Wireless Data Collection in a Harsh Environment

NOAA FISHERIES
Northwest Fisheries Science Center

Wireless Electronic Data Gathering System

Code Name: Buzzard

Victor Simon
February 8,2016

Some things about West Coast Groundfish Bottom Trawl Survey….

- **What we do (program Overview)**
- **How We Do It (Innovation and Efficiencies)**
- **Why the "How" Matters**

What We Do

What We Do: Overview

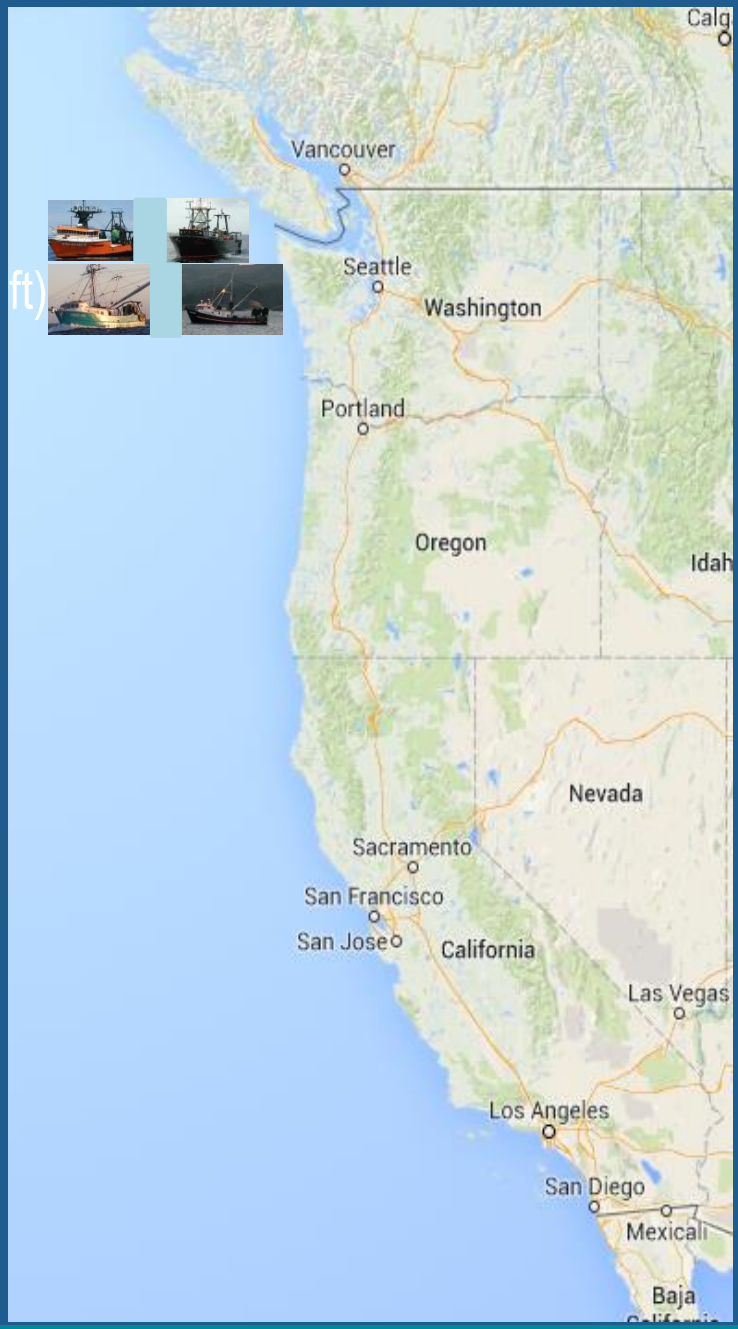
West Coast Trawl Survey from Canada to Mexico

- 4 chartered small West Coast fishing vessels (65 -95 ft)
- 2 passes (N to S) down coast (May – Jul; Aug –Oct.)
- Sample depths 55 – 1280 meters
- Target 750 stations per year
- Started in its current form in 2003

