

**Literature Search:
Research and Publications to Support
Improved Chilling and Handling in Salmon Fisheries**

Prepared for:
**Bristol Bay Regional
Seafood Development Association**

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Introduction

The Bristol Bay Regional Seafood Development Association (BB-RSDA) is the fisherman-funded marketing organization for salmon harvested in the Bristol Bay driftnet fishery. According to Alaska statute, the organization has the authority to invest in infrastructure development, education, marketing, and research that support the seafood products harvested in the region

The Board of Directors of BB-RSDA is working to identify areas where the organization's funding would best serve the fleet. Five strategies are outlined in their current strategic plan. They are the following:

- A. Improve quality through chilling and improving handling practices.
- B. Support research into the economic and biological aspects of the Bristol Bay salmon fishery.
- C. Market and promote Bristol Bay salmon.
- D. Collaborate with and form partnerships with other entities in the fishery.
- E. Continuously work to strengthen the organizational foundation of the BB-RSDA.

To support prudent and productive investment, the Board and staff of the organization are assessing the work that has already been done to support these strategies. Toward that end, the BB-RSDA contracted with Dory Associates to determine what research and resources related to chilling and handling practices (Strategy A) have already been developed in Bristol Bay, around the state, and elsewhere. This ensures that the BB-RSDA can focus on investments that meet needs and fill gaps in the existing body of research.

The Evolution of the Research Project

The scope of this project evolved during the research process. The initial research proposal and scope was limited to a literature search. The search was to identify published works related to quality and handling practices that could be relevant to the Bristol Bay fishery. Sources for the search were to include academic and professional journals, university presses, research extension organizations, workshop handouts, web-based interactive tools, and trade journal articles. In addition, this search would seek to include research projects for which no formal publication was developed. The goal of this portion of the research was to identify resources that already exist and investments that have already been made. With a catalog of these resources, the Board and staff of BB-RSDA would be better equipped to proceed with investments in support of their mission.

The initial literature search effort revealed some publications addressing quality and handling. Many appeared to focus on the impacts of poor handling or chilling or the potential benefits of good handling and chilling practices. However, there appeared to be relatively few that provided information on how to prioritize or implement changes *on board the vessel* to help improve the quality of the fish. The data and research was useful, but hard to translate into the realities of a fisherman's decision-making process and the unique challenges of Bristol Bay. After consulting with the executive director of the BB-RSDA, the scope of the research was expanded to include conversations with industry members involved in helping fishermen make changes *on the ground* in Bristol Bay and other fisheries. The expectation was that the interviews would yield additional information that was more relevant to fishermen than some of the academic work.

The interviewees' insight was used to augment the literature search, and to provide practical and current information on activities within the industry. The interviews also helped identify additional literature sources. With the literature search, this information will support BB-RSDA's efforts to identify the best opportunities for investments that support improved quality in the Bristol Bay fishery.

The following individuals were interviewed regarding quality practices. This is not a complete list of all individuals contacted as part of the research process.

- Sylvia Beaudoin, Wild Harvest Seafoods, Kasilof, AK
- Nancy Blakey, Snopac Products, Inc. (Dillingham), Seattle, WA
- Mark Buckley, Digital Observer, Inc., Kodiak, AK (New Brunswick, Canada)
- Chuck Crapo, Marine Advisory Program, University of Alaska, Kodiak, AK
- Bill Feda, Fuller Boatyard, Inc., Kodiak, AK
- Steve Grabacki, GRAYSTAR Pacific Seafood, Anchorage, AK.
- Bill Henderson, B&C Fiberglass, Dillingham, AK
- Karin Holbrook, Kenai River Seafoods, Kenai, AK
- Don Kramer, Marine Advisory Program, University of Alaska, Anchorage, AK
- Randy Rice, Alaska Seafood Marketing Institute, Seattle, WA
- Doug Short, Integrated Marine Systems, Port Townsend, WA
- Bill Webber, Gulkana Direct Seafoods and Board Member for Copper River/Prince William Sound Marketing Association, Cordova, AK
- Tom Whinihan, Peter Pan Seafoods (Dillingham), Seattle, WA

The Contents of This Report

This report has three major sections. The first section summarizes *The Current Body of Research*.

1. The most important piece of the first section is the literature search matrix. The literature is grouped first by the type of publication (peer-reviewed papers, educational research and publications, and interactive resources such as web-based modules or workshops). Then it is organized by research institution (e.g., all Alaska Sea Grant/Marine Advisory publications are grouped together). Each publication is coded by theme, so report users can look quickly to see if a given publication is relevant to their need. The key to the code is provided at the bottom of each page of the matrix. Where possible, the content of each resource is summarized. In some cases, descriptions are taken directly from article abstracts or catalog summaries.

In addition to the matrix, a brief narrative summarizes some of the major themes of the body of research.

Following the matrix are brief summaries of work that has been executed or is underway for which there are no formal write-ups. This category primarily consists of numerous projects conducted with funding from the US Department of Agriculture, Cooperative State Research, Education, and Extension Service (CSREES).

2. The second section summarizes the *Interview Findings*. Common practices, concerns, and observations are noted. The purpose of this section is to give readers a sense for current trends, issues, and progress on quality in Bristol Bay. A second purpose was to ensure that we did not overlook any major bodies of research or publications considered highly valuable by interviewees.

