists. Survey days were chosen during or after the highest tides and with the broadest temporal sampling windows chosen, to mimic the area of beach that would be available to spawning surf smelt. Drift cells of suitable substrate were identified based

[15] Shaffer, A., et al. 2013.

on the 1.0-7.0 mm “pea-sized gravel” size range identified by previous studies as ideal surf smelt gravel.[16]

Marine Program Manager Rosa Laucci sampling.

These cells were then mapped with a GIS handheld device, slope aspect was measured with a trimble, and ambient and bed temperatures were taken. Additionally, visitors, weather, and extraneous circumstances were notated. Sometimes, beds were too saturated to take adequate temperature readings, either due to wet weather conditions or prior extreme tidal levels. Early project components included sampling freshwater input quality, as well as sampling for eggs. These components were phased out early on, as they were too taxing on the Natural Resource Department’s limited time and energy. The beach was divided into five ~1000 ft long sections, based on the current and historic mapping and sampling convention used by Washington Department of Fish & Wildlife in Puget Sound, and assigned sequential beach section ID numbers of 1 through 5 (**Figure 2)**. This sectioning allowed for heterogeneity in sampling protocols without requiring sampling on a logistically unmanageable scale.

III. GIS METHODS

Five years of data provided a solid baseline for estimating constants on DNS. TDN’s Natural Resource Department recorded over 14,000 square feet of suitable gravel, resulting in 449 individual polygons. After initial cleaning, the polygons were spatially joined with spreadsheet data, then merged to create a unified vector dataset. A visualization of polygon density was completed in ArcGIS to map areas of high concentrations of suitable gravel **(Figure 3)**. Polygons were converted to centroids, and the study area was converted to a fishnet grid. Centroid density was found by performing “Points in Polygon” within the fishnet. Measures of bed temperature, ambient temperature, and slope were analyzed outside of ESRI ArcMap in Excel.

IV. RESULTS

As seen in **Figure 3,** certain areas of DNS were found to have higher concentrations of gravel density over the course of the 5 years. Sections 4 and 5 in particular exhibited the highest frequency of suitable gravel density. However, average gravel area for all sections tended to stay relatively flat over the study period (**Figure 4)**, which we might infer to mean that DNS has consistently provided suitable for gravel area for surf smelt. It is important to note that this project was conducted long after declines had already been reported by community members for surf smelt, and may not be representative of beach characteristics when surf smelt were plentiful.

[16] Shaffer, A., et al. 2013.

Slope aspect was also recorded for each gravel bed. Average slopes per section ranged from 2.4-3.3% across all sections (**Figure 5)**. Smelt are believed to be able to tolerate a spectrum of beach slopes.[17] It is likely that the slope of DNS is suitable for surf smelt spawning.

The maximum, average, and minimum gravel bed temperatures were averaged for all years (**Figure 6)**, as well as during the month of July (**Figure 7)**. July is peak spawning time for surf smelt, and bed temperatures during this month may be crucial for spawning success. Gravel bed temperatures above 95 degrees Fahrenheit are reported as being fatal for 100% of incubating surf smelt embryos.[18] Even if not over this threshold, high temperatures could still possibly increase mortality of surf smelt embryos by lowering the surrounding humidity.[19] Not all years were sampled during the same months, so a July average was completed along with a yearly average. In July, between 2014-2018, average bed temperatures ranged between 63 and 59 degrees Fahrenheit. *Total* annual average temperatures between 2013-2018 stayed in the range of 60 degrees Fahrenheit, with the exception of 2014. One sample day resulted in measurements of up to 74.6 degrees Fahrenheit. Gravel bed temperatures appear to be in the suitable range for surf smelt.

[17] Quinn, T. 2012. Patterns of Surf Smelt, Hypomesus pretiosus, Intertidal Spawning Habitat Use in Puget Sound, Washington State. Estuaries and Coasts 35, 1214 – 1228.
[18] Rossell, L. 2006. Temperature and shading effects of surf smelt, Hypomesus pretiosus, Egg Survival. Shannon Point Marine Center. Bellingham: Western Washington University.
[19] Lee, C.G. 2007. The effects of temperature and desiccation on surf smelt (*Hypomesus pretiosus*) embryo development and hatching success: Preliminary field and laboratory observations. Northwest Science, 81:2, 166-171.

