Summary of the Gulf of Mexico Shrimp Effort Data Collection

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Gulf of Mexico Effort Data Collection-1960's to present

At the December 7, 2021 meeting of The Gulf of Mexico Fishery Management Council's Shrimp Advisory Panel Meeting, Dr. Jim Nance provided a brief history of effort data collection and estimation methods for the Gulf shrimp fishery. This document is a summary of his notes to the AP and is supplemented based on subsequent discussions, summaries and sources. The discussion here also borrows heavily from Dr. Nance's paper for SEDAR 7 Red Snapper Data Workshop (Nance 2004).

There have been changes over the years in the data collection and estimation methodologies so the history is broken up into distinct time periods.

1960 – late 1990s – Port agent interviews

State and federal port agents historically were stationed at ports around the Gulf of Mexico region. There were port agents in every major port area in the Gulf of Mexico. Among their other duties, these agents interviewed shrimp boat captains on their return to port. There were port agents in every major port area in the Gulf of Mexico. In addition to species composition, landings volume, and effort measures, the data collected included the area fished (statistical subarea(s)) and depth zones (5 fm intervals). These were the "location cells" – i.e. the statistical stratification level at which at which estimates were produced.

Gallaway et al. 2003 sums up the process:

> "Nonrandom interviews are obtained from a sample of the fleet by NMFS port agents to determine monthly estimates of days fished and catches in some 210 statistical area and depth zone combinations. The interview data are used to calculate area-specific data on catch per nominal day fished [CPUE]. Landings data for each trip are obtained from dealers and are allocated to specific statistical areas and depth zones by the port agents, using the best data available or their own judgment. The CPUE values are then used to estimate the total effort for each zone by dividing the total landings that have been allocated to that zone by the sample CPUE. Missing values are imputed by using a general linear model (GLM). The zone values are then summed to obtain total monthly effort, and monthly efforts are summed to provide an annual estimate of shrimp fishing effort."

More details are provided in Nance 2004:

> "Because the fishing trip was the basic sampling unit, the fundamental principle of the data collection procedures was to collect both landings and interview data on a trip-by-trip basis. However, because the number of fishing trips that occur in the Gulf shrimp fishery was so large it was impossible for a record to be made of every fishing trip. Consequently, data collection procedures include two modifications to this principle.

> “The first modification is that the port agents are only required to record landing statistics for fishing trips made by documented vessels (fishing craft registered with the U.S. Coast Guard) that fish nearshore and offshore (seaward of the COLREG line). The port agents may combine the landings statistics and record only monthly totals for the pounds, value and number of trips that are made by boats (state licensed fishing craft) in these nearshore and offshore areas. In contrast, port agents may combine the landings statistics and record only monthly totals for the pounds, value and number of trips that are made by both boats and vessels that fish in inshore areas (inside the COLREG line). Consolidation of data is also used for trips that are made in nearshore and offshore areas, when the vessel that made the trip could not be identified from the dealer's records.”
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> “The second modification is that port agents only conduct interviews from a sample of the vessels that fish nearshore and offshore. The intent of this protocol is to select a few individuals that are representative of the total population and collect information from the sample rather than the entire population. The logistics of fishing, however, make it impossible for the port agents to perform interviews that are selected randomly from the vessel population. Most of the time port agents do not know where and when vessels are going to land, so specific vessels cannot be targeted in advance for selection. As a result, the port agents are instructed to regularly visit the docks in their areas and interview vessel captains as the opportunity arises. If there are more vessels in port than can be interviewed, the agents are instructed to select the vessels by "random" process, in an attempt to avoid systematic bias (i.e., always interviewing the same vessels, at the same port).”
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> “In summary, port agents visit all the shrimp dealers in their assigned area at least once per month, and collect landings statistics for individual fishing trips for all the vessels fishing nearshore and offshore that can be identified. From a sample of these trips, the port agents interview the captain or crew member to collect fishing effort and catch location information. For nearshore and offshore trips made by boats, and inshore trips made by both boats and vessels, the port agents may combine the landings statistics for the trips made each month.”

The unit of effort was taken to be “Days Fished” which was the number of 24-hour periods that the trawls were in the water. So two days of shrimping, each with twelves hours in the water, would be recorded as “One Day Fished”.

