EcoMatrix Concept

CCTF | MARCH 2022

Diverse Coalition

Alaska Longline Fishermen's Association

Aleut Community of St. Paul Tribal Government

Ocean Conservancy

CBSFA St. Paul Island

The Pew Charitable Trusts

Kawerak, Inc.

Alaska Marine Conservation Council

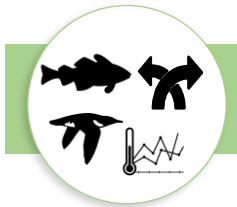
Origins of the concept

- Responsive to the October 2021 Council Motion
- Responsive oral and written testimonies
- Concerns re: Bering Sea productivity
- Diverse knowledge systems and diverse data
- Community, subsistence & associated bycatch/ predators explicitly considered in TAC setting
- New management tool that is not duplicative with any Council/NMFS processes



CLIMATE RESILIENCE AND HARVEST SPECIFICATIONS AT THE NPFMC

LARGE MARINE ECOSYSTEM INDICATORS



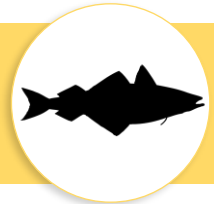
ESRs – annual LME information relevant for setting harvest specifications, currently links directly into the risk tables and ESPs (ABCs)

Climate Report (BS specific) – one-time assessment of climate resilience in council management and list of potential new adaptation tools

Ecosystem Health Report (BS specific) – Bi- or triennial basin-level, ecosystem-wide indicators review

BS FEP (BS specific) – updates as needed, specifies ecosystem objectives and describes EBFM, developing indicators to track against FEP ecosystem objectives

SPECIES-SPECIFIC INDICATORS TO INFORM ABC



SAFE – species-specific biomass/abundance estimates

Risk Table – summary of ESR and ESP information used to inform ABC determination, considers *impacts of ecosystem on fish stock status*

ESP – ecosystem and socio-economic data used to inform ABC, identify potential covariates for stock assessment

TARGET FISHERY INDICATORS TO INFORM TAC

Economic Status Report – annual economic data report for target groundfish fisheries

*Ecosystem Matrix – concept tool that evaluates the *impacts of a target fishery on the ecosystem*

- Draws from ESR, SAFE and diverse knowledge systems.
- Framework to formally address subsistence, community and climate in TAC setting process.
- Tool for advancing EBFM and climate resilience at the NPFMC.
- Can inform EC, FEP and associated Action Module work.

Information adapted from FEP Plan Team/ESR presentation slides

Consistent with CCTF/ FEP/ Council goals

- NPFMC 2014 Ecosystem Approach
- FEP 6 Ecosystem Goals
- FEP Objective #16 – *"Ensure that fishery management is sufficiently adaptive to account for the effects of climate change or other ecosystem changes, including loss of sea ice and ocean acidification."*

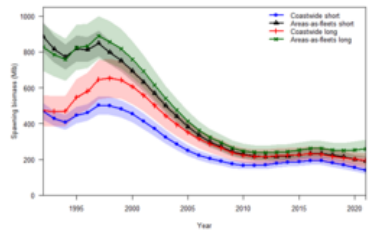
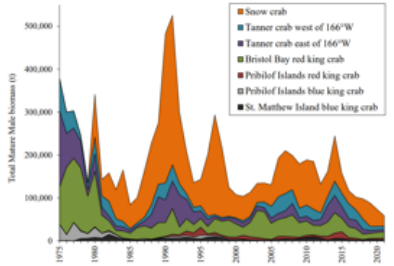
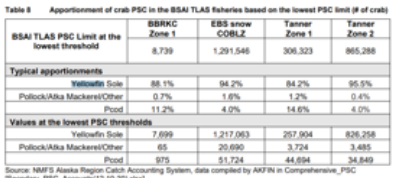
Bering Sea
Fishery Ecosystem Plan

1. Maintain, rebuild, and restore fish stocks at levels sufficient to protect, maintain, and restore food web structure and function;
2. Protect, restore, and maintain the ecological processes, trophic levels, diversity, and overall productive capacity of the system;
3. Conserve habitats for fish and other wildlife;
4. Provide for subsistence, commercial, recreational, and non-consumptive uses of the marine environment;
5. Avoid irreversible or long-term adverse effects on fishery resources and the marine environment;
6. Provide a legacy of healthy ecosystems for future generations.

