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Summary of the Interagency Crab Research Meeting held December 12– 14, 2007

by

Joel Webb

and

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September 2008

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

Symbols and Abbreviations

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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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ABSTRACT

This report summarizes the fourteenth annual interagency crab research meeting, held December 12–14 in Anchorage at the Anchorage Hilton 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 included a special session on ocean climate effects and management of the snow crab fishery in the Newfoundland and Labrador region of eastern Canada.

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

PARTICIPANTS

The 2007 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), Alaska Sea Grant (ASG), Norton Sound Economic Development Corporation (NSEDC), and Department of Fisheries and Oceans (DFO) Canada. 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 audiovisual operations were run by Joel Webb. Following introductions and welcoming remarks, the draft agenda (Appendix 2) was adopted without change.

SUMMARY OF PRESENTATIONS

The order of presentations followed the agenda (Appendix 2), which was organized roughly by contributing group, University, International, NMFS, and ADF&G.

SPECIAL TOPIC: OCEAN CLIMATE EFFECTS AND MANAGEMENT OF THE NEWFOUNDLAND AND LABRADOR SNOW CRAB RESOURCE

Overview of the Newfoundland and Labrador snow crab resource: Don Stansbury, Department of Fisheries and Oceans, Canada

The snow crab resource in Newfoundland supports ~3,300 enterprises and is comprised of ~40 management areas. Historically, landings were low in the 1980s (~10,000 tons) increased in the 1990s to a peak of 70,000 tons in 1999, and have since ranged from 40,000 to 55,000 tons through 2006. The snow crab fishery is managed with a non-transferable individual quota system and is harvested using 4 ft conical pots with 5.25 to 6 in mesh. Other regulations include a male-only harvest rule and 95 mm carapace width minimum size. The resource is assessed by an offshore trawl survey, an inshore pot survey, and a post-season inshore and offshore pot survey in cooperation with industry. Fishery catch per unit effort (CPUE) and discard mortality rates are determined from fishery observers. A commercial CPUE series is also determined from fishers' logbooks. An overall decline in exploitable biomass has occurred since 1998 but survey and commercial CPUE data indicate that the biomass has increased in the north, in Labrador (2J) and

[1] Revised March, 2006, and available from the authors.

northern Newfoundland (3K) waters, while declining in the southern area. In the northern area the abundance index of small crab or prerecruits oscillated from high in the late 1990s to low (1999-2003) before rising again from 2004 to 2006. Exploitation rate, percent discarded, and prerecruit mortality were highest during the period of low abundance. In the southern area exploitable biomass and recruitment were high in the late 1990s and declined with some increase in exploitation rates from 2001 to 2006. Long-term recruitment prospects are uncertain due to the persistence of a warmer oceanographic regime relative to the late 1990s.

Effects of ocean climate on production, size-at-terminal molt, and recruitment of snow crab (*Chionoecetes opilio*) on the Newfoundland-Labrador shelf: Earl Dawe, Department of Fisheries and Oceans, Canada

The effect of temperature on snow crab size at terminal molt, recruitment, and production was investigated using bottom temperature and biological data from stock assessment surveys. Logistic regression models were used to explore relationships of bottom temperature with male and female size at terminal molt. Mean female size-at-maturity generally increased with increasing bottom temperature. Male size at terminal molt was also highest at the warmest bottom temperatures observed (3 to 4 °C). Time series analysis (ARIMA) was used to determine cross correlations and significance of time-lagged snow crab CPUE with bottom temperature and ice cover. Higher ice area was associated with higher time-lagged snow crab CPUE and lower snow crab CPUE was associated with higher bottom temperatures. A conceptual model was developed based on the hypothesized functional relationship that a warm thermal regime may result in poor physiological condition, low larval/juvenile survival, and large size at terminal molt for Newfoundland/Labrador snow crab.

CONTRIBUTED TALKS

Transport of Dungeness crab (*Cancer magister*) megalopae into Glacier Bay, Alaska: Heidi Herter, University of Alaska Fairbanks

Along the west coast of the continental United States, Dungeness crab are exported offshore in the early larval stages prior returning to the coast as post-larvae or megalopae. This study investigated whether similar patterns of offshore/onshore transport might be observed in Southeast Alaska. Previous studies indicated that larvae might be exported from Glacier Bay. Light traps were used to sample megalopae at the surface and at a depth of 10 m at three locations in Glacier Bay in 2004 and 2005. Significant spatial variation in abundance was observed with the highest megalopal abundance observed at the sampling site closest to the mouth of Glacier Bay in Bartlett Cove and decreased abundance in the northern Beardslee Islands further away from the mouth. Significant differences were also observed between years with higher megalopal abundance in 2004 versus 2005 at all sites. Megalopal abundance in Bartlett Cove was correlated with tidal amplitude at +3 to 5 day lags and pulses of megalopal abundance may be associated with wind events. These patterns indicate that Dungeness crab may be using tidal transport to reinvade Glacier Bay after being exported as zoeae.

