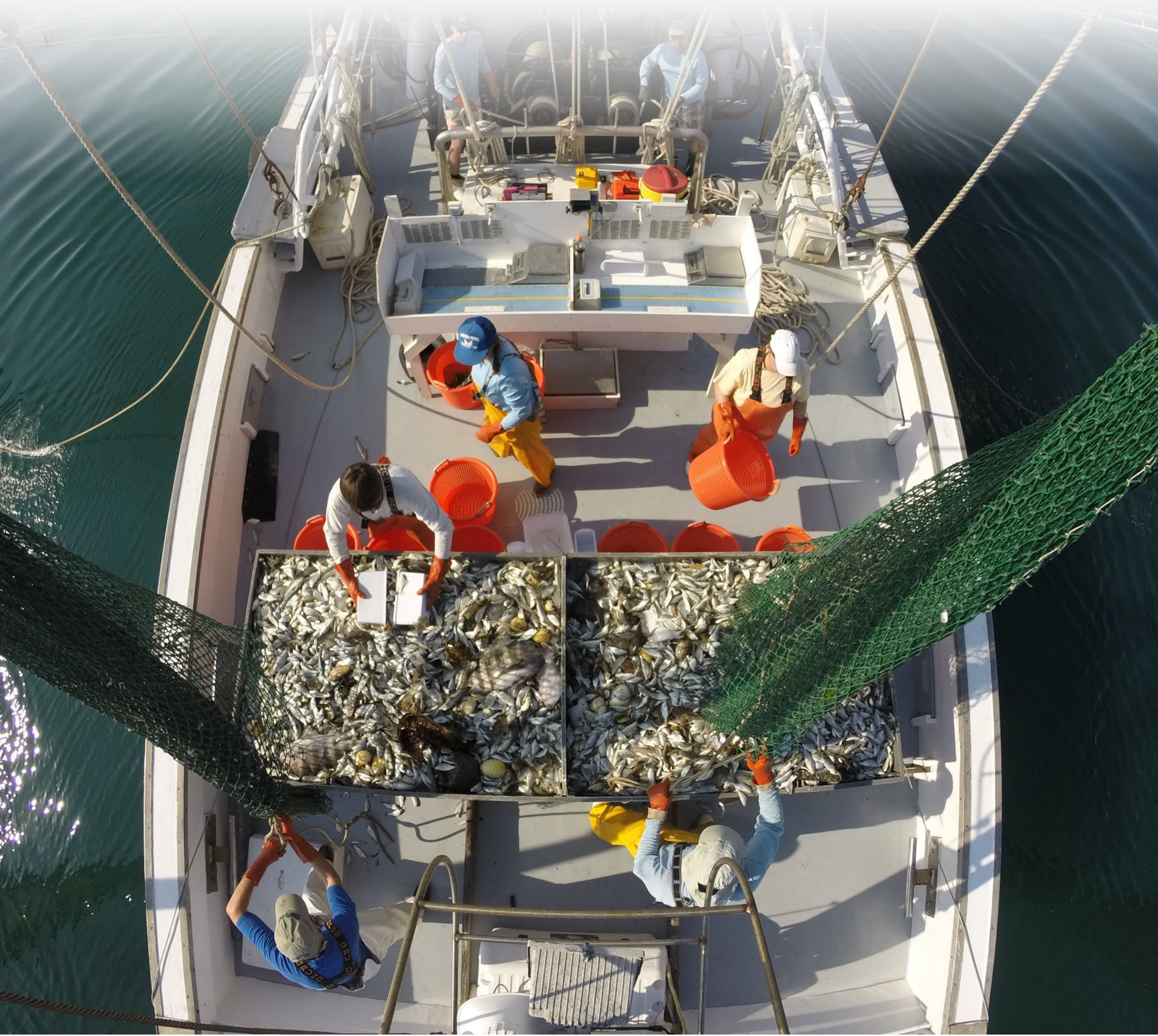
The NEAMAP and SEAMAP

Guide to Vessel and Gear Change and Calibrations



The Northeast Area Monitoring and Assessment Program (NEAMAP) &
Southeast Area Monitoring Program and Assessment Program (SEAMAP)

Guide to Vessel and Gear Change and Calibrations

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Contents

Introduction

Fisheries-independent survey programs aim to provide data to stock assessment scientists and fisheries managers to better evaluate and understand the current state of fisheries stocks to create well-informed management decisions. The Northeast Area Monitoring Program (NEAMAP) and the Southeast Area Monitoring Program (SEAMAP) are two groups of fishery-independent surveys with a focus on eastern U.S. coastal waters. Both groups run surveys that provide time series data for economically and socially important recreational and commercial fisheries species.

The equipment for these surveys require constant upkeep to provide accurate data. Calibration studies are necessary when changing a vessel or net in order to avoid impacting the time series or providing inaccurate data to scientists and managers. These calibration studies often require paired-tows—a system where two vessels are run simultaneously using the same methods to collect target species. From there, analysis can be run on the catch data to establish calibration factors for each species. This method is costly and can sometimes be avoided through the use of modeling simulations, but both require time and effort.

From January 16-18, 2024, the Atlantic States Marine Fisheries Commission ran an online vessel and gear calibration workshop to bring together survey leads from NEAMAP and SEAMAP to discuss common issues agencies encounter when changing a vessel or gear for their bottom trawl surveys. This workshop was open to fishery-independent survey leads, fisheries scientists, and stock assessment scientists from across the U.S and Canada, with the aim of better understanding how to tackle problems that can arise when changing survey vessels or gear. Attendees included representatives from the Alaska Fisheries Science Center, the Southeast Fisheries Science Center, the Northeast Fisheries Science Center, and the Memorial University of Newfoundland. The workshop was split into three categories: Vessel changes and outages, gear changes, and statistical methods in calibrations.

This document aims to summarize workshop presentations and outline best practices and guidance identified during discussions.

Vessel Changes & Outages

Bigelow Albatross Calibrations: Lessons for Consistent Trawl Survey Operations

By Russell Brown (summarized by Jainita Patel)
NOAA Fisheries Northeast Fisheries Science Center

The goal of trawl surveys is to maintain consistency in methodology and sampling performance through time to produce accurate and comparable data. In this, there are factors within the control of those running the survey (proper rigging and setting out, standardized deployment and retrieval procedures, and control of vessel speed), and factors outside of control (inherent vessel characteristics, currents, sea state, and vessel motion). Based on these factors, the Bigelow-Albatross IV transition was conducted in three phases: vessel design characteristics, trawl sampling gear design, and trawling operational protocols.

