**Special Publication No. 07-11**

# Summary of the Interagency Crab Research Meeting held December 13–15, 2006

**by**

**Joel Webb**

**and**

**Doug Woodby**

**May 2007**

**Alaska Department of Fish and Game** **Divisions of Sport Fish and Commercial Fisheries**

## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Measures (fisheries)**

| | |
|---|---|
| fork length | FL |
| mideye-to-fork | MEF |
| mideye-to-tail-fork | METF |
| standard length | SL |
| total length | TL |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | *e* |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | *E* |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*SPECIAL PUBLICATION NO. 07-11*

# SUMMARY OF THE INTERAGENCY CRAB RESEARCH MEETING HELD DECEMBER 13-15, 2006

by

Joel Webb
Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau

and

Doug Woodby
Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

May 2007

The Division of Sport Fish Special Publications series was established in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and other documents that do not fit in another publication series of the Division of Sport Fish. Since 2004, the Division of Commercial Fisheries has also used the same Special Publication series. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone editorial and peer review.

*Joel Webb*
*Alaska Department of Fish and Game, Division of Commercial Fisheries,*
*Headquarters Office, 1255 W. 8th St. P.O. Box 25526, Juneau AK, USA*

*and*
*Doug Woodby*
*Alaska Department of Fish and Game, Division of Commercial Fisheries,*
*Headquarters Office, 1255 W. 8th St. P.O. Box 25526, Juneau AK, USA*

*This document should be cited as:*
*Webb, J. B., and D. Woodby. 2007. Summary of the Interagency crab research meeting held December 14-16, 2005. Alaska Department of Fish and Game, Special Publication No. 07-11, Anchorage.*

# TABLE OF CONTENTS

**Page**

# TABLE OF CONTENTS (Continued)



# LIST OF APPENDICES

**Appendix** **Page**

# ABSTRACT

The thirteenth annual interagency crab research meeting was held in Anchorage, Alaska from December 13-15 2007. There were approximately 50 participants representing the Alaska Department of Fish and Game, the National Marine Fisheries Service, the North Pacific Fishery Management Council, the School of Fisheries and Ocean Sciences of the University of Alaska Fairbanks (UAF), the University of Alaska Southeast (UAS), and the School of Aquatic and Fisheries Science of the University of Washington. The guest speaker was Dr. David Armstrong, who spoke on recent snow crab research in eastern the Bering Sea. Twenty-two additional presentations were made providing updates of ongoing crab research. The next meeting is planned for December 12-14, 2007 in Anchorage.



Key words: Alaska crab research, red king crab, snow crab, Tanner crab, Dungeness crab, golden king crab


# PURPOSE

This report summarizes the twelfth annual interagency crab research meeting, held December 14–16 in Anchorage at the Hilton Anchorage Hotel. The interagency crab meetings began in 1993 and are held annually as prescribed in the "State/Federal Action Plan for Management of Commercial King and Tanner Crab Fisheries[1]," an agreement between the National Marine Fisheries Service (NMFS) and the Alaska Department of Fish and Game (ADF&G). This meeting continued the tradition of providing an informal opportunity for researchers from each of the active crab research centers to present their work on Alaskan crab species among peers.

# PARTICIPANTS

The 2006 meeting was attended by approximately 60 participants representing ADF&G, NMFS, the North Pacific Fishery Management Council (NPFMC), the School of Fisheries and Ocean Sciences of the University of Alaska Fairbanks (UAF), University of Alaska Southeast (UAS), and the School of Aquatic and Fisheries Science of the University of Washington. A list of participants and contact information is included in Appendix 1.

# PRELIMINARIES

The meeting was jointly chaired by Doug Woodby and Russ Nelson and audio-visual operations were run by Joel Webb. Following introductions and welcoming remarks, the draft agenda (Appendix 2) was adopted without change.

# ACKNOWLEDGEMENTS


The authors thank the presenters for providing us with electronic copies of their slide presentations, allowing us to faithfully summarize the material presented. The authors of this report accept responsibility for errors in interpretation.


# SUMMARY OF PRESENTATIONS

The order of presentations follows the agenda (Appendix 1), which was organized roughly by contributing group, University, NMFS, and ADF&G.

[1] Appendix A of the Fishery Management Plan for the Commercial King and Tanner Crab Fisheries of the Bering Sea/Aleutian Islands, July 18, 1998. A revised agreement was signed in April, 2006.

## SPECIAL TOPIC: EASTERN BERING SEA SNOW CRAB LIFE HISTORY AND POPULATION DYNAMICS

### The environmental ratchet hypothesis tightens on snow crab in the Bering Sea: larval advection, lurking cod, and languishing females – Dave Armstrong, School of Fisheries and Aquatic Sciences, University of Washington

