

# Methods for Standardizing the U.S. West Coast Groundfish Trawl Survey

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## Survey Team

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# Fisheries Resource Analysis and Monitoring Division, NWFSC

**Mission:** provide the scientific basis for the management of U.S. West Coast groundfish stocks and their ecosystems

**Tools:** fishery-independent resource surveys, fishery monitoring, biological investigations, and population models

**Survey goal:** provide data for assessment purposes on the distribution and abundance of commercially important West Coast groundfish, including changes in species composition, size and age with geographic area and depth

**Focus:** steps for standardizing the West Coast Groundfish Trawl Survey's methods and gear in order to minimize differences in sampling efficiency and maintain consistency across the range of conditions encountered and over time

# West Coast Groundfish Trawl Survey (WCGTS)

**History:** In 1998, the NWFSC assumed responsibility for the WCGTS, extending two pre-existing surveys conducted by the Alaska Fisheries Science Center (AFSC).

**1977 - 2001** AFSC's triennial shelf (55 - 500 m) trawl survey using chartered AK commercial trawlers (>110 ft)

**1984 - 2001** AFSC's West Coast slope (183 – 1280 m) trawl survey using FRV Miller Freeman (>200 ft)

**1998 - 2002:** NWFSC annual slope (183 -1280 m) trawl survey using smaller (< 93 ft) chartered West Coast (CA, OR, WA) commercial fishing vessels

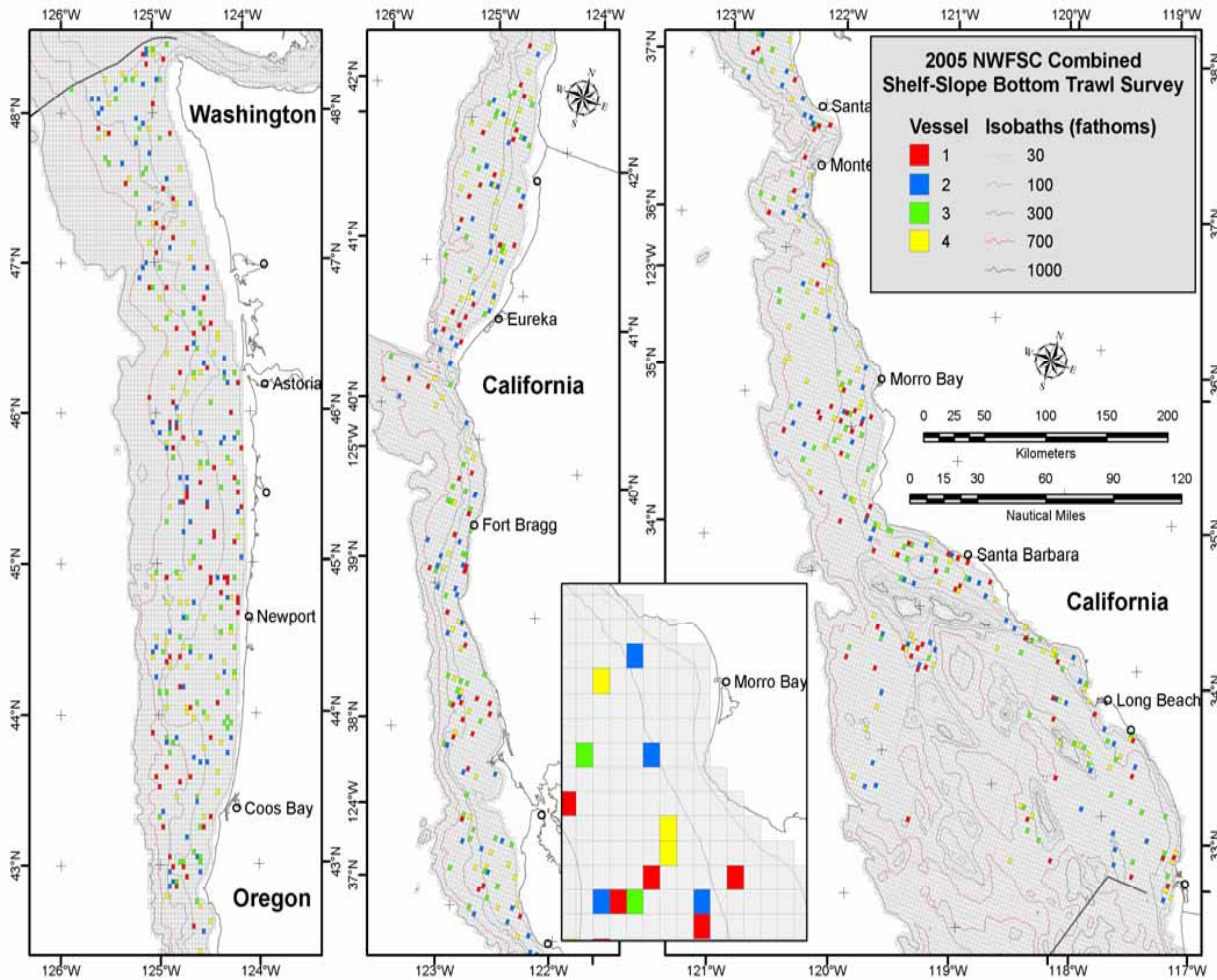
**2003 - present:** NWFSC survey expanded to cover shelf and slope waters (55 - 1280 m) from US-Can to US-Mexican borders

# WCGTS Methods

- Annually charter 4 West Coast fishing vessels, 3 scientists, 3 crew
- 2 passes down the coast (N to S) each with 1 pair of vessels
- 47 fishing days-at-sea per vessel (May - Oct)
- Standardized fishing gear: four-panel Aberdeen 85/104' bottom trawl equipped with net mensuration gear
- Wireless back deck with electronic scales, fish meter boards, bar code scanner, with trawl and catch data input via FSCS and customized software
- Target tow speed 2.2 kt; target duration 15 minutes
- Fish during daylight hours
- 4-6 tows per day
- Catch sorted to species and weighed
- Selected species sexed, measured
- Collect stomachs and age structures
- Average catch 300 kg/tow (range <1 to 18,000 kg/tow)
- Special projects undertaken



