



Preliminary assessment of sand flea prevalence in Pacific halibut commercial fisheries

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PURPOSE

To address the request IPHC-2025-RAB026-Req.02 ([para. 29](#)):

*“The RAB **REQUESTED** that the IPHC Secretariat set up efforts to increase documentation of sand flea occurrence during commercial fishing activities by encouraging fishing vessels to report such occurrences in logbooks, and to also relay this information to IPHC Fisheries Data Specialists (Field).”*

BACKGROUND

Nil.

DISCUSSION

Provided at **Appendix A** is the first spatial and risk factor analysis of sand flea infestation prevalence in Pacific halibut in the IPHC Convention Area, providing a basis for the reporting efforts requested by the RAB. It is adapted from a report prepared during the summer of 2026 by an IPHC Intern (W. Mixon). The work was supervised by B. Hutniczak, A. Hicks, and I. Stewart, and also benefited from discussions with IPHC field staff, guidance from the FISS HQ team in working with the FISS dataset, and information about sand fleas and the accompanying video provided by C. Dykstra. The original work has been revised and expanded here, but the analysis, maps, and findings build directly on the interns work.

RECOMMENDATIONS

That the RAB **NOTE** paper IPHC-2026-RAB027-INF01, that provided the RAB with an update on Secretariat efforts regarding IPHC-2025-RAB026-Req.02 ([para. 29](#)):

*“The RAB **REQUESTED** that the IPHC Secretariat set up efforts to increase documentation of sand flea occurrence during commercial fishing activities by encouraging fishing vessels to report such occurrences in logbooks, and to also relay this information to IPHC Fisheries Data Specialists (Field).”*

APPENDICES

Appendix A: Risk Factor and Geospatial Analysis of Sand Flea Infestation Prevalence

APPENDIX A

RISK FACTOR AND GEOSPATIAL ANALYSIS OF SAND FLEA INFESTATION PREVALENCE

(W. MIXON, B. HUTNICZAK, A. HICKS, I. STEWART)

ABSTRACT

Sand flea infestation has long been observed in the Pacific halibut (*Hippoglossus stenolepis*) fishery but has yet to be formally documented. This study aimed to produce the first spatial and risk factor analysis for sand flea damage in the IPHC Convention Area. Data from the fishery independent setline survey (FISS) and 2026 fisherman-initiated data collection trial (commercial) were used to model the effect of environmental variables and gear use on the probability and severity of sand flea infestation. Using generalized additive models, factors such as set depth, soak duration, and bottom temperature were shown to have a relationship with infestation probability but showed no clear relationship with infestation severity. Maps produced from the FISS dataset showed that broad trends of distribution are sustained over decades, with particularly high activity around Kodiak Island, in the central Aleutians, and in southeast Alaska. The commercial logbook dataset confirmed that sand flea infestations are being reported across several Regulatory Areas, but in its first year remained too limited to support detailed analysis. The FISS and commercial logbook datasets are both valuable resources for documenting sand flea prevalence and should be the subject of continued investment by the fishery.

INTRODUCTION

Modern commercial fisheries are regularly subject to human-wildlife conflicts as evolving exploitation practices lead to opportunistic behaviors of marine wildlife. Among these fisheries, longliners are particularly vulnerable to marine predators and scavengers (Tixier et al., 2021) as prolonged exposure while on the hook makes captured fish easy targets. These removals incur economic loss and drive down catch rates (Peterson et al., 2014), interfering with population assessments and lowering the profitability of the fishery. In order to understand the evolving landscape of wildlife conflict and reciprocal changes in fleet behavior, managers must have an adaptive strategy which can minimize instances of conflict and account for its occurrence. Therefore, documenting the activity of these wildlife opportunists and building models to predict conflict are key to the productivity of a fishery.

The directed commercial Pacific halibut (*Hippoglossus stenolepis*) fishery operates nearly exclusively using longline gear and must contend with a variety of marine wildlife conflicts. Among these are sand fleas – members of the amphipod family *Talitridae* whose activity can render catches completely unmarketable (Figure 1). These arthropods are known to infest hooked Pacific halibut by intruding through the eyes, mouth, and anus, which either kills the Pacific halibut on the line or seriously reduces its chances of surviving discard (Dykstra et al., 2024). Despite damage, any captured Pacific halibut considered unfit for human consumption must be counted as part of quota (except in IPHC Regulatory Area 2B), which directly reduces the economic potential of an individual's quota ownership. Sand flea infestations can have an additive effect with other forms of wildlife conflict as well. When vessels are fishing in an area with extreme sand flea infestation they may choose to haul in their gear even while depredating marine mammals are present, giving them an opportunity to eat fish off the line. This decision to “fish through the whales” can exacerbate losses and risk damage to the gear (Peterson et al., 2014) by exposing catch to other forms of depredation.