Early benthic phase Dungeness crabs in Southeast Alaska: Ginny Eckert, University of Alaska Southeast, Juneau, Alaska

The abundance and distribution of first benthic phase Dungeness crab in the intertidal was measured from 2000 to 2007 using settlement bags in Bartlett Cove, Glacier Bay. The distribution of settlers averaged over years did not vary significantly with the position of

settlement bags from low to high in the intertidal zone. Settler abundance did vary interannually with higher relative abundances in 2000 versus later years in the time series. Laboratory studies indicated that settlement earlier in the season (September versus October) might confer a growth advantage. Crab that settled in September had completed more molts and thus were larger in size by the following spring than those that settled later. These results combined with the juvenile size frequency-data collected from the intertidal during the summer near Juneau indicated that juvenile Dungeness crab growth rates are likely lower in Southeast Alaska than in British Columbia or Puget Sound and that growth is slowed primarily by increased duration of the intermolt interval versus decreased molt increment.

Spatial variation and evidence for multiple transport pathways for Dungeness crab (*Cancer magister*) late stage larvae in Southeast Alaska: Quinn Smith, University of Alaska Fairbanks

Understanding of larval dynamics may improve understanding of organismal responses to environmental change and factors influencing species abundance and distribution. In the upwelling system along the west coast of North America Dungeness crab *Cancer magister* larvae are exported from coastal to offshore waters as zoeae and return to coastal areas as megalopae, or postlarvae, prior to settlement. This system contrasts with the complex shorelines and downwelling regime of Southeast Alaska. Previous studies in Glacier Bay have shown that *C. magister* zoeae may be exported from Glacier Bay and return as megalopae. To determine whether similar patterns might be observed in greater Southeast Alaska, light trap sampling was conducted in Echo Cove north of Juneau and in Bartlett Cove, Glacier Bay, in autumn 2005. Light traps were also used to examine spatiotemporal variability in megalopal abundance at nine sites in northern Southeast Alaska over a two-week period in autumn 2006. Megalopal abundance was much higher at Bartlett than Echo Cove in 2005, was highest among all sites in 2006, and time-lagged peaks in abundance between sites that might suggest transport pathways were not observed. Megalopae sampled in the Glacier Bay/Icy Strait region were significantly larger and heavier than those from other areas. Oceanographic modeling has suggested that flow patterns may favor transport from western Icy Strait into Glacier Bay rather than further eastward up Icy Strait. These differences may indicate that *C. magister* megalopae in the Icy Strait/Glacier Bay region are utilizing different transport pathways than those in Chatham Strait or Lynn Canal.

Red king crab early benthic phase habitat studies in Southeast Alaska: Jodi Pirtle, University of Alaska Fairbanks

The commercial fishery for Red king crab in Southeast Alaska is currently closed. Understanding of mechanisms related to fluctuations in abundance is limited—particularly for the ecology of early life history stages. The objectives of this study are to describe settlement habitats for first benthic stage red king crab, characterize nursery habitats *in situ*, and examine the value of varying nursery habitats for survival and growth of early stage red king crab. Settlement bags were deployed in 2007, and settlement bags and pails will be deployed at sites in the Juneau area in 2008 to assess the spatial distribution and variability in red king crab settlement. Dive surveys to identify nursery habitats were conducted in 2007 and field studies will continue in 2008 to quantify habitat specific densities and collection of specimens for manipulative experiments. Juvenile habitat preference experiments were conducted in the laboratory. Complex, biogenic habitats were preferred significantly among the seven habitats tested. Tethering methods for

juvenile red king crab were also developed for future field trials of habitat association and survival.

Temporal variation and habitat use of nearshore crab populations in Kachemak Bay, Alaska: Ben Daly, University of Alaska Fairbanks

The distribution and abundance of larval, juvenile, and adult crab which may vary in relation to habitat complexity was studied in Kachemak Bay, Alaska. Two hypotheses were proposed: (1) Larval crab abundance varies among habitat types and (2) Juvenile/adult crab abundance and species richness is higher in high complexity versus low complexity habitats. Nine sites—three sites within each of three habitat groupings: sand, understory kelps (medium complexity), and high complexity—were chosen and sampled via light traps for larval abundance and SCUBA for habitat characteristics and juvenile/adult crab abundance. The number of all crab zoeae caught in light traps did not vary significantly among habitat types but megalopal catch was significantly higher in the sand habitat versus the high complexity, canopy habitat group. As hypothesized juvenile/adult crab abundance was significantly higher in the habitat groups with understory kelps but also varied among species likely due to species-specific life history and habitat preferences.