Compromise occurred in vessel design since this FSV-40 vessel needed to fulfill requirements for multiple NOAA regions including the western Pacific Ocean, western Pacific coast including Alaska, the Gulf of Mexico and the Atlantic coast. When designing the Bigelow, vessel size and acoustic quieting were taken into consideration as vessels are likely to affect the behavior of fish before they encounter the sampling gear. All vessels create both a pressure wave and sound that can impact fish behavior by influencing depth distribution or encouraging sideways movement away from the vessel path. This effect is more likely pronounced in shallow water or when using a larger vessel. For gear design considerations, the aim was to have gear that was simple to build and maintain that would still optimize catchability across a range of species and was easy to standardize, handle and repair on the vessel.

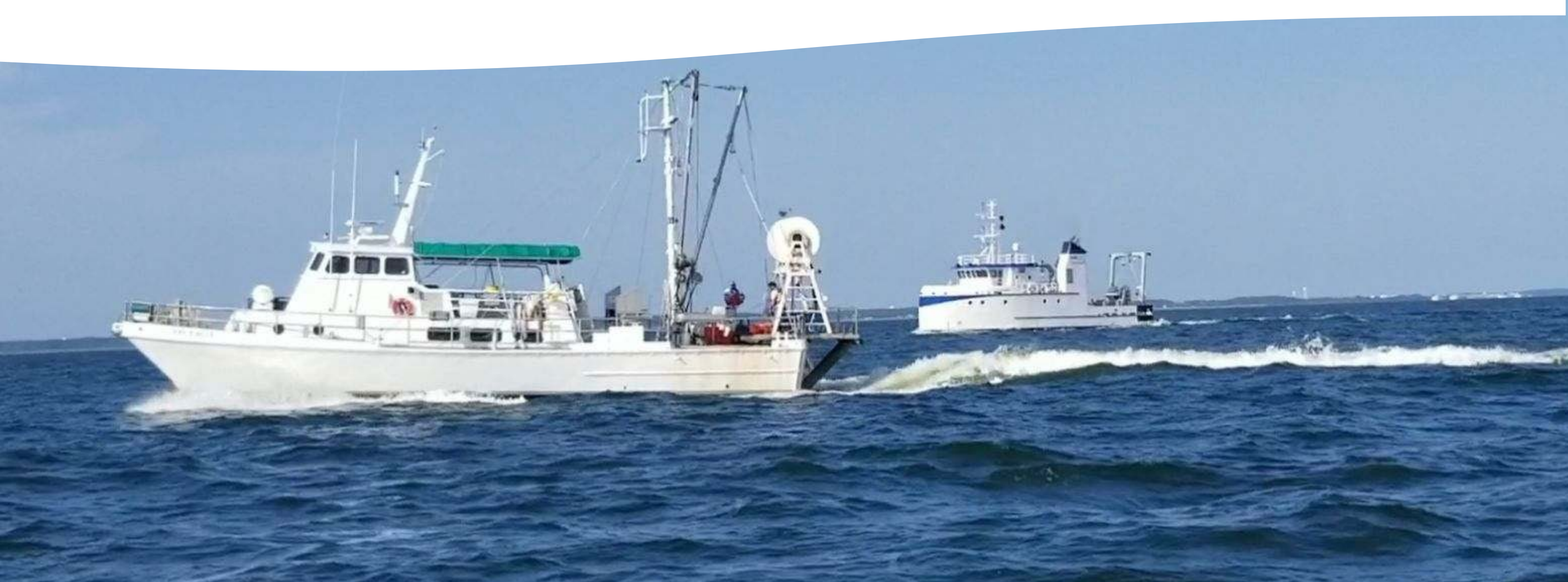
For the trawl operational protocols, the three areas of focus during this transition were the correct rigging, setting and hauling procedures, and towing procedures. To ensure correct rigging, photo documentation and clear gear diagrams are essential for transitioning to and maintaining standardization of new trawling gear. In terms of setting and hauling procedures, even the simplest change can impact the catchability of the survey. When rigging gear, ensuring correct bridle hookups, checking that the door backstraps are not twisted, ensuring correct door settings, and checking that there are no missing gear components are all essential steps for gear standardization. The scope/wire out is important because the weight and distance of the trawl warp in front of the doors affects door spread, wing spread, headrope height, sweep bottom contact, and overall trawl stability. Timing of setting and hauling can be impacted by winch speed, vessel speed, scope/wire out/depth, and operator behavior. Variability in setting and hauling can impact fishing in the water column, gear settling and lift-off times, and catch escapement or washing out of the net. After learning about the importance of bottom contact time and the timing of winch locking with the Albatross, new protocols were developed to standardize bottom fishing time with the Bigelow, where tow start time is based on the lead fishermen interpretation of net mensuration information. In the case of the FSV Bigelow, the vessel and winches are able to produce sufficient speed to lift the net from the bottom consistently at the end of the tow. Standardization of effective tow time became even more critical with target tow time being reduced from 30 minutes (R/V Albatross IV) to 20 minutes (FSV Bigelow).

Towing speed is also important because speed cannot be optimized for all species in a multi-species survey. Higher speeds can result in increased door and wing spread, reduced headrope height, and the amount of bottom contact time by the ground gear. Higher speeds can also reduce catchability of sedentary demersal species and increase the catchability of fast-swimming species. Lower speeds may result in the opposite. To take this into consideration, researchers chose to calibrate based on speed over ground since it was easier to standardize and it accounts for sensor lag time (which makes it difficult to get an accurate representation of speed through water). Distance over ground is likely a better basis for standardization of catchability of bottom oriented species, but may introduce variability (vs. speed through the water or water volume sampled) for pelagic species.