Figure 2

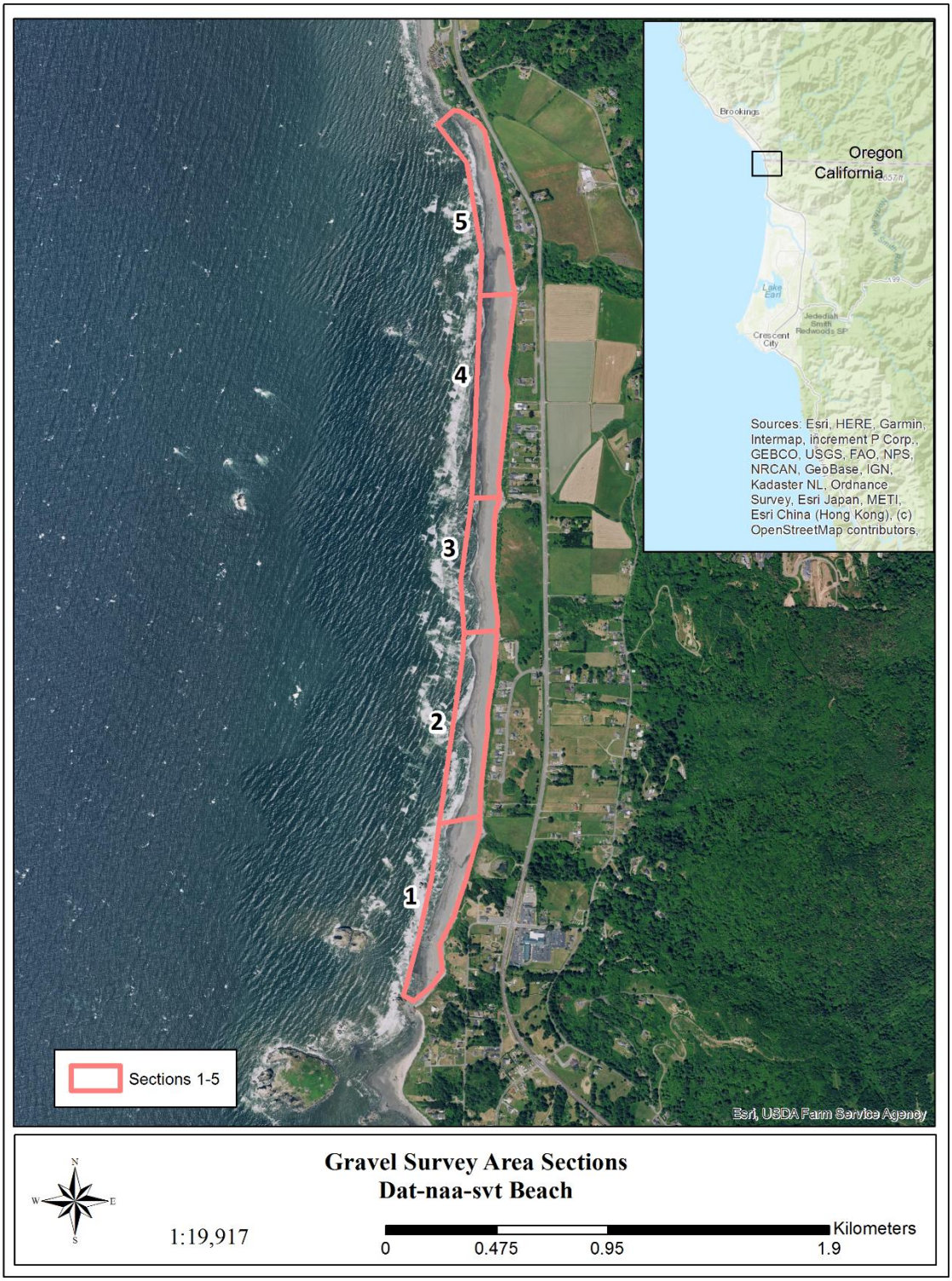


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Figure 3

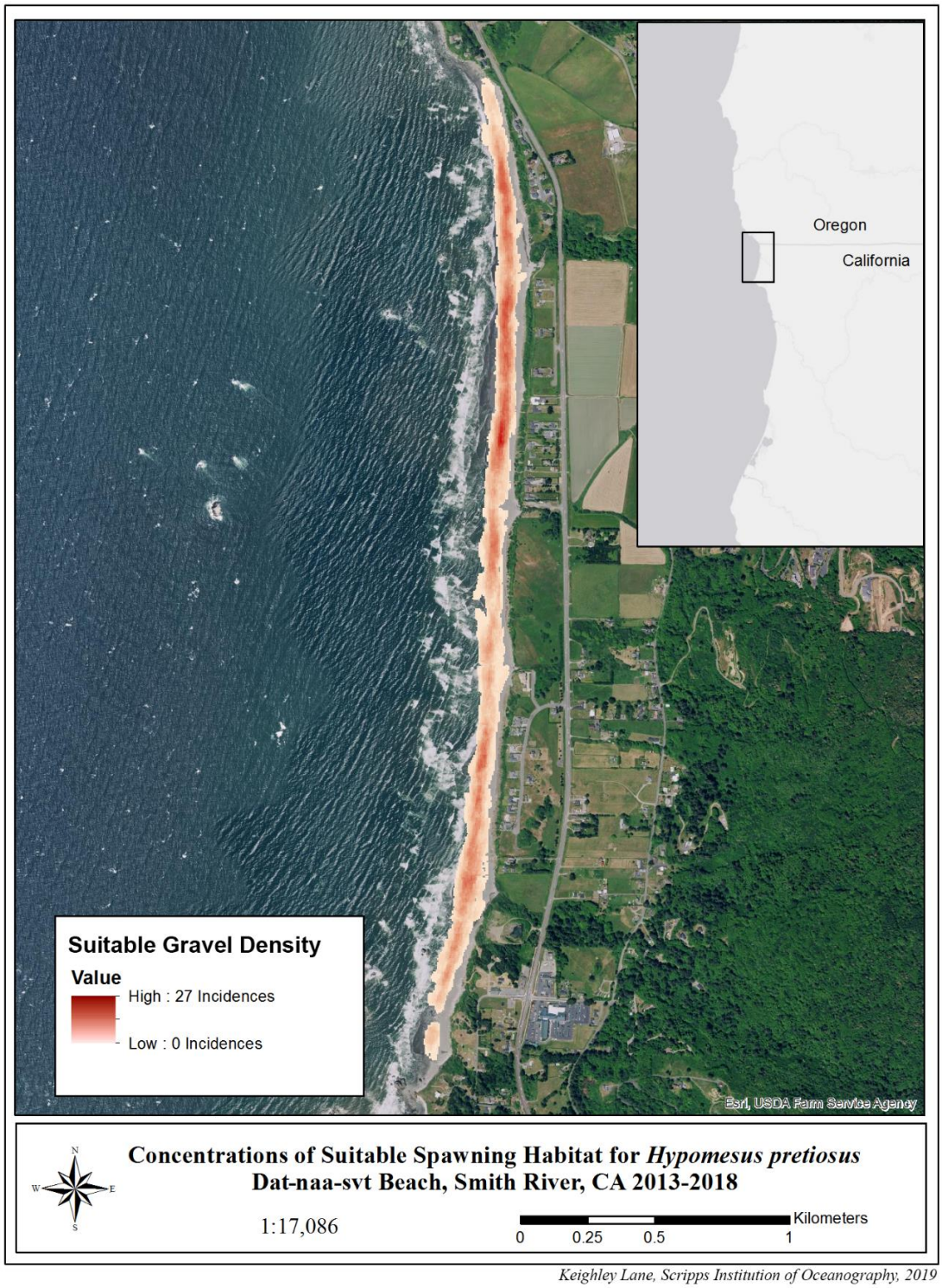