New tools for investigating crab reproduction: Sherry Tamone, University of Alaska Southeast

Sexual maturity is established by functions of the endocrine system in both male and female crab. Molting and reproduction, two energetically intensive processes, are temporally coordinated in most brachyuran crab. Contrasting patterns of molting and reproduction are observed among commercially important crabs in Alaska. Development of molecular tools to detect synthesis of vitellogenin can allow characterization of relationships between reproduction and other physiological and environmental variables. The objective of this project, in cooperation with investigators from the Center of Marine Biotechnology (Baltimore, MD) was to isolate RNA from the hepatopancreas of Dungeness, Tanner, and red king crab and then identify DNA sequences associated with the production of vitellogenin, the protein that is synthesized by the hepatopancreas and sequestered within oocytes for embryonic development. Partial sequences were successfully identified for Tanner and Dungeness crab and this information can be used to measure the expression of the gene regulating vittelogenin production under varying physiological conditions.

Reconstructing the Kodiak red king crab time series: An updated update: Bill Bechtol, University of Alaska Fairbanks

Harvests of Kodiak red king crab peaked in the mid-1960s and continued at much lower levels through the 1970s before declining dramatically in the early 1980s. A three-stage catch analysis incorporating harvest and survey data was used to reconstruct the spawning stock abundance and recruitment for this stock and to estimate a stock-recruit relationship. Fishing effort occurred inshore near Kodiak Island during the early years of the fishery but progressed offshore in later years as effort levels increased. Model results indicate that both male and female recruitment peaked in the early and late 1970s, was very low during the early 1980s, and continued at low levels to present. Mortality was estimated to be low prior to the mid-1970s before increasing to consistently higher levels from the 1980s to present. Future investigations will examine stock-recruit relationships and potential environmental or fish predation effects on recruitment.

Alaska king crab research, rehabilitation, and biology program: an introduction – Ben Daly, Alaska Sea Grant

Fisheries for Pribilof Islands/St. Matthew Island blue king crab and Kodiak red king crab have been closed since the mid 1990s and the mid-1980s respectively. This project was designed to investigate the feasibility of large-scale culture of red and blue king crabs. Similar programs have achieved success in culturing various crab and lobster species from egg to benthic phases followed by release into the wild, but little information is currently available on the contributions or impacts of these individuals on wild populations. Mature female blue and red king crab were collected in 2006 and transported to the Alutiiq Pride Shellfish Hatchery in Seward, Alaska. Phytoplankton and zooplankton are cultured onsite for larval crab diets. Larval crab were raised at varying densities and with varied diets to determine optimal conditions for larval survival. Survival to the fourth zoeal stage was highest for red king crab at the lowest tested density, while survival to the glaucothoe stage was uniformly low at all densities for blue king crab. High mortality was observed during the later larval stages and handling effects may have contributed to mortality. Rearing studies in 2008 will focus on monitoring and adjusting rearing conditions and larval diet to reduce potential sources of mortality.

Investigations of diet influence on large scale larval culture of red and blue king crab: Celeste Leroux, University of Alaska Fairbanks

Studies on larval rearing diet for red king crab as well as diet and handling stress for blue king crab were conducted in 2007 in conjunction with the Alaska King Crab Research, Rehabilitation and Biology Program. Of four diet treatments, mean survival of red king crab larvae from the first to the fourth larval stage (ZI to ZIV) ranged from approximately 10 to 20% with higher survival observed for larvae fed either *Artemia* sp. nauplii only or *Artemia* sp. fed in conjunction with *Pavlova lutheri*. Survival rates may have also been affected by flow-related temperature fluctuation and handling stress of survival estimates during the experiment. A second experiment investigated the effects of diet and handling on survival of blue king crab larvae. Survival to ZIV was above 50% through the fourth larval stage for both treatments but decreased to below 10% for glaucothoe under both handling regimes and diets. Algal enrichment with concentrates versus live cultures may be viable. Adjustments to water flow, tank circulation, diet, and density were recommended. Research on proximate composition and fatty acid profiles for comparisons of red and blue king crab from these studies is underway and may provide further insight into interspecific differences and dietary effects.

Kodiak lab research update: Bob Foy, National Marine Fisheries Service, Kodiak, Alaska

National Marine Fisheries Service Kodiak Lab personnel are responsible for organizing and conducting the crab component of the NMFS eastern Bering Sea trawl survey. Other research projects conducted at the lab include crab culture, ocean acidification effects on crab, and life history studies focused on development of biological reference points for crab fishery management. The 2007 eastern Bering Sea survey covered 380 stations between 11 June and 28 July. Claire Armistead has been using GIS to summarize distributions from the survey data and is seeking input on development of an atlas on the distribution of commercially important crab species. Lou Rugolo works with crab stock assessments, the Crab Plan Team, and snow crab life history research. The Kodiak Lab Dive Program with Eric Munk and Pete Cummiskey has been using an air lift pump to sample the distribution and habitat association of juvenile red king crab.

