MEMORANDUM

TO: Council and Board Members

FROM: David Witherell
Fishery Biologist

DATE: January 27, 1998

SUBJECT: Bering Sea/Aleutians Crab Management

ACTION REQUIRED

(a) Receive crab plan team report
(b) Receive report from Pacific Northwest Crab Industry Advisory Committee (PNCIAC)
(b) Receive public testimony

BACKGROUND

Crab Plan Team

The Crab Plan Team provides the council with scientific recommendations regarding the conservation and management of king and Tanner crab stocks in the Bering Sea and Aleutian Islands area. The team is composed of biologists, fishery managers, biometricians, and an economist drawn from ADF&G, University of Alaska, NMFS, and the NPFMC. The team remains relatively active, generally meeting two or three times per year. Their next meeting is scheduled for March 5-6. Team chair Peggy Murphy will be on hand to review the Team's activities.

PNCIAC

The Pacific Northwest Crab Industry Advisory Committee provides a special means of access to the regulatory process for non-residents of Alaska. The PNCIAC operates under the authority of the Council, and, under the Crab FMP, occupies the same consultative role on preseason and inseason management measures as all other existing State of Alaska Fish and Game advisory committees. Chairman Garry Loncon and Secretary Arni Thomson will be on hand to discuss PNCIAC concerns and recommendations.

OTHER

The Alaska Board of Fisheries is accepting proposals to change statewide king crab and Tanner crab shellfish regulations (see attached notice). Proposals are due by April 10, 1998. These proposals will be considered by the Board during the November 1998 - March 1999 meeting schedule.

CALL FOR PROPOSALS

THE ALASKA BOARD OF FISHERIES
CALL FOR PROPOSED CHANGES
IN THE SUBSISTENCE, PERSONAL USE, SPORT, GUIDED SPORT, AND COMMERCIAL FINFISH REGULATIONS FOR THE COOK INLET AREA, AND KODIAK/CHIGNIK MANAGEMENT AREAS, AND STATEWIDE KING/TANNER CRAB SHELLFISH REGULATIONS.

PROPOSAL DEADLINE - APRIL 10, 1998

The Alaska Board of Fisheries is accepting proposed changes to the subsistence, personal use, sport, guided sport, and commercial finfish regulations for the Cook Inlet and Kodiak/Chignik finfish management areas. Finfish includes: salmon, herring, trout, char, burbot, northern pike, whitefish, groundfish, etc. Also, the Alaska Board of Fisheries is accepting proposed changes to all King crab and Tanner Crab and shellfish issues (including all regional fisheries).

To insure that the proposed booklets are distributed well in advance of the board meetings and the fishing season, the board has set a Friday, April 10, 1998 proposal deadline. The Board recognizes this is an early deadline, however, feels the advisory committees, fishermen organizations, public and department staff have benefited by having more time to review the proposals.

Your proposal must be received by any Board Support Section office by close of business on Friday, April 10, 1998. The following offices can officially receive proposals:

Robert Speed
Headquarters
PO Box 25526
Juneau, AK 99802-5526
Phone: (907) 465-4110

Joe Chythlook
Southwest Region
PO Box 1030
Dillingham, AK 99576-1030
Phone: (907) 842-5142

Ann Wilkinson
Southcentral Region
333 Raspberry Road
Anchorage, AK 99518-1599
Phone: (907) 267-2354

Ida Alexie
Western Region
PO Box 1788
Bethel, AK 99559-1788
Phone: (907) 543-4467

Susan Bucknell
Arctic Region
PO Box 689
Kotzebue, AK 99752-0689
Phone: (907) 442-4320

Jim Marcotte
Interior Region
1300 College Road
Fairbanks, AK 99701
Phone: (907) 474-8634

All proposals must contain an original signature, contact telephone number, and address. Proposals must be received in one of the specific offices listed above by the deadline (only being postmarked by that date is not considered as valid timely receipt). You are encouraged to submit proposals at the earliest possible date.

[Note: Proposals received per the above "Call For Proposals" deadline will be considered by the Board of Fisheries during the November 1998 - March 1999 meeting schedule.]

The State of Alaska, Department of Fish and Game complies with Title II of the Americans with Disabilities Act of 1990. Individuals with disabilities who may need auxiliary aids, services, and/or special modification to make a proposal; should contact Bob Speed at (907) 465-4110. (To correspond by text telephone (TDD), call 1-800-478-2028) no later than April 3, 1998 to make any necessary arrangements.

Crab Plan Team Report

Joint Meeting of the
North Pacific Fishery Management Council
And the
Alaska Board of Fisheries

Anchorage, Alaska
February 3, 1998

The crab plan team has 10 members representing the Alaska Department of Fish and Game (ADF&G), National Marine Fisheries Service (NMFS), the University of Alaska (UAF) and the North Pacific Fishery Management Council (Council). The Council appointed Mr. Al Spalinger to the team as management biologist Mr. Ken Griffin retired.

Joshua Greenberg (*UAF, Fairbanks*)
Rance Morrison (*ADF&G, Dutch Harbor*)
Peggy Murphy (*Chair, ADF&G, Juneau*)
Bob Otto (*NMFS, Kodiak*)
Doug Pengilly (*ADF&G, Kodiak*)
Jerry Reeves (*NMFS, Seattle*)
Kim Rivera (*NMFS, AKRO, Juneau*)
Tom Shirley (*UAF, Juneau*)
Al Spalinger (*ADF&G, Kodiak*)
David Witherell (*NPFMC*)

The crab plan team met August 28, 1997 and January 6-7, 1998 in Anchorage. Primary tasks addressed by the team include review of: Status of BSAI crab stocks and guideline harvest levels; Crab FMP amendment proposals; Council, Board of Fisheries (Board), and advisory committee meetings; Preliminary Essential Fish Habitat Report; and The draft crab FMP housekeeping amendment. The team also spent considerable time reviewing the proposed National Standard Guidelines and is currently drafting an amendment to the crab FMP redefining overfishing to comply with the Magnuson-Stevens Fisheries Conservation and Management Act.

The team would like to bring attention to the fact the *Chionoecetes bairdi* fishery was closed for the 1997 season due to depressed stock condition. The team decided there is sufficient scientific data to define two stocks of *C. bairdi* in the Bering Sea: a Pribilof Islands stock and a Bristol Bay stock. The plan team will submit this change with the FMP amendment package. The team will also submit a proposal to the Council to consider splitting the prohibited species catch (PSC) for Bering Sea *C. bairdi* among these two stocks and redefine the bycatch zones to correspond with stock distribution. Also, the *C. opilio* stock has apparently failed to realize recruitment of small crab the past two years and significant decline in legal stock abundance is anticipated in the near future. Given status of the *C. opilio* stock, the team concluded they will review the PSC limit and bycatch zone for *C. opilio* in their development of an overfishing definition and rebuilding plan for the stock. If this review indicates a change is appropriate, the team will submit a proposal to the Council for consideration.

In developing overfishing definitions, the team carefully debated interpretation of the proposed National Standard Guidelines. The team was perplexed with the use of the term MSY since in general fishery science had dispelled the notion that maximum yield could be sustained. The team noted it is unfortunate that the concept is given credence. At issue is strict interpretation of the guidelines to mean OY cannot exceed MSY – should this be the case MSY would decline to zero as the long-term average yield declines. The team submitted comments to NMFS recommending clarification in the guidelines that OY can exceed MSY and that "long-term" and "prevailing" be defined with some bounds on measure of time. The plan team agreed to evaluate multiple approaches to estimate MSY and the MSY control rules given these vague aspects of the guidelines. Additionally, the plan team commented that the 10-year period for rebuilding a stock to the MSY level is unrealistic for BSAI king and Tanner crabs and will encumber development of rebuilding plans regardless of relevant biological and environmental factors.

Definitions of overfishing for each of the 18 stocks of BSAI king and Tanner crabs will differ according to the amount and type of data available. Some crab stocks are not targeted but exploited as bycatch and only have limited records of catch. While data on other crab stocks is extensive including abundance estimates, catch records, tagging, growth and observer data. Details of the different approaches used to define overfishing the stocks and an overview of a general rebuilding plan are covered in the January crab plan team minutes.

The tasks before the plan team to amend the BSAI crab FMP to comply with the revised National Standards are formidable. The plan team recognizes the importance of coordinating this work with the Board of Fisheries regulatory proposal cycle and noted that state management of BSAI crab stocks can be more conservative than mandated by the Magnuson-Stevens Act. The plan team will provide members of the Board of Fisheries copies of the draft FMP amendment package when it is completed in early April. Prior to that time, should any Council or Board members have questions or comments on the proposed FMP amendments, please contact Peggy Murphy, Kim Rivera or David Witherell.

Draft Minutes of the Bering Sea/Aleutian Islands Crab Plan Team Meeting, January 6-7, 1998 Anchorage, Alaska

Members Present:

Rance Morrison (ADF&G-Dutch)
Peggy Murphy, (Chair,ADF&G-Juneau)
Bob Otto (NMFS-Kodiak)
Doug Pengilly (ADF&G-Kodiak)
Kim Rivera (NMFS-AKRO-Juneau)
Tom Shirley (UAF-Juneau)
Al Spalinger (ADF&G-Kodiak)
Dave Witherell (NPFMC)

The Bering Sea/Aleutian Islands (BSAI) Crab Plan Team met in Anchorage, 8:00 am – 5:00 pm, January 6-7, 1998. Members Jerry Reeves and Joshua Greenberg were unable to participate. Reference papers were distributed to team members prior to the meeting including:

1) *Draft Fishery Management Plan for the Commercial King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands* (FMP) dated Dec. 24, 1997;
2) Comments by NOAA General Counsel, Jonathan Pollard, on the Draft FMP dated January 16, 1996;
3) A packet titled *Information and Comments on Revisions to the Crab FMP*, 1996 & 1997, compiled December 23, 1997; Federal Register Vol. 62, No. 248, Monday, December 29, 1997, Proposed Rule reopening of public comment period on national standard 1;
4) A packet titled *Information on Overfishing*, compiled Dec. 24, 1997;
5) *Environmental Assessment for Amendment 1 to the Fishery Management Plan for the Commercial King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands*, date November 20, 1990; and
6) *Environmental Assessment and Economic Analysis for Amendment 44 to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area and Amendment 44 to the Fishery Management Plan for the Groundfish Fishery of the Gulf of Alaska to Redefine Acceptable Biological Catch and Overfishing*, dated January 6, 1997.

The team meeting was conducted based on the following agenda:

Membership; Approve agenda and last meeting minutes; Announcements.
Status of crab and groundfish FMP amendment proposals.
Annual report assignments.
Appeal of the Board of Fisheries' Bristol Bay red king crab exploitation rate.
Recap of Dec. 1997 Interagency Research meeting.
SSC comments to the team on Tanner and snow crab exploitation rates.
PNCIAC comments to the team on PSC limits, stock status and distribution relative to closure areas.
Status of crab bycatch data collection in the NMFS groundfish observer program.
AKFIN comments on license limitation program data needs.
Final tasks for crab FMP housekeeping update.
Amendments for compliance with the Magnuson-Stevens Fisheries Conservation and Management Act.

The team welcomed their new member Mr. Al Spalinger, Regional Shellfish and Groundfish Management Biologist for Westward region. Al's 18 years of fishery management experience with the Alaska Department of Fish and Game (ADF&G) will be a great asset in making recommendations and evaluating the management, biology, economic and social conditions of crab fisheries.

