MEMO

(with addendums)

TO: Sean Corson, Chair, Sustainable Fisheries Goal Implementation Team
Bruce Vogt, Sustainable Fisheries Goal Implementation Team Coordinator.
FROM: Donna Bilkovic, H. Ward Slacum, Kirk Havens, Danielle Zaveta, Christopher F.G. Jeffrey, Andrew Scheld, David Stanhope, Kory Angstadt, John Evans
DATE: August 6, 2018
SUBJECT: Authors' Response to the Chesapeake Bay Stock Assessment Committee's (CBSAC) Comments Regarding the NOAA Sponsored *Ecological and Economic Effects of Derelict Fishing Gear in the Chesapeake Bay* 2016 Report

Dear Sean,
Thank you for providing the authors' of the report *Ecological and Economic Effects of Derelict Fishing Gear in the Chesapeake Bay (2016)* the opportunity to address comments from the Chesapeake Bay Stock Assessment Committee.

We appreciate you and the Sustainable Fisheries GIT leadership's interest in the ecological and economic impacts associated with the issue of lost and abandoned crab pots and the potential for appropriate management actions to address the concern. The National Oceanic and Atmospheric Administration (NOAA) has long been aware of the significance of derelict fishing gear and has led the way in providing support for addressing the issue. The concern regarding derelict fishing gear is worldwide (Inniss et al. 2016). *The Ecological and Economic Effects of Derelict Fishing Gear in the Chesapeake Bay* report was conducted to provide information that would be useful for managers and policy makers. In the following comments, we address the comments from CBSAC and provide a summary of the report's important findings.

Addendum: Any information added to the original memo (dated Aug 6, 2018) to be responsive to the CBSAC revised evaluation (dated 4 Sept 2018) and inclusive of new relevant data are indicated as addendums. It is important to reiterate that the Bilkovic et al. (2016) report was a multi-investigator, collaborative effort that synthesized new and existing data from multiple studies in both Maryland and Virginia; and many of those studies included in the synthesis had also been published in the peer-reviewed literature.

CBSAC Comment

Bilkovic et al. (2016) concluded that derelict trap removal (DTR) increased blue crab harvest by "a Bay-wide total of over 38 million lbs. (23.8%, valued at $33.5 million) over the 6 year period [2009-2014]," and that "for each pot removed [by DTR], harvests increased by 868 lbs."

These conclusions are based on their estimates that derelict traps "kill over 3.3 million [crabs annually] - 4.5% of the 73 million crabs harvested in 2014,"

Authors' Response

No. The harvest increase due to the removal of derelict pots was based on reported harvest and effort utilizing lbs. This comment conflates the harvest increase analysis, which is a gear efficiency issue, with the capture/mortality study which is a separate analysis. Mortality numbers were not used in the harvest analysis.

and that “removing as little as 10% of the derelict pots from the 10 most heavily fished sites (5 sites in Virginia; 5 in Maryland) could increase blue crab harvest in the Chesapeake Bay by 22 million pounds or approximately 14%.” The impact of these findings is not trivial. Substantial time, effort and funds are required to implement DTR, such that it is critical to identify the mechanisms underlying catch and abundance variability to use funds and effort effectively.

Authors’ Response

We concur that the economic impact associated with derelict pots is not trivial.

CBSAC Comment

The Chesapeake Bay Stock Assessment Committee (CBSAC) was asked by the Chesapeake Bay Program’s Sustainable Fisheries Goal Implementation Team to review the Bilkovic et al. (2016) report to evaluate the reliability and implications of their findings for management of blue crab in Chesapeake Bay.

CBSAC members evaluated the findings in the Bilkovic et al. (2016) report. Where necessary, CBSAC reviewed earlier literature to assess the degree of support for individual elements of the 2016 report. Individual CBSAC members wrote their own independent reviews, which were combined and edited to form this consensus report.