# Standardized Design: Stratified-Random



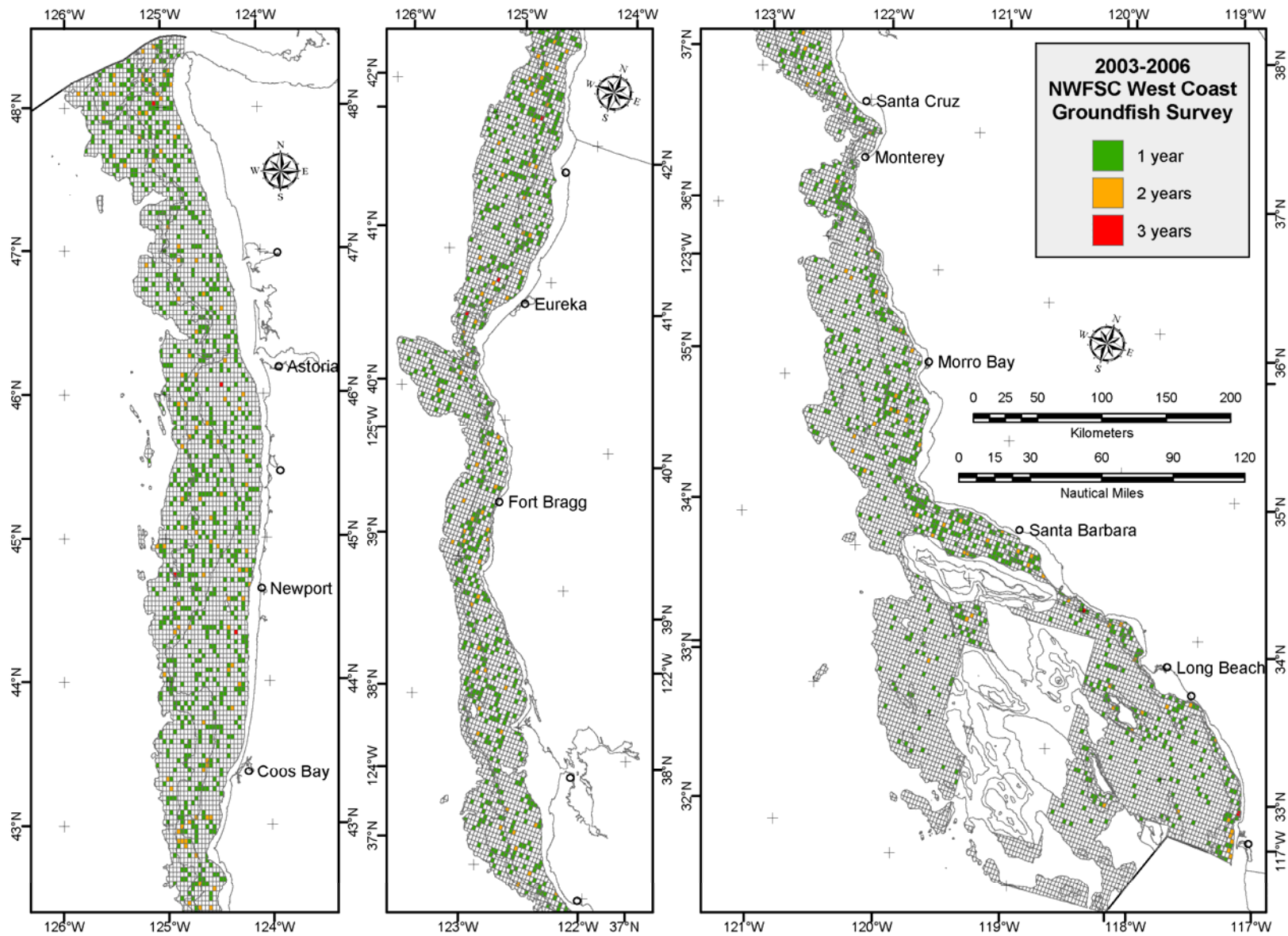
- US Canadian border to US Mexican border
- Survey area sub-divided into >12,000 equally sized cells (1.5 X 2.0 nm)
- Each of 4 charter vessels randomly assigned a set of 190 cells, secondary and tertiary cells also assigned (not shown)
- 2 geographic strata: 80% N of Pt. Conception, 20% S
- 3 depth strata (55-183 m, 183-549 m; 550-1,280 m)
- Minimum 30 tows/strata

# Standardized Trawl Search and Selection Procedure



- Search within a randomly selected, previously specified cell
- Search within a specified depth range
- Limit search for trawlable ground 1-hr per cell
- If no trawlable site found within 1-hr, move to secondary cell and repeat 1-hr search
- Repeat at tertiary site if needed





# Standardized Survey Operations

- Developed detailed operations manual
- Improved fishing gear specifications
- Compiled equipment and gear checklists
- Initiated side-by-side warp marking
- Net as research tool





# Warp Standardization and Measurement

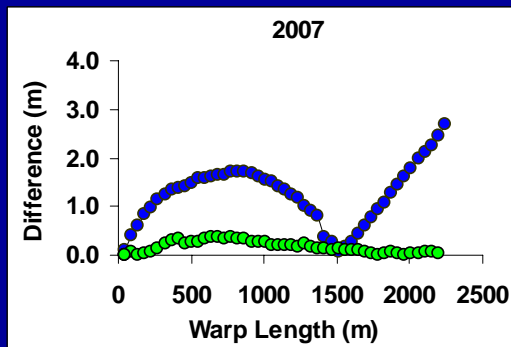
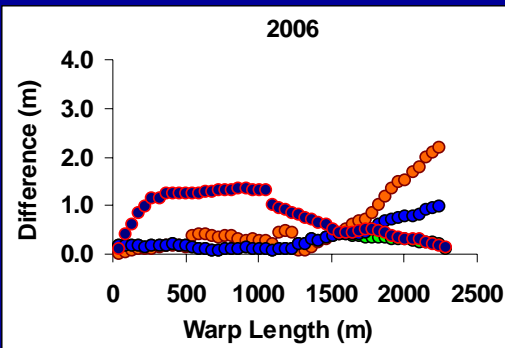
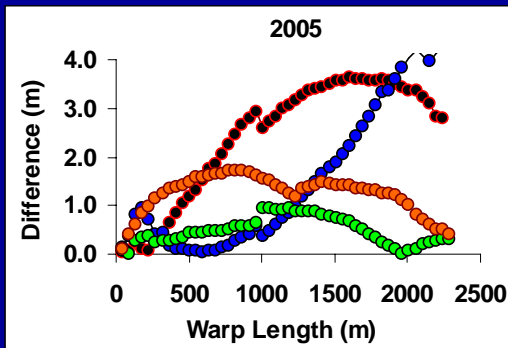
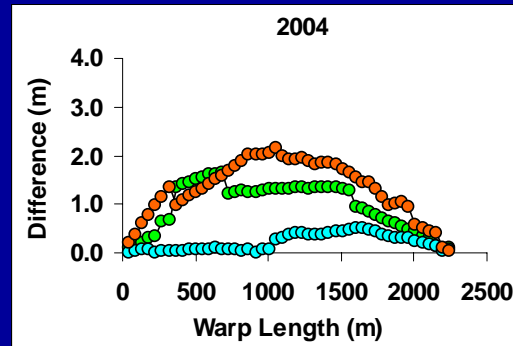
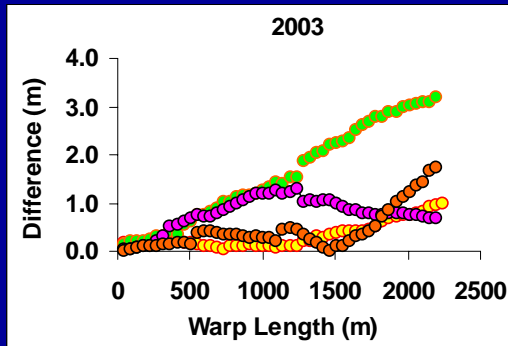


- At start of survey, NWFSC provides each vessel with paired 5/8" steel core cables, 2,288 m (1,250 fathoms) in length to ensure consistent warp diameter and composition
- Warps are run through a series of blocks and measured side-by-side as they are spooled onto the vessel's winches

- Cables are marked at 25 fm increments by scientists working together with gear personnel
- Each wire is measured and marked prior to each deployment and after any significant hang-up
- Wires are removed and measured at end of charter



# Cumulative Differences between Port and Starboard Warps at the End of Each Charter by Year and Vessel



**Ideal:** Markings provide real time verification of release of equal warp length from both winches while setting a tow

**Reality:** Differential warp stretch and contraction occur along the length of the wire

**Result:** Various patterns emerge over time but cumulative differences for all vessels for all years are <4.2 m

**NOAA standard:** difference between port and starboard warps greater than 4% of the sum of the bridle and foot rope lengths not acceptable (WCGTS critical value: 6.3 m)



# Net as Research Tool



Detailed diagrams and checklists for construction, certification and repair of nets, footropes, framing lines, rigging, fishing lines, doors

# NWFSC Net Standardization

- Detailed net, rigging and gear diagrams completed in 2003, upgraded in 2005
- Nets built, stored and repaired at commercial net facility
- Nets and all components (netting, head rope, bolsh line, fishing line, breast line and ribline) built to exact standard and individually identified
- All nets examined, repaired and certified prior to each use: scientists work with net shed personnel
- Each vessel supplied with 2 nets prior to start of charter
- If net and footrope in perfect condition, it takes ~8-hr for two people to measure, check and count all portions of the net

## Top Center Panel

	Required	Actual
<b>Material</b> (please circle)	5-1/2" 5.0mm, double twine <i>Olivene</i> polyethylene.	Yes / No
Mesh Count - Open Meshes	34	
Mesh Count - Panel Dimensions (open meshes)	10/42	

## Aberdeen 89'/104' Top Body Materials Check List

Net #:	
Date:	
Person of Record:	