The environmental ratchet hypothesis proposed eight hypotheses to explain shifts in the distribution and decreased abundance of female eastern Bering Sea snow crab. Subsequent investigations combining analysis of temporal and spatial dynamics and linkages among life history stages have contributed to understanding of changes in snow crab distribution and populations dynamics over the last three decades. The NMFS shell condition index was used to identify and track "pseudocohorts" from the molt to maturity through successive years. Time-lagged contraction of female distribution from SE to NW tracked closely with a five year period of increasing bottom temperatures and northward movements observed in the southern Bering Sea during the late 1970s. Spatial analyses found that individual females undertake ontogenetic migrations onshore to offshore (NE to SW) over distances from 50 to 150 km. Previously, successful recruitment may have been related to strong spring phytoplankton blooms and favorable thermal conditions (0°–2°C) for early juvenile instars. The range of females has not expanded southward in recent cold years and current patterns do not favor larval transport southward. The ranges of predatory fish, including Pacific cod, expanded northward with warmer water temperatures and may control the southern boundary of female distribution. The current distribution of the spawning population is north of the historic distribution and larval advection patterns are unlikely to supply larvae back to the south. This combination of factors may explain the asymmetry of response to changing environmental conditions with the conclusion that fishery removals of male snow crab may not be responsible for the range contraction and decreased abundance of snow crab in the eastern Bering Sea. A model has been developed to study larval transport from release to settlement in the Bering Sea. Years of cold and warm ocean conditions are being used to test the model; preliminary results indicate that a proportion of larvae may be advected off the continental shelf or settle in areas with bottom temperatures unsuitable for juveniles. Future work will combine the larval transport and settlement model with actual female reproductive parameters and temperature-dependent larval growth to investigate historical patterns of larval settlement.

## CONTRIBUTED TALKS

### Further developments of a three-stage catch survey analysis for Kodiak red king crab – Bill Bechtol, University of Alaska Fairbanks, Juneau

The fishery for red king crab *Paralithodes camtschaticus* in the Kodiak Island area declined after peak harvests in the 1960s and was closed to harvest in 1983. Retrospective catch survey analyses were undertaken to reconstruct historical spawning stock abundance and recruitment, estimate a stock-recruit relationship, and investigate temporal changes in abundance and distribution in relation to environmental and fishery effects. Fishery effort was focused nearshore in the 1950s, progressed offshore with larger catches in the 1960s, and was widely dispersed with low overall catches in the 1980s. Historic abundance and biological data from trawl surveys, pot surveys, and tagging studies were used with fishery catch information to construct a stock dynamics model. Pot survey data had a strong influence on the time series, had relatively low catchability, and matched well with model results while trawl data had less influence and

high catchability. Model results indicated relatively high but variable abundance in early and late 1970s followed by a recruitment failure in the early 1980s.

### Ecdysteroids in Glacier Bay Tanner crabs: Comparison of molting hormones to claw allometry – Sherry Tamone, University of Alaska Southeast, Juneau

The presence of determinate growth or a terminal molt in male Tanner crab *Chionoecetes bairdi* has been the subject of past debate and is important for fisheries management. The ratio of chelae height to carapace width has often been used to classify males which have teminally molted and have acquired large-claw status. Of a variety of methods for assessing molt status, accurate, non-lethal molting-hormone assays applied to large sample sizes may be preferred. Morphometrics and hemolymph data were collected from male Tanner crab in Glacier Bay, Alaska in 2003 and 2005 to confirm that the large-claw allometry was a practical assessment of terminal molt. Molt increment modeling demonstrated that small-claw males can attain chelae-height and carapace width characteristics similar to those observed in large claw males in a single molt. Small-clawed males, determined by a chela-height to carapace width ratio less than 0.18 had higher molting hormone levels than large-claw males which had uniformly low molting hormone levels indicating that large-claw males are unlikely to molt. Large proportions of sublegal large-claw males observed in Glacier Bay and Kachemak Bay may be of concern to fisheries managers.

### Dungeness crab *Cancer magister* megalopal dynamics in greater northern Southeast Alaska – Quinn Smith, University of Alaska Fairbanks, Juneau

The zoeal stages of Dungeness crab move offshore and return to shore as megalopae along the west coast of the U.S. via prevailing currents, wind, and tidal transport. Patterns may be different in Southeast Alaska due to complex shorelines, island archipelagos, and downwelling coastal currents. Previous studies indicated that Dungeness zoeae may be exported from Glacier Bay and megalopal abundance was higher near the mouth of the bay in the fall. In 2005, light trap sampling showed that peak megalopal abundance was observed in Berner's Bay during the new moon, and matched patterns of abundance in Glacier Bay lagged by several days—indicating that tidal transport of megalopae is likely. In 2006, light trap sampling was conducted for two weeks in late September at nine sites in northern Southeast Alaska. Abundance of Dungeness megalopae peaked at stations in Chatham Strait prior to peaking in Icy Strait but abundance was higher in Icy Strait. Megalopae sampled in Icy Strait were significantly larger than those from Chatham Strait. Differences in timing and size suggest that larval transport and source populations may be different between these two areas.

### Seasonal movement and aggregation of sonic-tagged adult female Tanner crabs and red king crabs in Glacier Bay, Alaska – Julie Nielsen, University of Alaska Fairbanks, Juneau/United States Geological Survey

Mature female Tanner crab and male and female red king crab from Glacier Bay, Alaska were tagged with sonic tags to investigate patterns of seasonal movement and to determine if female Tanner crab aggregate in the spring similar to large aggregations observed near Kodiak, Alaska. Advanced tag technology allowed tracking of multiple tags over large areas with resolution suitable for assessing movement of populations. Individual locations were determined at six-week intervals during winter and two-week intervals in April and May. Preliminary results indicate that male and female red king crab occurred together, were aggregated during late

winter/spring, and may have discrete summer, winter, and reproductive ranges. Sudden movements potentially associated with red king crab reproduction occurred in May. Female Tanner crab aggregated at depths of 100–150 m prior to larval release, with a lag in aggregation and larval release timing observed between two locations ~ 5 km apart. Some females made brief movements to shallower water then returned to deeper water as aggregations dispersed.