The team read an Alaska State Chamber of Commerce (ASCC) resolution urging the Governor and Alaska Legislature to support an operating budget for the Alaska Department of Fish and Game (ADF&G) that enables good fisheries management and proper research. This is unique as at the same time the ASCC is supporting privatization of public services in other agencies. Arni Thomson noted that the Unalaska/Dutch Harbor Chamber of Commerce submitted the proposal to the ASCC and several UFA members worked to finalize the resolution. The team recognized these efforts and thanked Mr. Thomson for bringing it to their attention.

The four proposals to amend the crab FMP were not taken up by the North Pacific Fishery Management Council (Council) nor were proposals to the groundfish FMP dealing with crab bycatch. The team was concerned about the lack of emphasis on crab given the status of stocks. The team concluded review of PSC limits and zones would occur in their development of overfishing definitions and rebuilding plans and that they would submit proposals to the Council regarding PSC if appropriate.

In review of upcoming meetings the team noted that the Council/Board Consultation Group meeting, February 3, focuses again this year on groundfish and not crab. The team respectfully refers this group to the State/Federal Action Plan for Management of Commercial King and Tanner Crab Fisheries (October 1993) that outlines the purpose of the joint Council/Board meeting to meet publicly on an annual basis to focus on crab issues.

The team discussed the current format of the SAFE which is a compilation of multiple reports from ADF&G and National Marine Fisheries Service (NMFS) and a bibliography of the year's reports and papers pertaining to BSAI crabs. The team concluded the SAFE should be reformatted to provide one coherent document that centralizes information on status of BSAI crab stocks and fishery management and fulfills additional reporting requirements of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). Critical to the endeavor are funds for an editor and multiple day meeting to complete a first draft. Peggy will draft a letter to the director of the Council from the plan team requesting support for this endeavor.

The appeal of the Board of Fisheries (Board) Bristol Bay red king crab harvest strategy was unanimously denied at their October 14, 1997 teleconference. The Board supported the current exploitation rate and rebuilding program for red king crab noting foundational language in their policy on king and Tanner crab resource management, the Act and its proposed guidelines for national standard 1. The Board acknowledged endorsement of the current strategy by the Council technical committees, NMFS, and the majority of the BSAI crab industry.

The interagency research meeting December 17-19, 1997 provided a forum for highlighting ongoing and impending crab research. Five of the crab plan team members were able to participate in the meeting. This year's discussion topic and action item was crab rebuilding plans. Central to the topic was the infrequency of strong year classes in North Pacific crab stocks. Stock dynamics extend over a long periods of time while for many stocks data series are of short duration. Participants agreed that normative management is appropriate for crab stocks, that is when stocks are below average, low harvest rates are appropriate and when stocks are above average, then greater harvest rates would be applied. Operationally this approach requires thresholds and biological reference points to define when the stock is healthy enough to support a fishery and an exploitation rate schedule keyed to stock size. The group debated objective criteria for these definitions, discussed additional management measures, and marine sanctuaries for king crabs and Tanner crabs. Southeast region intends to continue their current management strategy for king crabs but will manage Tanner crabs more conservatively than in past fisheries if the season length becomes more abbreviated. Central region is developing management plans for both king and Tanner crabs and will propose regulatory language to the Board to close fisheries until management plans are in place. Westward region will update the management plan for Kodiak, Bristol Bay, Pribilof and St. Matthew Islands king crabs and draft harvest strategies for Tanner and snow crabs. In developing rebuilding plans for BSAI crab stocks, the plan team will draw upon the work completed at the interagency research meeting.

During review of guideline harvest levels (GHL) for *Chionoecetes bairdi* and *C. opilio* the SSC voiced concern over the high exploitation rates for these two species given their stock status. A small GHL was estimated for the 1997 *C. bairdi* fishery but ADF&G closed the season for stock conservation. A length-based model has been developed by ADF&G for *C. bairdi* and it will be used to analyze harvest strategies for the stock. The department plans to take *C. bairdi* management plans to the Board for consideration in 1999. Despite apparent recruitment failure of *C. opilio*, exploitation at the current rate impacts a small percentage of the reproductive portion of the stock due to industry preference for larger crabs. The team noted exploitation rates for these two species will be reexamined in development of overfishing definitions and rebuilding plans.

A point was raised at the Pacific Northwest Crab Industry Advisory Committee (PNCIAC) meeting that attainment of the *C. bairdi* prohibited species catch (PSC) in Zone 2 groundfish fisheries could trigger an overfishing condition. As the stock declines the distribution of crabs contracts to a smaller geographic area resulting in disproportional PSC since the C. bairdi PSC was defined using distribution of crabs at higher abundance. The plan team interjected concern for this situation throughout the debate of *C. bairdi* PSC. The plan team reviewed trawl bycatch of C. bairdi in Zone 2 in 1997 and didn't think the PSC would be reached in Zone 2 in 1998 due to declining PSC in the zone in recent years. They did

note that the *C. bairdi* PSC cap was exceeded in Zone 1 in 1997. King, Tanner and snow crab bycatch by week and zone were compared for pot and trawl gear. Bycatch in pot gear is orders of magnitude less than in trawl gear. ADF&G will evaluate potential prospecting by pot (Pacific Cod) and trawl (pollock) vessels prior to the Bristol Bay red king crab fishery when fish ticket data are available. The plan team embarked on discussion of *C. bairdi* population dynamics resulting in a decision that there is sufficient scientific data to define two stocks of *C. bairdi* in the Bering Sea. The plan team will submit this change with their FMP amendment package. The plan team will also submit a proposal to the Council to consider splitting the PSC for Bering Sea C. bairdi among the Pribilof Islands and Bristol Bay *C. bairdi* stocks. The management plan being developed for C. bairdi in the Bering Sea will also incorporate this change for Board review. Focus shifted to the *C. opilio* PSC limits and concern with PSC when abundance declines to zero. The team agreed the overfishing definition for the stock should preclude the situation.

The Volstad study contracted by NMFS to review bycatch sampling has been completed and is available for review. The plan team noted the study addressed just two fisheries and its usefulness was limited with regards to the team's 1996 concerns with PSC estimation. The groundfish observer program is measuring crab to the nearest 5 mm and will consider other crab data collection requests once given clear sampling instructions. A sub-committee of Doug, Tom, and Bob will draft standards for assessing crab injury and shell condition. The team agreed that these standards could then be combined with sections of the ADF&G shellfish observer manual to provide sampling guidelines to NMFS groundfish observer program.

The Alaska Fisheries Information Network (AKFIN) will be assembling the database used for the license limitation program. ADF&G is integrating shellfish fish ticket and registration data with Commercial Fisheries Entry Commission (CFEC) data and will provide this database to AKFIN. The definition of vessel length has changed over time and documented length may not always reflect length overall (LOA). The plan team noted a survey of a vessel's LOA can be subject to interpretation of the surveyor. Verification of a vessel's current LOA for license and registration is needed for management. Peggy will draft a letter to CFEC outlining the plan team's concerns.

Update of the FMP will include amendments for license limitation program, housekeeping, essential fish habitat, and overfishing. The license limitation program amendment 5 has been approved and Dave will incorporate the language in the March draft of the crab FMP. A list of member tasks for completion of the housekeeping amendment follows below. The preliminary assessment report for the essential fish habitat amendment was distributed for review. Peggy noted the section titled "Identification of Non-fishing Threats" will be updated according to comments in the housekeeping amendment. The team noted sections titled "Identification of Conservation and Enhancement Measures" and "Research Needs" need to be completed. First draft of the sections for the overfishing amendment are due to Dave by February 10 along with housekeeping tasks. Dave will send team members a draft the overfishing definitions and updated FMP for review by March 2. The plan team will meet March 5-6 in Anchorage to review overfishing definitions, the assessment report for essential fish habitat and draft FMP.

As a precursor to discussion of overfishing it was noted in the 1990 EA for amendment 1 of the FMP, the team recommended overfishing definitions based on threshold levels coupled to maximum fishing mortality rates.

In development of overfishing definitions for BSAI crab stocks, the plan team carefully debated interpretation of the Magnuson-Stevens Act definitions of OY and overfishing and the proposed Magnuson-Stevens Act provisions for National Standard Guidelines. The team was perplexed with the use of the term Maximum Sustained Yield since in general, fishery science had dispelled the notion that maximum yield could be sustained. It is unfortunate that the concept is given credence. At issue was whether OY could exceed MSY. The plan team requested comment from NOAA General Counsel on the setting of GHLs prior to the October 1998 submission of the amended FMP given Table 6.1 in the current FMP specifies MSY values below estimated OY. Jon Pollard (NMFS) and Lance Nelson (State) noted strict interpretation of the proposed National Standard Guidelines requires OY to be lower than MSY however the proposed National Standard Guidelines have been reopened for comment. NOAA General Counsel therefore concluded that the January 24, 1989 FMP is in effect until the amendments have been approved by the Secretary of Commerce.

The team emphasized that strict interpretation of the guidelines to mean that the largest long-term average yield (MSY) provides a "not-to-exceed" cap on the long-term average catch (OY) results in a decline in MSY to zero as the long-term average yield declines. This interpretation also effects the minimum stock size threshold used to evaluate whether or not a stock is overfished. The minimum stock size threshold is to equal whichever of the following is greater: One-half the MSY stock size or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock were exploited at the maximum fishing mortality threshold. As MSY declines to zero then

so does the minimum stock size threshold based on one-half the MSY stock size.

The team agreed that the 10 year period for rebuilding a stock to the MSY level is unrealistic for BSAI king and Tanner crabs. North Pacific crab stocks are characterized by patterns of naturally fluctuating recruitment where a pulse of high recruitment for one year or so is interspersed between lengthy periods of low or very low recruitment. The team recognized that the proposed National Standard Guidelines allow for the 10 year restriction on rebuilding schedules is allowed to be modified when the biology of the stock or environmental conditions dictate otherwise. Unfortunately, random and thus unpredictable fluctuations in environmental conditions impede fishery management actions to rebuild a slow-growing and long-lived stock on a schedule of short duration. To define a time period for rebuilding with certainty, a minimum probability of rebuilding needs to be specified as a target to evaluate management objectives against. This approach is feasible for stocks with a stock recruitment relationship. Of the seventeen stocks of BSAI crabs under the FMP, a relationship has been developed for Bristol Bay red king crabs only. Therefore, the plan team believes that in practice the specification of a maximum rebuilding time will encumber development of rebuilding plans, regardless of relevant biological and environmental factors.

The plan team decided to submit comments on the National Standard Guidelines to the Department of Commerce regarding interpretation of OY relative to MSY and elimination of specification of a maximum rebuilding period. Doug, Peggy and Bob were tasked with writing these comments.

The team struggled with two ambiguous terms in the guidelines that measure time and have direct bearing on the MSY control rules. MSY is the largest "long-term" average yield that can be taken from a stock under "prevailing" ecological and environmental conditions. Three definitions of "long-term" were debated: more than a life span, a life span, or a recruitment cycle. Not only does the species dictate definition of "long-term", so can the number of years of catch data for a stock and the length of environmental regimes. Prevailing conditions were considered those at the current time implying the average yield would be based on something less than a "long-term". The team concluded that for stocks with sufficient data they would compare two estimates of MSY prior to finalizing a definition; MSY equal to an average of all available years of catch data for a stock and MSY estimated from multiple series of years of catch data that characterize a stock's status based on knowledge of recruitment, environmental regimes, and stock abundance.

