Quantifying Quality in Bristol Bay

Final Report: Quantifying Quality in Bristol Bay
Time Frame: April 1 2010 through April 30, 2012
Date of report: February 19, 2012
Report Prepared by Mark Buckley
Digital Observer, Inc.
Box 9013
Kodiak, AK 99615
mkbuckley@alaska.com

Table of Contents

2010-11 Handling Practices and Report Card Studies—the report

Introduction

Bristol Bay, Alaska is home to America's – and the world's – most valuable salmon fishery. Its economic potential, however, is significantly under-exploited. There are direct correlations between the percentage of high-quality "#1" fish in Bristol Bay and the economic outlook of its stakeholders, from individual crewmembers to captains and their families, as well as the broader local and regional economies supported by this amazing natural resource.

As recently as 2008 the percentage of high quality "#1" fish delivered in Bristol Bay fluctuated across a cheerless range of 40% to 45%. Even the most quality-conscious processors only produced #1 filets in a range of 60% - 65% – a far-too-low figure that reinforced the need for this program.

This program built upon a pair of successful pilot projects "bench-tested" during the fast-paced, high-volume 2009 fishery in Bristol Bay. Those projects examined two sides of the quality equation: 1: how specific shipboard handling practices affected the quality of salmon, and 2: how quality varied overall among a subset of vessels in the fleet. This project carried on that work. In so doing, it has now established relationships between specific shipboard fish handling practices and the quality of salmon that were graded at a shore plant.

In 2010 and 2011, this project examined specific handling practices while at the same time tracking individual fishing crews, providing them with quality scores. The results (discussed below) show that different shipboard handling practices can have significant effects on salmon quality—for the better or the worse. Additionally we were able to demonstrate that a subset of fishermen we have been following for years continue to make steady improvements in the overall quality of their deliveries.

This study also produced some startling and unexpected discoveries, namely: a) fish quality is more than a function of handling practices aboard fishing boats; it varies directly with time and distance from the fishing grounds to the processing plant, and, b) rough weather can result in significantly degraded quality. One noteworthy point is that fishing styles and handling practices can have a huge bearing on quality. The best-handled fish in our studies produced 87 percent #1 quality salmon, when graded to ASMI standards. The worst handled fish produced 46 percent #1 quality fish—a drop of more than 40 percentage points.

Grant fund usage summary

The Bristol Bay RSDA funded this two-year project at $115,000. Of that, $95,000 was a pass-through from a US Department of Commerce Saltonstall-Kennedy grant, administered by NOAA Fisheries. The balance ($20,000) was supplied by the RSDA. Most of the Commerce/RSDA money was used to pay for labor, overhead, airfare and supplies. The rest went for vehicle rental in the Bay, insurance, licenses and rent.

In addition to financing from the RSDA and Department of Commerce, four other groups eventually supported this project. Leader Creek Fisheries contributed a total of $15,000. In 2010, another Bristol Bay seafood processing company (which has requested anonymity) funded a $49,386 quality study, also conducted by Digital Observer. That company has agreed to let us incorporate that study's data into the Quantifying Quality Project. The University of Alaska Sea Grant Program contributed airfares amounting to $2,033 and the Kodiak Chamber of Commerce contributed $250 toward airfare. This brought non-RSDA/Commerce matching funds to $66,669. The total cost of the project, then was $181,669. The breakdown is: Department of Commerce S-K Program: 52%, RSDA: 11%, other sources: 36%.

Detailed use of grant funds

Commerce/RSDA Budget: $115,000 Timeline: April 1 2010 through December 30, 2011

NOTE: As of December 30, 2011 Digital Observer Inc. had received a total of $95,000 from the BB-RSDA, with a balance of $15,000 due on the RSDA's acceptance of this report.

Air Fares: $11,655.40—Five persons from Seattle to Bristol Bay and return in both 2010 and 2011. Additionally, Mark Buckley made speaking tours from Seattle to Cordova and Petersburg in 2010 and from Seattle to Kodiak in 2011. The purpose of those tours was to inform interested audiences about quality improvement in Bristol Bay.

