# Gulf of Mexico Shrimp Effort Estimates

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# Effort Estimates

- Fishing effort estimates are calculated for the US Gulf of Mexico commercial shrimp fishery

- Current effort estimates are used for various programs:
  - Three annual GOM Penaeid shrimp stock assessments
  - Several GOM fish stock assessments
  - Sea turtle and marine mammal BiOP analyses
  - Bycatch estimates from the shrimp trawl fishery

# Effort Estimation with Landings Data pre-ELB

- Fishing effort estimates are calculated using data collected by NMFS Port Agents and State Trip Ticket systems.

- Port Agents visit shrimp dealers collecting:
  - Shrimp weight, size, value

- Port Agents visit the docks and interview vessel captains collecting:
  - Fishing effort and location – based upon recall

# Effort Estimates

Current effort estimates are derived using a simple ratio estimator:

$$\frac{\Sigma\, trip\ catch}{\Sigma\, trip\ effort} = \bar{x}\ \ CPUE^{a}$$

[a] for interviewed trips for a given location cell

# Effort Extrapolation

$$Total\ Effort = \frac{\Sigma\ Landings^{a}}{\bar{x}\ CPUE^{\ b}}$$

[a]Landings is the month's total pounds of shrimp reported by dealers to NMFS, allocated to the location cell in question.

[b]CPUE from the interview records

# Data Collection

7,000 lbs

3 days

3,000 lbs

4 days

200 lbs

1 days

10,000 lbs

4 days

6,000 lbs

5 days

400 lbs

2 days

*300 lbs*
*? days*

*1,000 lbs*
*? days*

*2,000 lbs*
*? days*

*1,500 lbs*
*? days*

*10,000 lbs*
*? days*

*4,000 lbs*
*? days*

# Effort Calculations

For this example the calculations would be as follows:

- Total pounds = 45,400 ($\Sigma$ interviewed +$\Sigma$ non interviewed trips)
- Total pounds interviewed = 26,000 lbs ($\Sigma$ pounds from interviewed trips)

- Fishing effort interviewed = 19 days

- CPUE = $\frac{2600\ lbs}{19\ days}$ = $1400\ \text{lbs per day}$

- Total Effort = $\frac{45000\ lbs}{1400\ lbs\ per\ day}$ = $32.4\ \text{days}$

# SN Pooling Method

SN coded pooling method was selected as preferred method for effort estimation (SEDAR 7, 2004)

The SN Pooling Method is 3 trimesters, 4 subareas, and 2 or 3 depth zone combinations

| | | |
|---|---|---|
| The 3 trimesters are: | | (1) January – April |
| | | (2) May – August |
| | | (3) Sept – December |
| Subareas: | | |
| Statistical zones | | (1) 1 – 9 |
| | | (2) 10 – 12 |
| | | (3) 13 – 17 |
| | | (4) 18 – 21 |
| Depths: | 2 depth method | (1) 0 – 10 fathoms |
| | | (2) > 10 |
| | 3 depth method | (1) 0 – 10 |
| | | (2) 11 – 30 |
| | | (3) >30 |

# Calculation of Effort

So Why is the Calculation of Effort Difficult?

- Fleet is large are widely scattered
- Species of interest are not uniformly distributed
- Effort must be calculated for each month
- Effort must be calculated for small areas
- Trips are often long (up to 60 days) – based upon recall

# Port Agent Interviews

At the end of a fishing trip NMFS port agents would interview the captain regarding the location(s) and the amount of the effort expended.  Thus, a CPUE could be estimated for the trip for a particular location.

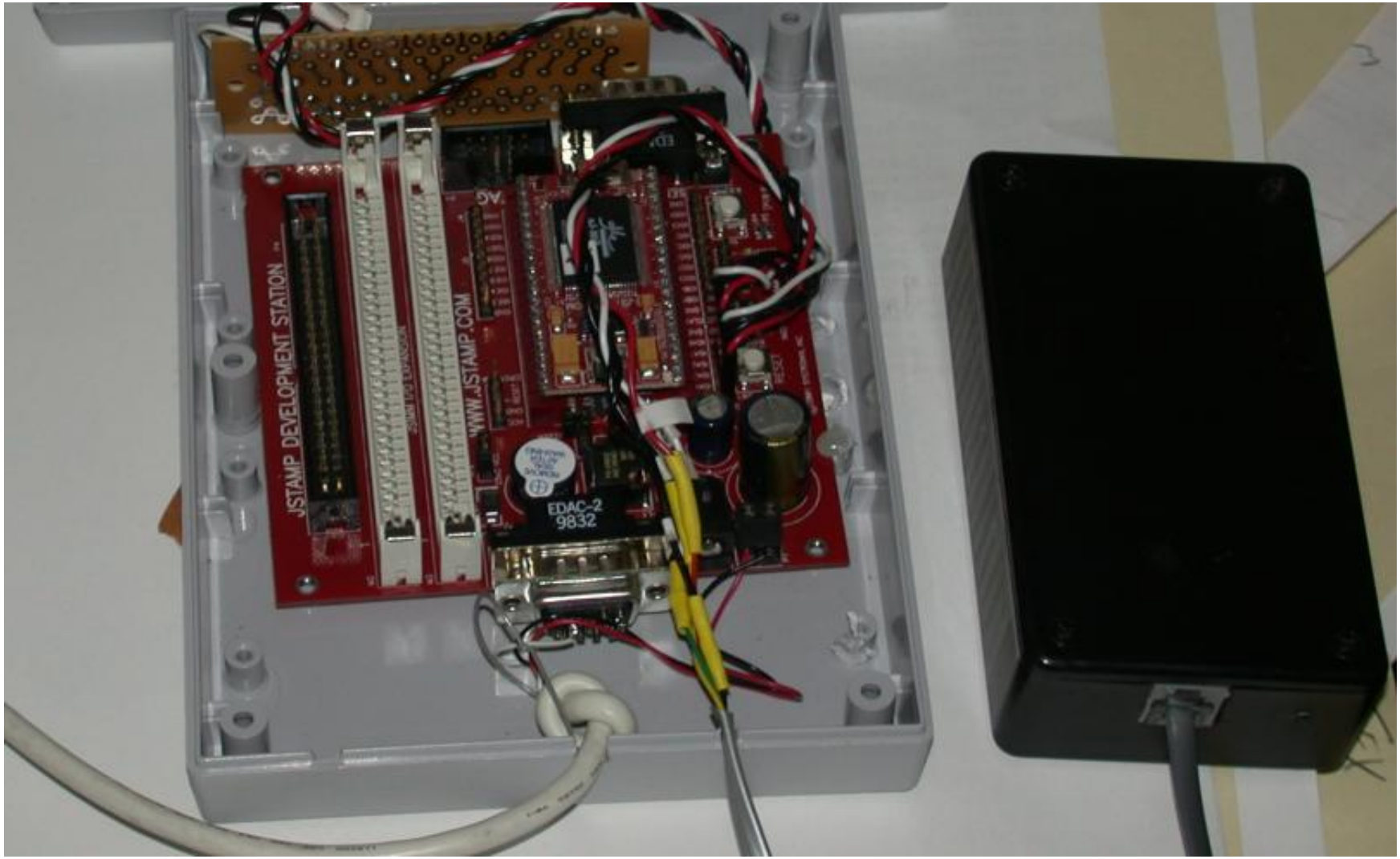
Difficulty in recalling where and how long they fished in a particular area.