## Top Wings

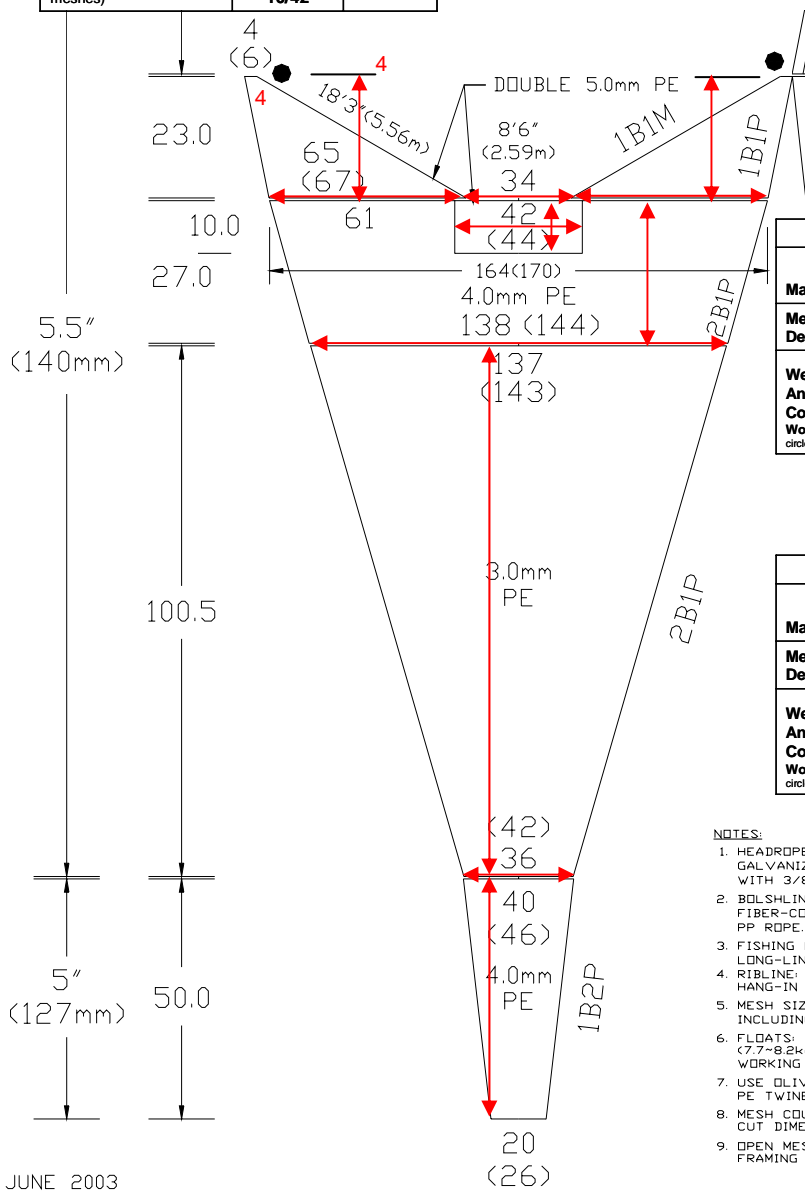
	Required	Port	Starboard
<b>Material</b> (please circle)	5-1/2" 5.0mm, double twine <i>Olivene</i> polyethylene.	Yes / No	Yes / No
<b>Web Is Free Of Holes And Is In Good Condition (Not Frayed, Worn or Chafed)</b> (please circle)		Yes / No	Yes / No
<b>Mesh counts (Width)</b>	4/65		
<b>Mesh Counts (Depth)</b>	23		

## Top Center Body

	Required	Actual
<b>Material</b> (please circle)	5-1/2" 3.0mm single twine <i>Olivine</i> polyethylene	Yes / No
<b>Mesh Counts - Depth/Width</b>	100.5/36	/
<b>Web Is Free Of Holes And Is In Good Condition (Not Frayed, Worn or Chafed)</b> (please circle)	<b>No Holes!!</b> Minimal Wear, No Frayed Knots or Seizings. Substandard Material Must Be Repaired or Replaced.	Replaced or Repaired? Yes / No

## Top Riblines

		Port	Starboard
<b>Material</b>	1-1/4" Polypropylene 8-braid line	Yes / No	Yes / No
<b>"Hang In"</b> (Riblines are to be 95% of length of stretched measure of gored seam) (This is an estimated measurement)	5%	(estimate)	(estimate)
<b>Lacing</b>	Gored seams are attached to the Riblines every 16" (inches) with #60 braided nylon twine, using <i>benzel</i> lashing technique		



## Top Front Body

	Required	Actual
<b>Material</b> (please circle)	5-1/2" 3.0mm single twine <i>Olivine</i> polyethylene	Yes / No
<b>Mesh Counts - Depth/Width</b>	27/138	/
<b>Web Is Free Of Holes And Is In Good Condition (Not Frayed, Worn or Chafed)</b> (please circle)	<b>No Holes!!</b> Minimal Wear, No Frayed Knots or Seizings. Substandard Material Must Be Repaired or Replaced.	Replaced or Repaired? Yes / No

## Top Aft Body

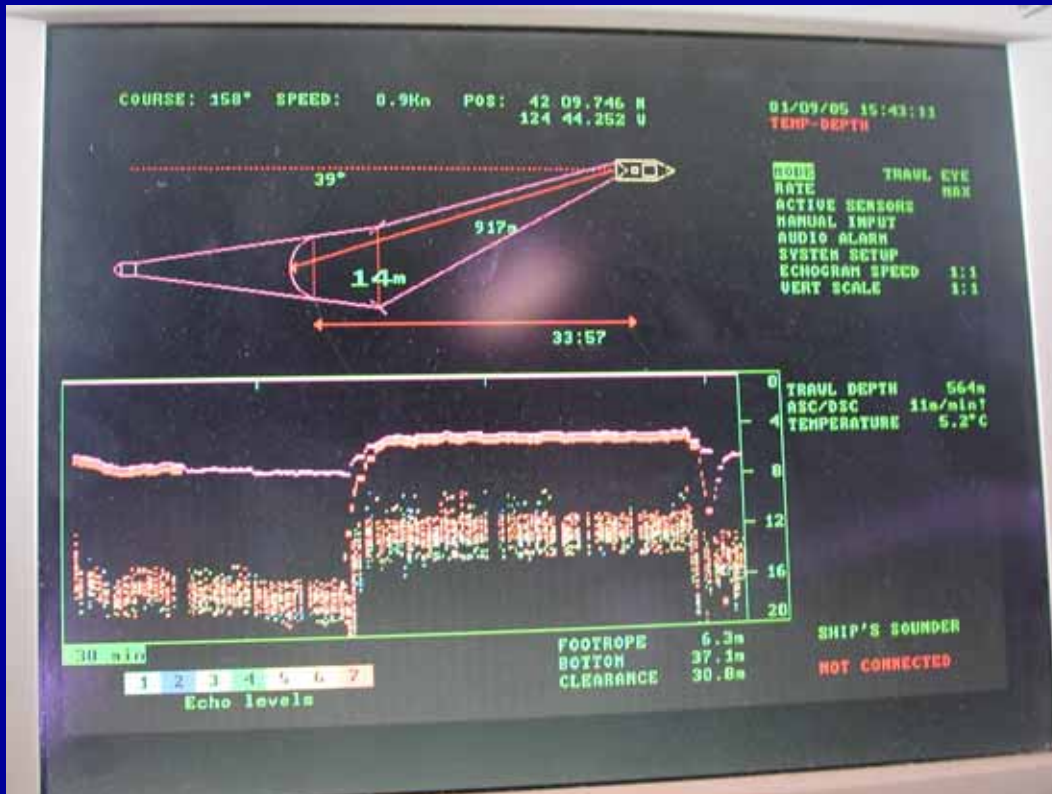
	Required	Actual
<b>Material</b> (please circle)	5-1/2" 3.0mm single twine <i>Olivine</i> polyethylene	Yes / No
<b>Mesh Counts - Depth/Width</b>	50/20	/
<b>Web Is Free Of Holes And Is In Good Condition (Not Frayed, Worn or Chafed)</b> (please circle)	<b>No Holes!!</b> Minimal Wear, No Frayed Knots or Seizings. Substandard Material Must Be Repaired or Replaced.	Replaced or Repaired? Yes / No

