HABCAM GROUP
27 February 2015

Review of Sea Scallop Survey Methodologies and
Their Integration for Stock Assessment and Fishery Management
PEER REVIEW PANEL

TERMS of REFERENCE

1. Review the statistical design and data collection procedures for each survey system

Statistical design
approach
We want to know what is in survey area, every sq meter, but....will have to settle for parallel line transects as close together as possible, with the inflexion point being one of "cost" i.e., vessel time, people time, annotation time, where you price work out of the competition.

What's adequate - good enough? It really depends upon what we are trying to document or measure. Patches of scallops are generally much larger and more dense than fishes (currently). The main issue is that populations of different species have differing densities and patchiness so sampling requirements vary with species, funding is for scallop. not YTFL... and then there is substrate....where you want every meter. I like continuous mosaics, and/or broader scale sonar, for definitive finer scale. back to cost.

Would rather have too much than too little.

After survey design, image data is "annotated" targets counted and measured, substrate noted, and annotator comments entered into searchable text. Results for scallop are then converted to sizes, with kriged results then used to estimate biomass.

Backing away to get perspective but it seems that a perfect i.e. 100% accurate survey method does NOT account for "missing" biomass over a multiple year fishery... something else.... discards, high grading, die off from having the shucking waste dumped back on the fishing grounds is confounding the results of the diligent survey efforts.

data collection procedures
Towed vehicle, 12 bit RGB images, other data via fibre cable to surface vessel, to hard drives, image processing - color and lightfield correction, conversion to jpeg, annotation to searchable textfile.

2. Evaluate measurement error of observations including shell height measurement, detection of scallops, determination of live vs. dead scallops, selectivity of gear, and influence of confounding factors (*e.g.*, light, turbidity, sea state, tide etc.)

measurement error including shell height

systemic "errors" or biases

- 3 dimensional measurement projected onto 2D image plane
- roll pitch and yaw plus target not flat to the bottom that is rarely flat anyway, small error
- percentage of targets parallel to CCD plane ? Very low.
- bias intuitively always and only smaller because of this "foreshortening"
- what percent ?? 2 pixels or 1-2mm
- when measuring scallop, 100mm 1-2% 1-2mm, if 20mm 5-10%, but small has little biomass.
- best example is trying to accurately measure the height of attached epifauna from above.
- some variation and thus bias between and among annotators. Test runs for SH ±3%

detection
personnel - annotation technician, an artform,

camera optics - water clarity, altitude, and target size, resolution 0.5 to 1mm pix

live vs dead - an annotator art, water clarity or turbidity, altitude, scallop age, substrate type

selectivity - presumably neutral, however also annotator issue ...half in half out bias small ?

influence of confounding factors (light, turbidity, sea state, tide etc)
light - generally ok
turbidity - plankton - euphausids - sometimes obscures to 100%, see season
sea state - to 3-4 meters - risk goes up, with decreasing percentage viewable
tide (and currents) - not a large effect unless downcurrent of sand waves near flood
season - summer more difficult than winter, more life in the water
nearby fishing operations - downcurrent from surf clam vessels for several miles.

3. Review the biological sampling aspects of the surveys, including sub-sampling procedures and the ability to sample all size classes. For each survey, evaluate the utility of data to detect incoming recruitment, assess the potential ability to assess fine scale ecology (*e.g.*, Allee effect, predator-prey interactions, disturbance from fishing gear, etc.)

biological sampling - entirely by imagery is difficult except for counts and sizes

sub-sampling - two types
along track - i.e. every image, every other, 1 in 10, 1 in 50, 1 in 100, 1 in 200, etc.
Entirely depends on objectives, and species, where too great a spacing may miss small patches, and certainly widely spaced individuals.

within an image - measuring 100s of any smaller animals in one image is not best use of time

ability to sample all size classes
YES

ability to detect incoming year classes
YES, our experience (depending on turbidity) is scallops down to ~10-15mm

ability to assess fine scale ecology
Allee effect- "positive correlation between increased population density and individual fitness." Do not believe adequate soley via optical examination of surface aspects only.

predator-prey interactions - many examples, however NOT on demand, serendipitous

"disturbance" from fishing gears - vs "disturbance" let's say from 2-4 kt tidal currents
Rarely see definitive evidence of the passage of fishing gears in the optical imagery. However it is clearly evident and easily and accurately tracked in acoustic sonar imagery. Also evident in the sonar imagery are the tidal scours around boulders, or any other larger objects, not evident in the optical imagery.