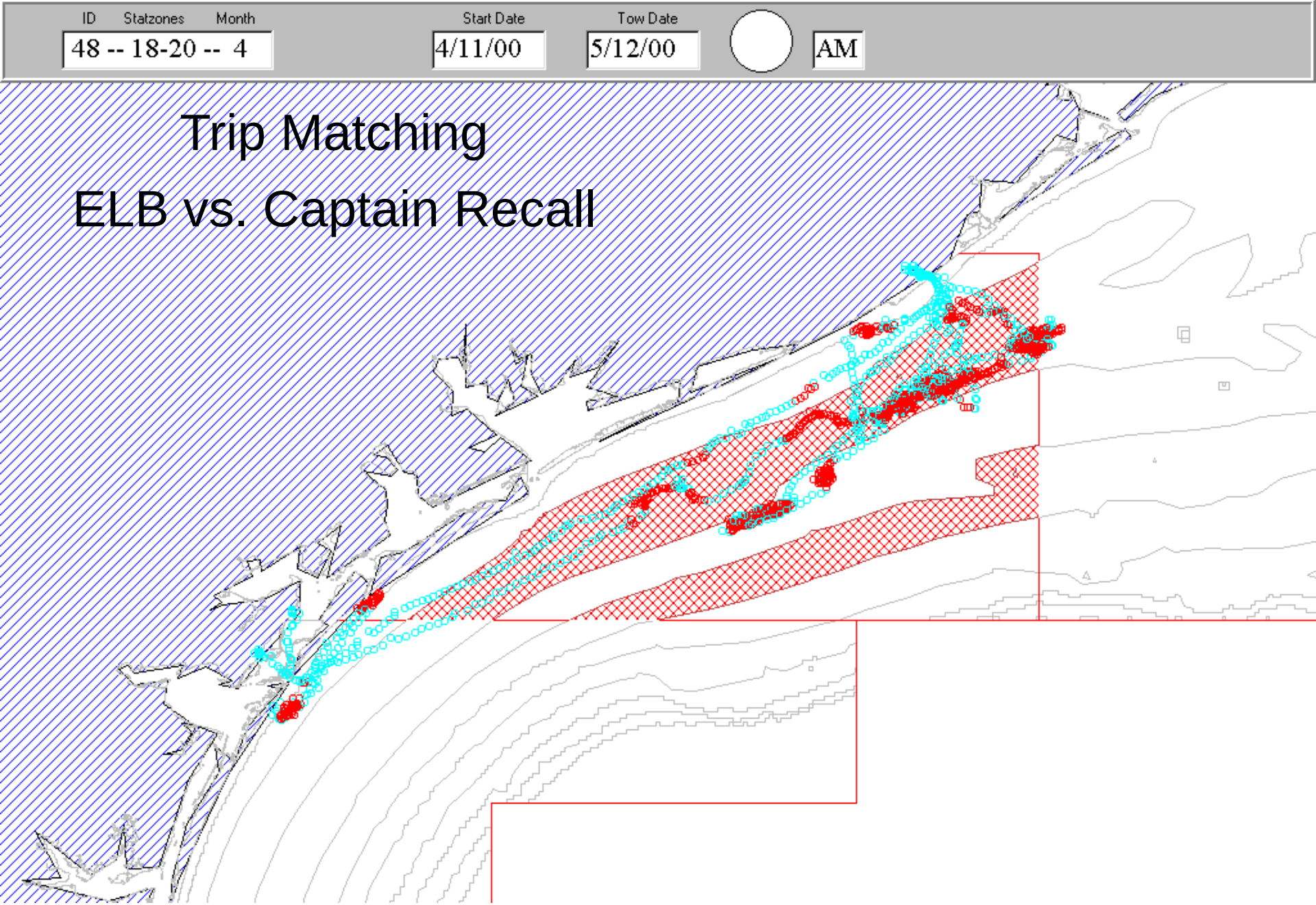
# Electronic Log Books

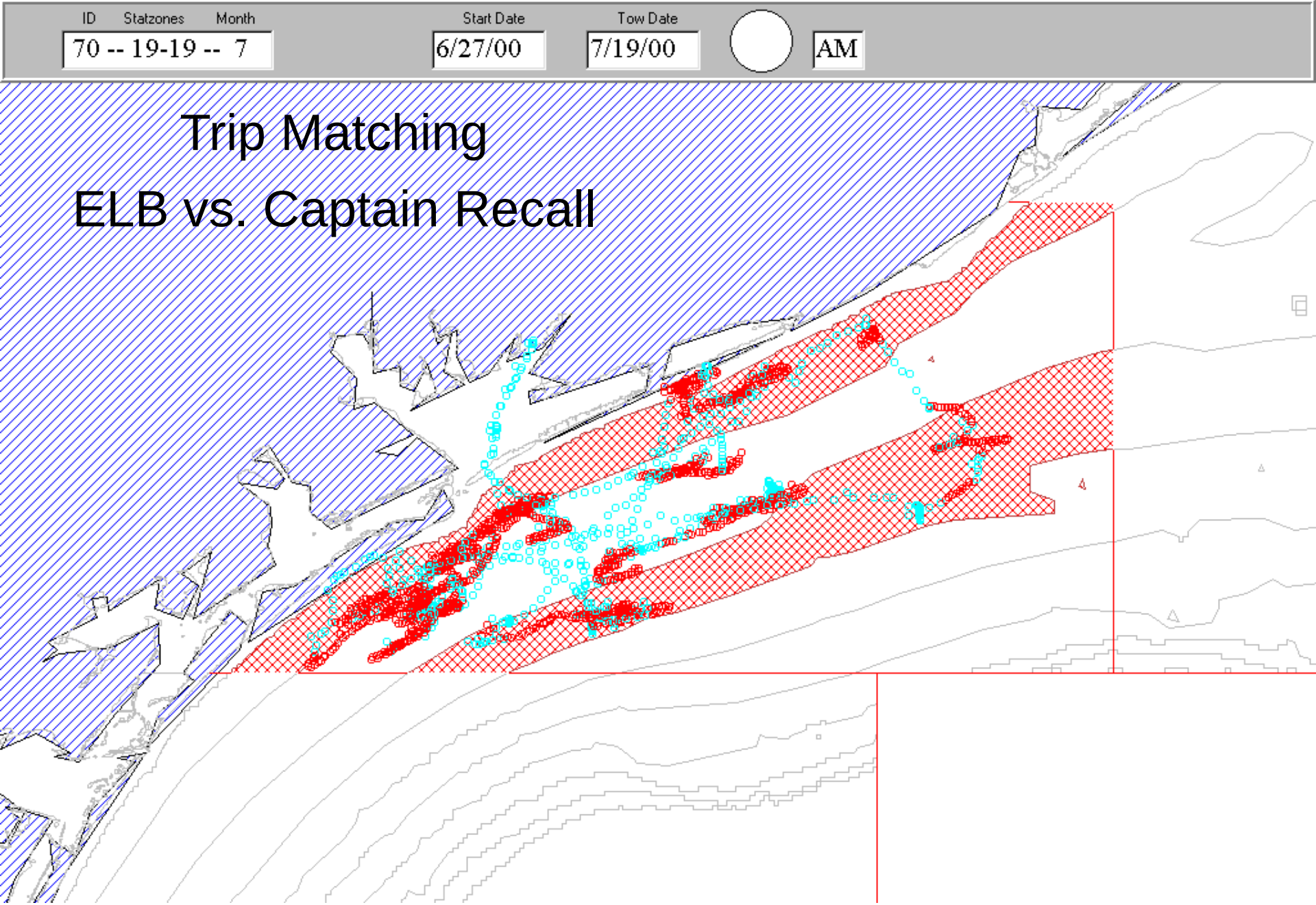
To alleviate this recall issue, vessels were equipped with electronic log books (ELB). These units collected location coordinates every 10 minutes. Effort determined by calculating time between “pings.” Vessels met at the dock to collect “data chips.”