CBSAC expresses extreme caution over the level of impact of derelict traps on the blue crab population in Chesapeake Bay claimed in the Bilkovic et al. (2016) report. Hence we also question the value of any ongoing DTR effort on the long term sustainability and productivity of the blue crab fishery. Hereafter, we summarize the reasons for our disagreement with the findings of Bilkovic et al. (2016) to determine the most likely causes of the recovery of the blue crab fishery and population, and ultimately to inform management of the blue crab fishery and population.

Authors’ Response

As stated in the report, comprehensive estuarine-wide removal programs can be expensive, however, targeted removals in areas of high potting activity, “hotspots”, can be a cost effective strategy to increase blue crab harvest baywide. The issue of derelict blue crab pots is not unique to Chesapeake Bay. In response to documented adverse effects of derelict gear, most blue crab fishery states have implemented some management actions to address these impacts, including targeted removals. Below is a list, with contact information, for targeted removal programs in other states.

Alabama: Jason Herrmann, Alabama Department of Conservation & Natural Resources, Marine Resources Division, 251-861-2882, Jason.herrmann@dcnr.Alabama.gov

Delaware: Nicole Rodi, Delaware Coastal Programs, 302-739-9283
Florida: Pam Gruver, Florida Fish & Wildlife Commission, 850-487-0554
Louisiana: John Lopez, Lake Pontchartrain Basin Foundation, jlopez2@charter.net, 504-421-7348; Kristen Butcher, kristenbutcher@gmail.com; Julie Anderson Lively, Louisiana State University, janderson@agcenter.lsu.edu, 225-578-0771.
Maryland: Sandi Smith, Maryland Coastal Bays Program, sandis@mdcoastalbays.org, 410-213-2297; Ward Slacum, Oyster Restoration Partnership, wslacum@oysterrecovery.org, 410-990-4970
Mississippi: Harriet Perry, Center for Fisheries Research & Development, harriet.perry@gmail.com, 228-872-4218; Lauren Thompson, Department of Marine Resources, lauren.thompson@dmr.state.ms.gov, 228-523-4053
New Jersey: Mark Sullivan, Richard Stockton College of New Jersey, mark.Sullivan@Stockton.edu, 609-626-3575
North Carolina: Sara Hallas, NC Coastal Federation 252-473-1607
South Carolina: Peter Kingsley-Smith, SC Department of Natural Resources, kingsleysmithp@dnr.sc.gov
T**exas**: Carey Gelpi, Texas Parks & Wildlife Department, 409-983-1104
Virginia: Kirk Havens, Virginia Institute of Marine Science, kirk@vims.edu; Donna Bilkovic, Virginia Institute of Marine Science, donnab@vims.edu

CBSAC Comment

CBSAC identified some simple arithmetic and logic errors that led to an inflated estimate of the impact of DTR claimed by Bilkovic et al. (2016). Bilkovic et al. (2016) estimated that DTR increased blue crab catch by "a Bay-wide total of over 38 million lbs. (23.8%, valued at $33.5 million) over the 6 year period [2009-2014]." The actual catch estimated by CBSAC for 2009-2014 is about 334 million pounds. If we accept the estimated 38 million pounds baywide increase caused by DTR claimed by Bilkovic et al. (2016), then the actual percentage increase in harvest due to the program = 38/(334-38) x 100% = 12.8%, not 23.8%.

Authors' Response

The CBSAC comment and subsequent calculation is wrong. As stated in the Report, only years where removals occurred were used. While removals occurred in all 6 years in Virginia only 2 years occurred in Maryland. In addition, no Potomac River jurisdiction harvest data should be included in the harvest total. The actual reported harvest (VA 2009-2014, MD 2010-2012) is currently 200.89 million lbs. The model prediction (mean) of actual harvests (with removals) for the same period was 199.19 million lbs. The model prediction (mean) of counterfactual harvests (without removals) for the same period was 161.02 million lbs. Given that we were reporting % increases due to the removal program, the proper baseline is the counterfactual (i.e., what would have been harvested). The harvest number used by CBSAC is inflated because they included additional years (MD 2009, 2011, 2013, & 2014) and additional areas (e.g., Potomac). Our analysis is saying actual harvests were increased because of removals, thus to judge the % increase you would need to know what harvests would have been without removals (the counterfactual). It is also important to point out that the model did very well at predicting actual harvest (199.19 million lbs vs 200.89 million lbs). The correct calculation is 199.19-161.02 = 38.17 million lbs increase from removals. (38.17 / 161.02) x 100% = 23.7%.

