OCS Study
MMS 2004-033

Alaska OCS Region

Proceedings of a Workshop on the Variability of Arctic Cisco (Qaaktaq) in the Colville River

November 18, 19, and 20, 2003

Kisik Community Center
Nuiqsut, Alaska

MMS
U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

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Prepared for:

U. S. Department of the Interior
Minerals Management Service
Alaska OCS Region
3801 Centerpoint Drive
Anchorage, Alaska 99503

Prepared by:

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, California 92626

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Table of Contents

Page

Disclaimer ... ii
Acknowledgements ... iv
Executive Summary ... v
Introduction ... 1
Welcoming Remarks ... 2
Background Presentations
Life History of Arctic Cisco in the Alaskan Beaufort Sea - Larry Moulton ... 7
Physical Environment and Habitat of the Arctic Cisco - Bob Fechhelm ... 9
Traditional Knowledge Panel Discussion
Eli Nukapigak ... 11
Carl Brower ... 12
Gordon Brown ... 14
Joeb Woods, Sr. ... 15
Marjorie Ahnupkana ... 17
Ruth Nukapigak ... 18
Dora Nukapigak ... 19
General Discussion ... 20
Workshop Presentations
Mackenzie River Arctic Cisco Biology and Population Trends – Randal Pokiak ... 26
Alaska Beaufort Arctic Cisco Biology and Population Trends – Bob Fechhelm ... 30
Colville River Arctic Cisco Population Trends – Larry Moulton ... 33
Canadian Beaufort Nearshore Oceanography and Mackenzie River Winter Hydrology – David Fissel ... 35
Beaufort Oceanography and Colville River Hydrology – Kate Wedemeyer ... 37
Arctic Ocean Climates Cycles – Kate Wedemeyer ... 39
Possible Global Warming and Arctic Oscillation Impacts on Small Fish Stocks – Two Crow ... 42
Exploitation Dynamics of Small Fish Stocks like Arctic Cisco – Jennifer Nielsen ... 45
Modeling Approaches to Understanding Variability in Small Fish Stocks – Terrance Quinn II ... 47
Working Group Discussions and Recommendations
General Comments ... 49
Studies Categorized ... 54
Information Sources ... 56
Funding and Partnering ... 57
Closing Remarks ... 58

Appendix A - Questions and Issues listed by Group
Appendix B – Attendee List
Appendix C – Agenda
Appendix D – Arctic Cisco Bibliography

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We would like to acknowledge Leonard Lampe, Sr. for his invaluable assistance in making this workshop a success. We appreciate the participation of the panel of elders and local experts including: Leonard Lampe, Sr., Eli Nukapigak, Carl Brower, Gordon Brown, Joeb Woods, Sr., Marjorie Ahnupkana, Ruth Nukapigak, and Dora Nukapigak

In addition, although she was unable to attend, we would like to acknowledge Lois Harwood, Dept. of Fisheries and Oceans Canada for her efforts in coordinating participation from Canada. We would especially like to thank Randal and James Pokiak, from Tuk Harbor, Canada. Even though due to travel complications they did not make it to the meeting, we appreciate their enormous efforts.

MMS would like to thank Larry Moulton for sharing his extensive Arctic cisco bibliography

EXECUTIVE SUMMARY

It is the responsibility of MMS to manage the offshore development of oil and gas resources in an environmentally sound and safe manner. For more than 20 years MMS investigators have studied how to protect natural resources that could be affected by offshore development.

Falling catches of Arctic cisco in recent years and the possible correlations with offshore development are of great concern to residents of the North Slope Borough. MMS convened this workshop to bring together local experts from Nuiqsut, Kaktovik, and Barrow Alaska and Tuktoyaktuk, Canada, as well as scientists from the United States and Canada. Collectively they represent a wealth of expertise and experience. The primary goals were to share their knowledge of the Arctic cisco, to identify important questions and consider how those questions might be answered in the future.

The present scientific theory is that the Arctic cisco found in the Colville River are carried west as young-of-the year by wind-driven currents from the Mackenzie River in Canada. They feed in brackish waters along the coast in the summer and in August enter the Colville Delta to overwinter. They remain in the Colville Delta region reaching maturity at 7 to 8 years of age, and then migrate one or more times to the Mackenzie River to spawn.

Commercial catches within the Colville Delta have been monitored since 1967, and subsistence catches since 1985. Reported catches have been variable over time with higher than average catches in 1974, 1985, 1994, 1997, and lower than average catches in 1980, 1989, 1995, and a series of declining catches from 1997 to 2002. It is this latter sequence that has caused community concern.

A panel of community elders and local experts recounted to fellow workshop participants their personal observations of historical catches of Arctic cisco, and events associated with the rise and fall of the catches or availability of the fish. Some of these observations were before 1940. The changes most emphasized in the presentations were the decreases in subsistence catches from nets set under the ice of the Colville River during the 1970s, with many examples of catches dropping from hundreds of fish per day to tens of fish or less per day. Residents reported Arctic cisco have also decreased in size, now requiring the use of smaller mesh nets. Concerns and possible correlations with oil development include both onshore and offshore activities. The elders noted changes in the landscape with erosion; changes in weather; faster earlier breakups, slower later freeze ups; more west winds; unusual weather; and sudden turbulent ocean currents in the absence of winds. Additional presentations of Arctic cisco ecology, oceanography, genetics techniques and fisheries modeling continued with discussions of issues and information needs.

Some of the participants were asked directly “what was the most surprising or significant piece of information they had learned during the prior day.” One of the elders, Ruth Nukapigak (age 79 yrs), responded with the statement that she *“already knew all of the stuff the scientists had said.”* Indeed, she had recounted observations

that had validated the scientific observations, and in turn the scientists had validated the traditional observations.

The participants divided into two discussion groups, each with a mix of local experts, elders and scientific disciplines. Each group assembled a prioritized list of issues and questions regarding Arctic cisco that need to be addressed in future studies. Each participant contributed what he or she considered the most important issues or information needs. Once each participant had the opportunity to present at least one idea, the process was repeated to insure that all issues were recorded and understood. Each participant identified the three information needs or issues they felt were most important. Those top priority rankings were combined to obtain the group-prioritized list.

One discussion group's top concerns included:

1. Using existing long term data from Endicott causeway studies, e.g., fyke net data
2. Using the long term fisheries catch data.
3. Gather genetic data to ascertain spawning stock sources.
4. Is the diet of the fish changing or being affected by activity from industry?
5. Gather and document traditional knowledge from the elders about the biology, ecology, etc. of arctic cisco.
6. Identify factors that affect survival from age 0-5.

The second discussion group's top concerns included:

1. Exploration and development effects on Arctic cisco and their migration.
2. Better understanding of Arctic cisco stocks and source populations.
3. Fish health and whether the fish are safe to eat.
4. Effects from ice bridges on current flow, starting with the Colville River.
5. How the changing depths of the Colville River and the delta affect Arctic cisco migration into the Colville River.
6. The decreasing size of Arctic cisco.

The discussion groups reassembled as one group to present the lists, seek clarification, and entertain questions. The final priority of study topics based on combining all participant votes was:

1. Effects of Development and Human Activities
2. Review Previously Collected Canada and Alaska Data, including Elders' information
3. Arctic cisco life history
4. Migration of Young of the Year from Mackenzie River
5. Water quality, contaminants
6. Genetics, source stocks
7. Colville River Dynamics
8. Ice roads and bridges

9.5 Seismic, noise

9.5 Climate change

11. Socio-economics

Conceptually, there was a consensus that initial efforts should be made to collect and synthesize available information. There are very good catch statistics for both the commercial fishery since 1967 and the subsistence fishery since 1985. There is relevant

data on the fisheries, fishes, oceanography, weather, water quality, and land use. If it were necessary to rely on "to-be-collected" data, the time required to attempt to answer some of the questions asked during the workshop, would probably be more than a decade. Such a time interval is unacceptable.

If a database were assembled and synthesized it would be of great assistance in identifying gaps. Such a study would make use of the existing data to gain further understanding of the observed trends in Arctic cisco abundance and estimate what factors influence population variation. It would also help weight priority data to be acquired in future studies.

Therefore, emphasis should be given to a careful examination of the database available so that its use can be maximized to identify trends over space and time. Proposed studies for future efforts can be used to both validate past trends and correlations, and to focus on specific questions that have not been previously addressed.

There was also considerable interest in genetic and otolith microchemistry studies to address questions on stock structure and life history information in terms of migratory patterns.

Some of the existing data sets participants were aware of include:

Iñupiaq archives of interviews and records on catch patterns over time.