Sara Persselin has recently been conducting larval rearing, diet, and survival studies in concert with those conducted for the Alaska King Crab Research, Rehabilitation and Biology Program (crab enhancement) project at the Alutiq Pride Shellfish Hatchery in Seward. Researchers (Sara Persselin, Katherine Swiney, Jeff Short, and Aaron Ellsworth) have also continued laboratory experiments exploring the effects of ocean acidification on blue king crab larvae. Other projects involving Kodiak Lab researchers include: Reproductive biology of the hairy crab (Susan Payne), crab size-weight relationships (Liz Chilton), golden king crab research (Scott Van Sant), Tanner crab mortality (Eric Munk), red king crab reproduction (Kathy Swiney), and pathobiology (Frank Morado). Future and continuing research efforts at the Kodiak lab will likely address ocean acidification, trophic ecology, oceanography, and *in situ* studies of king crab settlement behavior.

Tanner crab mass-molting: Is it a guy thing? Erik Munk, National Marine Fisheries Service, Kodiak, Alaska

Mass-molting events of Tanner crab have been observed in Southeast and on Kodiak Island, Alaska. The goals of this study were to describe the location, timing, and characteristics of molting Tanner crab on Kodiak Island. Molting events occurred in Monashka Bay at the north end of Kodiak Island. Size frequency, sex, and maturity data were collected from live crab and molts by collections from beaches and diving. Molting events primarily occurred during the months of February and April and were comprised almost entirely of male crab. Size-frequency analysis indicated that the mean size of molting individuals increased by year from 2003 to 2006 and was composed of more than one instar each year. Based on carapace/chelae allometry none of the molting males were mature. These patterns are similar to published descriptions from Southeast Alaska and raise important questions as to the location of female molting and why morphometrically immature males are molting during the mating season.

Assessing probability of discard-related mortality in *Chionoecetes* spp. using reflex behaviors: Allan Stoner, National Marine Fisheries Service, Newport, Oregon

Bycatch mortality is considered to be an important source of direct mortality for *Chionoecetes* crabs but there is a lack of comprehensive methods for assessment of mortality especially under fishing conditions. Factors in discard-related mortality include interactions with the capture gear, seawater conditions during ascent to and descent from the surface, and conditions and handling at the surface. Immediate mortality may be detected at the surface but methods for accurate assessment of condition and prediction of mortality are more challenging. *Chionoecetes* crab were captured by bottom trawl in the Bering Sea, assessed for the presence or absence of six reflex actions, and monitored for mortality in tanks on the vessel. Results indicated that holding conditions were not detrimental as most mortality occurred within two to four days post-capture and few changes were observed in reflex testing after ten days. Logistic regression indicated that reflex assessment was ~80% accurate for predicting mortality for *C. bairdi* and ~90% for *C. opilio*. Discard mortality can be an important source of mortality for *Chionoecetes* crab, reflex impairment assessment was predictable and reflected stress and survival. Composite indexes of reflex impairment were useful for predicting mortality and will increase in usefulness with more research under various fishing conditions and with other species such as red king crab.

Reproductive potential of Bristol Bay red king crab–assessment and preliminary results: Kathy Swiney, National Marine Fisheries Service, Kodiak, AK

Population egg production may be a suitable indicator of reproductive potential for use in fisheries management. The objectives of this study are to investigate survey clutch fullness index as a predictor of egg production, establish size/fecundity relationships, assess egg loss during brooding, and measure larval fitness in relation to egg and maternal characteristics to improve understanding of how these factors may affect reproductive potential. Fecundity was measured for female red king crab collected during summer surveys and autumn fisheries to establish size/fecundity relationships and for assessment of egg loss during brooding. Egg-bearing female red king crab collected during the autumn fishery were also held in the laboratory for sampling of egg biochemical content which will be compared to starvation survival and biochemical content of hatched larvae from each female. Preliminary results indicate that fecundity increases with female size in a near linear relationship, clutch volume is highly correlated with fecundity estimated by dry weight methods, and survey clutch fullness estimates may not be reliable proximate indicators of relative fecundity on fine scales.

Determining essential habitat for Alaskan crabs—identifying research needs and limitations and charting a direction for the future: Sara Persselin, National Marine Fisheries Service, Kodiak, AK

Identification of essential fish habitat is mandated under federal fisheries management legislation and is a crucial component of ecosystem-based management. However, limited information is available on essential habitat of the early life history stages of commercially important crabs in Alaska. Habitat consists of both benthic and oceanographic variables and numerous methods may be needed for sampling and characterization. Past lab and field studies have identified habitat of settling for juvenile red king crab around Kodiak Island, while more recently studies on habitat preference, competition, and settlement have been conducted for blue and red king crab in the laboratory. Future habitat work at the NMFS Kodiak Lab will have the specific goals of identifying areas of larval supply, settlement habitats, functional relationships between larval supply and juvenile abundance, and potential impacts of predation on habitat use.

