Summary of: Review of Sea Scallop Methodologies and Their Integration for Stock Assessment and Fishery Management

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Joint Scallop PDT and AP Meeting
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New England
Fishery Management Council

Background

- In April 2012 the Council tasked the SSC to review Habcam survey technology methods, review how habcam results will be integrated into assessments, and determine the impact on current survey methods
- Further discussions broadened the scope to include all survey methods
- Draft TORs reviewed by SSC and Council in Sept 2012, schedule for meeting moved back due to other priorities
- March 2015 independent reviewers invited to serve as external peer review to assess the strengths, weaknesses, and identify potential opportunities for collaboration

Meeting Details

- Panel Members – J.J Maguire (Chair, SSC Member)
  Noel Cadigan, CIE Reviewer, Canada
  Martin Cryer, CIE Reviewer, New Zealand
  Jon Helge Volstad, CIE Reviewer, Norway
  Brent Wise, CIE Reviewer, Australia
- Presentations and materials provided by all survey groups (Arnie's Fisheries, NEFSC, SMAST, VIMS, and WHOI)
- Three day meeting with over 20 presentations – March 17-19
- About 50 people attended the meeting as well as 1-2 dozen participants online
- All materials available at: http://www.nefsc.noaa.gov/saw/scallop-2015/

Terms of Reference

1. Review statistical design and data collection procedures
2. Evaluate measurement error
3. Review biological sampling aspects of surveys (sub-sampling, ability to sample all size classes, ability to detect incoming recruitment, ability to assess fine scale ecology)
4. Review methods for estimating abundance and accuracy of estimate of absolute abundance (measure of bias)
5. Evaluate methods for uses outside of assessment (management uses)
6. Comment on contribution of surveys for non-scallop purposes
7. Comment on current or any proposals for optimal frequency and combination of survey methods
8. Identify future research and areas of collaboration

General Findings

- Summary Report with input on each TOR
- Individual Reports from each CIE Reviewer

- This presentation tries to pull out overall conclusions – full reports should be considered as well

- Council expected to consider these findings in June
- Next Steps?

TOR #1

Review statistical design and data collection procedures (dredge on research vessel, dredge on commercial vessel, SMAST video, HabCam on research vessel and HabCam on commercial vessel)

Conclusions:

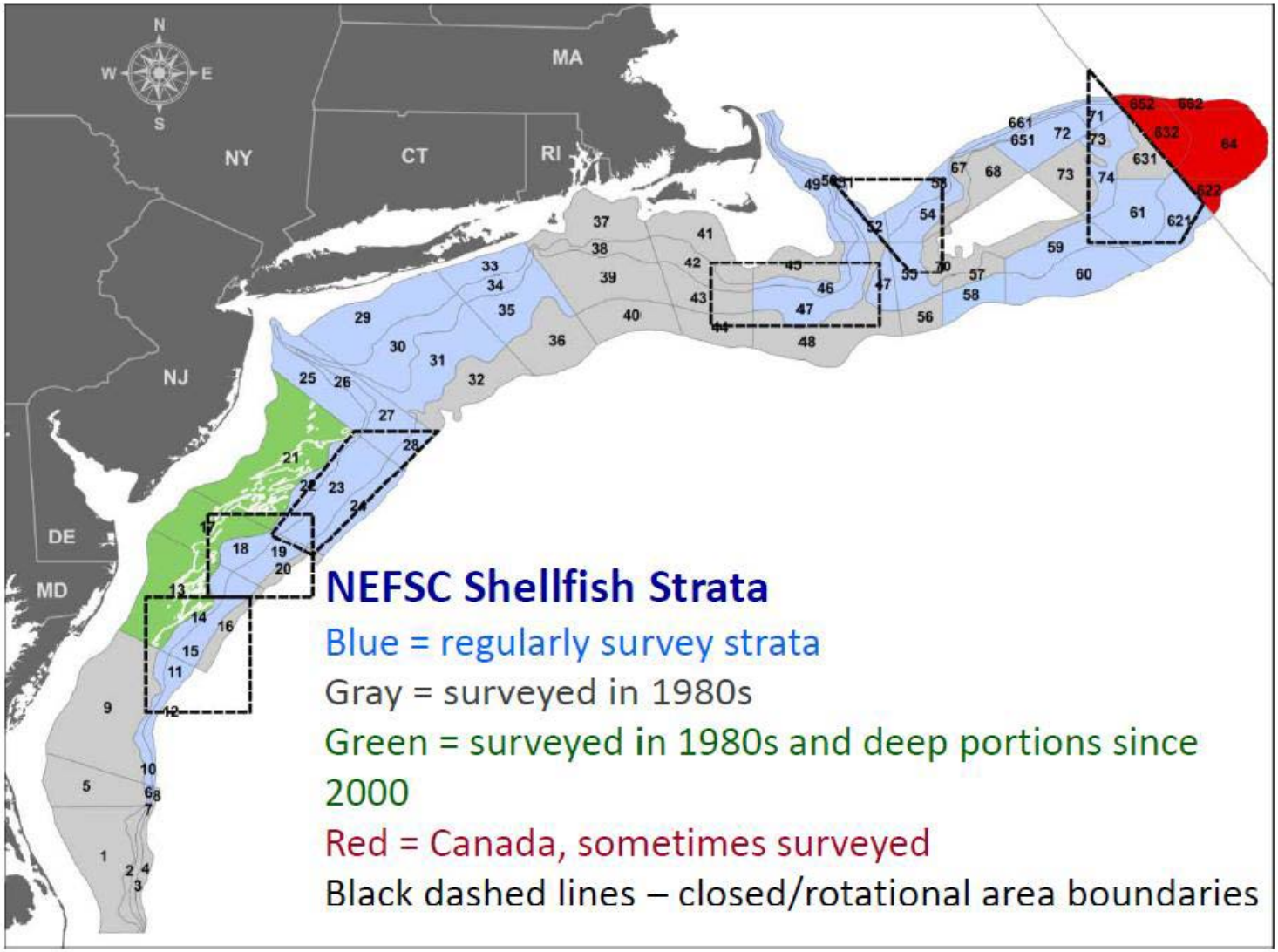
1. All surveys have strengths and weaknesses.
2. All provide unbiased estimated of mean abundance in surveyed areas, but difficult to produce a design-unbiased estimator of the variance for grid design surveys.
3. Overall sampling intensity of drop camera and VIMS dredge are inefficient because sampling intensity is the same in areas of low and high abundance. Estimates would be more precise with more sampling in high abundance areas, but surveys have other objectives. Optimal design depends on primary purpose and compromises necessary if multiple objectives.

TOR #1 (cont.)

Review statistical design and data collection procedures

Conclusions (cont.):

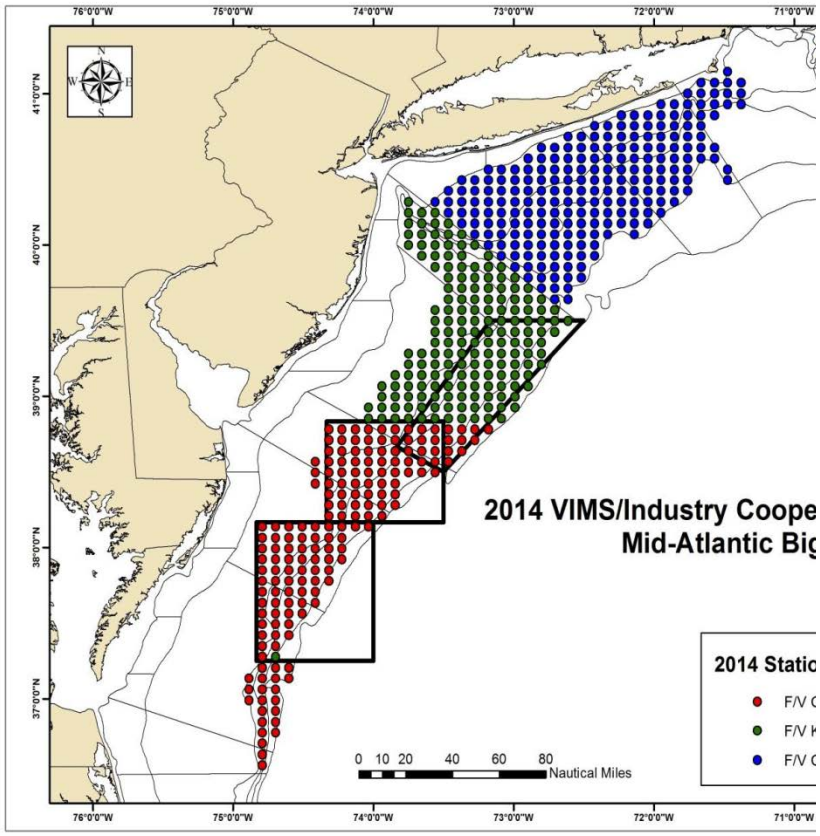
4. Federal Habcam has very detailed info along transect, but distance between transects seems wide and Industry Habcam has short distances between transects but for smaller parts of the stock area.
5. NEFSC dredge survey has reduced over time and this introduces risk that estimates are less reliable (less precision and potential bias). A stratification method for quasi-optimal allocation of tows was presented but insufficient details about specific sampling plans or analysis of its potential efficiency compared to stratified random sampling were available. However, federal survey is flexible and can take into account other surveys to achieve a comprehensive survey. Gear types have been calibrated so results can be combined.