3. The final section of this report briefly identifies some *Gaps in the Existing Body of Research* and discusses *Potential Future Projects* that could be pursued by the BB-RSDA. Some of these projects were identified by interviewees, while others respond to apparent gaps in the current research.

In total, this research provides a scan of available resources and previous research. It is certain that some resources exist that are not identified herein. This is particularly true because many research projects are never formally written up. However, numerous projects and resources are identified, produced by a broad range of entities. With the support of the interview process, we are confident that this research captures the majority of publications and efforts related to improving the quality of salmon in Bristol Bay's driftnet fishery.

Key Findings

This research yielded several important findings:

- First, significant information exists documenting the **importance and benefits of chilling salmon**. Ample data shows the impacts in terms of increased shelf-life, improved flesh quality, reduced bacteria counts, and other important quality results.
- Second, some information exists on the **negative quality impacts of poor on-board handling**. Bruising and gaping and other quality degradations are well documented, as are some of their causes (crushing, handling fish by tails, etc.)
- However, **few resources exist to help fishermen apply changes in the actual Bristol Bay fishery**. Bristol Bay's structural challenges—the 32-foot size limit, the compressed harvest window, tidal action, and weather, among others—place extra demands on quality-oriented fishermen. There are very few Bristol-Bay specific resources to help fishermen identify the best opportunities for investments that make the most meaningful impact, given these limitations.
- Finally, little information exists to **quantify the market and financial impacts of fishermen's handling changes**. For example, how is the ratio of #1-graded to #2-graded fish impacted when fishermen chill with RSW? With slush ice? When fishermen bleed their catch, or make shorter sets? Though financial incentive is perhaps the most important method for changing fisherman behavior, we were not able to identify resources that clearly described the relationships between changed behavior and resulting quality and financial benefits.

Research Gaps

Numerous gaps in the research body were identified. Among them were the need for:

- Small-boat chilling solutions
- Prioritization of quality investments or changed behavior
- Information on the market (price) benefits of improved quality
- Information that quantifies the impacts of particular handling behavior changes

Additional research gaps are discussed on Page 21.

The Current Body of Research

While the bibliography presented here cannot be assumed to be absolutely complete, its compilation has revealed several research trends, and has also identified some holes in existing research.

The following resource matrix is followed by information on additional, unpublished research, and by a summary of major themes of the research body. This starts on Page 16.

Strengths of the Existing Body of Research

The literature review reveals that the body of research on the importance and effects of temperature control and chilling salmon (or failing to chill salmon) is quite extensive. Researchers have shown the importance of chilling for extending shelf life, maintaining the quality of the salmon's muscle tissues, reducing bacteria counts, and more. Numerous research projects also compared the relative effectiveness of various chilling methods—slush ice, chilled seawater (CSW) systems, refrigerated seawater (RSW) systems, and ice. Some also provide technical specifications for the design of chilling systems on board vessels.

Best practices guides also exist for seafood shippers, suggesting systems for maintaining temperature control over fish products while they're in transit.

Publications also address the importance of handling practices that reduce the occurrence of gaping, bruising, or other quality degradations. Guides published by Sea Grant programs in Alaska and elsewhere describe and illustrate these quality problems. In order to minimize the likelihood of these problems fishermen are advised to refrain from handling fish by their tails, dropping or throwing them, and handling them roughly during rigor mortis. In interviews it was also found that processors are using financial incentives to encourage fishermen to load fish in smaller brailer loads in order to minimize opportunities for crushing that can result in gaping and bruising. Brochures and booklets address various handling techniques, and at least one region-specific video addresses these practices as well.

Several educational publications related to proper sanitation also exist. Some are flyers meant to be posted in work areas in processing plants.

Weaknesses of the Existing Body of Research

There are some significant weaknesses in the existing body of research, particularly as it relates to Bristol Bay's driftnet fishery.

Foremost, there is little research that specifically addresses Bristol Bay. It is well recognized throughout the industry that Bristol Bay faces special challenges due to factors such as the time constraints on harvest that are imposed by the biology of the salmon return, the 32-foot regulatory size limit on vessels, and tidal conditions, among others.

Additionally, there is little research that would help fishermen or organizations prioritize investments at the vessel level.

Published Literature and Conference Proceedings





CODE	AUTHOR(S)	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
CRS VM	Kolbe, E.	Refrigeration Energy Prediction for Flooded Tanks on Fishing Vessels.	Applied Engineering in Agriculture. 1990, 6(5):624-628.	N/A	Periodical databases; likely require library service.
CRS	Tomlinson, N., S. Geiger, J. Boyd, B. Southcott, G. Gibbard, and S. Roach	Comparison Between Refrigerated Sea Water (with or without Added Carbon Dioxide) and Ice as Storage Media for Fish To Be Subsequently Frozen.	<i>In</i> Cooling and Freezing Aboard Fishing Vessels. International Institute of Refrigeration Commissions B-2, D-3 Annex, 1974-14, Paris, pp. 163-168.	N/A	Periodical databases; likely require library service.
CRS ✱	Tertnes, G., N. Losnegard, and E. Langmyhr	Studies on the Quality of Fish Held in Chilled Seawater and in Ice. Part VI.	Norwegian Directorate of Fisheries Reports and Notes, Bergen. 1984.	N/A	Periodical databases; likely require library service.
CRS ✱	Himelbloom, B. H., C. Crapo., E. Brown, J. Babbitt, K. Reppond	Pink Salmon (<i>Oncorhynchus gorbuscha</i>) Quality During Ice and Chilled Seawater Storage.	Journal of Food Quality. 2007, 7(3):197-210.	Pink salmon were stored up to ten days in ice, chilled seawater (CSW), transferred from ice to CSW and from CSW to ice, and evaluated by chemical, physical, microbiological, and sensory methods. The sensory quality of CSW-held fish declined at a faster rate than for iced fish.	Periodical databases; likely require library service.



