Testing P-Sea WindPlot for Expanded Sampling of the Fleet for Effort Monitoring in the Gulf of Mexico Shrimp Industry

Final Report

to the Gulf of Mexico Fishery Management Council

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Summary

Due to a variety of technical issues and the need for user input from shrimp vessel captains, this project did not achieve a workable replacement system for the previous 3G cELB (cellular electronic logbook) program to collect and automatically transmit shrimp vessel positions used to estimate shrimping effort in the Gulf of Mexico at a level that meets fishery management mandates.

Background

Monitoring shrimping effort is critical to fishery management for assessing how shrimping activity impacts other species, including calculating takes and interactions with sea turtles and inputting mortality estimates to Red Snapper stock assessments. Continuing effort data is also important to assessing impacts to the shrimping industry and fishing grounds from activities such as aquaculture siting, offshore wind energy development, and placement of artificial reef structures.

Previously, monitoring trawling effort was achieved through a cELB program run by NOAA Fisheries. In this program, the standalone cELB device collected vessel position data at 10-minute intervals by recording latitude/longitude and the associated date/time stamp, by which vessel speed could be calculated. These data were automatically recorded whenever the vessel generators were powered. Vessel speed is indicative of fishing behavior, with shrimp towing activity occurring between 1.9 and 3.8 knots. Speeds above the upper threshold indicate transit/steaming, and speeds below the lower threshold indicate stationary or “on the hook” behavior.

Position and timestamp data were transmitted automatically via Verizon 3G cellular networks to NOAA Fisheries for estimating effort. However, in December 2020, Verizon discontinued 3G service, which disrupted automatic transmission of the cELB units. Vessel position data were still recorded by the cELB units to an extractable SD card, so from December 2020 continuing through the time of this report, position data has had to be retrieved manually. Shrimpers with a cELB are required to return and replace the SD cards in cELB units every six months, with mailouts coordinated by NOAA Fisheries.

Shrimping industry stakeholders suggested that existing navigational software on shrimp boats (primarily dominated by P-Sea WindPlot software) could be used to obtain the same data as recorded by cELBs. Consequently, the Southern Shrimp Alliance (SSA) funded LGL Ecological Research Associates, Inc. to work with the P-Sea WindPlot developer to modify the software to record the same information as the existing cELB program (i.e., location data at 10-minute intervals) in a way that would be compatible with existing software routines and algorithms that use those data to calculate shrimping effort. These modifications were successful, but P-Sea WindPlot was not designed to automatically transfer data. The automatic transfer of

position data (similar to the previous cELB system) was considered by NOAA Fisheries to be an essential component of any effort monitoring system. This project attempted to address that shortcoming of the previously developed P-Sea WindPlot ELB program by developing a mechanism for vessel position data to be securely and automatically transferred to a designated server.

Objectives

In April of 2022, the Gulf of Mexico Fisheries Management Council (GMFMC) funded LGL Ecological Research Associates to conduct work to achieve five objectives:

1. Update P-Sea WindPlot so that it electronically transmits ELB files with the latitude/longitude and date/time in the format used in the cELB program to a specified destination (e.g., server);
2. Develop a mechanism by which computers using P-Sea WindPlot can connect to a mobile communications services network;
3. Conduct initial tests on five commercial shrimp boats from across the Gulf of Mexico;
4. Troubleshoot and revise software/hardware and implementation protocols as necessary;
5. Conduct secondary tests on twenty additional commercial shrimp boats.

Results

Objectives 1 and 2 – Software Update and Connection to Mobile Communications Services Network

P-Sea WindPlot software was updated by the developer to allow for automatic transmission of vessel position data. This entailed the successful addition of an FTP client using Secure Shell (SSH) file transfer to a designated server.

At the start of a new trip, P-Sea WindPlot automatically wrote a file designated by a unique ID based on either the MMSI number for the boat (an AIS designation) or the P-Sea WindPlot Key and the date/time P-Sea WindPlot was started. Every 10 minutes, the date/time and lat/lon were appended to this file. If the computer was connected to the internet, this file was transferred to the designated server every 10 minutes. If the internet connection was lost, data continued to be recorded and upon re-connection with the internet, files were automatically transmitted to the server. File naming conventions and processing ensured that no duplicate files were transmitted to the server.

