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Summary of the Interagency Crab Research Meeting held December 14–16, 2005

by

Joel Webb

and

Doug Woodby

February 2006

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, χ^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

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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. The meeting opened with a special session devoted to ecosystem management of blue crab on the east coast of the United States.

PARTICIPANTS

The 2005 meeting was attended by 59 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), Virginia Institute of Marine Science, and Natural Resource Consultants. A list of participants and contact information is included in Appendix 1.

PRELIMINARIES

The meeting was jointly chaired and audio-visual operations were managed by Doug Woodby and Russ Nelson. 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.

SPECIAL TOPIC: ECOSYSTEM-BASED MANAGEMENT AND RESTORATION OF THE BLUE CRAB

Ecosystem-Based Restoration and Enhancement of the Blue Crab in Chesapeake Bay - Rom Lipcius (Virginia Institute of Marine Science - The College of William and Mary)

An ecosystem-based management plan has been developed for management of the Blue Crab, *Callinectes sapidus,* in Chesapeake Bay. Ecosystem management accounts for influences other than fishing by incorporating species life history characteristics, food web interactions, food web modeling, habitat features, watershed impacts, marine protected areas (MPAs), and socioeconomic concerns. Blue crab fisheries landings, spawning stocks, and recruitment have all decreased in the past fifteen years. Blue crab life history patterns are beginning to be well understood. Female blue crab migrate from estuaries in upper Chesapeake to the lower bay whey they release larvae, larvae are exported offshore, return to settle in eel grass beds as megalopae, and then migrate up bay on flood tides where they are resident from 1 to 1.5 years before migrating down bay for spawning. To protect spawning stock an MPA has been designed that protects 75% of the spawning grounds during the spawning season and includes the migration corridor where most spawning stock are present. The mobility of the species and enforceability were primary concerns in MPA design. A tagging study has indicated that the MPA is effective with regard to mobility since females are three to six times more likely to be recaptured outside the sanctuary than within and spend significantly more days at large in the sanctuary than outside. A second management objective has been to estimate annual and semi-annual survival through summer and winter tagging projects. Yearly survival was estimated to be ~ 8% and natural mortality estimates were higher than previously thought. The blue crab fishery in Chesapeake Bay is a recruitment fishery. Focusing management on fishery exploitation rates is not sufficient. Research on the feasibility of hatchery based enhancement efforts is underway. Hatchery-reared and wild juveniles have equivalent survival rates while avoiding high rates of cannibalism which occur at smaller sizes. Hydrodynamic models indicate that enhancement efforts should take place at the mouth of the estuary. Juvenile habitat, distribution, and abundance, and prey availability are all being examined. Future research and management objectives are to improve understanding of spawning habitat and movements and account for these in MPA design, to evaluate the potential of stock enhancement efforts, to increase knowledge of predator-prey relationships, and to expand ecosystem based management to other species.

CONTRIBUTED TALKS

Linking larval and adult abundance in Glacier Bay – Ginny Eckert (University of Alaska Southeast/University of Alaska Fairbanks, Juneau)

Adult Dungeness crab (*Cancer magister)* and the first larval stage are found in Glacier Bay but disappear until the megalopal stage. Larvae were sampled using light traps at Bartlett Cove. It is hypothesized that Dungeness larvae from Glacier Bay are exported offshore. Pulses of megalopae appear in the bay in September and October during the dark phase of the moon with high interannual variability in abundance. Future work will focus on linking larval and adult time series of abundance.

Based on the work of Shanks and Roegner, larval recruitment lagged four years is highly predictive of catch for Coos Bay, Oregon. Much of the variation in larval settlement there can be explained by the timing of the spring transition (seasonal shift in wind/current directions) when transport changes from offshore to onshore. When the transition is early megalopal return is high suggesting that cross-shelf transport is aided by currents over the shelf. The size of the adult population seems to be dependent on initial settlement, not post-settlement processes. These observations support the export hypothesis for larvae from Glacier Bay and suggest that onshore transport may drive larval abundance; however, local oceanographic conditions are poorly understood.