Again, from Nance (2004):

> “To estimate fishing effort for each location cell on a monthly basis, there must be two elements of data for each cell: 1) total pounds of shrimp caught by species and, 2) the average catch per unit of effort (CPUE; pounds per twenty-four hours fished) (Nance 1992a). Total pounds caught by species are acquired from commercial seafood dealers

located along the Gulf coast, while CPUE is obtained from interviews with captains from shrimp vessels at the termination of their trip. Although the interview level has no effect on the collection of total pounds data, it does have a direct effect on the estimation of average CPUE. Obviously, the more interviews that port agents can gather during a particular month, the more precise the estimate of average CPUE for that month. During peak shrimp production months greater than 80% of the pounds of shrimp caught have an average CPUE associated with them (Figure 5).

"Monthly effort (days fished) for each location cell is estimated by dividing the monthly shrimp landings from a location cell by the average CPUE during the same time and location combination. To calculate total shrimp effort in a particular location cell, total pounds of shrimp (i.e., all species combined) are divided by the average CPUE calculated from all the interviewed trips within that location cell. For example, the following procedures would be used to calculate total effort for subarea 15, depth zone 3, during the month of July (see Table 1 for data collected from this location cell during July). During July a total of 591,361 lbs of shrimp were caught from this subarea and depth zone (549,331 lbs of species A and 42,030 lbs of species B). Interview data from three vessel captains that fished this location during July were summarized by trip number (Table 1). To estimate the total effort during the month of July from this one location cell, we first calculate the average CPUE; (3,286 lbs + 7,444 lbs + 1,390 lbs) / (5 days + 10 days + 2 days) = 712.9 lbs per day. Divide the total pounds caught in this location (591,361 lbs) by the average CPUE (712.9 lbs per day) to obtain the effort value estimate; 591,361 lbs / 712.9 lbs per day = 829.5 days fished."

For a detailed description of the statistical estimation employed when there are landings reported, but no interviews from which to calculate a CPUE, again see Nance (2004) (p.10-12) and Gallaway et al.(2003).

Nance goes on to discuss the limitations of this method in addition to the scenario where the CPUE must be estimated. The biggest concern was the decrease over time in the temporal and spatial coverage of the port agent interviews, potentially leading to increased bias in the estimation. These concerns led to the desire to develop passive electronic means to estimate effort in the shrimp fishery.

Late 1990s, early 2000s

LGL Ecological Research Associates, in association with the shrimp industry, stated to work with the NMFS Galveston Laboratory to develop an automatic method to collect effort data, referred to as the Electronic logbook (ELB). Note that the system was not designed to collected information normally found on fishery logbooks such as catch. Instead it was designed to be a location recording device, similar to a VMS (vessel monitoring system). The system developed was "home-made" and included an SD card for data storage, a GPS antenna, and an electrical system (AC or DC depending on the vessel). The vessel position data was collected every 10

minutes and stored on the SD card. Periodically the SD card was collected by LGL personnel and a new card was provided and installed in the unit. The program was never intended for real time position detection. It was only used to collect position data used for effort data calculations. The program was funded by a congressional line term to the Southern Shrimp Alliance. The funding was passed to NMFS for the contract with LGL to provide the shrimp effort data.

Effort data calculation

For each month the total pounds from all the interviewed trips in a given location cell was divided by total effort (hours) for all the interviewed trips in that same location cell. This produced an average CPUE for that month and location cell. This average CPUE was divided into the total pounds of shrimp landed from that location cell to get the total effort.

2012-2020: Cellular elb development

The Congressional line item funding ended around 2011 and NMFS became the responsible funding source to continue the program. Uncertainty around funding and responsibility for collecting SD cards, required the development of a new program to collect the shrimp effort data. The type of data collected by the initial ELB program was considered to be excellent, and no changes in the collected data were needed. However, the need was to develop an automated data delivery system, and develop a new ELB that could send the data directly to a computer. NMFS began to look for new ELB and assigned a software engineer at Stennis Laboratory to develop the new ELB unit. A comparable 3G System was in production from Microtech Electronics that was used to track 18-wheel trucks and other commercial vehicles (i.e., ambulances, delivery trucks, etc.). The unit was programmable, and had ability to collect and store GPS locations, and to send the data over the 3G network. The Stennis engineer ordered two units (box, SD card and thumb drive, 3G/EPS antenna, and power units). Initial programming began around 2013. The unit was termed a Cellular Electronic Logbook (cELB) to separate it from the original ELB unit type still being used on the shrimp vessels.