Cost of Labor: $44,800. This covered the costs associated with having four project personnel in the plant and aboard the tenders in both 2010 and 2011. Each project employee earned a base salary of $200 per day for approximately 28 days.

Supplies: $11,484.37. This includes tags, fasteners and sampling guns, shipboard sampling kits, gloves, various office supplies, field notebooks, and miscellaneous objects.

Insurance: $2,669. Workers' Compensation for both 2010 and 2011.

Commercial Fishing Licenses: $1,245. Shipboard field representatives are required to purchase Alaska Commercial Fishing Licenses

Vehicle rental in Bristol Bay: $1,400. This reflects 48 days at $50/day

Reward Program: $7,400. Fishing crews earned $100 each time they performed handling practice experiments at sea and delivered the experimental salmon in separate brailers. This

program was introduced in 2011 as a means of providing incentives to fishermen who had to make extra efforts to provide sample salmon to the handling practices study.

Facilities rent: $3,000. Housing for personnel in Naknek

Project Management: $31,346.23. During 2010-11, Digital Observer provided in-season project management plus pre- and post-season presentations to the fleet and others around Alaska.

Research Methodology

The Handling Practices and Report Card studies discussed below shared many commonalities. All salmon came from three districts in Bristol Bay: Naknek, Egegik and Ugashik. Driftnet fishermen who were pursuing their normal fishing activities caught the salmon during regular openers. Many fish (except where noted) were bled, and "floated" in deep refrigerated seawater (RSW), chilled to 39 degrees F, or less.

Per normal in Bristol Bay, all salmon were delivered to tender vessels. Project field staff were stationed on the tenders where they selected, and tagged, random samples of fish during regular delivery times. Sample size from each participating fisherman was usually 20-50 fish. Tags employed for the Handling Practice Study were of one color, orange, while tags used in the Report Card Study were yellow. Each tag bore a code that referred either to the handling practice in question or the name of the boat that would ultimately receive a report card.

After fish were tagged, they were placed, along with the rest of the catch, in the tender's RSW hold(s). There, they were stabilized at temperatures less than 39 degrees F. for the trip to the processing plant. Multiple samples were taken for each research item, and whenever possible the samples also were taken in different districts. Regardless of where the fish were caught and sampled, the tenders all traveled to one of two Naknek processing facilities where the fish were pumped off the tenders and held in chilled brine.

In 2010-11, Leader Creek Fisheries and many Leader Creek fishing crews participated in the Handling Practice and Report Card studies. In the company's Naknek plant, study (i.e. tagged) salmon were pulled from the line and placed in iced totes. Project personnel graded the fish per the Alaska Seafood Marketing Institute (ASMI) "headed and gutted" standard. For consistency, the project employed the same two graders through the course of both the 2010 and the 2011 seasons. The graders looked for bruising, blood spots, gaping and softness in fish flesh, per ASMI's grading standards.

A second Naknek-based seafood company, which has requested anonymity, participated in the Report Card Study in 2010. We were able to extract Handling Practice data, along with Report Card data, from the information gathered in that study. In that company's case, the fish were offloaded from the tenders and held in RSW tanks on the company's dock. The fish were then moved into the fresh frozen plant, where tagged salmon were directed to the H&G line. After the fish were headed and gutted, professional graders decided which were #1 quality, #2 quality or #3 quality. Like Leader Creek, the grading practices in that plant were essentially the same as ASMI standards.

Regarding our measures for evaluating success: Indicators were as follows:

a. Number of sampling events: 1,351
b. Gross number of salmon tagged aboard the tenders: 29,183
   Number of tagged fish recovered at the plant: 21,790.
   Recovery rate: 75%.
c. In the proposal to NOAA Fisheries the original plan was to tag 15,000 fish.
d. Number of report cards issued: 68.
e. In the proposal to NOAA Fisheries the original plan was to issue 60.
f. For the purposes of this report, we have eliminated any experimental results that fell below a six sampling events (replication) threshold due to insufficient data.