Spatial variation in supply of Cancer magister megalopae in Glacier Bay, Alaska – Heidi Herter (University of Alaska Fairbanks, Juneau)

Adult Dungeness crab populations are much larger downbay near the mouth than upbay in Glacier Bay. On the western coast of the U.S. Dungeness larvae are transported offshore before returning as megalopae. Light trap sampling indicates that megalopal supply is higher at the sampling site nearest the mouth of Glacier Bay versus other sites further in to the bay, megalopae are primarily found at the surface on nighttime flood tides (a possible transport mechanism), especially in late September and early October. A gradient of megalopal supply is observed from with decreasing numbers with increasing distance from the bay mouth. It is hypothesized that this gradient affects adult distribution.

Cancer magister larval supply in Berner's Bay, Alaska – Quinn Smith (University of Alaska Fairbanks, Juneau)

Light trap sampling of larval *Cancer magister* in Berner's Bay show peaks of abundance in September and October with a pattern (during the new moon) similar to that observed in Glacier Bay but delayed by several days. Larval abundance observed in Berner's Bay is much lower than Glacier Bay. Future plans include adding additional sites in Berner's Bay and Icy Strait, and comparisons of abundance patterns with wind data.

Larval dispersal of Dungeness crabs in Glacier Bay and neighboring straits – Wongyu Park (University of Alaska Fairbanks, Juneau)

Patterns of Dungeness crab larval retention and advection were explored by taking net samples at five sites inside and outside of Glacier Bay in Southeast Alaska. Based on the stage specific differences in size and distribution inside and outside the bay it is hypothesized that larvae are incubated at different temperatures prior to dispersal, larvae in the inner bay are younger than those in the outer bay, and stage one larvae in the inner bay are smaller than those in the outer bay. Evidence indicates that Dungeness crab populations in Glacier Bay are part of a larger metapopulation with larvae from Glacier Bay dispersing to neighboring straits.

Trans-molt Floy tag retention and tagging effects on juvenile Tanner crabs – Julie Nielsen (University of Alaska Fairbanks, Juneau)

Field research on Tanner crabs, *Chionoecetes bairdi*, has been hindered by the lack of a suitable tag that will last through the molt. In this study, juvenile Tanner crabs, were tagged to assess the usefulness of Floy tags in tagging juvenile Tanner or snow crab. Single or double "T" tags were applied at the epimeral suture and anchored either in the dorsal muscle or in the internal body cavity of premolt juveniles. Survival and retention rates through one molt were 47% for all

treatments, but when deformities were included the proportion of crab unaffected by tagging ranged from 27 to 33%. Tagging did not significantly affect molt increment compared to a control group. Results of molting with a tag included limb deformities, limb loss, or adherence of the exuviant to the tag. One of the problems is that the dorsal muscle, in the vicinity of the epimeral line, is a small target in which to place a tag.

Overview of research at the Kodiak lab – Brad Stevens (National Marine Fisheries Service, Kodiak)

Liz Chilton - recently joined the shellfish group from RACE groundfish, she will be working with the Bering Sea Survey and has an interest in oceanography (AOOS)

Susan Payne – Investigating the reproductive biology of hairy crab, *Hapelogaster mertensii*, with comparisons to red king crab (RKC)

Claire Armistead – finishing the reorganization of crab survey database with conversion to Oracle and serves on the Fisheries Scientific Computer System committee

Mike Litzow – Long term and historic changes in Alaskan fisheries with climate change

Pete Cummiskey – Sonic tagging of RKC, followed one group for several years

Eric Munk – Tanner crab maturity studies

Sara Persselin – Cultivation of king crab larvae and bitter crab disease

Scott Van Sant – recirculating tank systems, early juvenile king crab diets, and characteristics of golden king crab embryos and larvae

Lou Rugulo – Bering Sea crab survey, completion of snow crab survey

Recent Retirees: Rich MacIntosh and Bob Otto, who retired 4 days prior to this meeting.