Summary of the International Bitter Crab Disease Workshop, September 20-22, 2007: Frank Morado, National Marine Fisheries Service, Seattle, Washington

The workshop included sessions on fisheries effects, parasite biology, host biology, parasite genetics, and pathobiology of Bitter Crab Disease (BCS). Since the first description in 1931, *Hematodinium*, the causative organism of BCS, has been described from a number of regions globally and in a number of host species. The purpose of the workshop was to review and advance current understanding of *Hematodinium* life history, transmission, and disease progression in relation to hosts, environmental factors, and population effects. Macroscopic, microscopic, immunological, genetics or a combination of these methods are currently used to detect *Hematodinium*. Progression of the disease is seasonal with intensity increasing in the fall and is usually fatal within 12 to 18 mo for southeast Alaska Tanner crabs *Chionoecetes bairdi*, and about 3 mo for the east coast blue crab, *Callinectes sapidus*. Salinity likely limits the distribution of BCS in Chesapeake Bay but variability with other environmental factors is unknown. Two species of *Hematodinium* have been described morphologically while molecular techniques have suggested three possible subtypes. Studies suggest that mortalities from BCS approach 100% in certain affected populations, with the disease occurring more frequently in

recently molted adult and juvenile crab. A variety of approaches including both laboratory studies and field sampling will be needed to further understand the dynamics of BCS in affected populations.

Temporal changes in size at maturity and their implications for fisheries management of eastern Bering Sea Tanner crab: Jie Zheng, Alaska Department of Fish and Game, Juneau, Alaska

Temporal variability in male and female size at maturity was examined from trawl survey data for Tanner crab *Chionoecetes bairdi* in the eastern Bering Sea. Morphometrically mature male Tanner are identified by an allometric growth of the chelae relative to carapace width while mature female Tanner crab are identified by allometric growth of the abdomen relative to carapace width at the maturity molt. Female size at maturity decreased for both Bristol Bay and the Pribilof Islands areas between 1975 and 2006 and was significantly related to depth and longitude. For males size at 50% maturity in Bristol Bay declined significantly since 1990. Lower size at maturity may result in low yield per recruit and reference harvest rates may not be achievable within the current legal size and size at maturity framework. Reduction of current harvest rates and size limits while maintaining current gear requirements would result in higher fishery yields and higher male spawning biomass per recruit than those under the current harvest strategy.

Sperm reserves of primiparous snow crab, *Chionoecetes opilio,* in the eastern Bering Sea—spatial patterns relative to available males: Laura Slater, Alaska Department of Fish and Game, Kodiak, Alaska

Characterization of temporal and spatial variability in sperm reserves of primiparous snow crab can improve understanding of reproductive biology and assist in determining whether sufficient males are available to ensure full female reproductive success. This is a concern due previous observations which indicate sperm reserves in primiparous females from the eastern Bering Sea are low relative to those from eastern Canada. Sperm reserves for primiparous females collected during the summer 2007 eastern Bering Sea shelf trawl survey were low and similar to levels reported in previous years. The spatial mismatch between the areas of high abundance for large males and mature females observed during the trawl survey showed skewed sex ratios in favor of females and may be associated with low sperm reserves observed in primiparous snow crab. Continued monitoring of female snow crab sperm reserves across a wide area of the eastern Bering Sea and exploration of sperm reserves in multiparous females should provide a greater understanding of spatiotemporal variability and mechanisms associated with dynamics of sperm reserves in snow crab females.

Development of egg production based biological reference points for Bering Sea *Chionoecetes*—methods and preliminary results: Joel Webb, Juneau

The incorporation of reproductive potential in the development of biological reference points is a pressing fishery management need for Bering Sea crab stocks. Currently, spawning stock biomass, which does not incorporate variability due to density-dependent or density-independent factors, is used as an index of reproductive potential for management of Bering Sea crab stocks. The study objective was to develop more accurate and precise quantitative indices of reproductive potential, which are sensitive to variability. For development of biological reference points of reproductive potential, we are quantifying female size/age specific fecundity, egg loss

during brooding, and egg viability for eastern Bering Sea snow and Tanner crabs for three consecutive years. Females of both species were collected during stock assessment surveys in 2007 and fecundity was determined in the lab. Fecundity increased with female size for Tanner, and snow crab, but egg production per unit size was much higher in Tanner than snow crab. Ultimately, critical data and functional relationships will be generated to incorporate into stock assessment models, providing a baseline against which future monitoring can be used to test for environmental or fishing-induced effects on dynamics of stock reproductive potential.

