Development of a standardized fisheries independent bottom trawl survey program (FIS) off the west coast of Canada.

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And
Many Others

Why ?

- Historically we have relied on commercial catch and effort data to index abundance
- Unfortunately commercial catch data are prone to hyper-stability, display market bias, and show the impact of resource management actions.
- Since at least 1999 authors of assessments have pointed out these deficiencies and recommended the development of a fisheries independent index of stock abundance.
- Fisheries independent surveys really existed for only a couple of groundfish species: Sablefish Pacific Halibut and Pacific Hake.
- The only existing multi-species bottom trawl survey trawl survey was the Hecate Strait Assemblage survey and it was not particularly well designed to index species abundance.

So…

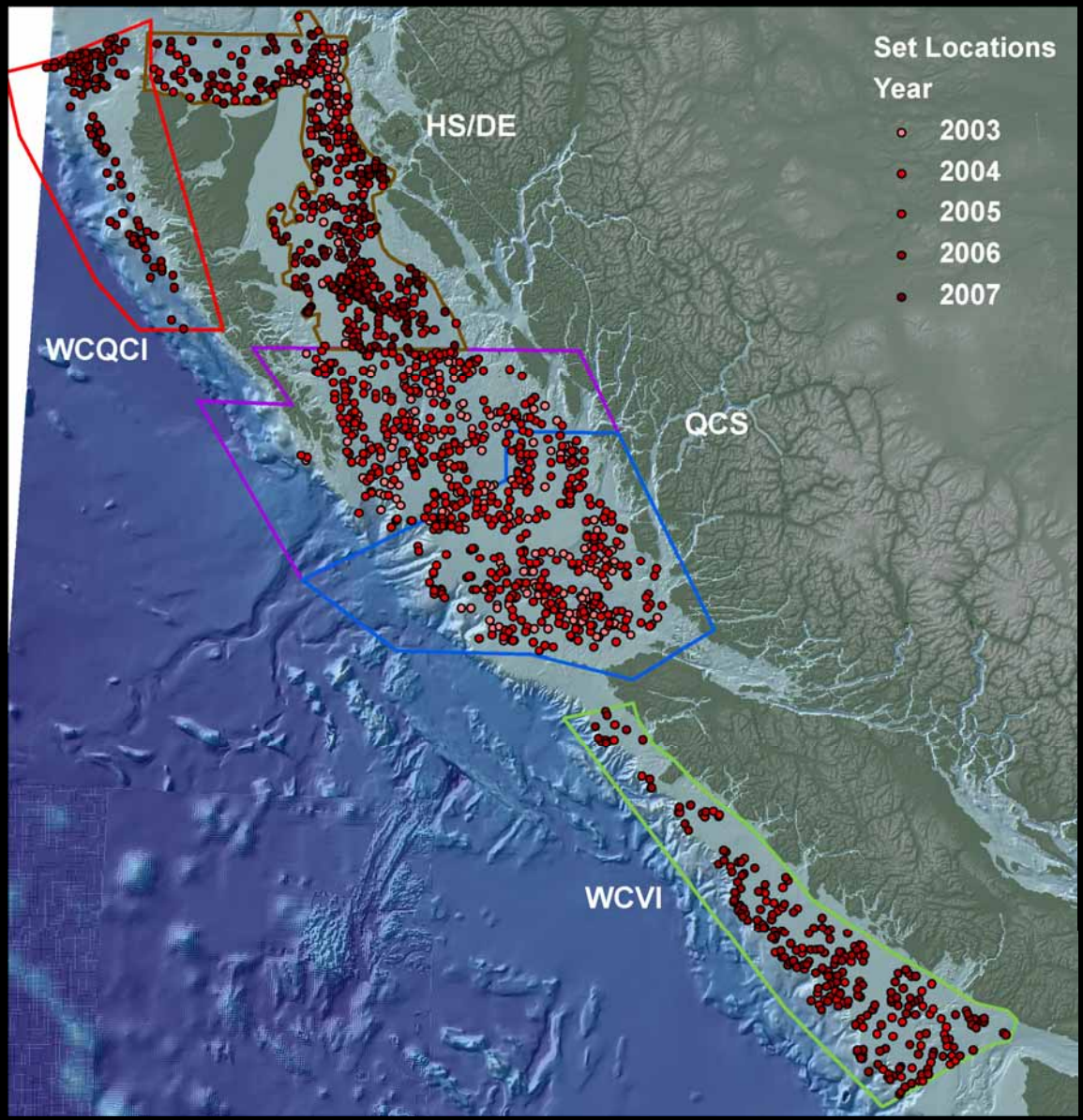
- In 2003 the Pacific Biological Station initiated a series of bottom trawl surveys designed to index the abundance of all demersal groundfish species available to bottom trawl gear on the west coast of Canada.
- Survey design and operational consideration were based on the findings of a working group struck in 2002 to examine the feasibility of a coast wide multi-species bottom trawl survey
  - Feasibility of Multispecies Groundfish Bottom Trawl Surveys on the BC Coast. Sinclair, A., Schnute, J., Haigh, R., Starr, P., Stanley, R., Fargo, J., and Workman, G. CSAS Res Doc 2003/049
- At the outset we acknowledged that for a time series to be meaningful we would have to develop a fixed set of survey protocols, software tools, gear mensuration requirements and a standardized survey trawl.