Embryonic development of blue king crab studied by image analysis and clustering techniques – Brad Stevens (National Marine Fisheries Service, Kodiak)

Digital image analysis techniques were used to examine the development of blue king crab (BKC), *Paralithodes platypus*, embryos in the laboratory. Full development takes approximately thirteen months with the embryo becoming visible at day 120 and eye pigment at day 180. Cluster analysis was used to quantify development based on morphometric measurements; twelve developmental stages can be assigned using this method. Visual staging methods are better for staging eggs during early development (cell division), while morphometric techniques are more effective later in development.

Annual vs. non-annual egg extrusion, mating vs. utilization of stored sperm to fertilize egg clutches, and larval hatching of Kodiak area Dungeness crab – Kathy Swiney (National Marine Fisheries Service, Kodiak)

Ovigerous and non-ovigerous female Dungeness crab, *Cancer magister*, from the Kodiak area were held in the lab and allowed to mate. After mating females were observed twice a week for extrusion and embryo development. All females do not extrude a clutch in a given year, but the extrusion rate was higher in the Kodiak area than SE Alaska, smaller females tend to molt and mate while larger females rely on stored sperm, and if a female skips a reproductive season she will brood the following season. Females that carried broods in consecutive years had lighter

colored eggs (off-white in color) than females who skipped a season and then extruded (bright orange). Larval hatching took place from May to June with a mean duration of 11 days. Larger CW females had longer hatching times possibly due to larger clutch sizes.

Phylogenetics of *Hematodinium* and implementation of a diagnostic PCR protocol for monitoring BCS – Frank Morado (National Marine Fisheries Service, Seattle)

Two clades of the dinoflagellate *Hematodinium* have been described with twenty-five decapod crustacean species infected worldwide. Visual, smear (microscopic), and PCR methods are used for detection. Visual detection is not always accurate and there are discrepancies between smear and PCR methods. Study of BCS in SE Alaska Tanner crab showed hot spots in the Douglas Island area. A laboratory study to resolve discrepancies between smear and PCR techniques confirmed the diagnostic value of the PCR technique for Tanner and snow crabs with nearly perfect agreement between the methods. Genetic techniques continue to be improved. Future directions include full implementation of the PCR assay method and research on life history and method of infection in captive animals in Kodiak. A *Hematodinium* workshop is in the planning stages and Chesapeake Bay is being considered as a model system to study *Hematodinium* in a crab population.

Economic data collection in BSAI crab fisheries: Origins, goals, and objectives - Ron Felthoven (National Marine Fisheries Service, Seattle)

Existing data collection instruments are insufficient and baseline data are needed to understand the impact of rationalization on BSAI crab fisheries and the welfare of stakeholders. Reporting is now mandatory and will focus on building understanding of resource utilization, efficiency, and stability. Data collection will include effort, costs, and revenue for vessels, processors, and outside interests in the BSAI crab fisheries. Location of purchase will be collected to help assess community impacts, and unique crew identifiers will be collected to estimate number of individuals involved in the fisheries. Historic data will be collected for three past years (1998, 2001, and 2004) under a range of conditions for comparisons with current and future data. The goals of the program are to facilitate analysis, enable verification, and determine if the objectives of rationalization are being met.

Developing a retrospective analysis of the Kodiak red king crab resource – Bill Bechtol (University of Alaska Fairbanks, Juneau)

Spawning stock abundance and recruitment estimates, stock-recruitment relationship estimates, and potential relationships of biogeography with historic fishery removals, ecological factors, and oceanographic conditions from 1960 to 2005 for Kodiak area RKC will be reconstructed from environmental, catch, and survey data sources in this project. Advice and assistance are welcome.

Coordination of molting and reproduction in female Dungeness crab, *Cancer magister* – Sherry Tamone (University of Alaska Southeast/University of Alaska Fairbanks, Juneau)

Molting and ovary development are both energetically demanding processes that can potentially occur concurrently or be temporally separated in female Dungeness crab. Of twenty females that were eyestalk ablated to remove molt inhibiting and gonad inhibiting hormones two weeks post extrusion/molt, post-molt animals had no reaction to eyestalk ablation and post-extrusion animals

showed a rise in ecdysteroids. These results indicate that two physiological states may exist with females being ready to molt or ready to extrude but not both. Further efforts will be to develop better non-lethal techniques for assessing reproduction in the field.