Objectives:

- Provide and maintain spatial time series biomass estimates for 90+Fisheries Management Plan (FMP) species
- Primary source of fisheries independent data
- Sample biological and oceanographic data
- Determine sea bottom type and untrawlable habitat

Since 2003, the survey team has sampled more than 2.6 million kilograms of fish and invertebrates



Typical Survey Year

(Estimates based on historical collections)

Sampling days	192
Number of stations allocated	752
Distinct species encountered	635
Number of stomachs	800
Number of Ovary samples	850
Number of otoliths	23,000
Individual weights	26,000
Individual sex/length	106,000
Other Samples: fin clips, tissues, etc.	1,500
Total Weight of Catch	**220,000 kg**

West Coast Groundfish Bottom Trawl Survey

What We Do

Conduct Annual Trawl Survey From Canada to Mexico to:

- Prepare and maintain spatial groundfish time series biomass indices from CPUE
- collect associated biological and oceanographic data
- determine sea bottom type and untrawlable habitat

How We Do It

- Annual 6 month (May-October) survey
- 3 Scientists per boat
- Convert commercial fishing boats into research vessels
- Utilize technological innovations to maximize efficiencies

Why the "How" Matters

- Safety
- Data Quality
- Data Volume
- Data Utilization
- Speed
- Efficiency

Small Vessels – Three Scientists

Ms. Julie – 72 Feet

Excalibur – 65 Feet

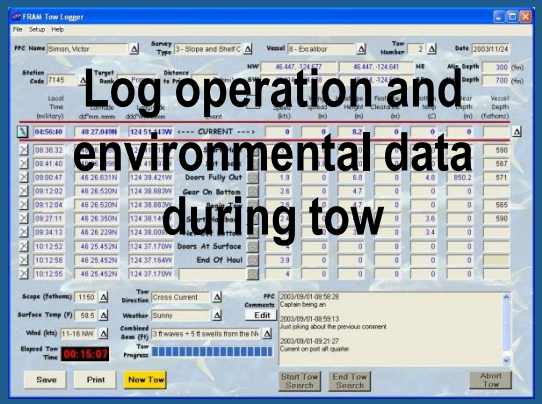

Last Straw – 78 feet

How We Do It: Innovation & Efficiencies

FRAM Survey Sampling Infrastructure Timeline

To 1997	1998 - 2002	2003 - 2014	2015 - 2016	Future
Paper Based Data Logging	Electronic logging in the Scantrol FM Board and Display	Implement Wireless backdeck and C coded software packages	Implement Python coded Data-based program suite and rugged label printer box	

Customized Software



Log operation and environmental data during tow

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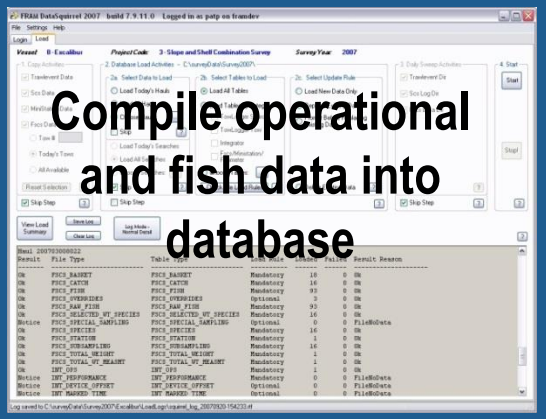
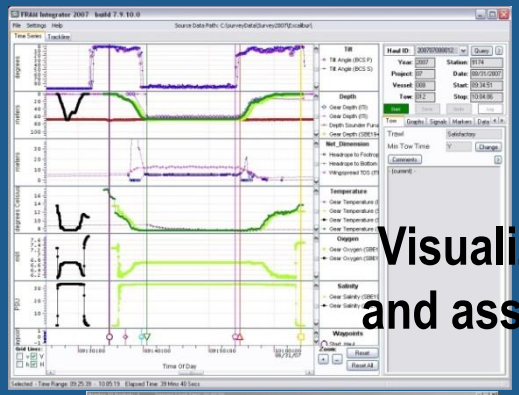
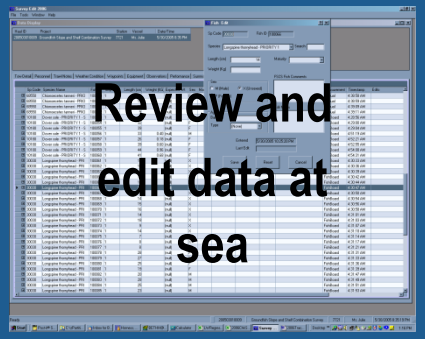