Switching Gears in Multispecies Fisheries Surveys: Calibration Trials & Tribulations*

By Troy Tuckey
Virginia Institute of Marine Science

The VIMS Juvenile Fish Trawl Survey, which has been in operation since 1955, has undergone considerable changes to the sampling gear, location of sampling sites, and methodology used to select sampling sites. Recently, a new vessel, the R/V Tidewater, replaced the R/V Fish Hawk, which had been in service for 25 years. In addition to the change in vessel, a new net was used; this net design is more robust to deployment methods and performs more consistently under varying environmental conditions. Therefore, a calibration study was conducted whereby the two research vessels with different nets fished in the same area at the same time. This calibration study provides an estimate of the species-specific factors necessary to 'convert' the R/V Tidewater catches to those of the R/V Fish Hawk, taking into account the combination of vessel and net. All other protocols (tow duration, scope, vessel speed, and sample processing) remained unchanged. Comparison sampling with the R/V Tidewater and the R/V Fish Hawk began in April 2014 and concluded in May 2015;



additional paired tows were completed in August 2016 to provide sufficient samples for scup, black sea bass, and adult summer flounder. Researchers completed a total of 1,141 paired tows during 97 days-at-sea, capturing a total of 327,526 fishes, crabs, and shrimp aboard the R/V Fish Hawk and 323,580 fishes, crabs, and shrimp aboard the R/V Tidewater. From these data, calibration factors were developed for 41 species groups (species-age or species-size combinations). Calibration factors were estimated from the best-fitting model among four candidate models that accounted for variability in catches between the two vessels. In addition, species composition of the catches from the paired tows were examined using multivariate analysis and it was found that catches from the two vessels were similar in all months and strata except for shallow stations in Chesapeake Bay. The 'whole survey' approach allowed scientists to estimate calibration factors for species in all available habitats that are routinely monitored by the VIMS Juvenile Fish Trawl Survey. Further, consideration of depth, tidal currents, tow direction, water clarity, tow distance, and salinity in the calibration models ensures estimates are applicable across the range of estuarine characteristics inhabited by these species. The estimated calibration factors will be applied to catches of the R/V Tidewater at the individual-tow level; relative abundance indices will be estimated using the random-stratified survey design in effect since 1988, thus preserving the integrity of the long-term survey data for estimating relative abundance of juvenile fishes and blue crabs in Chesapeake Bay.

* Presentation and summary based on:
Fabrizio, M. C., & Tuckey, T. D. (2016). Calibration of VIMS Research Vessel Catch Data To Ensure Continuity of Recruitment Indices for the Chesapeake Bay Region.

VIMS Vessel Calibration

By Jameson Gregg
Virginia Institute of Marine Science

The Virginia Institute of Marine Science (VIMS) and the Multispecies Research Group (MRG) have been involved in several gear and vessel calibrations efforts. While specific survey gear and the vessels operating those gear are heavily linked, aspects of each portion of the calibrations can be discussed separately. Many vessel calibrations can be planned if the existing vessel and the new vessel are both available at the same time. Logistically speaking, operation of two full survey vessels occupies a significant number of resources, including communication, time, personnel, and available budget. The MRG was able to prepare for the vessel calibration during the transition from the old survey vessel, the 65' *R/V Bay Eagle* to the new 93' *R/V Virginia* used for the Chesapeake Bay Multispecies Monitoring and Assessment Program Trawl Survey (ChesMMAP). VIMS needed a new research vessel due to the age of the R/V Bay Eagle. The MRG had the benefit of being involved in planning the construction of the new research vessel and was able to provide many details, suggestions and requests. MRG staff performed a significant amount of research and "homework" on other research vessels and commercial fishing vessels and applied these findings to the new research vessel plans. All throughout this lengthy vessel planning stage, the MRG discussed additional potential survey changes such as restratification due to the size of the new vessel, sampling frequency, and overall operational costs of the vessel. Prior to the new vessel discussion at VIMS, the MRG was already exploring new gear options, and a package similar to the efficient gear package used on its Southern New England/Mid-Atlantic portion of the Northeast Area Monitoring and Assessment Program (NEAMAP). A half size version of the NEAMAP net was configured to assist in the standardization of gear packages to be able to provide more robust sampling in Chesapeake Bay. The MRG decided the best path forward for the vessel and gear calibration would be to perform paired tows between the *R/V Bay Eagle* and the old ChesMMAP gear and the *R/V Virginia* and the new gear (Miller 2013). Once the *R/V Virginia* was delivered to VIMS, dedicated days were scheduled to test and fish the new ChesMMAP 200x12cm gear package. During the tests and trials, only minimal adjustments were required to hone the optimal net geometry on the new research vessel. A total of 516 paired tows were performed between the vessels across a two-year period. All calibration tows were conducted separately as not to bias normal ChesMMAP survey operations (Lewy et al 2014 and Brown et al 2007). Calibration coefficients using the *log-Gaussian-Cox* model (Thygesen et al 2019) would be later calculated between the two vessels to be applied on a species level.

Additionally, the MRG participated in a subcontract experiment from the Northeast Trawl Advisory Panel (NTAP) sponsored through NOAA's Cooperative Research Branch for the use of a restrictor rope between the trawl doors to maintain optimal geometry of the fishing net. Optimal net geometry is monitored by a net mensuration system throughout active fishing or survey trawls. The *F/V Darana R*, which is contracted for the VIMS SNE/MA NEAMAP survey, and the standard NEAMAP gear package, were used to perform duplicate tows using an A-B/B-A method at stations with and without the restrictor rope. A total of 36 paired tows were completed across spring and fall sessions separate from the regular NEAMAP survey sampling. The experiment proved to be effective and the impact of using of the restrictor was insignificant on the gear's catchability. This experiment will soon have its own white paper for other surveys to reference when potentially encountering vessel or trawl door changes to maintain their consistent net geometry.

Challenges to Long-term Continuity of SEAMAP-SA Surveys

By Tracey Smart
South Carolina Department of Natural Resources

SEAMAP-SA has been conducting standardized, fishery-independent surveys off the U.S. Southeast Atlantic coast since 1986. Two of the oldest surveys, the Coastal Trawl Survey (CTS) and the Southeast Reef Fish Survey (SERFS, also funded through MARMAP and SEFIS), have faced similar issues with their longevity. The primary challenges to continuity of activities and data are funding, weather, vessels, and management needs. Each survey has undergone both highs and lows with available funding, with many years of stagnant funding and increased costs in the last decade, meaning that data streams such as life history are often cut to increase time efficiency at sea. As the oceans have warmed, the southeast has also experienced increasingly challenging weather, both day-to-day conditions and the frequency and intensity of tropical systems. These both mean lost sea days and unfinished sampling plans as sampling seasons and schedules are set well ahead of actual sampling. For SERFS, a change in vessel is less problematic because their primary fishing gears are fixed (not attached to the vessel). However, vessels may vary in their sampling capabilities, locations of depth sounders and GPS units, and reliability, all of which add variation into these long-term data series. CTS will change vessels in 2024, meaning a change in trawl gear. Researchers were unable to identify funding or personnel to conduct true vessel/gear calibrations, and so are relying on net mensuration measurements and designing the new gear as best as possible to mimic the quintessential elements of the old gear. Both surveys have ultimately relied on data standardization to cope with many of these challenges or specific analyses to provide context to changes that were unavoidable.