2007 St. Matthew Island blue king crab survey: Leslie Watson, Alaska Department of Fish and Game, Kodiak, Alaska

The primary objective of the fifth triennial St. Matthew Island pot survey in 2007 was to assess the relative abundance, distribution, and reproductive status of blue king crab and to determine catch composition of other crab and fish species. A consistent decreasing trend in survey abundance was observed for blue king crab from 1995 to 2004, but mature female, sublegal male, and legal male abundance all increased in 2007 relative to 2004. Immature and mature females were distributed in warmer waters nearshore while legal and sublegal males were more broadly distributed among both nearshore and offshore stations with colder temperatures. The abundance of snow crab caught during the survey also increased in 2007 relative to 2004 with catch composition of mostly mature males 79 to 101 mm carapace width in the offshore stations.

2006 Petrel Bank red king crab survey: Skip Gish, Alaska Department of Fish and Game, Kodiak, Alaska

The western Aleutians red king crab fishery started in the 1960s and increased into the early 1970s. Harvests were low from the late 1970s to the late 1990s with several closure years and Petrel Bank as the primary fished area. The fishery has been intermittently closed or had low guideline harvest levels in recent years. Following an industry sponsored survey in 2001, Petrel Bank was systematically surveyed for the first time in 2006. Pot strings were set systematically by station and in niche fishing locations chosen by the captain of the vessel. Areas of red king crab distribution were spatially reduced from those observed in the 2001 survey with crab primarily distributed on the northwest portion of the bank. Numbers of legal males, sublegal males, and females were also reduced in comparison to the 2001 survey.

2006 Northern Bering Sea trawl survey: Charlie Lean, Norton Sound Economic Development Corporation, Nome, Alaska

A trawl survey was conducted by personnel form the Norton Economic Development Corporation in cooperation with several other organizations during summer 2006 in the northern Bering Sea from east of St. Lawrence Island north to King Island and in Norton Sound. The primary survey objectives were to collect information on red king crab distribution and abundance, blue king crab size frequency and distribution for refined guideline harvest levels, and preliminary sampling of clams in the Bering Strait area. Hauls were successfully completed at 119 stations. Catches consisted of commercially important crabs and fishes and numerous other fishes and invertebrate species.

ADF&G Central Region large mesh trawl survey and Tanner crab catchability study: Rich Gustafson, Alaska Department of Fish and Game, Homer, Alaska

The large mesh multispecies trawl survey is designed to estimate abundance of male and female Tanner, Dungeness, and red king crabs in Cook Inlet and Prince William Sound. Mature male and female Tanner crab abundance estimates in Kamishak and Kachemak Bays were low compared to historical peaks. Prerecruit male abundance in the Montague and north Montague districts of Prince William Sound was relatively high compared to recent years but legal male abundance remained low. A video system has been used since 1999 to assess trawl performance. Review of archived video for Tanner crab catchability indicated that trawl catchability varied with net orientation and distance and bottom tending characteristics ranging from 20% to 90%.

The biotwine project: David Barnard, Alaska Department of Fish and Game, Kodiak, Alaska

Escape mechanisms or openings are required by regulation in pots used to fish crab and groundfish so that animals may escape if captured in lost or discarded pots. These openings are typically secured by cotton twine that will degrade and fail after exposure to salt water for a given time period. Rationalization of crab fisheries has led to increased soak times and some fishers have complained of twine failures which have led to proposals to increase twine sizes in regulation. This project was designed to examine 1) failure times of biodegradable twines deployed by observers on pots from fishing boats in the Aleutian Islands golden king crab fishery and 2) comparisons of failure times among various sizes of cotton twines. Time-to-failure of cotton twine (#30) deployed on crab pots was 31 to 42 days, soak time to loss of strength for #30 twine was 68 to 95 days, and use of #60 twine may extend time of failure for one to three weeks.

Data collection with a mobile handheld system: Julie Bednarski, Alaska Department of Fish and Game, Douglas, Alaska

Data collection and management are essential components of fisheries assessment, catch sampling, and surveys. Processes typically associated with data are collection, validation, editing, and analysis. Paper-based data collection, the most common approach to data collection, requires the intermediate step of data entry into a central database and manual data editing and correction, with errors potentially occurring during each of these steps. Electronic methods of data collection have the advantage of eliminating time-intensive keypunch data entry and correction while maintaining data quality through validation rules. For purposes of data collection during field surveys and dockside sampling a mobile application was developed in cooperation with software contractors and deployed on a ruggedized handheld computer for dockside sampling and for the Golden King Crab Observer program in Southeast Alaska. Data is entered directly into the handheld computer using electronic calipers and a user interface, the handheld is synchronized with a mobile database following the same business rules as the central database and the two databases are then also synchronized. The application is built of objects which are easily adaptable and application in diverse field data collection projects is anticipated in the future.