### Reproductive dynamics of multiparous female Tanner crab in Glacier Bay, Alaska – Joel Webb, ADF&G, Juneau

Monitoring of population reproductive potential and understanding reproductive biology are important for management of exploited crustacean populations. Improved methods of assessing fecundity and mating history are needed. Several laboratory studies have examined sperm reserves and fertilization for multiparous female Tanner crab in the laboratory but field studies have focused on primiparous females. Concurrent with a seasonal movement study multiparous female Tanner crab were collected from Glacier Bay, Alaska at two-week intervals prior and subsequent to hatching and mating and assessed for sperm reserves, fecundity, and egg fertilization in the laboratory. Hatching, mating, and egg extrusion occurred from late-April to mid-May. Mated females had significantly higher sperm reserves by weight (41%), sperm cell count (66%), and sperm per gram of spermathecal load (51%) indicating a substantial decrease in sperm cell counts during sperm storage. All mated females had grasping marks on the second and third walking legs while unmated females did not. Both mated and unmated females successfully fertilized full egg clutches. Egg cleavage stages which are important for determining fertilization status were completed 21 days post-hatch. Analyses indicated that the fecundity of a single pleopod is a reliable predictor (97% – 99%) of overall fecundity across a range of clutch sizes for multiparous female Tanner crab.

### Shell “age” or shell “condition”: Both or neither? – Doug Pengilly, ADF&G, Kodiak

Shell condition and shell age are often used interchangeably but the implications of this are not often discussed. Shell condition data is collected by survey biologists and dockside samplers and is used by a third group of analysts. Differences in the timing of data collection (summer vs. fall/ winter), experience in data collection, and work environment are likely to affect the data quality. Shell condition indices are based on subjective criteria, differ among research groups, lack clarity relating “age” to “condition”, and are not supported by strong empirical research. Contrasting substrate preferences among commercially harvested species are one factor likely to affect rates of shell wear and color changes confounding shell condition as an indicator of age. Tagging study results for both red king crab and snow crab show that shell condition may not be representative of shell age, possibly due to differences in personnel collecting data or poor performance of criteria. Removal of references to life cycles and time from shell condition indices, formulation of objective rather than relative criteria, and collaboration among researchers to establish improved indices is recommended.

### Overview of research in the NMFS shellfish program – Frank Morado, National Marine Fisheries Service, Kodiak

Liz Chilton – Publication of Eastern Bering Sea survey reports; updating of red king crab, Tanner crab, and snow crab size-weight relationships.

Jan Haaga – Eastern Bering Sea survey staffing and logistics; graphics specialist; image archive creation and maintenance; reproductive biology of the hairy crab.

Lou Rugolo – Eastern Bering Sea survey reports; Crab Plan Team.

Kathy Swiney – Extrusion, incubation period, and embryo development of primiparous and multiparous Tanner crabs.

Erik Munk – Tanner crab *in situ* distribution, reproductive dynamics study in Women's Bay, Kodiak Island.

Scott Van Sant – Golden king crab embryonic development, hatching, and survival with varying density and temperature.

Susan Payne – Reproductive biology, embryo incubation, hatching, and egg extrusion of the hairy crab.

Claire Armistead – Maintenance and updating of Eastern Bering Sea survey database; publication of Eastern Bering Sea survey reports.

Mike Litzow – Community structures in relation to cold pool retreat in the Eastern Bering Sea.

## Bitter crab research in *Chionoecetes*: updates and new directions – Pam Jensen, National Marine Fisheries Service, Seattle

Reports of the parasitic dinoflagellate *Hematodinium* sp. in decapod hosts have increased worldwide since the 1980s, at times with high prevalence. In *Chionoecetes* spp., the infection is termed bitter crab syndrome (BCS). Infection results in host mortality; altered flavor and texture make infected crab meat unmarketable. Ongoing research is focused on *Hematodimium* detection, identification, life history and modes of transmission. Traditional techniques of detecting BCS by hemolymph smears are time consuming and relatively insensitive. A polymerase chain reaction (PCR)-based assay has been developed for diagnostic identification of *Hematodinium* in *Chionoecetes* spp. Using the assay, *Hematodinium* can be detected in crab hemolymph samples with high accuracy, large-sample sizes, and low cost-per-sample. Sequencing studies of *Hematodinium* from multiple crustacean hosts indicate that two species are likely in the northern hemisphere. Further research is needed into prevalence, transmission, reservoirs, and host mortality rates; recent detection of *Hematodinium* sp. in a scarlet king crab may be of concern.

## Alaskan king crab enhancement – Sara Persselin, National Marine Fisheries Service, Kodiak

Persistent low abundances in a few areas despite fishery closures have prompted interest in enhancement of king crab stock in Alaska. A workshop on crab enhancement was held in spring 2006 in Kodiak, Alaska. The objectives of the stock enhancement project are to determine the feasibility of large scale culture of blue and red king crabs and eventually release hatchery-reared juveniles to enhance natural populations. Red and blue king crabs were collected in 2006 from Kodiak Island and the Pribilof Islands, respectively. Experiments will be conducted in spring 2007 to determine optimal diets, larval density, and tank size for rearing. Future research will focus on developing enclosures for acclimation and predator protection upon release, tagging methods for released juveniles, and genetics/pathology concerns.