Addendum: A recent peer-reviewed published paper provides empirical evidence of the impact of derelict pots on harvest (Delbene et al. 2019).

CBSAC Comment
Bilkovic et al. (2016) also assume that "1 blue crab ≈ 0.475 lbs." to make calculations regarding DTR effects on harvest. Bay-wide, the mean weight of harvested blue crabs is approximately 0.343 lbs (CBSAC, 2017).

Authors' Response
The CBSAC comment that the '1 blue crab = 0.475 lbs' was used to make calculations regarding derelict pot effects on harvest is incorrect. The harvest increase due the removal of derelict pots was a lbs to lbs calculation. The conversion factor was only used to show how lbs related to number of crabs. The '1 blue crab = 0.475 lbs' conversion was provided by VMRC. Most of the reported harvest impact is from Virginia (≈ 30 million vs ≈ 8 million in MD). The only other place the conversion factor was used was to convert the overall reported harvest to number of crabs to show how the loss of 3 million crabs due to mortality relates to the overall harvest. The mean weight mentioned in the CBSAC comment is not in the reference they cited, nonetheless, if a different conversion number is now available that certainly can be applied.

Addendum: To reiterate and as stated in the report, the economic model and estimates are in lbs, using harvest reports from Virginia and Maryland, and **did not require or depend** on conversion. As noted in the report, Maryland & the NOAA Chesapeake Bay Office reported a similar mortality of harvestable crabs due to derelict pots equaling 4% in 2007 (Slacum et al. 2009). The conversion factor used by VMRC is 0.475, ["The conversion used in our database for number = 0.475 to convert numbers to lbs" S. Iverson, VMRC Data Supervisor, email 2/20/2015].

CBSAC Comment
This also assumes that every crab caught by derelict gear could be legally harvested otherwise.

Authors' Response
No. The confusion is the result of CBSAC conflating DFG capture/mortality and the competition effect. Because DFG captures/kills crabs, people may think that the reduction in harvest should equal the number of crabs captured/killed. This is wrong for two reasons: 1) crabs captured or killed would not necessarily be harvested so cannot be counted directly as lost harvest (though they may contribute to future recruitment/abundance); and 2) there is no consideration of harvest lost due to gear interaction / competition. Separating these two mechanisms of potential lost harvest is the most critical piece.

CBSAC Comment
The estimated number of traps fished in Virginia appears to be a significant overestimate, such that the number of derelict traps is also likely overestimated. Not all license holders actively fish

(about 1/3 are inactive) and the maximum number of traps allowed under each license does not always correspond to the number of traps that waterman actively fish. All of these assumptions artificially increase the impact of DTR on harvest.

Authors' Response

The comment refers to appendix G (Scheld et al 2016 Nature Scientific Report article) and an estimate of 300,000 pots deployed in Virginia waters. We agree that not all license holders may be active though it should be noted that in 2009 regulation in VA required that a license holder must have reported some harvest in 2008 to be eligible for a 2009 license and subsequent licenses. Also, a license buy-back program was initiated in VA during this time. In addition, during the 2008 to 2014 time period licenses issued had the potential for about, on average, 360,000 pots (hard and peeler) to be deployed annually (revised to licenses defined as "eligible" by VMRC). More importantly, that number was only used to estimate the percentage of derelict pots removed relative to the overall pool of derelict pots and was **not** used in the harvest impact calculations. The model estimating harvest impacts used harvest and effort reports submitted by watermen and provided by VMRC and MDDNR (note that MD effort #'s were scaled up by ~x11 after comparing area specific catch per pot in the VERSAR report w/actual data). In the time period corresponding to above (2009-2014 VA and 2010, 2012 MD), there were 88.9 million pot pulls (average catch 200.89/88.9 = 2.26 lbs/pot).