NOTE ON SAMPLING PROTOCOLS: To maximize efficiency, as often as possible field representatives would note multiple circumstances in effect each time they tagged salmon. Each of those circumstances would then apply to one or more experimental goals. For example: a certain boat might be part of the report card study. The salmon from that boat that the field representative randomly sampled might have been from a brailer weighing 500 pounds. In addition, the fishing boat might have been using a salmon slide, which is a tarp-like device that is suspended above the boat's deck in order to prevent fish from falling onto that hard surface. Therefore, data from that one sampling event could be parsed into three separate streams: report card, brailer weight and slide/no slide.

NOTE ON GRADING: Our original plan was to grade filleted fish. However, the addition of a second seafood processing company to the project changed things. That is because that company wanted data on Headed and Gutted salmon only. The better to keep the data comparable between the two companies, we switched to the H&G salmon grading system.

VALUE SCORE: To standardize reporting we developed a scoring system that assigns one overall value to a mixed-quality sample of fish. Under this system, a #1 quality H & G salmon is assigned a value of 2.50. A #2 is assigned a value of 2.00 and a #3 is assigned a value of 1.50. On this scale, a sample that is 100 percent #1 quality is valued at 2.50, while a sample that is 100 percent #3 quality is valued at 1.50—a spread of 100 points.

Therefore, if a fisherman delivers a load of salmon that grade out as 70 percent #1 quality, 20 percent #2 quality and 10 percent #3 quality we find the sample's value thus:

70 percent of 2.50 = 1.75 + 20 percent of 2.00 = .40 and 10 percent of 1.50 = .15. Therefore adding 1.75 + .40 + .15 yields a score of 2.30.

Handling Practices Study

Our primary goal for this study was to isolate the effects of specific handling practices on fish quality. We did this to provide fishermen with valid information that answers the questions, "What happens when I do this to the fish? What happens when I don't do it?" In some cases, fishermen assisted us by doing experiments at sea. For example, they might note the length of time a particular set was soaking. When they hauled the net, they would place salmon from that set into a brailer reserved solely for those fish. When they delivered the fish to the tender, the fishermen would inform our field representative that this particular brailer held these particular salmon. Our field person would then tag a random sample of those salmon with an appropriately marked tag.

At other times, our field staff sampled fish opportunistically. For example, if they saw one brailer go by that weighed about 500 pounds; they would sample fish from that brailer as part of the brailer weight study. This variety of sampling required no special assistance from the fishermen—it was sufficient simply to observe and sample.

In all we studied 20 variables during the course of the Handling Practices project.

The section below presents the data for the specific handling practices. The analysis of those data is presented on the "Conclusions" section, which follows.

The study's **results** were as follows:

Benchmark

Benchmark (top quality) salmon are fish as close to troll-caught quality as feasible in Bristol Bay: These fish were alive when brought aboard. They were gently removed from the net and were stunned to minimize bruising. Their gills were cut and they were placed in deep RSW, where they essentially bled to death while unconscious. Brailer weight did not exceed 200 pounds.

Results	87%	#1
	12%	#2
	2%	#3

Data: 16 sampling events, 321 fish tagged, 211 recovered. Quality score: 2.43. All fish tagged in Ugashik

Note: This number, 87% #1 quality fish, correlates very closely (± 1%) with results from studies in 2008 and 2009. These were the best fish in the study and are the benchmark upon which all other fish are measured.

Brailer weights

Salmon fishermen in Bristol Bay usually deliver their fish in heavy cloth bags called brailers. To facilitate this, their boat's fish holding area is divided up into smaller fish holds. Each of these holds typically accommodates one or two brailers. This study examined how loading brailers affects salmon quality. All the fish in this study were bled at the time of harvest. "Floating" them in deep RSW also chilled them. The study indicates that lighter brailer weights, coupled with just one brailer in a fish hold versus two, result in better fish quality. However, it also appears to show that when brailer weights get above 500 pounds there is not necessarily a reduction in quality if the fish are "floating" in deep RSW.

