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Summary of the Interagency Crab Research Meeting held December 17–19, 2008

by

Joel Webb

and

Doug Woodby

December 2009

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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The Special Publication series was established by the Division of Sport Fish 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 became a joint divisional series in 2004 with the Division of Commercial Fisheries. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone editorial and peer review.

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PURPOSE

This report summarizes the fifteenth annual interagency crab research meeting, held December 17–19, 2008 in Anchorage at the Hotel Captain Cook. 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 (revised March, 2006, and available from the authors), an agreement between the National Marine Fisheries Service and the Alaska Department of Fish and Game. 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 molecular tools for crab research and discard and bycatch mortality in Alaskan crab fisheries.

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

PARTICIPANTS

The 2008 meeting was attended by approximately 60 participants representing Alaska Department of Fish and Game (ADF&G), the National Marine Fisheries Service (NMFS), The School of Fisheries and Ocean Sciences of the University of Alaska Fairbanks (UAF), University of Alaska Southeast (UAS), Norton Sound Economic Development Corporation (NSEDC), Bering Sea Fisheries Research Foundation (BSFRF), and the Marine Conservation Alliance (MCA). 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.

SUMMARY OF PRESENTATIONS

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

SPECIAL TOPICS: MOLECULAR TOOLS FOR CRAB RESEARCH AND BYCATCH AND DISCARD MORTALITY IN ALASKA CRAB FISHERIES

Basic molecular ecology tools you can use to address ecological questions in Alaska crabs

Pam Jensen, National Marine Fisheries Service, Seattle

Molecular tools provide a suite of methods for investigating questions of ecological and management importance for Alaskan crab stocks. When considering studies incorporating molecular tools, a range of decisions is required—including cost, sample size, and the molecular method most appropriate to the study objective. First, the type of DNA collected may vary with the study objective. Nuclear DNA is inherited from both parents while mitochondrial DNA (mtDNA) is maternal in origin; together they are referred to as genomic DNA. DNA extraction kits are used to obtain DNA from tissues and Polymerase Chain Reaction (PCR) is used to replicate a desired section of DNA for downstream applications. PCR primers are designed to stick to and bracket certain sections of DNA for replication. Depending on the goals of the study such as differentiating among species or separating stocks within a species, choosing primers is an important step—as specific or universal primers can be chosen or developed to copy regions of DNA that are highly variable, conserved, or maternal in origin. Once DNA has been extracted

and replicated, it is common to run samples on gels for visualization and scoring against base pairs of known weight. DNA can also be fluorescently labeled and detected with lasers to obtain sequences. For example, comparison of DNA via restriction length fragment polymorphism was used to identify *Chionoecetes* hybrids in the eastern Bering Sea and to determine the direction of hybridization. Microsatellites are repeated fragments of DNA which have high mutation rates resulting in high variability. Molecular approaches using microsatellites and single nucleotide polymorphisms (SNPs) can usually be used to achieve similar objectives. Microsatellites are more frequently used than SNPs because they are less costly and time consuming to develop, but SNPs may have a statistical advantage in some situations. Possible applications of these techniques to current research priorities for Alaska crab stocks include investigation of stock structure through demographic histories, larval transport, source-sink dynamics, and diet studies. Building on these observations, landscape genetics can combine information on genetics, habitat, and spatial statistics to identify stock or population boundaries. Molecular techniques can also be useful for species identification in mixed samples such as plankton and stomach content (diet). Quantitative PCR, or QPCR, involves detection and enumeration of the number of organisms (or cells) present in a sample by estimating the amount of DNA present; the number of PCR cycles necessary to detect the DNA in a sample is compared to those required to detect known numbers of individuals (or cells) through comparison to a standard curve. Similar approaches can also be applied to gain insight into stock reproductive potential. Microsatellites have been used to estimate effective reproductive population size (N_e = the number of individuals effectively contributing to future generations) for some fish and oysters. N_e can differ from the population census size by several orders of magnitude. Similarly, parentage or kinship of individuals can be determined by comparing the microsatellite alleles in eggs, larvae, etc. to putative parents and other individuals. A primary application of molecular techniques in Alaskan crab stocks has been monitoring and identifying disease dynamics, e.g. bitter crab syndrome (BCS) in Tanner and snow crabs. In the near future, genomics, or analysis of the entire genome, will become cost effective, and with expertise in bioinformatics, genomics can provide the information for examining differential gene expression under differing environmental conditions and identifying important linkages between genetics, physiology, and ecology.

