

I. Background

A. History of data collection and analysis

- 1975 – 2008 survey years consisted of data from numerous sources, not just standard or pre-programmed tows. Multiple tows per station were sometimes included, as were special project tows. Tows made during a given survey had a variety of goals:
 - Stock assessment
 - Reduce variability in population estimates in areas of high king and Tanner crab abundance
 - Gear comparison studies
 - Provide data to ADF&G for establishing annual GHLL's
 - Aid to fishermen and processors in determining productive areas and general availability of crabs from year-to-year
- Tow duration for all hauls in 1975 was 1-hour; tows used for 1976 analysis consisted of tows with 1-hour and 30-minute duration (part of an experiment to compare catch rates between hour and half-hour trawls: no significant differences were found); all tows after the 1976 survey were 30-minute duration
- Fixed net width of 50 feet was used for area swept calculations
- 400 mesh eastern trawl was the primary trawl used 1975-1981 (tows from vessels using the 83-112 eastern trawl were included in 1976 and 1981 data sets); only the 83-112 eastern trawl used since 1982
- Survey area ranged from SE Bering Sea only (1975) to covering Bristol Bay to northwest of St. Matthew Island
- Survey pattern, while always on a 20-nm grid, completed in somewhat random pattern through 1981
- Data format was flat files (ASCII); data was not stored in a central location, and was not in database form until the early 1990's when a FoxPro database was constructed. From 1997 – 2006, survey data was housed in an ACCESS 97 database.
- In 2004, an Oracle table of crab data from 1975-2003 was created. Survey data from 2004-2008 was added to this database, though the "official" database remained in ACCESS 97. In 2009, the ACCESS 97 database was no longer updated or maintained as we officially switched to Oracle for data warehousing, extracting, and preliminary analyses.

B. History of new time series development

- Goal to reproduce as closely as possible the historical data set, removing or adding tows if deemed necessary. One specific change from the 1991 historical was to include a tow made at station F-08 that contained a large number of legal-sized red king crab: this tow had been dropped from the original analysis.
- Revised stratification scheme as appropriate for a given stock, striving for consistency
 - Include area of poor performance stations IF in core habitat for given stock
 - 1975-1982, 1987, 1989 used only stations towed
 - 1983-1986 created strata stanzas: if station not towed, area was still included

- 1988, 1990-2013 used all stations falling inside standard survey grid
- Pribilof District Multiple Tow Core Area (MTCA) designated in 1981 (beginning of consistent towing of corner stations) with a fixed area of 10,025 square nautical miles; St. Matthew Island District MTCA designated in 1983 with a fixed area of 7,218 square nautical miles (station Q-24 is untrawlable but area is included as station is inside the high density area)
- Total eastern Bering Sea area surveyed varied from 56,541 – 143,558 square nautical miles; current area is 140,350 square nautical miles
- Use variable net width for area swept calculations instead of fixed 50' net width
 - 1975-1980 net width determined to be 12.19m
 - 1976 used tows from vessels towing 83-112 instead of 400 eastern: net width = 17m for those tows
 - 1981 used vessels towing both 400 eastern and 83-112: net widths were 13.4m and 14.3m for 400 eastern, and 18m for 83-112
 - 1982-current, net width calculated using net mensuration equipment or calculated using inverse relationship between net scope and net width
- Completed Oracle scripting of programs to generate abundance, biomass, and variance estimates

C. Other Considerations

- Bristol Bay retow years (rkc only): in cold weather years, resurvey of some stations in Bristol Bay deemed necessary as rkc females have not yet gone through the molt/mate cycle in June, when Bristol Bay is normally surveyed. Methods of analyzing the data have been inconsistent:
 - 1999 – 2000; 2006-2009 data for both male and female rkc was averaged
 - 2010-2011 males were averaged; for females, leg 3 data replaced leg 1 at retow stations
 - 2012 leg 1 males; for females, leg 3 data replaced leg 1 data at retow stations
 - Since the purpose of the retow is to assess the size of female rkc after molt and also to assess reproductive condition, we should use leg 3 data for females and leg 1 for males
- “hot spots”
 - Prior to 1994, there was no established method for determining when or if to retow a station based on “high” incidence of legal king or Tanner crab in the catch. In 1977, 1984, 1990, 1991, and 1993 additional tows were made in the vicinity of what was considered to be a high incidence of red king crab: number of crab that initiated additional sampling and number of tows made was not consistent from year-to-year.
 - Rationale for additional sampling was to reduce variability in population estimates
 - Hot spot protocol established in 1994: when 100 or more legal-sized king or bairdi Tanner were caught at a standard station, 4 additional tows were made 0.5 nmi north, south, east, and west of the original station. Standard trawl protocol was followed for the additional tows.
 - Hot spot towing was discontinued effective 2011
 - Deemed inappropriate as practice is not statistically sound (post hoc sample)
- Corner stations