Outages on the North Carolina Pamlico Sound Trawl Survey

By Daniel Zapf
North Carolina Division of Marine Fisheries

The North Carolina Division of Marine Fisheries (NCDMF) Pamlico Sound Trawl Survey has been conducted over two-weeks in June and September since 1987. Sampling occurs in Pamlico Sound and adjacent tributaries at 54 randomly selected stations spread across seven strata based upon depth and geographic location. Sampling takes place aboard the NCDMF owned R/V Carolina Coast, a 44 ft. fiberglass hulled double rigged trawler. At each station, double rigged 30 ft. mongoose-type Falcon trawls are towed for 20 minutes at 2.5 knots. The vessel crew includes a dedicated captain and first mate and three scientific staff.

Completion of the survey can be time consuming due to the scale of the sampling area, vessel limitations, and the significant weather impacts that can occur. Under ideal conditions, the survey can be completed in around six field days, but more often sampling takes a full two weeks or more. While delays have not been frequent, they do occur primarily because of poor weather, mechanical issues, and less frequently, because of crew shortages.

Despite delays, sampling targets have been maintained primarily due to adaptability of survey staff and availability of replacement staff. Recent issues with turnover in the captain position have highlighted a vulnerability in survey operations and the importance of having experienced staff in this role. While scientific staff is more readily available and there is a large pool of NCDMF staff that have been cross trained in scientific operations of the survey, the captain role is more specialized, requiring unique skills that make it difficult to cross train staff. Recently, efforts have been made to account for potential delays during the scheduling process, and adjustments have been made to front load some survey preparations so when conditions are favorable field days can occur as scheduled.

To account for survey deviations or delays, NCDMF survey staff have maintained detailed program documentation and meta data detailing survey timing, reason for delays, or any other changes to normal survey operations (e.g., incomplete sampling in 2020 and 2021 due to COVID restrictions). Survey staff have provided guidance to data users about how to evaluate data when faced with deviations but have deferred decisions about inclusion of data in stock assessments to stock assessment sub-committees.

Gear Changes

VIMS Trawl and Gear Calibration

By Jameson Gregg
Virginia Institute of Marine Science

The Virginia Institute of Marine Science (VIMS) and the Multispecies Research Group (MRG) have been involved in several efforts surrounding gear and vessel calibrations. While specific survey gear and the vessels operating those gear are heavily linked, aspects of each portion of the calibrations can be discussed separately. The MRG was able to prepare for the change in fishing gear calibration for their Chesapeake Bay Multispecies Monitoring and Assessment Program Trawl Survey (ChesMMAP) from the old survey trawl net (shrimp net) and vee trawl doors. Due to the consistency in catches and gear geometry of the NEAMAP trawl gear, discussions started in 2009 with net manufacturers and commercial fishers to see if a smaller version of the NEAMAP gear could be implemented for the ChesMMAP survey in the Chesapeake Bay (Johnson and McCay, 2012). This resulted in a 4-seam, 3-bridle bottom trawl, 11.2m headline, 24m fishing circle and a 3.8cm rubber disk sweep, essentially one-half the size (200x12cm) of the NEAMAP net (400x12cm). A 1:6 scale model was built and tested in the flume tank at Memorial University in St. John's Newfoundland, CA in 2010 (Winger et al. 2010). In 2010 and 2011 the new net was field tested on the *R/V Bay Eagle*. Tests confirmed an estimated one-half geometry to the NEAMAP net with a greater diversity of taxa and broader size ranges. While this new gear provided larger more diverse catches, many modifications would be required to the *R/V Bay Eagle* to implement the new gear for full ChesMMAP survey use. Required changes and modifications were as follows: Dual winches for practical and efficient hauling of the trawl doors, additional workstations to process larger catches, a larger net drum to accommodate the larger fishing gear, and a way to efficiently accommodate both the new gear and the old gear for comparisons/calibrations. Upon additional networking through trawl net and door manufacturers and commercial fishermen, it was determined a smaller 44" Type IV Thyboron trawl door would be best suited for the 200x12cm net. In late 2011, discussions started for the construction of a new state-of-the-art research vessel at VIMS. The decision was made to wait to switch both the survey gear and vessel at the same time rather than performing two rounds of calibrations for first the net then the vessel. The MRG decided the best path forward for the vessel and gear calibration would be to perform paired tows between the *R/V Bay Eagle* and the old ChesMMAP gear and the *R/V Virginia* and the new gear (Miller 2013). Once the *R/V Virginia* was delivered to VIMS, dedicated days were scheduled to test and fish the new ChesMMAP 200x12cm gear package. During the tests and trials, only minimal adjustments were required to hone the optimal net geometry on the new research vessel. A total of 516 paired tows were performed between the vessels across a two-year period. All calibration tows were conducted separately as not to bias normal ChesMMAP survey operations (Lewy et al 2014 and Brown et al 2007). Calibration coefficients using the *log-Gaussian-Cox* model (Thygesen et al 2019) would later be calculated between the two vessels to be applied on a species level.