ADF&G Westward region update: Doug Pengilly, Alaska Department of Fish and Game, Kodiak, Alaska

Laura Slater and Jeanette Alas joined the Region 4 staff this year while Dan Urban and Ivan Vining have left after a number of years with ADF&G. A video sled has been developed for scallop assessment by Gregg Rosenkranz with assistance from Ric Shepard. This sled captures 4 frames per second of high resolution digital imagery with a 1.1 by 0.83 m field of view and sufficient overlap of the frames to create a continuous path that is georeferenced in real time. The camera has proven useful for detecting Tanner crab both active and buried in the Kamishak district of Cook Inlet. Video assessment has several specific advantages over trawls including: organisms and habitat are recorded *in situ*, finer scale information is collected, and smaller vessel crews are necessary. Limitations of video assessment in comparison to trawls are area covered per unit time, data processing post-survey, and reduced information on size, sex, species, and reproductive condition for individual crab. Video based assessment is a useful tool to augment existing trawl surveys and for exploration of questions related to trawl performance and data.

Common fish and invertebrates found during pot and trawl surveys: Susie Byersdorfer, Alaska Department of Fish and Game, Kodiak

A photographic guide to common fish and marine invertebrates found in pot and trawl surveys in the Gulf of Alaska, Aleutian Islands, and Bering Sea is being developed. Information will include taxonomic references, identifying characteristics, size, and distribution information.

Crab overfishing reference point, Fx%, revisited with Southern Gulf of St. Lawrence snow crab: Shareef Siddeek, Alaska Department of Fish and Game, Juneau, Alaska

The southern Gulf of St. Lawrence snow crab fishery is managed using male-only, minimum-size, and effort (season, license, and trap) limitations. The annual total allowable catch is determined using Kriging-based estimates of biomass with no model-based tuning. In this study a stage-based projection model was used to simulate population dynamics of male snow crab and simulations were conducted to determine overfishing reference points for the snow crab fishery. Because of complexity in determining effective female spawning biomass that involves mating ratio, we chose the total mature male biomass as the spawning index to develop the stock-recruitment relationship for stochastic simulations. Recruitment trends were highly autocorrelated which was accounted for in the simulations. The maximum target harvest rate for F40% was 34% of legal males at the time of the survey while estimates of recent harvest levels range from 45 to 70%. Although a different model parameterization and approach were used in this study, results of the estimation of biological reference points for Southern Gulf of St. Lawrence snow crab were comparable to those for Bering Sea snow crab.

Aleutian Islands golden king crab (*Lithodes aequispinus*) stock assessment—an integrated analytical approach: Shareef Siddeek, Alaska Department of Fish and Game, Juneau, Alaska

Golden king crab differ from other commercially important lithodid crabs in life history and reproductive biology with lecithrotrophic larvae and an asynchronous reproductive cycle. Management strategies for the Aleutian Islands fisheries consist of guideline harvest levels based on estimation from historical average catches, inseason monitoring of fishery performance, and other stock production indices. Integration of these and other data sources into a model for

estimation of important population parameters is needed for management. Data sources for integrated analysis consisted of catch data, pot survey data, observer data, and tag-recapture data. Standardization and integration of these data are challenging but will be combined in a population dynamics model for estimation of molting probability, fishery selectivity, fishing mortality, natural mortality and other parameters such as a time series of abundance, which is important to determine a limit harvest level under the new overfishing tier system.

PLANS FOR 2008

The annual Alaskan crab research meetings continue to be productive and valuable for free exchange of scientific results, ideas, and perspectives. A 15th annual meeting is expected to be scheduled for the approximate dates of December 17–19, 2008, in Anchorage.

PROPOSALS FOR NEXT YEAR'S SPECIAL TOPIC

1. Genetic effects of fishing on crab populations
2. Climate change and crab biology/population dynamics

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

ACKNOWLEDGEMENTS

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APPENDIX

Appendix A.–List of participants at the 2007 interagency crab research meeting.

Last Name	First Name	Affiliation	Location	Email
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Appendix A.–Page 2 of 2.

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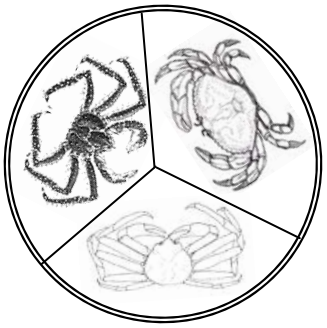
Appendix B.–Final agenda for the 2007 interagency crab research meeting.

