

Proposal for Methodology Review of the Canadian Swept-Area Trawl Survey conducted along the West Coast of Vancouver Island for Inclusion into the Pacific Sardine Stock Assessment

1. Title: Canadian West Coast Vancouver Island Trawl Survey (WCVI).
2. Name of proposers:
 - a. Fisheries and Oceans Canada (DFO Canada): Jake Schweigert, Linnea Flostrand, DFO
 - b. NOAA Fisheries/Southwest Fisheries Science Center will act as sponsor.
3. How the proposed methodology will improve assessment and management for CPS species: Both the 2009 and 2011 Pacific Sardine Stock Assessment Review Panels recommended the addition of the WCVI survey as an additional fishery-independent data set, stating that the data set is potentially valuable since it provides abundance information for a large area within Canadian waters. Inclusion of the Canadian survey would also provide valuable insights into the northern most extension of the population, the largest size classes, and the timing and extent of migration during different years. There is also interest in expanding scientific data exchange and cooperation.
4. Outline of methods (field and analytical): The time series for the summer WCVI surface trawl survey has a combination of sample designs (see attached summary). From 1997-2004, fishing was conducted during day time periods along transects and at ad hoc sites between transects lines, where transect locations often varied between years. In 2005, some daytime and night time comparisons were made and sampling coverage was relatively limited. From 2006 to 2011, all fishing was conducted between dusk and dawn periods and line transects in combination with random spot sites were applied in 2006-2009, whereas in 2010 and 2011 the use of line transects was abandoned and fishing was planned at randomly selected sites of a ~ 10x10km grid plan, at approximately equal sampling intensity throughout the survey region. The surface trawls generally fished at depths ≤ 25 m.

PACIFIC SARDINE WEST COAST OF VANCOUVER ISLAND TRAWL SURVEYS – CANADA

I. Introduction and Background of Survey Method

Surveys of marine fish populations are generally undertaken to obtain estimates of absolute or relative abundance of the species of interest as well as obtaining data on their distribution and biological attributes (length, weight, sex, age, maturity, etc.). The general theory behind trawl survey sampling methods is that if one assumes that the population is randomly distributed within the area of the survey then it is reasonable to expect that conducting a number of trawl sets in the area will provide an unbiased estimate of the average density of the species in the area of interest and then the mean density can be expanded to the entire distribution of the species to estimate the total population size. However, there are a number of considerations that will impact the ability to conduct this survey in a manner that will provide an accurate (unbiased) estimate of population size.

Possibly the most difficult variable to assess is the total area of the population distribution. The ocean is pretty big and so it is not a simple task to cover the area of possible distribution and confirm that there are no additional schools outside the survey area. Missing schools will impact the estimate of total population abundance and result in an inaccurate estimate (biased low).

Another factor that affects the accuracy of trawl surveys is vessel and gear avoidance. In particular, sardine are surface oriented so that they will be easily disturbed by an approaching noisy vessel and move away from the trawl path, similarly larger fish may have a higher ability to avoid approaching nets. Again the result would be to underestimate sardine density (biased low).

Perhaps the most critical assumption in a trawl survey program is that the population is randomly distributed while we know that fish are generally in schools and that the schools are distributed in patches. As a result attempts to make 'random' sets within a survey area will provide a biased estimate of fish density. A huge statistical literature exists on determining the correct distribution of the population from trawl surveys and how to either transform the data prior to analysis or assume a different sampling distribution for the data than the usual normal distribution. The effect of this assumption is really to alter the estimate of variability around the abundance estimate depending on sampling distribution that one assumes. It generally does not impact the estimate of average population density and total abundance.

The output of the trawl survey can be an estimate of the total population if there is good evidence that the entire distribution of the species of interest has been sampled or it can provide an index of population abundance that can be used to monitor trends in abundance and as such could feed directly into a stock assessment model such as a catch-age analysis.