Figure 1: Examples of sand flea infestation on Pacific halibut.

While they are well-known pests that already influence fleet behavior, little verified information exists about sand flea distribution, behavior, and their overall effect on the Pacific halibut fishery. There are many examples of anecdotal sand flea experience among fishermen which determine how they set their gear. Captains avoid setting lines at night when amphipod activity is assumed to be highest and have noted that infestations are more prevalent in some areas than others. A common tactic for fishermen when operating in areas of suspected sand flea activity is to reduce soak times and set at shallower depths. Outside the Pacific halibut fishery, scavenging amphipods are known to arrive at fish carcasses within 90 minutes of discard (Bozzano & Sardà, 2002), which puts the probable onset of sand flea attacks well within the typical soak time of a Pacific halibut longline set (Keith et al., 2014). The attacking behavior of sand fleas in the Pacific halibut fishery is not fully understood and may not be directly comparable to discards, but this suggests that soak duration is likely only partially responsible for infestation outcomes. Evidence gathered by previous studies has shown that dead Pacific halibut brought on board – the majority of which were infested by sand fleas - are correlated to lower bottom depth and colder bottom temperatures (Dykstra et al., 2024) which may also be contributing factors to infestation probability.

Although anecdotal and research knowledge suggest that factors such as depth, temperature, soak duration, and time of day may correlate with infestation, no direct analysis has yet been conducted. It is the purpose of this report to assemble the first verified dataset of sand flea infestations and lay the groundwork for future investigations. This dataset will be used to document where infestations are most prevalent within the IPHC Convention Area and assess infestation risk based on environmental factors and gear use.

This report utilized two sources of data collected in the Pacific halibut fishery: the fishery-independent setline survey (FISS) and the fisherman-initiated data collection trial (commercial). The data collection trial began during the 2026 season in response to requests by the Research Advisory Board (RAB) to document sand flea infestations. Under the trial, captains may voluntarily record in their logbooks how many Pacific halibut on each set were observed to have been damaged by sand fleas. The FISS is conducted annually by the IPHC at predetermined stations and uses standardized sets to estimate Pacific halibut abundance and collect biological information for each captured Pacific halibut (Figure 2). This includes evidence of sand flea damage. Both data sources were evaluated for how they may contribute to future sand flea prevalence studies.

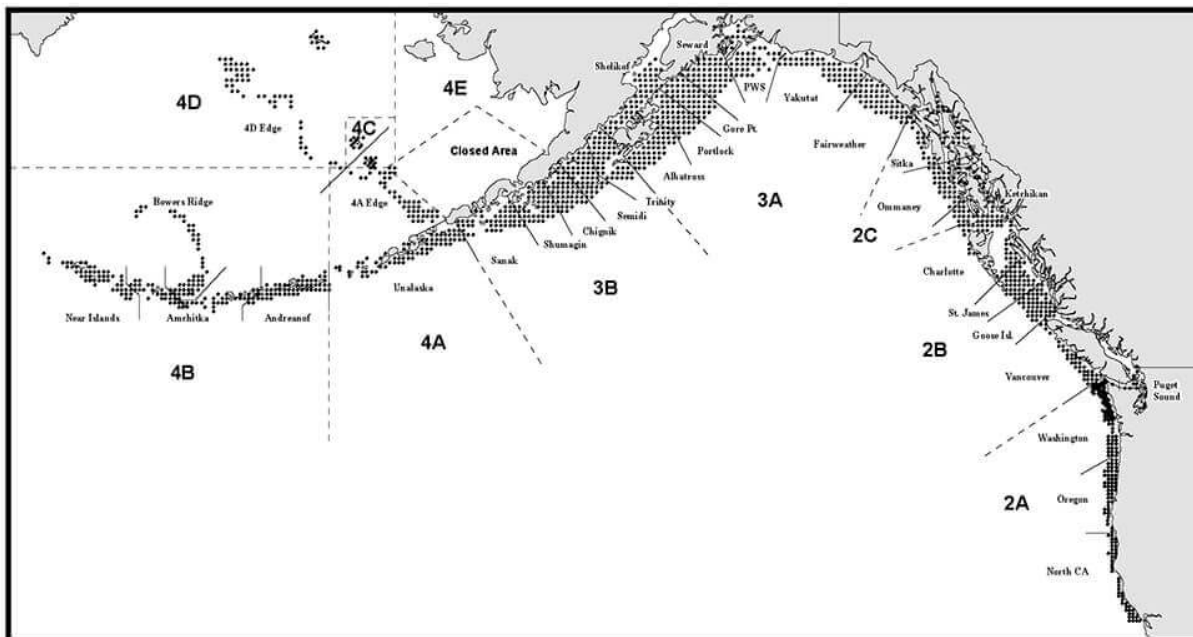


Figure 2: The fishery-independent setline survey operates annually and returns to geographically selected stations. Since 2020, only a subset of stations have been covered by the survey each year.