### NOTES:

- HEADROPE AND BREASTLINES: 9/16" (14mm) 6X19 GALVANIZED FIBER-CORE WIRE ROPE WRAPPED WITH 3/8" (10mm) PP ROPE.
- BOLSHLINE: 3/8" (10mm) 6X19 GALVANIZED FIBER-CORE WIRE ROPE WRAPPED WITH 3/8" (10mm) PP ROPE.
- FISHING LINE: 1/2" (13mm) GRADE 70 OR 80 LONG-LINK CHAIN.
- RIBLINE: 1 1/4" (32mm) PP ROPE 8-BRAIDED HANG-IN 5% MEASURE WITH 400 LBS (181kg) TENSION.
- MESH SIZE ARE STRETCHED MEASURE OR INCLUDING 1 KNOT.
- FLDATS: 12" (300mm) Ø, BUOYANCY OF 17-18 LBS (7.7-8.2kg) WITH MINIMUM OF 800 FCM (463m) OF WORKING WATER DEPTH x 18 PCS TOTAL.
- USE OLIVENE NETTING AND SIMILAR OR GREATER PE TWINE. COLOR CODE ON HAND SEWN SEAMS.
- MESH COUNT NUMBERS ARE FINISHED DIMENSION. CUT DIMENSIONS IN PARENTHESIS.
- OPEN MESHES NEED TO BE LACED OR LASHED TO FRAMING LINE TO PREVENT OPEN AREA.



# Simrad ITI System Used to Monitor Trawl Performance



Simrad ITI system integrates data streams of net width, net height, trawl position, depth of head rope, distance to sea floor, temperature, distance fished, net configuration

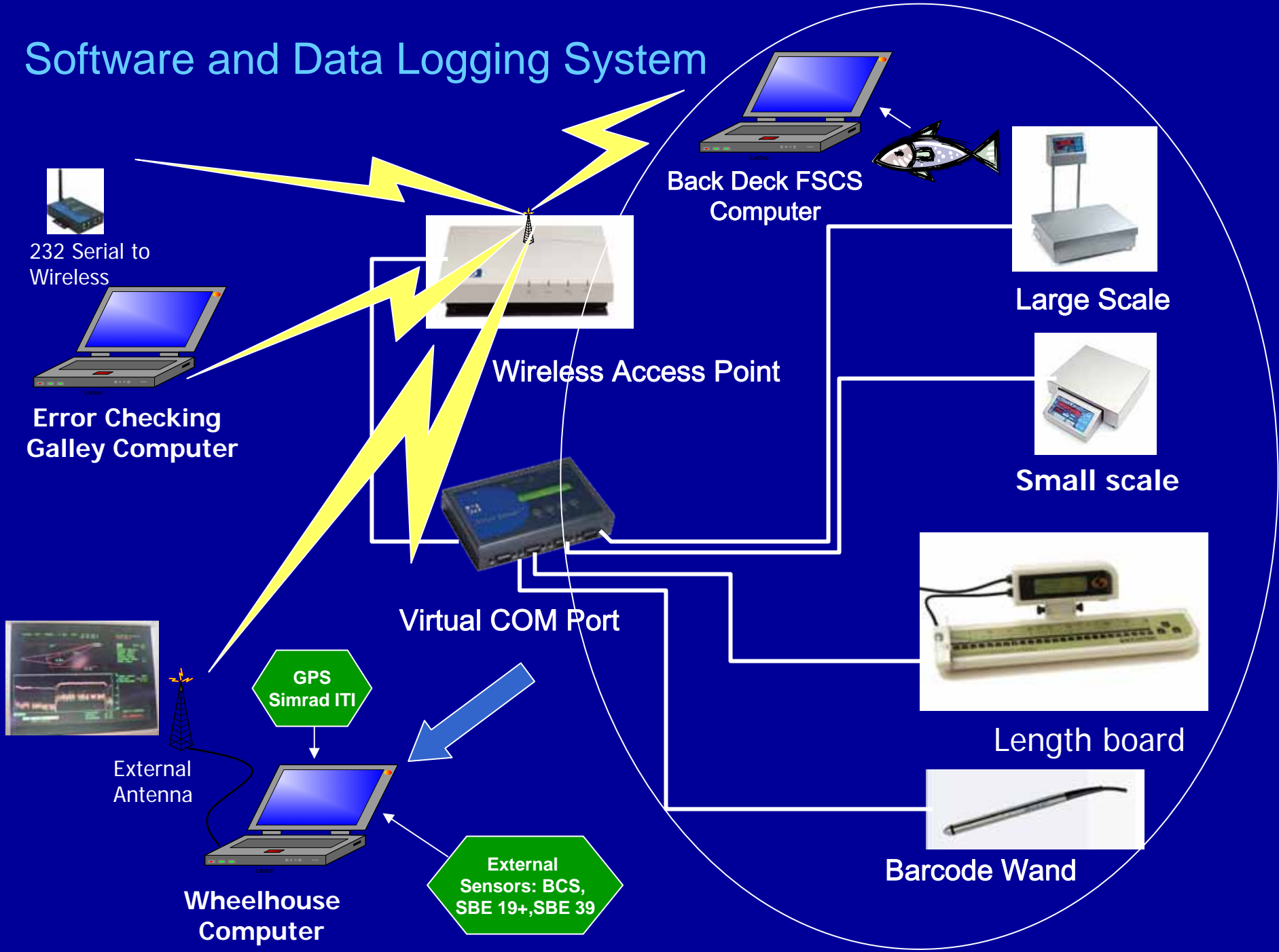
# Net Mensuration and Trawl Performance Monitoring



## Sensors supplied by NWFSC:

- Dual/triple beam transducers mounted on vessel hull (through hull design)
- GPS and gyroscope for vessel position and heading
- Simrad sensors mounted on net
- Bottom contact sensors mounted on footrope (port and starboard) to monitor bottom contact, net touch down and lift off
- Seabird sensor mounted on head rope: temperature, depth, salinity, dissolved oxygen

# Software and Data Logging System



# Customized Software

- TowLogger - input
- Integrator - visualize
- DataSquirrel - compile
- SurveyEdit - edit
- SurveyAnalyzer - analyze





# TowLogger – Used to log operations and environmental data during bottom trawling

FRAM TowLogger build 7.8.31.0

File Setup Help

FPC Name: Kamikawa, Dan Survey Type: 3 - Slope and Shelf Combinat Vessel: 8 - Excalibur Tow Number: 1 Date: 2007/09/10

Stn Code: 8418 Target Rank: 1 Distance to Primary Stn: 0 (nmi)

Net: 46°54.651N 124°39.816W

Local Time	Latitude dd°mm.mmmN	Longitude ddd°mm.mmmW	Speed (kts)	Event	Wing- spread (m)	Headrope Height (m)	Footrope Clearance (m)	Bottom temp (C)	Gear Depth (m)	Sounder V Depth (fathoms)	Manual V Depth (fathoms)
21:21:11	47°38.6655N	122°18.3727W	5.9	Current	11.8	0	7	9.2	111.5	529.1	
06:16:05	45°12.716N	124°54.342W	4.1	Start Haul	0	0	0	0	0	473.9	
06:22:25	45°13.071N	124°54.389W	5	Set Doors	9.5	5.9	1.4	18.6	16.7	495.7	
06:53:38	45°15.079N	124°54.534W	2.3	Doors Fully Out	0	0	0	5	956	519.5	
06:56:14	45°15.178N	124°54.530W	2.3	Gear On Bottom	0	0	0	0	956	521.5	
06:56:16	45°15.181N	124°54.530W	2.3	Begin Tow	0	0	0	0	956	521.9	
07:11:20	45°15.771N	124°54.474W	2.5	Start Haulback	0	4.6	0	4.4	941.4	523.9	
07:18:22	45°15.969N	124°54.421W	1.4	Net Off Bottom	0	6.4	0	0	932.6	527	
07:45:10	45°16.449N	124°54.008W	1.6	Doors At Surface	7.2	0	8	7.2	42.1	511.4	
07:45:14	45°16.452N	124°54.005W	1.9	End Of Haul	7.2	0	8	7.2	42.1	511.4	

