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**MEMORANDUM**

TO: Bert Lewis, Regional Supervisor DATE: January XX, 2018

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FROM: Greg Buck, Area Research Biologist

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THROUGH: Aaron Poetter, Regional Management Supervisor

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On 7 December 2018 an informal discussion amongst staff was conducted where it was decided that we needed a plan to spend additional research monies for Togiak herring should any become available. In general, our ability to manage the Togiak herring fishery depends upon:

1. using an appropriate harvest rate, and
2. our ability to accurately forecast the annual mature biomass which in turn depends upon
   1. estimating annual spawning biomass with aerial surveys,
   2. estimating the age composition of the annual spawning biomass,
   3. accounting for harvest.

The following strategies have the potential to improve our ability to manage the Togiak herring fishery:

1. **Provide a second aircraft and aircrew stationed either in Togiak or Dillingham**. Aerial surveys on the days of peak and post-peak spawn are critical for assessing the size of the spawning population in a year and are necessary to fish at the maximum 20% harvest rate. Simply adding funds to our existing survey effort is not sufficient as the main limiting factor is weather and not available funds. Therefore, the most direct method of strengthening our aerial survey effort is to add additional flying time during good weather periods. This would cost approximately $XXXX per day.
2. **Explore options to digitize existing surveys**.Our current real-time survey protocol is subject to considerable uncertainty and possible bias. Digitizing the existing aerial surveys might allow some type(s) of post-survey analysis that could reduce our uncertainty and could provide a training tool and/or reference method to increase consistency and decrease bias among estimators. Further research would be required to assess the feasibility and cost of this strategy.
3. **Charter a test fishing vessel.** A properly equipped chartered vessel would allow us expand our age-sex-length sampling over space and time and improve our ability to accurately estimate the age composition of the spawning biomass. Specifically, this would enable us to sample portions of the biomass during the fishing season that are not being currently fished by the purse seine fleet and to sample the population before(?) and after the fishing season ends. This is particularly critical since the age composition of spawning fish varies over time. An accurate sampling of the spawning population is necessary to accurately estimate maturity in the age-structured model and biological reference points necessary for updating the harvest rate strategy. Embarking a 2 person sampling crew would allow us to work up the samples during the course of fishing operations. A chartered vessel might also serve as a platform to conduct feasibility studies to assess the ability of various off the shelf UAV technologies that might bolster our aerial survey efforts. This strategy would cost approximately $5,000 per day for a vessel charter. The cost of sampling technicians would depend on whether the sampling technicians were state employees or not. The cost of UAV technologies we might be interested in testing is also highly variable but $5,000 should be enough to purchase ~2 off-the-shelf UAVs for feasibility testing.
4. **Increase our sampling crew size.** Currently we are able to sample approximately 6,000 herring from the commercial harvest each year using a crew of two fisheries technicians and one supervising biologist sampling from the shore plants in Naknek. Adding an additional technician to the existing crew would cost about $8,500 and allow us to sample an additional ~3,000 fish from harvest landed at shore-based processing plants in Naknek. Fielding a second 2-person sampling crew at Togiak Fisheries International (TFI) in Togiak would cost about $25,000 and would give us the ability to sample an additional ~5,000 fish from harvest processed by TFI and the floating processors.
5. **Review the harvest rate strategy (threshold and target harvest rate)**. This would require time from State biometric staff as well as funding for outside biometric support in the form of a post-doctoral position or as a contractual service. The estimated cost is approximately $XXXX and take XXXX years to complete.

**Provide a second aircraft and aircrew stationed either in Togiak or Dillingham**.

Our current aerial survey protocol is to fly at 3,000 ft in a small aircraft with two surveyors on board. Surveyors sit on opposite sides of the aircraft and cover…………….