Program Overview

- The Fisheries Independent Trawl Survey Program is now Comprised of 4 area specific surveys
- Each Area is surveyed on Biannual rotation.
- The four areas, the West Coast of Vancouver Island (WCVI, 3C/3D), Queen Charlotte Sound (QCD, 5A/5B), Hecate Strait/Dixon Entrance (HS, 5C/5D), and the West Coast of the Queen Charlotte Islands (WCQCI, 5E).
- Two surveys are conducted annually, one aboard a charted commercial fishing vessel and the other aboard a government research trawler.
- Chartered vessel surveys cover QCD and WCQCI while government vessel based surveys cover WCVI and HS/DE.

After five years of surveys

- 10 surveys completed
- 6 sponsored by industry
- 4 sponsored by DFO
- > 2300 usable sets processed
- > 300,000 specimen sampled



Pre-survey Analyses

- Analyses are undertaken to:
  - estimate the required level of effort (N Sets)
  - estimate the optimal allocation of effort amongst strata
  - develop a stratification scheme
- This is done by estimating variance of abundance indices at various effort levels with a variety of stratification and allocation schemes using commercial fishery or existing survey data as inputs
- The objective of the exercise is to come up with an effort level and allocation scheme that produces > 10 commercial species abundance indices with an estimated CV of < 0.2.
- For details of the method see:
  - Shnute J. T. and R. Haigh. 2003. A simulation Model for Designing Groundfish Trawl Surveys. Can. J. Fish. Aquat. Sci. 60: 640 – 656.

Example of pre-survey analyses results

Using 1997 WCQCI Survey data for input

Depth Range		Equal	Area	Catch	Density	Optimal	Actual	Chosen
125-200		28	17	3	28	17	3	20
200-330		28	35	68	54	68	39	40
330-500		28	33	37	19	20	63	40
500-800		28	25	2	9	5	5	10
Number of species achieving a target CV	< 0.1	0	1	0	0	0	1	0
	< 0.2	5	7	3	6	5	4	7
	< 0.3	13	12	10	16	14	9	13
	< 0.5	27	28	19	26	27	18	27
	< 1.0	33	33	31	33	33	33	33

	B	CV	CV	CV	CV	CV	CV	CV
Shortspine thornyhead	1446	0.13	0.12	0.11	0.13	0.13	0.10	0.11
Dover sole	942	0.11	0.10	0.19	0.13	0.14	0.12	0.11
Arrowtooth flounder	3904	0.22	0.20	0.21	0.16	0.15	0.23	0.19
Rosethorn rockfish	52	0.25	0.22	0.16	0.19	0.17	0.21	0.21
Silvergray rockfish	5817	0.24	0.22	0.30	0.18	0.18	0.31	0.21
Sablefish	929	0.15	0.14	0.31	0.17	0.21	0.19	0.16
Pacific ocean perch	17157	0.33	0.29	0.21	0.24	0.22	0.27	0.27
Schoolmaster gonate squid	58	0.22	0.20	0.20	0.24	0.23	0.17	0.19
Spotted ratfish	46	0.39	0.35	0.26	0.29	0.26	0.33	0.33
Rougheye rockfish	6996	0.22	0.20	0.30	0.25	0.26	0.20	0.20
Shortraker rockfish	606	0.15	0.14	0.40	0.21	0.26	0.23	0.18