An introduction to crab discard (handling) mortality

Doug Woodby, Alaska Department of Fish and Game, Juneau

Total accounting of mortality is required under Amendment 24 to the Bering Sea/Aleutian Islands Crab Fishery Management Plan which stipulates that total fishing mortality be less than the overfishing level. Fishing mortalities occur primarily in the directed pot fisheries, in pot fisheries for other target species, and in groundfish trawl fisheries. In Alaskan crab fisheries with large-male only harvest rules, discards consist of females, males below the harvestable size, and legal-sized males which may not be of desirable condition. In 2008, the magnitude of the discard/bycatch allowance in the overfishing limits ranges from a small proportion of the total allowable catch (16%) for Bristol Bay red king crab to a large proportion (72%) for Bering Sea Tanner crab. Differences in these numbers are partially due to high variability in estimates of discard mortality in the scientific literature for fishery management plan crab stocks. The rates used in assessments range from 80% for snow and Tanner crab in trawl fisheries (which does not include mortalities of crabs that are contacted by the gear but not brought to the surface) to 20% for red king crab in the pot fishery. Some members of the fishing industry are of the opinion that these estimates may be high and further research is needed on this topic.

Estimating unobserved mortality of Bering Sea crabs due to encounters with bottom trawls

Craig Rose, National Marine Fisheries Service, Seattle

Trawl fisheries in the Bering Sea are limited in regulation by bycatch and presumed mortality of commercially important crab species encountering bottom trawls, but there is a paucity of empirical data to inform this issue. The objective of this study was to estimate the mortality rates of snow and Tanner crab encountering trawls. In addition to the area swept by the net, a large proportion of the area swept is due to the trawl sweeps which attach the net to the door. Modifications to raise sweeps above the seafloor and changes in disc size and spacing on the footrope were evaluated as measures to reduce crab mortality. Recapture nets were placed at various locations on the trawl and sweeps to capture crab that had encountered the gear. The Reflex Action Mortality Predictor (RAMP) was used to assess crab mortality. Study tows were conducted east of the Pribilof Islands. Nearly 7,000 individuals each of snow and Tanner crab were assessed. Mortality estimates were slightly higher for Tanner than snow crab and ranged from approximately 20% for crabs encountering the net wings to 7% for crab captured in the control recapture net. Modification to the trawl sweeps and footrope also effectively decreased estimated mortality for both species. Results of this study have been presented to the North Pacific Fishery Management Council for consideration of implementation in regulation.

Assessing handling mortality in Alaska crabs using RAMP: Experiments with freezing stress and other unpleasant events

Allan Stoner, National Marine Fisheries Service, Newport, Oregon

A study was conducted in 2008 to assess mortality in male Tanner and snow crabs due to freezing and trawl-related mortality using the RAMP approach—from which the probability of mortality can be estimated from reflex impairment. Tanner and snow crab in good condition were collected near the Pribilof Islands and held at a range of freezing temperatures aboard the ship for up to eight hours. The ability to right from an upside down position and limb autotomy were compared with RAMP as predictors of mortality. Mortality increased with increasing temporal exposure to freezing temperatures for both species with nearly 100% mortality within eight hours. Limb autotomy and righting behavior were not reliable predictors of mortality. The RAMP approach predicted mortality of both species with an accuracy of approximately 80%. Differences in the types of reflex impaired were observed between species and between experiments evaluating trawl injury and freezing. Tanner crabs were more sensitive to physical injury (e.g. injury during trawl capture) than snow crabs, which were more sensitive to freeze stress. The RAMP protocol is an effective method for assessing probability of mortality due to stress associated with capture. However, indirect effects such as increased susceptibility to predation or disease and molt-related mortality may or may not be directly correlated with decreases in RAMP scores. In either case, absolute mortality will be proportional to RAMP score, and the RAMP approach is a powerful tool in fishing experiments designed to evaluate improvements in handling and discard methods.