Catch data and otoliths from studies of causeway effects in the 1980s

Catch data and 15 years of otoliths since 1984 on Nuiqsut subsistence fisheries

MMS, USFWS fyke net studies in lagoons and coastal waters, 1970s and 1980s

DNA genetics data from 1991 study

Freshwater Institute of Canada tagged fish data in the 1960s

Because MMS is limited in the types of projects that can be funded, the participants identified potential state, federal and international agencies or organizations that may be approached for joint efforts or possible funding. Particular importance was given to the potential for a cooperative or collaborative effort between the Canadian and Alaskan communities. For some concerns such as water quality, ground water contamination, and measurements of body burden levels of possible contaminants in subsistence foods there are existing programs the community can ask for assistance or participation.

INTRODUCTION

It is the responsibility of MMS to manage the offshore development of oil and gas resources in an environmentally sound and safe manner. For more than 20 years MMS investigators have studied how to protect natural resources that could be affected by offshore development. In recent years residents of the North Slope Borough have been concerned with falling catches of Arctic cisco and the possible correlations with offshore development. MMS offered to convene a workshop bringing together local experts from Nuiqsut, Kaktovik, and Barrow, Alaska and Tuktoyaktuk, Canada, as well as scientists from the United States and Canada. The primary goals were to share knowledge of the Arctic cisco, and to identify important questions and how those questions might be answered in the future.

Presenters and panelists were provided the opportunity to review this document. Please note that we have made every effort to accurately transcribe places names. We apologize if any are misspelled.

WELCOMING REMARKS

Leonard Lampe, Sr.
President, Native Village of Nuiqsut
Kuukpik Corporation, P.O. Box 187, Nuiqsut, AK 99789
(907) 480-6220, FAX (907) 480-6126, E-mail: llampe@astacalaska.net

I am glad that you have all come up today from many parts of the States. I appreciate you taking the time to come up to the workshop. I also want to thank our residents for taking the time to join the workshop. I know it takes a lot to come up to Nuiqsut; we are not a regular stop with Alaska Airlines. Again, thank you for taking the time. Arctic cisco is a big traditional part of our village lifestyle in Nuiqsut. We have always been a thriving fishing community. Approximately 30-40% of our diet is from the fish of the rivers of the Nigliq Channel and Colville River. We depend on the cisco quite heavily. Before I go any further on the agenda I am going to first welcome you all to Nuiqsut and of course as I have expressed, thank you all for coming. I am going to go ahead and introduce our panel members as well as village residents that are here to participate in the workshop. But first I will ask Adeline Hopson to give us the blessing to start this meeting. Please stand for a prayer. It is a tradition among the Eskimo people on the North Slope to start off meetings with a blessing so that the meeting will go a lot easier and smoother as people give their views and to recognize the One above who has brought us here today.

Blessing from Adeline Hopson:

> *I want to thank everybody for being here and thank Leonard for asking me to lead this blessing. Let's pray. Lord we thank you for this beautiful day and we thank you for helping us to all come here safely to attend this gathering. And Lord let every person here today be a part of something that needs to happen and give us the resources and knowledge to do our best. Oh Lord we thank you for this meeting, for our families, and all the love that you give us. Let us share what we know and all that needs to happen as we discuss this very important food source in this community. And Lord thank you for all of your guidance and your help. In Jesus name, we pray. Amen.*

Our facilitator is Chuck Mitchell. Ben Nageak is our translator for the elders. I again would like to thank you for being here and we welcome you to Nuiqsut. Kate Wedemeyer from MMS will be saying a few words. Now I would like to make the introductions of our Nuiqsut panel. I will first recognize our elders and then residents of the village. Marjorie Ahnupkana is an elder that has been here on the Colville River all of her life. She is very knowledgeable of the rivers and the patterns of the animals and the fishes of the Colville and the Nigliq channel. Joeb Woods, Sr. is very familiar with the Nigliq channel as well. He has family history on the Nigliq channel. His family was the only family that stayed and resided in the area when everybody moved back in the 1940s. So Joeb is very knowledgeable about this area.

Paul Okarok is also a resident of the Colville area and Nigliq channel. He has lived in the area all of this life. Paul is very familiar with the traditional knowledge of the area. Ruth Nukapigak has also been in the area all of her life. She knows the patterns and the seasons of the animals and the cycles of the fish. She is very active in the village and the community as well. Gordon Brown is a fisherman here who subsistence hunts. He has also held many titles here in the village. He helped start up the subsistence panel in the village. Carl Brower is also a fisherman in the village. He is also in the work force of the village corporation. He is a whaler and, more specifically, he is our

whaler. He has killed all the whales in the past few years for the village. Eli Nukapigak has also held many titles in the village. He is a fisherman and a subsistence hunter of the area. He is very knowledgeable of the area. Dora Nukapigak is a fisherwoman of the Nigliq channel as well as the Colville. She is a very active hunter and fisherwoman. Her family is a very active subsistence family in the village. Her mother is Ruth. She is also a participant member of the community and other organizations as well as subsistence organizations.

James Taalak, who works for Conoco-Phillips, is our "eyes and ears." If there are any problems we go directly to James. He also deals with the local panels on subsistence issues, projects, and informs the leaders on what is happening and whom we can contact further if we want more details. Later we are expecting Isaac Nukapigak, he is also a fisherman of the area. Perhaps Bernice Kaigelak will make it. She is a local schoolteacher who is also an active fisherwoman of the Nigliq channel. So hopefully, she will be joining us later. Joeb Woods, Sr. may also come. This is our local panel and thank you for coming.

Kate Wedemeyer
Agency Coordinator for Arctic Fish Studies, US Minerals Management Service
949 E. 36th Avenue, #308, Anchorage, AK 99508-4363
(907) 271-6424, FAX (907) 271-6507, E-mail: kate.wedemeyer@mms.gov

Paglaqivsi! I would say welcome in Iñupiaq but you probably wouldn't understand my heavy accent! Instead, on behalf of the Minerals Management Service, I'll say in English, *Welcome*!

As we begin I would like to especially thank the Nuiqsut residents for allowing us to come to your village and for sharing your knowledge with us today and tomorrow. Speakers and attendees, thank you for the benefit of your participation. Special thanks go out to our Canadian attendees for your willingness to take the long trip by plane. Some of them had to travel from Tuktoyaktuk Harbor southeast to Edmonton, west to Seattle and back north to Fairbanks where they are stuck until tomorrow. For them it would have been shorter and more reliable to come directly west by dogsled! Finally, thank you to MBC for arranging to get us here and for keeping us on track the next two days.

In your packet is a sheet that describes the MMS mission. I'll briefly describe that mission and why MMS sponsored this meeting. It is the MMS responsibility to manage oil and gas exploration and development on the Outer Continental Shelf–that is three miles or more offshore–in an environmentally sound and safe manner. Within MMS, the Environmental Studies Program's goal is to carry out studies that help us to predict, and minimize potential effects of offshore oil and gas activities on the humans, animals and plants in and around the Beaufort Sea.

As the MMS Coordinator for Arctic Fish Studies it is my responsibility to collect information about fish that helps MMS to make better decisions, to monitor in case there are changes that we do not expect, and to help apply the information to improve future management decisions.

Why did MMS sponsor this Arctic cisco workshop? For twenty years, MMS studied how to protect resources that might be affected by offshore development. Local residents were telling MMS about the low Arctic cisco catch and the North Slope Borough invited MMS to join the Arctic Cisco Working Group. That group identified the need to gather experts to share information and develop a plan to identify the causes. MMS offered to organize this workshop.

Why are local residents concerned? There have been record low numbers of Arctic cisco in the subsistence catch in recent years. The theory is that east winds that carry young Arctic cisco from the Mackenzie River to the Colville River have been less strong. But that theory doesn't seem to completely answer the record low numbers. We also need to look at how other physical and biological factors, including human activities, may be part of the reason for the decline in Arctic cisco numbers.

Who was invited to this workshop? First of all, experts who have ten thousand years of experience with Arctic cisco, residents of Nuiqsut and Kaktovik, Alaska and of Tuktoyaktuk Harbor, Canada. We also invited Scientists who study Arctic cisco in Canada and Alaska, as well as local, state, federal, and industry representatives.

Our workshop goals are:

Share what we already know about the variability of Arctic cisco abundance,
List the questions we need to answer to understand the causes, and
Identify the most important questions, and how to answer them.

Tomorrow evening we'll:

Identify which questions, in particular, can be related to the MMS mission,
Develop brief study descriptions on how to answer them,
Identify existing data, and
Identify potential local, state, federal, and industry partners who can help answer the questions.