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Figure 4

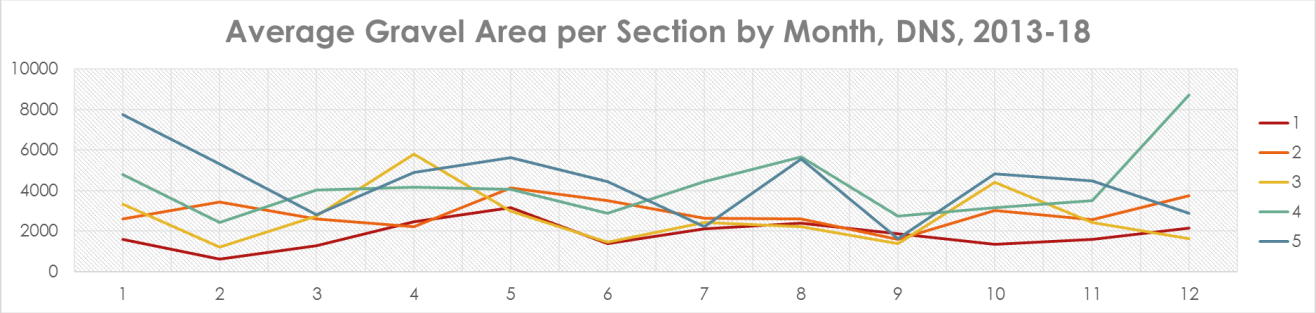


Figure 5