## Crab studies in Women's Bay, Kodiak, Alaska using SCUBA – Peter Cummiskey, National Marine Fisheries Service, Kodiak

Women's Bay is a protected bay located adjacent to the city of Kodiak on Kodiak Island, Alaska. Pods of red king crab were first observed in Women's Bay in the 1960s. In recent years, individuals have been marked with sonic tags allowing repeated observations and tracking of pod movements by divers. Data on molt increment and molt timing were collected during observations. In one exceptional case an individual pod was tracked for four years. Males and females of similar size podded together in the winter and fall and dispersed to some extent in the summer. Specific areas were associated with molting, which was often synchronous, and occurred primarily at night. Pods have been observed to meet and merge. When crab reached >100 mm carapace length groups were more dispersed but crab still occurred in smaller aggregations. Mature crabs occur in deeper water but some stayed within Women's Bay through ontogeny. It is possible that some crab complete their life cycle in Women's Bay.

## State of the region: Tanner crab in southeastern Alaska – Chris Siddon, ADF&G, Douglas

Multiple sources of catch, effort, and abundance including landings, logbooks, and survey data exist for Tanner crab in Southeast Alaska. Comparison of these data sources for agreement or contrast is important for management of the species. Catches in the Tanner crab fishery in southeast Alaska peaked in the early 1980s, fluctuated above the long-term average in the 1990s, and decreased since 2000 to about one-half the long-term average. Fishery effort also decreased but did not completely explain reduced catches. Catch, logbook, and pot survey data were compared and incorporated in a three-stage catch-survey analysis model. Correspondence of standardized commercial and survey catch per unit effort (CPUE) among six core areas ranged from good to poor and comparisons were data-limited in two areas. Overall trends in CPUE contrasted among core areas with three areas above average or increasing, two areas lower than average, and one area at lower than average but likely to increase.

## Development of an onboard observer program for Southeast Alaska golden king crab – Gretchen Bishop, ADF&G, Douglas

There is currently no abundance-based management system for golden king crab in Southeast Alaska and life history information is limited. After high catches in the 1980s, catches decreased substantially in the mid 1990s, and subsequently recovered and stabilized. The fishery is managed by permit, pot, size, sex, and season limits. Stock assessment and biological data are collected from fish tickets, logbooks, dockside sampling, and limited onboard observer coverage. Dockside sampling and limited observer data collected in past years has been useful for detection of pre-recruit and post-recruit age classes. An onboard observer program was established with fleet support in 2006 to collect data with the objective of collecting accurate information on crab abundance, life history, habitat, fishing techniques, bycatch, and gear loss. Observer data collection will allow monitoring of trends in pre-recruit and recruit populations, female size, and female clutch condition.

## Relative abundance of golden king crab in Prince William Sound – Ken Goldman, ADF&G, Homer

A pot survey was conducted for three years in western Prince William Sound (2004–2006) to determine the relative abundance and distribution of golden king crab. Mark–recapture and soak-

time/bait studies were also undertaken to examine movement and optimal sampling methods. Catch did not vary significantly with depth or temperature, but higher CPUE values were observed at depths > 200 m and CPUE was most consistent at depths of 300–400 m. CPUE was maximized in pot soak-time experiments after 48 h versus 24 h soak times with nylon mesh bait bags versus plastic bait jars. Surplus production modeling was not feasible as no tagged crab were recovered. Comparisons with historical survey data and commercial fishery CPUE data indicated a lack of surplus production in this stock and a fishery is not recommended at this time.

### Spatial distribution of tag recoveries in the Aleutian Islands golden king crab fishery – Leslie Watson, ADF&G, Kodiak

The division between management areas in the Aleutian Islands golden king crab fishery was moved from 171° to 174°W longitude in 1996–1997. Over 60% of the total Aleutian Islands commercial harvest occurs from 170° to 172°W with a consistently higher proportion from 171° to 172°W. A pot survey has been conducted in the area from 170° to 172°W triennially. A tagging study was conducted during each survey to obtain information on movements, harvest rates, and abundance. Legal size males (7,167) sub-legal males (14,406), and females (5,913) were tagged and released in 1997, 2000, and 2003 with subsequent legal-sized male recovery rates of ~20% in 1997 and 2000 and ~10.5% in 2003 in the winter fishery. Recovery rates decreased two years post-tagging at 6.6% in 2000 and 3.6% in 2003. Recovery rates also varied between areas with higher recoveries east of 171°W in 1997 and 2003 but similar recovery rates between areas in 2000. First year female recovery rates (~3–7%) were less than those of sublegal males (~7–23%) in both areas. Tagged crab of all size and sex classes were consistently more likely to be recovered at the longitude of release than at other longitudes.

### Estimates of red king crab bycatch during the 2005–2006 Bristol Bay fishery with comparisons to the 1999–2004 seasons – David Barnard, ADF&G, Kodiak

The Bristol Bay red king crab fishery was rationalized in 2005. Ending the “race for fish” and bycatch reduction were among the goals of this management change. An associated management concern was the possibility of increased legal male discard in the fishery in an effort to maximize the value of retained catch. Data collected by onboard observers were used to compare legal male discard rates between seasons prior to (1999–2004) and post-rationalization (2005–2006). Mean soak time per pot in the non-community development quotient fishery doubled while retained legal male CPUE was similar in 2005–2006 versus 1999–2004. Discard rates for old-shell males were higher than those for new shell males. Estimates of total discarded red king crabs were among the highest observed in 2005–2006. Non-retained legal male discard was highest in 2005–2006 among all seasons in terms of CPUE, percentage of legal catch, and absolute number.