Number of brailers in hold/weight	Percent #1	Percent #2	Percent #3	Score
One @ 200 pounds each	85	13	2	2.42
Two @ 200 pounds each	76	29	4	2.36
One @ 500 pounds each	79	19	2	2.39
Two @ 500 pounds each	74	22	4	2.35
One @ 1,000 pounds each	Not	enough	data	
Two @ 1,000 pounds each	76	23	0	2.35

Table 1. Effects of brailer weights on salmon quality

Data:

One only 200-pound brailer, (sole occupant of a fish hold): 10 sampling events, 199 fish tagged, 162 tags recovered.

Two only 200-pound brailers (two brailers in one fish hold): 38 sampling events, 722 fish tagged, 527 recovered.

One only 500-pound brailer, (sole occupant of fish hold): 16 sampling events, 335 fish tagged, 213 recovered.

Two only 500-pound brailers, (two brailers in one fish hold): 37 sampling events, 900 fish tagged, 642 recovered.

One only 1000-pound brailer (one brailer sole occupant of fish hold): insufficient data—not enough samples.

Two only 1,000-pound brailers (two brailers in one fish hold): 6 sampling events, 110 fish tagged, 74 recovered.

Soak Time

Soak time refers to the length of time the gillnet was in the water. The longer the net remains in the water, the more damage that can happen to the fish, particularly those fish that hang in the net the longest.

Soak time. All fish bled and chilled in RSW

Duration of soak	Percent #1	Percent #2	Percent #3	Score
20 minutes	81	18	1	2.40
30-45 minutes	81	16	3	2.39
60 + minutes	78	19	3	2.37

Table 2: Effects of Soak Time on quality

Data:

20 minute (short) soak: 14 sampling events, 298 fish tagged, 192 recovered.
30-45 minute (medium) soak: 9 sampling events, 178 fish tagged, 123 recovered.
60 minute + (long) soak: 20 sampling events, 399 fish tagged, 300 recovered.

Bled vs. Not Bled

Bleeding salmon while they are still alive, or have died recently, is an effective way to minimize bruising and improve shelf life. This study involved 46 boats fishing June 23-26 2010 in Naknek, Egegik and Ugashik Districts. All fish were graded in one Naknek plant, 23 boats bled the fish, and 23 boats did not bleed.

Bleeding or not	Percent #1	Percent #2	Percent #3	Score
Bled	69	16	15	2.27
Not Bled	57	30	13	2.22

Table 3: Effects of Bleeding on quality

Data:
Bled fish: 49 sampling events, 1,147 fish tagged, 911 tags recovered.

Not Bled: 50 sampling events, 945 fish tagged, 816 tags recovered.

Salmon Slide or Rubber Mat, vs. no slide or mat

Increasing numbers of Bristol Bay fishermen use a Salmon Slide or rubber mat on deck to cushion the fish as they are shaken from the gillnet and drop to the deck. Many more, though, do not use a slide or mat. Evidence shows that using a slide or mat can improve salmon quality.

Samples came from Naknek, Egegik and Ugashik Districts in 2010 & 2011.

Note: citing the number of boats in this study would be misleading because some boats started the season with a slide and then removed it. Others started using a mat partway through the season. Our primary criterion for this study was whether the slide or mat was in use during the fishing period associated with the sampling event.

Boat situation	Percent #1	Percent #2	Percent #3	Score
Mat or Slide, yes	75	21	4	2.36
Mat or Slide, no	71	24	5	2.33

Table 4: Effects of Salmon Slide or Rubber Mat on quality

Data: 990 sampling events, 22,033 fish tagged, 16,525 fish recovered. In these experiments, all fish were chilled aboard the fishing boats.