CBSAC Comment

CBSAC also identified some methodological concerns over the reliability of the number of crabs impacted by the DTR program. Bilkovic et al. (2016) combine the results of side-scan sonar (Maryland) and actual trap collections (Virginia) to estimate the total number of derelict crab traps. These numbers are expanded statistically using geographically weighted regression (GWR) to predict the total number of crab traps baywide. GWR is known to perform well when used for statistical inference, but known to perform poorly when used for statistical prediction (Harris et al. 2010). The original author of GWR recommends ordinary kriging when prediction is the objective. As employed here, GWR utilizes Euclidean or straight-line distances as part of its estimation process. Application of Euclidean distance in estimating abundance in estuarine surveys has been criticized previously (Jensen et al. 2006). There are more recent versions of GWR that employ the preferred "through the water" distance measure (Lu et al. 2014), which may improve performance. Indeed, inspection of Figure 2-8 in Bilkovic et al. (2016) clearly shows that the GWR model performs extremely poorly (R^2~0.1) in highly invaginated regions of the prediction surface, further supporting concerns over the application of simple GWR. Hence, the estimate of 145,233 derelict traps is associated with unknown bias and precision.

Authors' Response

The use of GWR for this purpose is appropriate for several reasons including:

- GWR is a well-established approach for dealing with data plagued by spatial non-stationarity, spatial dependence and spatial autocorrelation [Brunsdon et al. (1996, 1998); Charlton and Fotheringham (2009); Lu et al. (2014)].
- GWR allowed us to evaluate several factors we expected to contribute to pot loss and determine the amount of influence that each of them contributes to the

overall variance in derelict pot counts. This approach helped us identify through statistical inference a set of rational, meaningful, and relevant environmental and management correlates that influenced derelict pot distribution and abundance during the period of study.

- As noted in the critique, GWR is known to perform well when used for statistical inference; and it performed well in explaining the variance observed in the response variables.
- The GWR model developed for the 2016 report was based on a previous calibrated GWR model (Appendix A, Versar, Inc., 2009; Slacum et al. 2011b, 2013) that was ground-validated with experimental data (i.e. derelict trap retrievals) from areas identified to be hotspots in MD portion of the Chesapeake Bay. This model was used by MD DNR to coordinate MD's derelict pot removal program. Thus the GWR model used in 2016, represents an experimentally calibrated model for estimating derelict trap abundance in sampled areas and predicting the same in unsampled locations of the Chesapeake Bay.
- The critique that kriging models generally outperform GWR-based models (as demonstrated by Harris et al. 2010 with simulated data) overgeneralizes that finding, and we disagree with the recommendation that kriging may have been a better approach in our study. Although kriging provides the least biased estimates of statistical parameters, it assumes stationarity of the data; i.e. there is spatial homogeneity and that the mean and variance of response variables are the same at all locations within the area of interest. In contrast, GWR does not require the assumption of stationarity; but rather it allows for spatial variation in variables and correlations among interacting variables. Because of the previous work done by Versar Inc. and others, we hypothesized that the distribution and average counts of derelict traps would vary locally within the Chesapeake Bay, and that GWR would better capture that inherent variation of the data.
- Harris et al 2010 concluded that, "Universal Kriging, and GWR models were shown to out-perform the naive Multiple Linear Regression and Ordinary Kriging models" ... and "accounted for spatial autocorrelation". Harris et al. (2010) claimed further that "Universal Kriging models specified with local neighbourhoods (our preferred choice) can sometimes suffer from calibration difficulties and if so, a GWRK (or sometimes, a more pragmatic GWR) model can provide a worthy alternative when predicting with non-stationary relationships".