Pilot Assessment Survey for Bristol Bay Red King Crab in 2005 – A new approach and plans for an extended survey in 2006 – Steve Hughes (Natural Resources Consulting Inc., Seattle)

A 2005 survey of Bristol Bay RKC was jointly funded by the Bering Sea Fisheries Research Foundation and NOAA Fisheries. This survey used different gear (smaller trawl with tickler chain) and methodology (shorter tows of 5 minutes each with higher density per unit area) than the standard NMFS bottom trawl survey. A total of 129 tows were made over 12 days in ten statistical areas of high RKC abundance. The survey results indicated higher abundance estimates than the NMFS survey for all age class and sex categories. Catchability coefficients were also markedly higher for the alternative gear than the standard NMFS trawl. Future plans include expanding the RKC survey to cover a larger area in 2006 and inclusion of Bering Sea Tanner and snow crab stocks.

Gulf of Alaska Tanner crab tagging project – Kally Spalinger and Lynn Mattes (ADF&G, Kodiak)

Male Tanner crab were tagged to determine location/movement from summer surveys to the winter commercial fishery. Legal sized males were tagged in 2004 (855) and 2005 (769) with Floy® tags in bays from the northeast to the southwest districts around Kodiak Island. Commercial fisheries have so far recovered 85 tags (~10%) from 2004. Average distance traveled estimates range from 0.39 to 9.20 mi from bay to bay with a mean of 7.32 mi. In at least one bay it appears that although movement occurred crab stayed at deeper depths within the bay. Further analysis could examine movements in relation to food, mating, bathymetry, or oceanographic conditions. Future plans for the tagging project may include population estimates, tagging of females or juveniles, or use of archival tags to gather further information.

2005 Pribilof king crab pot survey – Skip Gish (ADF&G, Dutch Harbor)

The Pribilofs island region is closed to fishing for both RKC and BKC due to the low abundance of BKC and concern over BKC bycatch levels if RKC are fished. A pot survey was conducted to assess the abundance and distribution of RKC and BKC as close to the fishing season as possible. The survey encompassed most areas of recent historical king crab catch in the Pribilofs area. The CPUE of legal males was 0.09 and 0.02 respectively for RKC and BKC with 815 pots set. The survey also employed “niche” fishing during which the vessel captain determined where to set the gear. Legal sized males were caught at 0.26 and 0.23 crabs per pot with 77 pot pulls. Survey results indicated that abundances were too low to open the fishery. A high proportion of ovigerous female RKC were observed during the study.

Dungeness crab mating genetics – Dan Urban and Christian Smith (ADF&G, Kodiak and Anchorage)

This work is directed at the questions of whether or not the legal minimum size limit of 6.5 inches is appropriate statewide. To determine the minimum size for paternity individual male and female Dungeness crab were mated in the lab. Tissue, embryo, and sperm (from the female’s bursa) samples were collected for genetic analysis. Microsatellite DNA was used for analysis,

genotyping of embryos proved difficult but using a higher number of loci increased ability to detect extra male influence. Males ranged in CW from ~105 to 150 mm. Females that used stored sperm mated with a large size range of males and males and several males as small as 110 mm CW may have successfully mated. Multiple paternities can be proven with 99% certainty but it is more difficult to rule out the use of stored sperm for fertilization.

The effectiveness of escape mechanisms on bycatch reduction in the Bering Sea *Chionoecetes tanneri* fishery – David Barnard (ADF&G, Juneau)

The grooved Tanner crab occurs on the Bering Sea and Aleutian Islands continental slope where pots are long-lined from 200 to 600 fathoms in depth and legal size is 5 inches CW. Four escape rings of 4.5 in diameter are located in the lower third of the pot wall. Escape rings are designed to reduce the bycatch of sublegal male and female crab and to avoid the potential mortality associated with aerial exposure, handling, and discard. Experiments were conducted by observers on board commercial vessels with escape rings blocked versus open to assess effectiveness. Observers selected a minimum of ten pots per day for bycatch sampling; six pots with rings blocked were deployed in strings with four control pots. Only one small significant difference was observed between vessels and years in latitude, longitude, depth, and soak time. Overall, escape rings were effective, significantly reducing sublegal male (-69%) and female (-87%) bycatch across vessels and years, while legal male catch was not significantly affected.