Improving our estimate of the total spawning biomass has more potential to improve our forecast accuracy than improvements in our ability to accurately estimate the age composition of the spawning biomass and may have a larger influence on the GHL than re-evaluating our harvest rate strategy. Our single largest difficulty in estimating the total run biomass is that our method is dependent on being able to estimate the biomass during a short period when the spawning biomass of herring is at its peak biomass. There are several areas of research that could improve the precision and reduce potential bias of our aerial survey biomass estimates:

1. independent verification of survey estimates herring school surface area,
2. developing a reference set of digitized surveys for training estimators and increasing consistency among estimators, and
3. increased spatial coverage of aerial data either through additional aircraft and staff, or via new technologies such as UAVs that could capture digital video and be processed post-season.

**Explore options to digitize existing surveys**.

Our methodology has the potential for very large amounts of variation between surveyors and the potential for surveyor bias is high. Obtaining paired observations would allow us to better quantify the variation in our biomass estimates. There are three basic ways to obtain paired observations:

1. capture video that closely aligns with what the surveyor inside the aircraft sees, or
2. have a second aircraft and surveyor duplicate the effort of the current survey, or
3. use a UAV to capture digital video that duplicates some subset of a traditional survey.

Paired observations that are digitized should allow more rigorous estimates of school size than our current real-time in aircraft methodology allows. Digitized observations could be made from either a manned or unmanned platform. Paired observations can either augment existing surveys or be used to verify existing survey estimates, and thus, improve the accuracy and or precision of the annual spawning biomass estimate which in turn should increase the accuracy of forecasts going forward.

**Charter a test fishing vessel** **and** **increase our sampling crew size.**

The age composition of the gillnet and purse seine harvest is estimated by directly sampling the harvest by gear type. Age composition of the purse seine harvest are also used to estimate the age composition of the mature population. One drawback to using purse seine harvest samples to estimate the mature population is that they are obtained in close spatial and temporal proximity don’t represent the age composition of herring schools across the full spawning grounds. The size of the purse seine fleet has dropped precipitously over the last 20 years (Figure 1) and constrains the spatial coverage of the purse seine harvest. Further, the harvest is dispersed to a range of processors. A second drawback is that the purse seine fishery only occurs during a portion of the spawn, generally towards the early portion. As larger herring tend to aggregate and spawn before younger herring, the samples from the purse seine fishery are likely biased towards older fish and negatively affects our ability to estimate maturity and biological reference points.

**Review the exploitation rate**.

Current regulations allow an maximum exploitation rate of 20% of the available mature biomass (5 AAC 27.865). This exploitation rate is based on (Funk and Rowell, 1995). This analysis is over two decades old and should be re-evaluated. This is particularly important if there have been changes in productivity. If Togiak or other eastern Bering Sea (EBS) herring stocks decline, whether due to environmental changes or inadvertent overharvest, impacts could include reduced harvest of the directed herring fishery, potential closures of Togiak and Dutch harbor fisheries, and ecosystem impacts. In addition, lower biomass of herring will create tighter restrictions on the EBS groundfish fisheries (primarily pollock) that could lead to higher prohibited species catch (PSC) of Chinook and chum salmon. The PSC limit for herring is set as 1% of the combined forecast of all herring stocks in the EBS. If this limit is exceeded by the EBS groundfish fisheries, closed areas are triggered to protect herring, which can push the pollock fleet into areas of higher salmon PSC. Therefore, it is crucial to repeat this analysis with an updated dataset. It would not be possible to conduct this analysis in-house given current staffing and work load. Therefore, this analysis could be accomplished by either an outside contractor or by hiring a post-doctorate researcher in a permanent or non-permanent capacity..

**REFERENCES**

Funk, F. and K. A. Rowell. 1995. Population Model Suggests New Threshold for Managing Alaska’s Togiak Fishery for Pacific Herring in Bristol Bay. AK Fish Res Bull. 2(2):125-136.

Figure 1. Peak count of purse seine vessels by fishing year in the Togiak herring fishery.