The MSY control rules for BSAI crab stocks will vary according to the data available which ranges from just catch records to a compendium of abundance estimates, catch, tagging, growth, and observer data. Stocks with catch data alone are exploited as bycatch in other fisheries (e.g., Bristol Bay and Northern district golden king crab, and Adak and Eastern Aleutian *C. bairdi*). Since these data are insufficient to estimate MSY directly, the "long-term" average catch will be used as a reasonable proxy for MSY. The MSY control rule for stocks with catch and limited survey and observer data, such as Adak red king crab and Aleutian golden king crab, will be based on "long-term" average catch. If feasible, legal crab abundance will be estimated using average historic rate of exploitation and an exploitation rate suitable to the stock's population dynamics and characteristics of the fishery will be applied to refine MSY. Stocks with catch, annual survey data, and estimates of growth, molting probability, and natural mortality will have MSY control rules based on "long-term" average effective spawning biomass or mature male abundance exploited at a rate suitable for the stock's abundance, population dynamics and fishery characteristics. Stocks with this level of data include Bristol Bay red king crab, St. Matthew blue king crab, Bering Sea C. opilio and C. bairdi crab.

For stocks with no estimate of abundance there is no gauge of a minimum or rebuilt stock size to base either a maximum fishing mortality rate or minimum stock size threshold. Traditionally, managers have limited harvest and closed fisheries using fishery performance data. The plan team agreed to two proxy criteria to reduce exploitation and/or close a fishery. First, was a 50% decline in CPUE between fishing seasons. Second, was a shift to a recruit fishery evidenced by change in carapace size and weight of crabs in sampled catch. Both criteria for determining if a stock is sufficiently small to warrant a change in management practices to achieve an appropriate level and rate of rebuilding can be defined for BSAI crabs that have estimates of abundance within the constraints of interpretation noted above. A maximum fishing mortality threshold will not exceed a fishing mortality rate F equal to natural mortality or a more suitable rate based on data available, the stock's abundance, population dynamics and fishery characteristics. Above MSY the fishing mortality rate cannot exceed the maximum fishing mortality rate. Stocks with sufficient data to estimate abundance will have a minimum stock size threshold equal to ½ the MSY stock size or to the stock size needed to rebuild the stock to a specified target level with reasonable probability given variation in recruitment and the environment. A stock above the minimum stock size threshold but below the target rebuilt level will be exploited at a reduced rate from a stock at or above the target rebuilt level. A threshold below which no fishing would occur was also discussed. The team noted that state management of stocks can be more conservative than mandated by the Magnuson-Stevens Act. The draft

amendment package for the FMP will be sent to Board members when completed in early April. The Department of Fish and Game will consider the FMP amendments in regulatory proposals they submit to the Board for consideration during 1999.

Crab Plan Team Tasking.

Murphy: Meeting minutes; letter with team comments on national standard guidelines proposed final rule; letter to Council concerning SAFE document; letter to CFEC concerning documentation of vessel LOA; provide D. Witherell updated historic catch table, maps of management areas, and figures for annual management cycle, inseason management and stock fishery and biological seasons, and text from RIR No. 5J97-15 for FMP executive summary.

Rivera: Provide Witherell updated information on other federal laws applicable to the FMP. Review minutes.

Witherell: Provide a copy of the Volstad et. al. report to team; update crab species profiles; copies of community profiles to team; incorporate edits in housekeeping amendment and the LLP amendment of FMP and provide to team, compile from authors overfishing analysis and distribute to team; subsistence language.

Doug: Table E7 subcommittee; subcommittee on crab injury and shell condition standards; text on shellfish observer program for FMP housekeeping amendment;

Otto: Draft spreadsheets of trawl survey estimates of abundance for all years, and grouped by representative years; Table E7 subcommittee; Estimate size at 50% maturity for 2 *C. bairdi* stocks and *C. opilio* stock. Subcommittee on crab injury and shell condition standards.

Morrison: Review Witherell's crab species profiles; restructure and update table of registration areas.

Shirley: Table E7 Subcommittee; species nomenclature.

Spalinger: history of target and actual exploitation rates.

DRAFT Minutes of the Bering Sea/Aleutian Islands Crab Plan Team Meeting, August 28, 1997

Members Present:

Josh Greenberg (UAF)
Rance Morrison (ADF&G)
Peggy Murphy (ADF&G, chair)
Bob Otto (NMFS)
Doug Pengilly (ADF&G)
Jerry Reeves (NMFS)
Kim Rivera (NMFS)
Tom Shirley (UAF)
Dave Witherell (NPFMC)

The Bering Sea/Aleutian Islands (BSAI) Crab Plan Team met August 28, 1997 at the West Coast International Inn in Anchorage. The team meeting was conducted based on the following agenda:

Introductions
- Status of Stocks and available GHL's
- Review Crab FMP Proposals
- Review Council and Board of Fisheries meetings
- Review preliminary EFH report
- Discuss overfishing definitions

Other discussion
Election of officers
Adjourn

The meeting began with introductions and general business. Minutes from the previous meeting (Nov 1996) were approved without changes. The draft agenda was approved and some subjects were suggested for other discussion. The team discussed harvest of crab in Russian waters, accounting of marketed crab, and noted interest in reading the Russian Report on the agenda for the September Council meeting.

Status of Crab Stocks and GHLs

The team briefly reviewed status of the Bristol Bay red king crab stock. The LBA model estimated the current biomass of legal males to be about the same as last year, whereas large increases were observed in all other size groups. An above average year-class from spawning in 1989-1991 was nearly fully recruited to the survey, and will begin to recruit to commercial fisheries beginning next year. This is the largest year-class observed since 1975. Increased harvests over the next few years are likely. The GHL for 1997 was established at 7.0 million pounds. A paper by Zheng et al. (1997) summarizing the status of the Bristol bay red king crab stock was distributed to the team and public.

Bob Otto reviewed the status of eastern Bering Sea opilio stock as indicated by preliminary survey analysis. The survey encountered numbers of large opilio, but very few opilio less than 50 mm were observed. Bob also observed an increasing incidence of bitter crab disease in opilio west of 123 degrees along the date line. Overall, prevalence remains low relative to the total population abundance. Survey data for C. opilio and C. bairdi have not been reviewed by ADF&G, so GHLs have yet to be announced. Bob noted that there were still plenty of large hair crab in the Bering Sea. Many were large animals, but carapaces were encrusted with a unique barnacle that reduces marketability.

Bob discussed other aspects of the Bering Sea trawl survey including significant changes in species co-occurrence this year compared to past years. A catchability experiment was conducted at the end of the trawl survey this year. NMFS towed a trawl underneath and slightly behind their normal survey net to get a handle on the survey net

selectivity. Both nets had identical footropes. For crab, the experiment indicated that medium sized C. opilio and bairdi crab were not fully sampled by the survey gear. Bob had long suspected that this was the case based on historic length frequency data obtained by the trawl survey. Of interest, Bob observed that hardshelled crab, that pass under the first trawl, appeared to be unharmed by this encounter. The team noted that the NMFS trawl net is not configured the same as most commercial nets targeting groundfish. Next year, the Center intends to examine if tow times could be shortened from 30 minutes to 15 minutes. Bob noted his concern for this proposed change and informed the team that an experiment will be done to estimate mean density of crabs for shorter tow lengths.

Review of Board of Fisheries Meeting

The Board met in Anchorage on August 25-27 to discuss management options for the Bristol Bay red king crab fishery. The BOF made several changes to enhance inseason management: a vessel registration deadline was set as the first Friday in October, the fishing season was set to open at 4 pm on November 1, a 30 hour tank inspection and delivery time was adopted; and baited gear will be allowed to remain on the grounds for up to 10 days following season closure if less than a 24 hour notice was given prior to closure time. Most significantly, the Board adopted tiered pot limits linked to GHLs and the number of registered vessels. These pot limits are shown in the adjacent table. Note that in all cases when pre-registration exceeds 250 vessels, the fishery will be managed by a pre-announced season closure instead of inseason. The Board also instructed the Department to establish a maximum of a 12 hour inseason reporting schedule with the fleet to facilitate management. These regulatory provisions will expire on December 31, 1998.

Pot limits established for the Bristol Bay red king crab fishery.

GHL	# of vessels	Pot Limit
< 4 million	no fishery	no fishery
4-5.9 million	< 200	80/100
	200-250	60/75
	>250	60/75
6-8.9 million	< 200	120/150
	200-250	100/125
	>250	100/125
9-12 million	< 200	200/250
	200-250	160/200
	>250	160/200
>12 million	any no.	200/250

Review of Crab Plan Amendments

A total of four amendment proposals were received by the public, and subsequently reviewed by the plan team. The following are the team's comments on these proposals.

Buyback Program for crab vessels/licenses (proposed by Crab Group Inc.): The proposal is to sever crab from groundfish licenses under the license limitation program, and then to allow a industry funded buyback program to reduce capacity of this fleet. Gordon Blue and Arni Thomson were on hand to discuss the proposal. A buyback program is authorized under the Magnuson-Stevens Act with a 66% approval of the fleet. The goal is to reduce fleet size to 200 vessels. As envisioned, the program would use a voluntary bidding process to set the value of these permits. Concerns were raised about how to deal with latent permits (those not currently fished). The plan team endorses this proposal as a means to address the overcapitalization problem and associated management problems, and recommends that Council proceed with analysis.

Accounting System for Crab Mortality (proposed by United Catcher Boats): The proposal is to initiate a reporting and accounting system for mortality of crab discarded in Bering Sea crab fisheries. The team noted that reporting of crab bycatch already occurs, but estimating mortality has not been an emphasis of the observer program. It was further noted that this was not a plan amendment, per se, but a suggestion for research priorities. This proposal dovetails with the proposed guidelines for National Standards (research on bycatch mortality). The team endorses this proposal and recommends forwarding it to the Research Planning Group.

Add Seven Non-Alaskan Members to the BOF (proposed by Alaska Fisheries Conservation Group): The proposal is to add four voting members from Washington and three from Oregon to the BOF in order to increase

equitability to fishermen from those states that fish for crab off Alaska. Tom Casey was on hand to discuss this proposal. The team noted that, as written, this was not a plan amendment. The BOF is regulated by state law (Title 16, Chapter 5, Section 16.05.221) to be composed of Alaska residents only. An alternative, which would require a plan amendment, would be to assemble a new Board of non-Alaskans, with management authority similar to the BOF. However, the team noted that the overall responsibility for crab management falls within the purview of the Council, which has non-Alaska votes. Further, the BOF is required to follow guidelines laid out in the FMP, as well as National Standards, when making management decisions.

Reduce Exploitation Rates of Tanner and Snow Crab (proposed by David Hillstrand): The purpose of the proposal is to cut back on exploitation rates for C. bairdi and C. opilio to prevent overharvest and rebuild these stocks. David Hillstrand was on hand to discuss this proposal. ADF&G staff noted that they were in the process of developing a comprehensive management approach for these species, similar to the harvest strategy for red king crab. The proposed exploitation rates could be considered as a rebuilding alternative as these plans are developed. Changing exploitation rates have both biological and socioeconomic implications that need to be analyzed in concert with other management tools. The team recommends that no action be taken on this proposal at this time, but that further study was endorsed.