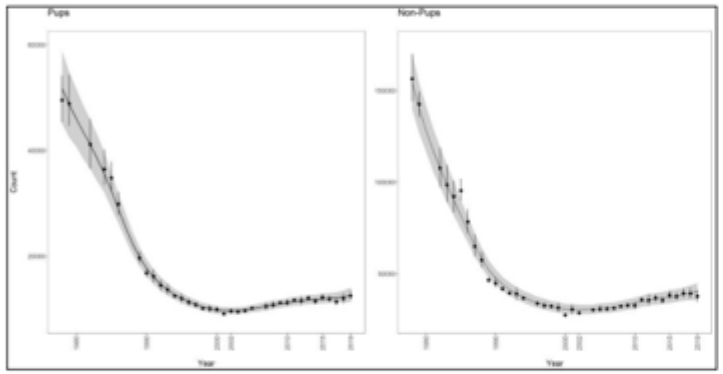
Methods – Qualitative/Indicator- based approach

DRAFT	Pollock		Pacific cod		Yellowfin sole		Sablefish	
Predator Indicator Species	**N. fur seal** Reliant on pollock, Decline since 2004	**Com. murre** Reliant on juv. pollock, UME 14-16, Current trend unknown	**Steller sea lion** Seasonally reliant on cod and pollock, mixed trends regionally	**Tufted puffin** Reliant on juvenile cod, trend unknown	**Pacific cod** Moderate decline since 2015; Overall variable trends in NBS and EBS	**Pac. halibut** Declines since mid-1990s, stable-low since 2010	**Arrow. Flounder** Variable long–term, recent declines since mid-2000s	**Sperm whale** Data-limited, current trend unknown
Bycatch Indicator Species	**Salmon** Chinook declines size & runs; Chum declines in NW AK 20/21	**Pacific cod** Moderate decline since 2015; Overall variable trends in NBS and EBS	**Short-tailed albatross** ESA-listed risk & at risk of extinction, recovering trend	**Skates (spp.)** Alaska skate stable, mod. reduction Aleutian & Bering skate	**Pac. Halibut** Declines since mid-1990s, stable-low since 2010	**Tanner crab** Significant declines since 2014	**Giant grenadier** Variable population trends since early 2000s	**Sharks spp.** Data-limited, Catch data suggest stable populations for 3 primary species
Subsistence Impacts	Salmon bycatch one of many cumulative stressors. W. AK communities have not met subsistence targets since 2010. Subsistence closed and/or dramatically reduced. Negative impacts to food security and culture.		Less direct impacts to subsistence users; however, catch of non-target fish in Pacific cod fishery in opposition to traditional values to not waste resources.		2018 Pacific halibut subsistence harvests in EBS regions down ~40% compared to 2014. Negative impacts to food security and culture.		Less direct impacts to subsistence users; however, catch of non-target fish in sablefish fishery in opposition to traditional values to not waste resources.	
Community Impacts	Job creation and food security in US. Low salmon returns have limited and/or resulted in closures of Chinook and chum fisheries. Loss of income source for many Alaskan communities.		Job creation in the EBS and food security in US. Pacific cod fishery has mixed impacts to communities reliant on Pacific cod and other directed fisheries.		Job creation and food security in US. Halibut bycatch primary source of BSAI removals. Alaskan communities reliant on halibut negatively impacted by reduced quotas.		Job creation and food security in Alaska. Community concerns regarding bycatch of large year classes of juvenile sablefish.	
Habitat Impacts	Pollock fishery pelagic trawl; however, gear is known to contact the bottom. 65% of Alaska EEZ closed to bottom trawling. Lost gear issues.		Pacific cod fisheries generally occur over mud and sand substrates. Multiple gear types with differential impacts. Lost gear issues.		Benthic trawl gear impacts to seafloor productivity and composition. Percentage trawl-disturbed habitat above average since 2013. Lost gear issues.		Longline gear impacts to seafloor and mobile epifauna. Fishery occurs over different substate types. Lost gear issues.	
Climate	Predicted SSB declines of up 70% by 2100 under high emissions scenarios. Predicted declines in recruitment in warmer temperatures.		Egg hatch success temperature dependent. Predicted SSB declines of up 41% by 2100 under high emission scenarios.		Long-term declines in SSB predicted. Increased growth correlated with warmer temperatures.		Potential for strong year classes in warm conditions due to larval growth, diverse diets, high thermal/ hypoxia tolerance.	
POTENTIAL OUTCOME	***Recommended TAC modifications by target fishery based on above matrix - TBD***							