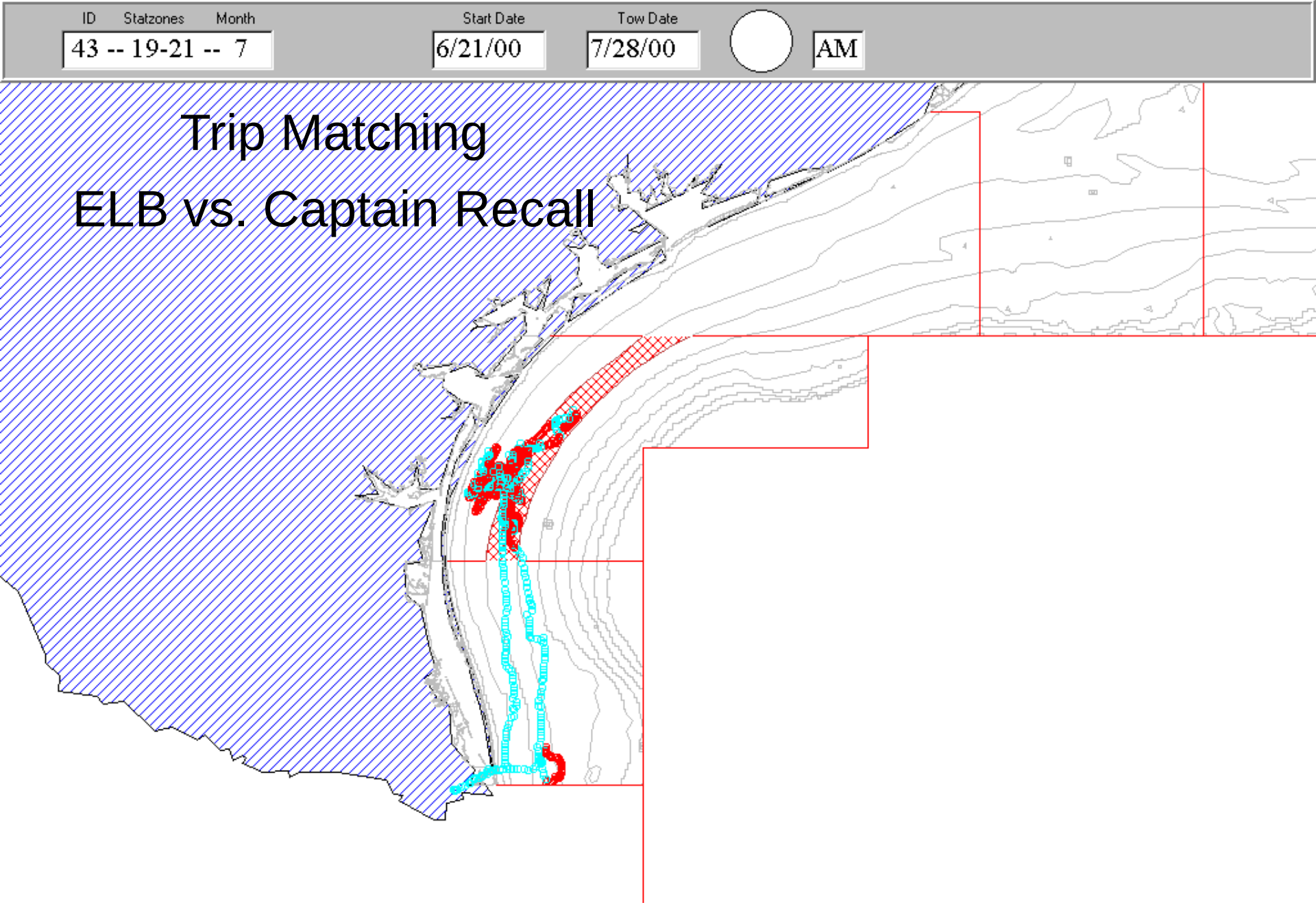
- 1999 - Pilot program started
- 2006 - Full scale ELB program - joint effort with NMFS and contractor LGL Ecological Research Associates ~400 vessels equipped with ELBs.

# Electronic Logbook




ID Statzones Month
48 -- 18-20 -- 4
Start Date
4/11/00
Tow Date
5/12/00
AM
Trip Matching
ELB vs. Captain Recall


ID Statzones Month
70 -- 19-19 -- 7
Start Date
6/27/00
Tow Date
7/19/00
AM
Trip Matching
ELB vs. Captain Recall

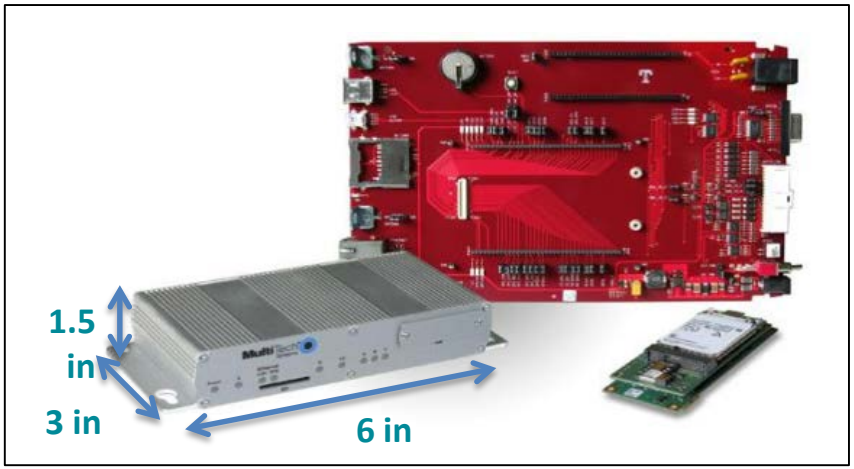

ID Statzones Month
43 -- 19-21 -- 7
Start Date
6/21/00
Tow Date
7/28/00
AM
Trip Matching
ELB vs. Captain Recall

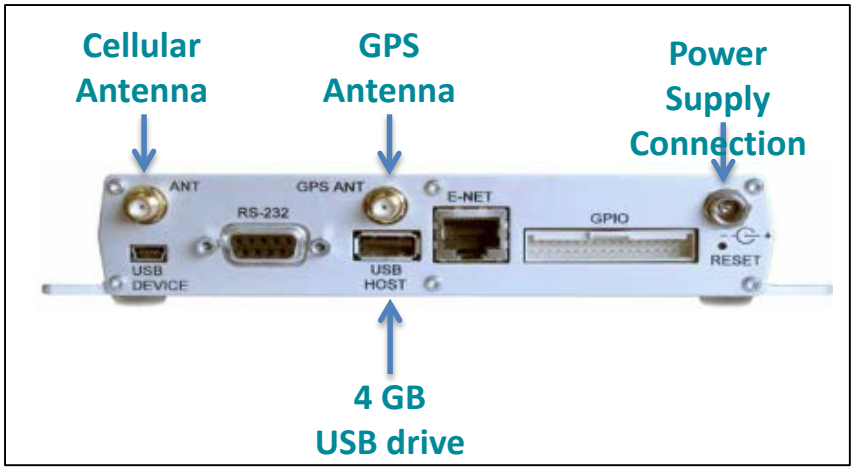
# Cellular Electronic Logbook (cELB)

The ELB contract ended in 2013 so NMFS Galveston explored new technology which could provide automated data delivery. A cELB program was seamlessly integrated and realized an annual cost savings to the Government. With the cELB, GPS data are transmitted via. cell phone connection to a US Gov. server.