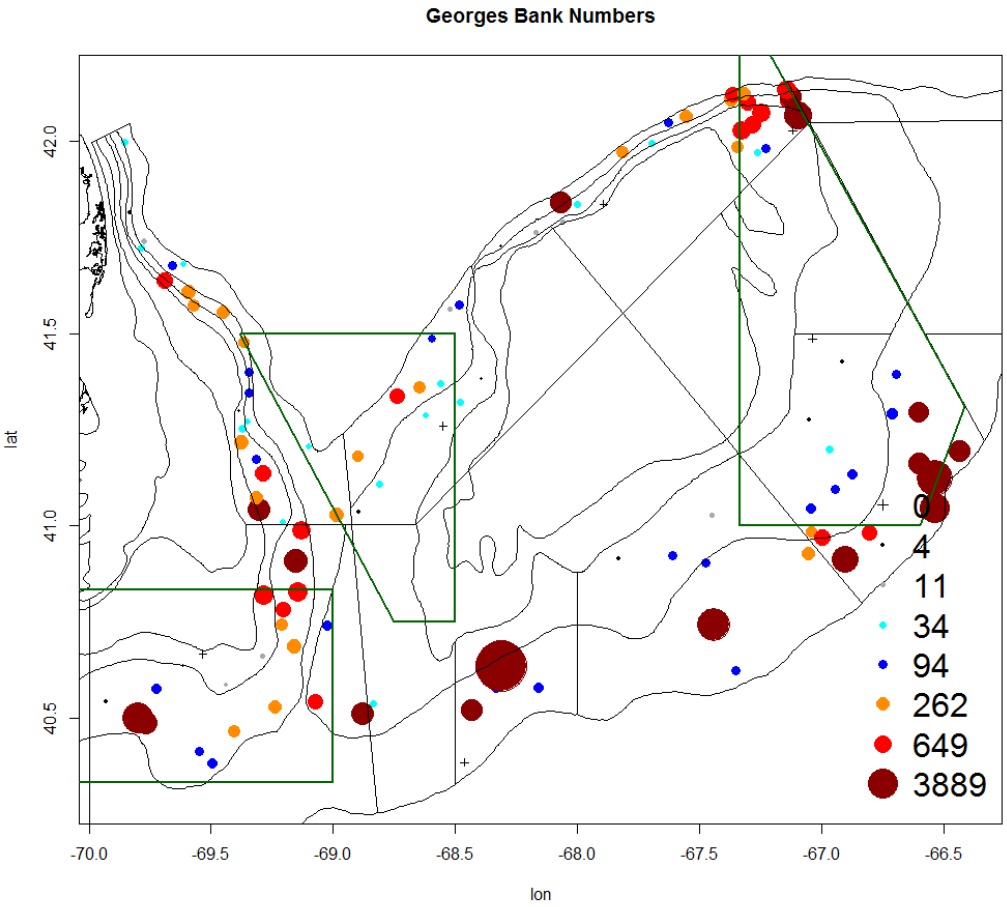


Slide 9 from NEFSCDredgeTOR1-4_final-Tues.pdf

Comprehensive Dredge Survey - 2014

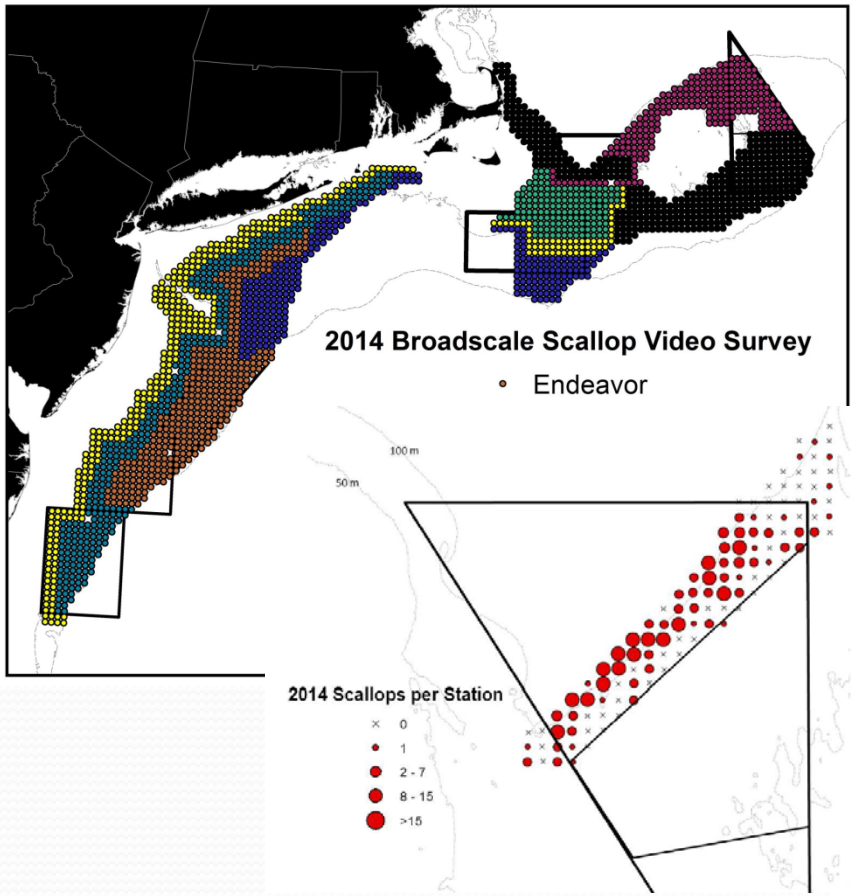
Dredge Surveys – VIMS in Mid-Atlantic and NEFSC on GB

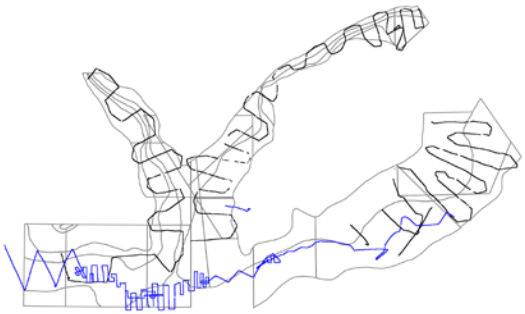




Comprehensive Optical Survey - 2014

SMAST – Broadscale GB and MA and CA1 sliver – intensive
Habcam – Both Version 4 (NEFSC) and Version 2 (Habcam Group)





NEFSC V4 – Black
Habcam Grp V2 - Blue

TOR #1 (cont.)

Review statistical design and data collection procedures

Conclusions (cont.):

6. Surveys with greater spatial coverage tend to reduce bias and provide more accurate estimates of stock size, especially for populations whose spatial distribution can vary.
7. Allocation of samples should ideally cover entire range of stock with more intense sampling in areas with higher abundance to increase overall precision.
8. Spatial management may require more detail sampling to achieve optimal use of resource.

TOR #2

Evaluate measurement error

(including shell height measurement, detection of small scallops, determination of live vs. dead, selectivity of gear, and influence of confounding factors like light, turbidity, tide, etc.)