METHODS

Observations from the 2026 IPHC fisherman-initiated data collection trial and from the FISS were retrieved via SQL Management Studio 22 from the IPHC database. The trial data were voluntarily collected and reported by vessels participating in the 2026 directed Pacific halibut fishery and marked with the damage code '2001' to indicate that sand fleas had intruded into the body of the fish. These data included the number of legal Pacific halibut damaged, location, set and catch information. The FISS data encompassed environmental measurements taken at each station, the biological properties of each Pacific halibut captured (including damage), location, and set information. 77,912 individual Pacific halibut observations from the 2019 FISS were used to construct a single-year snapshot of sand flea distribution across the IPHC Convention Area. This was expanded to 384,386 observations between 2019 and 2025 for semi-parametric modeling. 3,674 aggregated sites were collected from the setline surveys between 2000 and 2024 and used for spatial and temporal analysis. 2025 was excluded from the spatial analysis only for the purpose of creating even 5-year periods.

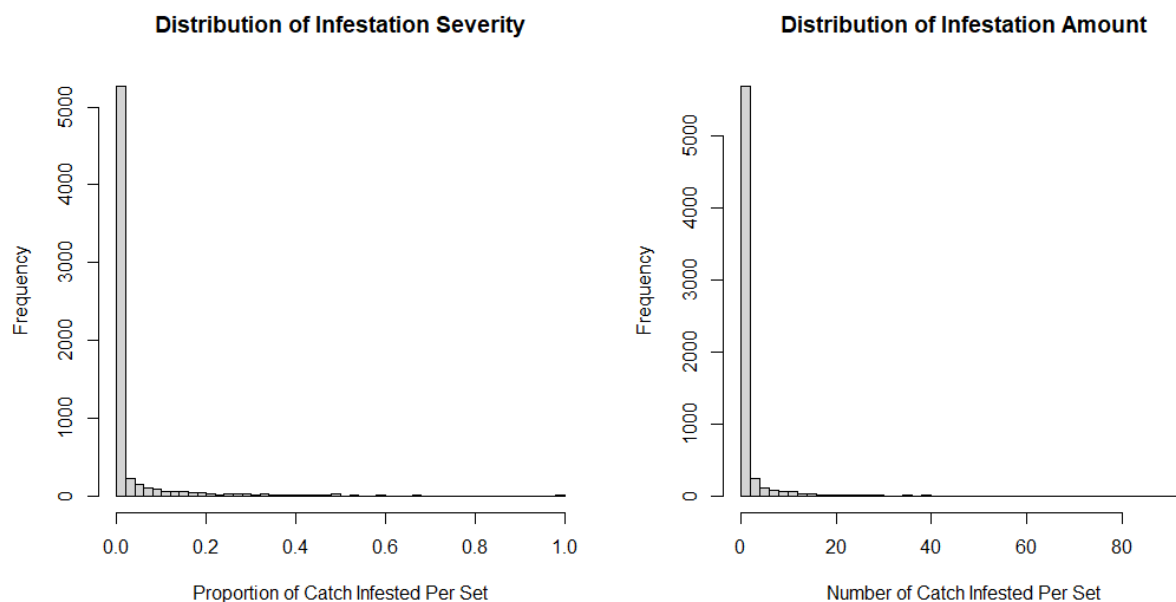


Figure 3: Both infestation amount and severity data from the FISS were extremely right skewed, with most sets reporting no Pacific halibut with signs of sand flea damage. The 95th percentile of each was seven or more infested Pacific halibut and 19% or more of the set being infested.

For the purpose of this report, a quantitative metric was developed for determining a ‘problematic site’ in the FISS – a station which exhibits high sand flea activity and could pose a risk to fishing productivity. Problematic sites were defined using the 95th percentile of two distributions across all sets: the proportion of the catch damaged by sand fleas and the number of fish damaged. The 95th percentile marks the value exceeded by only the top 5% of sets, so these thresholds single out the most heavily infested sites. As shown in Figure 3, a set had to have at least seven damaged fish and have those account for 19% or more of the total catch to be classified as problematic. However, this metric is not intended to predict what a captain considers to be too high of sand flea activity to continue fishing. Remarks from IPHC port staff suggested that a true metric for fleet behavior would be complex and potentially beyond the scope of this study, as the decision to haul gear in and set at another location is highly dependent on context beyond sand flea activity. Therefore, the determination of a problematic site only serves as a method of comparison within this report and should not be considered a predictor of fleet behavior.