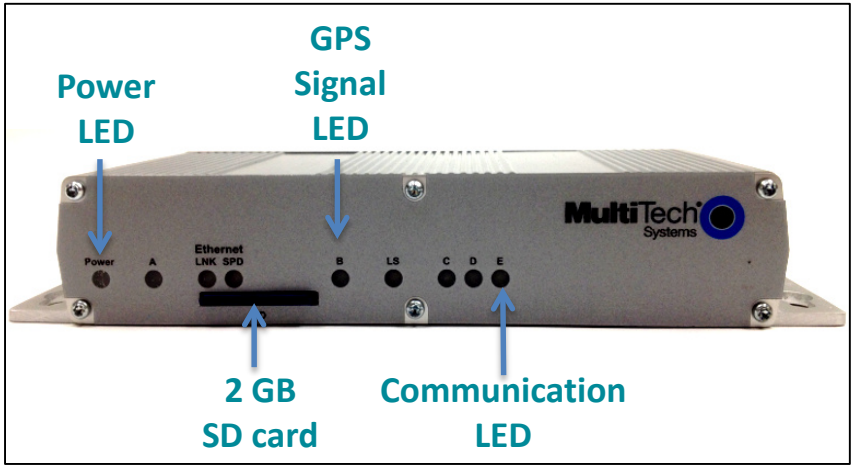
- 2014 cELB program fully run by NMFS.
- Approximately 475 vessels out of ~1,400 permitted vessels in the fleet are equipped with a cELB. Number fluctuates due to permit transfers, etc.

# MultiConnect™ OCG-D Features



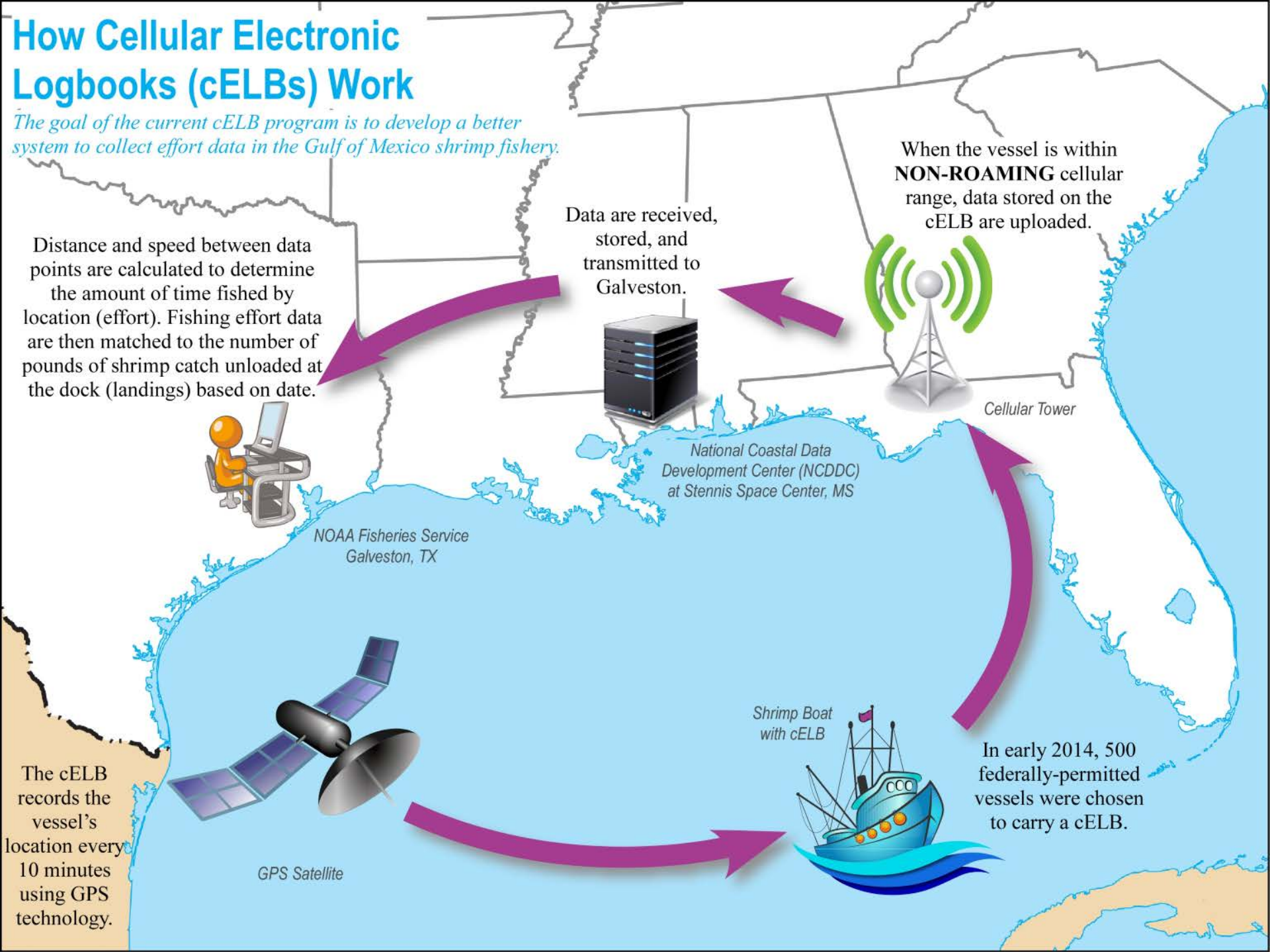




- External antenna for cellular communication and GPS reception
- LEDs to indicate device is communicating and GPS is valid
- Internal peripherals: GPS and cellular modem
- External interfaces: serial, USB, ethernet, and SD card memory slot
- Five year warranty from the manufacturer
- Device runs on 9V DC or 120V AC