Conclusions:

1. Dredge surveys provide more accurate measurements of shell height compared to optical surveys (both drop and towed cameras).
2. Critical to have reliable estimates of length compositions for length based assessment model. Collection of physical samples is necessary to estimate spatio-temporal variation, also critical to assessment.
3. Optical surveys provide almost complete detection of exploitable scallops and better detection of recruitment compared to dredge surveys; however recruitment info is still only qualitative. Optical surveys used to estimate dredge efficiency – 40% on sand and 24% on gravel.

TOR #2 (cont.)

Evaluate measurement error

Conclusions (cont.):

4. Drop camera edge-effect correction method inflates smapled area by including buffer around actual quadrat of width equal to half the average length of observed scallop. This underestimates abundance of small scallops because small scallops on edge not seen and overestimates abundance of large scallops. The latter bias particularly important for estimation of exploitable biomass. Panel recommends correcting for edge effect for individual scallops instead, and a method was offered.
5. In practice there also seems to be some differential detectability of scallops from drop camera, especially in corners, which probably leads to some negative bias. The panel also provided a potential method for correcting such bias that could be applied to existing data.

TOR #2 (cont.)

Evaluate measurement error

Conclusions (cont.):

6. Optical surveys would produce less reliable estimates of the proportion of dead scallops (false alive or dead) but the magnitude of this was not quantified
7. There are many confounding factors (optical distortion, attenuation, etc) for optical surveys and many of these have been addressed for both the drop and towed camera systems. The panel considers that the Habcam4 imaging processing procedures are more advanced and encourages further research.

TOR #3

Review biological sampling aspects of surveys
(including sub-sampling procedures, ability to sample all size classes, ability to detect incoming year classes, assess potential ability to assess fine scale ecology like predator prey relationships, disturbance from fishing gear, etc.)

Conclusions:

1. Both optical survey provide potential info on predator-prey interactions. The panel thinks finfish avoidance may be more of a problem with towed camera because it is more likely detected earlier; however, towed camera provides a much larger sample size (images) that could be used to evaluate predator-prey distributions.
2. Panel agrees there is a magnitude of work involved in processing large amounts of data and encourages further development of automatic processing capabilities (HabCam4).
3. HabCam4 with side scan sonar is the only sampling procedure reviewed that could be used to detect the physical impacts of fishing gear.

TOR #3 (cont.)

Review biological sampling aspects of surveys
Conclusions (cont.):

4. To collect biological information such as disease, grey meat, etc it is necessary to physically capture scallops. This is important for assessing potential future natural mortality, which can greatly affect the efficacy of management plans, growth rates and potential yield.
5. Optical surveys have higher detectability of scallops <20mm than dredge, but less accurate info on exploitable scallops because they introduce statistical noise – distributions of size are widened and cohorts are "smeared". However, there is some potential for dredges to have a dome-shaped selection pattern that can lead to underestimating proportion of very large scallops . These issues should be studied further.

TOR #3 (cont.)

Review biological sampling aspects of surveys

Conclusions (cont.):

6. Subsampling for meat weights is currently done on the federal dredge by selecting 5 baskets per station. Statistical sampling design should be developed and applied. Panel recommends the total # of baskets and fraction sampled be recorded and the between basket variation be recorded to estiamte this source of variation.
7. Drop camera does not subsample. Subsampling of HabCam seemed reasonable but the within transect variation can be large and alternative sampling strategies may be required for other species or areas where scallop densities are low.

TOR #4

Review methods for using survey data to estimate abundance indices. Evaluate accuracy of indices as estimates of absolute abundance

Conclusions:

1. Commercial dredge – post stratified into 9 sub-areas and standard design-based methods used. Panel did not review estimates of efficiency in detail but methods seem appropriate. Potential biases in efficiency estimates over time or space will affect accuracy. Variance estimate has issues and survey is exploring changes to survey design to address those issues.
2. Drop camera – method seemed appropriate subject to probable positive bias associated with edge effects correction and probable negative bias associated with detectability of 100% of scallops in image. Uses the same statistical uniform systematic design method as VIMS with the same potential biases.