Initial desktop testing was conducted by LGL to ensure successful performance of the basic demands of the P-Sea WindPlot ELB program. Multiple computers were updated with a series of versions of P-Sea WindPlot (testing iterations 7.28.54 through 7.28.117 and 7.29.51 through

7.29.109). The computers were wired with GPS and left running with P-Sea WindPlot on for several days of "simulated shrimping trips." An internet connection was provided through a mobile hotspot with Verizon, and a server operated by LGL was used as the data repository. Desktop tests successfully simulated logged ELB files that were sent automatically to the LGL server from P-Sea WindPlot upon connection to internet signal. P-Sea WindPlot also continued to log data when the hotspot was out of range and automatically reconnected to the hotspot when in range and transmitted unsent data, seamlessly continuing to transfer data thereafter.

Objective 3

Initial shrimp vessel tests were performed on three vessels out of Bayou La Batre, Alabama, and five vessels out of Palacios, Texas. These initial vessels were chosen based on proximity to trained P-Sea WindPlot installers, which included LGL staff (Palacios) and sub-contractor Jody Esfeller of E&R Marine Electronics (Bayou La Batre). Vessel computers onboard (a mix of desktops and laptops with a variety of Windows versions) were updated with P-Sea WindPlot that had the updated ELB/FTP program. Installations required extensive troubleshooting for a variety of hardware and software issues. There were also some challenges with communicating boat captains in how P-Sea WindPlot needed to be operated (e.g., turning on the hotspot, leaving the program continuously running). Reinstallations of revised software iterations were required on vessels in between trips owing to technical problems during testing.

Over the course of these initial tests, we identified key challenges to using P-Sea WindPlot as an effort monitoring tool for the shrimp fleet. These problems included a variety of technical issues when installing the latest version of P-Sea WindPlot on shrimp captain's computers. For instance, when updating P-Sea WindPlot on some computers the drivers associated with the boat's GPS stopped functioning properly and had to be reinstalled. In other instances, certain versions of Windows that had different levels of being "updated" resulted in incompatibilities with the SSH file transfer program. Sometimes the program would work correctly when we installed it, but then the computer would subsequently "update" after connecting to the internet and quit working later. Other technical issues involved the GPS devices used by some vessels did not correctly decode the date/time from satellite and thus would produce erroneous data on when shrimping effort was occurring (e.g., in one instance on Sept. 2, 2022, a GPS was reporting January 3, 2022; in another instance the year being reported was 2003). Captains also noted other problems during use during their trips, such as the program "freezing" after being on for several days and requiring multiple restarts. Some captains were confused with software glitches and errors to the map range setting (i.e., zoom function) or the boat heading icon that were inadvertently introduced during updates to the ELB/FTP function.

Other problems were related to the fact that P-Sea WindPlot necessarily required captain involvement. We noted that some captains did not want their computer to be "messed with," and some individuals would not allow us to install an update on their personal computer

(though they were comfortable letting us put a new laptop onboard that they would run independently for these tests). We had several instances when captains turned off P-Sea WindPlot during their trip or did not turn on the wireless hotspot. In one instance, when P-Sea WindPlot was used as directed by the captain and data were recorded for nearly 2 months, a significant portion (>60%) was not transmitted to the server owing to due to a "bug" in the FTP component of the software identifying files to send to the server.

Overall, each boat and computer setup created its own unique set of problems that hampered installation, use, and data retrieval.

Objective 4

In response to our findings after this initial testing, we revised our plans for Objective 5. We dedicated significant time to revising P-Sea WindPlot software and conducting desktop testing to try to ensure that an updated version of P-Sea WindPlot would not cause problems for the captains using it and would transmit the data appropriately. We made the following revisions to P-Sea WindPlot:

1. The installer selects the attempted transmission frequency (e.g., daily transmissions when connected to the internet) which aimed to reduce the burden on the computer's memory and minimize problems with P-Sea WindPlot freezing and running slowly.
2. The installer inputs the shrimp boat's permit number as the unique ID for the transmitted files, rather than using the P-Sea WindPlot key number (which would change if the captains traded or used a different key, which we also identified as an issue during initial tests).
3. The file transfer function was revised so that instead of appending records to a single file and uploading that to the server, a new file is written at each 10-minute interval, and all stored files that have not been previously transmitted are sent in batch to the server.
4. The installer selects whether P-Sea WindPlot should record the GPS time or the computer's time, based on whichever is more accurate.