✱ chilling impacts | ⌚ shelf life | VM vessel modifications | CRS chilling and refrigeration systems | ✋ handling practices | BL bleeding
 HS hygiene/sanitation | OBP on-board practices | QS quality standards | TO training opportunities

CODE	AUTHOR(S)	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
CRS ✳	Bronstein, M., R. Price, E. Strange, E. Melvin, C. DeWees, B. Wyatt.	Storage of Dressed Chinook Salmon, <i>Oncorhynchus tshawytscha</i> , in Refrigerated Freshwater, Diluted Seawater, Seawater, and in Ice.	Marine Fisheries Review. 1985, 47(1):68-72.	N/A	Periodical databases; likely require library service.
BL	Porter, P.J. and D.E. Kramer (in Bligh, E.G. et al., editors).	The Effects of Exsanguination of Sockeye Salmon on the Changes in Lipid Composition During Frozen Storage.	In Seafood Science and Technology, Proceedings of the International Conference "Seafood 2000" celebrating the tenth anniversary of the Canadian Institute of Fisheries Technology of the Technical University of Nova Scotia, 13-16 May, 1990, Halifax, Canada. Technical University of Nova Scotia, Halifax (Canada), 1992.	N/A	Periodical databases; likely require library service.

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Handbooks and Guides

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
University of Alaska Sea Grant and University of Alaska Marine Advisory Program					
	  HS OBP	Care and Handling of Salmon: The Key to Quality	Author: John P. Doyle Publication No.: MAB-45 Year: 1995 No. pages: 66 ISBN: 978-1-56612-010-4 Type of publication: Book	The Alaska wild salmon industry is thriving in niche marketing and other sectors. All users of Pacific wild salmon can learn more about how to produce a top-quality product from this book. It tells how to improve handling techniques, and covers salmon biology, harvest methods, causes of quality problems, and sanitation. Color photographs illustrate high-quality product and problems to avoid. Salmon is a fine food—handle with care!	Available from Sea Grant; single copies free
	  OBP	Seafood Shelf Life as a Function of Temperature	Author: John P. Doyle Pub. No.: ASG-30 Year: 1989 No. pages: 6 Type of Publication: Newsletter publication	Report describes the impact of delayed chilling on seafood shelflife. It explains the relationship between shelf life and temperature, including relative rates of spoilage for fish held at different temperatures.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): Single copies free, multiple copies \$0.30 each
	HS	Personnel and Plant Hygiene for Fishery Products (poster and handout)	Author: Alaska Sea Grant Publication No.: SG-ED-18A (poster); SG-ED-18B (handout) Year: 1994 Type of Publication: Poster and handout	A poster and information sheet in both English and Spanish, designed to help convey the importance of good hygiene in the workplace.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$3.00, up to 10 information sheets free

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Handbooks and Guides (cont.)

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
University of Alaska Sea Grant and University of Alaska Marine Advisory Program (cont.)					
	HS	Common Mistakes in HACCP	Author: Liz Brown No. Pages: 1 each for several sub-topics Publication Nos.: ASG-44, ASG-43, ASG-42, ASG-41, ASG-40, ASG-39, ASG-38)	These single-page flyers address common mistakes in the processing plant.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): Single copies free, multiple copies \$0.30 each
	* ⌚ CRS	Planning for Seafood Freezing	Authors: E. Kolbe and D. Kramer Pub. No.: MAB-60 Year: 2007 No. pages: 126 Type of Publication: Book ISBN: 978-1-56612-119-4	This manual helps seafood processors plan freezing operations in order to maintain the quality of fresh fish in frozen product and bring in higher profits. The publication treats the physics of freezing, selection of equipment, and important food science concepts. Sea Grant recommends the book for seafood plant managers and engineers, refrigeration contractors, processor planners, investors and bankers, and extension educators and advisors.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$15.00 each
	* ⌚ HS	Air Shipment of Fresh Fish: A Primer for Shippers and Cargo Handlers	Authors: Chuck Crapo and Brian Paust Pub. No.: MAB-32 Year: 1991 No. pages: 32 Type of Publication: Booklet ISBN: 978-1-56612-001-2	This guide covers the basic causes of quality loss in fresh fish and how best to prevent spoilage during shipment through proper packing, temperature control, and handling.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$3.00 each

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Handbooks and Guides (cont.)