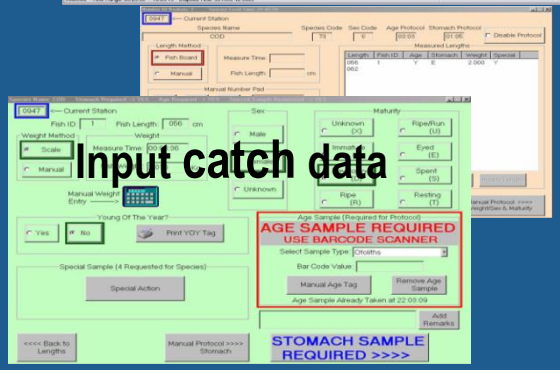
Compile operational and fish data into database



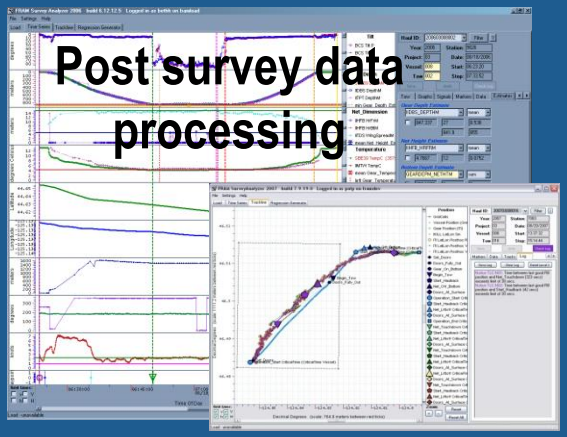
Visualize sensor data and assess tow quality



Review and edit data at sea



Input catch data



Post survey data processing

NOAA FISHERIES

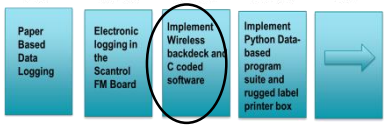
Hardware And Network Infrastructure

Wheelhouse

Data checking
Post tow validations
CTD download and analysis

Galley

192.254.253.3



External Antenna

Ethernet Switch

LAN 1: connections is essentially a wired wireless:
192.254.253.5

AP Client:
192.254.253.98

LAN 2 Serial to RJ45
192.254.253.100

Header file is created in the Wheelhouse which links the catch to a particular tow

Main tow and environmental data acquisition and main Storage DB

Sensor data in (8 com ports)
Net Mensuration (ITI, PI)
GPS
Heading, Roll, Pitch Heave
Wind Speed, direction
Surface Temperature
SBE39 Temp/Depth
Bottom Contact Sensor

Comm Box:
This Access Point is the heart and sole of the vessel intranet. It provides virtual com ports and vessel network

IP: 192.254.253.254
Mask: 255.255.255.0
Gateway: 192.254.253.1

192.254.253.253

Serial to RJ45 plugged into AP to provide virtual serial com ports

192.254.253.70
Printer Box

Deck Computing

192.254.253.2

Rugged IP67 Panasonic Toughbook Deck Computer

Wireless Sensor Data in (12 possible virtual com ports) from .253 and .70
Electronic Fish Measuring Board
Large Scale
Small Scale
Barcode Wand
Barcode Gun
Precision Digital Calipers

Data is pushed at specified intervals to the Wheelhouse DB

Two - 12 VDC, 35 Ahr batteries supply power to the Comm and Printer boxes. Here it is converted to usable power for all back deck devices (5, 9, 12 and 20 VDC)