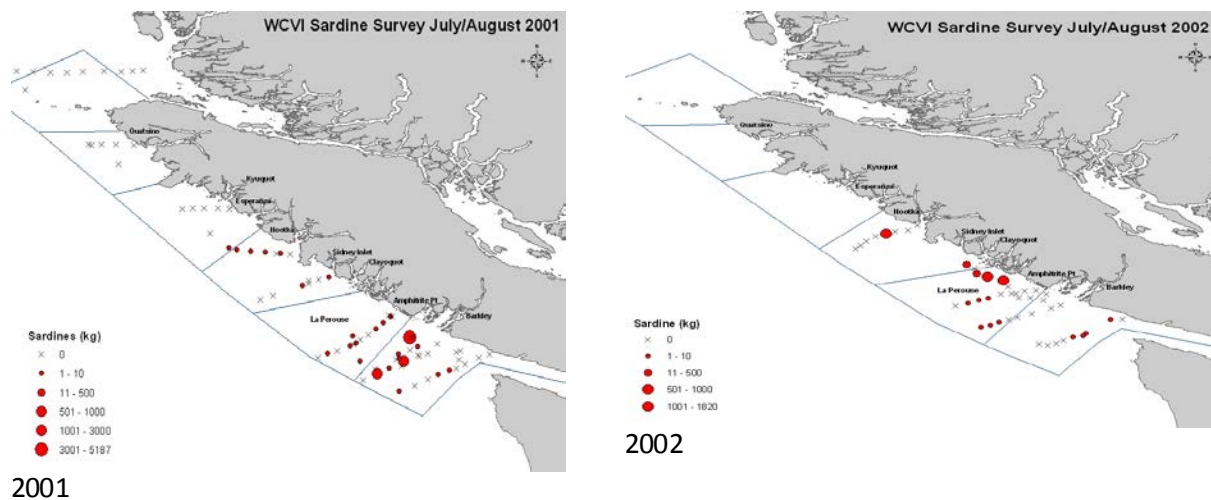
The major advantage of the trawl survey is that it is empirical so that if one conducts enough trawl sets it is possible to determine whether the population is increasing, decreasing, or stable. The biggest disadvantage is that it is expensive and difficult to cover the entire distribution of

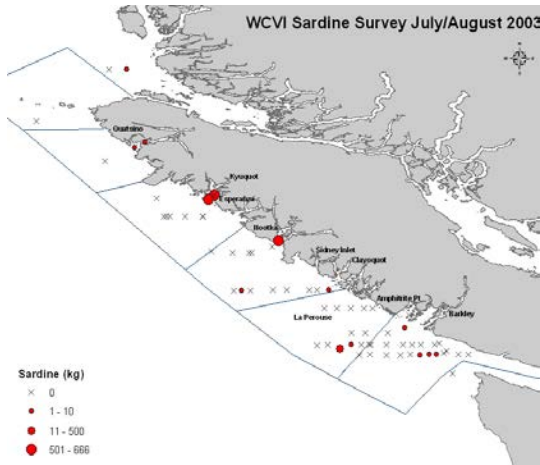
sardine in a reasonable time frame. It also requires a lot staff to support the survey and analyse the data.

Methods and Results

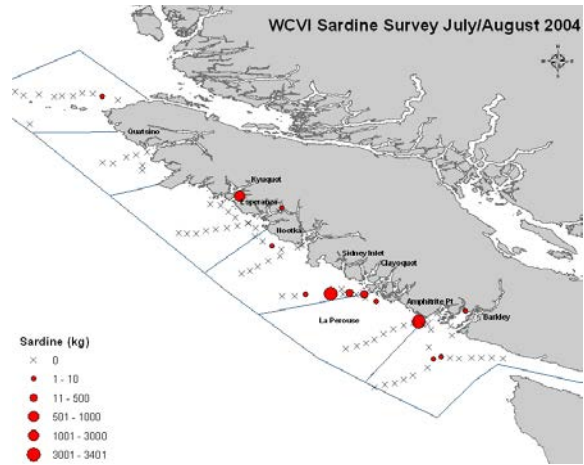
Summer surveys employing mid-water trawls near the surface have been conducted on the west coast of Vancouver Island from the mid-1990s to present to examine the distribution and relative abundance of sardines (McFarlane et al 2005; Schweigert et al 2009). The surveys were generally conducted during the last week of July or first week of August assuming that the northerly migration of fish into Canadian waters had peaked. Prior to 2006, sampling occurred during the day, subsequently all surveys are conducted from dawn to dusk. Prior to 2010, sampling applied a combination of transect lines and spot sampling configured to represent up to 6 strata, each varying in part by latitude and orientation to shore. For 2010 and 2011, random sampling was conducted at night but based on random selection of sites within a 10x 10km grid, rather than applying transect lines. Examples of survey coverage and catch densities are depicted in the figures below.

Abundance estimates for the region or by sub-region (stratum) have been calculated using sardine catch densities (weight/volume) from surface trawls representing the surface to 30 m depth and sardine densities have been extrapolated across the represented area's size and surface volume. Surveys have generally been conducted over 5-16 day (or night) periods and the number of fishing tows generally range from 40-109. There was a survey in 1997 but no surveys occurred in 1998 and 2007 and some of the earlier years had limited sampling coverage. Regional estimates of abundance from surveys conducted during 1997- 2005 range from ~ 25,000 to 125,000 metric tons and regional estimates of abundance from surveys conducted during 2006-2011 range from ~380,000 to ~150,000 metric tons (Schweigert et al 2009; DFO 2011).