What and where are the human activities to consider in relation to Arctic cisco? To orient us, here's a map (Figure 1) of the Alaskan Beaufort coast. (I apologize for my American computer cutting off the Mackenzie River and Tuktoyaktuk Harbor in Canada on this map.) The coastal population centers on or near the coast include the villages of Barrow, Nuiqsut, Kaktovik, and Tuktoyaktuk Harbor. Nuiqsut, Kaktovik, and Tuk Harbor residents harvest Arctic cisco and share with other residents.

The oil and gas development activities and areas include, the Barrow gas line and the National Petroleum Reserve (managed by BLM) to the west of Nuiqsut, the Alpine development on local lands, and to the east of Nuiqsut are all the developments on State leases around Prudhoe Bay and up to 3 miles offshore. To the north, MMS is responsible for developments farther offshore; to date that is only North Star, which is actually tapping both State and Federal leases. Are there any important human activities I've missed?

In your folder is this map of the Colville River Delta. Many of the place names came from the publication "Nuiqsut, Land Use Values Through Time" published about 30 years ago. It was so interesting that, with the permission of the Nuiqsut Village Tribal Council, we sent a copy on CD to many of you. We appreciate any additions or corrections that you may want to write on your map and call to our attention.

Also in your folder is a list of fish and ice terms in Iñupiaq, English and "scientific." If you have are any additions or corrections, please let us know. Again, welcome and thank you for coming.

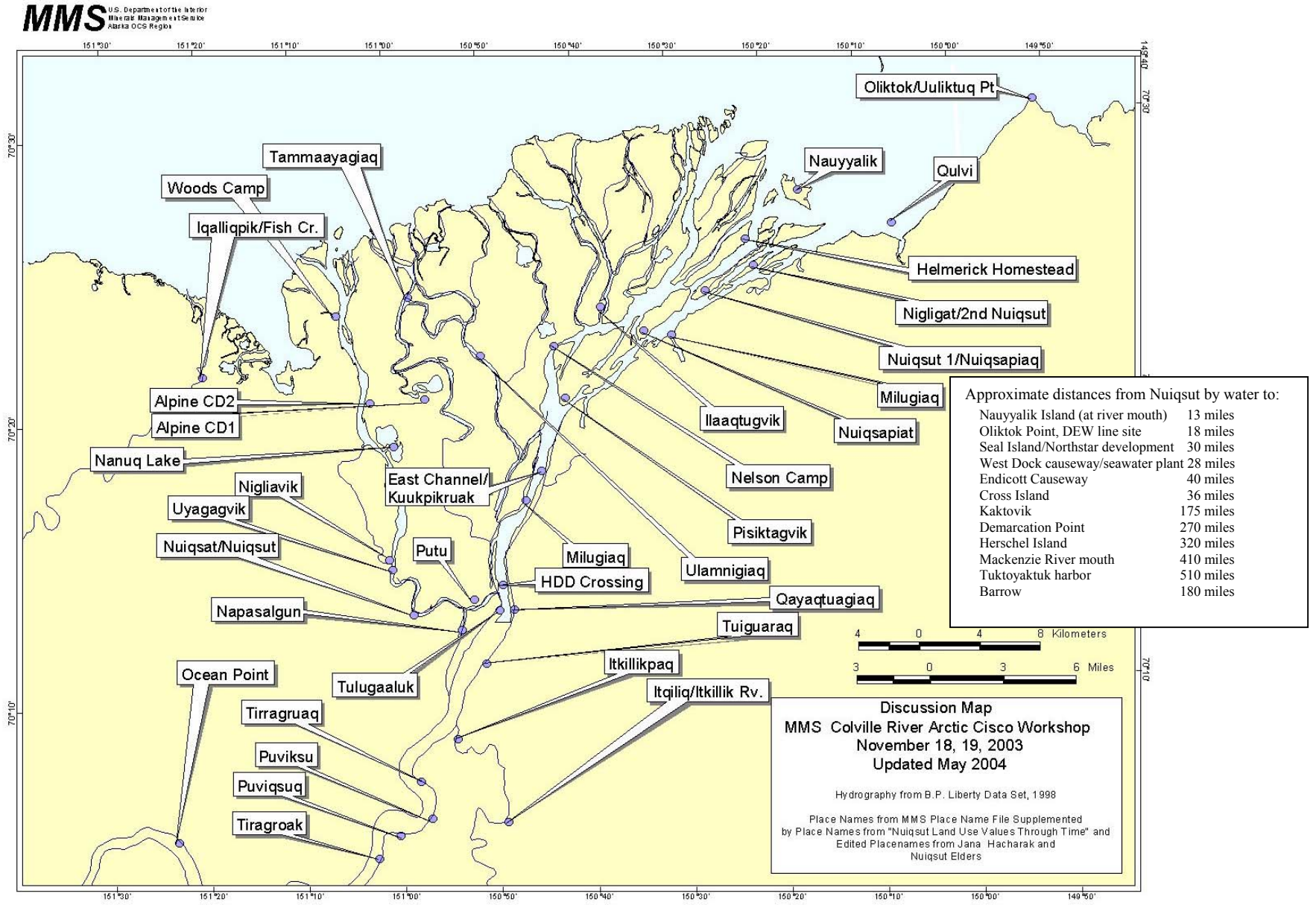

Figure 1. Discussion Map for MMS Colville River Arctic Cisco Workshop.

Chuck Mitchell, Meeting Chair
MBC Applied Environmental Sciences
3000 Redhill Ave. Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840, E-mail: cmitchell@mbcnet.net

Thank you Leonard and Kate. I am Chuck Mitchell. I am from MBC Applied Environmental Sciences and we are contractors to MMS. I will be facilitating the meeting over the next couple of days. Before we start, I, too, would like to thank the community of Nuiqsut for allowing us to have the meeting here in the community center. Thank you to the elders and the other residents that are here. It is really quite an honor to be here and help put together this workshop. Most of our participants, as Leonard has mentioned, have really come along way. We have brought people in from everywhere. So some of us are unfamiliar with the area and some of us are very familiar area. It ranges from one spectrum to the other. At this point I was going to introduce Leonard, but he obviously doesn't need an introduction now. And I thank you for that Leonard. It was a big help and thank you for introducing you panel. I would have probably stumbled hopelessly through all of those names.

Over the next two days, we'll collectively be sharing what we know about the Arctic cisco, its environment, and how the environment has changed in recent years. The decline in catch that we have all seen and that you all have been talking about are of great concern. It is our hope with all the expertise that is assembled here that somehow over the next couple of days, we can examine and prioritize possible causes and formulate study plans to identify or test for those causes. Collectively, I believe that we represent a wealth of expertise and experience. Each of us brings a part of the puzzle to share here of the next couple of days. I think we all have slightly different experiences and perspectives and that is what we need to exchange. Perhaps it is like an old paint-by-the-number picture. As we fill in those little segments, the picture will be come apparent, with a little luck at all, by the end of the two days. I don't want to over look any of the input from any participant, any of the people here. So I am asking please don't be shy. Be forthright, forthcoming with your descriptions and your input, and I'll be seeking out input from each one of you. So in essence you can't hide, I will come and get you because I want that input from everyone. There are no wallflowers here. To start the proceedings, we will have two speakers to provide us with general background on Arctic cisco life history and physical environmental and habitat

BACKGROUND PRESENTATIONS

LIFE HISTORY OF ARCTIC CISCO IN THE ALASKAN BEAUFORT SEA

Lawrence L. Moulton
MJM Research, 1012 Shoreland Drive, Lopez Island, WA 98261
(360) 468-4821 E-mail: lmoulton@rockisland.com

Arctic cisco is a migratory member of the whitefish complex that is found along the Alaskan Beaufort Sea coast. As with other ciscoes and whitefishes, they spawn in the fall in large rivers. Eggs hatch in spring and young are swept downstream during breakup. Sub-adults spend summers feeding along the coast, returning to river deltas to winter. For fish in the Alaskan Beaufort Sea, wintering is primarily in the Colville Delta, with some also in the Sagavanirktok Delta. Arctic cisco mature at 7 to 8 years old, at which time they migrate to spawning areas.

Studies of Arctic cisco in this region began during the mid-1970s with the MMS-sponsored Simpson Lagoon Studies. The researchers noticed that mature and spawned-out fish were not present in the Colville region, while similar stages for other whitefishes were commonly found. In addition, tagged least cisco remained in the fishery for many years, while tagged Arctic cisco rapidly disappeared from the population. Based on little direct evidence, it was theorized that the Arctic cisco found in the Colville River migrated to the region from the Mackenzie River during their first year, remained there until maturity, and then returned to the Mackenzie River to spawn.