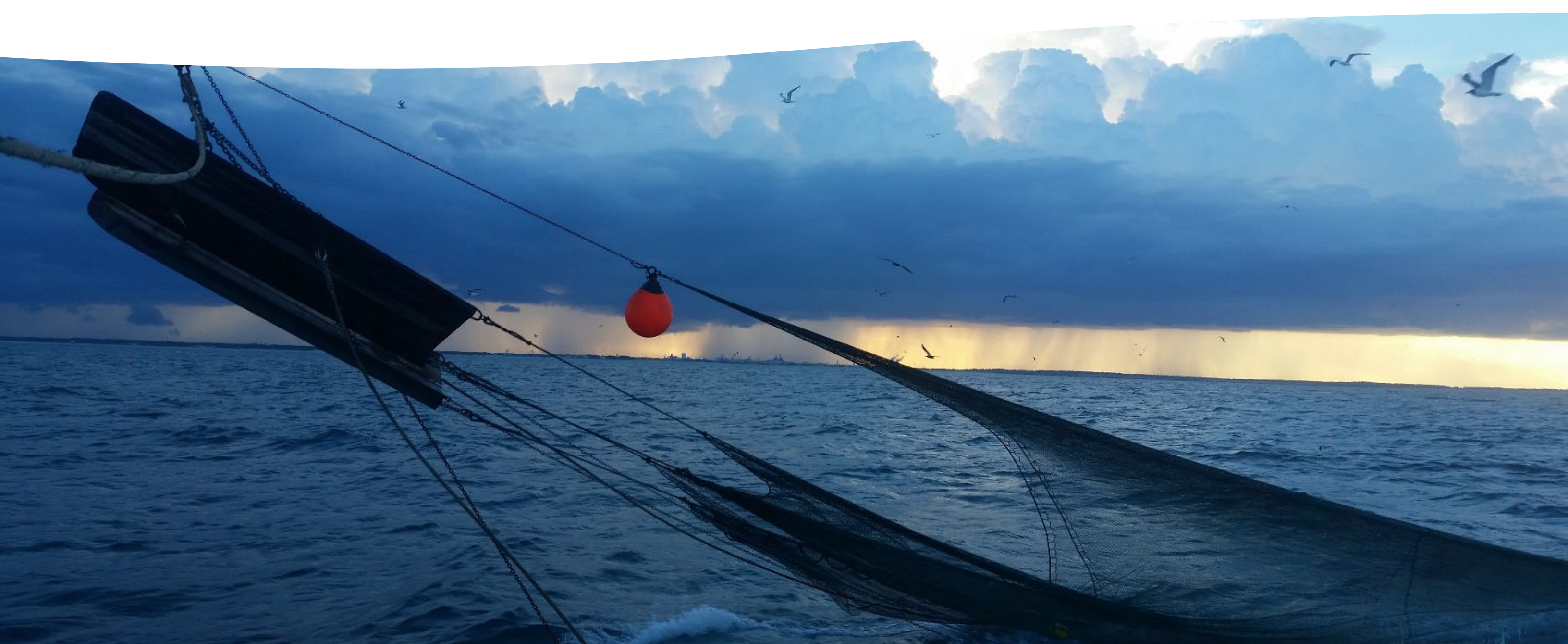
Survey Modernization and Bering Sea Survey Gear Calibration

By Stan Kotwicki
NOAA Alaska Fisheries Science Center

Surveys are the foundation of modern fisheries management and ecosystem research, providing consistent time series of data for use in stock assessments. Standardization of survey operations is the key to consistency, but all surveys experience unavoidable and necessary change as a result of logistics, equipment, or environmental forces. In the Bering Sea, there are 3 surveys necessary to assess the fish and crab stocks (Eastern Bering Sea, Northern Bering Sea, and Slope); however, in recent years only 2 of the surveys have been conducted due to lack of funding for the Slope survey. Fish frequently move among the 3 areas, so it is important to merge the 3 surveys into 1 survey, which can be done in 1 swath over the entire region, to avoid bias that can arise from migrations. The goal of survey modernization is to combine the 3 surveys and increase survey efficiency by implementing new gear and fishing methods, developing new stratification, and optimizing effort allocation. A new survey design will also allow for flexibility in effort allocation with respect to the data needs and incremental adaptation of new technologies as they become available for surveys (e.g. use of cameras, eDNA, etc.). However, adaptation to new technologies and changes in survey design and methodology require money, time, people, good planning, knowledge from experts, engagement from stakeholders, testing, and a transition period.

There are a few necessary steps when designing a new survey and transitioning from an old time series to a new one. For the Bering Sea surveys, 6 milestones were identified: (1) investigating optimal survey design through simulation models, (2) deriving selectivity correction factors using side-by-side calibration tows, (3) deriving calibration factors for slope/shelf surveys, (4) designing and building new bottom trawl gear, (5) calibrating new survey gear, and (6) creating a survey time series calibration, design, and transition plan.

The primary goal in designing new gear for the survey is to assure consistency in trawl performance across time and space, within and between tows. Trawl performance measures that can be used in the assessment of new



gear are: mean and variance of door spread, wing spread, headrope height, footrope/bridle distance off bottom. The data for estimation of performance metrics can be obtained using spread, height, and bottom contact sensors. Bottom contact sensors can be attached to different parts of the footrope and bridles to measure footrope distance off bottom and net symmetry.

Ideally, new gear should be cost-effective and built with accessible materials for optimal serviceability. The AFSC aims to create a gear type that can be used across multi-species surveys in different regions. Currently, the nets used for AFSC surveys are standardized and certified, but there is variability in trawl performance between individual nets, and this is especially apparent when comparing newer vs. older nets. Nets tend to exhibit improved bottom contact as they age. Differences in performance are often attributed to vessel effects, but this variability can often be attributed to captain and net differences, especially when the vessels are similar in size.

The new survey gear designed for Alaska groundfish surveys should have the following qualities: (1) ability to swap footropes for use on different bottom types, (2) simple design to aid in faster repair times at sea to reduce survey down time, (3) constructed of materials easily obtained and of modern standards, (4) trawl must meet web size requirements to insure the retention of 4-5 cm *Chionoecetes* spp. and other similarly-sized benthic macroinvertebrate species, (5) headrope requirements of an average of 5-6 meters height opening to reduce variability in escapement, (6) a maintained average of 15-20 meters width from wing tip to wing tip at optimal angle of attack of 18-21 degrees for the trawl to assure optimal fishing efficiency, and (7) consistent performance across variable bottom types, current conditions, and depths.

We hope to start gear calibrations in 2026. It is likely going to be impossible to obtain good quality catchability and selectivity calibration factors for all species and sizes that the surveys target. Given this reality, it is important to establish a goal for desirable quality (precision) for calibration factors. It is also important to determine ahead of time how the transition between the old and new survey will be conducted. These goals can be achieved using modeling simulations of the stock assessment outcomes under potential transition options from the old to new survey.