- Higher density sampling at standard station corners in Pribilof and St. Matthew Island Districts
- Pribilof corners 1981 (consistent sampling), St. Matthew corners 1983
- Leave in as these stations have been towed consistently and consecutively enough that they do not bias the time series
- “AZ0504”
 - Station originally planned as Z-04, but center of Z-04 is beyond the 200m bathymetry boundary. Over the years, tow location moved from Z-04 to the corner of columns 4 and 5, rows Z and A. Station assignment based on point-in-polygon methodology often finds this station in the A-04 cell, making A-04 a multi-tow station. In the new analyses proposed, tows at AZ0504 have been dropped.

II. Other Data Sets

A. Additional Data

In addition to the standard 1975 – 2013 EBS bottom trawl survey data sets, non-standard survey data were also collected. The extent of these data ranges from a handful of tows (special projects) to full-scale surveys (OCSEAP, triennial, synoptic, winter).

III. 2014 Workshop recommendations

1. select one "standard haul" (HAUL_TYPE=3) per station for each station at which standard hauls were conducted,
 2. assign stations to the same standard strata for all years (Prib's MTCA, St. Matt's MTCA, rest of west 166W, east 166W),
 3. calculate average CPUE (numbers and weight) and standard errors by year over all sampled stations for each stratum,
 4. report the area in each valid stratum by year (i.e., the sum of grids associated with sampled stations),
 5. provide results (average CPUE in numbers and weight) by year, stratum, and sex, as well as by year, stratum, sex, shell condition, maturity state (for females) and size (1mm bins).
- Unmeasured (“crushed”) crabs have been encountered in the survey in some years. Available biological sample information should be used to characterize these catches, preferably from the same tow. If no crabs were measured in a tow, adjacent similar tows can be used. The file of data supplied to assessment authors should clearly indicate which crab were actually measured and which ones were ‘inferred’.
 - Biological information should be included in the file provided to assessment authors with sufficient information that the sum of the measured crabs, after accounting for the sampling fraction, would match the observed haul weight for the species. The information provided in the past did not always satisfy this specification: for example, when the haul was not completely sampled, there were “crushed” crabs in the tow, or the length-weight regression differed from that assumed.
 - Representative maturity information for Tanner and snow crab should be collected. Mature male Tanner crabs are identified based on chela height using a functional relationship that assumes fixed proportions of mature and immature males by size category across years. This is unlikely to be correct, given annual variation in recruitment. The workshop identified that separating mature and immature males by size

category was analogous to the use of an age-length key in groundfish surveys and noted that such keys are never applied across years. Consequently, the current practice, which summarizes sampling over a 30 year period, is not correct. The workshop recognizes that changing this method should not be implemented without careful consideration of the consequences. The workshop recommended that a future modeling workshop consider how the Tanner and snow crab models should be modified to use the information on the proportion mature by length over time.

IV. NEW time series

- Identify new time series appropriate for stock assessment
- Considerations
 - Spatial coverage
 - Avoid bias associated with multiple tows at station
 - Tow duration (avoid 1-hour tows)
 - Increase coverage where possible using available data, while maintaining consistency with survey timeframe, gear, tow duration, standard density (one tow per station)
- Standardize strata for opilio for total EBS (single and MTCA)
- To accomplish this goal, data sets were created based on **4 scenarios**
 1. Current data set
 2. 1 tow per station, include corner stations, increase coverage where possible, analyze Bristol Bay rkc retow years using leg 3 data for both male and female rkc
 3. 1 tow per station, include corner stations, increase coverage where possible, analyze Bristol Bay rkc retow years using leg 1 data for male rkc and leg 3 data for female rkc
 4. 1 tow per station, exclude corners, do not increase coverage, analyze Bristol Bay rkc retow years using leg 3 data for both male and female rkc