Round Haul effects

Many times in the course of a Bristol Bay, season fishermen want to retrieve the net quickly. This is usually best accomplished by the captain causing the boat to back down on the net while the crew pulls it rapidly aboard. There is often no time to remove the fish from the net. The section of the net closest to the boat ends up at the bottom of the pile, and any fish caught in the net often end up in the pile, as well. Usually, the fishermen remove the fish from the net after the whole net is safely aboard the boat. If there are many fish in the net, it can sometimes take hours for the crew to remove them all. During this time the fish at or near the bottom of the pile can be stepped on, squeezed, and pass into and out of rigor mortis. This type of round haul event—a big catch—is relatively rare. Because of this, we were unable to get a significant enough number of samples, and recovered tags, for good, valid, data. We plan to pursue this in the future.

Round Haul effects: insufficient data—only 5 experiments in 2010-11

Shallow Set, tow net through mud or sand

Sometimes fishermen set the net in very shallow water on an ebb tide. They position the boat at the deep-water end of the net and, as the tide ebbs, they will slowly tow the net toward the deeper water so it does not go dry. This can be an effective strategy when the salmon are running in water that is less than waist deep. Unfortunately, the fish caught in the net, and towed through the mud or sand, often end up the worse for the wear.

46% #1
38% #2
11% #3

Data: Six sampling events, 2010-2011, 129 fish tagged, 87 recovered. Quality score 1.91
NOTE: This handling practice produced the worst quality of all the practices studied.

Report Card Study

While fish selected for the Handling Practices Study came from a wide variety of boats that may or may not have provided other samples, fishing boats selected for the "Report Card Study" were tracked, if possible, every time they delivered fish to the tenders. The goal of the Report Card Study was to demonstrate how salmon quality varies overall among and between the individual boats in the fleet. Salmon selected for the Report Card Study were selected at random from each fishing crew's deliveries.

The results have been striking. In 2010, to cite one example, we studied 40 boats that delivered to one processing company based in Naknek. We sampled those 40 boats a total of 762 times; no boat was sampled fewer than 10 times and more than two-thirds of the boats were sampled 15+ times. The best boat in that fleet had a quality score of 2.37, with 84% #1 quality fish. The worst boat had a quality score of 2.19, with 62% #1 quality fish. A version of that report card, with the names of the boats and processing company deleted, is attached to this document.

In 2010 and 2011, our field representatives tagged 22,033 Report Card salmon targeting 68 boats with 990 discreet sampling events. Of those tagged fish, 16,458 tags were recovered in one or the other of two Naknek seafood plants--a 75% recovery rate. In each plant, the fish were headed, gutted, and then graded per similar grading systems.

The good news is that quality in Bristol Bay appears to be making significant advances. In 2010, the average quality score for all salmon from all Eastside districts was 2.33, with 69% of the fish graded at #1 quality. In 2011, the number rose to 2.36, with 75% at #1.

Quality, however, is not simply a function of fisherman willpower. It appears a significant factor in the quality equation involves time and distance to the processing plant. Table 5, below, illustrates this point.

Dist/Type (2010-11)	Average	No Chill	Chill	Chill + Slide/Mat
Naknek	2.33	2.31	2.36	2.39
Egegik	2.32	2.28	2.34	2.35
Ugashik	2.29	2.26	2.30	2.33

Table 5. Quality Scores by District and Handling Practice

Table 5 breaks down salmon quality scores by eastside district—Naknek, Egegik and Ugashik. It also examines whether the fishermen chilled or did not chill and whether the fishermen who chilled used or did not use a mat or salmon slide. Sample size for boats that did not chill but did use a mat or slide was very small, so that category is not included here.

Table 5 clearly shows that time and distance to the seafood plant affects quality. Fish caught in the different districts, sometimes by the same fishermen after they transfer from one district to another, can vary in quality. Table 5 also demonstrates how chilling and the use of a slide or mat can affect quality. The best fish came from Naknek boats that chilled and used a mat/slide. The worst fish came from boats in Ugashik that did not chill and did not use a mat or slide. Fish caught in the Naknek district were rarely (if ever) delivered to tenders that were more than 15

miles from the seafood plants in the study. Many times the tenders were closer than 8 miles. Fish caught in Egegik were generally about 40 miles from the plant when delivered to the tenders. Fish caught in Ugashik were generally delivered to tenders anchored about 90 miles away from Naknek. A fish caught in Naknek in the morning can therefore be at the plant the same afternoon. A fish caught at the same time in Egegik generally won't be at the plant until the following morning (weather and tides permitting) while a fish caught on the same morning in Ugashik would likely arrive at the plant during the evening of the following day, or later. Apparently, transit time makes a difference in quality.