Objective 5

Owing to the need for more extensive troubleshooting and desktop testing of P-Sea WindPlot (which reduced available time to conduct tests) and a major drop in shrimping activity as a result of Hurricane Ian and high fuel prices (which reduced the number of vessels that were planning to go shrimping), only ten tests were conducted onboard shrimping vessels. We targeted the period between Thanksgiving and Christmas to conduct our final set of tests when we would be able to access shrimp boats that had recently come to port. The majority of tests (9/10) were conducted during this window, and a single test was conducted from late October

to mid-December. Summary details are provided in Table 1. Vessel selection was based on our previous interactions with the shrimping industry and identifying participants willing to volunteer for these tests. These tests included nine trips out of Palacios, Texas, and one trip out of Tampa, Florida. For tests, we used P-Sea WindPlot version 7.28 (rather than newer versions of 7.29 or 7.32), as this version was shown to work best in our tests using a variety of Windows versions and was considered most stable/reliable from Mr. Esfeller's experience over the years. For seven out of the ten tests (Tests 3- 9) we used equipment on the vessels (i.e., the captain's laptop or desktop and the vessel's GPS unit) and installed P-SeaWindPlot 7.28.117. For the remaining three tests (Tests 1, 2, 10), we used P-Sea WindPlot version 7.28.116 installed on newly purchased laptops (HP, Windows 11) and with newly purchased GPS units (US Globalsat Bu-353-N USB GPS Receiver). The laptops and GPS were chosen in consultation with Mr. Esfeller as he considered them to be both reliable and commonly used in the shrimping industry. This "older" version of P-Sea WindPlot (7.28.116) was required for use with the Windows 11 computers because desktop testing revealed incompatibilities of the 7.28.117 version of P-sea Windplot's FTP function. In seven of these tests (Test 1-7), a cELB unit was also installed on the vessel and provided a point of comparison. For Test 5, while installing P-Sea WindPlot on the captain's laptop, the cELB unit originally onboard did not appear to be operating correctly, so a new cELB unit was installed alongside it.

As noted above, the main need for P-Sea WindPlot to function for the purpose of effort monitoring is to record latitude and longitude at 10-minute intervals. To quantify the robustness of this aspect of P-Sea WindPlot, we determined the number of data records that were recorded at 10-minute intervals (+/- 30 seconds) in each test. We then divided that value by the number of 10-minute intervals between the start and end of each test. This gave the percentage of data points that were recorded at the specified interval. We calculated these percentages for the records that were transmitted to the LGL server, that we retrieved manually from the vessel computers, and that we retrieved manually from the cELB units (Figure 1A). The reason position data need to be recorded at 10-minute intervals is so that they are compatible with the "effort estimation algorithm" that was developed by LGL and has been subsequently applied by NOAA Fisheries. Thus, we also ran the data obtained through this algorithm to estimate the total number of towing days that occurred in each test (Figure 1B). As described above, this algorithm uses the time and distance between points to estimate vessel speed and thus designate whether the vessel is "steaming" (transiting, moving more quickly than would characterize trawling activity), "on the hook" (anchored or moving more slowly than would characterize trawling activity), or "towing" (moving at intermediate speeds characteristic of trawling). We plotted the positional data on maps indicating these three activities for each test (Figure 2).

Overall, the ten tests conducted indicated substantial problems with P-Sea WindPlot for the purpose of monitoring shrimping effort. In five of the ten tests, no data were transmitted at all. In only one of the ten tests (Test 3), approximately 95% of the data were recorded at the appropriate 10-minute intervals. In comparing transmitted data to the data recorded on the

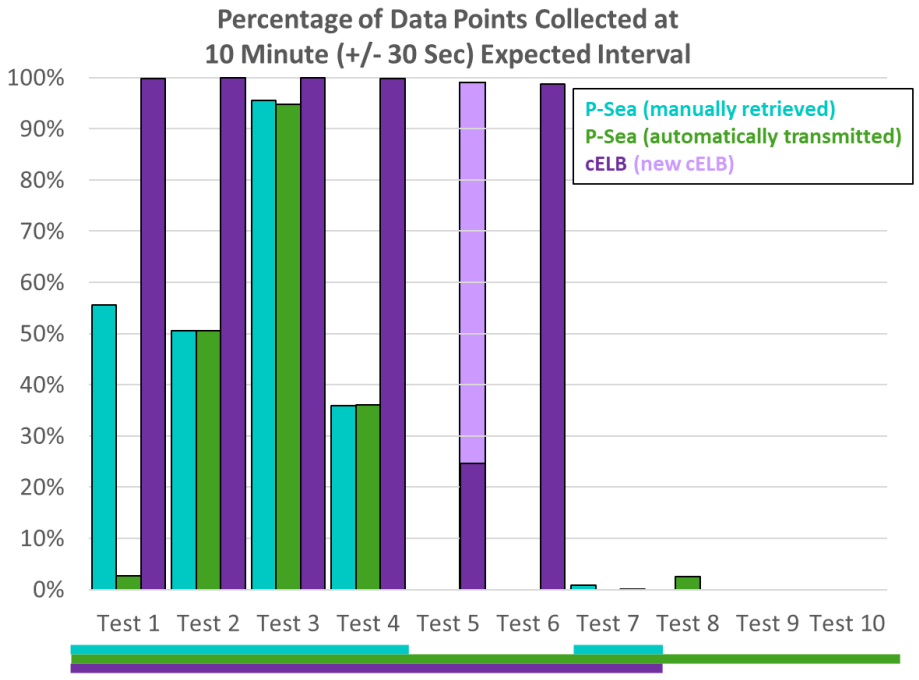
computer hard drive, it appeared that most problems occurred at the data-recording stage. In one test only (Test 1), substantially more data were recorded on the computer (55%) than were transmitted to the LGL server (2.6%). In that instance the problem may have been associated with how the captain operated the cellular hotspot, but this is not an explanation for issues in other tests where data were manually retrieved from computers. In Test 1, much of the recorded data was recorded at sub-10-minute intervals (60 seconds to 480 seconds) which caused problems for towing estimation by the effort algorithm, resulting in long tracks of probable trawling activity being misclassified as steaming (Figure 2).