Tanner crab soak time experiment in Icy Strait, Southeast Alaska – Jan Rumble (ADF&G, Douglas)

Regulations for the Tanner crab fishery in SE Alaska require four escape rings (4.75 in. diameter) on each pot. As the Tanner crab season has shortened soak times have also shortened, pots are pulled as often as three times per day (24 h). Study objectives were to determine 1) if escape rings were effective in releasing sublegal males and females over soak periods of less than 24 hours, 2) when females and sublegal males begin to exit the pot, and 3) catch rates of 7-ft diameter conical pots. Pots were set in Icy Strait in 2004 and 2005, Stephens Passage (04 only) and Excursion Inlet (05 only). At each location 12 pots were set, 6 with rings open and 6 with rings closed. Pots were soaked for 3, 9, 18, or 24 hours. Only Icy Strait results have been analyzed so far. Escape rings are effective in releasing sub-legal males and females. Efficacy rises as soak times increase to nine hours or more. The pot catch rate is not linear, increasing from 3 to 18 hours soak time and then flattening through 24 hours.

Red king crab survey restratification in Southeast Alaska – Gretchen Bishop (ADF&G, Douglas)

The objective of Southeast RKC survey restratification is to reduce the survey catch rate variability through reallocation. A primary source of variability is very high catch rates in certain individual pots. Catch rates were related to depth, distance between pots, differences in years, and covariance among normalized pot catches. Kriging was used to estimate relative abundance within a 50 m radius from each location in all survey areas. New strata were based on abundance of king crab allocated to five levels: low (30%), medium low (20%), medium (20%), medium high (15%), and high (15%). Pots from the 2005 were then allocated to each strata based on standard deviation and area. After survey restratification 42% of pots caught no crab, 70% of pots had average catch, and 5% were 5 times the average. In general stratification worked as expected with high abundance areas having high catch and low abundance areas

having very little or no catch. Catches were higher than expected in the medium low abundance strata for several areas. Restratification reduced the variance by almost one-half of expected for juvenile males and females and by over half for mature males. Almost twice as many pot pulls would have been required prior to restratification to achieve the same level of precision.

Preliminary assessment model for Tanner crab populations in Southeast Alaska – Jie Zheng (ADF&G, Juneau)

Survey, catch, and growth data were used to build a model for Southeast Alaska Tanner crab, with each of the eight Southeast Alaska RKC survey areas are assumed to have one Tanner crab stock. The model for male crab is based on a growth matrix that assumes log-normal error distribution and a natural mortality rate of 0.3. Male crab are divided into three groups, pre-recruits range from 109-137 mm CW, new-shell recruits from 138 – 169 mm, and old-shell post-recruits from 137 – 169 mm and greater. The female Tanner crab model assumes a terminal molt to maturity, that new shell females molted within the past year, and old shell females molted more than one year ago. Data inconsistencies in several areas (Pybus Bay, Port Frederick, and Juneau) led to only later years being used. Testing higher estimates of M resulted in a better model fit and higher male legal abundance estimates so M= 0.3 is a reasonable assumption. Adding handling mortality to the model had little effect on estimates of harvest rate and legal abundance. The response surface of M is sensitive for some stocks.

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 70's and 80's 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.

2005 Bering Sea snow crab tagging project – Kirsten Gravel (ADF&G, Kodiak)

The region in which the current eastern Bering Sea snow crab fishery takes place differs from the historic fishery area. The distribution of legal males also changes between the summer survey and winter fishery moving from northeast to southwest across the continental shelf. Project objectives are to determine recovery rate as a function of release location in the 2005 - 06 fishery, determine the recovery rate by statistical area as a function of release location in the 2005-06 fishery, and to compare shell age classifications between NMFS samplers in the summer and ADF&G dockside observers and onboard observers in the winter. Fifty stations were sampled in the summer of 2005 with 8,448 legal males tagged and released. The bulk (80%) of crab was released in the southern portion of the sampling area. Crabs were tagged with a brightly colored tag fastened around the body between the second and third walking legs using the "tie" knot. Brightly colored tags can be easily seen in dark conditions by dockside samplers.