Other Business

The team briefly reviewed groundfish plan amendment proposals. It was noted that many of these proposals deal with crab bycatch and development of sanctuary areas. The team would be interested in providing further review for the Council should any of these proposals get tasked for analysis.

Dave briefed the team on the essential fish habitat initiative. A preliminary EFH report was distributed to team members for their review. Peggy requested comments, changes in the distribution maps, and suggestions for scaling the distribution data classified as presence/absence (level 1) be forwarded to her, Dave, or Jerry for inclusion in the next draft. Rance noted that he may have some GIS maps of crab distribution already. The team requested that it have a chance to review the final draft when available.

Peggy provided copies of a paper reviewing current overfishing definitions for BSAI crab stocks. A review of overfishing definitions is being conducted by the NMFS central office, and we may be required to amend our overfishing definitions. On a related note, copies of the proposed rule for National Standards were distributed to team members. Comments are due September 19.

Upcoming meetings include the Council meeting (September 22-28 in Seattle), a PNCIAC meeting (October 1 in Seattle), and a Lowell Wakefield symposium on Stock Assessment Models (October 8-11 in Anchorage).

The meeting closed with election of officers. Peggy Murphy was re-elected as chair for another 2-year term. After discussion of workloads and staff schedules, the team agreed that a vice-chair position should be created to assist the chair and Council staff with team presentations. Kim Rivera was elected as vice-chair for a 1-year term.

Others in attendance were:

Arni Thomson	Henry Mitchell	David Hillstrand
Steve Ganey	Gordon Blue	Tom Casey
Joe Sullivan	Al Spalinger	

RESULTS OF THE 1997 NMFS BERING SEA CRAB SURVEY
EXECUTIVE SUMMARY

This document summarizes data presented in the Report to Industry on the 1996 Eastern Bering Sea Trawl Survey. Numbers presented are trawl survey indices of population level and do not necessarily represent absolute abundance. For further information, contact Dr. Robert Otto, NMFS, P.O. Box 1638, Kodiak, AK 99615. Phone (907) 487-5961. (GHL = Guideline Harvest Level.)

Red king crab (Paralithodes camtschaticus) Bristol Bay.

Legal males:	9.3 million crabs; 66% increase.
Pre-recruits:	8.9 million crabs; 154% increase.
Large Females:	24.9 million crabs: 109% increase.
Outlook:	Increased abundance of legal males is within the error of the survey and probably not due to recruitment. The Alaska Department of Fish and Game's estimated abundance at 5.9 million legal males; for this reason the GHL was set at an intermediate level, with an exploitation rate of 10 %. However, abundance of prerecruits has increased due to growth of a strong year classs probably hatched between 1989 and 1991. This cohort should start to reach legal size by 1998 and result in a significantly increased fishery.
GHL:	7.0 million lbs (3180 metric tons, mt). Fishery opens November 1.

Red king crab (Paralithodes camtschaticus) Pribilofs District.

Legal males:	1.1 million crabs; 120% increase.
Pre-recruits:	0.6 million crabs; four-fold increase
Large Females:	1.0 million crabs; 11 % increase
Outlook:	Legal and pre-recruit male crab are concentrated at few stations, and index has very low precision. Females and small males are poorly estimated. Both survey and fishery data indicate a long term population decline. Red king crab are relatively rare in the Pribilof Islands and usually harvested as incidental catch in the blue king crab fishery.
GHL:	Fishery combined with blue king crab in 1995.

Pribilof Islands blue king crab (P. platypus) Pribilof District.

Legal males:	0.8 million crabs; 32% decrease.
Pre-recruits:	0.4 million crabs; 52% decrease.
Large Females:	2.5 million crabs; 46% decrease.
Outlook:	Population is low and trends are not easily detectable.
GHL:	1.5 million lbs (681 mt) of **red and blue king crabs (see above)**. Preliminary ADF&G data indicate XX million lbs were taken in the September fishery.

St. Matthew blue king crab (P. platypus) Northern District.

Legal males:	4.0 million crabs; 16% increase.
Pre-recruits:	2.3 million crabs; 15% increase.
Large Females:	Not well estimated.
Outlook:	Population is above average levels. Rocky grounds preclude surveying important portions of the habitat, and abundance estimates may be affected by annual changes in the portion of the stock available to the survey.
GHL:	5.0 million lbs (2270 mt). Preliminary ADF&G data indicate that 00 million lbs (00 mt) were landed in the September fishery.

Tanner crab (Chionoecetes bairdi) Eastern District.

Legal males:	3.4 million crabs; 63% decrease.
Pre-recruits:	9.1 million crabs; 61% decrease.
Large Females:	10.0 million crab ; 64% decrease.
Outlook:	Population still declining, and little sign of recruitment is apparent. This years estimate of legal males is second lowest, and females is lowest, in history of the survey.
GHL:	Fishery will not open in 1997.

Snow crab (C. opilio) All districts combined.

Large males:	306 million crabs; 78% increase.
Small males:	1491 million crab; 44% decrease.
Large Females:	1383 million crab; no change.
Outlook:	Abundance of large males is increasing due to growth of a large cohort of small crabs, as expected. This population should remain stable or increase next year. Decline of small crab may indicate poor long term recruitment.
GHL:	225.9 million lbs (102,680 mt). Fishery to open January 15, 1997.

Hair crab (Erimacrus isenbeckii)

Total males:	5.9 million crabs; 30% decrease.
Large Females:	Not well estimated.
Outlook:	Population is declining from a recently high level. Recruitment trends are not apparent.
GHL:	0.8 million lbs (364 mt) Pribilof District only. Fishery opens November 1.

(907) 487-5961

BOF Tab 2

January 8, 1998

Coverpage

m Casey
.O. Box 910
Woodinville, WA 98072
(425) 823-3964

Dear Tom,

Here is an actual page from the Report to Industry on the 1997 Bering Sea Crab Survey, of which I am the principal author. It says the same thing I stated in my previous letter, "Among sampled mature [red king crab] females, the proportion which had molted and extruded new, uneyed eggs was 91%, compared with 98% last year." As far as we know, red king crabs do not extrude egg clutches if they have not been mated. Although we have no way of knowing if 100% of the eggs in each clutch were fertilized, that is really splitting hairs. Therefore, despite whatever proportion of females the ADFG model predicts might (or might not) have been mated, the actual data (on which their model is based) shows that 91% were mated. I was on the survey vessel, I saw those crabs, I measured them (not every one, but a majority), and I have the data. The fact that the model does not fit the data on which it was based indicates that the model needs adjustment, not the data. ADFG has the same data, since I gave it to them, and they can examine it to verify my conclusions. The difference between this year and last is simply annual variation the timing of molting/mating; we have no reason to believe that the remaining 9% of mature females would not have molted and mated within a few weeks of the survey. One minor difference between our interpretations of the data is that we define mature females based on the actual presence of eggs or egg case remnants, whereas ADFG defines them on the basis of size (≥ 90 mm CL), but that rarely makes more than a few percent difference in overall numbers.

As for the other matter we discussed, we are looking for a new or used ROV (remotely operated vehicle) which would greatly aid our studies on behavior of king and Tanner crabs. We have used them in the past on lease or loan arrangements, but our work requires us to use it on an intermittent basis over long time periods, rather than intensively for a week or two, so we really need to have one in Kodiak. I am enclosing some specs for one particular model that would do the job (although there are alternatives). The Phantom HD2, with additional components necessary for our work (particularly the longer 1100 ft cable) cost about $75,000 in 1990. I am sure they cost more now. I have met some crab fishermen who have owned and used these or similar models for prospecting; if they no longer use it, perhaps they would be willing to donate or sell it at a bargain price, and write it off as a tax deductible donation.

Sincerely,

Bradley G. Stevens

Bradley G. Stevens, PhD.

cc: Bob Otto

1997 Bristol Bay Red King Crab Fishery: a $17,550,000 Disagreement

---

-Status of the King Crab Stock-

Issue	ADFG	NMFS
1. "Large number of mature females went unmated in 1997"	**Yes** P3	**No** P4
2. Must reduce min. harvest rate of mature males from 20% down to 10% to guarantee fertilization of all mature females & quickest stock **recovery (55m# ESB)**	Yes	No P5-8
3. Sub-legal males "as or more virile" than legal **males**	No P9	Yes P10-13
4. ADFG's population model should be changed to better track reality	No	Yes P14

-Cost /Benefit of ADFG's New Harvest Strategy-

A. 1997 Gross Income @ 10% min. exploitation rate

8.6m# GHL x $3.25/# = $27,950,000 ex-vessel

B. 1997 Gross Income @ 20% min. exploitation rate

14m# GHL x $3.25/# = $45.5-million ex-vessel

C. 1997 Lost Income = $17.55-million ex-vessel

D. Lost Income / Vessel = $17.55-million / 260 vessels

= $67,500 / crab vessel

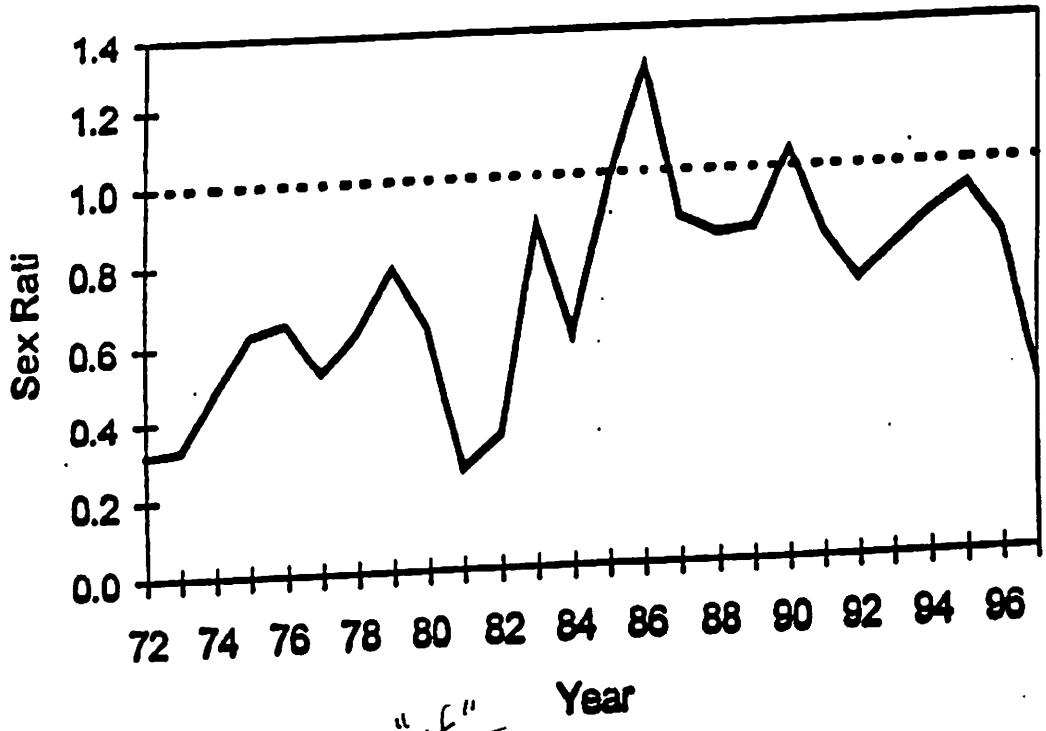
Conclusion: MSA requires that the Bristol Bay red king crab fishery be managed "risk aversely" using the "best scientific information available." ADFG claims that it is actually doing that. NMFS disputes ADFG's claim and its population model. If NMFS finds a vast majority of the Bristol Bay red king crab females bearing full egg-clutches during the summer trawl survey, the management strategy is **risk averse.**

In the 1997 summer survey (after an 18% harvest rate in the previous November's fishery), NMFS found 98% of the mature females to be egg-bearing.