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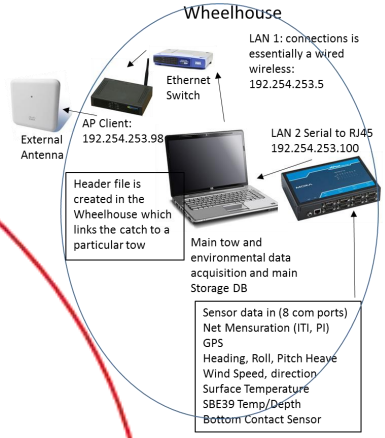
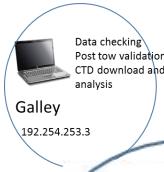


Hardware And Network Infrastructure



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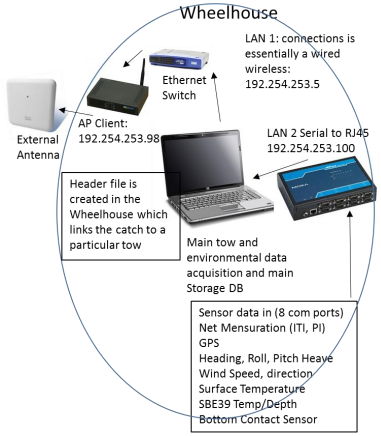

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Deck Equipment Schematic

Panasonic
H2 Tablet

Panasonic
CF31

Wireless Rugged
Printing Center

2 Extra Com Ports

I like options

??

Comm Box

Large Scale

Electronic Fish
Measuring Board

Small Scale

Barcode Wand

Precision Digital
Calipers

Barcode Gun
Reader

Trawl Survey Network Attributes

- Wireless LAN
- 802.11 protocols
- Static IP addresses
- Defined Station and Device IP address
- 2 systems (Orange and Blue) different subnets in the third triplet
  - Simultaneous vessel set up side by side
- Different work groups (SSID)
- IPV4
- Security

  IP address limit and Mac address limits

Why the “How” Matters

Microsoft Excel - Excel Spread sheet with data.xls [Read-Only]