Subsequent field research demonstrated that the Mackenzie-origin theory is probably correct: young-of-the-year Arctic cisco have been documented moving along the coast from the Mackenzie to the Colville, and adult Arctic cisco tagged in Alaska have been recovered in the Mackenzie River. The recruitment of young fish is dependent on prevailing winds during summer, with strong easterly winds during July and August favoring strong recruitments and predominantly westerly winds preventing recruitment.

Discussion

Terry Quinn – Where does the data come from?

Larry Moulton – The Mackenzie data is from Bill Bonds' work in the Mackenzie Delta. The least cisco ages and the Arctic cisco ages are from data that I have collected here.

Terry Quinn – Does the data come from the fishery?

Larry Moulton – Yes. The least cisco and the Colville Arctic cisco are from the 1999 samples taken from the Colville River. The numbers for the 4 to 7 year old fish are going to change quite a bit because you have one year class that dominates. It is going to move through the fishery.

Dora Nukapigak – Were those studies done just during the summer?

Larry Moulton – No, those are done just during the fall fishery.

Two Crow – Do Arctic cisco spawn in Russian waters?

Larry Moulton – Not the Arctic cisco that we are discussing now, but other populations do spawn there. Bering cisco rather than the Arctic cisco.

Eli Nukapigak – Bering cisco that we are catching now...

Larry Moulton – It looks like they are coming from the Yukon River. Bering cisco are very different including the age structure of the fish.

Carl Brower – Are Colville Arctic cisco going to Barrow in the summer?

Larry Moulton –Bering cisco are traveling over to Barrow. They have a very different life history. Some Arctic cisco are also coming from the Mackenzie River; about 80% are Bering cisco and about 20% are Arctic cisco.

Bill Streever – Looking at the data, there are no age classes representing years 1-2. Does this reflect the sampling methods or the actual numbers?

Larry Moulton – Gill nets are used to sample therefore we are unable to catch the small fishes that comprise those age classes. It is all standardized to one mesh size, 3-inch mesh.

Eli Nukapigak – When is maturity reached? I have seen some big fish. I've caught a 10 year old.

Larry Moulton – Maturity is reached at about 7 years of age. The big fish that have been observed are usually between 9 and 10 years old. Some fish start maturing as late as 8 years old. There is no exact age when maturity is reached.

Jennifer Nielsen – This question is for the local community, is there any information or memory of a change in size of the fish caught traditionally other than the data taken from the 1999 sampling?

Dora Nukapigak – Last year the fish were very small.

Carl Brower – In the 1970s the fish were very large. Compared to the 1970s when we had large fish, last year we had small ones. They've grown smaller every year.

Marjorie Ahnupkana – In the 1970s I remember the fish being very large and over the years the fish have been getting smaller. I have seen a lot of changes of the years in the size of the Arctic cisco. Black spots are the difference between Bering and Arctic cisco.

Joeb Woods, Sr. – In 1948 we used larger nets, 3 inches or larger. We saw both the Bering cisco and Arctic cisco and were able to tell the difference between the two species of fish. In 1970, we noticed changes starting to occur, the fish seemed to be getting smaller and smaller. We had to go down the river farther because of the currents and again the fish are not as fat.

PHYSICAL ENVIRONMENT AND HABITAT OF THE ARCTIC CISCO

Bob Fechhelm
LGL, 1410 Cavitt St., Bryan, TX 77801
(979) 775-2000, FAX (979) 775-2002, E-mail: bfechhelm@excite.com

Fishes of the North Slope are typically classified in terms of four life-history strategies. They are either anadromous, amphidromous, freshwater, or marine. The habitat preferences of freshwater and marine species are obvious. Freshwater species spend their entire lives in freshwater lakes, streams, and rivers of the North Slope. Marine species spend their entire lives in the marine environment, although some species like fourhorn sculpin and Arctic flounder migrate into nearshore brackish coastal water areas during summer and have been known to move considerable distances upriver.

Amphidromous species spend the winter beneath the ice in freshwater systems of the North Slope. Overwintering areas must ultimately be deeper than six feet to allow for ice cover in late winter. During summer, amphidromous species migrate out into coastal waters of the Beaufort Sea where they feed. Most growth and weight gain is achieved during this summer feeding season. Amphidromous species also have large components of their population that remain in freshwater lakes, ponds, and streams during summer. Amphidromous species use both the freshwater and marine environment during the open-water season.

Once in coastal waters, amphidromous species generally remain nearshore where river discharge and solar heating tend to keep waters warmer and less saline than offshore marine waters. Westerly winds tend to keep this brackish water from flowing offshore. This band of nearshore water forms a migratory corridor within which fish move up and down the coast to feed. Areas behind barrier islands are very protected from the influence of offshore marine waters. During east winds, warm, brackish water flows seaward along the surface and bottom marine water moves onshore. If this onshore movement of marine water is strong enough to disrupt the nearshore band of warm brackish water it may prevent fish from moving along the coast.

Anadromous species spawn in freshwater, then migrate out to sea where they spend their entire lives. They only return to freshwater to spawn. Salmon are among the most well known anadromous species. Qaaktaq (Arctic cisco) are considered anadromous because they only enter freshwater to spawn. However, unlike salmon, they do not remain at sea during most of their lives. Arctic cisco overwinter in brackish waters of major river systems like the Colville in Alaska and the Mackenzie in Canada. During summer, they disperse out into coastal waters to feed like the amphidromous species.

Thus, qaaktaq are neither truly anadromous (they do not spend their lives at sea) nor amphidromous (they do not enter freshwater to overwinter). Because they require saline water for overwintering, they are confined to brackish habitats of the lower Colville Delta. These areas should be considered critical habitat for Arctic cisco.

Discussion

Bob Fechhelm – In the beginning of August, the Arctic cisco turn around and start moving back into the river. Large fish seem to disperse a long way east and west from the Mackenzie River. Other white fish from the Mackenzie peter out at Herschel Island. Other fish from the Colville peter out at Flaxman Island. But Arctic cisco are found all the way along between the Colville and Mackenzie.

Ruth Nukapigak – I have fished most of my life and have noticed that the fish follow the currents. During the summer months we would never have to leave the shore to catch fish. I also remember that most of the Arctic cisco caught during the summer had eggs within them. Starting in July when it starts getting darker, they follow the salinity of the ocean. They never leave the shoreline in summer. The families used to fish where Helmerick put his cabin. Once the causeway was built, the seawater treatment plant, changes began to occur. These changes affected the size and abundance of fish.

Bob Fechhelm – That is very interesting. Do you think the plant changed the salinity of the water within the area, which in turn affected the fish?

Ruth Nukapigak – There are lots of fish within the area. The plant sucks in the yearling fish and also changes the salinity of the water within the area. The place where the most cisco are found is where Old Nuiqsut, currently Helmericks fishery, was located. Causeways could block the fish from traveling between the Mackenzie and Colville Rivers.

TRADITIONAL KNOWLEDGE PANEL

Eli Nukapigak, Carl Brower, Gordon Brown, Joeb Woods, Sr., Marjorie Ahnupkana, Ruth Nukapigak, Dora Nukapigak

Eli Nukapigak

I am concerned with the effects from North Star and the pipeline development that began in 1999. The ocean turned muddy for three to four months straight and the marine life within the area between the Mackenzie Delta and Colville Delta moved offshore. It has affected the migration of Arctic cisco from the Mackenzie to the Colville River. There was a sharp drop off of Arctic cisco in the fall. This development has affected our fisheries. I am very concerned with the development of future offshore islands. How many more offshore islands are they going to develop? And they need to have a better plan than the one they had with North Star.

Discussion

Chuck Mitchell – What kinds of effects did you notice from the offshore oil exploration?

Eli Nukapigak –I noticed gravel within the water that was stirred up during ice dredging. They were mixing gravel and water and putting it on the ice [for islands and/or ice roads].

Isaac Nukapigak – Dredging affects the turbidity of the water and in turn affects the Arctic cisco and their migration patterns.

Leonard Lampe, Sr. – Dredging also changes the natural surroundings.

Two Crow – A gravel island was built? Where is North Star located, on the map?

Isaac Nukapigak – It sits where the two contours meet, the 30-foot and the 60-foot contours, which has had an affect on the cisco. The construction also affected the turbidity of the water.

Chuck Mitchell – It is an area of current interface.

Jennifer Nielsen – In which months did you notice the three to four months of fish disturbance in that area occurring.

Eli Nukapigak – During winter and into spring; about 15 April. The fishnet was getting [only] 3-5 fish in 3 to 4 days. This year the catch is up with a mixture of Bering cisco and other species that we don't usually see in our river. So there are two different ciscoes in our delta. This summer we mostly had west winds and hardly any east winds. We could see some saffron cod moving in and out of the river within the 30 psu salinity water where the two ocean currents mix.