Table 1. Test logistics, result metrics, and problems encountered for all ten test trips.

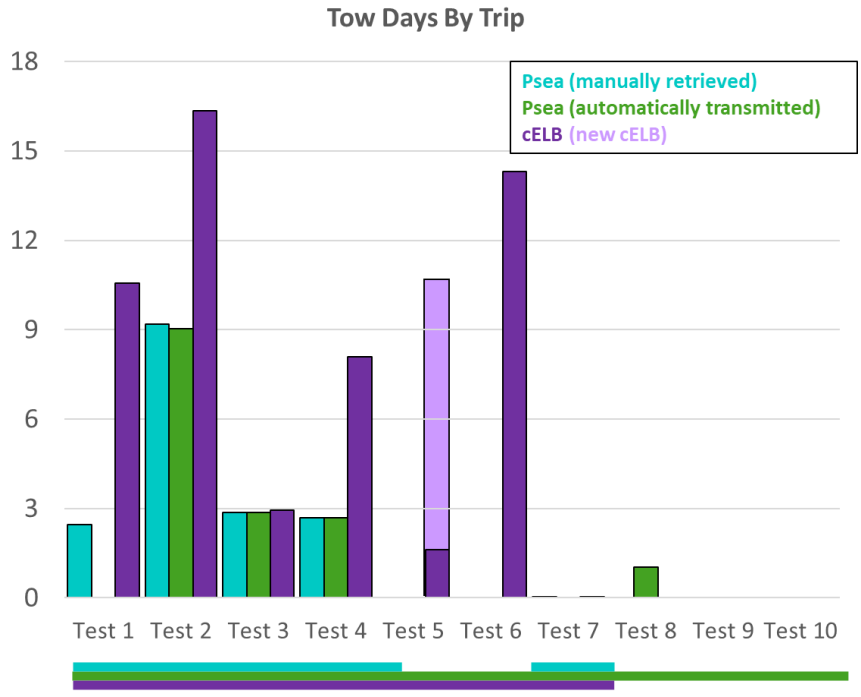
Test #	Dates	Port	P-Sea Details	Data Recorded / Transmitted	Problems Encountered
Test 1	11/30 – 12/19 2022	Palacios, TX	New Laptop/ GPS	55.6% / 2.6%	Failed to transmit after leaving port, erratic recording. Likely Windows 11 incompatibility.
Test 2	11/29 – 12/18 2022	Palacios, TX	New Laptop/ GPS	50.5% / 50.5%	Erratic (on/off) recording and transmission. Likely Windows 11 incompatibility.
Test 3	11/28 – 12/3 2022	Palacios, TX	Captain Desktop /GPS	95.4% / 94.8%	Performed well.
Test 4	12/8 – 12/17 2022	Palacios, TX	Captain Desktop /GPS	36.0% / 36.0%	Psea WindPlot "froze" during trip resulting in captain turning off computer for parts of the trip
Test 5	11/27 – 12/12 2022	Palacios, TX	Captain Laptop/ GPS	-- / 0%	Failed to transmit after leaving port Laptop was old/unreliable
Test 6	11/27 – 12/15 2022	Palacios, TX	Captain Laptop/ GPS	-- / 0%	Failed to transmit after leaving port Laptop was old/unreliable
Test 7	11/27 – 12/16 2022	Palacios, TX	Captain Laptop/ GPS	0.8% / 0%	Failed to transmit after leaving port. Capt. may have primarily used another Psea WindPlot version
Test 8	10/27 – 12/8 2022	Palacios, TX	Captain Desktop /GPS	-- / 2.5%	Scattered transmissions of location. Capt. proficient with Psea WindPlot troubleshooting
Test 9	11/27 – 12/17 2022	Palacios, TX	Captain Laptop/ GPS	-- / 0%	Failed to transmit after leaving port. Unsure why.
Test 10	12/3 – 12/19 2022	Tampa, FL	New Laptop/ GPS	-- / 0%	Failed to transmit after leaving port. Unsure why.