File Edit View Insert Format Tools Data Window Help Acrobat

A1 'SAMPLEID

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	SAMPLEI	STARTTI	VESSTAR	VESSTAR	VESENDL	VESENDL	BOTDEPI	DURATIO	DISTSAM	NETWIDT	PERFCOI	STATIONI	TRANSEC	DEPTHMI	DEPTHM
2	2E+11	8/20/1998	48.14833	-125.687	48.14	-125.688	268.9472	0.346667	1165.143	14.22511	0	1A	48.16667	182.88	256.032
3	2E+11	8/20/1998	48.15217	-125.705	48.145	-125.712	444.262	0.295	959.3817	14.40561	0	1D	48.16667	402.336	475.488
4	2E+11	8/21/1998	47.84933	-125.133	47.84483	-125.124	193.4006	0.321667	1064.515	14	0	5A	47.5	182.88	256.032
5	2E+11	8/21/1998	47.82717	-125.121	47.82117	-125.113	306.7198	0.393333		14.75	0	5B	47.5	256.032	329.184
6	2E+11	8/21/1998			47.823	-125.45		0.616667			5	5H	47.5	841.248	987.552
7	2E+11	8/21/1998	47.80133	-125.649	47.7925	-125.651	1044.711	0.395	1649.773	15.04351	0	5I	47.5	987.552	1133.856
8	2E+11	8/21/1998			47.79133	-125.673	1139.099	0.495		15.14314	0	5J	47.5	1133.856	1280.16
9	2E+11	8/22/1998	46.81617	-124.929	46.808	-124.926	466.1504	0.29	1089.077	14.5	0	9D	46.83333	402.336	475.488
10	2E+11	8/22/1998	46.81833	-124.947	46.81	-124.945	539.7696	0.388333		14.4	0	9E	46.83333	475.488	548.64
11	2E+11	8/22/1998	46.818	-125.15	46.80983	-125.152	753.8173	0.358333	1451.027	14.66667	5.1	9G	46.83333	694.944	841.248
12	2E+11	8/22/1998	46.8015	-125.193	46.79183	-125.192	1046.347	0.476667	1876.726	14.8	5.1	9I	46.83333	987.552	1133.856
13	2E+11	8/22/1998			46.77067	-125.24	1139.099	0.648333		15.14314	1.11	9J	46.83333	1133.856	1280.16
14	2E+11	8/23/1998	46.162	-124.669	46.15583	-124.677	269.9544	0.3		10.75	-5.1	13B	46.16667	256.032	329.184
15	2E+11	8/23/1998	46.12333	-124.682	46.11483	-124.684	424.4625	0.326667		14.71429	5.1	13D	46.16667	402.336	475.488
16	2E+11	8/24/1998	45.51883	-124.89	45.52667	-124.883	1231.056	0.418333	1514.35	14.25	0	17H	45.5	841.248	987.552
17	2E+11	8/24/1998	45.494	-124.812	45.502	-124.809	824.9903	0.35		13.42857	-4.2	17G	45.5	694.944	841.248
18	2E+11	8/24/1998	45.485	-124.744	45.47767	-124.743	522.54	0.268333	817.2985	13.2	1.11	17E	45.5	475.488	548.64
19	2E+11	8/24/1998	45.46583	-124.486	45.45717	-124.482	397.418	0.341667	1276.253	14.16667	0	17D	45.5	402.336	475.488
20	2E+11	8/24/1998	45.49067	-124.464	45.48183	-124.463	292.5558	0.328333	1169.568	14.4	0	17C	45.5	329.184	402.336
21	2E+11	8/27/1998	44.83033	-124.572	44.82183	-124.576	298.3538	0.313333	1174.098	15	0	21B	44.83333	256.032	329.184
22	2E+11	8/27/1998	44.84217	-124.672	44.83283	-124.675	400.5458	0.315	1188.695	15	0	21C	44.83333	329.184	402.336
23	2E+11	8/27/1998	44.79583	-124.782	44.78833	-124.788	449.3869	0.315		15	0	21D	44.83333	402.336	475.488
24	2E+11	8/27/1998	44.83767	-124.988	44.84517	-124.996	966.0236	0.478333	1826.148	15	0	21H	44.83333	841.248	987.552
25	2E+11	8/27/1998	44.86	-125.011	44.86183	-125.026	1069.572	0.463333	1893.268	15	0	21I	44.83333	987.552	1133.856
26	2E+11				44.12533	-125.056					-5.7	25J	44.16667	1133.856	1280.16
27	2E+11	8/28/1998	44.14267	-125.056	44.15133	-125.055	1275.699	0.29		14	0	25J	44.16667	1133.856	1280.16
28	2E+11	8/28/1998	44.12983	-125.039	44.13667	-125.027	999.6871	0.413333	1824.335	14.44444	1.11	25H	44.16667	841.248	987.552
29	2E+11	8/28/1998	44.149	-124.993	44.13817	-124.993	469.0675	0.3	1205.883	14	-5.1	25E	44.16667	475.488	548.64
30	2E+11	8/28/1998	44.164	-124.985	44.13967	-124.984	385.9856	0.275	1357.922	14	0	25C	44.16667	329.184	402.336
31	2E+11	8/28/1998	44.14833	-124.97	44.15783	-124.972	301.0533	0.303333	1268.18	14.28571	0	25B	44.16667	256.032	329.184
32	2E+11	8/29/1998	43.45517	-124.681	43.46383	-124.677	378.7834	0.291667	1174.736	14.85714	0	29C	43.5	329.184	402.336
33	2E+11	8/29/1998	43.49067	-124.697	43.48167	-124.699	456.1829	0.283333	1130.236	14.14286	0	29D	43.5	402.336	475.488
34	2E+11	8/29/1998	43.47883	-124.911	43.46967	-124.912	776.9786	0.321667	1255.14	15	0	29G	43.5	694.944	841.248
35	2E+11	8/28/1998	43.47817	-124.955	43.4685	-124.955	965.039	0.343333	1405.24	14.88889	0	29H	43.5	841.248	987.552
36	2E+11	8/29/1998					1057.933	0.653333		13.6	-6.4	29I	43.5	987.552	1133.856
37	2E+11	8/30/1998	42.81067	-124.94	42.81833	-124.946	630.7496	0.326667	1300.306	15.28571	0	33F	42.83333	548.64	694.944
38	2E+11	8/30/1998	42.79667	-124.901	42.80383	-124.908	436.2395	0.291667		14.33333	0	33D	42.83333	402.336	475.488
39	2E+11	8/30/1998	42.81467	-124.796	42.82333	-124.799	300.8279	0.313333	1186.194	13.875	0	33B	42.83333	256.032	329.184
40	2E+11	8/30/1998	42.81833	-124.771	42.82683	-124.774	224.388	0.333333	1275.715	13.5	0	33A	42.83333	182.88	256.032