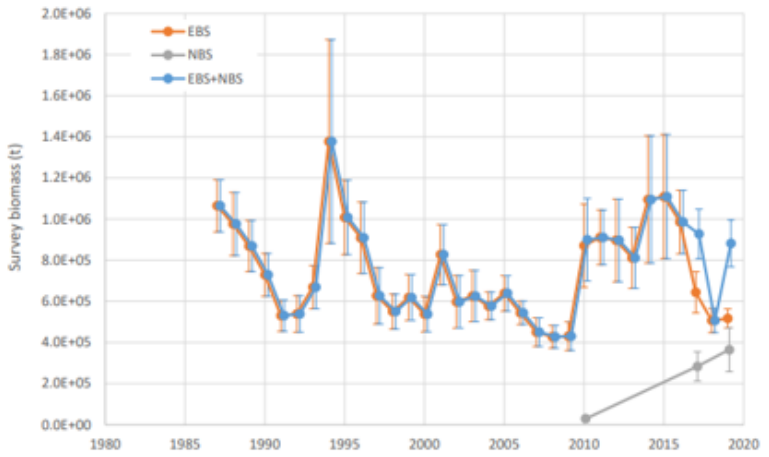
Extensive research and literature review

Bycatch Species 1 - Pacific halibut	Bycatch Species 1 Trend - DECLINING INDICATOR	Bycatch Species 2 - Snow crab/Tanner crab	Bycatch Species 2 Trend - DECLINING INDICATOR	
Pacific halibut is a main bycatch species in the yellowfin sole fishery and the yellowfin sole fishery catches about 30% of the total incidentally caught Pacific halibut.	**Pacific halibut abundance has declined considerably since the late 1990s. While the population has remained stable since about 2012, it declines slightly in 2021. Though well below 1990s levels, the biomass is above the limit reference point, but there is a high probability that it will decline more in the next several years.**	**Snow crab and tanner crab are commonly caught in the yellowfin sole fishery, and the fishery targeting yellowfin sole is responsible for about 25%-75% of all snow and tanner crab bycatch, depending on the species.**	**Abundance of crabs including snow crab and tanner crab have declined since 2015 and are near historic low abundance, according to bottom trawl survey data in the Eastern Bering Sea.**	
Prohibited species / Yellowfin Sole fishery % of total bycatch Halibut mortality 30 Herring 2 Red King crab 5		Prohibited species / Yellowfin Sole fishery % of total bycatch C. bairdi 25.5 Other Tanner crab 78.2 Salmon <1		
Pacific halibut: The YFS fishery is responsible for 30% of the total bycatch of Pacific halibut. Source: Spies et al. 2020	The results of the 2020 stock assessment indicate that the Pacific halibut stock declined continuously from the late 1990s to around 2012... The relative spawning biomass in 2021 was estimated to be 33% (credible interval: 22-52%) down slightly from 34% in 2020, but greater than the values estimated for the previous decade. The probability that the stock is below SB30% is estimated to be 41% at the beginning of 2021, with less than a 1% chance that the stock is below SB20%...At the status quo TCEY (36.6 million lb, (~16,600 t), the probability of spawning biomass declines is 62 and 61% for one and three years respectively. At the reference level (a projected SPR of 43%) the probability of spawning biomass decline to 2022 is 65%, decreasing to 63% in three years, as the 2011 and 2012 cohorts mature. Source: IPHC 2021	The yellowfin sole fishery is consistently apportioned the vast majority of the TLA sector's PSC limit for each crab species, ranging from 84% of the Zone 1 Tanner PSC limit to 95% of the Zone 2 Tanner PSC limit...The majority of trawl caught crab PSC occurs when vessels are targeting yellowfin sole. This is the case across all crab species (NPFMC 2021, C4 Crab PSC limits). The YFS fishery is responsible for 25% of the total bycatch of C. bairdi and 78% of bycatch of other Tanner crab. Source: Spies et al. 2020	At about 58,522 t, mature male biomass for commercial crab stocks in 2021 is the lowest on record and only 66% of the estimated biomass in 2019.	Table from "Crab PSC Limits in the BSAI Groundfish Trawl Fisheries." Feb 2021 (NPFMC 2021)
Spies et al. 2020	IPHC 2021	Spies et al. 2020	Zacher et al. 2021	NPFMC 2021