Estimating mortality due to handling injuries in red king crab from tag recovery data – Doug Pengilly (ADF&G, Kodiak)

Bristol Bay RKC catch peaked in the early 1980's before continuing at much lower levels to present. High levels of female and sublegal male bycatch in this fishery may have a negative effect on the stock and management if bycatch mortality rates are large. State and federal

agencies currently incorporate bycatch mortality estimates ranging from 8% - 20% and handling mortality rates up to 50% are under consideration. Lab and field studies have found a range of mortality levels from none to 100% varying with temperature, exposure time, and handling protocols but indicate that release methods may not effect mortality. Onboard observers collected injury data in the Bristol Bay RKC fishery from 1997-99. Overall 13% of crab had injuries, 8% with broken rostrums and 4% with walking leg injuries. To estimate release and injury related mortality rates, Bristol Bay RKC were tagged during 2001 (3,937) and 2002 (4,994) within 1 to 3 weeks of the fishery opening, using a spaghetti tag around the isthmus muscle. Three treatments (control, rostrum break, or leg crush) were used with approximately equal numbers per treatment. Crab were released at stations ≥3 nmi apart during both years. No significant differences in mortality rates were observed for short (1-3 w) vs. long term (1-2 y) nor were there effects due to year of release. The recovery rate of "leg crush" crab was significantly less (77%) than control crab and was not significantly different between years or short vs. long term. Recovery rates of "rostrum break" though less were not significantly different from control crab with no significant differences for short vs. long term or year of release. The study concluded that the assumption of 20% handling mortality in the fishery is precautionary for management unless fishery practices change. Caveats are that 1) the results were for legal males, not males and sublegal males that are the typical discards, 2) recovery of leg-crushed crabs may be reduced due to culling of injured crabs from deliveries or to lower catchability of crabs with broken legs, and 3) broken parts (e.g., rostrum) may be a symptom of greater injuries (blows) not tested in this experiment.

Norton Sound and St. Lawrence Island area update – Wes Jones (ADF&G, Kodiak)

An unknown crab species caught in 2003 by Jerry Iyapana on a hand line at Little Diomede was identified by ADF&G biologists as a Spiny King Crab, *Paralithodes brevipes*. This species had not been previously reported in the area. A subsistence harvest (pots through holes in ice) for BKC has taken place at Little Diomede for many years. The Norton Sound Economic Development Corporation (CDQ) explored the potential of establishing a commercial fishery, but no legal-sized (5.5 in) males were caught. The corporation also conducted a small survey along the coast between Cape Prince of Wales and Teller in northwestern Norton Sound where some female and juvenile BKC were caught as well as large numbers of female and juvenile RKC. The survey also included waters around King Island where they caught juvenile red and blue king crab as well as female BKC. The corporation is in favor of reducing the minimum legal size of BKC (5.5 in) to match that of RKC (4.5 in).

Revisiting the Norton Sound red king crab model eight years later – Jie Zheng (ADF&G, Juneau)

Minor changes were made in the model used for Norton Sound RKC eight years after initial development. Sample size reduction percentages, molting probability levels by time period, and summer fishery selectivity for two size groups were adjusted. Multiple data sets were put together for the model. Harvest rates are conservatively estimated at 8-9%. The estimated abundance in 2005 was 1.7 million crabs with a harvest rate of 8.2%, this abundance was a 31% increase from 2004 with a harvest. The projected legal abundance is 1.6 million in 2006. An 8% harvest rate applied to this population would yield 0.13 million crab. The 2006 estimates will be revised after the winter fishery. Abundance estimates are uncertain due to a lack of survey data,

but available data indicates that strong recruitment occurred in 2002 and this cohort reached commercial size from 2003-05. Legal abundance may start to decrease in 2006.