### Westward region marine resource assessment: An overview of trawl survey methods and brief description of special projects – Kally Spalinger, ADF&G, Kodiak

The Westward region marine resource assessment survey is conducted annually from the ADF&G research vessel Resolution using a 400-mesh Eastern otter trawl to sample stations around Kodiak Island, along the southern coast of the Alaska Peninsula, and as far west as Unalaska Island. Catches are typically subsampled and weighed, fish and crab are identified to species, size and biological information are recorded electronically, and data are downloaded directly to trawl survey databases. Survey data is used to determine Tanner crab fishery openings

and for setting guideline harvest levels. Numerous special projects are conducted annually during the survey, including monitoring for bitter crab syndrome, chelae-height/carapace width, fecundity and brood symbionts in Tanner crab, and tissue sampling for red king crab genetics research. Tagging of Pacific cod, pollock otolith collection, dogfish diet and spine collection, and skate sampling are further examples of the many groundfish research projects that take place during the survey. Requests for collections are accepted with necessary permits and should be submitted to ADF&G Kodiak by April.

## Bering Sea snow crab, 2005 pot survey and tagging, 2005–2006 fishery and recoveries – Doug Pengilly, ADF&G, Kodiak

Recent mismatch in the survey estimate of large male distribution and winter fishery effort and catch for large male snow crab in the eastern Bering Sea have led to concern about the need for management measures to equalize exploitation rates. In 2004, the survey estimated that 26% of large male abundance was south of 58°30′N latitude but 66% of harvest was from south of 58°30′N. Possible explanations for this include one-way seasonal migration of large males from the middle to the outer shelf in the winter and back to the mid-shelf in the summer, one-way ontogenetic migration from the middle to the outer shelf, or trawl survey underestimates of large-male abundance. To examine movement and changes in distribution of large males on the Eastern Bering Sea shelf, 615 large males were captured by pot and tagged in the northern area (60.5° to 61.5°N) NW of St. Matthew Island, 2,576 males were tagged on the southern mid-shelf (~58° to 59°N), and 5,257 were tagged on the southern outer-shelf. Tagged large males were recovered at an overall rate of 11% in the 2005–2006 winter and spring fishery, but the recovery rate was only 1.1% for males from the northern area. Patterns of tag recovery indicated that (A) aouthern area males were 10× more likely to be captured in the fishery than northern area males, (B) large males tagged on the mid-shelf in the summer were captured in the outer-shelf fishery during the winter, and (C) mid-shelf tagged crabs were recovered to the south of their summer distribution, but outer-shelf crabs were either sedentary or may have moved northward. The lack of representation in the fishery of males distributed in the northern area and potential survey underestimation of large male abundance on the outer shelf during the summer are of management concern.

## Crab larval advection and recruitment in the eastern Bering Sea – Jie Zheng, ADF&G, Juneau

Recent catch and abundance of Bristol Bay red king crab (BBRKC) and eastern Bering Sea snow crab (EBSSC) have been low compared to historical highs. With some variability recruitment for these stocks has also been lower in recent years compared to peaks in past decades. Northward shifts in distribution of mature females have been observed for both Bristol Bay red king crab and eastern Bering sea snow crab since the 1970s. Immature crab distributions are generally down current from adult female distribution so patterns of larval advection are likely to be important in successful recruitment. The OSCURS model of surface circulation was used with variable start dates, larval durations based on temperature, and annual start points to investigate historical patterns (1967–2004) of larval advection for BBRKC and EBSSC. For BBRKC, the larvae tended to settle more in the north in the early and mid-1980s and more in the south in the late 1960s and mid-1970s. Larvae hatched earlier tended to settle more in the west. For snow crab, settling locations shifted to the north greatly during the late 1970s and gradually during the 1980s and 1990s. Like red king crab, larvae hatched earlier tended to settle more in the west for

snow crab. Simulation results indicate that larvae of both species hatched later or in the southern portions of their range may have greater chances of settling in favorable habitats and the that northward shifts in the distribution of mature females made it difficult to supply larvae back to the southern portions of their range. Changes in settling locations over time may have affected recruitment strength for Bristol Bay red king crab; larvae associated with strong year classes were dispersed to suitable nursery areas throughout Bristol Bay. Larval advection could not consistently explain strong and weak year classes for snow crab; other factors may play a very important role in recruitment success.

### Crab data management: Ideas and priorities – Joel Webb, ADF&G, Juneau

Evolution of technology and personnel turnover among shellfish staff presents a challenge for accurate cataloging and retention of research and management datasets. Recently, efforts have been undertaken to standardize data collection methods and migrate historical data to common formats. However, a common index of metadata or descriptions of datasets is still lacking. Rather than collecting historical datasets and dealing with issues of access, format, and organization, use of a metadatabase system which inherently organizes and describes data is a preferred alternative. Development and deployment of an ADF&G shellfish metadata database modeled after the North Pacific Ecosystem Database will be undertaken in 2007. Web-based submission, access, and editing are envisioned. A robust, metadata-linked, data-storage system with common formatting will be concurrently developed for long term storage of smaller datasets.