The ‘sp’ and ‘tmaps’ packages in R were used to construct a spatial analysis of infestation prevalence in both datasets. For the FISS, the proportion of catch damaged by sand fleas was determined by dividing the number of Pacific halibut with remark code ‘S’ by the total number of Pacific halibut caught. Latitude and longitude were then rounded to the nearest tenth of a degree and all stations within were averaged by catch size and proportion infested. Points with higher proportions of infestation were layered above overlapping points for visual clarity. Sites which had been deemed ineffective by the FISS team due to sand fleas were noted. A single map was produced for the 2019 FISS, as it was the most recent survey to encompass all IPHC Regulatory Areas. For the comparison over time, five 5-year periods were selected between 2000 and 2024. The point size was determined by the number of times that each site was visited within that period, and color was graded based on the percentage of those years that the site was labeled as problematic. To reduce overlap and improve readability latitude and longitude were again rounded a tenth of a degree and point attributes were averaged. The commercial data were reviewed only in general terms to describe the broad distribution of reported infestations; the

limited number of first-year observations and data confidentiality requirements prevented detailed maps from being presented.

The commercial data were not selected for modeling as a lack of consistent absence data prevented strong relationships from being determined. Instead, risk factor analysis was conducted exclusively using the FISS data. Set depth, soak time, and bottom temperature were explored as variables influencing the probability and severity of sand flea infestation. Generalized additive models were used to model each covariate separately, in pairs, and in a combined model. Model selection using Akaike's Information Criteria (Akaike, 1998) indicated that the combined model had the best fit and that soak time should be modeled without a smooth term. For infestation severity, sets with no sand fleas were trimmed from the data set and a transformation was applied to fit the data onto a range between zero and one (Smithson & Verkuilen, 2006). GAMs were built using the beta family and model selection yielded the same results.

RESULTS

The single year spatial distribution of sand fleas in 2019 (Figure 4) shows infestation across all IPHC Regulatory Areas, however greater severity of infestation was observed in the inland channels of IPHC Regulatory Area 2C, as well as in the Shelikof Strait between Regulatory Areas 3A and 3B. A similar pattern was observed among sites deemed ineffective by the FISS due to extreme rates of sand flea infestation. Five-year comparisons showed a distribution of problematic sites in southeast Alaska, around Kodiak Island, along the Alaska Peninsula, and in the Aleutian Islands (Figure 5). The most consistent problematic sites between 2000 and 2024 could be found in the Icy Strait and off the coast of Kodiak Island.