Jennifer Nielsen – What was the size of the cod?

Eli Nukapigak – They were pretty big in size because we had used a 2.5- to 3-inch mesh net. Some were about 18 inches long.

Jana Harcharek – There used to be tons of them but not in the river. What other kinds of fish were present?

Ben Nageak – Saffron cod, first time catching these fish this year.

Craig George –Saffron cod, uuqaq, Saffron cod, used to be quite rare. We would catch them occasionally offshore using a marine net or fyke net and they were small. Kaktovik reported catching large ones and now they are being to be caught in Nuiqsut.

Ruth Nukapigak – Earlier when they were living at Oliktok there used to be tons of them.

Ben Nageak – They used to be found only along the coast in the summer time but now the fish are showing up in rivers.

Ruth Nukapigak – When did the numbers increase in Kaktovik for the saffron cod?

Craig George – In 1999, I was in Kaktovik for the fall whaling and they reported the saffron cod as something unusual.

Carl Brower

I've worked for the Kuukpik and also as a polar bear tagger for the Alaska Department of Fish and Game and for Clean Seas. When we moved into the area, there were lots of fish that we could catch right here off the boat dock. We would catch 200 per day. Now, when we put our nets are put out, there aren't even 10-20 per day. In the 1970s we use to put nets out and never catch any fish that were contaminated.

The fish today, have contaminated skin and meat. I want to know why the fish have big gouges in their skin, not like bites. I wonder if it is the contamination from the oil industry or is it just from the ocean.

Discussion

Kate Wedemeyer – Have you noticed the size of the fish remaining the same or are they different?

Carl Brower – The fish are smaller nowadays.

Leonard Lampe, Sr. –To set our nets we have a tool that is a 15 –20 foot stick with a hook on the end. We cut through the first hole and then drop the hook with a weight attached. We move to the second hole and pull the rope using the tool in that hole; then move to next hole and pull the rope again, until all the holes have the rope connecting them. The net then gets pulled into the water and lies under the ice.

Everyday we have to cut through the ice by hand to check the net; the thickness of ice is about 2 to 3 inches. This is all done in the cold, no tents and no warm-up shack.

It takes one person 1 to 1.5 hours to perform this activity. The nets must be checked every day that takes about 20-40 minutes. Fifteen to 18 miles at 40 below and then finding one or two fish. It isn't fun after a while.

You can see the frustration; frustrated not only with industry, but the State and agencies, because, "How could this be happening to us?" We used to be a thriving fishing community. Now all of a sudden we get two to three cisco. It is very frustrating to an individual and as a family as well. You spend time and effort and money. The average family will set two nets, sometimes three nets to try to make up the loss of one net. It takes a lot of money to fish; prepare the snowmobile, buy gas and nets and you have to spend time away from your family and home. Our diet consists of 30-60% Arctic cisco.

Bob Fechhelm – Do the different families all go to the same spot or do you all spread out?

Leonard Lampe, Sr. – Everybody generally spreads out trying different spots in order to find a productive location.

Bill Streever – What area of the river do you cover when fishing?

Leonard Lampe, Sr. – The most active fishing sites are down river at Uyagagvik "a place of rocks." It used to be, 20 years ago, we could just step outside and fish the river right here within the village. Some people believe that the closer you are to the mouth of the river the greater the catch. Which is true sometimes.

Ben Nageak – In Barrow, we used to go out fishing in September but the past few years the ice didn't freeze until mid-October. How was it here in Nuiqsut?

Leonard Lampe, Sr. – It depends on Mother Nature. We wait until freeze up occurs. This is when the ice is two to three inches thick, safest for the snowmobiles to go out on. The first person out is generally the most successful. Joeb Woods usually doesn't wait this long, he parks his snowmobile on the shore and walks out onto the ice rather than riding out on a snowmobile. There are a lot of myths on how far and deep you should put your nets. Everyone is learning new ways. We always ask Larry Moulton if we are going to have a good fish year.

Chuck Mitchell – Are the nets always set perpendicular to the shoreline?

Leonard Lampe, Sr. – Yes, we set perpendicular from one shoreline to the other.

Rosemary Ahtuangaruak – It depends on whether the channel is narrow or wide. Where it is too narrow, it can't be put out perpendicular.

Chuck Mitchell – Is there ever any difference in the catch between the two sides of the net?

Larry Moulton – No, we haven't found any differences between the sides of the nets. However, we have noticed some vertical differences.

Dora Nukapigak – Farther out toward the mouth of the river, the fish are bigger. This year my mother[Ruth] thought the run occurred early. We had our nets out in September. It was still accessible by boat. We were catching qaaktaq. She had her three-inch and five-inch mesh gill nets out in open water for broad whitefish and she was getting least cisco right before freeze up.

Terry Quinn – What is the duration of the season?

Leonard Lampe, Sr. – The season lasts six weeks to two months; the nets go out between the last week of August and the first week of September, whenever the first freeze is. By the last week of September and the first week of October everybody has their nets out. Generally, the nets get pulled in November but the hardcore fisherman will stay out through December. This year 45 nets were fished in comparison to last year when 60-80 nets were fished.

Gordon Brown

I've worked for the oil companies; I was a subsistence representative for Arco, moved on to Conoco-Phillips. I am on the subsistence advisory panel, Kuukpik Subsistence Oversight Panel.

I have noticed that fishing varied up and down until 1999. I am skeptical that the drill rig that was put at Nanuq, the CD2, a satellite of Alpine, affected the fish. I think that the constant noise from the development disturbed the fish. From 1999 to last year, the fish abundance went down, the lowest catches were during that time. We are all skeptical as to what is happening to the fish. We all know that they have periods when they don't come in. I was wondering if the noise bothers the fish. I think that the drill rig affects the fish counts. The reason I said up to last year is that they started to pull up oil from the CD2 area. So they are probably not drilling as much as they did when they were making the pad. So drilling has slowed down which makes me think that the fish are starting to come back in again because the noise has gone down. Fish counts seem to be better this year and the noise has been reduced.

Discussion

Leonard Lampe, Sr. – CD2 is a drill rig satellite of Alpine. The drilling has slowed down this year. It is located one mile from the Nigliq Channel going east of the Colville River. It was always a concern of the village. Five years ago the elders within the community stated that the development of CD2 was too close to the river and that it would disturb the habitat that the fish utilize. In addition they stated that it would also affect the caribou. The main Alpine pad is also located next to another river, the Tammaayagiaq, the middle channel, which is important to other species of fish, dog salmon.

Caryn Rea – I just put up a poster that shows the locations of the different sites. So you can see where CD2 and Alpine are located.

Leonard Lampe, Sr. – That shows you specifically where these sites are located on the Nigliq Channel.

James Patkotak – With 45 nets that Nuiqsut has out on the river, how has the catch been this year?

Gordon Brown – From what I have observed from the beginning of the season, the first nets out did very well and then fish counts began to decline. This year the fish came in early. We don't really know that. But personally, when I put my nets in the first time I caught the most. I was way up ahead of everyone.

Leonard Lampe, Sr. – The fish were plentiful from the second week of October until the first week of November. We fished 300% better than last year; caught 36 fish the first day. Last year I

caught less than 36 fish total. This was the first year that some caught a hundred fish, but this lasted only 5-9 days. Last year I was catching only a single fish a day.

Dora Nukapigak – But that only lasted a few days.

Eric ____- I spoke with some fisheries guys and they said the catch was 300% better than last year.

Isaac Nukapigak – A lot of people used to fish in Nuiqsapigat [First Nuiqsut]. The AlaskaDepartment of Fish and Game (ADF&G) gave a permit for a commercial fishery, Helmericks, allowing them to harvest 160,000 pounds of fish a year. Helmericks moved to that area because of the abundance of Arctic cisco. At times that person blocked the Colville and that in turn put a hardship on the community. The Nigliq, north on the Colville Delta, was the heart for cisco fishing for us and now we have to go up a ways.

Rosemary Ahtuangaruak – The number of nets fished could be dependent on the other subsistence resources. For example, if caribou hunting is good or whaling is good, families don't have to fish as much, there isn't that high demand. However, last year many households really needed to have other resources and really wanted to get fish. The need was very high. Therefore there were a lot of families out fishing.

Leonard Lampe, Sr. – I would like to recognize Brent and Matt. They collect data pertaining to the cisco for Larry Moulton and MJM. How is this fishing season going in comparison to the last couple of years? And what do you foresee for the next year? We are looking to you for hope.

Brent Seavey – The fishing is very good this year compared to the last couple of years. It has slowed down a little bit. But fishing has been excellent. This is the best year in the 15 years that I have been here.