The cELB devices were programmed to collect a GPS location every 10 minutes and store the data as a unit number/date/time/location stamp on the SD card, with a backup on the thumb drive. The device would “look for” a non-roaming cellular tower to send the stored data into NMFS network, and mark the data when successfully sent and received by the computer network. This electronic certificate was needed with the data to allow entry into the NMFS network system. Once developed the cELB system was tested in a moving laboratory vehicle, the NOAA Ship Oregon II, and the NOAA Ship Carretta. Excellent results were observed with regards to speed and location. Six additional units were ordered and placed on six shrimp vessels for testing. NMFS paid the cellular transmission bills for these test units. After a few months of evaluating the units, it seemed the units would work well to collect, store, and send the needed information.

Year-end funding was found to purchase around 800 units (box, extra length GPS/Cellular Antenna, thumb drive, SD Card, DC Power Unit, and AC Power unit). Rugged Pelican Cases were also ordered to help keep the units out of the elements on the shrimp vessels. Once the units came were received in the NMFS Galveston office, 500 shrimp vessels (permits) were randomly selected to carry the system and letters were sent out. Letters contained the method to get cellular coverage for the unit, and instructions on contacting our office. It should be noted that if the vessel had an original ELB, that unit was kept active and comparisons were made between the data collected from the original ELB and the new cELB units. After NMFS was contacted by the vessel personnel, the unit assigned to that vessel was provided with a unique number assigned to that vessel, the programming instruction software was installed, and the unit was tested at the Galveston Laboratory. Prepaid shipping containers were used to send the programmed box, extra length GPS/Cellular Antenna, thumb drive, SD Card, DC Power Unit, AC Power unit, and Pelican case, with installation instructions to the vessel personnel.

Under ELB data collection, the effort estimation method was similar to the previous method but with an additional ELB adjustment (Nance et al. 2008). Over time NMFS settled on using the pooling method as outlined in the Nance 2008 report using what they termed the SN Cell approach. At the Southeast Data Assessment Review (SEDAR 7, 2004) the SN coded pooling method (3 trimesters, 4 subareas, 2 depths) was selected as the preferred pooling methodology for the estimation of shrimp effort in the Gulf of Mexico shrimp fishery (Nance 2004). The SN pooling method is one of many pooling techniques which were initially attempted when shrimp effort estimation methodologies were being developed. The 3 monthly trimesters were January to April, May to August, and September to December; the 4 subareas were statistical subareas 1-9, 10-12, 13-17, and 18-21; while the 2 offshore depths were 0-10 fathoms and > 10 fathoms. By group consensus they chose to use this standard as the pooling technique to combine the shrimp data, with exceptions noted above (state water based on regional regional subareas, and federal waters split into state water boundary to 30 fathoms, and > 30 fathoms). If a port has “random and voluntary ELB sampling coverage”, then “the total pounds for the ports having ELB coverage were distributed to the SN cells based upon the ELB sample distribution, and these values replaced the original estimates.” “ELB effort and catch rate data were also used to adjust the denominator values of the SN cells [i.e., the CPUE] fished by fleets determined to have complete ELB coverage.”

2020-present: Back to the past: the end of the 3G network

In December of 2020 the 3G cellular network ceased to operate. While there had been some testing of replacement 4G units, these were not deemed to be a suitable replacement at the time. Thus, the data collection process reverted to the pre-3G period model, but instead of having staff remove and replace the SD cards, the vessel operators were sent replacement cards by mail and asked to do the switch themselves, and return the SD cards to NMFS. This is still the process in place as NMFS and the GMFMC continue to discuss new methods to collect effort data. The data collected provide the input to the updated effort estimation method developed by the SEFSC (“The Dettloff Method”), as described in Dettloff (2023).

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