4. Review methods for using survey data to estimate abundance indices. Evaluate accuracy (measures of bias) of indices as estimates of absolute abundance.

methods for using survey data to estimate abundance indices
Thus far the HABCAM V2 surveys have returned to the same area only rarely (one NOS project over three years) otherwise is not on a planned or dependable revisit period. Thus any possible "indices" are sporadic, a happenstance of timing.

Evaluate accuracy (measures of bias) of indices as estimates of absolute abundance.
N/A

5. Evaluate any proposed methods for integrating and using surveys outside of a stock assessment model for management purposes.

proposed methods for integrating and using surveys...for (other) management purposes.

Current usage serves to better define areas of high scallop density, perhaps useful in making any future changes to access areas such as redrawing boundaries..

Am aware of hopes and discussion concerning use of HABCAM for "non-scallop" species, but not aware of formally proposed or specific ongoing efforts.

Use of instrument is a natural fit for habitat studies within all areas.

6. Comment on potential contribution of each survey to assessments for non-scallop species and use of data apart from assessment purposes such as characterizing species habitat, understanding sea scallop ecology, and ecosystem studies.

potential contribution of each survey to assessments for non-scallop species
Attached or sessile species particularly invertebrates have the most obvious potential, with epifauna and mussel being a prominent example, of interest because of their relationship to food for codfish. Surf clam siphons are another example, however exact speciation, e.g. spisula vs.

Stimpson (*mactromeris*) clam, likely difficult to impossible without corollary gear survey to attempt to identify visual differences.

Although fish are mobile, and can be either repelled or attracted to the light put out by the vehicle, the fact is that we see little movement in successive frames from all but a few fish species, e.g., barndoor skate and especially tilefish. Feel fairly certain that along transect few fish could be double counted in that they would have to sustain the same five knots that the vehicle makes good to appear in subsequent along track images. With parallel 1nm spacing transects double counting is possible since we may only be 1nm away from an initial "sighting" 6 or more hours later. Cross track transects are an entirely different matter where we may not come back to an area for many hours or days, then double counting is also easily possible.

use of data apart from (scallop) assessment purposes
Other sensors simultaneously record temperature and salinity, so the HABCAM instrument is able to produce snapshots of these environmental parameters over the survey area. Other sensors have been included on many cruises, e.g. fluorescence, and multibeam and sidescan sonars. Other sensors are possible.

characterizing species habitat, understanding sea scallop ecology, and ecosystem studies
Information about species assemblages and substrate type and variations over small and large areas has been and continues to be collected while surveying for scallop biomass. Still am a firm believer in the Canadian approach of large area multibeam in conjunction with fine scale biological sampling to produce fine scale maps of scallop species association, substrate, and "habitat". Same approach would produce similar data and maps for other species. However believe that the NEFMCouncil has a long way to go before utilizing such information.

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

current and/or any proposals for optimal frequency
While the desire has been expressed repeatedly to move the timing of assessment surveys to earlier in the year for administrative process reasons, am not aware of proposals to change the annual frequency for the scallop resource. There are good reasons to conduct multiple groundfish surveys because of the seasonal movement of many species. That said the low annual quotas for the fishing fleet may make it difficult to fund Cooperative Research out the groundfish resources or to continue to justify federal monitoring and documenting of that disaster, despite the obvious need.

combination of survey methods.
For the most part the independent but often overlapping surveys serve to crosscheck each other without consideration of actively working together. However the inability of both the dredge and optical surveys to adequately describe the bottom and quantify the scallop resources within the nothern portion of the Northern Edge CLAII HAPC suggests that the combination of both methods would produce better results than either survey conducted independently. That said it is well known that the dredge has variable catchability issues when towing in areas with cobble, and that the optical survey approach is severely limited by the coverage of attached epifauna, so

that getting defendably accurate estimation of substrate and scallop population is not possible whether the survey methods are used independently or in combination.