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University of Alaska Sea Grant and University of Alaska Marine Advisory Program (cont.)					
	* VM CRS	Chilled Seawater Systems: Installation and Operation on Alaskan Vessels	Author: Chuck Crapo Pub No: MAB-19 Year: 1985 No. pages: 20 Type of Publication: Booklet	This publication addresses specifications for various types of chilled seawater systems, addresses specifics of system design and operation, best practices, and potential pitfalls.	Available as PDF documents through the National Sea Grant Library, http://nsgl.gso.uri.edu
	* VM CRS	Salmon Quality: The Effects of Chilled Seawater Storage	Authors: Chuck Crapo et al. Pub No.: MAB-40 Year: 1990 No. pages: 15 Type of Publication: Booklet	The report describes experimental results comparing chilled seawater and ice for salmon storage. Research found that CSW storage over long periods results in greater quality loss and degradation than storage in ice.	Available as PDF documents through the National Sea Grant Library, http://nsgl.gso.uri.edu
	* VM CRS	Salmon Quality: The Effects of Delayed Chilling	Authors: Chuck Crapo, Donald E. Kramer, John P. Doyle Pub No: MAB-23 Year: 1986 No. pages: 8 Type of Publication: Booklet	The report details quality degradations in salmon based on delay before chilling. Chilling delays are shown to have serious negative impacts on quality.	Available as PDF documents through the National Sea Grant Library, http://nsgl.gso.uri.edu
	* Ⓢ VM CRS	Salmon Quality: The Effects of Elevated Refrigerated Seawater Chilling Temperatures	Authors: Chuck Crapo and Elisa Elliot Pub No.: MAB-34 Year: 1987 No. pages: 12 Type of Publication: Booklet	This report describes experimental results suggesting significant quality differences between fish held in refrigerated seawater systems at 31 degrees, versus 34 degrees Fahrenheit.	Available as PDF documents through the National Sea Grant Library, http://nsgl.gso.uri.edu

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University of Alaska Sea Grant and University of Alaska Marine Advisory Program (cont.)					
	❄️ 🕒 VM CRS 🖐️ BL HS OBP	Quality Handling of Hook-Caught Rockfish	Authors: B. Paust and J. Svensson Pub No.: MAB-20 Year: 1986 No. pages: 20 Type of publication: Booklet	This booklet addresses methods for maintaining consistent quality of rockfish on board the fishing vessel. (This research is not specific to salmon, but some of the general practices may have universal application.)	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$3.00 each
	❄️ 🕒 VM CRS 🖐️ BL HS OBP	Care of Halibut Aboard the Fishing Vessel	Authors: D. Kramer and B. Paust Pub. No.: MAB-18 Year: 1985 No. pages: 36 Type of Publication: Booklet	This is a step-by-step guide on how to land, prepare, and store halibut to produce a top-quality product. (This research is not specific to salmon, but some of the general practices may have universal application.)	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$1.00 each
	❄️ 🕒 CRS 🖐️	Factors Affecting Quality of Rock Sole Fillets	Authors: B.H. Himelbloom, C.A. Crapo, E.K. Brown, and J.P. Doyle Pub. No.: RP-95-03 Year: 1994 No. pages: 12 Type of Publication: Article reprinted from the Journal of Aquatic Food Product Technology	This study examines relative quality of flatfish handled under different conditions. (This research is not specific to salmon, but some of the general practices may have universal application.)	Available from Sea Grant bookstore (http://seagrant.uaf.edu): single copies free

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Handbooks and Guides (cont.)

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
University of Alaska Sea Grant and University of Alaska Marine Advisory Program (cont.)					
	M	Recoveries & Yields from Pacific Fish and Shellfish	Authors: Chuck Crapo, Brian Paust, Jerry Babbitt Pub. No.: MAB-37 Year: 2004 (revised) No. pages: 32 Type of Publication: Booklet	This booklet provides information on average recoveries and yields for various processed fishery products made from Pacific fish and shellfish species.	Available for free download from Alaska Seafood Marketing Institute (www.alaskaseafood.org) or from the Sea Grant bookstore
Alaska Seafood Marketing Institute					
	HS	Salmon Roe Flyers	Author: ASMI Type of Publication: Single page flyers in English and Spanish	Single page flyers provide information on sanitation practices for use in controlling <i>Listeria</i> , <i>E. coli</i> , and other bacteria during roe production.	Available for free download in the "Tech & Quality Control" section of ASMI's website
	❄️ 🕒 👤	Handle With Care: The Alaska Shipper's Guide to Seafood Quality	Author: ASMI Type of Publication: Online guide/report	This online guide/report includes four chapters: Planning, Temperature, Packaging and Labeling; Shipping by Air; Shipping by Refrigerated Van or Truck; and Shipping by Freezer Ships and Railroad. General advice provided for each shipping method, as well as pre-loading, loading, and post-loading recommendations.	Available to read directly from the "Tech & Quality Control" section of ASMI's website
	HS OBP QS	Recommended Salmon Quality Guidelines for Fishing, Tending & Processing Operations	Authors: Eric Gucker and Matt Johnson Year: 1986 Type of Publication: Online guide/report	This online guide/report provides recommendations on various means for safeguarding the quality of salmon, including those for fishing vessels, tender vessels and seafood processing plants (shore-based and floating). The guide includes limited recommendations specific to drift gillnet operations.	Available from ASMI's website, www.alaskaseafood.org