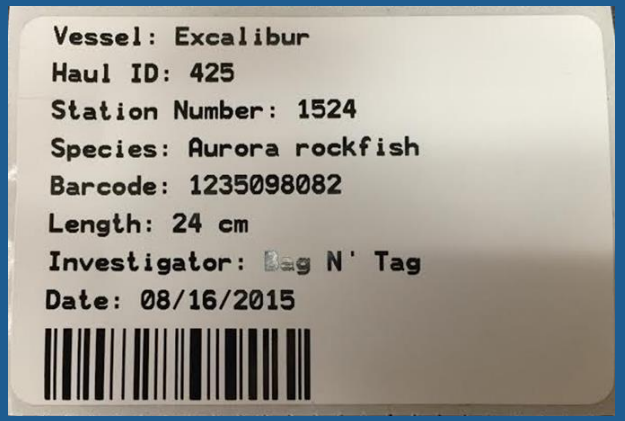
ERICA_tabA1

Ready

Manual Transcription vs Barcode System?

To 1997	1998 - 2002	2003 - 2014	2015 - 2016	Future
Paper Based Data Logging	Electronic logging in the Scantrol FM Board	Implement Wireless backdeck and C coded software	Implement Python Data-based program suite and rugged label printer box	

Species	Angler	Drop No.	Hook No.	Weight (kg)	Length (cm)	Sex	Otolith No.*	Fin Clip No.*	Special Project(s)
Verm	A	6	3	2.86	54	F	V446		
	A	6	4	[illegible]	56	F	V447		
	A	5	2	4.42	63	F	V448		
	B	5	5	3.52	52	M	V449		
	A	6	5	2.52	52	M	V450		
		6	1	1.36	42	F	V451		OJA
		8	2	1.92	46	F	V452		OJA
	B	6	4	2.74	51	M	V453		
	C	6	3	2.26	51	M	V454		
	A	6	1	3.97	59	F	V455		
	A	6	2	2.22	49	M	V456		
	B	6	3	2.84	53	M	V457		
Verm	C	6	5	2.34	49	M	V458		
ROCCA	B	4	4	1.7	54	M	B252		
	A	5	4	2.26	58	M	B253		