Solution: CIAC vote on AFCG appeal to restore 20% in 1998

Yes: Austin & Pennoyer **No:** Benton

In the second sentence of point number 2, you refer to Brad Steven's letter in which he does not see an impending shortage of males for fertilizing females at present or in the near future. Admittedly, we are somewhat perplexed by his comment, and the lack of supportive data from him makes it difficult for us to evaluate. We talked with Dr. Stevens and confirmed he has yet to see Paul and Paul's recent paper on red king crab reproduction. The historical time series of mature males to mature females is shown in the following figure. As it turns out, the sex ratio of mature males to mature females dropped from 0.8:1 in 1996 to 0.4:1 in 1997. As you can see in the graph, a lower sex ratio than this was experienced only in a couple of years in the early 1970s and early 1980s.



Kruse (1997) estimated that an average of 1.8 females could be mated by mature males in 1997 based on their size distribution and based on the mating results of Paul and Paul (1990) and Paul and Paul (*in press*). By multiplying the LBA estimate of mature male abundance of 10.495 million crabs in 1997 times the average mates per male equals a potential 18.891 million mated females. However, an estimated 23.699 million mature females were available for mating in 1997. Thus, if our calculations are correct, a large number of mature females went unmated. This calculation and the decline in sex ratio in 1997 shown in the graph above leads us to disagree with Dr. Stevens on this point. However, we do agree with Dr. Stevens that this situation is likely not to be an issue in the near future. The current low sex ratio of mature males to mature females is partly a function of a strong cohort of young crabs spawned in 1990. On average, females mature at 90 mm carapace length (CL) and males mature at 120 mm CL. At present, the modal size of females in the 1990 cohort is about 98 mm CL and the modal size of males is about 103 mm CL. Thus, owing to sexual differences in growth and size of maturity, most of the females in this cohort are mature whereas most of the males are immature. As crabs in this cohort continue to grow in body size, a higher proportion of males will become mature. Thus, we expect the sex ratio of mature males to mature females to improve in 1998 and 1999.

Source: A letter written by Bob Clasby, Director
ADFG Commercial Fisheries Division
Juneau Headquarters, Alaska

Kodiak, AK 99615
(907) 487-5961

January 8, 1998

om Casey
P.O. Box 910
Woodinville, WA 98072
(425) 823-3964

Dear Tom,

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Sincerely,

Bradley G. Stevens

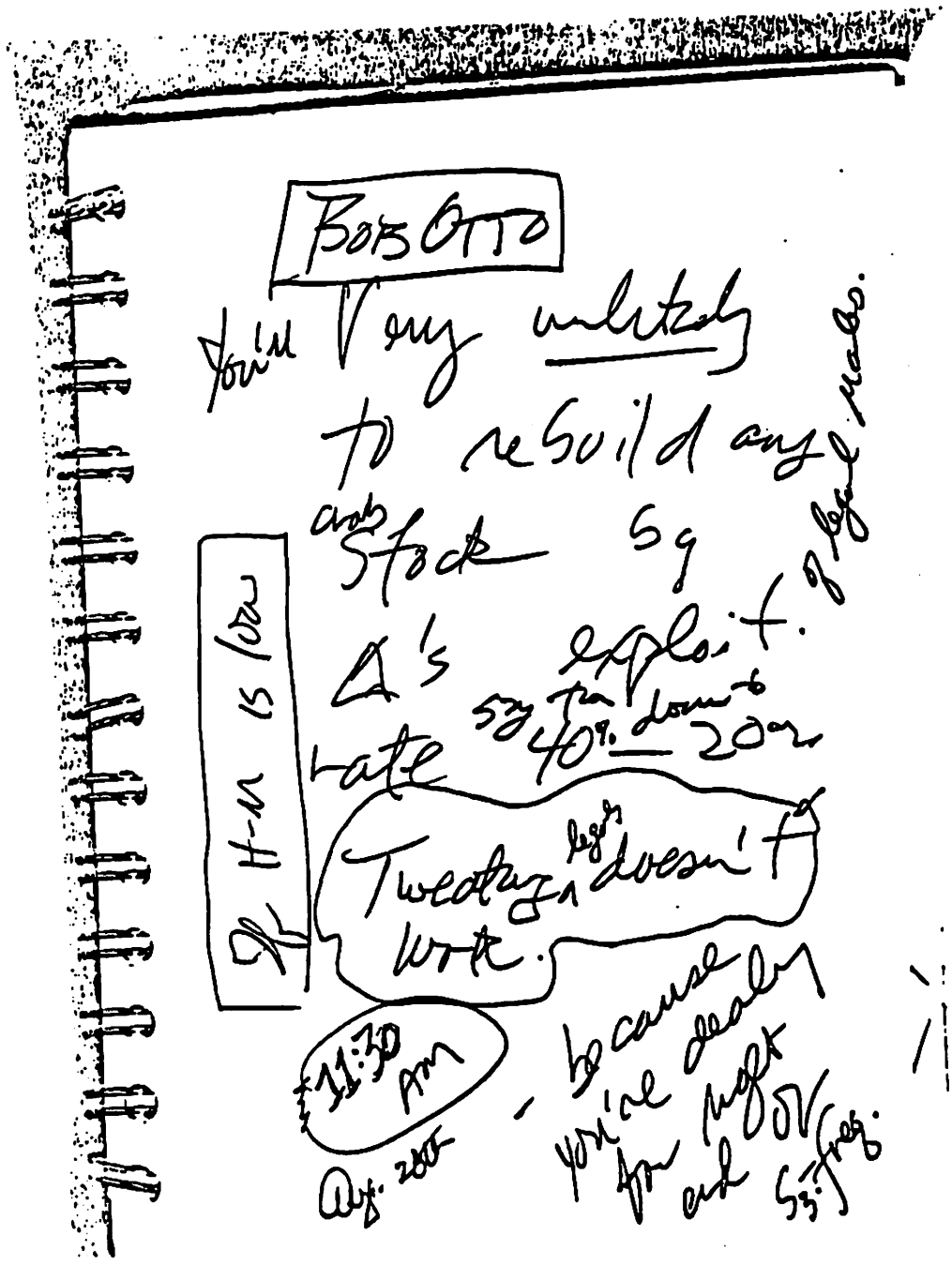
Bradley G. Stevens, PhD.

cc: Bob Otto

(4)

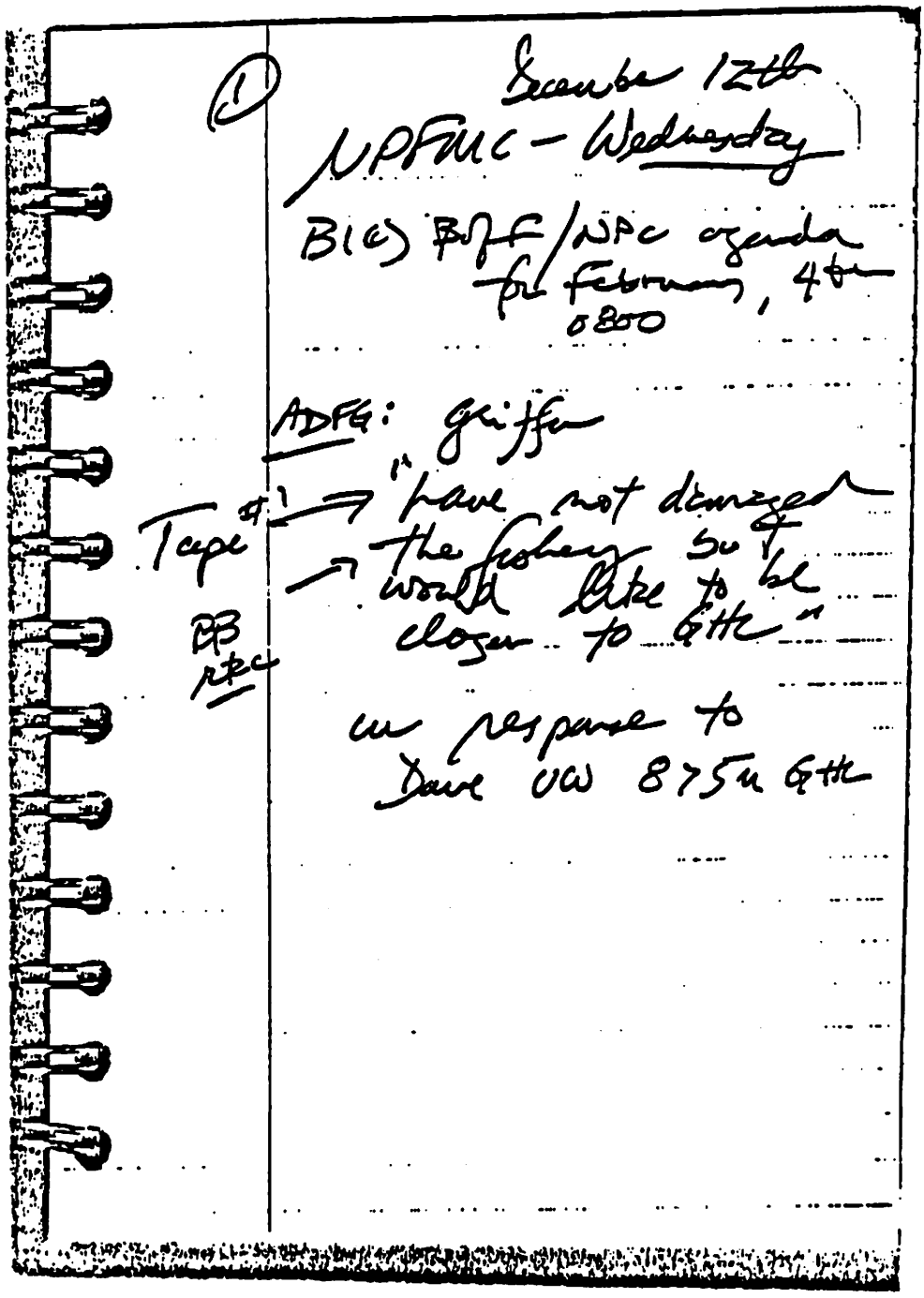
Bob Otto's Quote to the NPC's Crab Plan Team
August 28, 1997 @ 1130 ADT

"You're very unlikely to rebuild any crab stock by changing the exploitation rate say from 40% down to 20%. Tweaking legals doesn't work because you're dealing with the right end of the size frequency."



Ken Griffin's quote to the North Pacific Council
December 12, 1996 (Tape #1)

"We (ADFG) have not damaged the (Bristol Bay red king crab) fishery (by allowing the 1996 harvest to reach 8.4-million pounds) but we would like to be closer to the (5-million pound) GHL."