Handling mortalities in crab pot fisheries: An overview

Jie Zheng, Alaska Department of Fish and Game, Juneau

Accounting for bycatch mortality in addition to retained catch is an important step in evaluating the total mortality in fisheries stock assessments. A wide range of pot fishery bycatch mortality

rates (8%–100%) have been used in crab stock assessments since the 1990s. Higher rates (20%–50%) have typically been applied for Tanner and snow crab than red king crab (approximately 8%). Researchers have used modeling and experimental approaches to assess rates of bycatch mortality due to dropping and cold exposure. Published estimates of mortality due to cold exposure were 0.02% for red king crab and approximately 4% to 20% for snow and Tanner crabs. Handling mortality rates for red king crab were estimated in tagging experiments at 33% for crab with crushed legs versus those without. Laboratory and field experiments have generally observed no significant differences in mortality rates between crabs dropped into the water versus those placed in the water closer to the surface. Cold exposure and handling studies have generally estimated mortality at <6% for king crabs, <12% for Tanner crabs, and <20% for snow crabs. A consensus is needed among stock assessment scientists on how and what rates should be applied.

Crab handling mortality: Historical review and perspective on future needs

Liz Chilton, National Marine Fisheries Service, Kodiak

Handling mortality for crabs caught in trawl fisheries was assumed to be 100% prior to experimental investigation in the 1990s. Handling mortality rates were first estimated by holding trawl caught king, Tanner, and snow crabs in holding tanks aboard ship and assessing mortality. Mortality rates were estimated at 21% for Tanner and 22% for snow and king crabs and were influenced by shell condition and time in captivity. Currently trawl handling mortality rates are applied by crab stock or fishery and range from 20% for pot discarded king crabs, 50% for Pribilof Islands king crabs, 50% for snow and Tanner crab in pot fisheries, and 80% for all crabs discarded in trawl fisheries. The overfishing level determinations for Bering Sea/Aleutian Islands crab stocks require inclusion of bycatch mortality estimates in total catch calculations; the need for improved estimates was noted in 2008. The NMFS Kodiak Lab has developed—in cooperation with other agencies and industry groups—a project to estimate mortality in the snow and Tanner crab pot fisheries using the RAMP approach and to explore methods of reducing mortality.

CONTRIBUTED TALKS

Induction of late stages of Bitter Crab Syndrome in the Tanner crab *Chionoecetes bairdi*

Sherry Tamone, University of Alaska Southeast

Crustacean metabolic processes are directly affected by stressors which can include environmental changes that lead to changes in the physiology of the crab. Recent laboratory investigations with collaborators have investigated the role of crustacean hyperglycemic hormone in regulation of metabolism for Tanner crab. During the summer of 2008 primiparous (newly mature female) Tanner were collected from Auke Bay near Juneau, Alaska, and eyestalk ablated for the development of a crustacean hyperglycemic hormone bioassay. Unknown to the investigators, all of the primiparous females were infected with the dinoflagellate *Hematodinium*, the causative agent of BCS. Within one to three weeks of eyestalk ablation all primiparous females had released spores of the *Hematodinium* and died soon after releasing spores. A comparison of crabs prior to and directly after sporulation showed that sporulated crabs had body cavities that were visually free of indicators of the disease. Hemolymph and tissue samples were collected from each female to further characterize the life stages of *Hematodinium* present. It is

hypothesized that spore release was associated with eyestalk ablation in these females and may provide a tool for further investigation BCS in Tanner crab.

Model and *in situ* studies of larval dispersal and connectivity in Glacier Bay, Alaska

Ginny Eckert, University of Alaska Fairbanks

Glacier Bay is a recently deglaciated fjord in northern southeast Alaska that was closed to commercial fishing for Dungeness crab, *Cancer magister* in 1999, creating a functional marine reserve. Population connectivity is an important aspect of marine reserve design and several recent studies have investigated patterns of population connectivity via larval transport for Dungeness crab in Glacier Bay and surrounding waters. Light trap sampling in multiple years demonstrated that larval density decreased when distance from the mouth of Glacier Bay increased. Maximum larval densities were observed in Bartlett Cove near the mouth of Glacier Bay versus other locations in southeast Alaska. High larval abundance was also associated with wind forcing in Bartlett Cove, and the abundance varied with tidal forcing in other locations. Oceanographic modeling in cooperation with other investigators has suggested that persistent oceanographic features may limit larval transport in some areas. Further steps to develop understanding of larval connectivity include modeling of three-dimensional circulation and separation of tidal and wind effects.