Barcoding Improves Speed & Efficency

Barcode System Reduces Data Entry Time Up To 83% Over Transcription

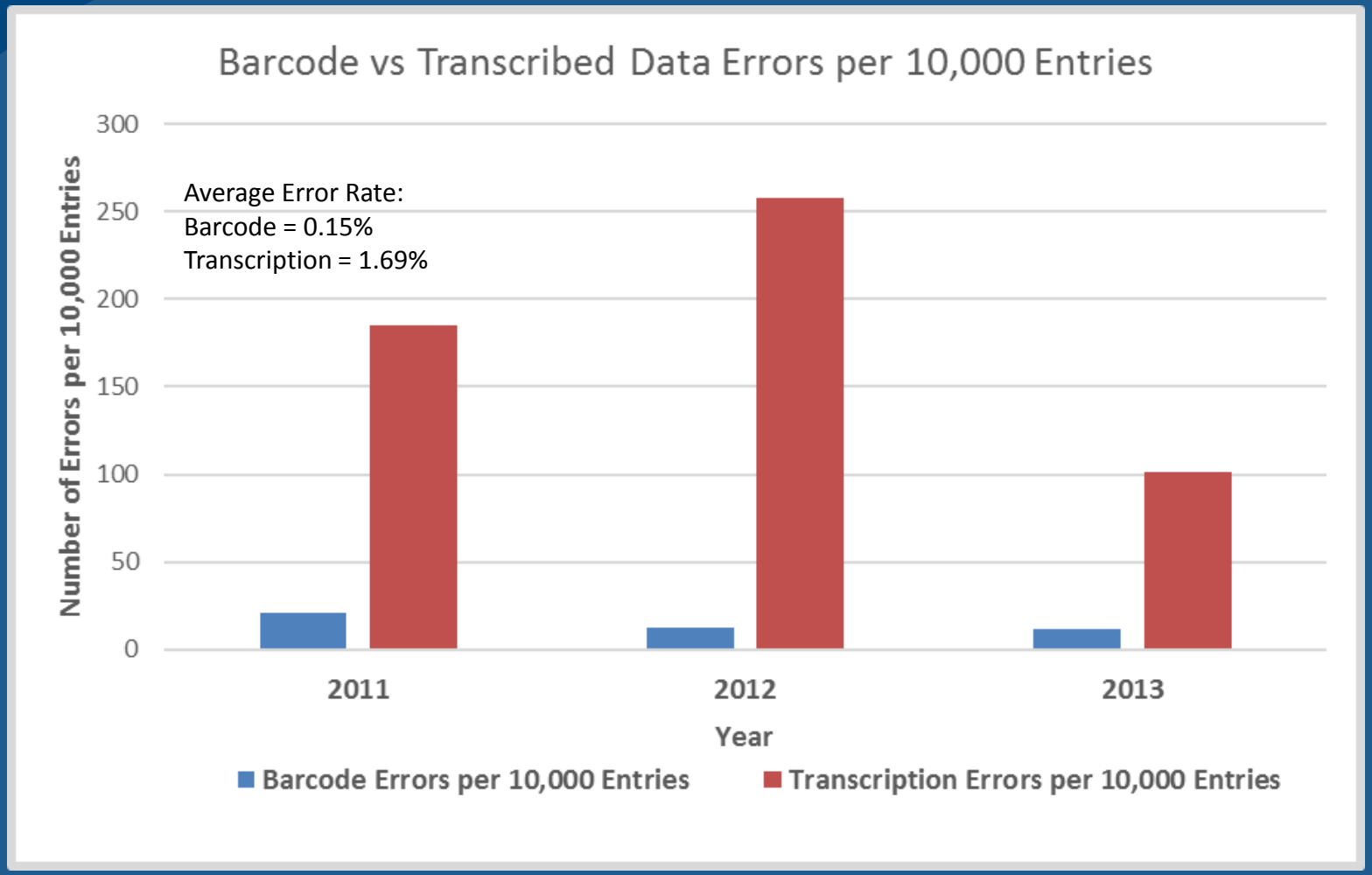
Transcription Method	Barcode Method
Specimen data retrieved and manually entered on paper in 30 to 60 seconds	Specimen data retrieved and printed within 10 seconds.
Risk of data entered not being legible, accurate, or containing pertinent trawl information.	Data printed accurately, legibly, with all pertinent catch and trawl information from the application

Benefits of Increased Speed & Efficiency

- More stations and more samples
- Increased return on investment for charter budget
- Faster access to data for analysis
- Reduction in time spent vetting collected data
- More time for scientists to rest
  - Improved safety
  - Better decision making