We believe that the GWR approach used in the DFG project represents a pragmatic, calibrated, and validated model for making statistical inferences and estimating the number of derelict traps as well as their ecological and economic impacts on the fishery.
The critique that "GWR model performs extremely poorly (R^2~0.1) in highly invaginated regions of the prediction surface" (as demonstrated in Figure 2.8), is valid; however, it fails to acknowledge that GWR performed extremely well in other areas of the Chesapeake Bay (R^2 ranged from ~0.1 to ~ 0.8, see figure 2.8). The large range in model R^2s additionally testifies to the non-stationarity of the derelict trap counts, and also suggests that there is a paucity of data in the invaginated regions, rather than the use of an inadequate model. We suggest additional

derelict trap surveys or using additional covariate data in invaginated areas where the model performed poorly would be more informative and would improve model performance much more than the use of predictive models such kriging.

We refute the statement: "However, currently, the estimate of 145,233 is associated with unknown bias and precision". Rather, we quantified the error and bias associated with mean estimates of crab pots within the Chesapeake Bay as follows:

> "Through the use of co-variable datasets with extensive spatial coverage, our GWR model successfully used 856 derelict crab pot locations to predict the presence, absence, and mean densities and standard errors of derelict crab pots for 7,216 1-km grid cells within the Chesapeake Bay with global mean of 35.4±0.26 crab pots per grid cell." (page 22, Bilkovic et al., 2016).

Based on the above, the bias associated with the estimate (i.e., ± standard error of the mean for each grid cell) amounted to a relative standard error of 26% suggesting that the total number of functional derelict pots range between 107,319 and 183,295 in the Chesapeake Bay.

Addendum: The Maryland Department of Transportation State Highway Administration (SHA) conducted a derelict trap removal program in a 10 square kilometer area located in the upper portion of the Bay. The trap retrieval location was chosen using GWR model results from Slacum et al. 2013. Over a 10 day period in March, watermen **removed 1,192** derelict pots that were considered intact and functional by the watermen participants (MDDOT 2018). The total number of intact derelict traps removed was similar to 2013 GWR model results and to independent derelict trap counts identified in side scan sonar survey imagery (MDDOT 2018). Results of the retrieval program also align with the refined 2016 Bay-wide GWR model (as described in Bilkovic et al. 2016) which **predicted 1,147** functional derelict pots thus providing empirical evidence of the accuracy of the model.

CBSAC Comment

Even ignoring uncertainty in the estimate of 145,233 crab traps for the remainder of this section, consider the application of this number in subsequent calculations. As far as we can determine the total number of derelict crab traps is multiplied by some estimate of catch rate to estimate the number of crab mortalities. This implies that every one of the 145,233 pots is actively fishing. Yet, the authors own work (Bilkovic et al. 2014) indicated that only 35% of the derelict crab traps are able to catch animals. This would suggest that the final estimates are possibly inflated by a factor of 2.8, independent of any uncertainty in the actual number of traps. We note that no data on the number of derelict traps in the Potomac River is provided, which would serve to lead to under-estimates of the total number of crab traps, and which potentially slightly offsets the concern identified above.

Authors' Response

The derelict crab pot location data used to inform the GWR model consisted only of functional derelict pots (i.e., pots that were intact and capable of capturing bycatch and rated by watermen as pots they would put back in their line). The condition of the derelict pots were recorded upon retrieval as was the occurrence of bycatch. This was done in order to conservatively estimate the number of derelict pots at any given time in the Bay that were capable of capturing animals and was considered a more informative number than a large number that includes pots of various capturing capacity ranging from functional to a piece of rebar with wire. The CBSAC correctly noted that the Potomac River was not included which would serve to lead to an underestimate. The Lynnhaven River and Back Bay region of VA were not included also contributing to a potential underestimate of the total number of derelict pots. The CBSAC is correct that the overall pool of derelict pots is much larger than the 145,000 functional derelict pots. Therefore, the assertion that final derelict pot abundance estimates are possibly inflated by a factor of 2.8 is unsupported.