Alaska red king crab population structure and mating system

Scott Vulstek, University of Alaska Fairbanks, Juneau

Genetics studies can provide insight into population connectivity or isolation and mating systems—both of which are important for fisheries management and stock enhancement efforts. Expanding on previous studies, this study will using hemolymph and tissue samples from red king crab throughout Alaska to investigate patterns of genetic differentiation, single or multiple paternity in the egg clutches of female red king crab, and migration rates among populations. A greater number of microsatellite loci will be included in this study to improve resolution of possible geographic differentiation between red king crab stocks. The egg clutches of female red king crab will also be analyzed for the genetic contribution of single versus multiple males, which has implications for a species managed with a large-male only harvest rule and flexibility in the mating system. Possible extensions of this research include genetic marking of hatchery crab and inclusion of blue king crab.

Growth physiology of wild-caught and hatchery-reared juvenile Alaska red king crab *Paralithodes camtschaticus*

Miranda Westphal, University of Alaska Fairbanks, Juneau

Crab enhancement, or culture of juveniles in captivity, is being explored as a potential tool to supplement wild stocks in areas in which red king crab have experienced population collapses. This study is investigating differences in growth patterns between juvenile red king crab from the settlement stage to six to eight months post-hatch. Juveniles are reared in individual containers and fed a varied diet. Introduction of calcium to the diet reduced mortality significantly. Preliminary results suggest that growth rates differ greatly among individuals of similar age. Further study objectives include exploring tagging methods for juvenile crab and comparing behavior between hatchery-reared and wild-caught juvenile red king crab.

Analysis of a stock-recruit relationship for Kodiak red king crab

William Bechtol, University of Alaska Fairbanks, Juneau

A retrospective analysis of the abundance and recruitment of the Kodiak red king crab stock and fishery was conducted. A length-based model combining catch, pot survey, and trawl survey information was used to analyze stock dynamics. Stock abundances and catches were high in the 1960s and early 1970s, decreased into the early 1980s and have been at very low levels to the present. The stock-recruit relationship with the best fit was an autocorrelated Ricker model with a lag of five years from spawning to legal size. Model results also indicated that population productivity was likely higher prior to the mid-1970s, decreased through the early 1980s, and subsequently increased again. A contradiction between high productivity and low abundance is apparent in recent years in the model which also predicts high but variable values of natural mortality to compensate for high productivity.

First look at images from a pilot camera sled survey of Bering Sea snow crabs and their habitat

Gregg Rosenkranz, Alaska Department of Fish and Game, Kodiak

A machine-vision camera sled which takes overlapping high-resolution digital images of the ocean bottom has been developed for scallop assessment by Gregg Rosenkranz of the Alaska Department of Fish and Game in association with researchers from the Woods Hole Oceanographic Institute. This camera sled was used to investigate the distribution and abundance of snow crab in July of 2008 northeast of the Pribilof Islands—at a station where snow crab are observed at high densities during summer bottom trawl surveys—and south of Saint Lawrence island. Preliminary results indicated that numerous dead mature snow crab, both males and females, were observed at the high density station and that competent males were associated with females. New shell snow crab and Alaska plaice were also observed south of St. Lawrence Island at temperatures less than 0°C. This data will be further examined for crab density estimates and the proportion live versus dead.

Kodiak Laboratory/Shellfish Assessment Program research highlights

Robert Foy, National Marine Fisheries Service, Kodiak

Three of the major research efforts underway at the NMFS Kodiak Laboratory are discovery and digitization of historic data, effects of ocean acidification on commercially important crab, and crab early life history, ecology, and reproductive potential. In 2008, a project was implemented to integrate environmental data collected during surveys dating back to the mid-1960s into a relational database. Availability of this information will allow inclusion of this information in research and modeling efforts. With increasing levels of atmospheric carbon dioxide, ocean acidification is a primary concern, potentially increasing the metabolic expense and affecting the ability of marine organisms to synthesize shells or exoskeletons. Kodiak Laboratory personnel have developed a regulated carbon dioxide delivery system which allows continual adjustment of seawater pH levels which will enable long-term laboratory studies of the effects of ocean acidification. This system will be used in the continued investigation of the effects of acidification on larval king crabs. Kodiak Laboratory scientists have also continued work on crab ecology, culture, and reproductive potential. Investigation supporting the development of culture methods for blue and red king crab has involved testing the effects of variability in diet and water sources on crab growth and survival. Assessment of fecundity variability and the

relationships between indices of clutch fullness and fecundity of Bristol Bay red king crab were continued in 2008. Studies of *in situ* abundance and habitat characteristics for early benthic phase red king crab were also conducted on Kodiak Island to identify essential habitat and patterns of habitat utilization.