A Hierarchical Model of the Relative Efficiency of Two Trawl Survey Protocols*

By Noel Cadigan
Memorial University of Newfoundland

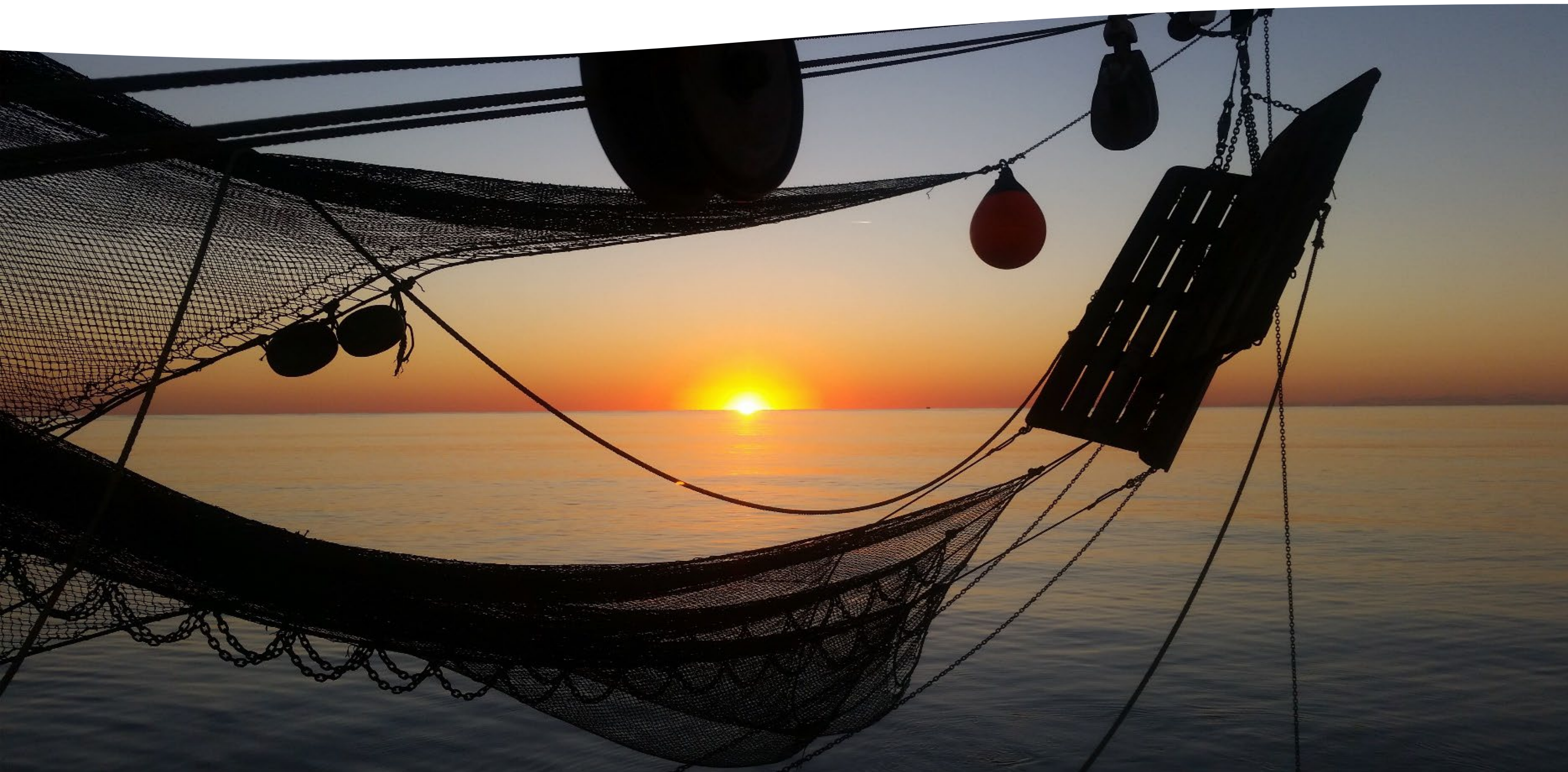
We present a hierarchical model for survey comparative fishing (CF) experiments (x) to utilize data from several species (s) and x to provide improved estimates of the relative efficiency of one survey protocol compared to another. This model is applied to four flatfish s and two x conducted by Fisheries and Oceans Canada (DFO) in 1995 and 1996. We used a monotone increasing function for relative efficiency, and included spatial effects to account for this important source of variation that was not considered in previous analyses of these data. We provide detailed analyses of the anticipated impacts of the various changes in the DFO survey protocols to better understand the reliability of the results. We show that there were important differences in relative efficiency among s, x, and spatial regions, which, combined with low sample sizes and low catch rates, contributed to poor precision in the estimates of relative efficiency. We conclude that stock assessment models in the future should have a goal of using unconverted survey indices, but also include information on the relative efficiency of trawl survey protocols as prior distributions. This will more adequately account for this important source of uncertainty.

*Presentation and summary based on:
Cadigan, N.G., Walsh, S.J., Benoît, H.P., Regular, P.M., Wheeland, L. J. (2023). A hierarchical model of the relative efficiency of two trawl survey protocols, with application to flatfish off the coast of Newfoundland, *ICES J. Mar. Sci.* 80:4, 1087–1102, https://doi.org/10.1093/icesjms/fsad039

NJOTS Door Calibration

By Gregory Hinks
New Jersey Department of Environmental Protection

The New Jersey Ocean Trawl Survey utilized traditional wooden otter trawl doors since 1988 and deemed it appropriate to upgrade the equipment to a maintainable industry standard Thyboron brand door. In preparation for the change, NEAMAP trawl survey colleagues supplied New Jersey with net mensuration equipment so preliminary measurements could be recorded. A full day of measurements were undertaken at various depths and directions and the data recorded. The survey eventually obtained the new trawl doors and its own set of net mensuration sensors. The trawl doors were then installed and adjusted to a configuration that resulted in measurements similar to the previous equipment. No calibration factors were ever established.



Key Takeaways for Vessel & Gear Changes

- Do your homework
    - It is vital to document and understand your vessel and gear specs when you get new gear so that when it comes time to purchase a replacement, you have a reference. This will also help you project into the future to understand the cost of upkeeping your vessel/gear.
    - Based on the variability across space and between tows, find an estimated number of paired tows needed to calibrate your new gear or vessel in order to prepare a timeline of how soon your new vessel/gear can replace the old one. Include a best- and worst-case scenario in this estimate and use the literature and your old specs as your guide.
    - Create a very good definition of your target species and know what your highest priority species are. These will usually be species that are of most management interest.
        - For multi-species surveys, understand that it will be almost impossible to account for calibration factors for every species and prioritize by management interest, followed by spatial factors.
    - Use modeling simulations to test calibrations and to fill in data gaps.
    - Understand your strata and think about how and if restratification is possible or necessary with your new vessel.
    - Standardize your methods – keep methods as similar as possible to one another so that you can account for specific differences between vessels. This will also help in case you ever need to switch between multiple vessels.
    - Maintain detailed records and documentation of vessel and gear and pass along this information to your data-users (mainly stock assessment scientists). This meta-data can be invaluable when it comes time to analyze your data.
    - Prepare and budget for the worst – change will happen.
    - When changing gear, it's important to invest in a system for net mensuration .
    - Additionally, having access to a flume tank can help set expectations for new gear performance before taking it out into the field.
    - Make sure to get industry input when changing gear as it is often a location-based experience.