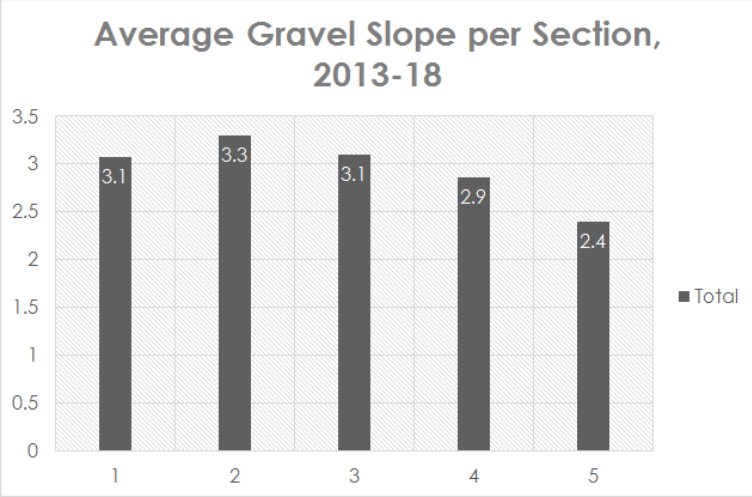


Figure 6

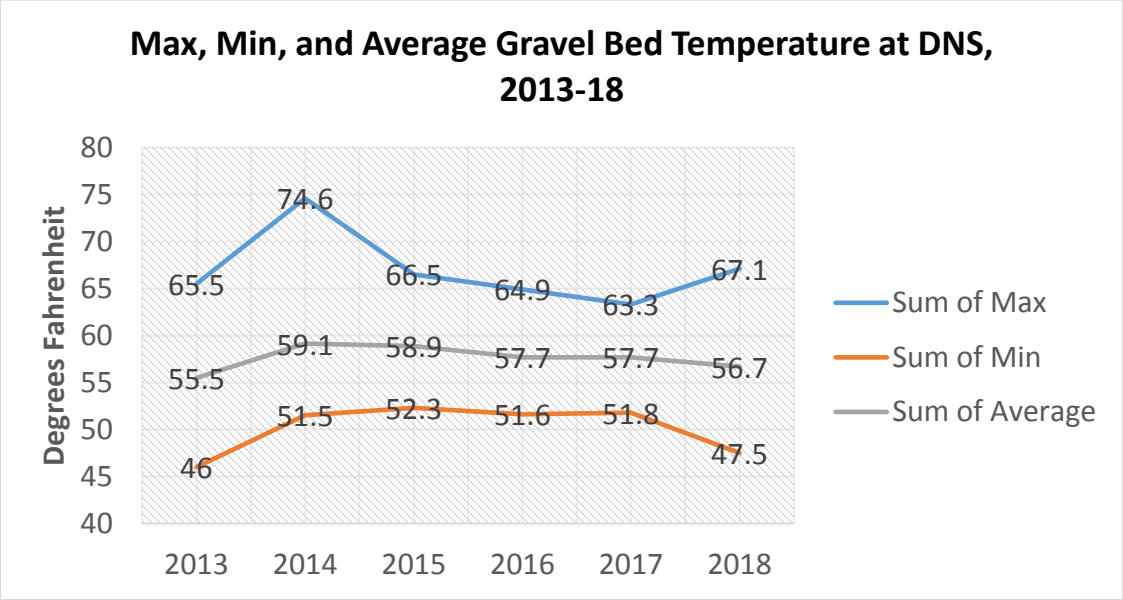
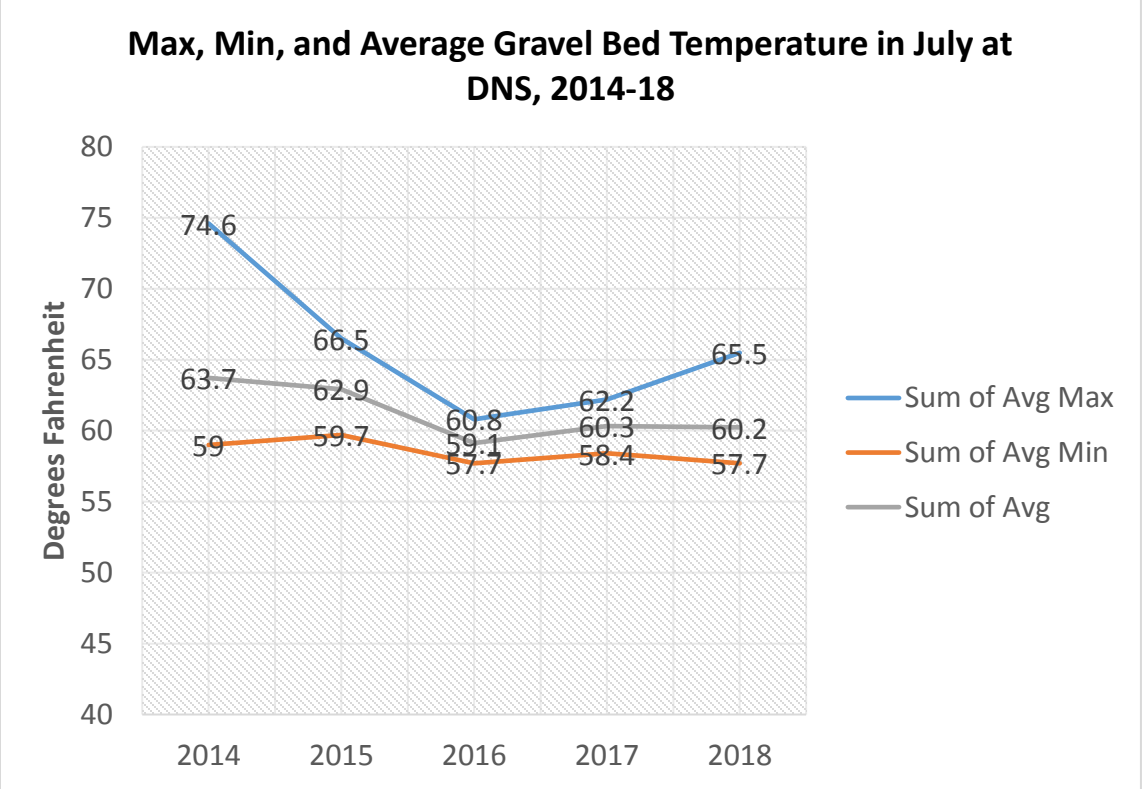