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PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
University of Washington Sea Grant					
	✳ 🕒 VM CRS OBP	Marine Refrigeration Workshop	Authors: Washington Sea Grant; Jefferson Education Center; Integrated Marine Systems No. pages: unknown Type of publication: Bound workshop handbook	Workshop handbook includes fourteen sections addressing multiple elements of marine refrigeration systems, from service of various system parts, to components of a refrigeration system, to the tools needed for system service, and more. Intended as the text accompaniment to a Sea Grant workshop.	Contact Washington Sea Grant 3716 Brooklyn Avenue NE Box 355060 Seattle, WA 98105-6716 (206) 543-6600
Integrated Marine Services, Inc.					
	VM CRS OBP	Refrigeration Tec-Tips	Author: Various	A compilation of research on refrigeration systems for fishing vessel, including book chapters, scientific publications, and other documentation related to fish-freezing.	By request from Integrated Marine Services
Oregon State University					
	✳ VM CRS	Chilling and Freezing Guidelines to Maintain Onboard Quality and Safety of Albacore Tuna	Authors: Edward Kolbe, Cormac Craven, Gil Sylvia, Michael Morrissey Publication No.: Special Report 1006 Year: 2004 Funded by: American Fisheries Research Foundation and NOAA Sea Grant Program NO0842	A report to support planning, design, and operation that will lead to improved quality of albacore tuna. It discusses onboard chilling and freezing under a range of conditions and with various freezing systems. The research is based on questionnaires. The freezing scenarios are predicted based on a computer model. (This research is not specific to salmon, but some of the general practices may have universal application.)	Copies available from Oregon State University Seafood Lab, 2001 Marine Drive Suite 353, Astoria, OR 97103-3420

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PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
Alaska Quality Seafood					
	❄️ 🕒 🙅 HS OBP QS	Drift Gillnet Handling Procedures: Handling Requirements & Compliance Procedures	Author: Alaska Quality Seafood Publication date: n/a	The document details the handling and quality procedures that are required in order to earn a quality certification (known as Alaska Quality Seafood) for drift gillnet salmon. The standard is meant to be adaptable to different fisheries.	Alaska Quality Seafood is no longer functioning as an organization. The document can be obtained from individuals involved with the AQS program
British Columbia Salmon Marketing Council					
	❄️ 🕒 HS 🙅 OBP QS	BC Salmon: Quest for Quality: On-Board Quality Guidelines	Publisher: British Columbia Salmon Marketing Council No. pages: 24 Type of Publication: Booklet	This booklet describes on-board causes of quality problems, including handling, temperature and contamination. It also provides tips for better handling, by gear type (gillnet, seine and troll).	Available from the BC Salmon Marketing Council (www.bcsalmon.ca)
California Sea Grant College Program					
	❄️ 🕒 🙅 HS OBP QS BL	Recommended Procedures for Handling Troll-Caught Salmon	Authors: Edward F. Melvin, B.B. Wyatt, and R.J. Price. Year: 1983, revised 2004	Describes handling practices, market conditions, quality and spoilage factors, and other elements related to best handling procedures for troll-caught salmon.	Available online at www.calkingsalmon.org/pdf/procedures.pdf

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Handbooks and Guides (cont.)

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
The Copper River/PWS Marketing Association					
	❄️ 👤 BL HS	Best Practices: Quality and Handling Guide	Producer: Copper River/PWS Marketing Association Number of Pages: 1 Type of publication: Brochure	This brochure explains the benefits and importance of various fishing and handling techniques.	Available from the Copper River/PWS Marketing Association

Courses and Online Training Programs

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
Alaska Seafood Marketing Institute					
	❄️ 🕒 👤 HS OBP	Alaska Seafood Quality & Handling Training Programs: Harvesting, Tender Operations, and Processing	Producer: Alaska Seafood Marketing Institute	The online training programs are interactive and combine narrative, graphics, and video clips to address best practices for maintaining quality in harvesting, tendering, and processing operations.	All three training programs are available on the ASMI website (www.alaskaseafood.org) in the Quality & Tech section. The trainings modules stream from the internet.
Marine Advisory Program					
	TO	Customized regional quality training modules.		The Alaska Sea Grant Marine Advisory Program provides customized quality trainings for fishermen on request in communities throughout Alaska.	Contact Marine Advisory Program, (907) 274-9691

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Films and Videos

PUBLISHER OR ORGANIZATION	CODE	TITLE	BIBLIOGRAPHICAL INFORMATION	DESCRIPTION	AVAILABILITY
University of Alaska Sea Grant and University of Alaska Marine Advisory Program (cont.)					
	❄️ 🕒 VM CRS 🤝 BL HS OBP	Quality is in Your Hands: Salmon Skiff Fishermen	Director: Deborah Mercy DVD No.: MAPV-62 Year: 2006 Length: 16 minutes	This video provides information on good handling and quality practices—how to handle fish gently, bleed them, and ice immediately, to prevent bruising, gaping, scale loss, and bacterial spoilage. Skiff management includes keeping a clean boat, having an adequate holding area, and sanitizing after delivery to the processor.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$15.00 each
	CRS 🤝 BL HS OBP	Halibut Dressing	Video No.: MAPV-05 Year: 1985 Length: 8 minutes Type of Publication: video	The film demonstrates good handling on deck, proper dressing, and correct icing to produce the highest quality product.	Available from Sea Grant bookstore (http://seagrant.uaf.edu): \$15.00 each
Seafood Producers Cooperative					
	🤝 BL OBP	Fish Cleaning Demo	Producer: Seafood Producers Cooperative	Educational video demonstrates fish cleaning techniques for multiple species of fish and demonstrates pipette bleeding technique.	Available to Seafood Producers Cooperative members

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 HS hygiene/sanitation | OBP on-board practices | QS quality standards | TO training opportunities

Additional Bodies of Unpublished Work

Some of the research on salmon quality and handling that is relevant to the Bristol Bay region did not result in formal published reports or documents. The greatest body of this work appears to have been conducted at the University of Alaska Fairbanks. It should be noted that, for obvious reasons, work that is not published is difficult to track down. It can be assumed that additional, unpublished research exists and was not identified through this research process.