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Investigations-Research
P.O. Box 1638
Kodiak, Alaska 99615-1638

October 1, 1997

Dr. John White, Chairman
Alaska Board of Fisheries
Juneau, Alaska
FAX: (907) 465-6094

Dear Dr. White:

I am in receipt of a letter to you from Mr. Tom Casey of the Alaska Fisheries Conservation Group dated September 18, 1997 and concerning an appeal of the Board's decision to maintain a 10% exploitation rate in the Bristol Bay red king crab. I received my copy via FAX from Mr. Casey. Mr Casey's letter states (Item 6): "At the Crab Plan meeting on August 28, NMFS' Dr. Bob Otto told us that the Board's rebuilding strategy (based on reducing the exploitation rate from 20% to 10% of mature males) is ineffective and won't work."

I am also in receipt of a letter from Mr. Paul Larson, Deputy Director, ADF&G, Commercial Fisheries Management and Development Division, August 25, in which Mr. Larson requests that I provide written clarification of "what your statements were with regard to this reference," (Mr. Casey's Item 6). Since I have been on travel for the past week and half I am only now responding. I will copy this letter to Mr. Larson as I believe it answers his concerns.

First, I have some difficulty in being sure what I said that led to Mr. Casey's statement because I do not recall commenting on the effectiveness of the rebuilding strategy. I do recall making comments on last year's fishery utilization rate (ca 21% of legal males in 1996, or 15% of mature males, calculated against the 1997 length based assessment [LBA]) which was unexpectedly high given a 1996 catch of 8.4 million pounds against a 1996 GHL of 5.0 million pounds. Referencing the past 3 year's male size-frequency information (attached along with 1997 male-female information) my comment was that I was not very worried about the overrun relative to the current situation. In particular the legal portion of the male population represented at the tail end of the size frequency and harvesting, say 20% of it, was unlikely to alter population structure. In this regard I said: "the tail does not wag the dog." This is simply an observation relative to the current situation that is apparently dominated by

A
B

7

recruitment. This is not a criticism of the rebuilding strategy which is a long term process that will, in any case, be reviewed in the Board's normal cycle.

Comparative figures (% of total males) for 1996 utilization rates are as follows:

	1997 LBA	NMFS Survey
1996	9.7	4.8
1997	3.8	2.7

The principal difference being that the large mode of recruitment in the attached figures was not captured by the LBA assessment until 1997. Otherwise, we must agree that the harvest was a small portion of the male population and while it might have been smaller (1% or 2% say), I doubt that this difference has any biological significance. Further, the males in the dominate mode are now growing faster than the females since the females matured this year. This means that there will be relatively large numbers of males maturing over the next two years and, hence, the little concern about reproductive potential.

For the record, I don't think that the events of 1996 materially affect rebuilding of the stock. Rather, the 1996 fishery overrun (100*8.4/5.0 = 168%) represents a problem relating to management control. I believe that the Board took rather comprehensive action to improve management control at its August meeting.

While I don't believe that the 1996 overrun was very important relative to present or future stock abundance, this should not be taken as an indictment of the rebuilding strategy, as Mr. Casey has evidently construed it.

I apologize for any confusion that I may have caused and look forward to working with the Board of Fisheries in the future.

Sincerely,

Robert S. Otto
Facility Director

Enclosure

cc: RACE Reading File
Mr. Thomas Casey, Alaska Fisheries Conservation Group
Mr. Paul Larson, ADF&G, Juneau
Dr. Gary Stauffer, NMFS/RACE, Seattle

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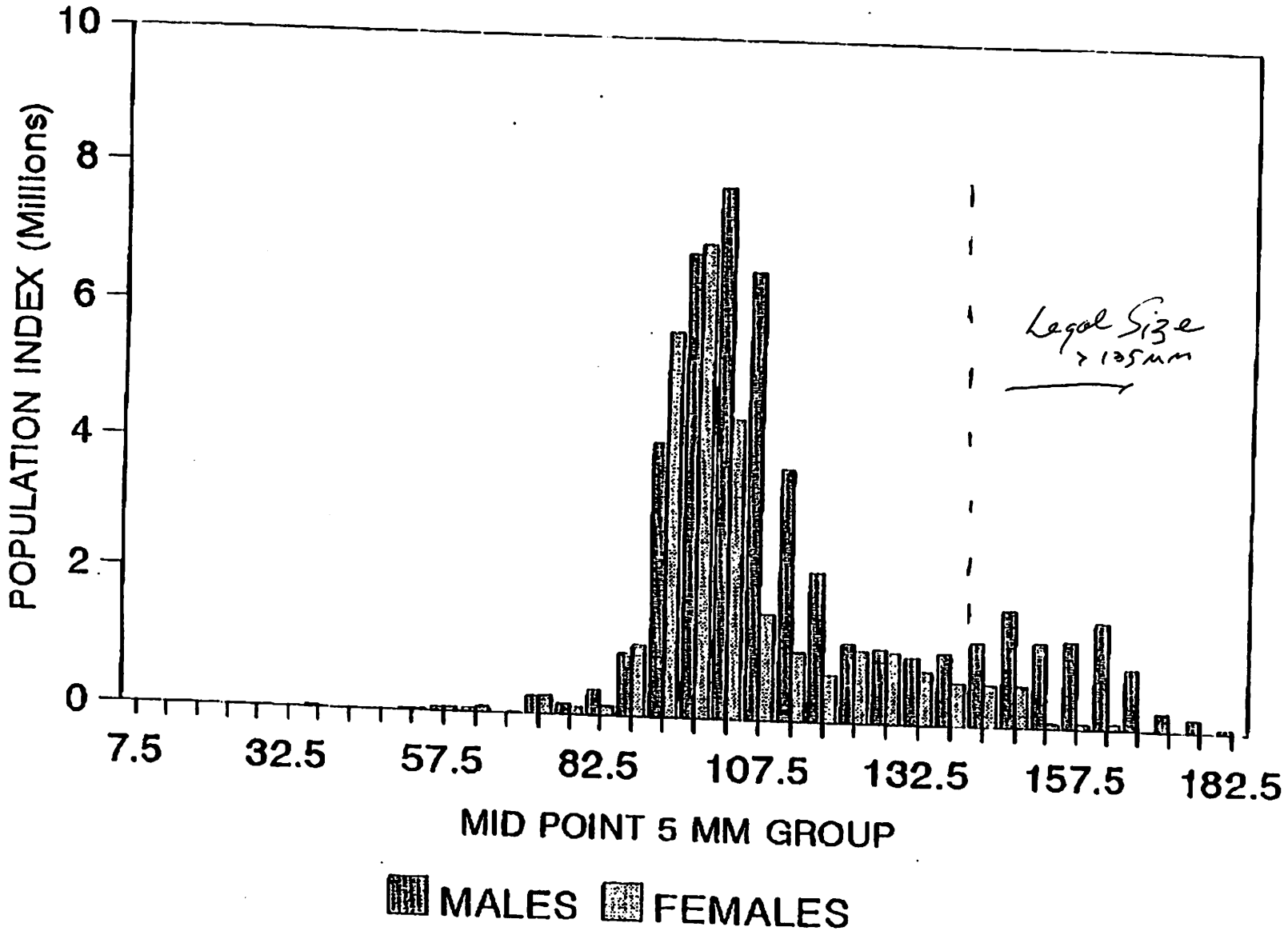
RED KING CRAB
BRISTOL BAY 1997



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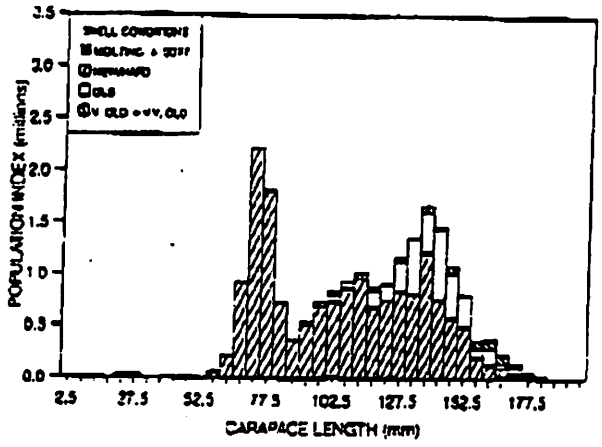
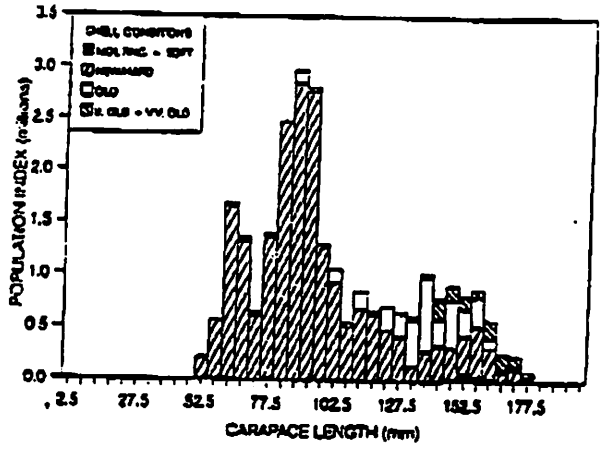
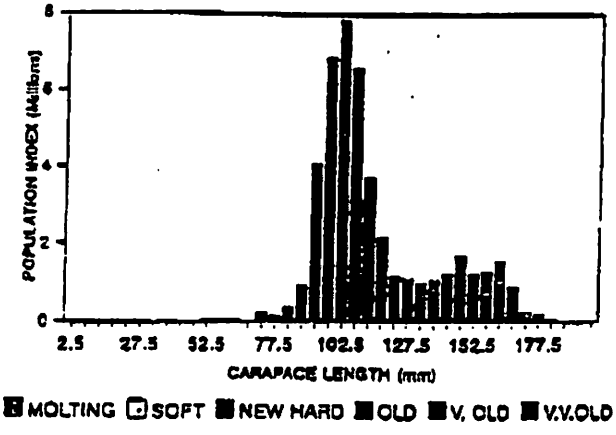
Red King Crab Length Frequency
Bristol Bay Area 1995