TOR #4 (cont.)

Review methods for using survey data to estimate abundance indices.

Conclusions:

3. Both HabCam surveys use model based methods (kriging and GAM with kriging) and a design based method (stratified mean) – all 3 tested through simulations. Panel concluded that no single method consistently achieved low bias. The geostatistical modelling approach seems reasonable but the biomass variance estimates are likely underestimated. More work recommended.
4. Model based methods should be used with care. The Panel notes that in a few cases the model estimated highest abundance in areas with no samples and it is not clear why. This could be seriously misleading if models used in spatial management.

TOR #5

Evaluate any proposed methods for using surveys outside of stock assessment model for management purposes

Conclusions:

1. VIMS and NEFSC dredge survey results have been combined and this is appropriate because the same gear is being used; however, these two surveys are not at the same time and populations could be different due to growth and mortality.
2. Survey results are currently combined into one overall biomass estimate (VIMS and federal dredge, SMAST drop camera, HabCam2, and HabCam4). Two methods have been used: straight average and inverse variance weighting method. Combining surveys is only appropriate if the estimates are for the same area. Raw averaging does not account for different precision of estimates. However, inverse variance weighting is reliable only if there are reliable estimates of variance, which is uncertain for VIMS and SMAST, where variance is expected to be overestimated. An analysis that combines all surveys in a single model using co-kriging was presented, but it is still a work in progress.
3. Data from these surveys are used for other management purposes, the panel concludes that complementary surveys provide enhanced capabilities to achieve other objectives because no survey covers the complete stock area on a regular basis.

TOR #6

Comment on potential contribution of each survey to assessments for non-scallop species and other purposes

Conclusions:

1. All surveys have potential to contribute to other purposes and in many cases info is complementary or additive. Optical surveys have provided additional information on habitat, scallop ecology, and ecosystem studies.
2. All have provided information on changes in abundance of other species.
3. Panel considers that HabCam V4 has the greatest potential in providing info on habitat, gear impacts, species interactions and spatial structure on a continuously variable variety of scales.
4. Both dredge surveys sample less area, which limits their contribution to ecosystem studies.
5. Broadscale info is particularly useful when contributing to ecosystem studies. Panel encourages further research in those areas.

TOR #7

Comment on current and/or any proposals for optimal frequency and combination of survey methods

Conclusions:

1. No specific proposals for optimal frequency were evaluated but the panel agrees that annual surveys are required to support the management process. Yearly surveys also make it possible to detect and protect recruitment events and avoid under and over harvest of stock components.
2. To some extent the surveys are integrated because they cooperate to address survey gaps and standardize dredge catch rates. Panel recommends that survey efforts should be further integrated to provide a standard monitoring survey of the entire stock.

TOR #7 (cont.)

Comment on current and/or any proposals for optimal frequency and combination of survey methods

Conclusions:

3. Optical and dredge surveys are complementary and both should be maintained and integrated.
4. Continuity of the time series should also be maintained to the fullest extent possible.
5. Panel recommends that all info be used to devise an optimal and integrated statistical survey design involving use of complementary methods for estimating stock size, spatial distribution, and other primary objectives. This may require simulation studies.

TOR #8

Identify future research and areas of collaboration among investigators and institutions

Conclusions:

1. Panel recommends that all available information from all surveys be thoroughly analyzed, including an evaluation of the efficiency of using shorter tow durations.
2. Further investigation into the correlation between dredge tow catches and HabCam observations, and using model assisted regression estimators may be a simple way to combine and improve estimation of stock size while maintaining continuity of federal dredge survey.
3. In a survey design with increased dredge coverage, the panel found no compelling advantage in using both dredge and HabCam gears on the same vessel. However, a portion of dredge samples that overlap HabCam track are still required. Panel agreed that continuous sampling of HabCam is the best use of the technology (compared to taking the vehicle in and out of the water). A joint integrated survey using two vessels could result in a better survey with improved coverage.

PDT/AP Agenda Item

- Consider and discuss findings
- Since I am not able to answer specific questions about these findings the PDT/AP could identify important questions to forward on.
- Should any of these findings be integrated into future research priorities related to scallop surveys?