FISS 2019 Sand Flea Prevalence

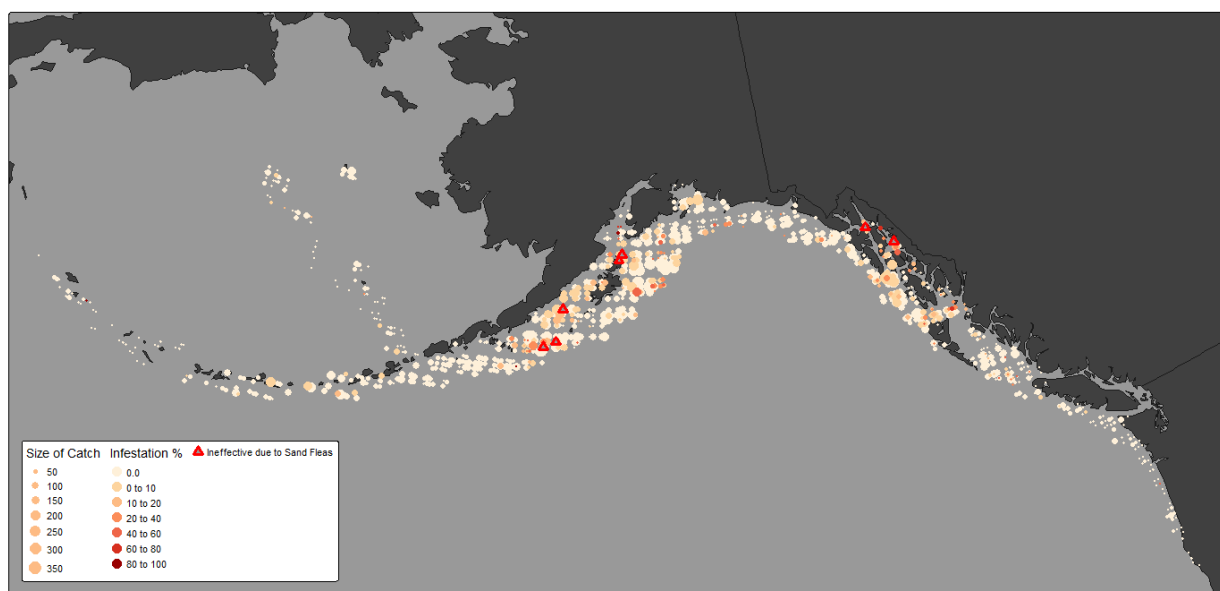


Figure 4: The 2019 FISS sand flea prevalence map. Stations have been binned together into longitude/latitude groups to the nearest tenth of a degree. Larger point size indicates a higher average catch in that group and darker shading indicates higher average infestation percentage. Higher infestations are layered closer to the top when points overlap. Stations deemed ineffective by the survey are indicated by red triangles.

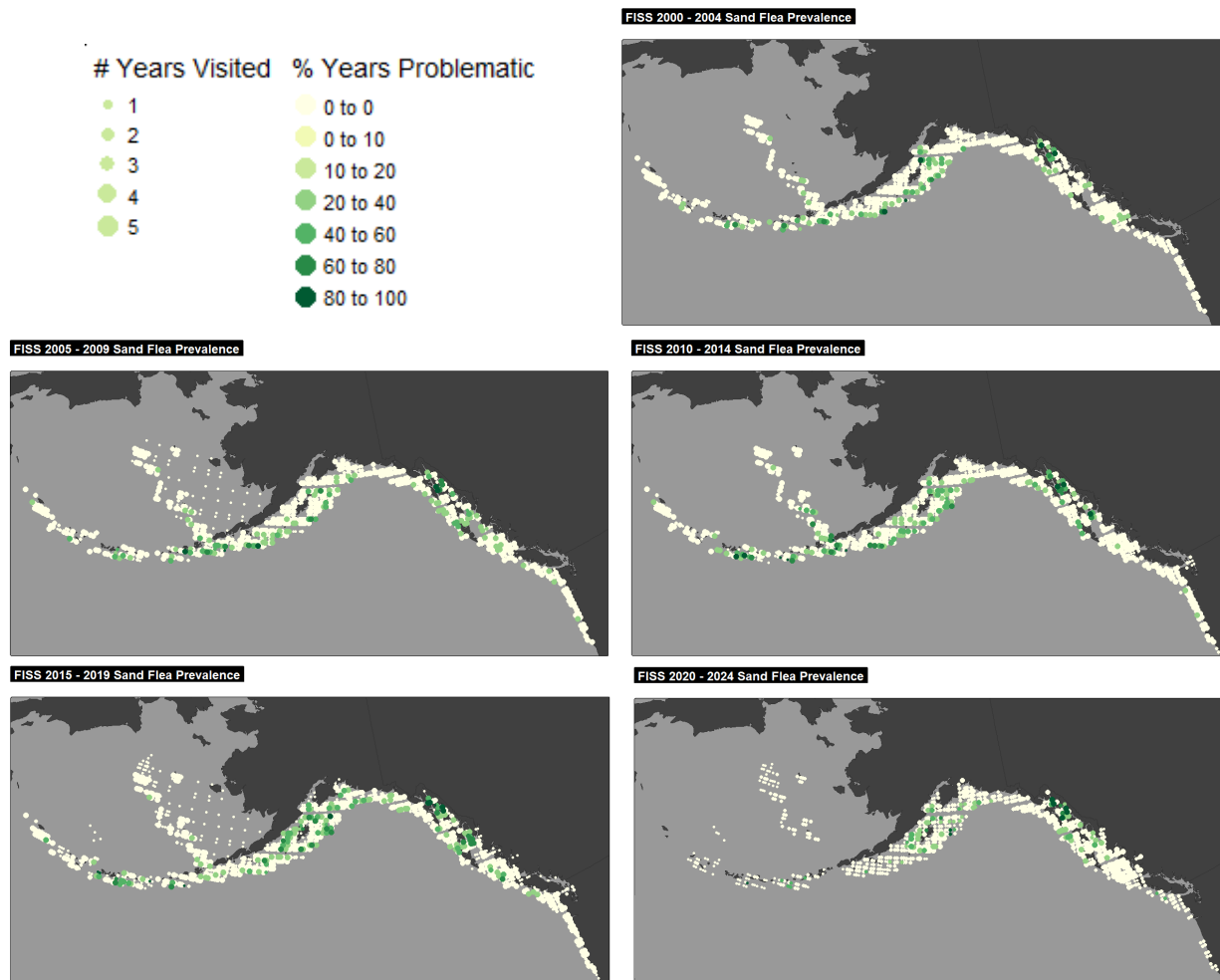


Figure 5: 5-year prevalence maps between 2000 and 2024. Stations have been binned together into longitude/latitude groups to the nearest tenth of a degree. Larger point size indicates a higher average number of survey visits during the 5-year period and darker shading indicates higher average percentage of times that a site was considered problematic.