Scope (fathoms): 1100 Tow Direction: Against Current

Surface Temp (F): 62 Substrate: MUD

Weighted BCS: N,N Weather: Partly Cloudy

Wind (kts): 7-10 NW Combined Seas (ft): 1 ft waves + 4 ft swells from the NW

Elapsed Tow Time: 00:15:04

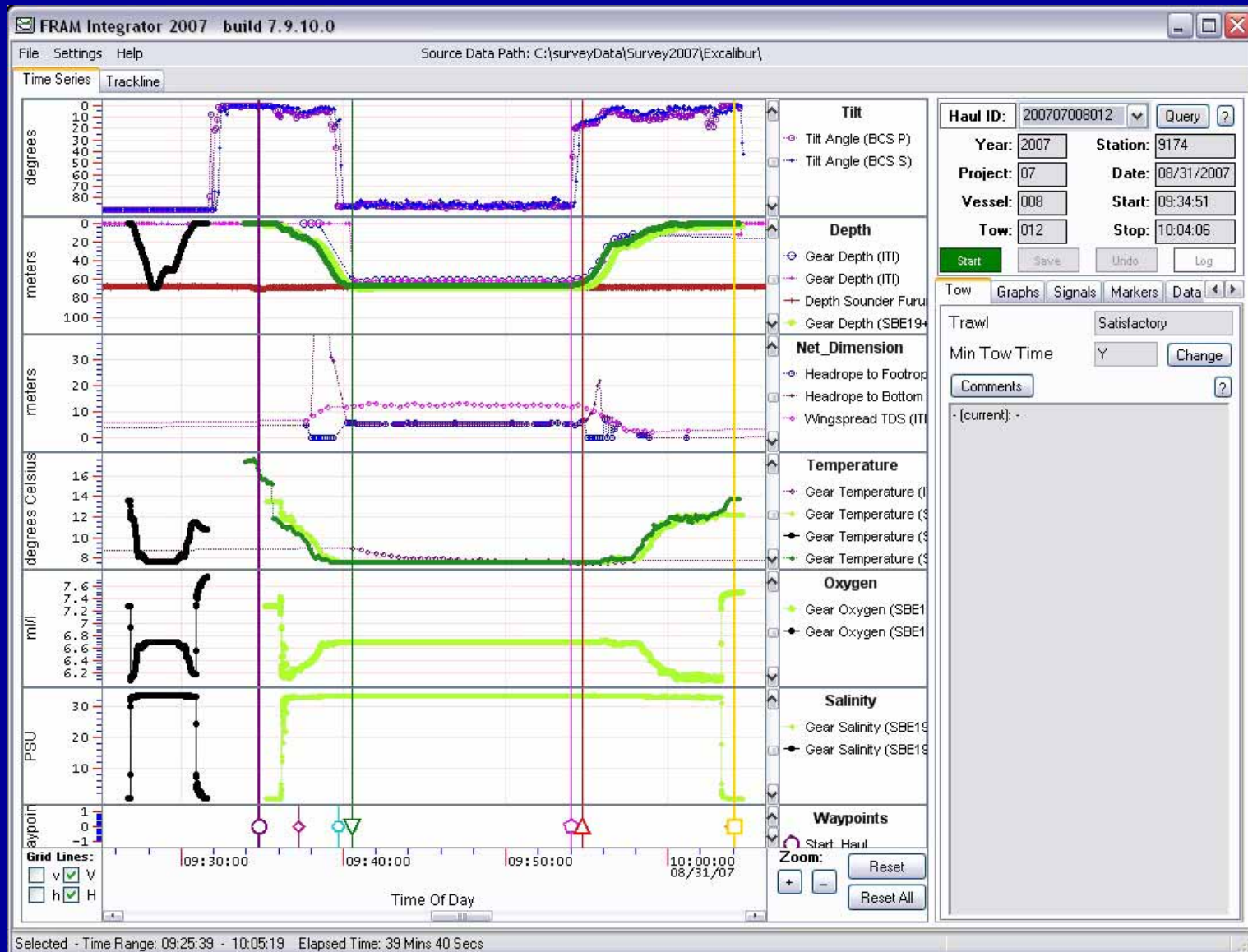
Tow Progress:

Save Print New Tow Haul ID: 200703008001 Start Tow Search End Tow Search Abort Tow

FPC Comments: 2007/08/18-07:01:28  
All units sent data at the beginning of the set. We lost all readings when they got near the bottom. When we dogged the doors and slowed down the ITI system came back. We do not have wings but we have TE and T/D and both are holding steady.  
PI 44 took a powder and has not come back.  
Depth approximately 520 fm  
2007/08/18-07:16:49



Integrator – Used to visualize sensor data collected during the trawl operation, and assess tow quality and success



# DataSquirrel – Used to manage raw data by providing tools to upload operational and fish data into a database.

FRAM DataSquirrel 2007 build 7.9.11.0 Logged in as patp on framdev

File Settings Help

Login Load

Vessel: 8-Excalibur Project Code: 3-Slope and Shelf Combination Survey Survey Year: 2007

1. Copy Activities

☒ Trawlent Data

☒ Scs Data

☒ MiniStation Data

☒ Fscs Data

☐ Tow #

☒ Today's Tows

☐ All Available

Reset Selection ?

☒ Skip Step ?

2. Database Load Activities ~ C:\surveyData\Survey2007\

2a. Select Data to Load

☐ Load Today's Hauls

☐ Load All Hauls

☒ Choose Hauls:

☐ Skip

☐ Load Today's Searches

☒ Load All Searches

☐ Choose Searches:

☒ Skip

☐ Skip Step

2b. Select Tables to Load

☒ Load All Tables

☐ Load Tables by Category:

☐ TowLogger Search

☐ TowLogger Tow

☐ Integrator

☐ Fscs/Ministation/Fishmeter

☒ Choose Tables:

Check File Load Rules ?

2c. Select Update Rule

☐ Load New Data Only

☒ Replace Existing Data

☐ Prompt Before Replacing Existing Data

☐ Delete Existing Data

☐ Skip Step ?

3. Daily Sweep Activities

☒ Trawlent Dir

☒ Scs Log Dir

☒ Fscs Data Dir

☒ Skip Step ?

4. Start

Start

Stop!

?

View Load Summary

Save Log

Log Mode - Normal Detail

Clear Log

Result	File Type	Table Type	Load Rule	Loaded	Failed	Result Reason
Ok	FSCS_BASKET	FSCS_BASKET	Mandatory	18	0	Ok
Ok	FSCS_CATCH	FSCS_CATCH	Mandatory	16	0	Ok
Ok	FSCS_FISH	FSCS_FISH	Mandatory	93	0	Ok
Ok	FSCS_OVERRIDES	FSCS_OVERRIDES	Optional	3	0	Ok
Ok	FSCS_RAW_FISH	FSCS_RAW_FISH	Mandatory	93	0	Ok
Ok	FSCS_SELECTED_WT_SPECIES	FSCS_SELECTED_WT_SPECIES	Mandatory	16	0	Ok
Notice	FSCS_SPECIAL_SAMPLING	FSCS_SPECIAL_SAMPLING	Optional	0	0	FileNoData
Ok	FSCS_SPECIES	FSCS_SPECIES	Mandatory	16	0	Ok
Ok	FSCS_STATION	FSCS_STATION	Mandatory	1	0	Ok
Ok	FSCS_SUBSAMPLING	FSCS_SUBSAMPLING	Mandatory	16	0	Ok
Ok	FSCS_TOTAL_WEIGHT	FSCS_TOTAL_WEIGHT	Mandatory	1	0	Ok
Ok	FSCS_TOTAL_WT_MEASMT	FSCS_TOTAL_WT_MEASMT	Mandatory	1	0	Ok
Ok	INT_OPS	INT_OPS	Mandatory	1	0	Ok
Notice	INT_PERFORMANCE	INT_PERFORMANCE	Mandatory	0	0	FileNoData
Notice	INT_DEVICE_OFFSET	INT_DEVICE_OFFSET	Optional	0	0	FileNoData
Notice	INT MARKED TIME	INT MARKED TIME	Optional	0	0	FileNoData

Log saved to C:\surveyData\Survey2007\Excalibur\LoadLogs\squirrel\_log\_20070920-154233.tif

# SurveyEdit – Used to review and edit data while at sea; includes multiple validation steps for error checking

Tow Detail | Personnel | Trawl Notes | Weather Condition | Waypoints | Equipment | Observations | Performance |  
Summary | Split Catch | Species | Baskets | Fish | OverRides | Validation Status

Total Catch Weight (KG)


Total Species

Total Baskets

Quantity Lengthed

Quantity Weighed

Quantity Aged



**Summary page** - displays tow summary information: total catch weight, total baskets, number of individual fish measured, weighed and with age samples taken.