CSREES Research

The University of Alaska Fairbanks conducts significant amounts of research with support of funding from the US Department of Agriculture Cooperative State Research, Education, and Extension Service (CSREES) grant program. The results of this research are not always written up in a formal way; instead, the results are intended for dissemination through the extension programs of the University of Alaska. These include the Marine Advisory Program and the Cooperative Extension Service, both functions of the University of Alaska Fairbanks. Faculty members at the Fishery Industrial Technology Center in Kodiak have conducted much of the research.

Simple summaries of relevant research conducted in recent years using CSREES are provided below. In each case, the primary investigator (PI) of the projects has been identified. Additional information about the research results can be obtained by communicating with relevant faculty and staff at the University of Alaska Fairbanks.

- **Evaluating Chilled Seawater (CSW) Systems** **PI: Chuck Crapo**
This research project looked at CSW systems (which rely on a combination of ice and water) and assessed their utility. Problems with the systems included hotspots in holds where fish were not chilled effectively.
- **Managing Salmon Fisheries for Quality** **PI: Chuck Crapo**
This research considered the impacts of various management practices on salmon quality in Prince William Sound. Fish harvested in fishing areas that were off capes were compared to those harvested near run termini. Results indicated that quality in cape harvests tended to be higher than that for terminus harvests. These findings imply that harvest management decisions can impact quality of the pack.
- **New Gillnet Roller to Improve Quality** **PI: Mark Buckley**
This project considered possible improvements to gillnet roller design for setnet skiffs. Designs tested in summer 2008 yielded no statistically significant results.
- **Evaluating Slurry Ice Systems for Alaska Salmon Fisheries** **PI: Chuck Crapo**
Slurry ice machines (machines that produce a water/ice mix on-board fishing vessels for use chilling fish) were evaluated. Results indicated that slurry ice quality is impacted by salinity of ocean water used in the system. These results suggest that machines would not be useful in the Bristol Bay region, where ocean salinity is reduced by major river drainages.
- **Analysis of Fish Traps for Alaskan Salmon Harvest** **PI: Mark Buckley**
This research considered the potential quality improvements that could be enabled by fishtrap harvests. The PI traveled to Japan to observe fishing practices at fish traps there. The PI found that poor post-harvest care of the fish, unrelated to the harvest method, negated any quality gains that the method provided.

Alaska Fisheries Development Foundation

The Alaska Fisheries Development Foundation (AFDF) funded a research project for summer 2008 that allowed researchers to tag fish from individual fishing vessels and trace them to the processing plant, where they were graded based on various quality factors. This research (conducted by Mark Buckley of Digital Observer, Inc.) helped pair on-the-grounds behaviors with quality outcomes. This research will be continued in summer 2009.

The potential value of tracing fish from the vessel to the processor can be noted from impacts seen in other fisheries. For example, in Cook Inlet, where fish can be graded boat-by-boat because fish are delivered directly to plants, poor-handling penalties create a clear economic motivation for improved on-board practices.

The AFDF/Digital Observer research provided reports to participating fishermen on the grade of their product. One thesis of the work is that fisherman behavior and on-board handling are the key determinant of quality in the end fish product. This nature of research may have particular promise for the Bristol Bay region, as it makes it possible to tie on-board activities to economic outcomes (assuming there are linkages between quality and ex-vessel price bonuses or penalties). Future efforts will reveal whether this type of chain-of-custody work will meaningfully impact fishermen's behaviors in the fishery.

Interview Findings

The interviews were used to supplement the literature search with examples and observations of practices that are being implemented in the Bristol Bay region and elsewhere. Interviewees were asked about modifications to vessels, equipment, fishing techniques, or other factors that are proving valuable in improving the quality of fish produced in Bristol Bay. Because each boat that fishes in the Bay is unique, this interview process cannot possibly identify every change that has been made to vessels in the fishery. Nevertheless, interviewees were able to provide information on observable trends, based on their own experience and expertise. Overall, several common themes and observations emerged that are relevant to the Bristol Bay driftnet fishery and improving salmon quality.