Red King Crab Length Frequency
Bristol Bay Area 1996



Red King Crab Length Frequency
Bristol Bay Area 1997



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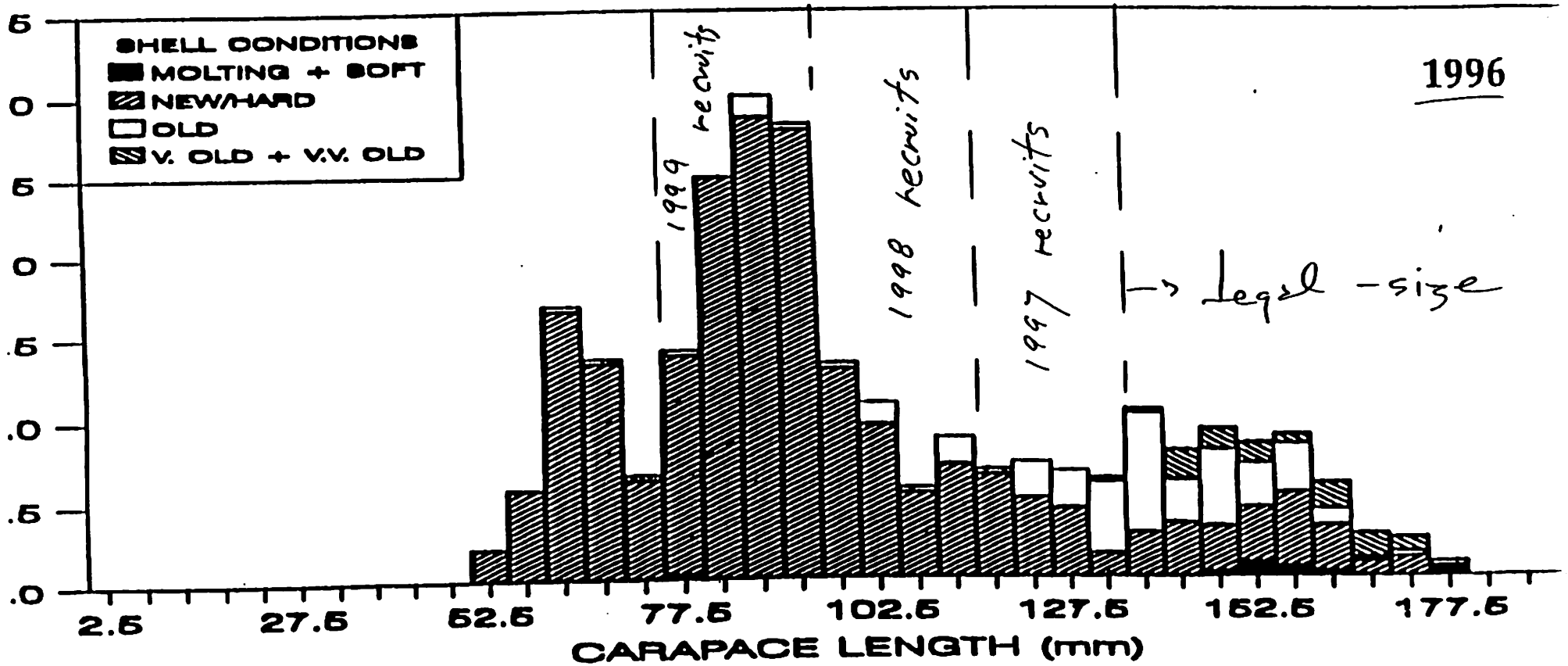

JRE 3. Size-frequency of male red king crab (*P. camtschaticus*) by 5 mm length class 1994-1996.

(11)

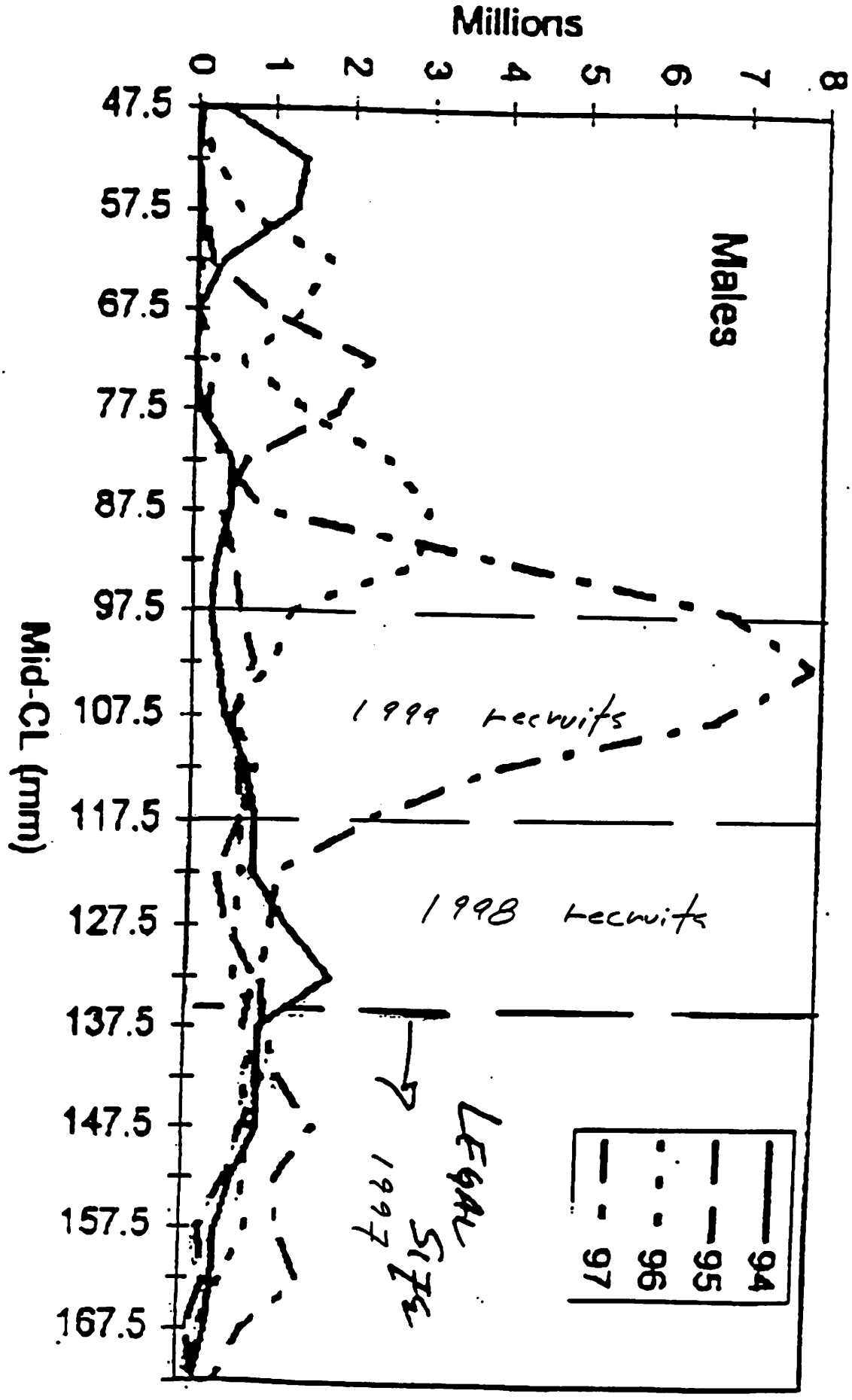
Millions
0
1
2
3
4
5
6
7
8
47.5
57.5
67.5
77.5
87.5
97.5
107.5
117.5
127.5
137.5
147.5
157.5
167.5
Mid-CL (mm)
Males
1999 recruits
1998 recruits
1997 size
Legal size
97
96
95
94

Table 1. Annual abundance estimates (millions of crabs), effective spawning biomass (millions of pounds), and 95% confidence intervals for red king crabs in Bristol Bay estimated by length-based analysis. Size measurements are mm CL.

	Males					Females		
Year	Recruits	Small	Prerec.	Mature	Legal	Recruits	Mature	Effective Spawning Biomass
mm→		(95-109)	(110-134)	(>119)	(>134)		(>89)	
a. Abundance Estimates and Spawning Biomass								
1972	NA	13.464	14.991	18.433	9.961	NA	59.707	55.245
1973	29.811	20.650	26.089	22.472	10.748	33.008	69.927	63.239
1974	20.597	14.965	34.825	34.019	14.765	28.116	71.392	93.396
1975	31.872	22.002	35.960	41.038	20.529	21.843	66.061	116.536
1976	43.370	30.094	45.295	48.753	25.389	34.445	75.388	129.274
1977	50.127	35.085	59.024	61.512	30.187	71.964	118.627	163.650
1978	19.138	14.940	57.518	74.237	39.244	46.214	119.129	199.305
1979	12.362	9.073	36.303	72.408	46.642	18.774	92.812	166.543
1980	23.364	16.003	25.500	58.568	43.446	35.932	93.529	166.120
1981	17.187	12.397	17.016	18.025	9.415	13.544	71.479	58.281
1982	22.985	15.986	16.028	10.018	2.917	17.362	29.972	23.567
1983	13.101	9.698	13.690	8.857	2.433	4.784	10.050	16.759
1984	18.503	12.849	12.908	8.082	2.337	11.729	13.497	16.337
1985	8.951	6.752	10.460	6.799	1.787	4.585	6.950	10.411
1986	5.865	4.416	12.250	11.434	4.236	3.787	8.911	14.180
1987	6.170	4.424	10.793	13.273	6.433	8.446	15.031	23.792
1988	5.834	4.209	9.806	13.868	7.898	5.475	16.567	27.787
1989	4.739	3.468	8.998	14.891	9.340	5.342	17.598	30.800
1990	1.377	1.187	6.912	14.554	9.867	0.891	13.910	26.946
1991	4.058	2.769	4.999	11.709	8.403	3.758	14.075	27.401
1992	5.355	3.765	5.914	9.859	6.739	3.532	13.949	27.396
1993	1.958	1.841	6.636	9.935	6.014	2.268	12.594	25.596
1994	0.934	0.879	5.224	8.517	4.839	0.430	9.760	21.457
1995	2.419	1.722	4.111	8.476	5.643	1.793	9.034	19.783
1996	3.336	2.453	4.457	8.530	5.925	3.844	10.535	21.258
1997	23.113	15.459	11.674	10.495	5.858	15.910	23.699	31.415
	up 600%	up 530%	up 160%	up 23%	NO change ?	up 344%	up 135%	up 58%

12

Thus, both laboratory and field evidence substantiates a conclusion that legal-sized male crabs mate with more females than do sublegal males. We know of no evidence that sublegal males are more virile than legal-sized males.