### Prince William Sound survey results 2005 – Bob Berceli, ADF&G, Cordova

The Dungeness crab fishery in Prince William Sound closed in 1992 after catches peaked in the late 1970s and 1980s before declining to low levels. Gill netters have reported legal male Dungeness bycatch in the Copper River/Controller Bay area, but this has not been quantified. Pot survey results in 2005 indicated a slightly higher survey CPUE for legal male Dungeness (~2 crabs/pot) but not enough to consider a fishery. Deep water pot sets caught more legal, sublegal, and oldshell males in 2005 than shallower sets.

### Overview on Bering Sea/Aleutian Islands crab overfishing definitions – Diana Stram, North Pacific Fishery Management Council, Anchorage

Crab fisheries in the Bering Sea/Aleutian Islands (BSAI) are managed under a cooperative federal/state regime under which fisheries are managed by ADF&G with federal oversight. Management measures are defined as fixed, frameworked, and discretionary under the BSAI fishery management plan (FMP) with differing levels of flexibility. A requirement of the Magnuson-Stevens Fishery Management and Conservation Act is that criteria be developed to identify fisheries that are overfished or approaching this condition. Current overfishing definitions are fixed in the FMP and require an amendment to modify them. These definitions are based on estimates of maximum sustainable yield with fixed natural mortality rates and minimum mature stock size thresholds relative to one-half maximum sustainable yield. Snow crab, Bering Sea Tanner crab, Pribilofs blue king crab, and St. Matthew blue king crab are currently under rebuilding plans. A crab plan team workgroup from NMFS and ADF&G has been working to craft and analyze a new tier-based overfishing definition system. The proposed new system in conjunction with the current definitions will be analyzed for an FMP amendment and will be presented for review to the North Pacific Fishery Management Council in 2007.

**Proposed revision of Bering Sea and Aleutian Islands crab fisheries management plan: Analysis of the proposed tier system – Shareef Siddeek, ADF&G, Juneau, and Diana Stram, North Pacific Fishery Management Council**

A tier system of overfishing definitions has been proposed by the overfishing definitions workgroup of the crab plan team for the Bering Sea/Aleutian Islands (BSAI) crab fishery management plan (FMP). Six tiers for the 22 BSAI FMP crab stocks have been proposed. The tiers and stocks recommended for inclusion in each tier were described.

Tier 1: The overfishing level fishing mortality is the arithmetic mean of $F_{MSY}$ distribution applied to a mature male biomass based function of fishing mortality control rule

No stocks

Tier 2: The mature male biomass based fishing mortality control rule with a point estimate of $F_{MSY}$

No stocks

Tier 3: The mature male biomass based fishing mortality control rule with a point estimate of $F_{35\%}$ as a proxy $F_{MSY}$. $B_{35\%}$ is the proxy $B_{MSY}$ for this Tier.

Eastern Bering Sea Tanner crab, snow crab, and Bristol Bay red king crab

Tier 4: The mature male biomass based fishing mortality control rule with a point estimate of $\gamma M$ as a proxy for $F_{MSY}$. A proxy $B_{MSY}$ estimate is needed to use in the control rule formula for this tier.

Pribilof and St. Matthew blue king crab; Pribilof, Norton Sound, and Eastern Aleutian Islands red king crab; Eastern Aleutian Islands Tanner crab

Tier 5: There is no biomass based control rule formula, but the overfishing level is determined as the average catch from 1985–2005 unless otherwise specified by scientific and statistical committee

Aleutian Islands and Pribilof Islands golden king crab, western Aleutian Islands red king crab, and eastern Bering Sea grooved Tanner crab

Tier 6: There is neither biomass based control rule nor overfishing level for this tier due to insufficient available information

Stocks with incidental or exploratory fisheries: Western Aleutian Islands Tanner crab, Aleutian Islands scarlet king crab, eastern Bering Sea scarlet king crab, Bering Sea triangle Tanner crab, St. Matthew golden king crab, St. Lawrence blue king crab, eastern Aleutian Islands triangle and grooved Tanner crab, western Aleutian Islands grooved Tanner crab

Analyses of the performance of different tiers especially $F_{MSY}$ versus a proxy $F_{MSY}$ (e.g. $F_{35\%}$) were conducted for stocks with adequate information available. Stochastic simulations of short- (30 y) and long- (100 y) term fisheries indicated that overfishing limits approximating $F_{35\%}$ under mature male biomass as the spawning index were appropriate for Bering Sea snow and Tanner crab and Bristol Bay red king crab under the proposed tier system.

## PLANS FOR 2007

The annual Alaskan crab research meetings continue to be productive and valuable for free exchange of scientific results, ideas, and perspectives. A 13th annual meeting is expected to be scheduled for the approximate dates of December 13–15, 2007 in Anchorage.

## PROPOSALS FOR NEXT YEAR'S SPECIAL TOPIC

1. At-sea electronic data collection/sampling
2. Novel methods of measuring natural mortality; mark-recapture techniques
3. Assessing individual and population reproductive potential
4. Habitat assessment and crab essential fish habitat

Proposals for other special topics are welcome. Please submit these to Russ Nelson and/or Doug Woodby.