Vessel Upgrades

Several vessel upgrades are becoming more common in the Bristol Bay fleet:

- **Flush decks.** Boat owners are retrofitting vessels to remove sunken cockpits from the stern of some Bristol Bay boats, or to make hatch-combing flush with the deck of vessels. In boats with sunken cockpits fish fall out or are picked from nets and end up in the cockpits (which were designed so fishermen could drive from the stern and work the net). Crew must then pick fish out of the sunken space and throw them back up onto deck, or into the fish hold. Most interviewees said the retrofit was being done to reduce physical demands on crew, but that it has the added benefit of removing one or two handling steps, and reducing the likelihood that individual fish will be thrown. This has the effect of reducing opportunities for bruising, gaping, and other handling-related quality problems.
- **Installation of RSW systems.** Fishermen are installing RSW systems in some Bristol Bay boats. Favorable financing programs from the State of Alaska, quality incentives from processing companies, and a changing “attitude” about quality and chilling all are reported as factors in this trend.
- **Insulating holds.** Numerous interviewees reported that fishermen are insulating their fishing holds. This improvement enables more effective icing practices, or supports more efficient RSW systems.
- **Installing dividers in the bottom of holds.** Some fishermen are installing grid-like dividers in the bottom of their fish holds to hold full brailer bags in place and keep them from pressing against one another (which can cause bruising and other damage in the salmon.
- **Bleeding systems (outside of Bristol Bay fisheries).** In some fisheries outside Bristol Bay it is an increasingly common practice to implement some sort of bleeding system (slush ice, pressure, etc.) into salmon fishing operations. There is little evidence of this trend in Bristol Bay.

Changes in Fishing and Delivery Practices

- **Changes in fishing practices**
 - **More frequent deliveries.** Some interviewees reported that fishermen (particularly setnetters) are making more frequent deliveries to tenders.
 - **Shorter sets.** There was little evidence from interviews that fishermen are making shorter sets. However, multiple interviewees did suggest that shorter sets are an important step for improving quality. The damage caused by struggling fish and by tension in the net from waves and current and the vessel itself can be

significant, and shorter sets reduce the opportunity for damage. This may be a trend that develops more in future years.

- **Increased use of ice.** Some interviewees observed that the increasing availability of ice in the Bay (with the placement of Bristol Bay Economic Development Corporation's ice barges) is causing a noticeable difference in fish quality as fishermen adopt icing practices.
- **Changes in offload practices**
 - **Smaller brailer bags.** Some fish buyers offer incentives to fishermen who deliver fish in brailer bags under a certain weight. (For example a bag of fish weighing less than 600 pounds might receive a several-cent bonus. Maximum weights and value of bonuses varies.)

Incentives for Change

- **Changes in pricing structures**
 - **Reconsideration of volume-based bonuses.** Some fish buyers have eliminated the practice of volume-based bonuses, as these bonuses can encourage fishermen to pursue volume at the expense of quality.
 - **Profit-sharing.** At least one buyer has implemented a profit-sharing system, which appears to incentivize fishermen to pursue quality as well as volume.
- **Changing peer expectations.** As incremental changes are made around quality and handling practices by individual members of the fishing fleet, the culture related to quality and handling evolves. Expectations for appropriate behavior related to quality and handling are transforming.
 - **Demonstrated successes by others.** One factor in the changing culture is demonstrations of successful efforts by other fishermen. Even if behavior is tied to programs or incentives offered by particular buyers, the culture can impact other fishermen beyond a given fleet.

Prioritization of Investments

- **Though no research was identified that clearly prioritizes investments** the general consensus among the interviewees was that successfully chilling fish was the most important investment.
- **Beyond chilling, it is difficult to identify investment priority.**
 - Based on behaviors observed in other fisheries, there appears to be some value in matching individual (boat-level) handling practices to fish quality at the point of processing through tagging, on-tender grading, or other efforts. Providing evidence of the outcomes of handling practices increases the motivation for behavior modification by fishermen.
 - Efforts to redesign holds to decrease compression damage when loaded brailer bags are removed from fish holds may prove valuable.
 - Investments in on-board handling tools or practices may be hard to standardize because of variation from boat to boat.

Continuing Areas of Trouble

- **Stern hauling.** Fish nearer the bottom of a stern-hauled net are significantly more damaged than those near the top of the pile, and delays in removing fish from stern-hauled nets can lead to significant quality degradation.
- **Towing on nets.** The tension in the net can increase damage to fish.
- **Round hauling.** Fish round-hauled on a reel are significantly damaged.
- **Lack of financial incentives for making changes.** Some fishermen may still perceive that their buyers do not provide financial incentives that reward changing behaviors to improve handling and quality.
- **Disconnect between harvesting and handling activities and quality outcomes.** Fish are harvested in great volumes and by numerous boats, and then are aggregated on tenders before being delivered to plants. As a result, it is difficult to illustrate the impact of individual fisherman behavior on the quality of the product, and therefore can be difficult to convince fishermen to alter their behaviors.

Gaps in the Existing Body of Research and Resources: Potential Future Projects

There are several gaps in the body of research that are particularly important for Bristol Bay. It is beyond the scope of this project to identify all possible gaps or to prioritize the relative utility of research to address them. However, identification of these gaps can support the board and staff in its strategic decision-making. The following list compiles some of the ideas presented by interviewees and the consultant, based on the existing body of research.

