**BSAI Octopus**

Risk Table information for the *Environmental/Ecosystem considerations* column

Very little is understood about mechanistic linkages between ecosystem drivers and octopus growth, survival, or stock dynamics. Octopus are fast-growing animals. Sano and Bando (2018) studied the giant Pacific octopus (*Enteroctopus dolfeini)* in captivity and found both growth and feeding rates have a dome shaped relationship with temperature where maximum growth rates have been observed around 10°C and maximum feeding rates between 10-15°C; activity also tends to increase with temperature. Limited knowledge of these species exists to identify stock-specific indicators. Peak spawning occurs in enter to early spring, hatch time varies between 150 days to one year and the paralarvae period of ~90 days occurs around June- Aug (Conrath and Conner, 2014). Octopus are managed as a complex, consisting of 9 species, with the giant Pacific octopus being the most abundant. Based on 1993-2022 bycatch records (North Pacific Observers groundfish data, https://apps-afsc.fisheries.noaa.gov/ords/r/fma\_ols/fma-map/) and frequency of occurrence in non empty Pacific cod stomachs from 1981-2011 (Rohan and Buckley, 2017) show octopus are distributed along the outer and middle domain, and the Aleutian Islands. Spencer et al. 2019 assessed the climate vulnerability of Pacific giant octopus based on traits and expert evaluation, and found the sensitivity, exposure and vulnerability to be low when rubrics were scored moderate only if 2 or more individual attributes had mean values ≥ 2.5. However, when an alternative logic rule was used (less than 2 attributes with mean value ≥ 2.5 and more than ≥2 attributes with mean value ≥ 1.5), then the ranking increased to moderate for sensitivity, exposure and vulnerability.

**Environmental processes**:

In 2023, broad-scale climate patterns, like the North Pacific Index, reflected a transition from La Niña conditions to developing El Niño conditions in the tropic Pacific. In the eastern Bering Sea, regional sea surface temperature trends were at or near the long-term average in 2023. Exceptions to near-normal sea surface temperature (SST) conditions include a relatively warm winter across the shelf. Above-average SSTs lasted through spring over the outer (100-200m isobaths) and middle (50-100m isobaths) domains. Bottom temperatures derived from the ROMS model showed consistently cooler than average bottom temperatures over the outer domain (100-200m) from September 2022 through August 2023. Sea ice metrics, such as early ice extent (Oct. - Dec.), annual ice extent, and sea ice thickness were all near the respective time series averages. The 2023 cold pool extent was also near its historical average (Hennon et al., 2023). Data from the 2023 EBS bottom trawl survey (AFSC 2023) show bottom temperatures below 6°C in the outer and middle domain. Likewise, bottom temperatures in the AI from 1994-2022 show mean bottom temperatures across the chain below 6°C. Temperatures from the longline survey show temperature between 100 - 300 m was also below 6°C in the eastern Aleutians (Sewicke, 2023). The trend of increasing temperatures in the AI favors faster growth rates and increased feeding rates. Within the EBS shelf, overall octopus biomass seems to be inversely relateed to cold pool area, however it is unclear whether the changes in biomass are driven by population increase or movement of octopus (e.g. from the slope to the shelf).

**Prey**:

Prey for octopus includes shrimps, crabs, and benthic infauna (e.g., clams). No direct measures for shrimps are available from the eastern Bering Sea or Aleutian Islands. In the eastern Bering Sea, biomass trends for several crab stocks have declined in recent years and are currently below their respective time series averages (Richar, 2023). Indirect measures of benthic infauna availability based on biomass trends of benthic foragers indicates reduced infaunal prey available (Siddon, 2023). Available information on prey resources for octopus is difficult to directly assess; some indicators of prey conditions appear low in 2023, though mechanistic linkages to octopus stock dynamics remain elusive. There is no prey information for the AI at this time.

**Competitors:**

Competitors of adult or large octopus include Pacific halibut and Pacific cod among others. The Pacific halibut stock decreased from a peak in the early 2000s and remains low in 2023, therefore represents no increase in competitor pressure (Stewart and Hicks, 2022). In the EBS Pacific cod had a modest increase in biomass from 2022 to 2023, but also does not represent a substantial increase in competitor pressure. In the AI, total biomass of Pacific cod has been steadily decreasing with biomass in 2022 at ~25% of its peak biomass in 1989 (Spies et al., 2022)

**Predators:**

Predators of octopus include Pacific cod, fur seals, Steller sea lions, and seabirds. Pacific cod had a modest increase in biomass from 2022 to 2023, while fish condition (based on length-weight residuals) over the outer shelf was below average in 2023 (Prohaska & Rohan, 2023). Fur seal population trends at St. Paul Island continued a declining trend through 2022 (Siddon, 2023). Seabird populations at the Pribilof Islands showed mixed trends for 2023 with higher reproductive success at St. George compared to St. Paul Island (Siddon, 2023). Additional occasional predators of octopus in the Aleutian Islands include Pacific halibut and Atka mackerel as well as Pacific cod and Steller sea lions (Orsmeth et al. 2020, Frits et al. 2019). Steller sea lion populations in the western and central Aleutian Islands continued a declining trend (Sweeney and Gelatt, 2022) and Atka mackerel decreased slightly in 2022 to around 561, 000 tons and is down from almost peak abundances in 2003-04 of 1 million tons. Overall predation on octopus in the Aleutians is expected to be lower than in past years.

*Summary for Environmental/Ecosystem considerations*:

* **Environment**: Oceanographic metrics for the EBS showed average conditions over the past year (August 2022 - August 2023). In the Aleutian Islands midwater temperatures remained below 6°C (summer 2023) in the Eastern AI, as have mean bottom summer temperatures across the chain.
* **Prey**: IN the EBS Some indicators of prey conditions appear low in 2023, though mechanistic linkages to octopus stock dynamics remain elusive. No information in the AI.
* **Competitors**: Trends in available information for competitors of octopus suggest no increase in competitor pressure in 2023 in the EBS and decreasing trends in the AI (of known competitors)
* **Predators**: Trends in available information for predators of octopus suggest no increase in predation pressure in 2023 for the EBS and decreasing trends in the AI

Proper evaluation of risk is difficult for a data-limited stock. However, the available data suggest there are no apparent ecosystem concerns--Level 1.

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