Figure 1. A) Percentage of total data points collected by each method that fell at the expected 10-minute interval within a thirty-second buffer. B) Tow days estimated for each method per trip by running raw data through the LGL effort estimation algorithm. Color bars below graphs indicate which tests should have data present from each method. Manually retrieved P-sea Windplot data were copied from computer hard drives as compared to data automatically transmitted over cellular networks to LGL's server. An additional new cELB (light purple) was installed on the vessel used in Test 5 along with the original cELB (dark purple).

A)



B)



In contrast, of the seven tests using cELB units, five cELBs performed well, with greater than 98% of data recorded at the appropriate 10-minute intervals. However, in Test 5, the original cELB only recorded 24% of the data at the expected 10-minute interval, whereas the new cELB recorded 98.7% of the data, and in Test 7, less than 1% of the data were correctly recorded on the cELB. The purpose of our study was not to investigate the efficacy of cELB units; however, it appeared that erroneous "nonsense" data were being recorded on these dysfunctional units (e.g., latitudes and longitudes that do not correspond to the Gulf of Mexico and dates in the distant past), but such errors may be indicative of faulty GPS antennas. These results do caution that the cELB units may require maintenance or replacement if they are to continue being used for shrimp effort monitoring while a long-term solution is being devised.

In comparing estimates of trawling between P-Sea WindPlot and cELB data, the lack of data recorded in most tests resulted in severe underestimates of effort when compared to functional cELB units. Only in Test 3, a relatively brief trip, did P-Sea WindPlot perform comparably (Figure 1B). The same vessel and captain conducted Trip 4, which occurred several days later. In that case, P-Sea WindPlot froze and was inoperable for a two-day period, which was a considerable problem for navigation during that period. These ten tests indicate that P-Sea WindPlot will not be able to function as an effort monitoring solution for the Gulf of Mexico shrimp fishery.

Conclusions

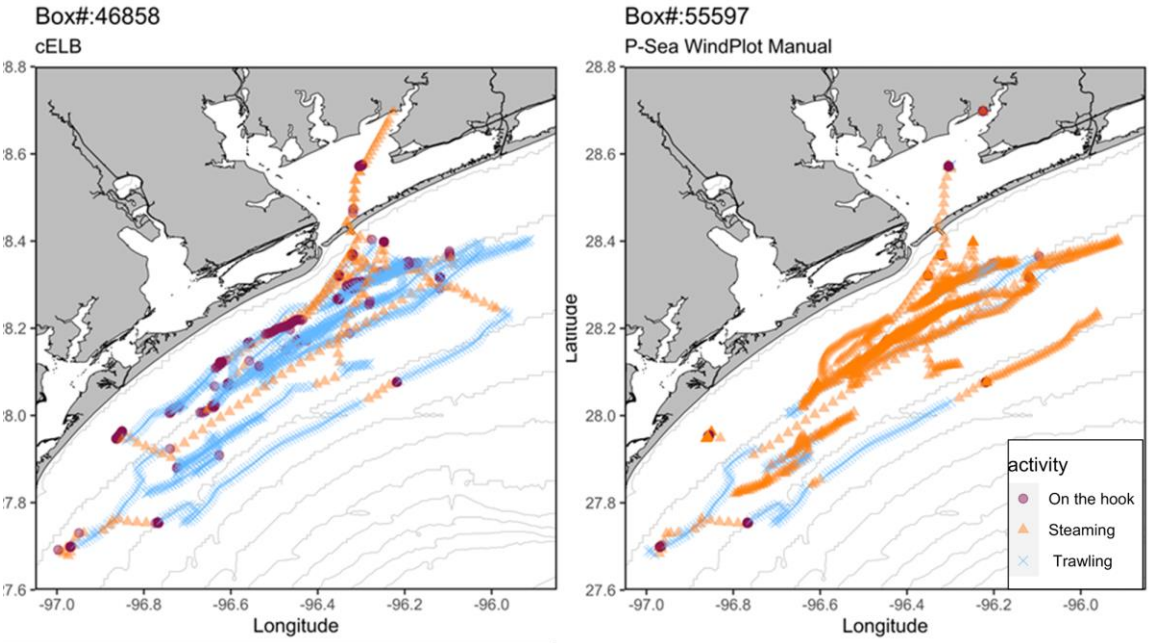
P-Sea WindPlot continues to display a variety of malfunctions despite extensive troubleshooting and revision. There is erratic performance of the software depending on specific vessel hardware/software configurations. Even if software could be sufficiently revised, there is still room for captain introduced error, such as by turning off the computer or failing to turn on the cellular hotspot. Likewise, during the installation process of P-Sea WindPlot updates to onboard computers, we received pushback from several captains who did not wish to have their navigation software modified (of note, these captains were cooperative and amenable to having their position tracked and recorded otherwise).

