Application of an adaptive acoustic/trawl survey to reduce uncertainty in rockfish biomass estimates

Dana Hanselman, Paul Spencer, Denise McKelvey, and Michael Martin (Alaska Fisheries Science Center)

Introduction and Background

Survey biomass estimates of several Alaskan rockfish species have shown large interannual variations that are not consistent with their longevity. This variability reflects the "patchiness" of the spatial distribution of the population. This study evaluates an experimental survey design (TAPAS, Everson et al. 1996) to reduce the variability in estimated biomass for Pacific ocean perch (POP).

The design is a variant of adaptive sampling and uses acoustic information to distinguish strata of different densities. In addition to planned trawl stations, additional trawl tows are conducted in the high density fish areas identified during the cruise. The rationale of the design is to reduce sampling variability by allocating more sampling effort in the areas of higher fish density. Reducing the uncertainty of biomass estimates for patchily distributed rockfish has been identified as an assessment and management priority.

Methods

Hydroacoustic algorithm and stations

- Analyzed historic Simrad ES60 hydroacoustic data collected on NMFS trawl surveys
  - Patch threshold equivalent to 80th percentile of mean *Sv* for area
  - Use a moving average window of 100 meter integrations (Fig. 1 top)
  - When 3 km average exceeds the threshold ~40% of the time, "patch" is declared (Figure 1 bottom)
  - Patch must be 1.5 km so a tow can fit
- 48 random background tows planned in Yakutat area of Gulf of Alaska between 200-300 m depth

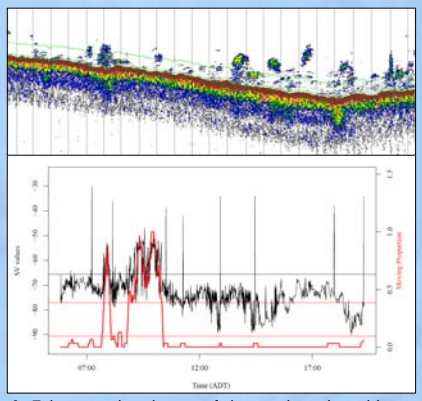

Fig. 1. Echogram data in one of the patches viewed in Echoview (top). Example of script outputs for real-time monitoring of patches (bottom). Black line is trace of *Sv* per 100 meters, red line is the proportion over the threshold.

On the F/V *Sea Storm*

Followed shortest trackline between planned stations (random)

- Used Echoview live viewing and R scripts to monitor for patches
- When "patch" was encounterd (red line on Fig. 1 bottom), follow trackline until the end of the patch
- After end of patch is delineated:
  - Chose random minute for tow EQ
  - Tow station
  - Continue trackline where we left off

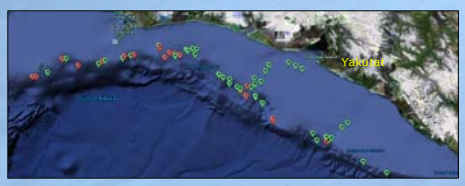

Fig. 2. Stations towed in field study. Red (with P) pointers are patch stations, green are background stations.

Fig. 3. Sorting the fish. Some tows were high in large rockfish like shortraker, others were almost pure POP.

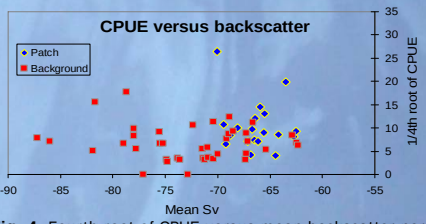

Fig. 4. Fourth root of CPUE versus mean backscatter per tow. Red squares are background stations, blue diamonds are patch stations.

Preliminary Results

General results (Figs. 2,3,4)

- 12 sampling days, Aug. 2-13, 2009
- 59 tows completed (40 background, 19 patch tows) (Fig.2)
- 30.1 tons of all species caught
- Mean POP CPUE 42,450 kg/km^2 in patch and 7475 kg/km^2 in background
- Area was 7800 km^2 (Depths between 200-300 meters).
- Trackline was 1,111 km long with 112 km in patches we towed on
- Almost half of the trackline (580km) was above the threshold but not long enough to tow
- Relationship between Sv and CPUE was weak, especially below -70 db (Fig. 4).

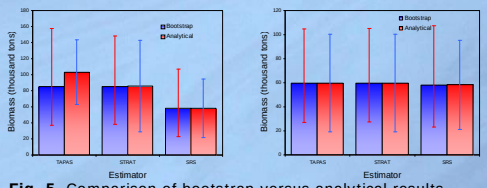

Fig. 5. Comparison of bootstrap versus analytical results for mean and 95% confidence interval for full data set (left) and reduced data set (right).

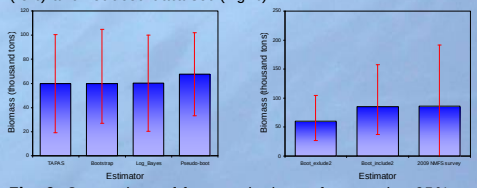

Fig. 6. Comparison of four methods to of computing 95% confidence intervals for reduced data set (left) and the bootstrap estimates compared with NMFS 2009 survey estimate (right).

Biomass estimate comparisons (Figs. 5, 6)

- The data was analyzed two ways
  - The full data set including off trackline patches on last day
  - The data set without the two extra patches
- Biomass were computed for
  - TAPAS estimators (Everson et al. 1996)
  - Stratified random sampling (STRAT)
  - Simple random sampling (SRS)with full *n*
- Variance was computed using both analytical methods and bootstrapping (Fig. 5)
- With reduced data set, all estimates were very similar (Figs. 5, 6).
- With full data set, TAPAS estimators were more efficient (Fig. 5).
- All estimates much more precise than 2009 NMFS survey estimate of area (Fig 6. right)

Discussion

In practical terms, the design and sampling algorithm worked well in the field. However, the results of the field study showed little gains over simple random sampling (assuming the same total sample size). When the extra patch stations which had high POP CPUE were included, the TAPAS results were more precise than SRS and stratified random sampling. Bootstrap results indicate that the published estimator for the biomass variance for TAPAS may be biased. Increases in precision for TAPAS were hindered by a weak relationship between the patch threshold and CPUE, and relatively low variance in the background stations. Patches also were sometimes ephemeral, and when returning to tow a station, the hydroacoustic signal had diminished. Further analysis will evaluate the performance of the survey design with respect to the variance of biomass estimates under alternative definitions of patch areas. The patch definition for rockfish may benefit from utilizing *Sv* variance in addition to the mean to differentiate from other species.