Survey Characteristics

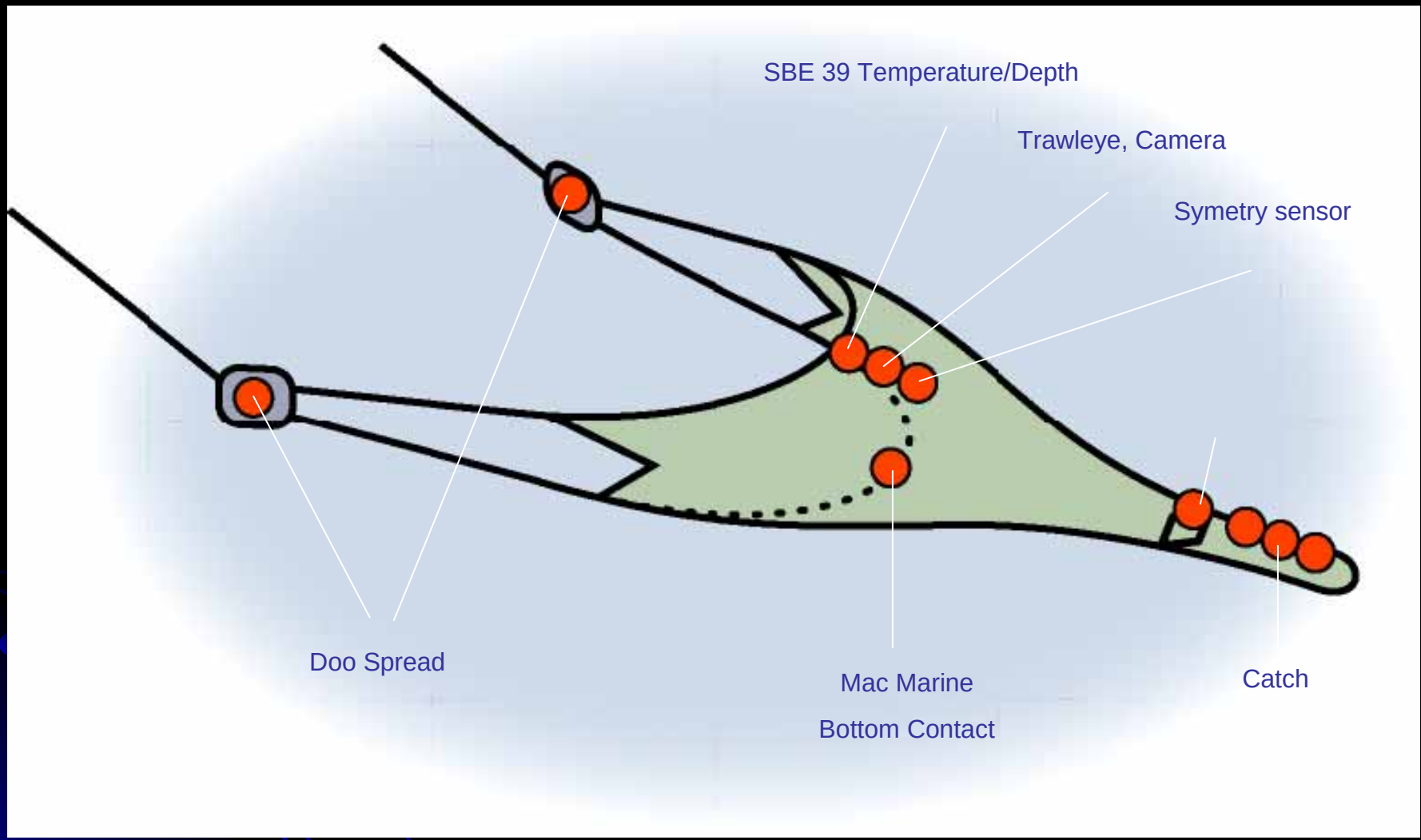
- The surveys use a random depth stratified design
- Each year a new set of survey locations is selected at random with replacement
- Allocation amongst strata can change annually but strata boundaries cannot
- Survey site selection is grid based:
  - A Grid of 2 km x 2 km is superimposed over the survey area
  - Mean depth of each block is estimated using a GIS
  - Blocks are selected at random based on the selected allocation scheme
  - ArcMap GIS application used to select survey sites and manage survey while at sea

The Net – Industry recommendation

- The survey net is an Atlantic Western 2a:
- 4 ½” and 5” Euroline premium web
- ¼ Mesh Liner in the codend
- 18” rock-hopper footgear with 18” tire gear in the bosom.
- 90’ sweeps and bridles
- Thyboron 104 Doors or equivalent
- Throughout the survey the trawl is to be maintained to original specification by the vessel crew, repairing all broken mesh as they are discovered
- Prior to each survey the nets are overhauled to ensure they meet specification