Barcoding Reduces Error Rates

Barcode System: 11.3 times less errors than Transcription

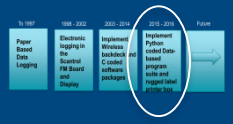


Benefits of Reduced Error Rates

Time and Data Quality

- Micro and Macro level impacts
  - Time editing data on the vessel
  - Data post processing time decreased
- Data may be directly accessible
- Year end reports generated on time
- Permit applications on time
- Data available for assessments on time
  - We can react to changing environments quicker

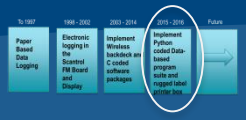
Application Driven Sampling Workflow



Value Added Sampling and Efficiency

Manual Sampling Workflow	Application Driven Sampling Workflow
Scientists manually determine best sampling area by reading paper-based clipboard data of geographic area/ size bins	Program automatically tells you when, what, and where to take
Risk of under sampling resulting in incomplete data set for analysis or oversampling data impacting time and budget	**Optimal data collected** for each species maximizing use of time and budget
Personal knowledge and memory driven specimen collection for rare species and out of range	Application informs the user when a specimen is out of range or needs to be collected and tells you to take it.

Real-time Validations



WeightsRequired
WeightsBeforeSampling
MixWeightFirstBeforeChilden
SaveSubsampleBasket
SampleSubsampleWeightsExist
SubSampleWeights
SpecimensTotalToSubsampleWeight
SpecimenHistoralAverageWeight
SalmonCountOnly
CountsOrProtocolCheck
SpeciesLatitudeDepthRanges
SalmonCoralsSampling
MaxScaleBasketWeight
ProtocolNoCount
AllOneSex
SpeciesHistoricalLengthRanges
ProtocolCountCheck
UniqueFishLengths
SpecimenWeightsEqualSubsample
FishSamplingUniqueBarcodes
Age Requires Barcode
ProperBarcodeFormat
SpeciesWeightLengthCheck
SpecialActionsUniqueBarcodes

SpeciesSalmonProtocol
SpeciesStandardProtocol
SpeciesCountsType
SpeciesSubsampleWtFishWt
SpeciesSubsampleWtManCt
SpeciesSubsampleWtFishCt
~~FishAgeFormat~~
~~FishAgeDuplicate~~
FishLengthNonZero
FishLengthLimits
FishLengthAve
FishMaturityNonZero
FishSexExists
FishSexAllSame
FishWeightPredicted
FishBasketOrphan
BasketCountsNonZero
BasketWeightNonZero
BasketSubsampleMarks
BasketSpeciesOrphan
Individual Length Range Check
Individual Weight Range Check
Protocol Check
Mix Integrity Check
Barcode duplication check
Barcode range check
Protocol Check
Protocol Check
Rogue Fscs validation Check

Highlights:

- Duplicated Sample Numbers
- Fish weight to length ratio
- Expected weights
- Fish size
- Geographic Distribution
- Depth Distribution
- Sequential sample numbers

The computer says this fish has no business being here and I should bag and tag it!

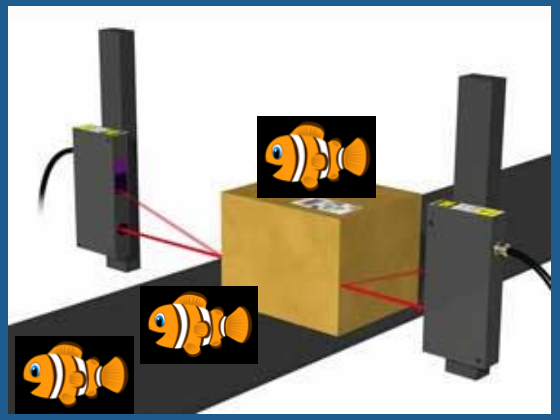
Future Options

RFID Printers and Scanners

To 1997	1998 - 2002	2003 - 2014	2015 - 2016	Future
Paper Based Data Logging	Electronic logging in the Scantrol FM Board	Implement Wireless backdeck and C coded software	Implement Python Data based program suite and rugged label printer box	

Voice Recognition Devices

Automated Laser Measurement



NOAA FISHERIES