Dora Nukapigak – Brent, have you ever counted the fish from Helmericks or the number of nets that they fish?

Brent Seavey – No.

Larry Moulton – Helmericks used to fish 30 to 40 nets. Now he fishes only four nets for the last five years and the number of fish he caught has been less since the kids left home. Fish counts get reported to the Department of Fish and Game every year.

Joeb Woods, Sr.

I have resided in Nuiqsut all my life. In 1949-1950 we first started fishing as a family; at Woods' fish camp. We would check the nets twice a day because they would catch up to 800 fish per day caught with one net. The Arctic cisco were very abundant then. I never noticed a change in abundance for many, many years. There was a constant catch of that amount of fish for many years without ever noticing a change in cycles. It was all good fishing.

My family also possessed a commercial fishing license. We used nets that were 8-9 feet tall, with 2.5-inch mesh, and 100 feet long right at Nigliq (Woods camp). We noticed changes in the landscape along the river from erosion. We first had a sod house then a cabin. But we had to move the cabin 150 feet from the river because of erosion. We used to have a cellar located 100 feet from the river that eroded away. There was lots of ice [permafrost] where our cellar was and it eroded away very fast. And the water level is coming up higher than in the past when it used to be east winds. The west wind causes the water to rise. The ice movement was so tremendous that it started affecting the landscape and eroding the bluffs.

Discussion

Leonard Lampe, Sr. – The ice movement was so tremendous that it started affecting the landscape and eroding the bluffs. The water level is coming up a lot higher than it used to.

Ben Nageak – Paul Ogarok mentioned during the break that there used to be floods all along the delta several years ago. When there were west winds, there was flooding.

Chuck Mitchell – So floods are associated with west winds?

Dora Nukapigak – The west wind causes the water level to rise and the east wind makes it go down.

Chuck Mitchell – So what happens to the fishing?

Gordon Brown – We have always thought that the west winds brought in the cisco for us along with the salinity of water.

Larry Moulton - The east winds bring in the smaller size fish.

Kate Wedemeyer – Have you noticed if winter or spring is arriving sooner or later? Have you noticed changes in the weather?

Joeb Woods, Sr. – In 1964 there was a big storm in Barrow that blew a strong west wind. I have noticed that freeze up occurs later than it used to than in the past.

Isaac Nukapigak – The past five years have been very unusual. There has been an early spring thaw out. We would be boating when it wasn't the time for us to be boating. This weather has been a phenomenon.

Ben Nageak – We see that change in Barrow also. We go out hunting in mid- to late June. The ice is gone.

Craig George – There was whaling in November this year.

Jana Harcharek – Mr. Jesse Walker, with the Louisiana State University, would be a good source of historical information regarding longitudinal erosion.

Craig George – In October of 1964 there was a tremendous storm in Barrow. The sea level rose 11 feet in Barrow. It was a devastating storm. Still there has been nothing like it in anyone's memory. I am wondering how that big storm in 1964 affected the Kuukpik [east channel] area?

Joeb Woods, Sr. – When the area flooded, my brother's big boat, like they have in Barrow, got swept across the river.

Ben Nageak – In Kaktovik in 1964, a 600-pound ship that sat on one spot for many years was swept across the river all the way to Demarcation Point and onto the bank.

Craig George – How did this affect the fish?

Joeb Woods, Sr. – We noticed the fish were smaller in size and had darker stomach contents. We used to find krill with the stomach of the fish but since then, we don't find the krill.

Ruth Nukapigak – These events occurred all along the coast, not just this area in 1964.

Leonard Lampe, Sr. – Other fishing camps also had to relocate.

Craig George – Did it change the river?

Leonard Lampe, Sr. – No, it pretty much changed where the structures were sitting.

Ruth Nukapigak – Two years ago I noticed erosion occurred all the way up the coast.

Isaac Nukapigak – In 1979-1980, the 100-year flood occurred. The entire delta was underwater and that was from the natural run off.

Marjorie Ahnupkana

During the break up of Kuukpik River, there used to be floods all the way up to Kayuqtusiluk. During the ice break up of 1945 the water level rose 20-30 feet. I haven't seen that since. In 1973 when we moved here, I remember catching lots of fish right by the school. I used 3-inch mesh net back then to catch the large fish that were present then.

Now I use a 2-inch mesh net because the fish are a lot smaller. So I have seen changes in the size of the fish. My sons used to help me fish for qaaktaq in those days. This fall there was a slow start; my son set out a net and didn't catch any Arctic cisco for three days. We did catch the least cisco and humpback whitefish using a 2-inch mesh net.

Joeb Woods, Sr. – You don't want the lead line on the net to be too heavy or it will stretch the mesh therefore making the mesh larger and allowing the fish to pass through. The larger the mesh size the easier it is for the smaller fish to pass right through.

Ruth Nukapigak

I was raised in and round this area. I was raised on the fish of the area and I was very happy. I have fished ever since I was a small child and continue to fish today at Nigliq.

At my home I have a barometer and have learned how to read it. This year and the past few years, I have noticed changes that occur. The barometer would indicate that a wind from the west would be coming and then out of the blue an east wind would come and vice versa. So it seems like our weather cycle has done a circle. So what is occurring with the weather is actually opposite of what the barometer is indicating that it should do.

I also know about fish and that scientists come in to conduct studies only during the fall and summer but not in the winter. There is opportunity for studies to be done during the long winter period.

My daughter set five nets last year between Kuupigruak and here and hardly caught any fish. The river mouth is shallow. When it froze there were strong winds and slush collected around the mouth of the river and thus blocked the fish from coming in. The few fish that we did catch last year were fat. This year the size is quite variable.

While I was in Anchorage at the AFN [Alaska Federation of Natives convention, October 20-24, 2003], my son caught 400 fish within the four nets that he had set. So this year is quite different. This could be due to the strong ocean currents entering into the river. The fish follow the ocean currents. In August there were lots of fish already in the river and I was beginning to catch qaaktaq in my nets. There are lots of qaaktaq this year. So many we can't even count them. I started putting fish in a bag before it was frozen. When the fish froze, the bag was really heavy. So there was maybe 100 fish in a sack. In addition, I noticed that caribou were around the area in healthy numbers. There were a lot of broad-nosed whitefish in the nets this summer.

When Alpine was built and up and running, I thought we were in for change. I had an opportunity to take a tour during development of Seal Island before Alpine was built. We rode around in a bus. All along the way, we could see where they had cut through the ice and were using a backhoe. However, a lot of sediment was being dispersed into the water while it was being brought up from depths. That is why we didn't see a lot of material being placed on the ice on the side. The plan was to bury two pipelines on the ocean bottom. The marine or aquatic plants must have been disturbed in this process and may have been a contributing factor to the decline in the fish populations.

For many years in the past, we haven't had a lot of fish. Then this year, our river didn't freeze for a long time. So it was open enough for the fish to be able to come in. What I suspect that they are going into deeper parts of the river where there isn't such a current. This year the river didn't freeze until later on in the season thus the fish were able to come into our river and remain in the deeper pools.

When I heard about the description of the burying of the pipeline into the ocean bottom, I was skeptical because of the material that was being brought in to cover the pipe. I was skeptical because I knew that the sediment would be dispersed while being brought up through the water column. I was really skeptical about the process that they were describing. I wonder how much of this process is contributing to the changes that we are seeing these days.

In addition, last year caribou and fish were scarce; therefore we didn't have as much traditional sustenance as we were used to. As a result the community was unhealthy and we had fewer jobs. We had to buy products from the stores in order to eat. Last year was very hard for us all.

At this place called Putu, it used to have a river when we first moved back here. Nowadays, it doesn't flow anymore. When they started producing oil, I suspect that the water level went down due to the removal of the sediment and thus making the river more and more shallow. The slush can collect in that area and contribute more to the blockage of fish entering and as a result the fish counts could be reduced.

The pingo islands within the delta are beautiful places that our ancestors used at one time. When they returned to the mainland from those islands, in June, they would set their nets. The fish from the ocean that they would catch would have an earthy taste. Why do they taste this way? We are now catching different varieties of fish and are not catching the types of fish we used to catch.

Thank you for listening.

Dora Nukapigak

I have learned about fishing from my mother. When I was a child, we used to catch over 100 fish with a single net, 60 foot by 8 foot nets. We could fish a lot closer to the village back then. When North Star was being built, I noticed a decrease in our qaaktaq. Other fish are coming in but not the Arctic cisco.

Many people say that we should blame the winds or the slush is blocking the mouth of the river, but if this were the case how are we catching other fish in our nets and not the Arctic cisco. The least cisco, where are they coming from? I used to have a net, and rather than go all the way to Nigliq, I would have it close to Drill Site 2.