This study continues to demonstrate that Report Cards, coupled with quality improvement data, can be useful tools in achieving overall quality improvements. We have been tracking 14 Leader Creek fishermen since 2008, rating their individual and collective quality and then giving them report cards along with data on methods to improve quality. The results show a continuous upward trend in quality of salmon when graded at the plant.

Season	Percent #1 H & G	Quality Score
2008	65%	2.28
2010	69%	2.33
2011	75%	2.36
Percent Increase 2008-11	15%	4%

Table 6.Overall improvements in quality among 14 selected drift fishermen tracked from 2008-11 (no applicable H&G data in 2009)

Weather

In 2011, we looked at salmon quality as a function of weather. On rough weather days, sea conditions can affect a) the condition of the net in the water, b) the difficulty of pulling the fish from the net and getting them into the hold, c) the pounding the fish take while they are in the fish hold, d) the beating the fish take during the offload process as brailers swing wildly and are purposely stabilized by dropping them onto the deck or letting them swing into a rail or bulkhead, and e) the friction the fish experience on the trip in the tender to the seafood plant. The Bay experienced two storms during the 2011 season, and when we deleted the stormy day data from the spreadsheet, we discovered the average score rose from 2.36 to 2.38. In contrast, salmon tagged during periods of stormy weather averaged 2.31.

Conclusions

Simple common sense tells us the vast majority of Bristol Bay salmon are #1 quality when they are alive and free in the ocean. Therefore we can assume the relative abundance of # 2 and #3 quality salmon is due to handling practices aboard fishing boats and aboard tenders as the fish are transported to the seafood plant. Poor handling practices have repercussions along the entire value chain. Once value is lost out on the ocean, it can never be recovered. Under the best of circumstances, 13 percent of Bristol Bay gillnet-caught salmon will be graded #2 quality or lower, due to the way the fish struggle against the net and the way they are transported to the plant. However experience shows us the real world acts of catching the fish, removing them

from the gillnet, getting them into the brailers, transferring them to the tenders and then moving them to the processing facility cause, on average, nearly 30 percent of them to be downgraded to #2 quality, or lower, when the fish are headed and gutted.

Our research has shown that best-treated salmon have a score of 2.43 (87% #1), while the worst treated salmon have a score of 1.91 (46% #1), a spread of 51 points. These two numbers represent more than mere percentages—they represent the difference between prosperity and despair for the Bristol Bay fishery. While individual fishermen may benefit by delivering many pounds of poor-quality salmon, the industry as a whole suffers. Therefore, the individual "free riders" benefit at the expense of everyone else.

Specific handling practices can be beneficial or detrimental, depending on the practice. Those practices are:

• **Chilling** is critically important, especially when the fish are caught at greater distances from the seafood plant. A Naknek fish that is chilled comes in at 2.36, while one that is not chilled averages 2.31. **Using a slide or mat** can make a significant difference, as well. Our data shows that a fish caught in Ugashik by a boat that chills and uses a slide or mat is of better quality, with a score of 2.33 than a fish caught in Naknek by a boat that does not chill or use a mat/slide (score: 2.31).