Figure 7



Dat-naa-svt Erosion Potential

I. BACKGROUND

The nearshore environment of DNS and the North Coast is a highly dynamic ecosystem of bluffs, sand dunes, heavy freshwater flow, and high wind and wave energy. There is also a predominantly southerly littoral drift. Understanding the processes that govern these movements can inform our understanding of surf smelt, as sediment transport provides an important ecosystem function of forming suitable spawning habitat. Disruption of sediment processes is often assumed to result in impaired nearshore ecological function but is seldom assessed in the field. A 2009 USGS study reported that 40% of California's beaches were eroding in the long term. This number increased to 66% in the short term, indicating that many beaches have shifted toward a state of chronic erosion.[20] On the North coast in particular, the average amount of coastal cliff recession measured was an average rate of -0.5 m/yr, with the highest rates reaching -3.1 m/yr. Many of the highest rates were measured on headlands that lie interspersed with small sandy beaches along the coast, much like DNS. Overall, the cliff-retreat rates in Northern California were higher than the rest of the state. Although the north coast has lower overall shoreline rates than other regions of California, the variable sediment influx can result in high erosion rates at site-specific locations, so it is important that surf smelt spawning beaches be looked at individually.

The relationship between nearshore physical habitat structure and surf smelt habitat function is complex. Specifically, the nearshore is highly variable with geomorphic habitat type and season. Surf smelt fishermen report that the beach will "change" even between when they arrive on a beach to fish for surf smelt in the morning, and night smelt later that night.[21] Shaffer et al. 2013 reports that sediment delivery from "feeder" bluffs maintains the grain size necessary for nearby suitable surf smelt spawning substrate.[22] The study continued to say that if there is impaired deposition, the beach will respond by coarsening its sediments, creating an unfavorable habitat for smelt spawning. Investigating erosion on DNS is further complicated because it is not only characterized by bluffs, but by dunes as well. The dunes at DNS are covered with an invasive species of European beachgrass (*Ammophila arenaria*), a plant

Exposed European beachgrass roots at DNS, 2019.

[20] Hapke, et al. Rates and Trends of Coastal Change in California and the Regional Behavior of the Beach and Cliff System. USGS. 2009.

[21] Personal Communication with Gene Logan, commercial smelt fisherman, 2019.

[22] Shaffer, A., et al. 2013.

originally introduced due to its superior stabilizing properties.[23] It can tolerate more sand burial than the native dunegrass (*Elymus mollis)* and produces more densely-packed shoots from its rhizomes, creating monolithic stands that outcompete other species (**Picture 1)**. It is possible that the beachgrass could limit natural fine sand movement onto the beach for surf smelt habitat, but this link was not explored in this report.

II. ASSESSMENT METHODS

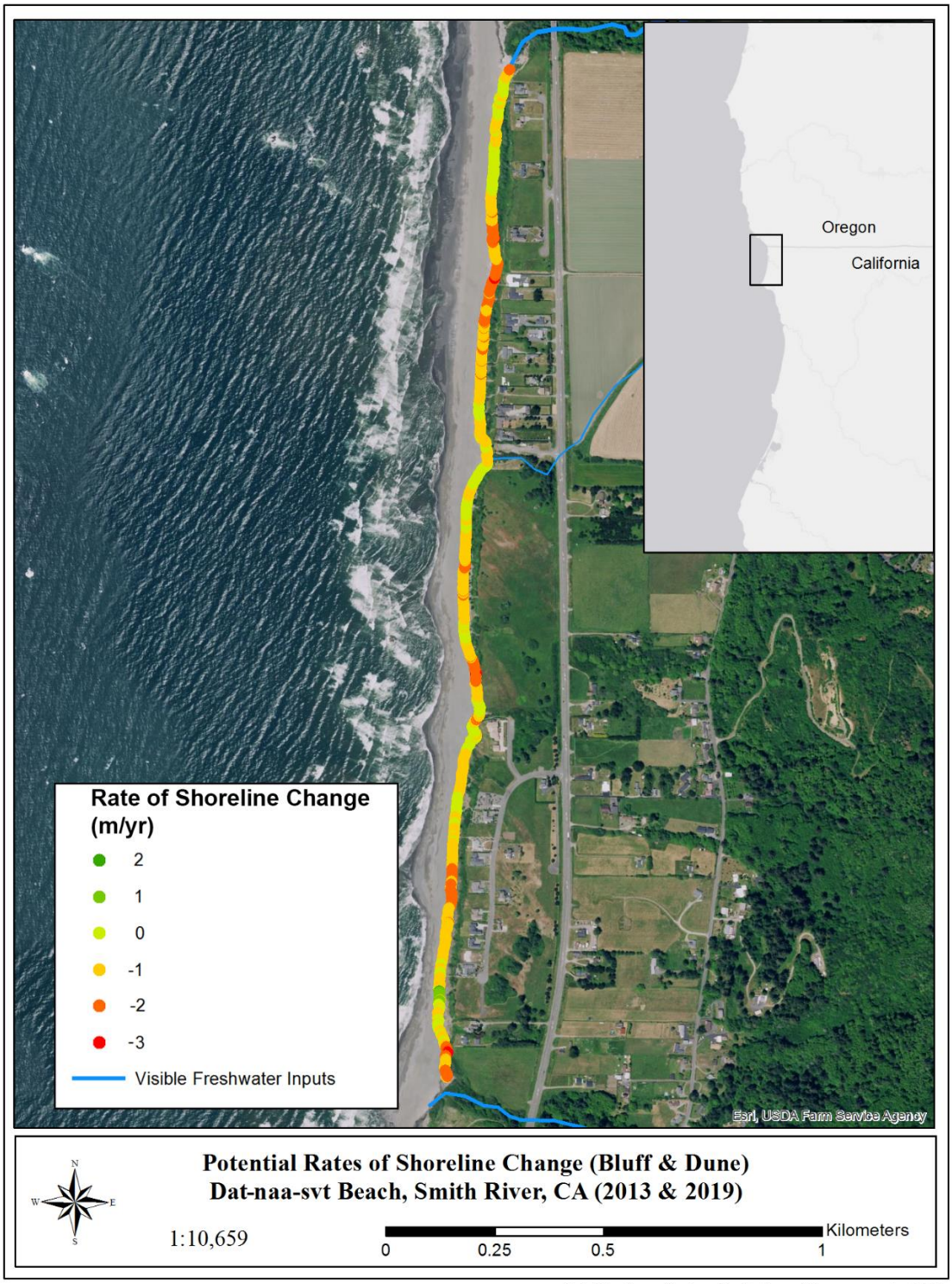
Like many of these areas of research, lack of existing data on the region means the TDN sought to find its own answers. A comparison between the bluff and dune shoreline of DNS measured in 2013 and again in 2019 was completed for this report. In 2013, one transect was completed beginning at Lopez Creek to Gilbert Creek along the edge of the bluffs/dunes in 2013, recorded as a line object in GIS. This was repeated in 2019, and mapped in GIS the same way. These two lines were converted to points spaced by 5 feet, and the distance between the 2013 and 2019 points was calculated, then divided by 6 to determine a 6 year average. This was then visualized on a color scale from +2 (accretion) to -3 (erosion). The combined rates can be viewed as a map in **Figure 8**.