The 2026 fisherman-initiated data collection trial provided only a limited number of observations in its first year. Because of this small sample size, the need to meet data confidentiality requirements, and uncertainty about whether the absence of sand fleas is being reported consistently, a detailed analysis of the commercial data could not be presented at this time. In general, the trial confirmed that captains reported sand flea infestations across several IPHC Regulatory Areas. Severity observations were too few to support meaningful interpretation. The challenges of the commercial dataset and options for strengthening future data collection are addressed in the Discussion.

For both infestation probability and infestation severity on FISS, the full model with all three covariates was found to have the best fit (Figure 6). The infestation probability GAM explained 11% of the deviance and showed positive trends in both set depth and soak time. Non-linear relationships were estimated for set depth and bottom temperature where an asymptote was reached at high values. All three covariates had much wider confidence intervals at larger values due to fewer data, and the prediction for high bottom temperature was highly uncertain but may decrease from a peak near six degrees Celsius. While the infestation severity model was able to explain slightly more deviance (13%), none of the covariates had a clear relationship with infestation severity. Confidence intervals on set depth and soak duration were wide enough to

encompass both increasing and decreasing relationships at higher values. Additionally, the temperature component of the model appeared to be heavily influenced by outlier points.

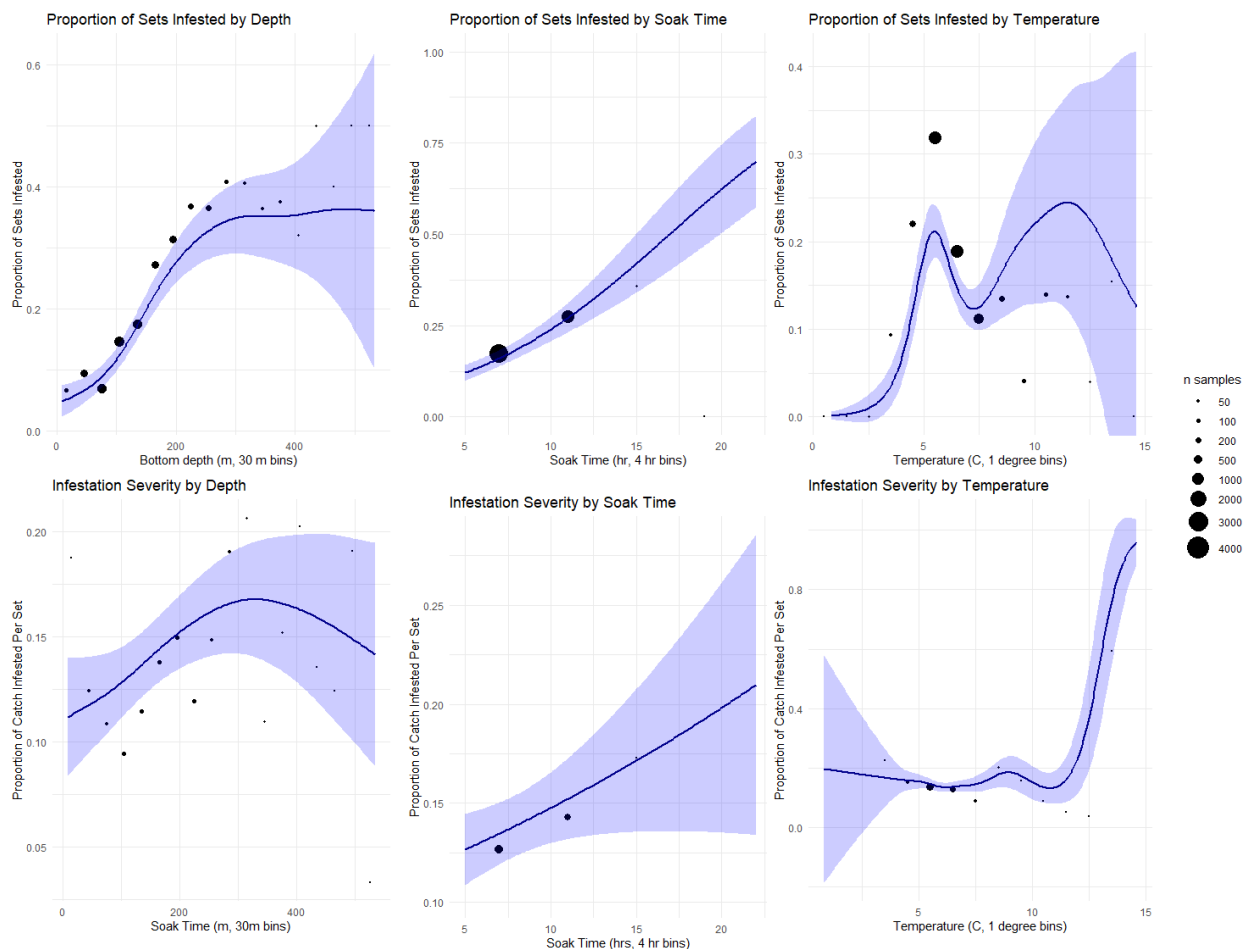


Figure 6: Two generalized additive models were produced, each with all predictor variables and one response variable: infestation probability and infestation severity. For visual clarity, raw data were binned together and the average value of each bin was calculated. The size of the point indicates the number of data points in each bin. In each figure, when another predictor variable is being manipulated, depth is held at 128 meters, soak duration at 7 hours, and bottom temperature at 6.3°C.

DISCUSSION

This report demonstrated that the distribution of sand fleas is not geographically even and may be influenced by environmental factors and local abundance. The FISS dataset revealed broad patterns in sand flea distribution which carried over several decades. Across the entire IPHC Convention Area, the greatest concentrations of problematic sites occurred in the channels of southeast Alaska, near Kodiak Island, and in the central Aleutians. These areas of high activity appear to have persisted for decades while other areas experience a more random rise and fall in activity. The wide and even placement of the FISS stations, however, means that although there is broad geographic range, patterns can only be observed with a very coarse resolution. By contrast, the commercial data suggest that areas identified by the FISS as having a sand flea presence may still show considerable variation in infestation severity when fished, although these early observations remain preliminary.

Generalized additive modeling demonstrated that the likelihood of encountering sand fleas is influenced by factors such as depth, temperature, and soak duration. Although the statistical