Tow Detail | Personnel | Trawl Notes | Weather Condition | Waypoints | Equipment | Observations | Performance |  
Summary | Split Catch | Species | Baskets | Fish | OverRides | Validation Status

	Sp Code	Species Name	Mix ID	Bskts	Sub Bskts	Tot Wt (KG)	Sub Wt (KG)	Ave Wt (
+	110	Black hagfish - SP PROJ	0	1	0	0.80	0	
+	210	Brown cat shark - SP PROJ	0	1	0	0.55	0	
+	460	Bathyraja trachura - SP PRO	0	1	0	0.75	0	
+	10190	Deepsea sole	0	1	0	3.75	0	
+	20038	Blackfin poacher - SP PROJ	0	1	0	0.01	0	
▶	20510	Sablefish - PRIORITY 1 - SP	0	1	0	14.25	0	1.7
<a href="#">View Baskets</a> <a href="#">View Individual Fish</a> <a href="#">View Special Samples</a>								
+	20614	Bathylagidae unident.	0	1	0	0.06	0	
+	21010	Pacific viperfish	0	1	0	0.04	0	
+	21220	Pacific grenadier - PRIORIT	0	1	0	1.80	0	0.1

**Species page** - displays species summary information: basket, individual fish, and special sample data are all accessed from this page by clicking on the plus sign next to the species code. Links to the basket, individual fish, and special sample data are displayed after expanding the plus sign.

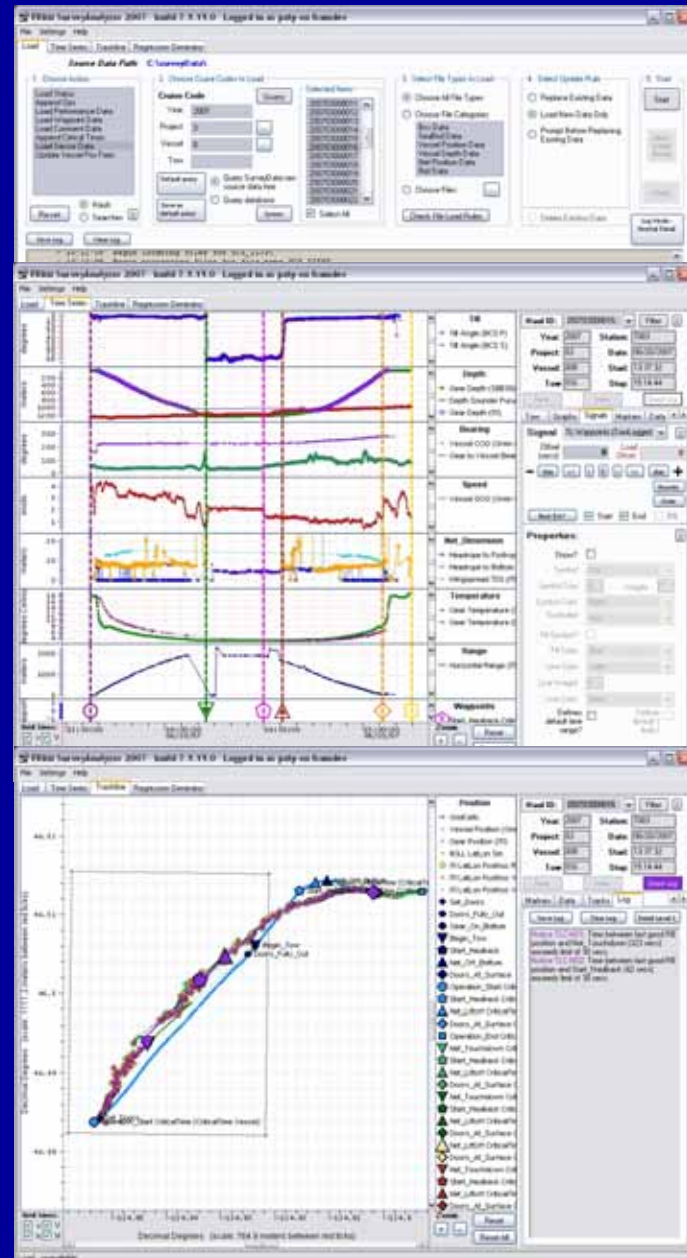
# SurveyAnalyzer – Used for post-mission data processing

**Step 1:** load sensor data into database

**Step 2:** visualize graphically, determine net touchdown and liftoff times, as well as point estimates for depth, temperature, wingspread, net height and vessel speed

Critical Times: start haul, net touchdown, start haulback, net liftoff, doors at surface, end haul

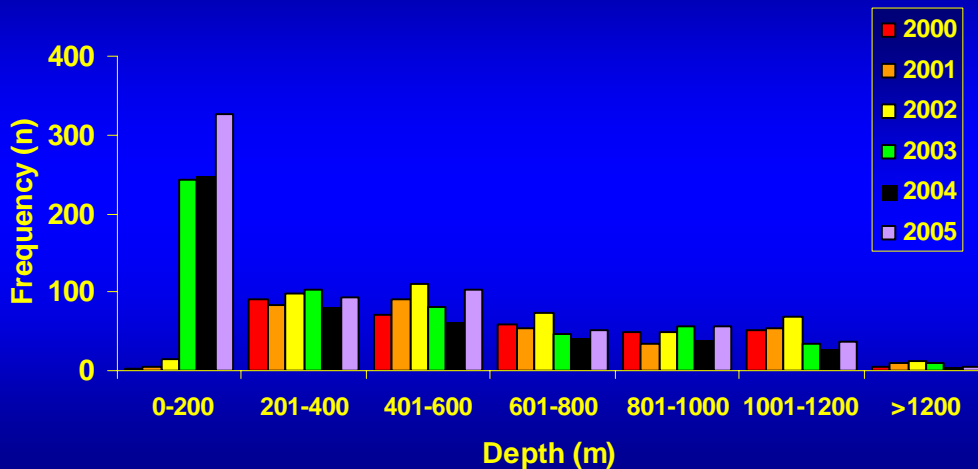
**Step 3:** process data to determine track lines (vessel and net) and distances (tow, lift-off-lag and total)





# Summary: Net Mensuration Data

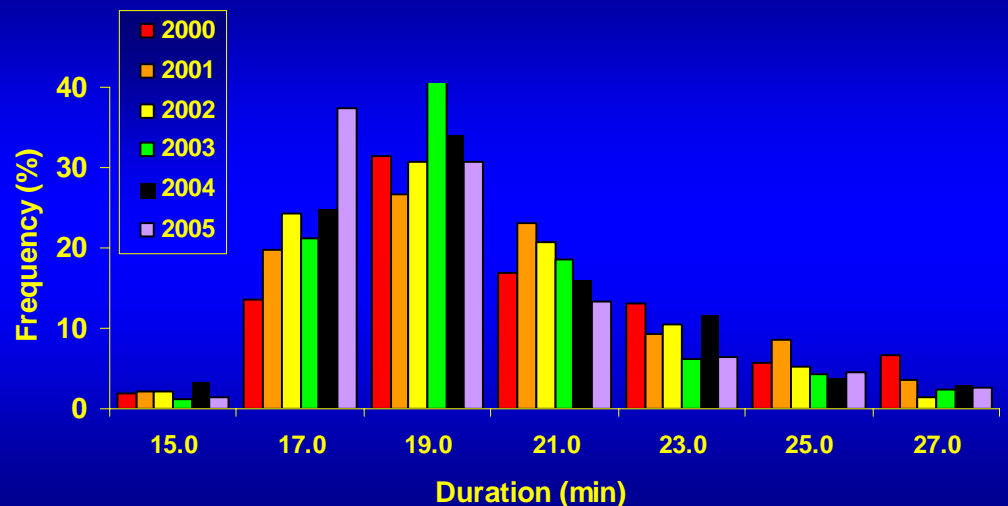
**Tow Depth  
2000 - 2005**



Distribution of tows by depth from 2000 to 2005: beginning in 2003 the shelf region was added to the survey. As the figure demonstrates the new design was structured to retain the same number of tows within the slope region as seen in prior years (2000-2002).