Prior to the development of Alpine I would catch hundreds of fish at the drill sites. As Gordon Brown said, it might be the noise and vibrations that are affecting the fish. The year the CD2 was built right on the bank, I caught a single fish. Where, in past years prior to the CD2, I would catch hundreds of fish. I used the same nets with the same mesh size. I noticed the vibration within the area; I could feel it. Fish abundance declined in the family net in that area. Using a 3-inch mesh, we were not catching many fish.

One year we had a drill site outside of the Colville, at Kalupik. We didn't catch many fish when that drill rig was there.

There was one year where they said because of the slush in Nigliq, people weren't catching fish. When they are not catching they tend to go to Nuiqsapiat. As deep as the Kuukpik (channel) is there is pretty much a wide channel. There catch had decreased as well. Our fish used to be a lot bigger. We have gone from 3-inch mesh nets to 2 and a half-inch mesh.

Before industry, there were no complaints about fishing. I never heard people saying, "Oh, it must be the winds today. We are not catching any fish." Everyone was happy. They were catching 20 or 30 sacks of fish, sending them to Barrow. Today, after all of the development in our community, the catch has really declined.

There was a decrease of Arctic cisco in Colville after a few years of the HDD drilling. Since it is up and operating and drilling has stopped, it seems like the Arctic cisco run is getting better. Now the fish counts seem to be getting better, perhaps because there is less industry activity, less underwater drilling.

It is a lot of work to go out there and chisel ice and coming back the next day to check the nets and there is only one fish. It was really sad last year. I barely made a half a sack of fish. When we caught fish, we send some to Barrow. Last year we sent three fish to Barrow and two elders fought over them. This year they are happy with what we are catching. We are able to send more. I hope it gets better.

I feel the decline in fish occurred when development began. It has really declined after three years of construction of the HDD (horizontal drilling under the river) near Putu. This year they drilled at Iqalliqpik (Fish Creek); we didn't catch many fish when that rig was there. Now that development is slowing down, we hopefully will see the fish counts increase. I believe noise and development are the cause for the decline in fish counts. Prior to development there were no complainants with the fish counts. First there was Alpine and then North Star.

Now the fish counts seem to be getting better, perhaps because there is less industry activity, less underwater drilling. When we catch fish, we send some to Barrow. Last year we sent three fish to Barrow and this year we are able to send more. The decline in fish occurred when development began. Now that development is slowing down, we hopefully will see the fish counts increase. I believe noise and development are the cause for the decline in fish counts. Prior to development there were no complaints with the fish counts. First there was Alpine and then North Star.

Discussion

Leonard Lampe, Sr.. – Our fish used to be a lot bigger. We have gone from 3-inch mesh net to 2.5 inch. One year they said the low catch in the Nigliq was because of the slush. After the first year of the crossing [HDD drilling under the river], there was a lot of drilling mud that was lost. Scientists and biologists believe that this mud has not affected or harmed the fish because the mud contains a lot of salt. Some people are skeptical; they feel that this didn't help the fish at all.

Dora Nukapigak – Not only did we have a decline in the qaaktaq when they were doing the horizontal drilling, we used to go fish at the Putu for burbot. After the HDD, there was no more. I had never heard complaints before the development was here. Our fishing was great every year. After Alpine, after North Star… everyone wants to blame global warming.

General Discussion

Chuck Mitchell – We have heard your opinions and we have heard about the things that you have observed over the years, the changes, and we have heard about possible causes. One cause mentioned was turbidity. Water clarity may be a potential cause whether it be from natural runoff or construction such as installation of pipelines, gravel filled causeways, or pads. We have heard that sound and vibrations could be a possible cause. Changes in characteristics of habitats whether it is due to gouging of ice and erosion from either natural causes such as flooding or the ice. Changes in salinity and changes in wind patterns were also mentioned. The next step is to hear from you all on how you would go about looking for solutions and answers. We need to try to set up some study plan and maybe go back and look over historical information looking for patterns.

Joeb Woods, Sr. – I want to know why is it that there are a lot of cisco offshore and along the coast but not up in the river were we usually fish for them? Why are the fish active around islands, and the coastline but we don't see them here within the river? I also want to know what their stomach contents contain.

Chuck Mitchell – So perhaps there could be stomach content analysis on fish going from down river, up river, offshore, and then laterally?

Joeb Woods, Sr. – I made a trip to Oregon and New York, where they discussed stomach content analysis and the finding worms in the stomachs of fish. I want to know more about that in relation to the Arctic cisco. Also during the summer, the Arctic cisco are located along the coast where we would expect to see them. Why is there such a drastic change after they enter into the river? Where are they going if we don't see them in the abundance that is expected?

Chuck Mitchell – Perhaps conduct both stomach content analysis in relation to feeding patterns and try to find out where the fish are going.

Dora Nukapigak – Maybe it is not just the qaaktaq that have changed. This summer I noticed that the broad whitefish had lumps in their stomachs, which is the favorite part of the fish to eat. The lumps are hard nodules like beans located within the lining of the stomach.

Ruth Nukapigak – The fish are scared and won't inhabit areas that have soap or rotten meat in the water.

Joeb Woods, Sr. – I have also noticed soap and rotting meat thrown into the water. People are not taking their nets out of the water and the fish begin to rot. In turn, fish will not inhabit these areas.

Marjorie Ahnupkana – As a small child, I was taught not to put soap in the water, not to throw trash, or even play within the river. I have noticed a few children play in the river nearby washing themselves with soap. There were no more fish in the area where they were washing. I just want people to be aware that washing with soap should be done in a bucket and dumped out onshore instead of in the river.

Chuck Mitchell – That is a good practice. Are there any other sources of soap? It is a common contaminant with domestic sewage. It can migrate through the soil quite fast and can be used as a trace material for tracing underground sewage waste and leaking pipes. It does have an adverse effect on a lot of things in the water table in both seawater and freshwater.

Isaac Nukapigak – Other factors that need to be looked at are unknown toxins. Take samples at the DEW line (old military sites) along the coast at Oliktok Point. When we first came in 1973, there were so many barrels and debris scattered around. There was a lot of dumping early on that was just buried over and now this has created a problem with the onset of erosion. I think these could be some factors affecting the water.

Chuck Mitchell – Has there ever been any water quality studies in the Colville? Has anybody ever come down and measured the chemistry, priority pollutants, and metals?

Caryn Rea – At Alpine, they inject their waste and sewage. The wastewater is treated.

Leonard Lampe, Sr. – Not on a regular basis. A major oil company here on the North Slope was fined heavily for illegally dumping at Endicott, which is on the migration route of the Arctic cisco to the Colville. I feel that illegal dumping is a serious problem, whereas five kids playing in a swimming hole is probably not the problem that has wiped out the cisco.

Isaac Nukapigak – There are a lot of factors that need to be looked at scientifically. We need data to see if those factors do have an affect on the fish habitat. We even need to consider whether to continue these OCS lease sales. These are all factors that need to be addressed.

Chuck Mitchell – It seems to me that there should be a considerable database on water quality along the coast but I am not sure if there is for the watershed.

Isaac Nukapigak – Cisco are the migratory fish that migrate from the Mackenzie. They migrate based on the current. They migrate a long way from point A to point B. There has to be some factor between these two points that is affecting these fish.

Joeb Woods, Sr.– In the past, contractors used to dump chemicals, contaminants, oil, etc. onto the tundra without any thought. Also materials from seismic operations, such as dynamite, were left behind.

Dora Nukapigak – Caryn [Caryn Rea of Conoco Phillips] do you take water samples during the summer or at the lakes when you do your work?

Caryn Rea – Yes, we take water samples but we don't conduct chemical analysis on them.

Larry Moulton – It depends on what you mean by water quality. There are many different aspects to water quality studies. If you are looking for contaminants… There was a study by the U.S. Army Corps of Engineers regarding burbot. So there has to be some information there.

Chuck Mitchell – When scientists go out and take fish samples, they will frequently take physical parameters like salinity, dissolved oxygen, and turbidity, in order to try to explain why the patterns are the way they are. In addition to those physical parameters there is another set that look at chemistry and sediment loads. However, these are very expensive. An EPA priority pollutant test probably runs about $1500 per sample. Some communities take samples once every couple of years and scan those marine samples, both water and sediment. This way, comparisons can be made over time. So you can see if there are any changes.

Joeb Woods, Sr. – There was a lake study at Anaktuvuk that occurred two years ago that looked at contaminant levels in the tissue of burbot, broad whitefish, and ling cod. In 1981, Canada did a similar study.