Presumptive evidence for climate and disease interactions in shellfish populations

Frank Morado, National Marine Fisheries Service, Seattle

Causes of disease in vertebrate and invertebrate populations are complex, likely to be affected by environmental change, and can also have wide-ranging effects on terrestrial and marine ecosystems. Environmental anomalies such as rapid changes in temperature have been observed in the Northern Pacific Ocean and other marine ecosystems, and can be accompanied by changes in the prevalence and intensity of disease causing organisms and disease incidence. The incidence of the dinoflagellate *Hematodinium*, the causative agent of BCS in *Chionoecetes* crab, appears to increase with temperature in the eastern Bering Sea, and there are indications that variability of BCS may vary with the ecotypes of *Hematodinium*. While the incidence of BCS may be expected to increase with temperature in *Chionoecetes* spp., possible responses to cooling trends are unknown.

Shape analysis of Tanner crab: An update

Dan Urban, National Marine Fisheries Service, Kodiak

Image analysis of the variability in carapace shape has been previously explored for efficacy in identification of snow, Tanner, and hybrid *Chionoecetes*. The shape of Tanner crab carapaces vary in a predictable pattern and similar image analysis techniques might be valuable for identifying crab instars. Male Tanner crab terminally molt to adulthood—identified by allometric growth of the chelae relative to carapace size—over a range of sizes, but it is unknown whether this variability is due to differences in the number of molts or growth per molt. Principal components analysis of carapace center to edge distance at one degree intervals, interocular distance, and carapace width data was effective for separation of male Tanner crab into adult versus sub-adult groups, but precision was less than that using a model which included chelae height. Variability in carapace shape was more subtle than expected, and further analyses will be conducted to explore these relationships. Possible future developments of this approach will include adding lasers to provide known references to each image, three-dimensional image analysis, and exploration of shape analysis in other applications such as photographs taken by camera sleds used for scallop assessment.

Trap fishery catch per unit effort and index of abundance: A review

M.S.M. Siddeek, Alaska Department of Fish and Game, Juneau

Traps or pots are a common gear design for harvesting a variety of crab species and are used as a survey sampling method in benthic environments which are unsuitable for sampling with other gear types such as trawls. Traps vary in design and the factors affecting trap catches depend on the behavior of the species targeted, inter- and intra-specific interactions, trap design, benthic characteristics, bait type and quantity, water column properties, and the density and soak time of traps. Given the complexity of factors affecting trap catches, models are needed to standardize pot catch rates to reflect the abundance. Efforts at modeling trap catch rates have included saturation, entry, escapement, and soak time as variables. Models relating trap catches to

abundance are needed for stock assessments for some Alaskan crab stocks such as Aleutian Islands Golden King Crab. Since the golden king crab fishery was rationalized in 2005, soak time increased substantially along with retained CPUE. Due to these changes, commercial fishery CPUE must be standardized—perhaps using the trap survey CPUE if CPUE is to be used as an index of abundance. Several standardization approaches, including Gulland and Beverton-Holt models and general linear models, were explained and the former model was applied to the eastern Aleutian Islands Golden King Crab data. The standardized time series of CPUE depicted a similar trend but lower than nominal CPUE. It was concluded that improvement is still needed for use of commercial fishery CPUE as an index of abundance for Aleutian Islands Golden King Crab.