# APPENDICES

**Appendix 1.–**List of participants at the 2006 interagency crab research meeting.

| Last Name | First | Affiliation | Location | Email |
|---|---|---|---|---|
| Allee | Brian | ASG/UAF | Fairbanks | brian.allee@sfos.uaf.edu |
| Alinsunurin | Rachel | ADF&G | Dutch Harbor | rachel_alinsunurin@fishgame.state.ak.us |
| Armstrong | David | SAFS/UW | Seattle | davearm@u.washington.edu |
| Barnard | David | ADF&G | Kodiak | david_barnard@fishgame.state.ak.us |
| Bechtol | Bill | UAF | Juneau | b.bechtol@uaf.edu |
| Bednarski | Julie | ADF&G | Douglas | julie_bednarski@fishgame.state.ak.us |
| Berceli | Bob | ADF&G | Cordova | robert_berceli@fishgame.state.ak.us |
| Bishop | Gretchen | ADF&G | Douglas | gretchen_bishop@fishgame.state.ak.us |
| Bowers | Forrest | ADF&G | Dutch Harbor | forrest_bowers@fishgame.state.ak.us |
| Burt | Ryan | ADF&G | Dutch Harbor | ryan_burt@fishgame.state.ak.us |
| Byersdorfer | Susie | ADF&G | Kodiak | susie_byersdorfer@fishgame.state.ak.us |
| Cummiskey | Pete | NMFS | Kodiak | pete_cummiskey@noaa.gov |
| Donaldson | Wayne | ADF&G | Kodiak | wayne_donaldson@fishgame.state.ak.us |
| Failor | Barbi | ADF&G | Dutch Harbor | barbi_failor@fishgame.state.ak.us |
| Gish | Robert | ADF&G | Kodiak | robert_gish@fishgame.state.ak.us |
| Gustafson | Rich | ADF&G | Homer | richard_gustafson@fishgame.state.ak.us |
| Hulbert | Lee | ADF&G | Juneau | lee_hulbert@fishgame.state.ak.us |
| Jensen | Pam | NMFS | Seattle | pam.jensen@noaa.gov |
| Lloyd | Denby | ADF&G | Juneau | denby_lloyd@fishgame.state.ak.us |
| MacIntosh | Katya | ADF&G | Kodiak | katya_macintosh@fishgame.state.ak.us |
| Mattes | Lynn | ADF&G | Kodiak | lynn_mattes@fishgame.state.ak.us |
| Mccullough | Jim | ADF&G | Kodiak | jim_mccullough@fishgame.state.ak.us |
| Menard | James | ADF&G | Nome | jim_menard@fishgame.state.ak.us |
| Milani | Krista | ADF&G | Dutch Harbor | krista_milani@fishgame.state.ak.us |
| Morado | Frank | NMFS | Seattle | frank.morado@noaa.gov |
| Nelson | Russ | NMFS | Seattle | Russ.Nelson@noaa.gov |
| Nielsen | Julie | UAF | Juneau | ftjkn@uaf.edu |
| Pengilly | Doug | ADF&G | Kodiak | doug_pengilly@fishgame.state.ak.us |
| Persselin | Sara | NMFS | Kodiak | sara.persselin@noaa.gov |
| Renfro | Kevin | ADF&G | Douglas | kevin_renfro@fishgame.state.ak.us |
| Sagalkin | Nick | ADF&G | Kodiak | nick_sagalkin@fishgame.state.ak.us |
| Salmon | Melissa | ADF&G | Dutch Harbor | melissa_salmon@fishgame.state.ak.us |
| Savikko | Herman | ADF&G | Juneau | herman_savikko@fishgame.state.ak.us |

-continued-

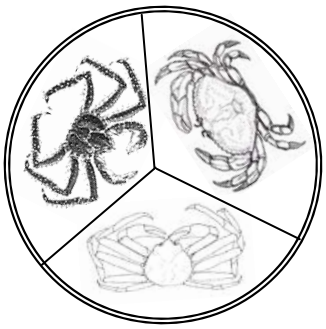
**Appendix 1**.–Page 2 of 2.

| Last Name | First Name | Affiliation | Location | Email |
|---|---|---|---|---|
| Shepard | Ric | ADF&G | Kodiak | ric_shepard@fishgame.state.ak.us |
| Siddeek | Shareef | ADF&G | Juneau | shareef_siddeek@fishgame.state.ak.us |
| Siddon | Christopher | ADF&G | Douglas | chris_siddon@fishgame.state.ak.us |
| Smith | Quinn | UAF | Juneau | q.smith@uaf.edu |
| Spalinger | Kally | ADF&G | Kodiak | kally_spalinger@fishgame.state.ak.us |
| Stram | Diana | NPFMC | Anchorage | diana.stram@noaa.gov |
| Stratman | Joseph | ADF&G | Petersburg | joseph_stratman@fishgame.state.ak.us |
| Szarzi | Nicky | ADF&G | Homer | nicky_szarzi@fishgame.state.ak.us |
| Tamone | Sherry | UAF/UAS | Juneau | sherry.tamone@uas.alaska.edu |
| Trowbridge | Charlie | ADF&G | Homer | charlie_trowbridge@fishgame.state.ak.us |
| Urban | Dan | ADF&G | Kodiak | dan_urban@fishgame.state.ak.us |
| Vining | Ivan | ADF&G | Kodiak | ivan_vining@fishgame.state.ak.us |
| Watson | Leslie | ADF&G | Kodiak | leslie_watson@fishgame.state.ak.us |
| Webb | Joel | ADF&G | Juneau | joel_webb@fishgame.state.ak.us |
| Woodby | Doug | ADF&G | Juneau | doug_woodby@fishgame.state.ak.us |
| Worton | Carrie | ADF&G | Kodiak | carrie_worton@fishgame.state.ak.us |
| Zheng | Jie | ADF&G | Juneau | jie_zheng@fishgame.state.ak.us |

**Appendix 2.–**Final agenda for the 2006 interagency crab research meeting.

# Interagency Crab Research Meeting

December 13-15th, 2006



Hotel Captain Cook
4th and K Streets
Anchorage, AK
907-276-6000

All sessions will be held in the Aft Deck room on the ground floor.