Is it feasible to use Clark's method for determining F% reference points for crab fisheries management? – Shareef Siddeek (ADF&G, Juneau)

$F_{20\%}$ is an F (fishing mortality) which produces an effective spawning stock biomass (ESB) per recruitment (R_F) equivalent to 20% ESB/R_0, where ESB/R0 is the spawning biomass per recruit at zero F. First, a yield per recruit relationship is estimated. Recruitment is estimated from a stock-recruitment relationship, Y is estimated as the product of yield per recruit and number of recruits, then Y is plotted vs F% to find the optimum F% value. Clark's recommendations of $F_{35\%}$ and $F_{40\%}$ are used as reference points in NPFMC groundfish management plans. Crab effective spawning biomass is calculated using a mating ratio whereas a sum of mature male and female biomass is used for groundfish; hence ESB/R curves for crab stocks have a different shape. Our analysis concluded that Clark's methods for determining F% are feasible for crab stocks. The results for Bristol Bay RKC indicated that $F_{45\%}$ is probably a good limit reference point because it produces over 80% MSY, reduces yield variability, and in a 100-year fishery simulation, resulted in <10% overfished status under a stochastic S-R relationship. At $F_{45\%}$ the rebuilding time for Bristol Bay RKC from 20% ESB to MSY under current input data values and model assumptions is about thirteen years.

Central Region Crab Work – Charlie Trowbridge (ADF&G, Homer)

Central region projects include: annual trawl surveys in Prince William Sound (PWS), biannual trawl surveys in Cook Inlet (CI), a Dungeness pot survey (PWS), golden king cab pot surveys, electronic data capture, and working with AKFIN to coordinate databases. Legal male abundance continued at low levels for Kamishak District Tanner crab, but a strong pre-recruit 1 class was observed in 2005. Southern District Dungeness crab pot surveys in 2005 found low levels of juvenile, mature male, and mature female abundance. All Tanner crab fisheries in Prince William Sound remained closed in 2005 with persistent low numbers observed in trawl surveys. It has been hypothesized that Tanner crab may have pulled back into the arms of the Sound e.g. Valdez Arm where both mature male and females are observed in trawls. Electronic data capture has progressed since the mod 1980's from calipers that did not work to the use of Fowler water resistant calipers (2004) and an upcoming integrated database project (2006).

PLANS FOR 2006

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 13–15th, 2006 in Anchorage.

PROPOSALS FOR NEXT YEAR'S SPECIAL TOPIC

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

APPENDIX

Appendix 1.–List of participants at the 2005 interagency crab research meeting.

Last Name	First	Affiliation	Location	Email
Alinsunurin	Rachel	ADF&G	Dutch Harbor	rachel_alinsunurin@fishgame.state.ak.us
Barnard	David	ADF&G	Kodiak	david_barnard@fishgame.state.ak.us
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Failor	Barbi	ADF&G	Dutch Harbor	barbi_failor@fishgame.state.ak.us
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Gravel	Kirsten	ADF&G	Kodiak	kirsten_gravel@fishgame.state.ak.us
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Appendix 1. Page 2 of 2.

Last Name	First Name	Affiliation	Location	Email
Pengilly	Doug	ADF&G	Kodiak	doug_pengilly@fishgame.state.ak.us
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Shepard	Richard	ADF&G	Kodiak	ric_shepard@fishgame.state.ak.us
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Zheng	Jie	ADF&G	Juneau	jie_zheng@fishgame.state.ak.us

Appendix 2.–Final agenda for the 2005 interagency crab research meeting.

AGENDA: INTERAGENCY CRAB RESEARCH MEETING
December 14-16, 2005

Hilton Anchorage, 3rd and E Streets, Anchorage, AK 907-272-7411

WEDNESDAY, DECEMBER 14

Afternoon Session: 1:00 - 5:00 pm

I. INTRODUCTIONS

II. OPENING REMARKS: Doug Woodby, Russ Nelson

III. MEETING AGENDA: Modify and Adopt

IV. GUEST SPEAKER: Dr. Rom Lipcius, VIMS

Ecosystem-based Management and Restoration of the Blue Crab.