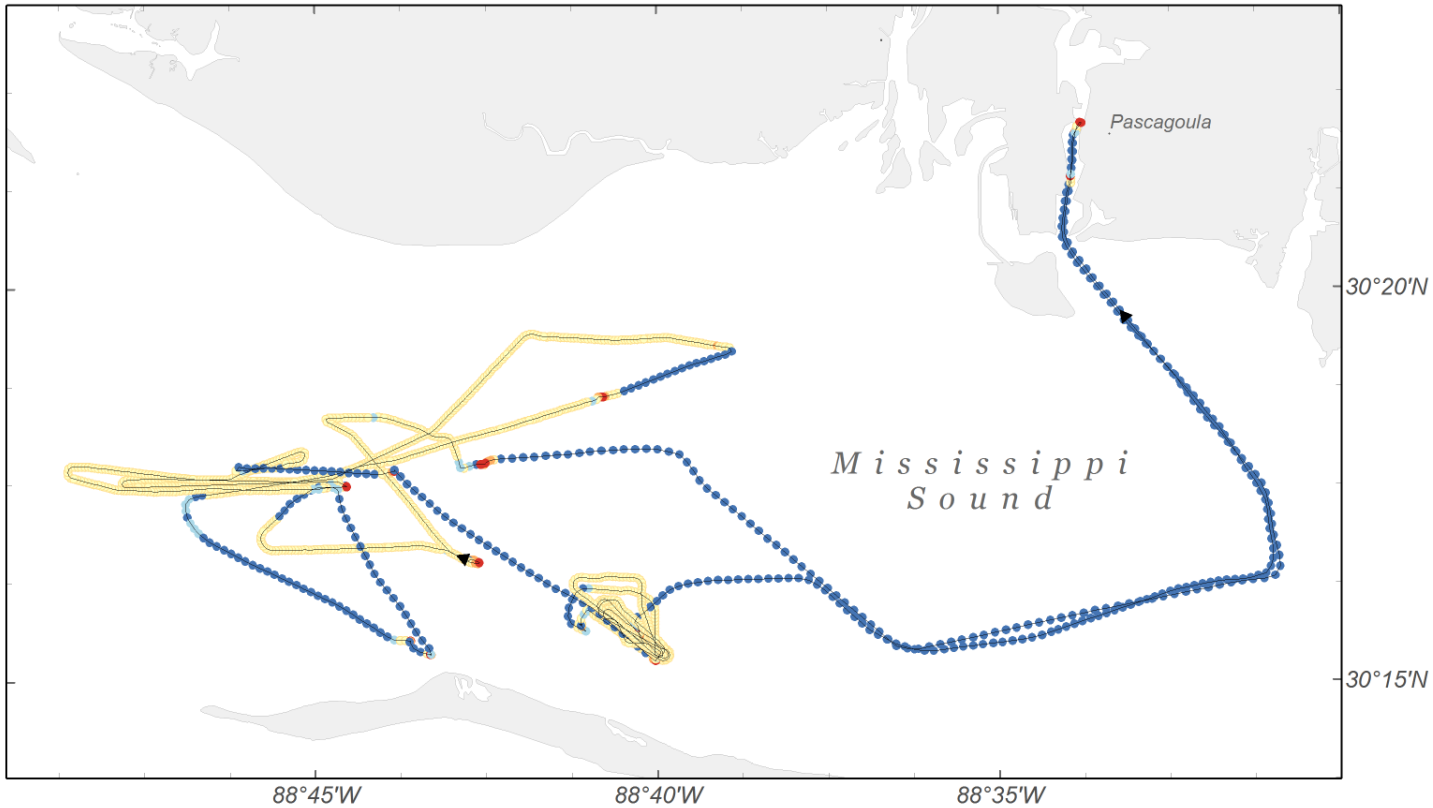
# How Cellular Electronic Logbooks (cELBs) Work

*The goal of the current cELB program is to develop a better system to collect effort data in the Gulf of Mexico shrimp fishery.*



# Field Test 3:

## NOAA research vessel *Caretta* October 2013 cruise




**RV Caretta October Cruise**

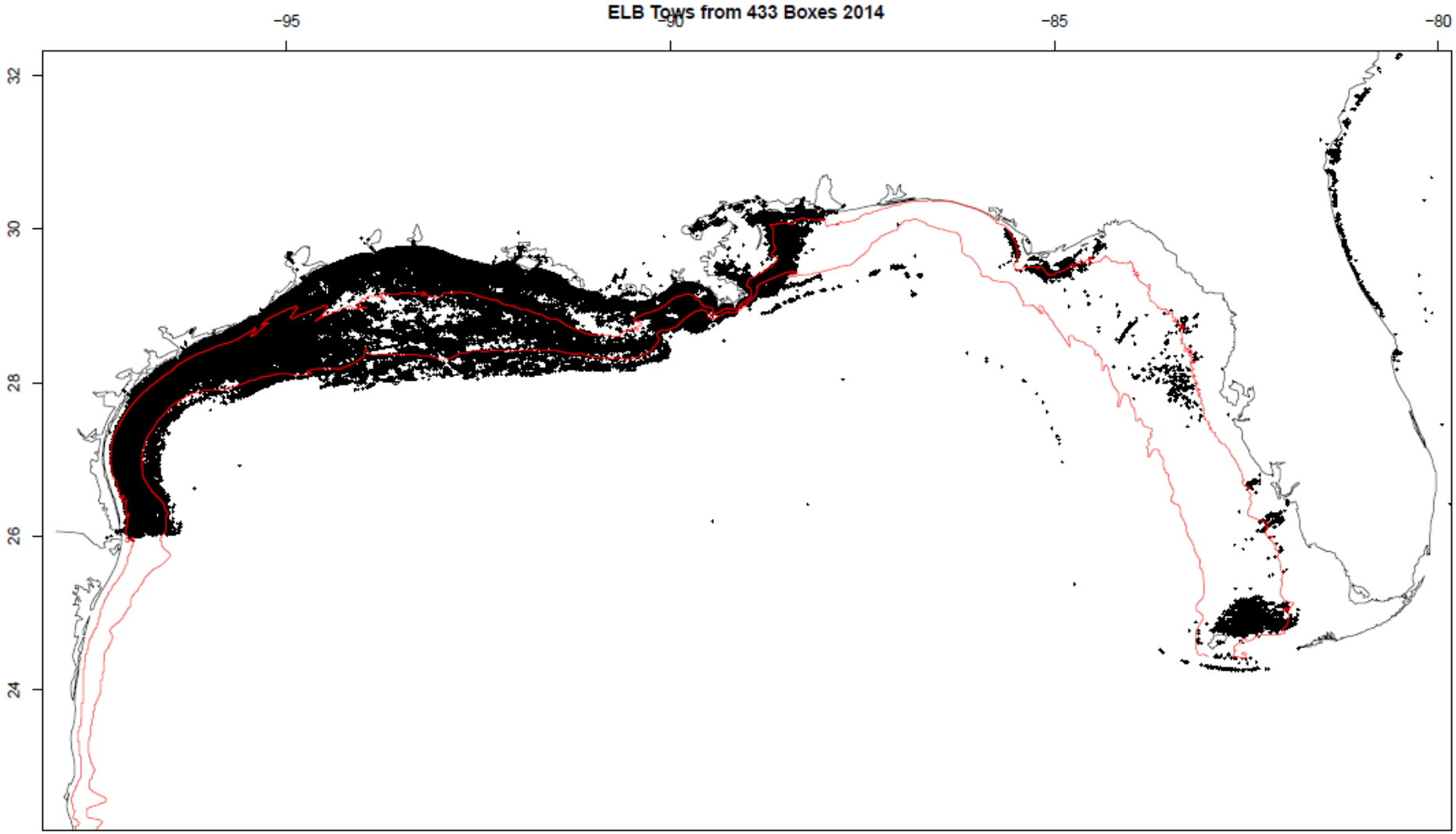
**Vessel Speed (knots)**

- < 1
- 1.0 - 2.0
- 2.0 - 3.8 (fishing)
- 3.8 - 5.0
- >5.0

0 2.5 5 10

Kilometers

*Projection: Albers Equal Area Conic*
*Data: NOAA Fisheries Service*
*Map Created by Jo Williams*