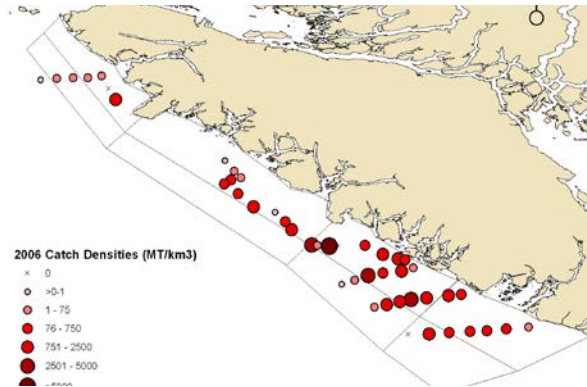


2003



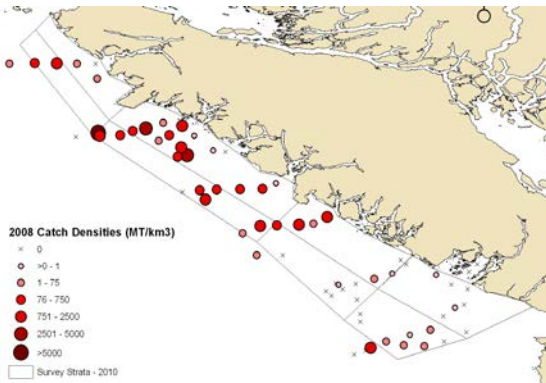
2004

Above figures represent day surveys (2001-2004) with transects and spot sampling. Note units are kg, not standardized by catch density.

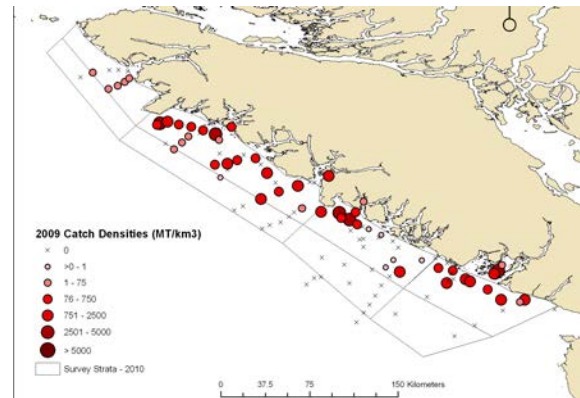


2006

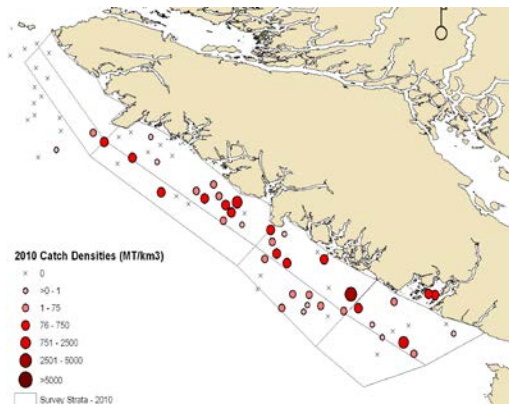
No survey in 2007



2008

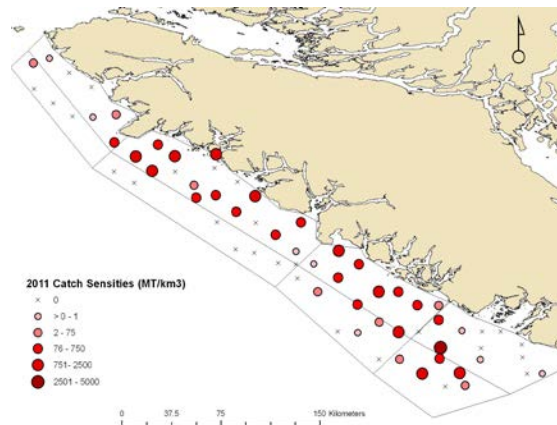


2009



2010

Above figures represent night surveys (2006-2011) with transects and spot sampling (2006, 2008, 2009) and random grid sampling (2010, 2011). Note units are standardized by catch density (metric ton/ km³).



2011

REFERENCES

- McFarlane, G.A., Schweigert, J., MacDougall, L., and Hrabok, C. 2005. Distribution and biology of Pacific sardines (*Sardinops sagax*) off British Columbia, Canada. *CalCOFI Sci. Rep.* 46: 144-160.
- Schweigert, J., McFarlane, G.A., and Hodes, V. 2009. Pacific sardine (*Sardinops sagax*) biomass and migration rates in British Columbia. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2009/088. 14p.
- DFO. 2011. Evaluation of Pacific sardine (*Sardinops sagax*) stock assessment and harvest guidelines in British Columbia. *DFO Can. Sci. Advis. Sec. Science Advisory Report.* 2011/016.