- **Small-boat chilling solutions.** While the importance and outcome of chilling have been clearly identified in the literature, little information exists identifying best practices or solutions for achieving well-chilled fish on small boats. Because every vessel is unique, it is impossible to standardize solutions. Nonetheless, Bristol Bay does have unique challenges that could be addressed in more focused publications.
- **Prioritization of quality investments or changed behavior.** There is no research that prioritizes the changes that fishermen can or should make to improve quality. With limited capital, limited space on board vessels, or harvest pressures, which issues are the most important for fishermen to address? What is the quality return for a change in behavior—for instance, does bleeding fish increase percentages of #1 graded product by 5% or 15%?
- **Information on the market (price) benefits of improved quality.** Fishermen who consider on-board investments to improve quality have an expectation that their investment should generate some return, typically in ex-vessel value for their harvest. This potential return is unknown, though evidence clearly exists (from other fisheries and specialized efforts in the Bay) to suggest that higher quality fish garner a higher value. Still, this unknown can be a barrier that prevents investment.
- **Information that quantifies the impacts of particular handling behavior changes.** If a fisherman invests in an RSW system or slush ice, what improvement will he or she see in the percentage of #1-graded fish? How many more fish will be graded #1 under different setting and towing conditions? How much improvement?
- **Video productions for use in instruction and training.** Several interviews highlighted the importance of videos as instructive tools, particularly related to handling practices. However, no videos were identified that explicitly address Bristol Bay driftnetting and the challenges unique to that fishery. A video could be used to illustrate impacts of various handling practices and provide guidance on methods for improving quality through handling, chilling, or fishing practices.
- **Small-boat handling solutions.** No research was identified that outlines best practices or possible solutions for minimizing bruising and other handling damage within the constraints of the small Bristol Bay boats. Gathering information on successful practices, either through direct request or through a competition or other incentivized means, may enable BB-RSDA to share good ideas more widely through the fleet.
- **Competition and award for best bleeding tool (or other quality/handling tool) design.** Little research has been conducted on good tools or innovations to assist Bristol Bay fishermen with tasks such as bleeding fish. In a model recommended by an interviewee, a cash prize could be used to encourage development and testing of labor-saving bleeding tools (or other tools) for use on Bristol Bay boats.

- **Understanding impacts of common fishing practices.** No research was identified that details damage caused to fish by common fishing practices in Bristol Bay such as towing on a gillnet during a set, setting in the mud, or round-hauling. Several interviewees suggested a lack of understanding of the impacts of various behaviors may keep fishermen from changing their harvesting behavior. While scientific analysis may not be necessary, information that details the damage caused by these practices may be useful for fishermen weighing the benefits of making changes in their fishing practices.

Summary

We undertook this research to help identify existing research and efforts relevant to handling and chilling in the Bristol Bay fishery. The purpose of the research was to support the BB-RSDA's efforts to make the most strategic and beneficial investments possible to support improved quality in the Bristol Bay driftnet fishery. It revealed several important findings.

- First, significant information exists documenting the **importance and benefits of chilling salmon**. Ample data shows the impacts in terms of increased shelf-life, improved flesh quality, reduced bacteria counts, and other important quality results.
- Second, some information exists on the **negative quality impacts of poor on-board handling**. Bruising and gaping and other quality degradations are well documented, as are some of their causes (crushing, handling fish by tails, etc.)
- However, **few resources exist to help fishermen apply changes in the actual Bristol Bay fishery**. Bristol Bay's structural challenges—the 32-foot size limit, the compressed harvest window, tidal action, and weather, among others—place extra demands on quality-oriented fishermen. There are very few Bristol-Bay specific resources to help fishermen identify the best opportunities for investments that make the most meaningful impact, given these limitations.
- Finally, little information exists to **quantify the market and financial impacts of fishermen's handling changes**. For example, how is the ratio of #1-graded to #2-graded fish impacted when fishermen chill with RSW? With slush ice? When fishermen bleed their catch, or make shorter sets? Though financial incentive is perhaps the most important method for changing fisherman behavior, we were not able to identify resources that clearly described the relationships between changed behavior and resulting quality and financial benefits.

There are important implications of these findings for the BB-RSDA. The first is that, while adequate information exists to “prove” the importance of chilling and of minimizing certain kinds of damage that can happen harvest, it is still hard to demonstrate to fishermen that changes in fishing practices will have set outcomes. For example, with the current knowledge base it is not possible to quantify the outcome from minimizing compression damage to salmon—either in the percentage increase in #1 fish, or in the ex-vessel value of the product.

The second implication is that applied projects—those that can serve as real demonstrations of changes that can be made on board real boats in Bristol Bay, may be particularly beneficial. There is a tremendous body of work that identifies the ideal handling practices, but the translation of that information into potential on-the-ground actions that are relevant to Bristol Bay driftnetters is very limited.

It is clear from the research that maximizing chilling in Bristol Bay is the first and most important priority for improving the overall quality of the pack in Bristol Bay. Beyond that, however, it is difficult to prioritize based on existing research—not least of all because of the shortage of information specific to the Bristol Bay fishery. Nor is it possible to pull a consensus—beyond the importance of chilling—from the interviewees.

BB-RSDA is uniquely equipped to produce meaningful research specific to the Bristol Bay fishery. Excellent partners for research exist in the state, ranging from the university's Fishery Industrial Technology Center to private quality control contractors to the Marine Advisory Program. By bringing the research focus in close, to Bristol Bay's gillnet fishery, BB-RSDA will be able to help answer many of the questions of prioritization and return on investment, and will be able to bring good ideas to the attention of the fishing fleet at large.

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