Based on our extensive testing and efforts working directly with the P-Sea WindPlot developer and one of the most experienced marine technicians in the Gulf of Mexico, we conclude that P-Sea WindPlot cannot perform according to the requirements of the shrimp industry, Council, or NOAA Fisheries and is not able to reliably record and transmit vessel position data as necessary. One of the major problems is the dependency on Windows-based operating systems, which when updated or upgraded to newer versions appeared to introduce a suite of glitches for P-Sea WindPlot software that would consequently require further updating and revision. Many fishers who use P-Sea WindPlot intentionally do not connect their computers to the internet so that Windows updates do not affect P-Sea WindPlot performance. Thus, even having the necessary connection to the internet so data can be transmitted would continue to introduce

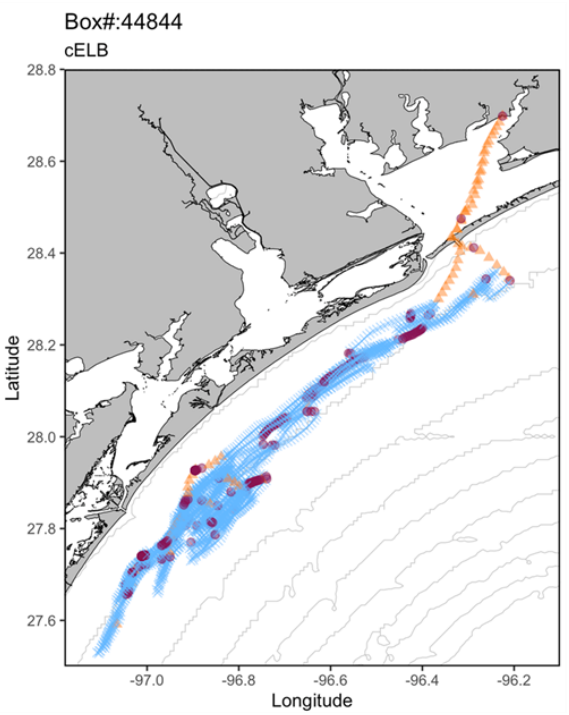
problems to obtaining effort data from P-Sea WindPlot into the future. In short, we do not recommend further investment in P-Sea WindPlot as a method to record shrimp vessel positions for calculating effort. Nonetheless, this is an excellent piece of software for purely navigational purposes, as it was originally designed.

Figure 2. Plots of shrimping activity (i.e., trawling, steaming, or on the hook) as classified by the LGL effort algorithm for Tests 1 - 4 and Test 7, i.e., all test trips that provided both P-Sea Windplot data (right/lower panels) and cELB data (left/upper panels). Trawling = blue X's, steaming = orange triangles, on the hook = maroon circles.