power of the binary model is relatively low, the relatively narrow confidence intervals over the observed range and clear trends indicate that set depth and soak duration may have a relationship with infestation probability. This relationship is not strong enough to be used as a predictor but could be used to support fleet behaviors like moving to shallower depths and reducing soak time to avoid infestation. Bottom temperature showed that the probability of sand flea infestation may peak near six degrees Celsius, which could indicate an optimal temperature range for sand fleas. However, it is important to note that observations of infestation may not exactly align with true sand flea distribution across geography and environmental conditions. The remaining deviation is explained by yet unknown or unmeasured variables, likely including sediment type and location, and timing. Infestation severity did not show a clear relationship with any of the covariates despite explaining a similar level of deviance. Severity may be a much more complex response variable than probability which will require an experimental study to better understand.

The breadth of the FISS dataset across the IPhC Regulatory Areas and through time made it an ideal starting point for an investigation into sand flea prevalence. Biological information being recorded for each Pacific halibut that was captured on the set made observations more comparable, as sand flea infestations could be standardized by total catch. However, the design of the FISS created limitations. Soak durations are standardized to be between 5 and 24 hours and only set during daylight hours. These parameters are meant to avoid sand flea infestation and may not accurately reflect commercial fleet behavior. Additionally, the FISS dataset is constrained to FISS stations, which aids in year-to-year comparison but locks the observations to a very coarse resolution. This is exacerbated in coastal regions like the channels of southeast Alaska, where landmasses interrupt the evenly spaced station grid, and by the recently reduced survey footprint.

The commercial logbook dataset is a growing resource with the potential to reveal further patterns in sand flea activity; however, its early state limits the contribution it could make to the analysis of this study. Remarks from port sampler interviews indicate that sand flea damage recordings are highly variable from captain to captain – some collected detailed observations while others only provided an estimate. Many more recordings did not state the number of Pacific halibut damaged by sand fleas on a set, but only that damage was observed. Recordings of sand flea damage may have also been partially dependent on other forms of damage. The nature of the logbook questionnaire has led to concerns that damage recordings are heavily associated with marine mammal interactions or that recording damage due to sand fleas is only prompted by recording other damage types.

Most importantly, it is often unclear whether a record of “no damage” reflects a deliberate determination that sand fleas were absent. A reasonable number of sets do report no damage, but these records typically indicate the absence of any damage rather than the absence of sand fleas specifically. Because the logbook questionnaire emphasizes other sources of damage, it is uncertain whether sand fleas were actively considered when no damage was recorded. This ambiguity in the absence data limits the potential to model relationships between sand flea damage and the environment.