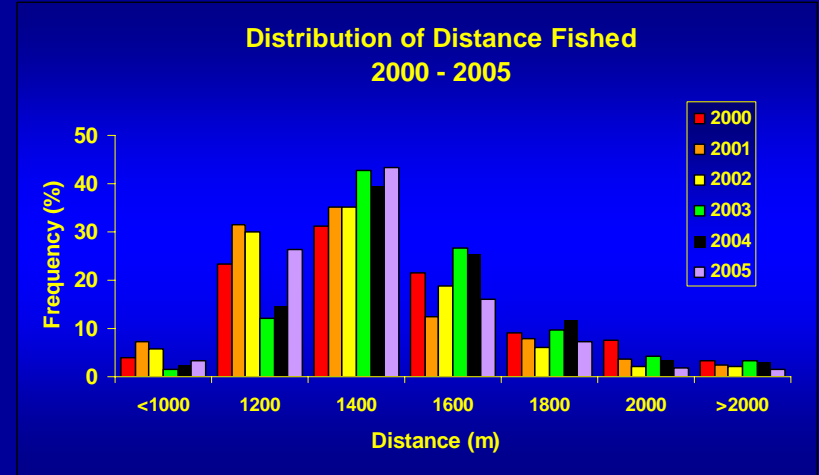
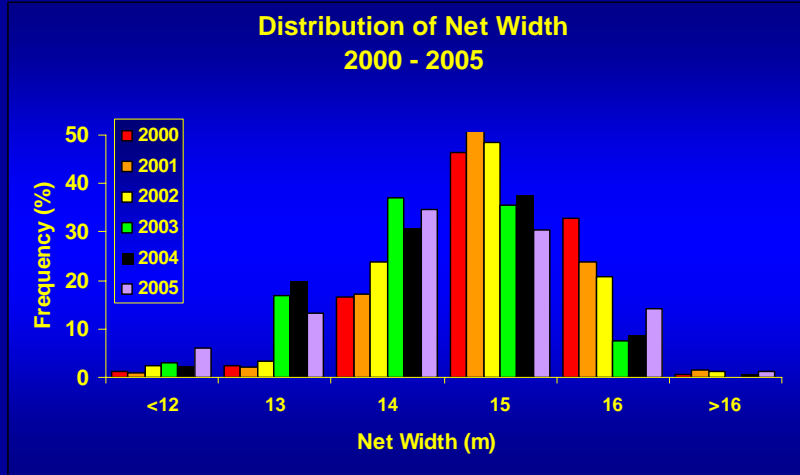
Distribution of total tow duration from 2000-2005: total duration includes both the tow and the lift-off-lag period. The distribution is log normal with the lift-off-lag period increasing with depth and the tow duration targeted for 15 minutes.

**Distribution of Tow Duration  
2000 - 2005**

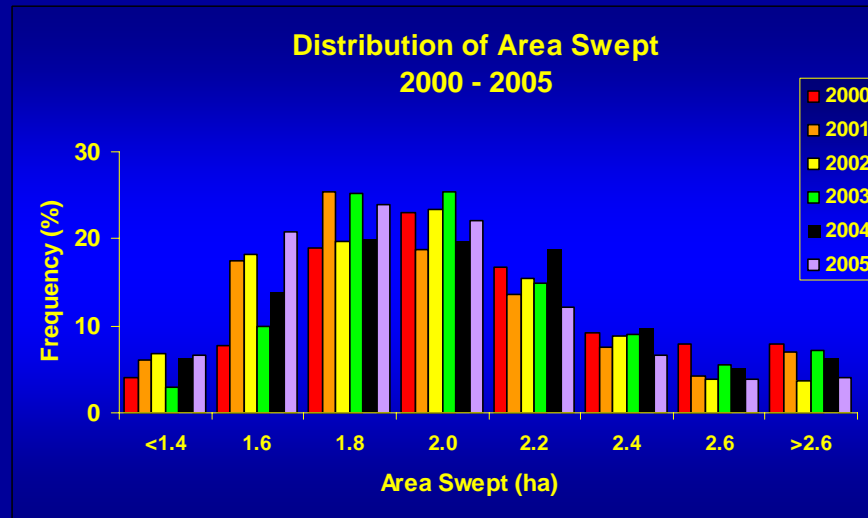




# Summary: Net Mensuration Data

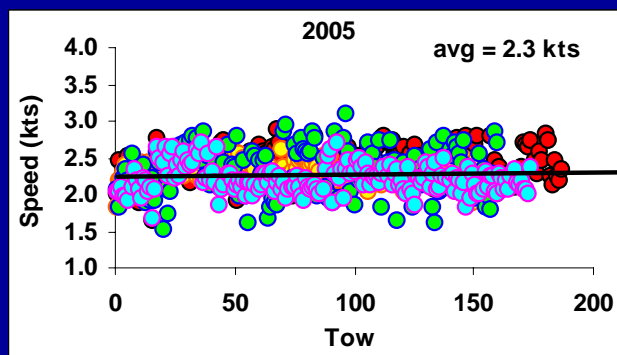
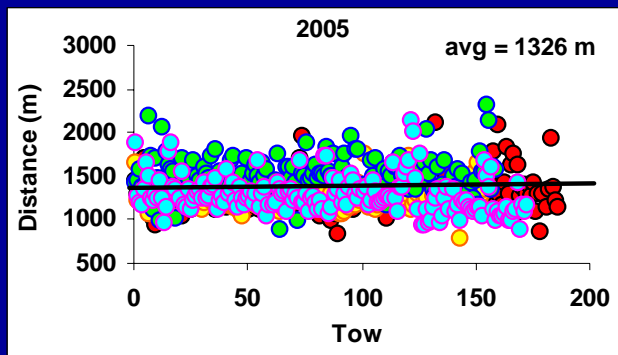
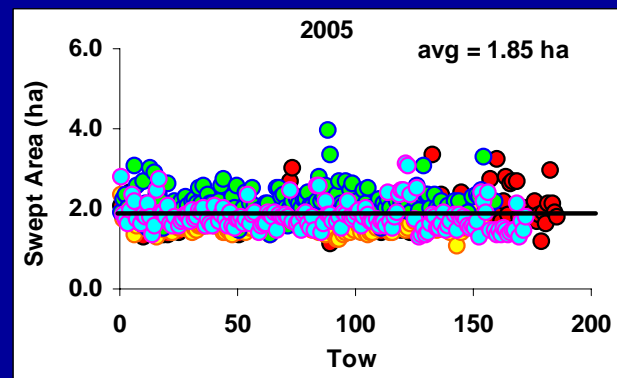
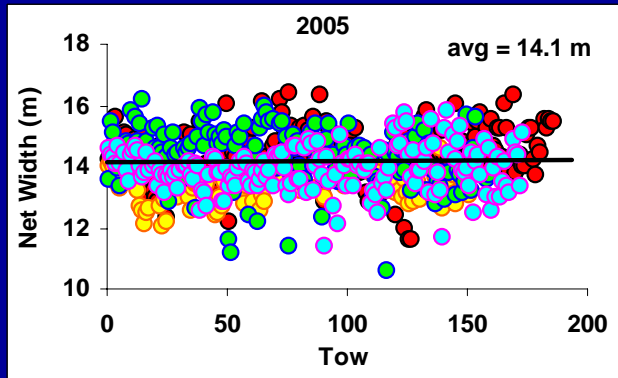
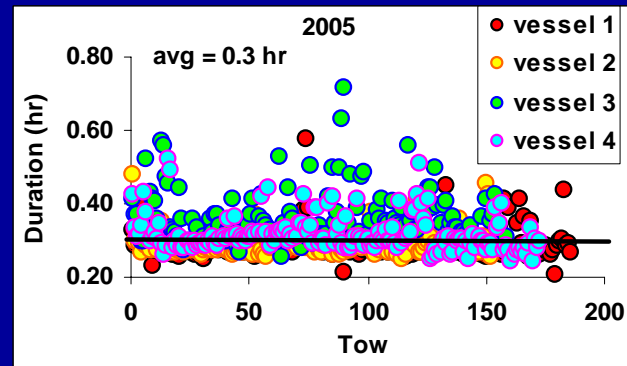
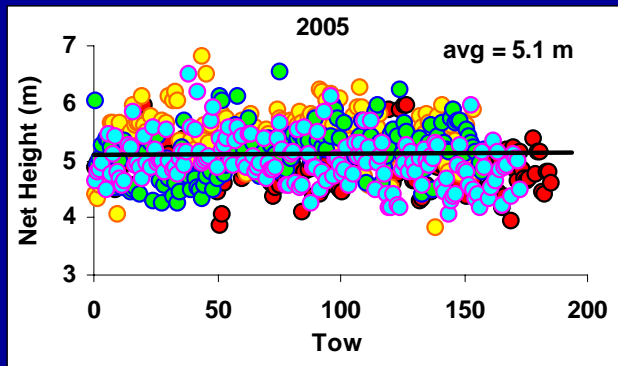