Pacific cod example – Predator species

Predator Species 1 – Steller sea lion	Predator Species 1 Trend – MIXED TREND
Pacific cod are an important prey item for endangered Steller sea lions in the EBS, particularly in the fall, when they are found in the diet of more than 50% of examined sea lions.	**There are two distinct Steller Sea Lion populations – the eastern DPS and the western DPS. The western DPS, which overlaps with the Eastern Bering Sea fisheries, decreased by approximately 80% between the 1970s and early 2000s, and has been gradually increasing since that time in the Eastern Bering Sea, although the population is continuing to decline in other regions of its range, and is still well below historical abundance levels.**
 **Figure 3.** Realized and predicted counts of Western Steller sea lion pups (left) and non-pups (right) in Alaska, from 1978 to 2019. Realized counts are represented by points and vertical lines (95% credible intervals). Predicted counts are represented by the black line surrounded by the gray 95% credible interval. Pacific cod are seasonally important in the diet of Steller sea lions in the Eastern Bering Sea, occurring in more than 50% of examined stomach contents in the fall (Sinclair et al 2018).	The western DPS includes all Steller sea lions originating from rookeries west of Cape Suckling (144° west longitude). Their population has decreased approximately 77 to 81 percent from the 1970s to the early 2000s. While the western DPS has been increasing slowly overall since 2003, there are strong regional differences across the range in Alaska and the population continues to decline in the central and western Aleutian Islands. The North Pacific Ocean marine heatwave of 2014 – 2016 was associated with a decline of pup productivity between 2015 and 2017 in the eastern and central Gulf of Alaska, a decline in adult female survival in the eastern Aleutian Islands, Gulf of Alaska, and Southeast Alaska, and with a subsequent decline in non-pup abundance throughout the Gulf of Alaska in 2019, contrasting with a previously increasing trend until 2017. (NOAA Fisheries website: Steller Sea Lions). <<< Model results indicated that pup and non-pup counts of Western stock Steller sea lions in Alaska were at their lowest levels in 2002 and have increased at 1.63% y-1 and 1.82% y-1, respectively, between 2002 and 2019 (Table 1; Fig. 3; Sweeney et al. 2019). However, there are strong regional differences across the range in Alaska, with positive trends in the Gulf of Alaska and the eastern Aleutian Islands region, including eastern Bering Sea (east of Samalga Pass, ~170°W), and generally negative trends to the west of Samalga Pass, in the central and western Aleutian Islands (Table 1; Figs. 4 and 5). (Muto et al. 2021)
Sinclair et al. 2018	https://www.fisheries.noaa.gov/species/steller-sea-lion
	Muto et al. 2021

Pollock example – Bycatch

Bycatch Species 2 - Pacific cod	Bycatch Species 2 Trend - MIXED INDICATOR
Pacific cod is the main bycatch species among other target species in the pollock fishery. Nearly 10,000 tons of Pacific cod were caught in the pollock fishery in 2020.	**In recent years, the biomass of Pacific cod in the Eastern Bering Sea has fluctuated. Pacific cod is not considered overfished or depleted, but it has declined since 2015.**
Pacific cod (Table 42 2020 SAFE) - Pacific cod is an indicator bycatch species as it relates to Pacific cod bycatch rates in the pollock fishery. For the time series as a whole, the largest year class appears to have been either the 2008 cohort or the 2013 cohort; and the 2006, 2010, 2011, 2013 are also estimated to have been well above average. In contrast, the 2014-2017 year classes are all estimated to be well below average, with the 2016 and 2017 year classes being two of the three smallest year classes of all time. 2018 was a strong year class, however spawning stock biomass has declined since 2019.	Pacific cod survey biomass (Figure 2-10 Pcod SAFE). 
Thompson et al 2020	Thompson et al 2020

Sablefish example – Subsistence, community, habitat, climate

Subsistence Impacts	Less direct impacts to subsistence users; however, catch of non-target fish in sablefish fishery in opposition to traditional values to not waste resources.
Community Impacts	Job creation and food security in Alaska. Community concerns regarding bycatch of large year classes of juvenile sablefish.
Habitat Impacts	Longline gear impacts to seafloor and mobile epifauna. Fishery occurs over different substate types. Lost gear issues.
Climate	Potential for strong year classes in warm conditions due to larval growth, diverse diets, high thermal/ hypoxia tolerance.

Draws from subsistence-relevant data, Tribal reports, ESRs, recent publications

Moving forward with the EcoMatrix

- Consider as an adaptation measure in climate-readiness report?
- Application in ACLIM 2.0?
- How can the Matrix be refined?
- Where/ what bodies can utilize this tool?