CBSAC Comment

Bilkovic et al. (2016) multiply the number of traps by the estimated catch rate. The average catch rate, Chesapeake Bay wide, is given as 43 crabs/trap/year with an associated level of dead crabs of 23 crabs/traps/year. Estimates of trap bycatch rates are notoriously difficult to come by and methodological differences account for much of the variability among studies as reported by Bilkovic et al. (2016) in Table B-1. For example, the Havens et al. (2008) study fished experimental crab traps that had been intentionally abandoned. In this work the funnel was held open for seven days and then closed for extended periods over a prolonged (many month) deployment in the York River. This study provided an estimate of 50.6 crabs/trap/year. In the report, the authors provide data from a new study conducted in large tanks on the VIMS campus over periods of 4, 53, and 168 h. The assumption of an additive catch process is a strong assumption in both cases (Havens et al. 2008 and the new study) – that is if 1 crab is caught every 4 hours, 4 crabs will be caught every 16 hours, 8 crabs every 32, etc.

Authors' Response

Two independent studies looked at blue crab capture, escape, and mortality in derelict pots in Virginia and Maryland. The Virginia study investigated capture rates in the field (8 sites) and pot escape rates in the laboratory. The Maryland study deployed 80 pots in three locations at two depths. The traps deployed in MD were baited initially to simulate a lost pot and checked weekly for 14 months. Individual crabs were tagged and tracked throughout the sample period integrating across seasons and pot condition.

The CBSAC comment conflates the Virginia capture study with the laboratory escape rate study. The laboratory study tagged and followed crabs over time intervals to investigate escape rates from the lower and upper chambers not capture rates. The field studies that investigated capture rates were only additive to the unsampled 3 weeks of each month i.e. the capture rate observed during the week sample period was applied to the month. Separate capture rates were calculated for each month to determine an average daily capture rate. The capture rate reported is likely an underestimate for multiple reasons: 1) no bait was used in the original deployment where high capture rates would be expected upon initial pot loss, 2) bycatch, including fish, were removed to avoid self-baiting which is known to increase capture rates, and 3) the daily capture rate was only applied to the time frame in which the sampling took place and in the 4 to 5 months when sampling was not conducted the capture rate was set at zero when extrapolating to the annual capture rate. We now know that capture of crabs in derelict pots continues over December through March.

Both studies resulted in similar mortality estimates for legal size crabs, 25 and 16, and are consistent with other mortality numbers for legal size blue crabs in derelict crab pots; 19 (NC Division of Marine Fisheries), 25.8 (Louisiana Department of Wildlife and Fisheries).

Addendum

As clearly presented in Table B-1, the catch rate by derelict pots was estimated by averaging rates from multiple studies and geographic locations within Virginia. To obtain a baywide mean estimate of catch rates, this value and Maryland catch rates were averaged. Furthermore, as stated above, our final mortality estimates for legal size crabs in derelict pots were consistent with other states and regions.

CBSAC Comment

There are well argued theoretical (Fogarty and Addison 1997), behavioral (Sturdivant and Clark 2011) and empirical (Bullimore et al. 2001) reasons to believe that mortality from crab traps is a non-additive process (Bullimore et al., 2001). Specifically, the presence of one crab in a pot likely lowers the probability of a second crab occurring in the pot (or possibly increases it during certain times of the year). Furthermore, evidence suggests that the catch rate of ghost pots declines substantially and inversely with time (Bullimore et al., 2001) SEE ABOVE.

Authors' Response

The CBSAC comment suggesting that "the presence of one crab in a pot likely lowers the probability of a second crab occurring in the pot" used the following references as support: Sturdivant et al., Bullimore et at., Fogarty and Addison, however; the Sturdivant paper states the exact opposite of how it is referenced by CBSAC. Sturdivant states "the presence of crabs in pots did not affect the catch rate" and "... intraspecific interactions were not observed or quantified to have an effect on catch or escape rates" and "the escape rate from the parlor [upper chamber] was almost zero."