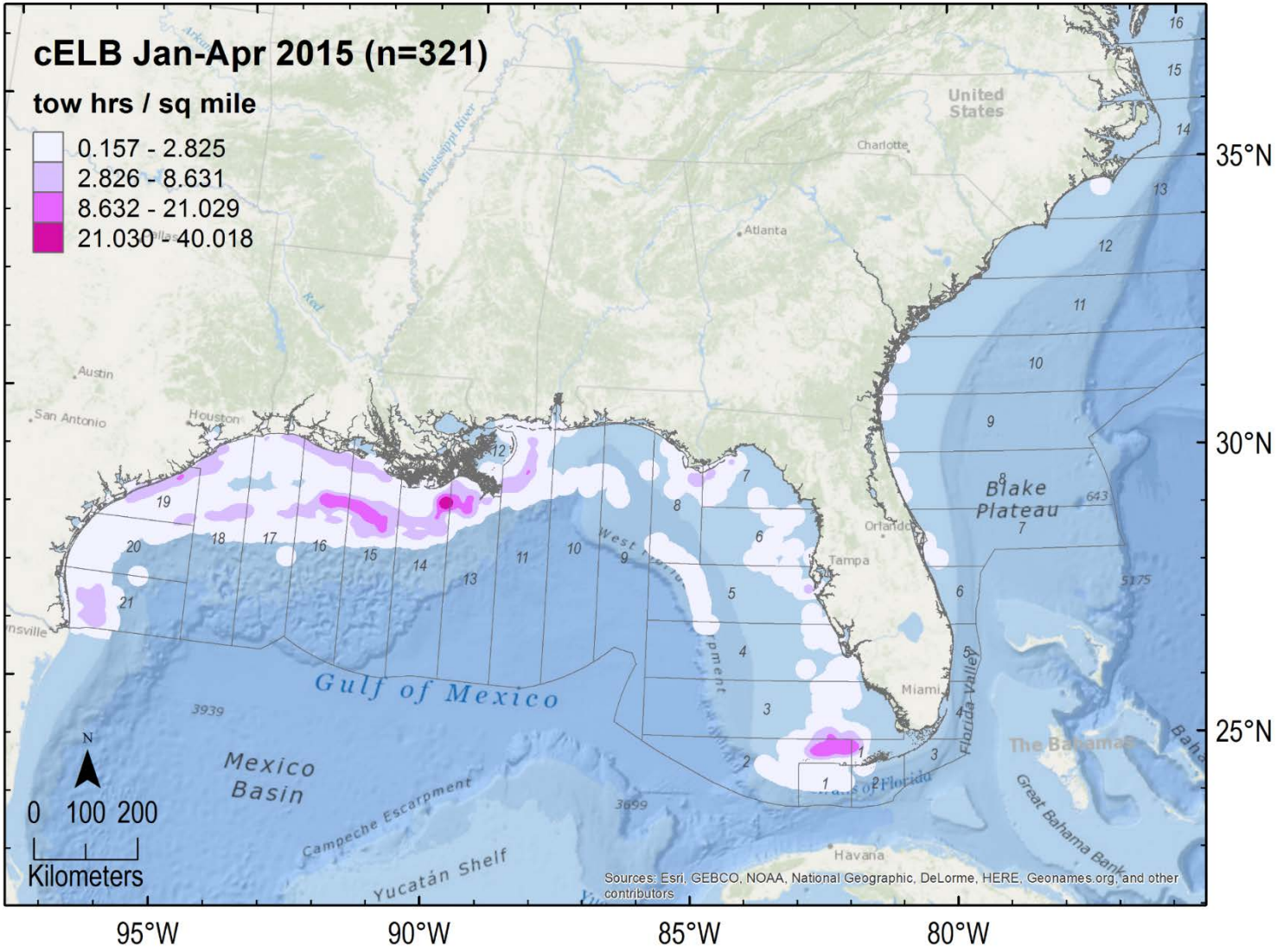

ELB Tows from 433 Boxes 2014
−95
−90
−85
−80
32
30
28
26
24

# Interviews and cELBs gives us estimates for shrimp CPUE

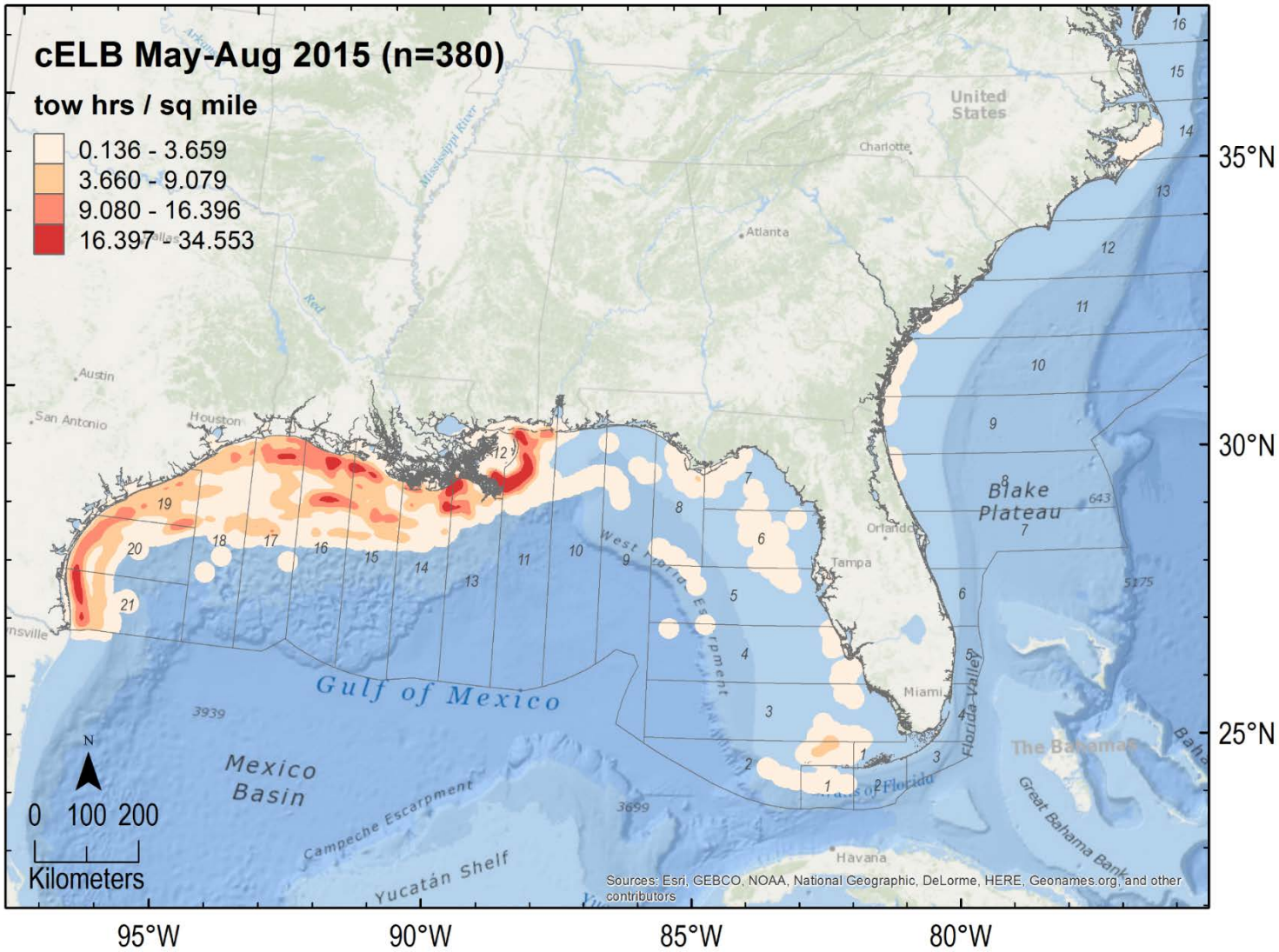
# Effort Estimation with cELB and Landings Data