**Net Width X Distance Fished = Area Swept**

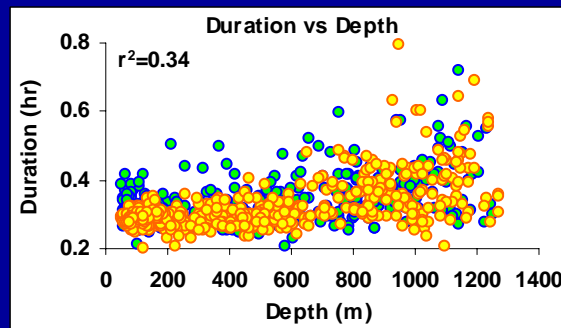
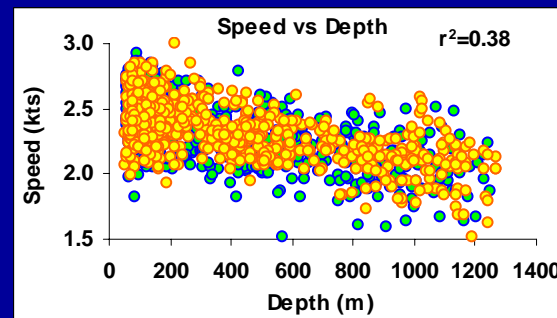
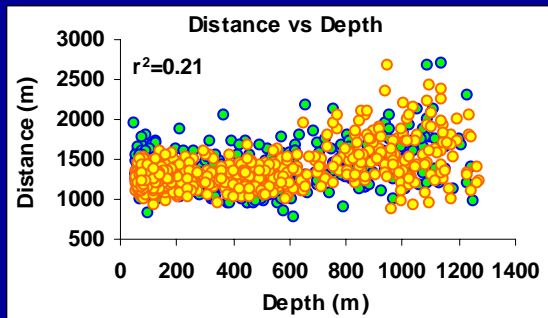
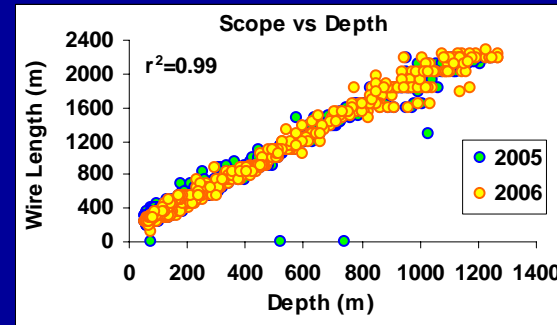
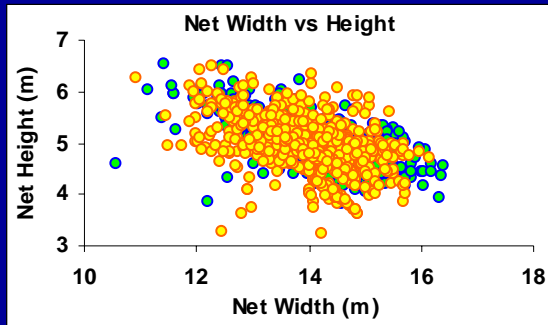


**CPUE (kg/ha) = Catch (kg) / Area Swept (ha)**

# Net Mensuration Data: summary by vessel



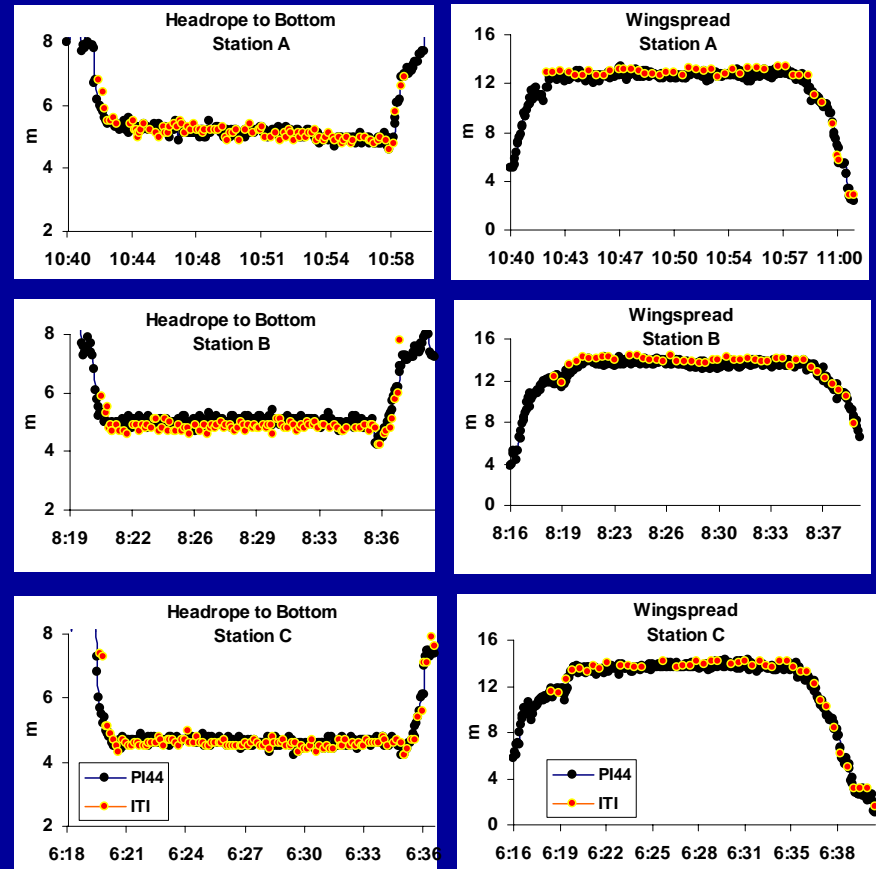
# Net Mensuration Data: relationships between measurements



Variation over time 2005 vs. 2006

# New in 2007

- Intercalibrated Simrad PI44 and ITI net mensuration systems
- Deployed seabird SBE19+ with dissolved oxygen and salinity sensors on net and vertical casts
- RMYoung Anemometer tested – wind speed and direction
- Depth Sounder data added to integrator display
- Surface temperature continuously recorded
- Real time ship and net track lines added to integrator
- Tested panasonic toughbook tablet



Also: corals, seabirds, stomachs, marine debris and genetic sampling added 2006-07

## Planned in 2008

- Collect wind data
- Routinely sample DO
- Routinely sample salinity
- Switch to PI44 system
- Test tilt-roll-pitch sensor
- Test tilt sensor on doors
- Evaluate: stationary computer screens with bright, high power screens versus mobile, dynamic work station with low brightness







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