Net Sensors

- Required!
  - Net mensuration gear (Scanmar, Simrad ITI or NetMind)
    - Minimum sensors array include Door spread, Net height, distance to bottom additional sensors are employed if available
  - Bottom Contact sensor (NMFS design) is mandatory
  - Seabird SBE 39 must be deployed for each set
- Optional..
  - In 2006 we added a Seabrid SBE 19+ CTD with DO sensor to the net
  - Periodically a headrope trawl camera has been deployed


SBE 39 Temperature/Depth
Trawleye, Camera
Symetry sensor
Doo Spread
Mac Marine
Bottom Contact
Catch

Execution

- All surveys are executed in a series of legs
- In three of the four surveys a South to North and return pattern is used in which ~ 2/3 of the survey blocs are visited during the first pass and the remaining 1/3 are completed on the return leg.
- In one survey, QCS the survey is executed in a series of wedges emanating from the primary port.
- The same pattern or sequence is used each year

Dealing with unfishable sites

- In the past (Pre 2004) we have always sailed with a set of primary stations and a set of alternates.
- This always resulted in potential selection by the vessel skipper of alternate sites that have more fish than primary sites.
- To avoid this problem and the associated difficulty in selecting alternates we adjust the selected set the selected set of stations the for anticipated rejection rate.
- For example with a target effort level of 240 blocks in Queen Charlotte Sound and an anticipated rejection rate of 22 % we select 309 blocks and fish or inspect every one.
- In 2004 we this resulted in 239 usable tows, in 2005, 240, and in 2007 the result was 256.

Deciding to fish

- Fishing masters or vessel skippers must visit each selected survey block during the course of the survey
- Each blocks fishability must be assed
- The block may be rejected:
  - based on the skippers previous knowledge of the area
  - based on an inspection with the depth sounder
  - on the basis of a previous tow failing
- The objective is to try and limit skipper bias

Rules of fishing

- Tows are to be 20 minutes in duration as determined using the “trawl eye”
- The scope ratio employed (depth to length of main warp) is at the skippers discretion but short or long wiring is discouraged < 2.5:1or > 3.5:1.
- The warps are fished even, there is no adjustment for tide or current.
- The target trawl speed is 2.8 knots, values between ~ 2.6 and 3.0 are acceptable
- If hung up its at the skippers discretion as to whether or not to try again.

What constitutes a usable tow?

- For a tow to be valid it must have a minimum of 15 minutes of bottom contact time as determined from the bottom contact sensor.
- With our survey design the skipper has the freedom to fish anywhere within a selected survey block but at least half the tow must be in the selected survey block
- If the trawl hangs up but releases quickly and is retrieved with no damage the tow is usable, if damaged or hung up for more than a minute not usable
- If there is a problem with the net mensuration data or bottom contact data the tow may rejected, this is at the chief scientists discretion

Software suite

- ArcMap GIS
  - Used to initially select sites, subsequently used to record the fait of each fishing location during the survey
- GFBio SQL Server data base
  - Used to enter bridge log, catch and biological data – some data is collected electronically
- Custom written application to capture NMEA 083 data
  - GPS, Scanmar, depth sounder, environmental data
  - Suite of utilities to download sensors –Boxcar, Seaterm