- Fishing effort estimates are calculated using data collected by NMFS Port Agents, State Trip Ticket systems, and the cELB program.
- cELBs collect effort data from a subset of vessels. Trips with cELB effort data are matched to landing records to estimate CPUE.
- Port Agents visit shrimp dealers collecting:
  - Shrimp weight, size, value
- Port Agents visit the docks and interview vessel captains collecting:
  - Fishing effort and location – based upon recall

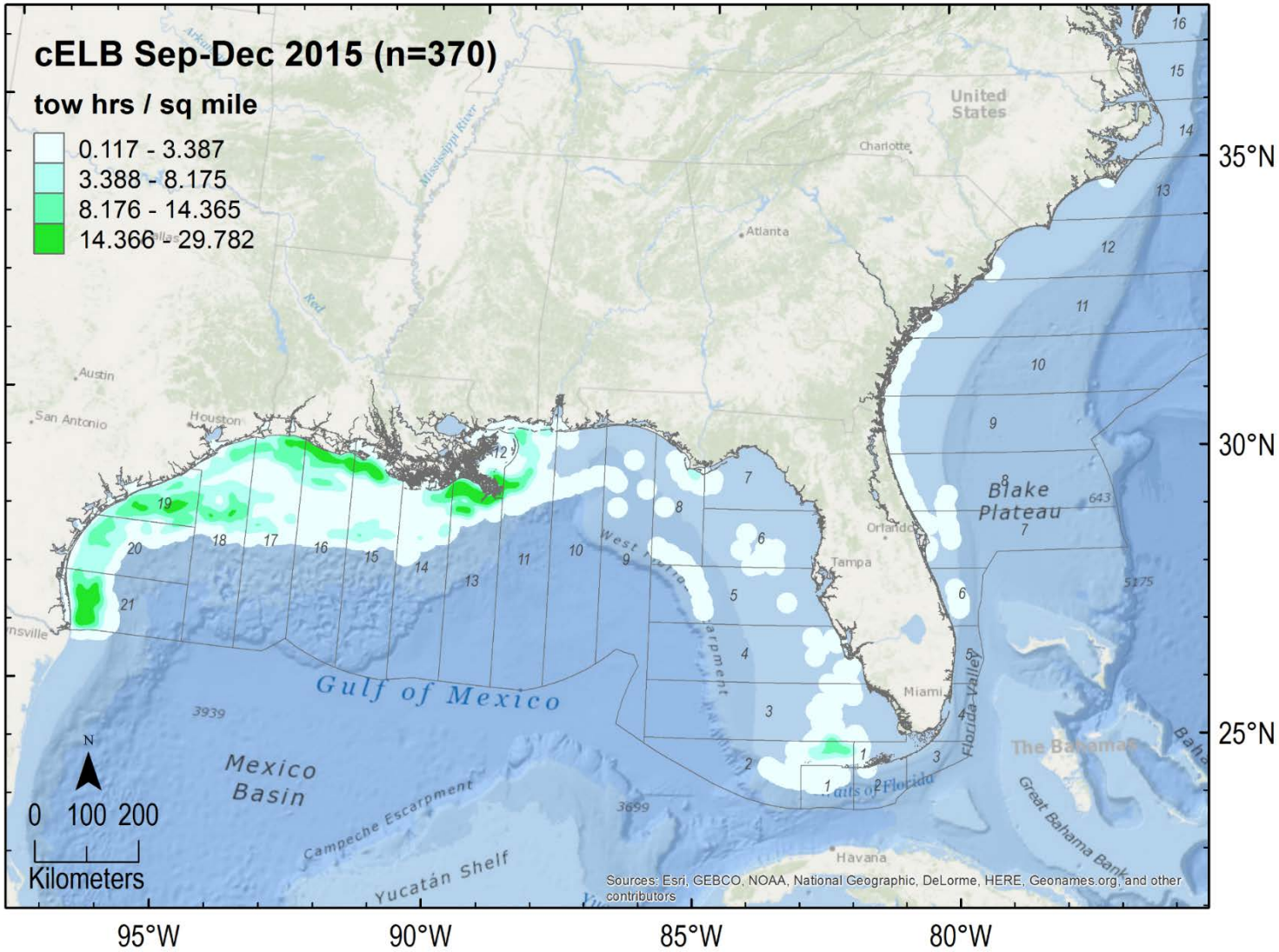
# Distribution of cELB Effort: Jan–Apr 2015