III. RESULTS

The total average for this section of DNS trended towards erosion, with an average overall loss of -0.95 m/yr. This is almost double the -0.5 m/yr average for the North Coast, but well below the highest rate of -3.1 m/yr. While this erosion mapping was preliminary at best, the above average rate of erosion on DNS does point towards a possible future avenue for surf smelt habitat research on the North Coast. Shoreline armoring, beach modification, and culvertization of freshwater inputs should be avoided to limit further detrimental impacts. Due to the predominant southerly littoral drift, it may be wise to investigate bluffs and streams to the north of DNS that may play a role in depositing sediment, as well as native bluff plant restoration.

[23] Invasive Species Management. 2017. Humboldt Bay National Wildlife Refuge Website. U.S. Fish & Wildlife Service.

Figure 8



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Increased Activity at Dat-naa-svt

I. TRIBAL CONCERNS

Considering surf smelt's importance as a source of sustenance, it is no surprise that Tolowa Dee-ni' tradition includes specific rites exclusively for the traditional smelt harvesting season, between July and August. One tradition in particular describes how it was forbidden for anyone aside from the fishermen, even dogs, to enter the breakers during the time of surf smelt harvest.[24] Like many prey animals, surf smelt display behavior that indicates they may be sensitive to disturbance in the water before they begin to run in earnest. Additionally, surf smelt eggs are demersal and incubate in gravel on land, which leaves them vulnerable to being crushed by heavy beach activities.[25] TDN members have reported watching surf smelt be inadvertently disturbed by recreationalists and dogs. TDN is highly concerned that the perceived increased rate of visitation and housing in DNS's nearshore environment may be one of the many influences disrupting their surf smelt runs.[26]

These concerns come on the heels of aggressive actions taken by local homeowners. The president of a nearby home owner's association escorted the Del Norte County Sheriff's Deputies to Sheryl "Suu-daa-chu" Bommelyn Steinruck's fish camp to arrest them for violating trespassing and vandalism laws. TDN's right to fish were protected in the home owner's association bylaws as "Native Americans have the right to fish on the beach from lot 14 through lot 18 from the months of July through September."[27] But the interaction served as a reminder that outside influences can encroach on TDN traditional use at DNS, and the need to maintain an environment for these uses.

II. DEL NORTE COUNTY BACKGROUND

The DNS study area lies on the Northwestern edge of Del Norte County, California's Northwestern-most county, and also the least populated on the coast.[28] Del Norte's population and population density have steadily increased since census records began in 1940s. Between 1948 and 2017, Del Norte's population increased at a rate of 367%. Comparatively, the state of California increased by 391% between those same years. (**Figure 9)**. Much of the county is rural, and areas of relatively high population density are clustered along the US 101 highway corridor between Crescent City, Smith River, and the Oregon border, a portion of which runs through DNS's nearshore environment.