Test 1



Test 2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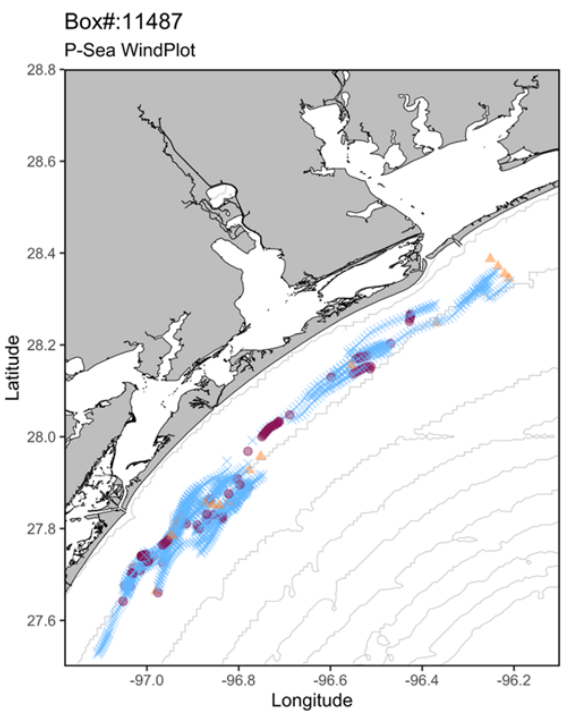
cELB
Latitude
Longitude
28.8
28.6
28.4
28.2
28.0
27.8
27.6
-97.0
-96.8
-96.6
-96.4
-96.2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P-Sea WindPlot
Latitude
Longitude
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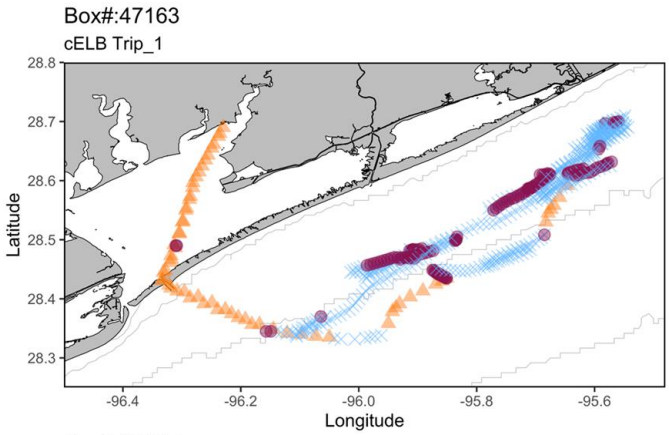
28.6
28.4
28.2
28.0
27.8
27.6
-97.0
-96.8
-96.6
-96.4
-96.2

Test 3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cELB Trip_1
Latitude
Longitude
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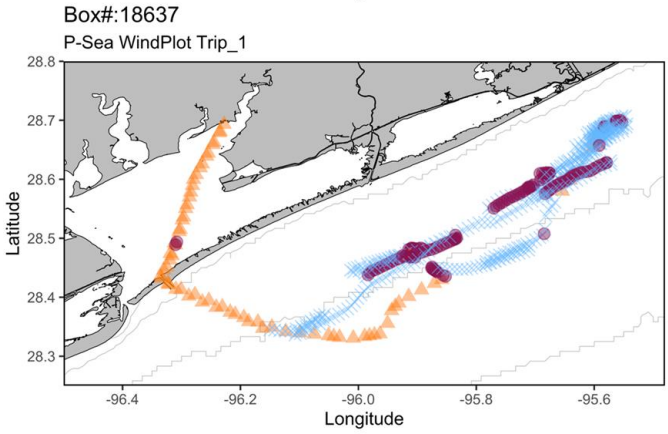
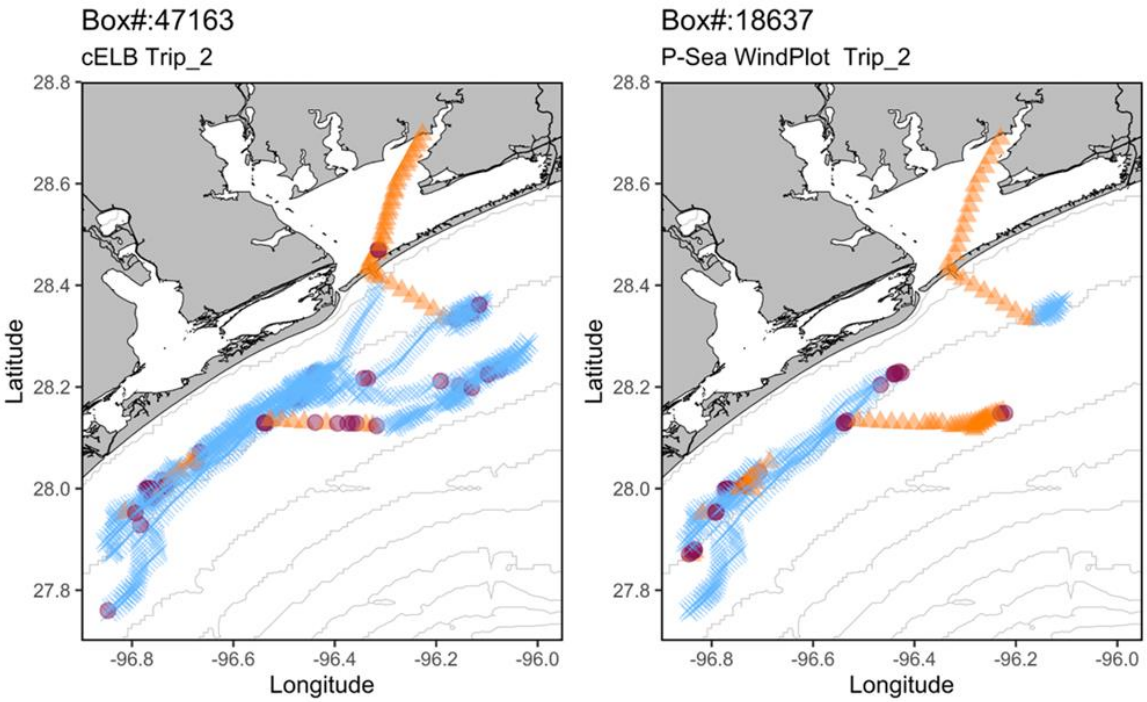
28.7
28.6
28.5
28.4
28.3
-96.4
-96.2
-96.0
-95.8
-95.6