Westward Region roundup

Doug Pengilly, Alaska Department of Fish and Game, Kodiak

The fisheries for Tanner crab had guideline harvest levels of 275,000 pounds for Kodiak and 400,000 pounds for the South Peninsula in 2008/09 while the Chignik area Tanner crab fishery was closed. Of the twelve crab stocks managed under the Bering Sea/Aleutian Islands crab fishery management plan, five were closed to fishing. The largest total allowable catches were 58.6 million pounds for the Bering Sea snow crab and 20.4 million pounds for Bristol Bay red king crab. After several years of development, federal overfishing definitions were implemented for the first time in 2008 during the Bering Sea/Aleutian Islands crab stock assessment process. Westward region personnel conducted a pot survey in September 2008 to assess the red and king crab stocks near the Pribilof Islands. Survey results showed red and blue king crab primarily near St. George Island, with red king crab present in higher abundance than blue king crab. Overlapping distributions were observed between the species. Biological research on crab stocks, including laboratory investigation of Bering Sea/Aleutian Islands snow and Tanner crab sperm reserves, fecundity, growth, and dactyl length, continued in 2008. A collaborative NMFS/ADF&G project on Dungeness crab size-at-maturity and physiological/functional maturity of males for evaluation of the commercial size limit is nearing completion.

ADF&G Central Region large mesh trawl survey and research

Rich Gustafson, Alaska Department of Fish and Game, Homer

The 2008 large-mesh trawl survey was completed with the objective of assessing the abundance of Tanner, Dungeness, and red king crab in the Kachemak Bay region of southern Cook Inlet. Further goals of the survey are to implement use of net mensuration during the survey, combine survey data in a robust relational database system, and continue video data collection for a trawl catchability study. The abundance estimate for legal-sized male Tanner crab decreased in recent years and continued to be at low levels compared to historical maximums. Data on carapace widths and chelae heights were collected from male Tanner crab during the survey in 2007 and 2008 and used to estimate the proportion and size-composition of large versus small-claw males. A management concern is that 60%–70% of large-claw males are below the legal size limit for harvest. Trawl survey stations in northern Kamishak Bay overlapped with areas surveyed by video sled and dredge for weathervane scallop abundance. Estimates of CPUE for Tanner crab were developed by each method in 2007. Size composition was relatively similar between the trawl and dredge methods but crab <40 mm carapace width were observed less frequently in video samples. The total number and CPUE of crab observed in scallop dredge catches (5,823) was higher than that observed in trawl catches (124) and by video (2,930).

How much or how many? A pilot study of variability in egg quality with shell condition for snow crab, *Chionoecetes opilio*

Joel Webb, Alaska Department of Fish and Game, Juneau

Understanding variability in population reproductive potential is important for management of exploited crab stocks. For the snow crab *Chionoecetes opilio* a commercially important species in the eastern Bering Sea, reproductive potential can be measured by the number of viable eggs carried by females. Population egg production is known to vary with female abundance and characteristics of individual females such as size and reproductive status. However, in addition to the number of eggs carried by mature females, reproductive potential may also vary if females produce eggs of differing quality. To assess possible trade-offs between egg number and egg quality, indicators of egg quality were evaluated among three groups of eastern Bering Sea snow crab of differing ages relative to the terminal molt to maturity. Females collected near St. Matthew Island in August 2007 were classified by condition of the exoskeleton as newshell primiparous, oldshell multiparous, or very oldshell multiparous. Primiparous females likely carrying their first clutch of ontogeny had significantly larger ($p<0.05$, approximately 3%) mean egg diameter, but similar egg energetic content, mean egg weight, and number of eggs per unit size as oldshell or very oldshell multiparous females. Several very oldshell females had relatively lower fecundity and non-developing ovaries indicating possible senescence. These results support the conclusion that reductions in reproductive potential for female snow crab are likely to be observed as lower individual fecundity rather than a decrease in egg quality.

PLANS FOR 2009

The annual Alaskan crab research meetings continue to be productive and valuable for free exchange of scientific results, ideas, and perspectives. A sixteenth annual meeting is expected to be scheduled for the approximate dates of December 16–18, 2009 in Anchorage.

PROPOSALS FOR NEXT YEAR'S SPECIAL TOPIC

1. Ocean acidification and crab biology/population dynamics

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APPENDICES

Appendix A.–List of participants at the 2008 interagency crab research meeting.