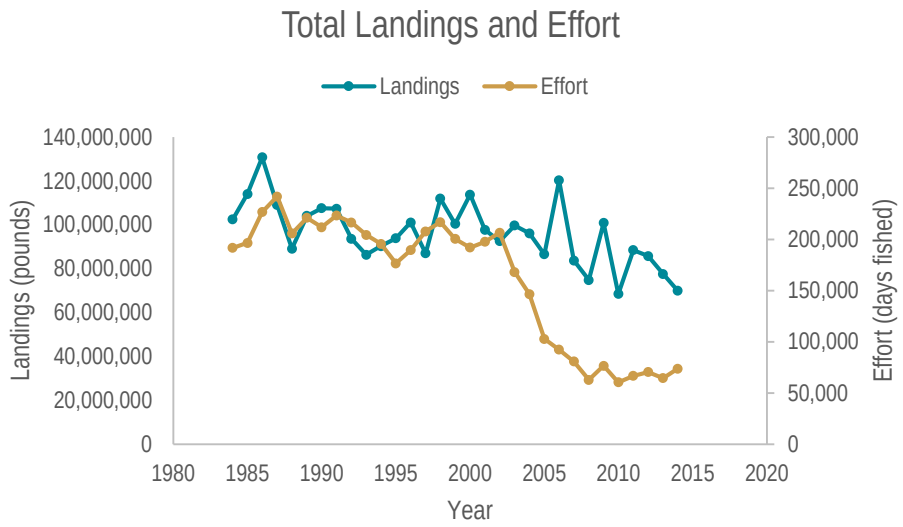


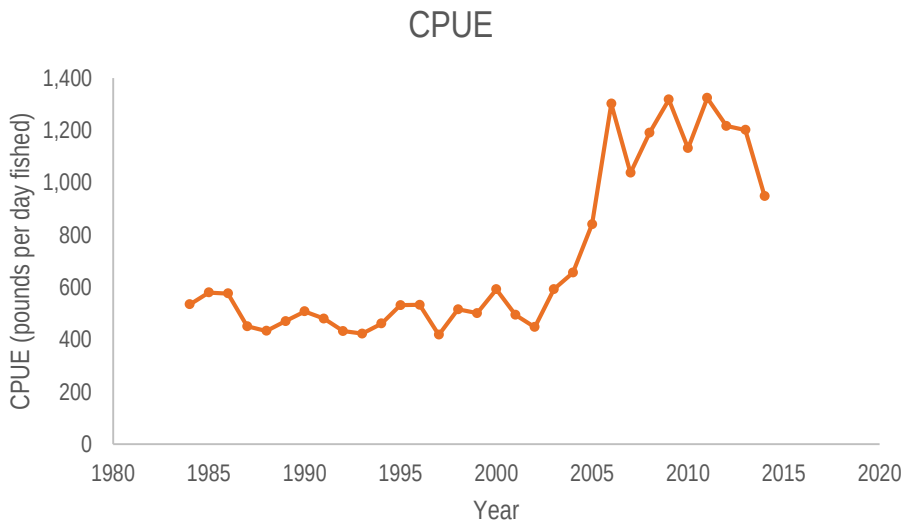
# Distribution of cELB Effort: May–Aug 2015



# Distribution of cELB Effort: Sept–Dec 2015




Total Landings and Effort
Landings
Effort
Landings (pounds)
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
Effort (days fished)
300,000
250,000
200,000
150,000
100,000
50,000
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


CPUE
CPUE (pounds per day fished)
1,400
1,200
1,000
800
600
400
200
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

# Effort Files Provided to Assessment Scientists

## SN_Cell…3-Depths…

Gulf of Mexico Commercial Shrimp Offshore Effort Data
Three Depth Zones

YEAR: 2015
AREA: 1 = Stat zones 1-9, 2 = Stat zones 10-12, 3 = Stat zones 13-17, and 4 = Stat zones 18-21, Gulf of Mexico Statistical Zones
SEASON: 1 = JFMA, 2 = MJJA, 3 = SOND, Months of the Year
FZ: 1 = 0-10 Fathoms, 2 = 11-30 Fathoms, 3= >30 Fathoms, Fathom Zone
Fishing Effort is in 24 hour days fished. For example: effort = 100 days, this would be 24 x 100 days = 2,400 hours fished
Pounds is in shrimp tails, not whole weight
Catch Rate is pounds of shrimp tails harvested per hour

File created December 21, 2016
Created by Rick A. Hart, Ph.D., NMFS Galveston Laboratory

| Year | Area | Season | Fathom Zone | Number of Observations | Catch Rate | Pounds | Fishing Effort |
|---|---|---|---|---|---|---|---|
| 2015 | 1 | 1 | 1 | 57 | 1575.78 | 1499179 | 951.39 |
| 2015 | 1 | 1 | 2 | 272 | 1179.29 | 788281 | 668.44 |
| 2015 | 1 | 1 | 3 | 19 | 1138.77 | 65170 | 57.23 |
| 2015 | 1 | 2 | 1 | 66 | 1350.64 | 1309309 | 969.4 |
| 2015 | 1 | 2 | 2 | 164 | 927.07 | 575235 | 620.49 |
| 2015 | 1 | 2 | 3 | 10 | 1065.78 | 29752 | 27.92 |
| 2015 | 1 | 3 | 1 | 32 | 775.63 | 1574464 | 2029.92 |
| 2015 | 1 | 3 | 2 | 164 | 1491.42 | 454433 | 304.7 |
| 2015 | 1 | 3 | 3 | 9 | 1099.74 | 73507 | 66.84 |
| 2015 | 2 | 1 | 1 | 54 | 891.53 | 90825 | 101.88 |
| 2015 | 2 | 1 | 2 | 135 | 885.64 | 358455 | 404.74 |

# Effort Files Provided to Assessment Scientists

## SN_Cell…2-Depths…

Gulf of Mexico Commercial Shrimp Offshore Effort Data
Two Depth Zones

YEAR: 2015
AREA: 1 = Stat zones 1-9, 2 = Stat zones 10-12, 3 = Stat zones 13-17, and 4 = Stat zones 18-21, Gulf of Mexico Statistical Zones
SEASON: 1 = JFMA, 2 = MJJA, 3 = SOND, Months of the Year
FZ: 1 = 0-10 Fathoms, 2 = >10 Fathoms
Fishing Effort is in 24 hour days fished. For example: effort = 100 days, this would be 24 x 100 days = 2,400 hours fished
Pounds is in shrimp tails, not whole weight
Catch Rate is pounds of shrimp tails harvested per hour

File created December 7, 2016
Created by Rick A. Hart, Ph.D., NMFS Galveston Laboratory

| Year | Area | Season | Fathom Zone | Number of Observations | Catch Rate | Pounds | Fishing Effort |
|---|---|---|---|---|---|---|---|
| 2015 | 1 | 1 | 1 | 57 | 1575.78 | 1499179 | 951.39 |
| 2015 | 1 | 1 | 2 | 291 | 1176.1 | 853451 | 725.66 |
| 2015 | 1 | 2 | 1 | 66 | 1350.64 | 1309309 | 969.4 |
| 2015 | 1 | 2 | 2 | 174 | 933.04 | 604987 | 648.4 |
| 2015 | 1 | 3 | 1 | 32 | 775.63 | 1574464 | 2029.92 |
| 2015 | 1 | 3 | 2 | 173 | 1420.95 | 527940 | 371.54 |
| 2015 | 2 | 1 | 1 | 54 | 891.53 | 90825 | 101.88 |
| 2015 | 2 | 1 | 2 | 235 | 886.03 | 710521 | 801.92 |
| 2015 | 2 | 2 | 1 | 217 | 1531.58 | 1770833 | 1156.21 |
| 2015 | 2 | 2 | 2 | 490 | 1515.83 | 3102067 | 2046.45 |

# SN Pooling Method

SN coded pooling method was selected as preferred method for effort estimation (SEDAR 7, 2004)

The SN Pooling Method is 3 trimesters, 4 subareas, and 2 or 3 depth zone combinations

| | | |
|---|---|---|
| The 3 trimesters are: | | (1) January – April |
| | | (2) May – August |
| | | (3) Sept – December |
| Subareas: | | |
| Statistical zones | | (1) 1 – 9 |
| | | (2) 10 – 12 |
| | | (3) 13 – 17 |
| | | (4) 18 – 21 |
| Depths: | 2 depth method | (1) 0 – 10 fathoms |
| | | (2) > 10 |
| | 3 depth method | (1) 0 – 10 |
| | | (2) 11 – 30 |
| | | (3) >30 |

# Acknowledgements

We thank the following groups/individuals for their significant contributions in making these effort estimates and ELB to cELB transition a success:

- Gulf of Mexico Shrimp Fishing Industry
- Dr. Benny Gallaway, John Cole, and LGL Ecological Research Associates, Inc.
- Gulf of Mexico Fishery Management Council
- Southern Shrimp Alliance – Mr. John Williams
- Gulf and South Atlantic Fisheries Foundation, Inc., – Ms. Judy Jamison
- Gulf of Mexico Commercial Shrimp Fishermen