Travel and recreational expenditures have slightly, but steadily, increased over the past 10 years, which may mean that DNS could receive increased traffic during the summer months,

[24] Informing the North Coast MPA Baseline: Traditional Ecological Knowledge of Keystone Marine Species and Ecosystems, 2017.
[25] Personal Communication with Jaytuk Steinruck, 2019.
[26] Personal Communication with Jaytuk Steinruck, 2019.
[27] "Dee-ni' Lhvmsr Xwee-ghatlh-ghelh" Tolowa Smelt Camp, Submitted by Sheryl "Suu-daa-chu" Bommelyn Steinruck, Tolowa Dee-ni' Nation Natural Resources Department, 2008.
[28] Del Norte County Economic & Demographic Profile, 2018, Center for Economic Development, California State University, Chico.

prime surf smelt spawning season.[29] Between what is not covered by forest or structures, much of Del Norte county is agriculture. The total value of agriculture in Del Norte county equaled $47,644,000 in 2018, and total harvested acreage equals 23,157 acres. The extreme use of pesticides on many Del Norte fields is a subject of contention in the county, and certainly demands further research, especially on its seepage into freshwater inputs that reach the ocean.

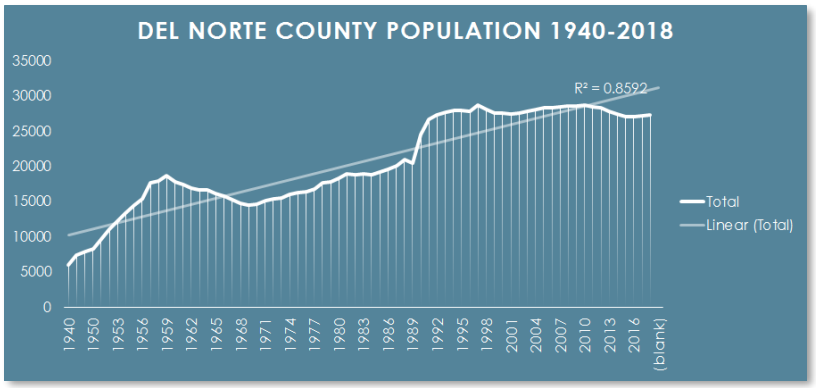


Figure 9

III. HISTORIC AERIAL PHOTO ANALYSIS

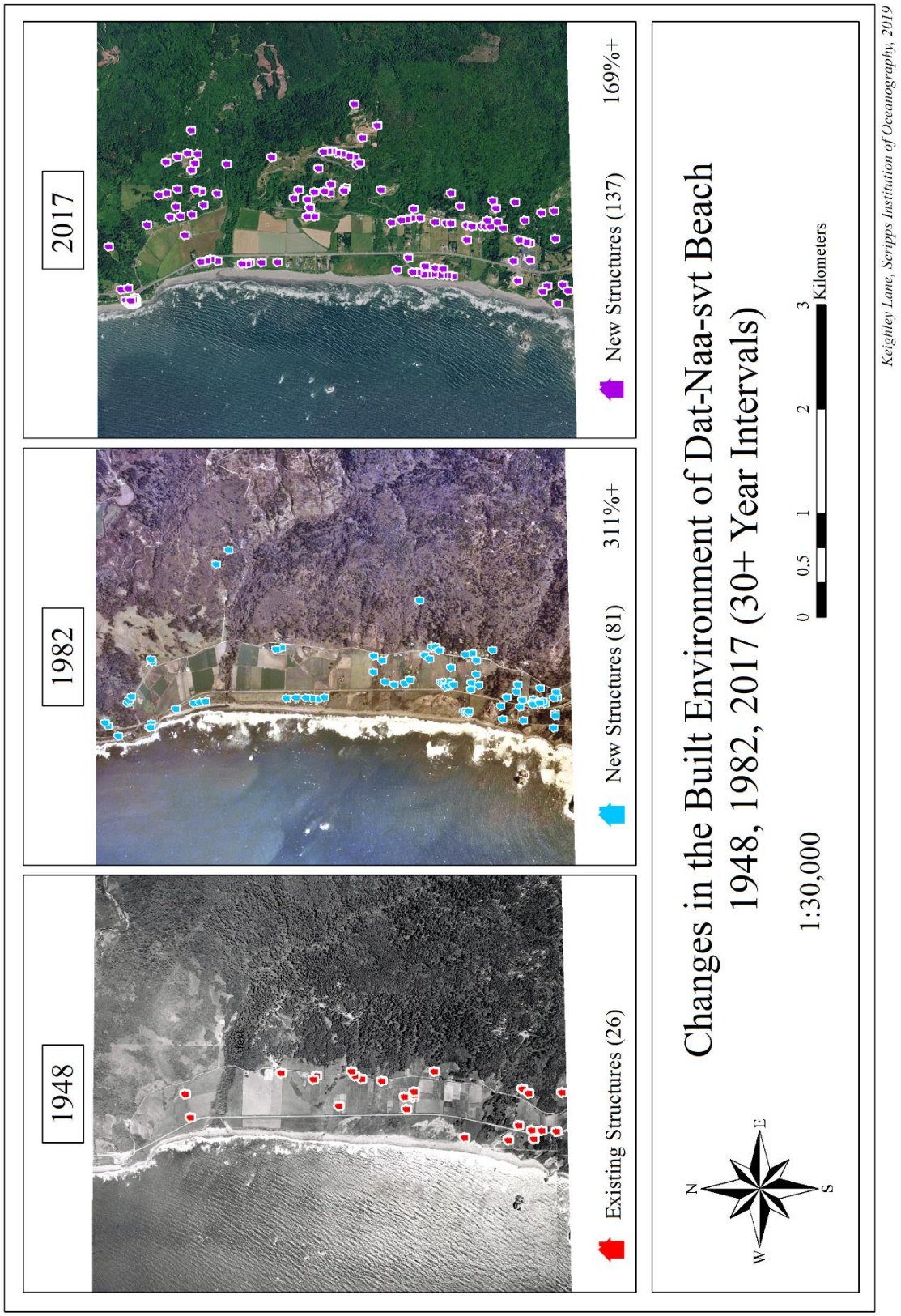
This report addresses tribal concerns through a focus on spatiotemporal changes in DNS's nearshore environment. Efforts were made to characterize new structures built over time, but further analysis can be done on the changes in farmland and logging that also impact this area. New structures not only bring more people, but also can be short-term rentals for beachgoing tourists, and can change drainage qualities. This analysis was done by georeferencing historic aerial photos acquired through University of California Santa Barbara's special collections library. The years used were 1948, 1982, and 2017. This allowed for a space of 34/35 years between the digital surveys. The new structures were represented as points on sequential maps, as seen in **Figure 10.**