So, How's it all working out

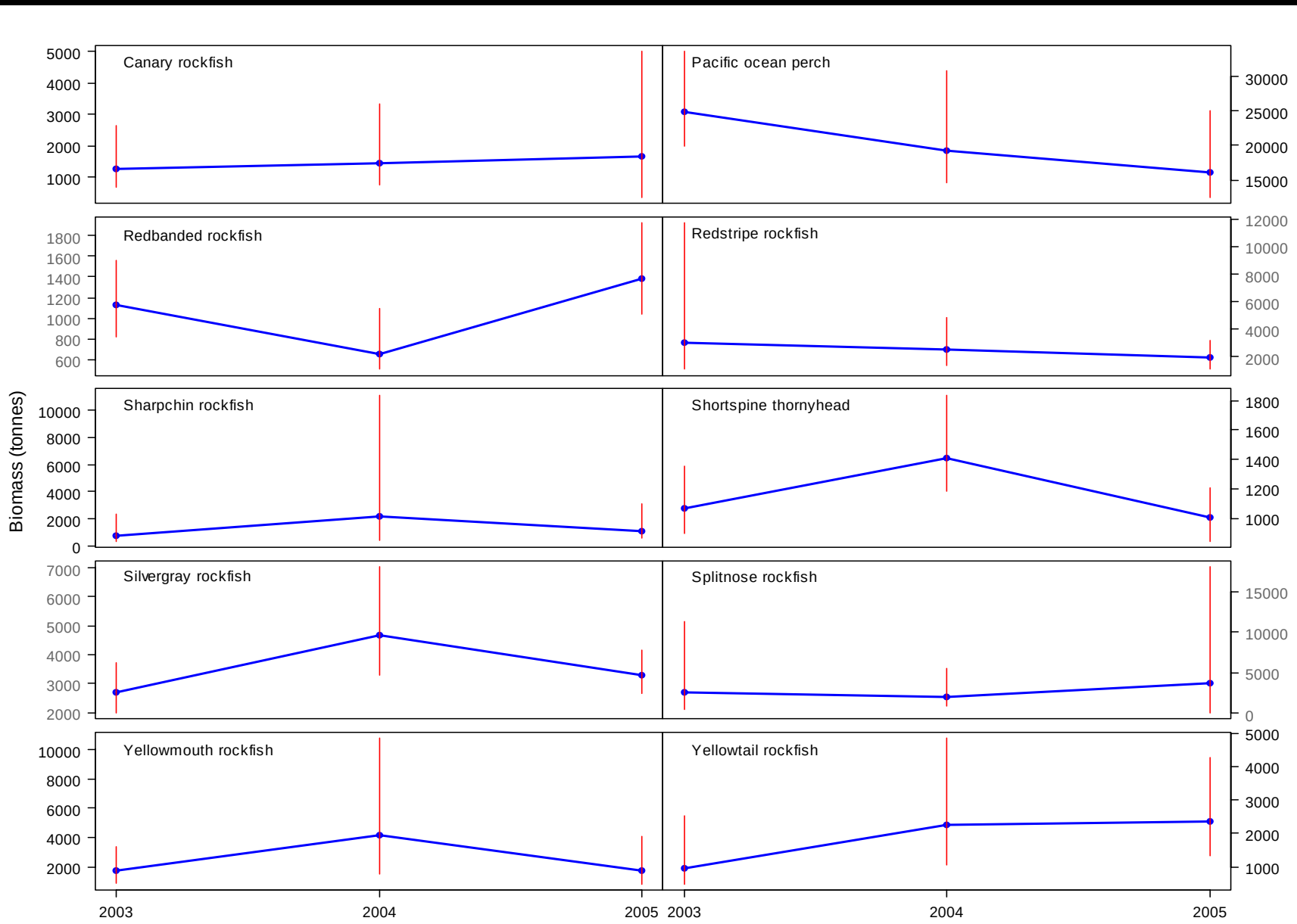
- Difficult to stick to some equipment requirements
  - BCS
  - Mensuration
  - Trawl camera
- Standardized gear (usually) isn't!
  - It requires a keen eye, lots of photographs and a comprehensive manual to maintain consistency in gear specs. Specifically, how the net is set on the footrope, lengths of shackles and drop chain, setback. Each skipper has his own way of rigging a net so diligence is required to ensure consistency amongst surveys.

- Each skipper will likely impart some bias to a given survey but rules minimize the effect
- Because we use a mix of platforms we cannot eliminate “vessel effect” but by ensuring the net, doors and rigging are consistent we hope to minimize it.