Box#:18637
P-Sea WindPlot Trip_1
Latitude
Longitude
28.8
28.7
28.6
28.5
28.4
28.3
-96.4
-96.2
-96.0
-95.8
-95.6

Test 4


Box#:47163
cELB Trip_2
Box#:18637
P-Sea WindPlot Trip_2
Latitude
Longitude
28.8
28.6
28.4
28.2
28.0
27.8
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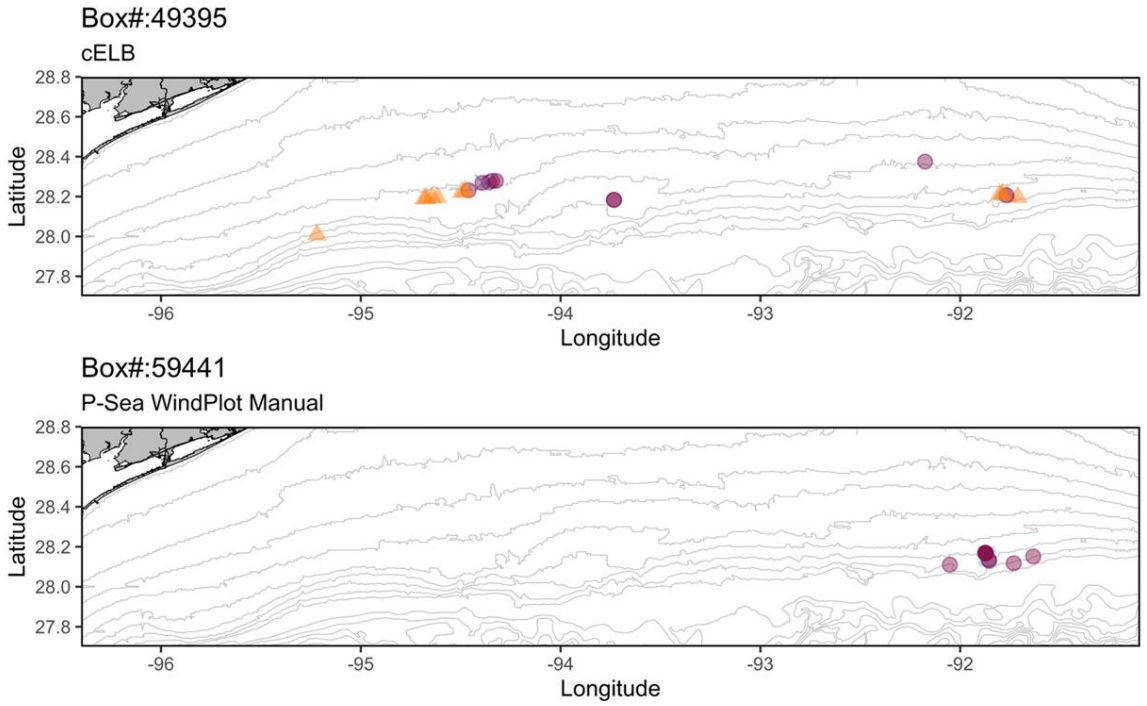
-96.4
-96.2
-96.0

Test 7


Box#:49395
cELB
Box#:59441
P-Sea WindPlot Manual
Latitude
Longitude
28.8
28.6
28.4
28.2
28.0
27.8
-96
-95
-94
-93
-92