- Remember that new equipment fairs better against wear and tear. When funds are available, try to make an upfront investment since it may save you time and money in the long-run. Always do a cost analysis before purchasing.

▶ Crew Experience and Cross-Training

- When you get a new vessel or gear, one of the most common and ideal ways to find calibration factors for target species is through paired tows. Unfortunately, this is costly and requires a lot of personnel. Start cross-training early if funding is available. This helps with staffing issues and helps run consistent operations when it comes time to conduct a paired tow with a new vessel. For example, if you run multiple surveys, swap captain and crew between surveys occasionally.

- If you are close to a university, find students who are willing to participate and can commit to multiple years (usually, these may be graduate students or undergraduate interns who want experience).

- Federal or state observers may also work as temporary staff in the field.

▶ Consult Other Agencies and Share Your Results

- Hold a space for vessel and gear considerations in your regular annual meetings.

- Participate and aid in the creation of more frequent workshops to share information about current vessel performance and share the results of your own agency's work and research on vessels/gear.

    - Funnel questions through the Atlantic States Marine Fisheries Commission to improve collaboration among states.

- Talk to your data-users (assessment scientists) and have them be part of discussions for new vessels and gears and they will better be able to share how data will be used/incorporated.

▶ Prepare for Vessel Outages:

- When possible, include a data disclaimer about vessel outages / extenuating circumstances when providing data.

- Cross-training will also help to mitigate personnel issues and outages that are caused by lack of staff.

- Maintain detailed program documentation and document specific dates and causes of outages.

- Before outages occur, if you have the capacity, identify an alternative vessel to use in case of mechanical issues.

Statistical Methods in Calibration

SCDNR Coastal Research Survey Changes*

By Julie Vecchio & Keilin Gamboa-Salazar
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The power of fishery-independent surveys for stock assessments and management decisions is in their consistency over time and space. Abundance indices from fishery- independent surveys are preferred in stock assessments for their robust scientific designs that minimize uncertainty and bias. Although the preference is to limit change to survey execution, such changes may be necessary. In multi-species surveys, changes that improve metrics for one species may be a detriment to survey performance for others. In addition, when sampling does not provide complete coverage, researchers may employ techniques such as imputation or standardization to improve accuracy and reduce bias. Here we examined the effects of incomplete sampling for a trawl survey and expanded sampling for a trap survey, both occurring in the coastal Atlantic Ocean off the southeastern USA.

Two methods were examined for adjusting for incomplete sampling within the Coastal Trawl Survey (CTS) of the SEAMAP-SA program for 3 commonly encountered species, the Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), and white shrimp (*Litopenaeus setiferus*): design- based imputation of missing data and standardization through the delta- generalized- linear- model approach. Additionally, it was the effect of modifying the seasonal component of the survey design was determined through retrospective simulation. For all 3 species, standardization improved precision in annual abundance estimates relative to values estimated with the design- based method. When a stratum missed in sampling overlapped with an area or time of high variability for a species, standardization did not improve precision over the design-based method. Results from examination of the effects of dropping entire seasons, because of funding or logistical challenges, indicate that rotating which season is dropped was the best approach to balancing characteristics of each species. Overall, scientists recommend the standardization approach for accounting for missing data within the CTS time series.

In 2010, the Southeast Reef Fish Survey (SERFS) was formed to address sampling needs off the U.S. Southeast Atlantic coast by intensifying effort in a historical chevron trap survey (MARMAP), especially at the northern and southern extent of the sampling range. Researchers used encounter rate, annual coefficient of variability, standard error, and relative abundance index values to determine the impact of the changes on trend estimates for three commonly encountered species with varying centers of distribution in the survey region. Gray triggerfish (*Balistes capriscus*) is found throughout the range of both surveys (i.e., centrally-distributed), while white grunt (*Haemulon plumierii*) and red snapper (*Lutjanus campechanus*) are centered near the northern and southern extent of the sampling range, respectively. For gray triggerfish, the survey intensification had no effect on encounter rate, reduced the coefficient of variation and indicated the historical index of relative abundance may have been overestimated. For white grunt, the survey intensification slightly improved CV but did not affect the index of relative abundance or encounter rate. For red snapper, SERFS increased encounter rates, reduced CV overall, and detected a population increase 5 years earlier than MARMAP. Overall, the intensification of the survey improved at least one performance metric for each species and showed few deleterious effects on performance, suggesting that intensification of the survey was a net positive for the accurate estimation of population trends in several species of interest.

*Presentation and summary based on:

Vecchio, J. L., Bubley W. J., Smart, T.I. (2023). Increased fishery-independent sampling effort results in improved population estimates for multiple target species. *Frontiers in Marine Science,* 10. https://doi.org/10.3389/fmars.2023.1192739

Zimney, A., Smart, T. I. (2022). Effects of incomplete sampling and standardization on indices of abundance from a fishery-independent trawl survey off the southeastern United States. *Fishery Bulletin*, 120: 252-267 doi: 10.7755/FB.120.3-4.6

Contemporary Analyses of Comparative Fishing Data*

By Noel Cadigan
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We re-analyze Thorny skate data from two comparative fishing experiments conducted by DFO in 1995 and 1996 using improved and more contemporary methods to estimate the relative efficiency of the Campelen 1800 demersal shrimp trawl survey protocol compared to the Engel 145 otter trawl. We correct possible bias in the method previously applied to these data. We investigate if there are size-based differences and if depth or spatial regions have important effects on results. We also investigate the influence and robustness of the estimation procedures, which was a concern in the original analyses of these data for other groundfish species. We did not find strong evidence that the relative efficiency of the Campelen trawl protocol compared to the Engel was different for smaller-sized Thorny skate compared to larger ones. However, we conclude there is a potential that size-based differential catchability existed but there is insufficient information to reliably estimate these effects for Thorny skate. We also found evidence of significant differences in relative efficiency among NAFO Divisions and experiments, which is similar to other flatfish species. However, the mechanisms for these differences are unknown and it is not clear if spatial estimates should be used when converting Engel indices to Campelen equivalents. Hence, we do not recommend a different Engel-Campelen conversion factor than the one currently used in stock assessments for Thorny skates on the Grand Banks (NAFO Divisions 3LNOPs).