Coffee: (time to be determined)

V. RESEARCH REVIEW (All presentations will be 20 minutes unless noted)

A. University of Alaska – part 1
   1. Linking larval, juvenile, and adult abundance of Dungeness crabs – Ginny Eckert, UAF/UAS, Juneau
   2. Spatial variation in Dungeness crab larval supply in Glacier Bay – Heidi Herter, UAF, Juneau
   3. Larval supply of Dungeness crabs in Berners Bay - preliminary project ideas – Quinn Smith, UAF, Juneau
   4. Larval dispersal of Dungeness crabs in Glacier Bay and the neighboring straits: implications for metapopulation dynamics – Won Park, UAF, Juneau
   5. Trans-molt retention and survival of Floy-tagged juvenile Tanner crabs – Julie Nielsen, UAF, Juneau

THURSDAY, DECEMBER 15

8:00 - 8:30 am Coffee

Morning Session: 8:30 – 11:30

B. National Marine Fisheries Service – Alaska Fisheries Science Center
   1. Overview of research at the Kodiak Lab – Brad Stevens, Kodiak (30 min)
   2. Embryonic development of blue king crab studied by image analysis and clustering techniques - Brad Stevens, Kodiak
   3. Annual vs. non-annual egg extrusion, mating vs. utilization of stored sperm to fertilize egg clutches, and larval hatching of Kodiak area Dungeness crab - Kathy Swiney, Kodiak
   4. Phylogenetics of Hematodinium and implementation of a diagnostic PCR protocol for monitoring BCS - Frank Morado, Seattle

Coffee: mid-morning

   5. BSAI crab rationalization: economic data collection and analysis - Ron Felthoven, Seattle

C. University of Alaska – part 2
   1. Developing a retrospective analysis of the Kodiak red king crab resource – Bill Bechtol, UAF, Juneau
   2. Coordination of molting and reproduction in female Dungeness crab, Cancer magister – Sherry Tamone, UAF/UAS, Juneau

Lunch: 11:30 am - 1:00 pm

Afternoon Session: 1:00 – 5:00 pm

D. Guest Speaker – Steve Hughes, Natural Resources Consulting, Inc.

   Pilot Assessment Survey for Bristol Bay Red King Crab in 2005 - a New Approach and Plans for an Expanded Survey in 2006 (45 min)

E. Alaska Department of Fish and Game
   1. GOA Tanner crab tagging project - Lynn Mattes and Kally Spalinger, Kodiak
   2. 2005 Pribilof King Crab Pot Survey – Skip Gish, Kodiak
   3. Dungeness Mating Genetics – Dan Urban, Kodiak, and Christian Smith, Anchorage

   Coffee: mid-afternoon

THURSDAY, DECEMBER 15 (continued)

4. The Effectiveness of Escape Mechanisms on Bycatch Reduction in the Bering Sea *Chionoecetes tanneri* fishery – David Barnard, Kodiak
5. Spatial distribution of tag recoveries in the Aleutians golden king crab fishery – Leslie Watson, Kodiak
6. Tanner soak time experiment in Southeast Alaska, and update – Jan Rumble, Douglas
7. Preliminary results from Tanner crab core/non-core management and red king crab restratification in Southeast Alaska - Gretchen Bishop, Douglas
8. Preliminary assessment model development for Tanner crab populations in Southeast Alaska – Jie Zheng, Juneau

FRIDAY, DECEMBER 16

8:00 - 8:30 am Coffee

Morning Session: 8:30 am – 12:00 noon

E. Alaska Department of Fish and Game, continued
   9. Preliminary report on Bering Sea snow crab tagging study – Kirsten Gravel, Kodiak
   10. Estimating mortality due to handling injuries in red king crab from tag recovery data – Doug Pengilly, Kodiak
   11. Norton Sound/ St. Lawrence Section Update - Wes Jones, Nome
   12. Revisiting the Norton Sound red king crab model eight years later – Jie Zheng, Juneau
   13. Is it feasible to use Clark's method for determining F% reference points for crab fisheries management? – Shareef Siddeek, Juneau

Coffee: mid-morning

VI. NEXT YEAR'S MEETING AND SPECIAL TOPIC SUGGESTIONS

VII. OTHER BUSINESS