Last Name	First Name	Affiliation	Location	Email
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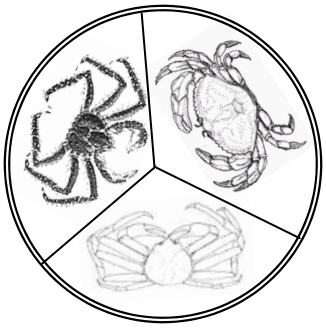
Interagency Crab Research Meeting

December 17-19th, 2008



Location**:** All sessions will be held in the Endeavour Room (downstairs from the lobby) at the Captain Cook Hotel

WEDNESDAY, DECEMBER 17
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

1. Induction of bitter crab syndrome by eyestalk ablation in the Tanner crab *Chionoecetes bairdi*
   Sherry Tamone, UAS/UAF, Juneau

2. Model and *in situ* studies of larval dispersal and connectivity in Glacier Bay, Alaska
   Ginny Eckert, UAF, Juneau

3. Alaska red king crab population structure and mating systems
   Scott Vulstek, UAF/JCSFOS, Juneau

4. Comparative growth physiology of wild caught and hatchery reared juvenile Alaskan red king crab *Paralithodes camtschaticus*
   Miranda Westphal, UAF/JCSFOS, Juneau

5. Analysis of a Stock-recruit relationship for Kodiak red king crab
   Bill Bechtol, UAF/JCSFOS, Juneau

Coffee: Mid-Afternoon

B. Alaska Department of Fish and Game

1. First look at images from a pilot camera sled survey of Bering Sea snow crabs and their habitat (30 min)
   Gregg Rosenkranz, ADF&G, Kodiak

-continued-

THURSDAY, DECEMBER 18

8:00–8:30 AM Coffee
Morning Session: 8:30–11:30 AM

C. Bycatch and Handling Mortality in Crab Fisheries

1. Introduction to bycatch and handling mortality in Alaska fisheries (10 min)
   Doug Woodby, Alaska Department of Fish and Game, Juneau

2. Estimating unobserved mortality rates of Bering Sea crabs due to encounters with trawls on the seafloor (30 min)
   Craig Rose, National Marine Fisheries Service, AFSC, Seattle

3. Assessing handling mortality in Alaska crabs using RAMP: Experiments with freezing stress and other unpleasant events (30 min.)
   Allan Stoner, National Marine Fisheries Service, Newport

4. Review of bycatch and handling mortality in pot fisheries for crab in Alaska
   Jie Zheng, Alaska Department of Fish and Game, Juneau

Coffee: Mid-Morning (15 min)

5. Crab handling mortality: A review of historical research and perspectives on future needs
   Liz Chilton, National Marine Fisheries Service, AFSC, Kodiak

D. Crab Genetics

1. Basic molecular ecology tools you can use to address ecological questions in Alaska crabs (30 min)
   Pam Jensen, National Marine Fisheries Service, AFSC, Seattle

Lunch: 11:30 AM–1:00 PM
Afternoon Session: 1:00–5:00 PM

E. National Marine Fisheries Service, Alaska Fisheries Science Center

1. Research highlights from the Alaska Fisheries Research Center, Kodiak Laboratory, Shellfish Assessment Program
   Bob Foy, Kodiak

2. Evidence for climate and disease interactions and potential impacts on North Pacific fish and shellfish populations
   Frank Morado, Seattle

3. Shape analysis of Tanner Crab: An update
   Dan Urban, Kodiak

Coffee: Mid-afternoon (15 min)

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F. Alaska Department of Fish and Game (continued)

2. Trap fishery CPUE and index of abundance: A review (30 min)
   Shareef Siddeek, ADF&G, Juneau

3. Westward Region update
   Doug Pengilly, Kodiak

4. Central Region survey update
   Rich Gustafson, Homer

5. How much or how many? A pilot study of variability in egg quality with shell condition for snow crab *Chionoecetes opilio* (15 min)
   Joel Webb, Juneau

G. Norton Sound Economic Development Corporation

1. NSEDC Crab Research in Norton Sound and the Bering Strait Region
   Wes Jones, Nome

VI. Next Year's Meeting and Special Topic Suggestions

VII. Other Business

Dinner: Glacier Brewhouse, reservations for thirty people in groups of ten at 5:45, 6:15, and 7:15

Poster Presentation: Effects of diet, stocking density, and substrate on survival and growth of hatchery-cultured juvenile red king crab
Daly, B., Alaska Sea Grant, Seward, Alaska; Swingle, J., Alaska Sea Grant, Seward, Alaska; and G. Eckert, University of Alaska Fairbanks, Juneau, Alaska.