8. Identify future research and areas of collaboration among investigators and institutions.

future research
using existing data
There is enough imagery and associated data on disk to keep any interested graduate students busy for a long time.

future research needs - HABCAM (or similar) technology may in fact allow some refining or expansion of future research needs to match its capabilities. As well fully expect to see radically improved technologies with greatly enhanced capabilities emerge fairly rapidly, within 10 years.

areas of collaboration among investigators and institutions
One would think that the opportunities for collaboration between investigators and institutions would be enhanced by the current funding logjams. What we seem to see instead is an increasing number of investigators from different institutions applying for these particular funds because of their availability, whether they have any long term connection with the scallop industry or not.

9. Additional comments and items that do not seem to fit exactly into specific ToRs:

1. HABCAM V2 while being towed by a commercial fishing vessel Kathy Marie, while not using the exact same technology as the NOAA V4 system, produces essentially comparable and compatible results.

2. The dense coverage of the HABCAM GROUP surveys removes some the skepticism that can arise from purely statistical results from sparse but statistically adequate surveys, of course at the cost of greater expense.

3. The HabCam V2 operations aboard the F/V Kathy Marie generally have a greater flexibility of operations than a UNOLS class vessel with their tightly scheduled contracts. This has been demonstrated twice in the last two years. In 2013 an entirely unplanned short survey of a significant area of new settlement noted by other survey groups was conducted with a short two day turn around including planning.

In 2014, after early engine problems, associated delays and a subsequent hurricane cut short a second cruise, the NOAA contracted UNOLS R/V Sharp could not modify its schedule enough to entirely complete the planned NOAA survey route. F/V Kathy Marie and the HABCAM GROUP personnel in consultation with the NOAA group modified their survey strategy and plan, and completed a 400 nm or 3.3 day segment of the NOAA survey route, without NOAA personnel aboard.

4. By conducting a large portion of the combined scallop survey aboard commercial scallop vessels several difficult to quantify benefits are evident. One, the experiential knowledge of the resource and the fishing grounds is a significant aid to planning and execution of our surveys.

Two, the additional knowledge gained is a benefit to the fishing fleet. And three, the simple fact that commercial scallop fleet vessels are participating serves to promote the intangible quality of buy-in to the results, particularly since three of the four survey groups conduct their surveys on commercial scallop vessels with industry personnel.

Below is a summary of all HABCAM cruises for the period 2003-2014.

HABCAM V2 SUMMARY OF SURVEYS 2005-2014					transect nm	transect nm	images	images
		47	<---TOTAL CRUISES TO DATE	SUBTOTALS nm ----->	7,341	11,578	31,713,120	50,016,960
YEAR	YEAR	CRUISES	AREA	SURVEY PATTERN	RSA_LEN nm	nm_YEAR	RSA SUBT	ALL PROJECTS
1	2003	1	GSC				11,000	
2	2005-2006	8	WGSC, NLSCLA, ET	PARALLEL and ZIG ZAG	770	770	3,326,400	3,326,400
3	2007	4	CLA1, WGSC, HAPC, SBNMS	PARALLEL and ZIG ZAG	900	900	3,888,000	3,888,000
4	2008	8	CLOSED AREA 1 AA	Zig zags, spirals	470	1638	2,030,400	7,076,160
5	2009	10	CLOSED AREA 1 AA	2nm parallel E-W	267	1897	1,153,440	8,195,040
6	2010	3	CLOSED AREA 2 AA	2nm parallel E-W	500	859	2,160,000	3,710,880
7	2011	2	CLOSED AREA 1 AA	2nm parallel N-S	500	1580	2,160,000	6,825,600
8	2012	4	CLOSED AREA 2 AA	2nm parallel E-W	490	1034	2,116,800	4,466,880
9	2012		CLOSED AREA 2 HAPC +W	1nm and.5nm E-W	544		2,350,080	-
			plus West Area	1nm N-S north portion				-
10	2013	3	CLOSED AREA 1 AA	2nm parallel N-S	700	1560	3,024,000	6,739,200
11	2013		CLOSED AREA 2 HAPC +W	1nm and.5nm E-W	500		2,160,000	-
			plus West Area	1nm N-S north portion				-
12	2013		PRELIM SEED MONITORING	PARALLEL and ZIG ZAG	360		1,555,200	-
13	2014	4	SEED MONITORING	ZIG ZAG and PARALLEL	400	1340	1,728,000	5,788,800
14	2014		ELEPHANT TRUNK AA	2.5nm parallel E-W	540		2,332,800	-
15	2014		HUDSON CANYON AA	wide ZIG ZAG NW-SE	400		1,728,000	-