The data collection trial represents a strong first effort, and participation is expected to grow as it continues to be distributed and adopted by the fishery. Building on this foundation, refining the reporting protocol — particularly how the absence of sand fleas is recorded — would substantially improve the reliability and analytical value of the dataset in future years. The RAB, which originally requested this data collection, could be a valuable resource in developing and

refining that protocol. Reporting initial findings from this study may also help promote continued participation in commercial data collection.

Despite its inherent challenges, the fisherman-initiated data collection trial has the potential to explore sand flea activity in ways that are unavailable to the FISS. Commercial logs offer a much wider range of potential data as they can be collected throughout the Pacific halibut commercial fishing period and are not constrained by the standardization of the FISS. Longer soak times, overnight sets, observations from outside the summer survey season, and densely located observations are all possible data points that can be recorded in the commercial logs. The number of sand flea damaged Pacific halibut per set is still an uncertain value that should be interpreted with caution, but presence and absence data alone is still a very valuable asset. Heat maps of sand flea activity may be produced which accurately depict where infestations occur and, assuming that infestations are reported at a consistent rate, would inherently reflect fishing effort.

To improve commercial data collection, this report demonstrates a need for clearer information on where sand fleas are absent and for greater standardization in how observations are reported. As discussed above, records of “no damage” are difficult to interpret, because it is unclear whether sand fleas were specifically considered or whether the entry reflects the absence of other damage types. One way to address this would be to include a separate question in the logbook dedicated specifically to sand fleas, rather than treating sand flea damage as an optional note tied to other forms of damage. A dedicated question would prompt captains to consider sand fleas on every set, making a record of absence as informative as a record of infestation. This is reinforced by the wording of the current trial flyer, which states, “When you are already reporting damaged Pacific halibut in your log, you may optionally note how many of those fish were damaged by sand fleas.” Because sand flea infestations are common and often occur without other accompanying damage, this phrasing may introduce bias by implying that another damage type must be present before sand fleas are reported.

The way sand flea observations are recorded could also be reconsidered. Rather than a single count of damaged fish, infestation could be collected as a categorical variable — for example, distinguishing the absence of sand fleas, their presence without damage, and damage severe enough to reduce marketable value. A categorical approach may be easier for captains to report consistently while still capturing meaningful variation in infestation impact. If counts are retained, it should also be specified whether they include sublegal Pacific halibut, which would be useful for estimating coast-wide mortality due to sand fleas. For future communications with the fishery, it is important to establish clearly what sand flea observations should describe and how they should be reported.

Future investigations into sand flea prevalence would be aided by conducting a regional study and investigating additional covariates. Coastwide-level analysis like that of this study increases variability within the dataset which may mask relationships between variables. By reducing the area of study to a smaller region, researchers can intentionally choose an area with known sand flea activity using the findings of the FISS and test how infestation varies with gear use in that area. Reduction in scope could also open the way to introducing difficult-to-measure covariates such as sediment type and total fishing effort. Sediment type may determine what stretches of seafloor are habitable to sand fleas and fishing effort across all bottom longline fisheries could indicate where sand fleas have abundant food resources. Captured fish and discard mortality create scavenging opportunity, so it is reasonable to hypothesize that sand flea populations may increase in areas with high fishing effort. Future studies could also examine the economic impact of sand flea damage, a key piece of which would be damage severity. Some sand flea damaged

Pacific halibut may still be sold as ‘Number 2’ fish to buyers at a lower price, while others are completely unmarketable. Documenting the value lost due to sand flea infestation would be another key piece of information for characterizing the prevalence of sand fleas.

As a separate effort, in 2026 the IPHC also introduced a Fisher Sentiment Survey to assess fishers’ perceptions and attitudes regarding their fishing experience in a given year. Among its questions is one on the challenges faced during the season, which includes “poor quality fish (e.g., small, infested)” as a response option. While less specific than logbook records, this survey could serve as a broad pulse of the fishery’s main concerns over time and help track whether sand fleas remain a prominent issue for the fleet. The IPHC encourages commercial fishermen to participate in both data collection efforts.

Continued investment in sand flea data collection and analysis would hold deep benefits for the Pacific halibut fishery. Knowledge of sand flea infestations is widespread across vessel captains, but each holds a small piece of the broader picture. Sharing that knowledge about where infestations occur would be mutually beneficial to all who participate in the fishery. Data can empower fishermen to avoid conflict with sand fleas and allow the IPHC to improve coastwide mortality estimates. As individuals, quota owners would be able to make more efficient use of their resources; as a fishery, better understanding of the Pacific halibut stock will help sustain it in perpetuity. Therefore, sharing personal understandings of sand flea distributions and accurately reporting data should be common practice in the Pacific halibut fishery.

LITERATURE

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