The Bullimore paper was an experiment off of Wales involving 12 traps (not replicated in other habitats) that are used to catch spider crabs, brown crabs, and lobster. Bullimore notes that catch declines after loss and depletion of the initial bait but further states: "Over the first few days, catches declined almost exponentially. Then, for the next few weeks, decaying bodies of fishes and Crustacea attract large numbers of scavenging crustaceans that also become trapped in the gear. Thereafter, there appears to be a continuous cycle of capture, decay, and attraction for as long as the gear remains intact." Final paragraph: "in some fisheries in North America, fishermen must fit their pots with escape gaps or escape panels that either biodegrade and fall out of the pot after a certain length of time… Conservation measures such as these are relatively inexpensive to introduce and would greatly reduce losses from the fishery of commercially important species..."

The final reference, Fogarty and Addison, is a modelling exercise focused on lobsters which references another paper (Williams and Hill 1982) that "noted that the presence of a crab in a trap reduced the probability of additional entries." That paper was on the giant mud crab (up to 7 lbs) of the mangroves Australia.

While there has been evidence of trap and bait defensive behavior in lobsters (Jury et al. 2001), there is little evidence of such activity in blue crabs. Indeed, a simple review of the effort and harvest data shows multiple crabs in pots as well as the evidence provided from the derelict pot removal programs that showed multiple crabs in pots in various combinations of all dead, a mix of dead and live, and all alive - all during the winter.

Addendum
Other studies (including those cited in the CBSAC comments) show similar mortalities to the ones reported in Bilkovic et al. (2016) including Arcement and Guillery (1993) with reported mortalities of 17.3 crabs/pot (without escape rings) and 5.3 (with escape rings) over a three month period. Whitaker (1979) reported a total average annual mortality due to derelict pots of 40 crabs/pot with a general range of 20-60 crabs. Casey and Wesche (1977) reported derelict pot mortalities of 7.7 crabs/pot over 3 months from January to March and 7.5 crabs/pot in August and September. In addition, Casey and Wesche (1977) did not initially bait their pots. Guillory et al. (2001) also states "Ghost trap data underestimates total mortality because many blue crabs escape and are subjected to delayed mortalities as a result of injuries, physiological stress, and lack of food while in the trap".

CBSAC Comment
Thus, we conclude that the simple, but strong assumption of additive catch rates in derelict crab traps in the Chesapeake Bay leads to an unknown, but likely substantial over-estimate of the ultimate catch, and thus the ultimate impact of the derelict traps on the crab population and its dynamics. We suggest that the error is likely to be an order of magnitude problem rather than a simple 1-3 fold difference, as in the estimate of the total number of traps.

Authors' Response
The conjecture by CBSAC that mortality in derelict pots is more likely 2 crabs per pot per year is an order of magnitude lower than the published literature on the subject.

Addendum
We did not assume additive catch rates in derelict crab pots, in fact, our experiments were designed to discern changes in catch rate over time and in varying conditions. It is important to remember that non-linearity does not equate to no mortality. In addition, the derelict fishing gear literature suggests that there are likely delayed mortalities associated with derelict fishing gear that are not accounted for in most studies; thus, these estimates may be conservative (e.g. Guillory et al. 2001). The conclusion by CBSAC that "additive catch rates in derelict crab traps leads to an unknown, but likely substantial overestimate of the ultimate catch" without provided any relevant data is concerning.

Addendum (CBSAC 4 September 2018) comment:

"Preliminary Findings from Ongoing CBSAC Analysis on the Effects of Fishery Management Actions and Derelict Trap Removal on Blue Crab Abundance and Landings

CBSAC has been analyzing abundance and landings data in relation to fishery management actions in 2008-2009 and the derelict trap removal program. These analyses indicate that fishery management actions were responsible for most of the increased landings from 2009-2014 due to concomitant increases in blue crab abundance and fishing effort. There was little evidence of an effect of the derelict trap removal program on either blue crab abundance or landings. These preliminary findings are consistent with CBSAC's evaluation of the 2016 report, and will be presented to the Fisheries GIT at a future meeting."