• **Brailer Weights**, along with the number of brailers in a given fish hold, appear to be another cause of lowered quality. Evidence indicates that light brailers of less than 200 pounds—which are also the only brailers in the hold and that are coupled with plenty of RSW to float the fish, result in quality that is comparable with the best handling practices possible, scoring 2.42. That is, 85 percent #1 quality. Having just one brailer in a fish hold, versus two, can help preserve quality even when weights rise above 200 pounds. When there was one 500-pound brailer in the hold the average score was 2.39. As brailer weight rises above 200 pounds and when more than one brailer is fitted into one hold, then quality appears to decline to a score of 2.35. However, evidence indicates there is virtually no difference in quality when two brailers of either 500 or 1,000 pounds each share one hold that also contains a sufficient amount of RSW to "float" the fish. We have insufficient data regarding the effects of heavy brailers on fish that were not floating in RSW.

Bleeding can an inexpensive way to improve quality, especially when fishing is slow and the crew has time to do it. Bleeding reduces bruising and extends shelf life. Bled and chilled fish averaged 2.27, while fish caught at the same time but were not bled and chilled averaged 2.22. The Leader Creek example demonstrates that if the fishermen are compensated well enough, they will bleed every fish they can.

• **Dropping fish** on deck seems to have a negative effect on quality. Many fishermen shake the fish out of the net and let them drop to the deck. Often the drop is two or more feet and the deck surface is aluminum or fiberglass. Some fishermen will kick or pitch salmon into the holds. Common sense indicates that dropping; kicking and pitching can bruise the fish. Using a **rubber mat** or **Salmon Slide** appears to preserve fish quality. In every district, adding a slide or mat to a chilling program yielded quality improvements of up to three points.

• **Shallow sets, especially in the mud or close to shore,** have deeply negative effects on quality. Water nearer the shore tends to be warmer, due to the effect of sunlight heating the beach when the tide is out. This encourages bacterial growth. Dragging the net through the mud/sand seriously degrades the salmon as scales are ripped away and muscle tissue is torn and crushed. Fish treated this way averaged 1.91, by far the lowest in the study. Bear in mind the overall Bay average was for both 2010 and 2011 was 2.34

• **Soak time** is another factor, although it is apparently not as important as the other variables studied. With shorter soaks, more fish are likely to be alive when the net is hauled and will be less bruised in the net. Conversely, longer soaks negatively affect all fish. Those negative effects may be related to the length of time the dead fish hangs in the net: the longer the time the more bacteria can grow and the higher the potential for net marks, scale loss and bruising. A soak of 20 minutes yielded an average score of 2.40, while an hour-long soak averaged 2.37. A goal for the future is to test fish that have been soaking for more than two hours. This might include fish caught during a multi-hour "sleeper set".

• **Distance (from the fishing grounds to the plant) and weather** are critical factors that, frankly, will be difficult to overcome. Perhaps spreading processing capacity among the various districts would be a way to get around this problem.

Recommendations

Due to the fishery's intense timing, run strength, and highly competitive fleet, Bristol Bay fishermen will often be forced to opt for production over quality. Given this fact, it is unlikely that recommendations to ban practices such as stern hauls would be taken seriously. Therefore, it is important to recommend practices that give the best "bang for the buck" in terms of cost or effort and that do not seriously compromise production. With that in mind, I am offering the following recommendations:

> • **The single most effective step to improve quality is to chill the fish**, possibly in RSW. This study corroborates many studies that have gone before, with scores (within each fishing district) consistently better for chilled than for unchilled salmon. Apparently, chilling the salmon in deep water, i.e. "floating" the salmon offsets negative effects of heavy brailers.
>
> • **Keeping brailer weights very low** is another way to improve quality. One strategy might be to always to distribute the fish among all brailers. This study shows that brailers of less than 200 pounds (again, when the fish are "floating" in RSW) can help keep quality high.
>
> • **Short soak times** can also improve quality. Getting the fish out of the net before too much damage is done can have a significant effect.
>
> • **Dropping fish onto a hard deck** also hurts quality. Common sense tells us that rough handling is bad for just about everything that is fragile. This study

indicates that dropping fish onto the deck can result in about 71 percent #1 fish, while dropping them onto a mat or slide raises the number to 75% #1. It is important to note this happens irrespective of whether the fish were also bled and/or chilled. Further study will help determine whether the mat or the slide is the superior choice.