BOB GLASBY LETTER
12.10.97

13

AJ Paul 1990

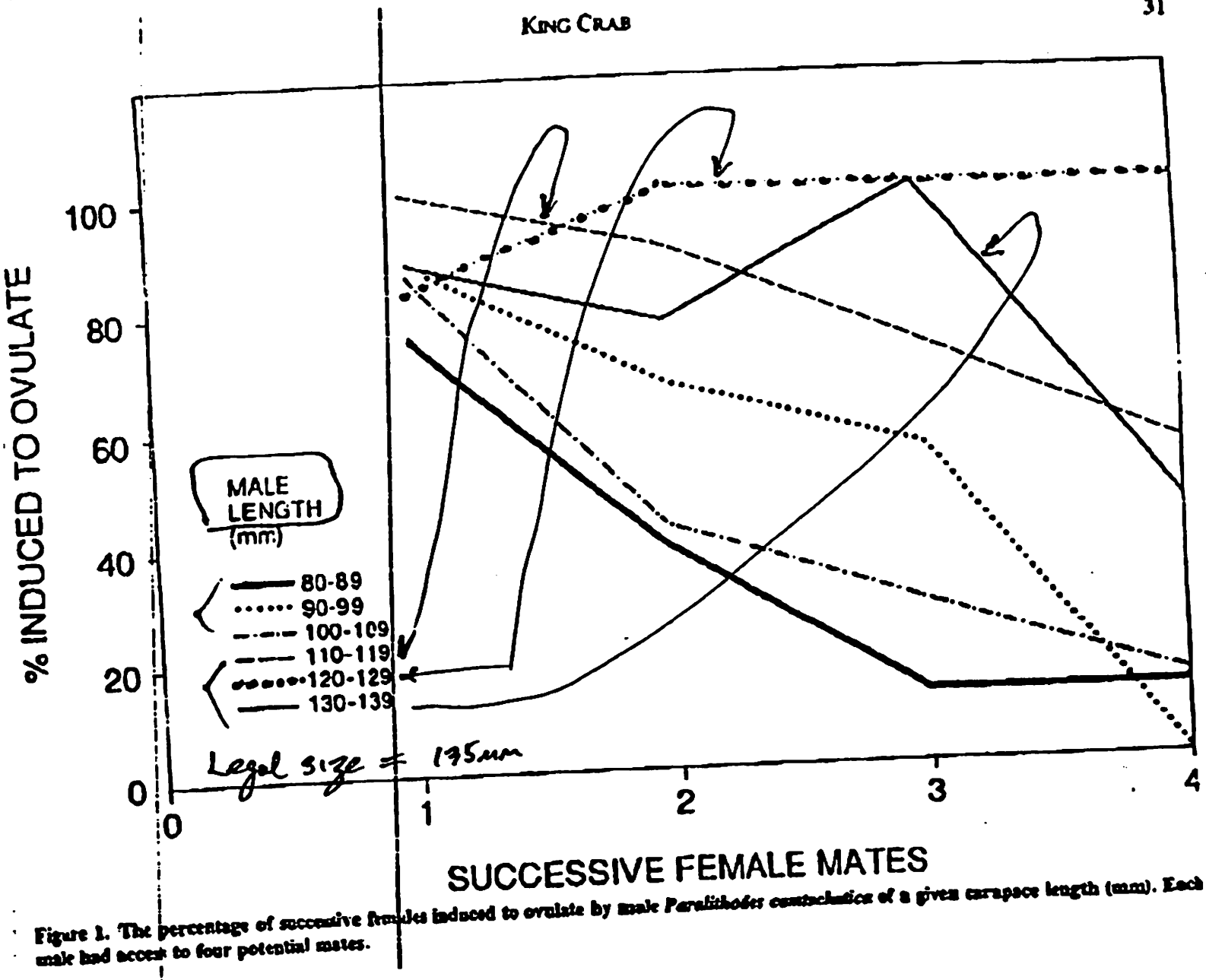

Figure 1. The percentage of successive females induced to ovulate by male *Paralithodes camtschatica* of a given carapace length (mm). Each male had access to four potential mates.

41

males are mature. Most of these males failed to induce more than one mate to ovulate. Only one male in this size range was able to fertilize all four females. One male killed three of his potential mates after they molted even though all had ripe ovaries. He molted and was cannibalized so it was not possible to check for sperm presence.

Eighty-eight percent of 90–99 mm males induced their first mate to ovulate, but only 66, 55 and 0% were successful at breeding females 2 through 4 respectively. The percentage of dividing eggs in clutches of females, bred by 90–99 mm males, decreased with each successive mating. Their first mates' clutches contained an average of 86% dividing eggs. Females that were 2nd, 3rd, and 4th in mating chronology had averages of 63, 41 and 0% of their eggs dividing. Two males in this size class killed some newly molted ripe females. In both cases males fertilized their first mates but did not induce their second mate to ovulate. One male killed females 3 and 4; the other killed female 4.

Males in the 100–109 mm group induced an average of 86% of their first potential mates to ovulate. Less than 42% of these males induced a second female to ovulate and only 14% bred a fourth female. An average of 83% of the eggs of first mated females initiated division while the 2nd, 3rd and 4th females in mating chronology had only 39, 26, and 13% of their eggs cleaving respectively. All males in the 110–119 mm size group induced one female to ovulate and 90, 72, and 54% of them bred a 2nd, 3rd, and 4th mate respectively. The percentage of eggs initiating division in clutches of female mates 1 through 4 was 98, 74, 62 and 44% respecuvely. One male killed the second female after she molted but successfully bred females 1, 3 and 4.

Males in the 120–129 mm group mated with all four females available to them in all but one case. The percentage of cleaving eggs in clutches of females that ovulated was typically high, 87–100%.

All but two of the 130–139 mm males bred three females successfully but 5 of 9 males did not induce a fourth available female to ovulate. Egg division rates averaged 87 and 76% for females 1st and 2nd in chronology, and 95 and 38% for the 3rd and 4th female mated. One male killed two of his potential mates after they molted, but females 1 and 3 ovulated and over 92% of their eggs were developing.

The percentage of females induced to ovulate by the different size classes of males is summarized in Figure 1. Qualitatively all clutches were of normal size and egg count. Even clutches with low percentages of dividing eggs did not exhibit gross abnormalities in regards to clutch size. Evidently even non fertilized eggs may attach normally. Egg counts for individual clutches in these experiments are available in a data report (Paul and Paul, in press).

Percentage of eggs dividing in clutches of *Paralithodes camtschatica* mated successively by a single male. A 0 indicates male did not induce female to ovulate, * means male killed that female. (Data listed as increasing male size)

Male Carapace length (mm)	% Eggs Dividing Mate 1	% Eggs Dividing Mate 2	% Eggs Dividing Mate 3	% Eggs Dividing Mate 4
80–89	59	0	0	0
	0	0	0	0
	94	15	0	0
	92	40	0	0
	99	0	0	0
	0	*	*	*
	100	96	98	99
	99	0	0	0
Mean	68	18	12	12
90–99	99	99	95	0
	98	0	*	*
	99	98	0	0
	0	0	0	0
	99	86	59	0
	86	0	0	*
	99	88	80	0
	99	97	41	0
	97	99	98	0
Mean	86	63	41	0
100–109	89	0	0	0
	98	99	99	0
	99	0	0	0
	100	0	0	0
	99	96	81	0
	0	0	0	0
	99	80	0	92
Mean	83	39	26	13
110–119	100	92	96	89
	99	83	86	0
	99	100	99	99
	100	99	100	99
	98	99	0	0
	90	99	40	0
	99	*	96	20
	100	1	67	75
	99	97	0	99
	99	62	100	0
	92	88	0	0
Mean	98	74	62	43
120–129	99	99	92	97
	0	99	98	87
	98	98	98	98
	100	99	97	99
	99	99	99	98
	98	99	99	100
Mean	82	98	97	96
130–139	99	99	99	96
	99	98	99	87
	99	99	96	0
	99	0	66	62
	0	98	100	0
	92	*	98	*
	99	92	99	95
	100	99	100	0
	99	98	99	0
Mean	87	76	95	38

NMFS,
P.O. Box 1638,
Kodiak, AK 99615

October 24, 1997

Tom Casey
P.O. Box 910
Woodinville, WA 98072
FAX (425) 823-3964

Dear Tom,

Here are my responses to your questions sent via fax on Friday, 24 October 1997:

1. The paper by A.J. Paul and J.M. Paul (1990), on breeding success of sublegal king crabs is the best available information I know of at this time. It should be used in conjunction with the data in Powell et al (1974), which I also sent you.

2. Concerning Paul and Paul's study: sub-legal
   A. They found the 120-129 mm CL size group had the greatest " success in both inducing females to extrude clutches (Fig.1), and in rate of egg fertilization (Table 1).
   B. Legal male red king crabs in Bristol bay are those with a carapace length >135 mm.
   C. We consider the average molt increment to be about 15 mm. Therefore, crabs larger than 120 mm would be likely to molt to sizes > 135 mm at the next molt.

3. Among the mature female red king crabs captured during the 1997 EBS trawl survey, 91% carried new eggs, 8% were in the process of hatching their previous clutch, and 1% had not yet started hatching the previous clutch. Of 570 females with new eggs, 196 (34%) were recorded as between 75 and 100% full, and 46 (8%) were recorded as less than 75% full. However, clutch fullness data are highly subjective. In a study done by ADFG, 20 experienced crab biologists rated clutch fullness in 10% increments, but our ratings only agreed when fullness was recoded into 33% intervals; i.e. the best we could do was to say the clutches were 1/3, 2/3, or 3/3 full. In addition, small females bearing their first clutches tend to have smaller clutches than older/larger females, so they tend to be rated as "less than 100% full" even though that may be as full as they get. Furthermore, we cannot estimate the % of fertilization aboard the survey boats, and as Paul and Paul have shown, a crab may carry a clutch which looks full, but has a low % fertilization. My best interpretation of our survey data is that 91% of females were carrying new clutches (with unknown fertilization rates), and the remaining 9 % would probably bear new clutches by the end of June.

4. The large mode of "immature" male RKC in the Bering Sea has a modal size of about 105

16

mm CL, with a maximum of about 120. Some of those crabs are probably "mature" meaning they can mate with females. After their next molt, a large portion, perhaps half of them or more will be "mature". Currently, there are about 12.4 million mature males larger than 120 mm, and about 25 million mature females. As the present crop of males grows and becomes mature, the situation will only improve. Therefore, I do not see an impending shortage of male crab available for fertilizing females at present or in the near future.

Sincerely,

Bradley G. Stevens

Bradley G. Stevens, Ph.D.

17

ADF&G's response to "Appeal of the Board's Decision to Maintain the 10% Exploitation Rate" by Tom Casey, September 18, 1997 (Attachment 2)

Also, Mr. Casey claims that the LBA is subjective when, in fact, it is a very objective, statistical procedure. Mr. Casey seems to fail to realize that the area-swept procedure is itself a model that, in 1997, scales the 2,578 crabs actually caught up to the 73 million total red king crabs estimated to be in the population. The procedure does this by taking one short tow per 400 square nautical miles and assumes that this years population has absolutely nothing to do with a past year's population. We prefer not to make this cavalier assumption and instead have developed an approach that tries to make sense out of sometimes conflicting annual trawl survey data. To ignore the 1996 trawl survey results in light of the 1997 estimate is truly to ignore reality.

NMFS area-swept

18

Kodiak, AK 99615
(907) 487-5961

January 8, 1998

Tom Casey
P.O. Box 910
Woodinville, WA 98072
(425) 823-3964

Dear Tom,

Here is an actual page from the Report to Industry on the 1997 Bering Sea Crab Survey, of which I am the principal author. It says the same thing I stated in my previous letter, "Among sampled mature [red king crab] females, the proportion which had molted and extruded new, uneyed eggs was 91%, compared with 98% last year." As far as we know, red king crabs do not extrude egg clutches if they have not been mated. Although we have no way of knowing if 100% of the eggs in each clutch were fertilized, that is really splitting hairs. Therefore, despite whatever proportion of females the ADFG model predicts might (or might not) have been mated, the actual data (on which their model is based) shows that 91% were mated. I was on the survey vessel, I saw those crabs, I measured them (not every one, but a majority), and I have the data. The fact that the model does not fit the data on which it was based indicates that the model needs adjustment, not the data. ADFG has the same data, since I gave it to them, and they can examine to verify my conclusions. The difference between this year and last is simply annual variation the timing of molting/mating; we have no reason to believe that the remaining 9% of mature females would not have molted and mated within a few weeks of the survey. One minor difference between our interpretations of the data is that we define mature females based on the actual presence of eggs or egg case remnants, whereas ADFG defines them on the basis of size (≥ 90 mm CL), but that rarely makes more than a few percent difference in overall numbers.

As for the other matter we discussed, we are looking for a new or used ROV (remotely operated vehicle) which would greatly aid our studies on behavior of king and Tanner crabs. We have used them in the past on lease or loan arrangements, but our work requires us to use it on an intermittent basis over long time periods, rather than intensively for a week or two, so we really need to have one in Kodiak. I am enclosing some specs for one particular model that would do the job (although there are alternatives). The Phantom HD2, with additional components necessary for our work (particularly the longer 1100 ft cable) cost about $75,000 in 1990. I am sure they cost more now. I have met some crab fishermen who have owned and used these or similar models for prospecting; if they no longer use it, perhaps they would be willing to donate or sell it at a bargain price, and write it off as a tax deductible donation.

Sincerely,

Bradley G. Stevens

Bradley G. Stevens, PhD.

cc: Bob Otto

19