Addendum Authors' Response:

We find the above statement from CBSAC to be highly questionable considering they have provided no data or analytical protocol.

The effect of derelict gear removals on harvests was estimated for discrete management areas (54 in VA and 9 in MD) by merging area- and year-specific removal data with corresponding fishery effort (i.e., pot pulls) and harvests (note that removals occurred before fishing began in a given year). This analysis also included annual blue crab abundance estimates to control for inter-annual shifts in resource availability, which were found to influence gear efficiency. Our findings indicate that gear efficiency improvements were found to correspond with the level of removals experienced in a particular area during a particular year (i.e., area-years with more removals saw increased efficiency improvements). It is not clear how CBSAC plans to analyze removal or other management action impacts on fishery harvests, or how they will consider variation in removals or management actions across space and time.

CBSAC Comment

Bycatch of Atlantic Croaker

VMRC has concerns about bycatch estimates, particularly for Atlantic croaker. The report estimated 3.6 million croaker are caught in Chesapeake Bay each year in derelict traps, with the vast majority caught in Virginia. In recent years the total croaker catch from all gears is around 3 million pounds, with an average weight of 0.5 pounds, which represents 6 million fish. It is legal to harvest croaker from crab traps and that practice has always occurred. The derelict trap estimate dwarfs reported catch of Atlantic croaker from commercial crab pots: 7,829 pounds in 2014, 1,991 pounds in 2015, and 2,386 pounds in 2016.

Authors' Response

The question is a fair point. However, the estimate of over 3 million Atlantic croaker entering derelict pots per year does not reflect mortality. As stated in the Report, escape rates and mortality rates were not investigated for finfish bycatch and, as pointed out in the Report, there is a fair amount of uncertainty around that number (40.7 ± 11.7). It would be interesting to see the CPUE associated with the Atlantic croaker landings reported from the commercial crab pots. As shown in the report of bycatch in the derelict pots collected during the winter, finfish bycatch is quite common and the two highest commercially important species reported in Virginia were black seabass and Atlantic croaker. We would be interested in following up this issue with VMRC as loss of Atlantic croaker to derelict pots has been discussed as a concern for recreational sport fishers.

Additional information that may be of interest to the Sustainable Fisheries GIT

The derelict pot removal programs in Virginia and Maryland were conducted over the winter. In Virginia data was collected weekly from Dec through mid-March from 2008 to 2014. In Maryland data was collected from the end of Feb through March for 2010 and 2012. Blue crabs were captured in pots throughout this period. While it has been known that crabs may be moving about in early December and again in early Spring, the data from the removal program shows crab mobility throughout December, January, February, and March. This could complicate the accuracy of the winter dredge survey, particularly in the southern Bay, if the methodological assumption is that blue crabs “are dormant and buried in the sediment” (Sharov et al. 2003). This bias will only increase as the bay temperature continues to rise (Ding and Elmore 2015).

Summary and Recommendations

- 107,000 to 183,000 (mean of 145,000) functional derelict pots in the Bay
- 2.2 million to 3.8 million legal sized crabs (mean 3 million) killed annually
- Significant economic impact due to cryptic gear competition resulting in active gear catch inefficiencies
- Derelict pot removal data shows a mobile blue crab population throughout winter suggesting potential issues with winter dredge survey assumptions of a buried and stationary sample population. Suggest the Sustainable Fisheries GIT collaborate with the Climate Change GIT to approach the Scientific and Technical Advisory Committee (STAC) to conduct an independent workshop on alternative sampling methods.
- Authors would be willing to assist the SF GIT regarding derelict pot issues and the SF GIT workplan.

For a primer on the impacts of derelict fishing gear, the following sites may be helpful:
https://marinedebris.noaa.gov/types/derelict-fishing-gear
https://marinedebris.noaa.gov/sites/default/files/publications-files/Ghostfishing_DFG.pdf

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