• **Distance and weather** can play important roles in salmon quality. The longer the time and distance to the processor the greater the quality loss. It is obvious that fair seas can help preserve quality while storms can degrade quality. Continued research, and probably some creative problem solving, will be necessary to address these issues.

• A system of **report cards** and value compensation would help identify, and presumably eliminate, the free riders who routinely deliver poor quality salmon. This compensation system must be designed with the understanding that some factors, such as time and distance to the plant, coupled with weather and the many different handling practices aboard tenders, are beyond the fisherman's control.

Acknowledgements

I wish to thank the Bristol Bay RSDA for their multi-year support of my research. Without the Board and staff's encouragement, this work would never have happened. A NOAA Fisheries grant made this project a reality and I thank them sincerely. Leader Creek Fisheries has been a steadfast and supportive partner, as have many of the fine fishermen who sell their salmon to that company. At Leader Creek John Lowrance and Norm Van Vactor, deserve special praise. I also want to thank the anonymous seafood company and their great fleet. Finally, I want to thank the tendermen, who have selflessly provided platforms, meals and bunk space for project staff.

Mark Buckley
President,
Digital Observer, Inc.

Attachment

Fleet Report Card

Deliveries between June 21-July 17

Rank	Boat ID	Sampled	Avg. value	% #1	% #2	% #3
1 (tie)	19	17 times	2.37	84%	7%	10%
1 (tie)	41	21 times	2.37	84%	7%	9%
2	17	21 times	2.36	81%	10%	9%
3 (tie)	20	17 times	2.35	79%	10%	10%
3 (tie)	30	14 times	2.35	83%	4%	13%
3 (tie)	35	19 times	2.35	82%	7%	11%
3 (tie)	45	17 times	2.35	79%	11%	10%
4 (tie)	3	22 times	2.34	79%	9%	12%
4 (tie)	18	23 times	2.34	78%	12%	10%
4 (tie)	24	11 times	2.34	82%	5%	14%
4 (tie)	29	23 times	2.34	79%	10%	11%
4 (tie)	34	22 times	2.34	79%	10%	11%
5 (tie)	6	24 times	2.33	80%	6%	14%
5 (tie)	12	19 times	2.33	78%	11%	11%
5 (tie)	21	16 times	2.33	78%	11%	12%
5 (tie)	22	19 times	2.33	78%	10%	12%
5 (tie)	39	19 times	2.33	77%	12%	11%
5 (tie)	42	21 times	2.33	76%	13%	11%
6 (tie)	4	15 times	2.32	77%	11%	12%
6 (tie)	5	24 times	2.32	78%	8%	14%
6 (tie)	32	17 times	2.32	77%	11%	12%
6 (tie)	36	22 times	2.32	78%	8%	14%
6 (tie)	40	15 times	2.32	74%	17%	9%
7 (tie)	8	17 times	2.31	73%	16%	11%
7 (tie)	10	20 times	2.31	74%	13%	13%
7 (tie)	13	25 times	2.31	76%	10%	14%
7 (tie)	15	17 times	2.31	77%	9%	14%
7 (tie)	16	19 times	2.31	74%	14%	12%
8 (tie)	11	16 times	2.30	75%	11%	15%
8 (tie)	28	19 times	2.30	74%	13%	14%
8 (tie)	37	20 times	2.30	72%	17%	11%
9	1	15 times	2.29	75%	8%	18%
10 (tie)	9	22 times	2.28	70%	16%	14%
10 (tie)	26	21 times	2.28	72%	12%	16%
10 (tie)	33	23 times	2.28	71%	14%	15%
11 (tie)	2	13 times	2.27	71%	13%	16%
11 (tie)	43	22 times	2.27	69%	15%	15%
12	38	22 times	2.26	71%	11%	18%
13	31	10 times	2.22	69%	7%	24%
14	23	23 times	2.19	62%	15%	23%

Note: Assigned values are for comparison purposes only.

Note: Percentages may not add up to 100 due to rounding.