IV. RESULTS

In 1948, 26 structures were visible within 2 km of DNS beach. In 1982, there were 81 additional structures (a 311% increase), and in 2017 there were 137 new structures (a 169% increase). Over the entire 69 years, this resulted in a rate of ~3 houses a year built in the study area, with a high rate of new homes being built on top of DNS's bluffs, or cut into the forested hills above the floodplain, which can increase erosion.

[29] Del Norte County Economic & Demographic Profile, 2018, Center for Economic Development, California State University, Chico.

Figure 10


1948
Existing Structures (26)
1982
New Structures (81)
311%+
2017
New Structures (137)
169%+
Changes in the Built Environment of Dat-Naa-svt Beach
1948, 1982, 2017 (30+ Year Intervals)
1:30,000
0
0.5
1
2
3
Kilometers
N
E
S
W
Keighley Lane, Scripps Institution of Oceanography, 2019

Discussion

Researchers recently outlined the features of shifting baseline syndrome, a condition whereby each new generation inherits an environment that has worsened from the generation before, producing lowered expectations for conservation and restoration.[30] TEK has a strong role to play in limiting the shifting of baselines, especially in countering perceptions of these regions as pristine environments. This report just scratches the surface of the myriad of factors that influence surf smelt spawning at DNS, but provides proof that TDN's Natural Resource Department will ensure that baseline data is committed to paper. The most apparent takeaways are that the gravel data for DNS shows the presence of relatively suitable gravel, in addition to the Traditional Ecological Knowledge data providing a strong basis for historic surf smelt abundance on the coast. To understand how the surf smelt are declining, or whether they are utilizing other spawning locations will take concerted efforts to not only understand north coast surf smelt, but surf smelt in general. It is unclear whether spawning habitat shifts are easy, or even possible, for fishes within a geographic area.

Coincidentally, the year that TDN's Tribal Fish & Game Council identified surf smelt as threatened is the same year that the Pacific Fishery Management Council described surf smelt as having "minor to moderate commercial significance".[31] Surf smelt's perceived lack of importance is a direct cause of their under-management, as well as a paucity of population estimates. Additionally, the California surf smelt fishery is managed exclusively by CDFW and is subject to few regulations, despite being one of the oldest in the state. TDN does not have historic Tribal landings data to conduct their own cross-correlation analyses with climate indices, most notably because they would rarely exceed what they needed for winter stores. As forage fish, surf smelt are likely to be heavily influenced by climate and oceanographic variability, and understanding this species at a larger scale will be essential to understanding why they are no longer utilizing DNS. The future of ecosystem-based management depends on State and federal authorities recognizing their duty to uphold the integrity of species that not only hold a market value, but ecological and cultural significance to historically ignored communities. A key part of this will be listening to historically ignored communities, and working with Tribes in an effort to co-manage culturally important resources. Furthermore, the success of such a highly variable species will also depend on supporting communities like TDN to establish baseline data on these fish and to incorporate the best science available.

[30] Soga M and Gaston KJ. 2018. Shifting baseline syndrome: causes, consequences, and implications. Front Ecol Environ 16: 222–30.
[31] Pacific Fishery Management Council, 201.

Tolowa Dee-ni' Nation Lhvmsr Habitat Assessment

Establishing Baseline Data for Spawning Runs of Surf Smelt

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- June 18th, 2019 -