**WEDNESDAY, DECEMBER 13**

**Afternoon Session: 1:00 - 5:00 pm**

I. Introductions

II. Opening remarks: Doug Woodby, Russ Nelson

III. Meeting agenda: Modify and Adopt

IV. Research Review (All presentations will be 20 minutes unless noted)

A. University of Alaska, Alaska Department of Fish and Game

1. Further Developments of a 3-Stage CSA Model for Kodiak Red King Crab – Bill Bechtol, UAF, Juneau
2. Ecdysteroids in Tanner crabs are compared with claw allometry: Further evidence for a terminal molt in the genus Chionoecetes – Sherry Tamone, UAS, Juneau
3. Transport of Dungeness crab (Cancer magister) larvae in greater southeast Alaska – Quinn Smith, UAF, Juneau

Coffee: Mid-Afternoon

4. Seasonal movement and aggregation of sonic-tagged adult female Tanner crabs and red king crabs in Glacier Bay – Julie Nielsen, UAF/USGS, Juneau (30 min)
5. Reproductive dynamics of multiparous female Tanner crab in Glacier Bay, Alaska – Joel Webb, ADF&G, Juneau (30 min)
6. Shell "age" or shell "condition": Both or neither? – Doug Pengilly (ADF&G, Kodiak)

Dinner – Glacier Brewhouse, reservations for thirty people in groups of ten at 5:45 (Joel W.), 6:00 (Doug W.), and 6:15 (Sherry T.).

-continued-

**THURSDAY, DECEMBER 14**

8:00 - 8:30 am Coffee

**Morning Session: 8:30 - 11:30**

B. Invited Speaker
   1. The environmental ratchet tightens on snow crab in the Bering Sea: larval advection, lurking cod, and languishing females. – Dr. David Armstrong, University of Washington (30 min)

C. National Marine Fisheries Service – Alaska Fisheries Science Center
   1. Research activities at the NMFS Kodiak Laboratory – Frank Morado, Seattle
   2. Bitter crab research in *Chionoecetes*: updates and new directions – Pam Jensen, Seattle

Coffee: Mid-Morning (15 minutes)

   3. Alaska King Crab Stock Enhancement and Restoration Program – Sara Persselin, Kodiak
   4. Crab studies in Women's Bay, Kodiak Alaska, using SCUBA – Peter Cumminsky, Kodiak

Lunch: 11:30 am - 1:00 pm

**Afternoon Session: 1:00 - 5:00 pm**

D. Alaska Department of Fish and Game
   1. Comparison of Tanner crab (*Chionoecetes bairdi*) stock assessment methods in southeastern Alaska. – Chris Siddon, Juneau
   2. Development of an observer program onboard commercial golden king crab vessels in Southeast Alaska – Gretchen Bishop, Juneau
   3. Relative abundance of Golden King Crab in Prince William Sound – Ken Goldman, Homer
   4. Spatial Distribution of Tag Recoveries in the Aleutian Islands Golden King Crab Commercial Fishery – Leslie Watson, Kodiak

Coffee: Mid-afternoon (15 minutes)

   5. Estimates of Red King Crab Bycatch during the 2005/2006 Bristol Bay Red King Crab Fishery – David Barnard, Kodiak
   6. Westward region marine resource assessment survey - An overview and description of special projects – Kally Spalinger, Kodiak
   7. Tag recoveries of Bering Sea snow crab as related to the perplexing mismatch between survey and fishery data – Doug Pengilly, Kodiak
   8. Crab larval advection and recruitment in the eastern Bering Sea – Jie Zheng, Juneau (30 min.)

-continued-

**FRIDAY, DECEMBER 15**

7:30 - 8:00 am Coffee

**Morning Session: 8:00 am – 10:00 am**

E. Alaska Department of Fish and Game, continued
   1. Crab metadata: Ideas and priorities – Joel Webb, Juneau
   2. Prince William Sound survey results 2005 – Bob Berceli, Cordova
   3. Proposed revision of Bering Sea and Aleutian Islands Crab Fisheries Management Plan – Available working group members and Diana Stram, North Pacific Fishery Management Council, Anchorage (45 min.)
   4. Proposed revision of Bering Sea and Aleutian Islands crab fisheries management plan: Analysis of the proposed tier system – Shareef Siddeek, Juneau

Next Year's Meeting and Special Topic Suggestions

Other Business

Poster Presentations:

1. Depth distribution of Tanner crab, *Chionoecetes bairdi*, larvae immediately after hatching in Adams Inlet, Glacier Bay, Alaska. Quinn Smith et al., University of Alaska Fairbanks, Juneau

2. Habitat association of Tanner crab, *Chionoecetes bairdi*, in Glacier Bay, Alaska. Joel Webb, Alaska Department of Fish and Game, Juneau