*Presentation and summary based on:

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Model-based Estimation and Scenario-Testing for Calibration Ratios*

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In density surface modelling, all point data are marked and thinned point-process. In the context of fisheries science, this often pertains to biomass measured as a numerical density, from which points are drawn and marked (usually by individual size). Then, a thinning rate (or catchability) is applied. For example, if a survey is a point, then a density surface model would sample from the entire surface and retain only a fraction of those based on the thinning rate. When combining data sets (integrated species distribution models), it is assumed that the two data sets in question measure the same intensity but differ in their thinning rates (catchability). So, it may be useful to jointly estimate the thinning rate and density to propagate uncertainty. To predict thinning rates, whether thinning rates are local fishing-power for survey rates, etc., data that are "nearby" in space and time are needed. In experimentally paired sampling, some attributes can be controlled and some cannot and when experimentally paired sampling cannot occur, an alternative is modeling calibration factors using: $\log(q_i) = \log(q_0) + \lambda_{s_i} + \beta \log\left(d_{s_i}\right) + \eta_{v_i} + \boldsymbol{\alpha}\mathbf{x}_i$ where q_i is catchability (the thinning rate) for sample i at location s_i, q_0 is median catchability, λ_{s_i} is residual variation that is spatially correlated, β is density dependence ($\beta = 0$ is density-independent), η_{v_i} is a vessel effect, and $\mathbf{x}_i$ is a design matrix with responses $\boldsymbol{\alpha}$.

One example of a study that has reviewed this is Perretti & Thorson 2019, where data from the NEAMAP surveys and offshore NMFS bottom-trawl surveys were combined for use in stock assessment by calibrating between the NEAMAP and the NMFS surveys. A design matrix was created for a single survey factor for a bivariate spatio-temporal model. This study focused on summer flounder and acted as proof-of-concept for model-based inter-calibration. Another example in the north Pacific is from O'Leary et al. 2022, where a "design-like" estimator and a "model-based" estimator were compared to determine the thinning rates between a Russia-based and a U.S.-based survey using VAST models. Fishing power correction was used to calibrate disparate data sets and the effect of an annual oceanographic index to explain variation in groundfish spatiotemporal density.

The spatially varying catchability ratio from the original equation is further explored in Grüss et al. 2023. This paper explores two case-studies in Chatham Rise (New Zealand) and the Eastern Bering Sea. The integrated models leveraged the strengths of individual data sources, while down-weighting the influence of the non-reference datasets via the estimated spatially varying catchabilities. This allowed for the generation of annual density maps for a longer time-period and for the provision of one single index rather than multiple indices each covering a shorter time-period.

The tinyVAST R package can be used with an expressive interface to specify lagged and simultaneous effects in multivariate spatio-temporal models. The purpose of tinyVAST is to be able to define a structural model that links multiple variables in a multivariate spatio-temporal model. It allows granular control over how different variables are connected with one another. In one drop-camera survey, there were six variables to measure aggregated species with parameters to indicate habitat effects from the drop camera and bottom trawl as well as density-dependence terms and spatial variation for each variable. Then using a structural model, the different assumed structures can be graphed and compared.

*Presentation and summary based on:

Grüss, A., Thorson, J. T., Anderson, O. F., O'Driscoll, R. L., Heller-Shipley, M., & Goodman, S. (2023). Spatially varying catchability for integrating research survey data with other data sources: case studies involving observer samples, industry-cooperative surveys, and predators as samplers. *Canadian Journal of Fisheries and Aquatic Sciences*, 80(10), 1595-1615.

O'Leary, C. A., DeFilippo, L. B., Thorson, J. T., Kotwicki, S., Hoff, G. R., Kulik, V. V., Ianelli, J. N., Punt, A. E. (2022). Understanding transboundary stocks' availability by combining multiple fisheries-independent surveys and oceanographic conditions in spatiotemporal models. *International Council for the Exploration of the Seas Journal of Marine Science*, 79(4): 1063–1074. https://doi.org/10.1093/icesjms/fsac046

Perretti, C. T., Thorson, J. T. (2019). Spatio-temporal dynamics of summer flounder (*Paralichthys dentatus*) on the Northeast US shelf. *Fisheries Research*, 215, 62–68. https://doi.org/10.1016/j.fishres.2019.03.006

Thorson, J. T., Anderson, S. C., Goddard, P., Rooper, C. (In preparation). TinyVAST : R package with an expressive interface to specify lagged and simultaneous effects in multivariate spatio-temporal models.

Key Takeaways for Statistical Methods

- Use multiyear approaches to transition and try multiple methods when it comes to analyzing your data.
- Modify model to fit data not data to fit model. There is a possibility here for using data standardization prior to modeling, processing preference, but uncertainty must be accounted for in model.
- Limiting factors like budget can cause the need for a model that can estimate data gaps.
- Use “procedural pilot” or simulation studies before full experimental calibration (can allow the identification of best option from multiple options).
- Good documentation is key so changes can be accounted for in future analyses—this also helps fill in data gaps if needed.
- It is important to understand what estimates mean to help us understand the different types of variances that often go largely unaccounted for. Understand what other factors could lead to greater uncertainty in data.
- Communicate limitations in data to stock assessment scientists, involving scientists in things like gear calibration.
- It’s difficult to keep track of small changes, but there are a few ways to make analysis easier: try to include things like strata shape files, inclusion probabilities, and metadata with your data sets. Metadata can also help when looking at comparative fishing data to develop more robust methods.
- Make sure raw data is stored and archived for use in modern studies.
- Document code in a repository to reproduce original analyses - GitHub could be an option for code storage and this would make it easier to share code amongst agencies who conduct similar surveys.
- Be careful cleaning out old offices, don’t throw away important documents and raw data that could be used to test future methods without having to collect more data.
- Always be aware of your legacy, bad data and meta-data will curse future scientists.

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