Indices from Queen Charlotte Sound 2003-2005

Species	2003	2004	2005	Mean CV
Pacific ocean perch	24,818,037	19,162,448	16,064,351	0.17
Arrowtooth flounder	6,217,743	12,750,277	14,883,219	0.15
Spiny dogfish	2,685,057	13,172,576	15,661,972	0.53
Pacific hake	1,227,047	6,281,609	6,342,406	0.20
Spotted ratfish	4,674,060	1,735,820	6,796,611	0.53
Silvergray rockfish	2,711,885	4,655,891	3,270,601	0.15
Splitnose rockfish	2,657,158	2,012,455	3,680,621	0.71
Yellowmouth rockfish	1,731,520	4,164,796	1,704,936	0.40
Redstripe rockfish	2,997,025	2,534,664	1,938,278	0.38
Rex sole	2,569,741	2,544,068	2,186,387	0.10
Dover sole	1,932,226	2,787,885	2,029,912	0.11
Yellowtail rockfish	958,877	2,256,065	2,357,411	0.36
Canary rockfish	1,272,799	1,441,506	1,665,111	0.43
Pacific cod	900,786	1,820,471	1,616,634	0.25
Sablefish	1,216,891	1,866,781	1,201,945	0.17
Sharpchin rockfish	696,524	2,143,700	1,048,930	0.57
Shortspine thornyhead	1,069,721	1,411,633	1,003,212	0.10
English sole	1,188,176	1,260,906	896,267	0.21
Redbanded rockfish	1,125,607	658,992	1,387,934	0.17
Southern rock sole	693,309	1,386,982	1,059,482	0.31
Pacific halibut	813,356	1,042,524	1,170,633	0.20
Rougheye rockfish	1,058,642	938,863	601,710	0.26
Flathead sole	571,025	1,017,952	949,006	0.29
Pacific sanddab	1,176,064	958,519	346,418	0.32
Lingcod	729,537	839,226	554,807	0.23
Longnose skate	529,820	588,502	618,653	0.15
Big skate	613,449	240,726	564,120	0.51
Walleye pollock	285,321	416,204	707,234	0.19
Petrale sole	338,578	422,472	406,671	0.25
Yelloweye rockfish	242,216	403,963	301,867	0.36
Bocaccio	127,677	312,900	274,158	0.65
Widow rockfish	165,541	361,320	180,015	0.54
Greenstriped rockfish	126,575	253,369	143,795	0.23
Quillback rockfish	77,681	229,620	189,255	0.53
Blackbelly eelpout	55,512	146,442	266,058	0.37
Darkblotched rockfish	135,285	188,976	49,299	0.51
Harlequin rockfish	2,120	347,854	1,800	0.83
Shortraker rockfish	74,285	207,959	30,532	0.50
Rosethorn rockfish	90,244	111,139	74,312	0.34
Slender sole	92,350	89,237	68,116	0.19

Species	2003	2004	2005	Mean CV
Eulachon	34,154	159,653	27,975	0.44
Chub mackerel	110,841	1,855	0	1.00
Chum salmon	35,528	35,779	9,950	0.56
Wolf eel	10,251	16,568	37,881	0.54
Curlfin sole	12,103	19,990	31,111	0.35
Sandpaper skate	23,985	16,163	19,313	0.33
Pacific herring	9,099	23,988	24,581	0.26
Shortbelly rockfish	11,844	35,117	414	0.72
Bigmouth sculpin	9,095	15,550	20,927	0.58
Kelp greenling	5,071	20,598	15,241	0.68
Aleutian skate	0	23,213	16,543	0.55
Longspine thornyhead	0	35,041	4,486	0.58
Pygmy rockfish	20,669	12,233	6,071	0.51
Threadfin sculpin	9,642	7,819	14,144	0.47
Blackfin sculpin	9,839	13,407	6,858	0.34
Pacific sand lance	863	27,840	139	0.80
Pacific tomcod	1,120	22,092	645	0.80
Roughtail skate	15,653	0	801	0.72
Black eelpout	472	9,549	6,172	0.57
Bigfin eelpout	6,945	5,672	3,413	0.36
Alaska skate	0	678	13,491	0.79
Stripetail rockfish	0	13,602	0	0.99
Pacific sardine	0	0	7,480	0.72
Aurora rockfish	390	6,480	0	0.65
Brown rockfish	5,164	0	0	0.62
Chinook salmon	0	5,122	0	1.00
Vermilion rockfish	0	0	4,802	0.69
Wattled eelpout	272	3,066	809	0.48
Pink salmon	4,005	0	0	0.49
Spinyhead sculpin	0	3,798	0	0.96
Jack mackerel	2,711	736	0	1.02
China rockfish	0	0	3,335	0.95
Brown irish lord	3,211	0	0	1.00
Brown cat shark	0	2,112	1,001	0.95
Chilipepper	3,072	0	0	0.98
Dusky rockfish	1,901	0	1,126	1.01
Butter sole	2,696	0	0	0.65
Whitespotted greenling	0	2,442	0	0.81
Black rockfish	760	1,570	0	0.98
Blackgill rockfish	1,169	0	932	1.03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Sharpchin rockfish
Shortspine thornyhead
Silvergray rockfish
Splitnose rockfish
Yellowmouth rockfish
Yellowtail rockfish
Biomass (tonnes)
2003
2004
2005

The plan.

- Continue surveys on a biennial rotation for the foreseeable future
- Maintain consistency in design and methods and gear
- Optimize bio-sampling
- Complete documentation of survey protocol
- Improve electronics package, paperless back deck

End