Interagency Crab Research Meeting

December 12-14th, 2007



WEDNESDAY, DECEMBER 12

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 and Alaska Sea Grant

1. Transport of Dungeness crab (*Cancer magister*) megalopae into Glacier Bay, Alaska: Heidi Herter, UAF/JCSFOS, Juneau
2. Spatial variation and evidence for multiple transport pathways for Dungeness crab (*Cancer magister*) late-stage larvae in Southeast Alaska: Quinn Smith, UAF/JCSFOS, Juneau
3. Early benthic phase Dungeness crabs in Southeast Alaska: Ginny Eckert, UAS, Juneau
4. Red king crab early benthic phase habitat studies in Southeast Alaska: Jodie Pirtle, UAF/JCSFOS, Juneau
5. Temporal variation and habitat use of nearshore crab populations in Kachemak Bay, Alaska: Ben Daly, UAF, Fairbanks

Coffee: Mid-Afternoon

6. New tools for investigating crab reproduction: Sherry Tamone, UAS, Juneau
7. Reconstructing the Kodiak Red King Crab time series—an update: Bill Bechtol, UAF/JCSFOS, Juneau
8. An introduction to and overview of the Alaska king crab research, rehabilitation and biology program: Ben Daly, UAF/Alaska Sea Grant, Seward
9. Investigations of diet influence on large scale larval culture of red and blue king crab: Celeste Leroux, UAF/SFOS, Seward

THURSDAY, DECEMBER 13

8:00 - 8:30 am Coffee

Morning Session: 8:30 - 11:30

B. International Participants

1. Effects of ocean climate variation on production, size-at-terminal molt, and recruitment of snow crab (*Chionoecetes opilio*) on the Newfoundland-Labrador shelf: Earl Dawe, Science Branch, Department of Fisheries and Oceans, St. Johns, Newfoundland, Canada (30 min)
2. Overview of the 2007 assessment of Newfoundland and Labrador snow crab: Don Stansbury, Department of Fisheries and Oceans, St. Johns, Newfoundland, Canada (30 min)

C. National Marine Fisheries Service & Alaska Fisheries Science Center

1. NMFS Kodiak lab research update: Bob Foy, AFSC, Kodiak
2. Mass molting of Tanner crabs: Eric Munk, AFSC, Kodiak

Coffee: Mid-Morning (15 minutes)

3. Assessing probability of bycatch-related mortality in *Chionoecetes* species using reflex behaviors: Allan Stoner, NMFS, Newport, OR
4. Reproductive potential of Bristol Bay red king crab–assessment and preliminary results: Kathy Swiney, AFSC, Kodiak
5. Determining essential habitat for Alaskan crabs—identifying research needs and limitations and charting a direction for the future: Sara Persselin, AFSC, Kodiak
6. Summary of the 2007 International Bitter Crab Disease Workshop: Frank Morado, AFSC, Seattle (30 min.)

Lunch: 11:30 am - 1:00 pm

Afternoon Session: 1:00 - 5:00 pm

D. Research Priority Review

1. Review of Alaska crab research priorities

E. Alaska Department of Fish and Game

1. Temporal changes in size at maturity and their implications for fisheries management of eastern Bering Sea Tanner crabs: Jie Zheng, Juneau (30 min)
2. Sperm reserves of primiparous snow crab (*Chionoecetes opilio*) in the eastern Bering Sea–spatial patterns relative to available males: Laura Slater, Kodiak (30 min)
3. Development of egg production based biological reference points for Bering Sea *Chionoecetes*—methods and preliminary results: Joel Webb, Juneau

Coffee: Mid-afternoon (15 minutes)

4. The 2007 St. Matthew Island blue king crab survey...the Blues are Coming Back! Leslie Watson, Kodiak
5. The 2006 Petrel Banks red king crab survey: Skip Gish, Kodiak
6. ADF&G Central Region 2007 large mesh trawl survey results and tanner crab trawl catchability studies: Rich Gustafson, Homer
7. The biotwine project: David Barnard, Kodiak
8. Data collection with a mobile handheld system: Julie Bednarski, Douglas

Dinner – Glacier Brewhouse, reservations for thirty people in groups of ten at 5:45, 6:00, and 6:15

FRIDAY, DECEMBER 14

7:30 - 8:00 am Coffee

Morning Session: 8:00 am – 12:00 am

Alaska Department of Fish and Game (continued)

9. Westward region update: Doug Pengilly, Kodiak
10. Common fish and invertebrates found during pot and trawl surveys: Susie Byersdorfer, Kodiak
11. Crab overfishing reference point, Fx%, revisited with Southern Gulf of St Lawrence Snow Crab data: Shareef Siddeek, Juneau
12. Model development for Aleutian Islands golden king crab assessment: Shareef Siddeek, Juneau

VI. NEXT YEAR'S MEETING AND SPECIAL TOPIC SUGGESTIONS

VII. OTHER BUSINESS