Bycatch — the capture of non-target organisms — is a persistent issue in many fisheries (Davies, 2009; Hall, 2000). While it first gained public attention through incidental take of charismatic megafauna (Hall, 2000), subsequent research has illuminated a range of concerns. These include the waste of edible protein (Hall, 2000; Zeller., 2018), conflicts between fisheries targeting different species (Lomeli, 2021; NPFMC, 2022), increased extinction risk for vulnerable species (Wallace, 2013; D’Agrosa, 2000), trophic disruption (Estes., 2011), and destabilization of population dynamics (Hall, 2000). As a result, considerable attention has been directed toward reducing bycatch.

Of particular concern in the state of Alaska is the incidental capture of Chinook salmon (*Oncorhynchus tshawytscha*) in the walleye pollock (*Gadus chalcogrammus*) fishery (NPFMC, 2022). The walleye pollock fishery is the largest in the United States by volume (NPFMC, 2022). The retained 2020 catch in just the Gulf of Alaska (GOA) totaled 107,000 metric tons and had a first wholesale value of $70.6 million (Monnahan, 2021). Within this fishery, Chinook salmon bycatch is considered prohibited species catch (PSC) meaning it is bycatch that cannot be retained or sold. PSC allowances are granted to the fishery but if those allowances are exceeded, the fishery is shut down regardless of the remaining allowable catch (NPFMC, 2024). For the Gulf of Alaska these limits are set at 18,316 fish for the Central GOA and 6,684 for the Western GOA, (Amendment 93) with limited provisions for reallocation of unused PSC between sectors (Amendment 103; NPFMC, 2024). As recently as 2024 two boats accidentally brought in enough Chinook salmon over a single weekend to exceed these allowances (Mapes, 2024). With such limited allowances, bycatch avoidance has been an area of active development.

Of those developments, one of the most promising has been cooperative data-sharing amongst fishers (NPMFC, 2022). Through such programs fishers can dynamically adjust their response to bycatch risk based on up-to-date information shared through the whole fleet. This information is also used to setup short-term closures in high-bycatch zones (NPFMC, 2022) – yet another tool in the dynamic ocean management toolbox that draws its power from near real-time, local information on bycatch risk (Squires, 2021). However, improved understanding of the spatial ecology of Chinook salmon while at sea, including their habitat and depth preferences may improve the efficacy of bycatch mitigation actions by identifying high risk zones.

Adding information on depth occupancy to this toolbox could prove fruitful. Adult walleye pollock are largely demersal (Adams, 2009) (Duffy-Anderson, 2003) whereas Chinook salmon are very active in the water column (Courtney, 2019, 2021; Orsi, 1995). While Chinook salmon spend most of their time between 0 and 50m their overall observed range extends beyond 500m (Courtney, 2019, 2021). They also display flexible diel behaviors, sometimes reverse their movement patterns seasonally (Arostegui, 2017; Courtney, 2019, 2021), and seem to vary their depth occupancy in relation to temperature, productivity indicators, and current velocity (Freshwater, 2024; Orsi, 1995; Hinke, 2005). In contrast, while walleye pollock are known to exhibit diel patterns, (Adams, 2009; Miyashita, 2004) the majority of adult walleye pollock are primarily demersal – a pattern reinforced by the fact that the fishery targets them at or near the sea floor (Stratton, 2023). These differences suggest that bycatch risk could be further mitigated if localized and dynamic information on Chinook salmon depth occupancy was available.

A model of localized, Chinook salmon depth occupancy has not yet been built. Most studies on depth occupancy in Chinook salmon have focused on understanding the factors influencing depth as opposed to developing inferential tools for localized prediction (Freshwater, 2024). One exception was Freshwater et al., (2024) who trained a model that leveraged localized environmental and temporal covariates to predict expected depth for Chinook salmon along the coast of Washington and British Columbia. However, to assess relative risk with specific depth range, a model would need to estimate the distribution of fish over the entire the water column. Arostegui et al. (2017) did produce such a distributional model but only used season and day/night as features preventing the model from being amenable to localized and dynamic predictions. Combining these two approaches remains an open opportunity for Chinook salmon.

Therefore, our goal is to build a Chinook salmon depth model capable of local prediction and show it can inform bycatch mitigation strategies. We will do this in three steps. First, we will build a model that leverages environmental and temporal context to predict the relative likelihood of depth-bin occupancy by Chinook salmon throughout the water column. Considered context will include oceanographic, biochemical, seasonal, and diurnal characteristics. Second, we will evaluate the model’s predictions against observed depth occupancy and compare it to patterns observed in past research. Finally, we will generate a year's worth of predictions over the Gulf of Alaska and illustrate how those predictions can inform the selection of places and times where there is lower risk of Chinook occupancy near the sea floor.