Kate Wedemeyer – I want to go back to Joeb's first suggestion about why <u>are</u> there a lot of Arctic cisco located along the coast but are not found in the rivers when you would expect to see them. Do you have any ideas or suggestions on how to study or figure out this problem?

Joeb Woods, Sr. – I believe that sediment studies along the DEW line should be looked at. Nowadays, the fish are skinny and not fat like they used to be. You should look at those problems from the past. Perhaps the fish have an altered migration path in order to avoid contaminated areas. Maybe they migrate out in the ocean farther. But there is something that is causing a change in their migration route. They are traveling longer distances and that is evidenced by the fact that they are not as fat as usual.

Bernice Kaigelak – I have fished all of my life. We need to establish a fishing association in case of an oil spill and in order to do this we need someone to fund it. This is important because migration patterns have changed. We used to fish right by the school and now we have to go farther. There have been a lot of changes. We need to look at stomach content and have to find out what is going on.

Leonard Lampe, Sr. – I am concerned with industry building more and more ice bridges every year. They build these ice bridges over the rivers of the Nigliq Channel as well as the Colville River. These ice bridges are used to enable rigs to travel over the river in order to reach the drilling site. These ice bridges are built in December and January.

My theory is that late in the season, with the building of ice bridges, migration routes are being blocked. With ice bridges being built across rivers, it naturally forms ice underneath. By the time the ice road was done in April we found about 70 feet of ice formed beneath the bridges and only about five feet of open water left at the bottom for the fish to pass. That practically covers the whole river and prevents any wildlife or fish to pass the river at these areas where ice bridges have been built. I would like a study to be done to determine if these bridges are being grounded to the ground. I feel that the bridges affect the fish greatly as well as the community. Industry says no, we need the oil here, but further studies need to be done to do it right.

Gordon Brown – I have watched these ice bridges seasonally. The ice gets built up, and over time from heavy equipment going over them, the ice tends to fall and potentially blocks the flow. I have addressed my concerns prior to this and was told that there is some flow at the bottom still. But how do we really know that there is still flow below? I feel this needs to be further looked at. We need to see how the flow is down below these bridges because the surface flow does get blocked. People have come out that have sent a steam hose down in order to ensure flow but we don't know how it is at the bottom of the river. The ice bridge does ground out at the bottom of the river. I have noticed that the east side of where the bridge is located is shallower than that of the delineated west side. You have to be there and watch this in order to understand what I mean. This has become a big concern.

Leonard Lampe, Sr. – This is a concern because the fish travel within a specific temperature of water and a specific depth. When the ice forms and blocks those specific areas they will turn around and go back or elsewhere. They probably will not go underneath and figure it out. A similar situation is seen among the caribou and the pipeline height. When the caribou encounter the pipeline they will turn away and go somewhere else. They will not stop and think that perhaps nearby there is a crossing path that could be used. With the forming of ice bridges I believe that the fish that encounter it will turn around and go back. I don't think they will go under it.

Ruth Nukapigak – The current fish studies set out fyke nets to study the fish. Why are the studies focusing on the small fish and not the big fish that are the important ones to us? Why don't you use the mesh size that we fish with and use our traditional ways?

Larry Moulton – We are trying to learn about the habitat and patterns of the small fish so that they will be harvestable later on. We are not trying to harvest them to use them as you are; we are just trying to make sure that they will be there later. So we are developing methods to look at the younger ones because those are the ones that will provide the food supply later.

Ruth Nukapigak – I was told by a researcher that that is how you find out how many fish there are by looking at the little fish. I want you to study the mature fish as well as the smaller fish.

Larry Moulton – We try to use methods that don't kill the fish. We are not trying to harvest the fish. We only want to catch them to learn more about their habits.

Bill Streever – Fyke nets can catch all different size ranges of fishes, both small and large.

Joeb Woods, Sr. – There are nets that have differing size mesh. I have seen them with 1, 1.5, 2, 2.5, and 3-inch mesh.

Eli Nukapigak – Are there any studies being done over winter in the Colville Delta pertaining to ice bridges and the migration of Arctic cisco?

Chuck Mitchell – Would you like to have studies that are conducted over the winter as well as other times?

Eli Nukapigak – Yes, focusing on ice crossings and ice bridges as well.

Dora Nukapigak – I want to elaborate on ice roads that are used to connect ice pads. There were two pads that blocked the route to Kuupik from Oliktok to Amoniktuk through July. Usually these pads are completely melted and we can hunt seals. Generally we can take our boats and go across our hunting grounds but with this big iceberg in our way, we had to work our way around. Usually we have complete boat access at the beginning of July. Also when the cost of gas was $4.00, we used to go by 4x4 in order to travel to Oliktok to buy cheaper gas. When construction was taking place, they would push the snow into the roads that we traveled making it more difficult to travel. Within the Nigliq Channel we had to follow 7 to 11 miles of ice when we went out seal hunting.

Isaac Nukapigak – Another study that should be done is looking at the watershed of the delta and the channels. Every year the channel is getting narrower and narrower and slush is coming in from the north. This slush creates a blockage. The delta then freezes easier due to the slush. The mud and silt is becoming a problem and the delta is getting shallower and shallower. I have observed this because I am a whaler.

Leonard Lampe, Sr. – What are the natural predators of the Arctic cisco? Have they increased or changed? That might be another factor that we haven't considered.

Isaac Nukapigak – Perhaps we need to look at dredging out the channels in order to keep them open.

Roger____ – The past three years the sewer is going out into the water. Instead of checking the whole river, get ten gallons of water and put a fish in it and see if it lives. Do one site at a time.

Chuck Mitchell – There are standard tests just like you are describing that are called bioassays.

Carl Brower – There are pollutants in the water that contaminate the fish and marine life. My entire family has been affected by these contaminants. I feel that tests should be conducted on the pollutants within the water as well as body tissue analysis.

Marjorie Ahnupkana – The flesh of the fish I catch in the net is paler than what I used to catch.

Leonard Lampe, Sr. – What about lakes? They are being depleted in order to build ice roads. What effects if any do these have on the fish or their spawning? Millions of gallons are being pumped from these lakes.

Larry Moulton – None, this does not affect the Arctic cisco.

Marjorie Ahnupkana – I saw the water within the delta dry up until there was just a sand bar left, this occurred early fall. This is evidence that something is going on within the delta. Up in the area of Ocean Point, there are small rivers that dry up. In turn, more water gets distributed to other rivers and the current gets stronger.

Isaac Nukapigak – This can create a nautical problem.

Sara Kunaknana – I remember when the delta was deeper, in 1940, and now it is shallower. When the water is shallower during the winter, the delta freezes and gets grounded therefore there are not so many fish around. This year there was a lot of west wind and more currents; therefore there was good fishing.

Isaac Nukapigak – Perhaps on the next OCS lease sale, part of the mitigation measures could be looking at a study and possible dredging of the channel.

Comment – When fall comes, we get north winds with natural slush. It turns solid and is grounded. Out in the ocean from Nelson Camp, it is very shallow. Also, where the Tammaayagiaq enters.

WORKSHOP PRESENTATIONS

MACKENZIE RIVER ARCTIC CISCO BIOLOGY AND POPULATION TRENDS

Randal Boogie Pokiak
Tuktoyaktuk NT, P.O. Box 335 Tuktoyaktuk NT X0E 1C0. Canada
(867) 997-2170, FAX (867) 997-2399

(Due to travel complications Mr. Randal Pokiak and his brother James Pokiak were unable to attend the meeting but did provide this presentation summary.)

Fishery and Oceans of Canada

The Department of Fishery and Oceans is the Federal Agency that plans, manages, and regulates all aspects of fish and marine mammals within Canadian waters (in and off-shore). Recently in Canada the DFO has focused their attention to the oceans in Canadian Jurisdiction. Water quality is one of the major concerns especially in the Canadian Beaufort and the Arctic Ocean, due to the oil/gas interest of some major oil companies and their rights to their leases offshore with their ideas of developing their oil/gas fields in the future. In the Inuvialuit Settlement Regions (ISR) there are several research activities that are identified by local harvesters where DFO has contributed funds to help answer some technical and biological questions for the benefit of all to produce a management plan for the harvesters and the oil/gas activity within the Canadian Beaufort Sea where applicable.

Arctic Cisco

The Arctic cisco has been one of the species targeted and researched within the ISR. DFO has done some research with the support of FJMC/IGC (Fishery and Joint Management Committee/Inuvialuit Game Council). Once the Inuvialuit has identified and supported a research program, funds are sought to develop and administer the research.

In the case of the research of the Arctic cisco, there have been some results and evaluations done by the technical and biological resources of DFO with the help of harvesters and the FJMC.

Key points:

-Arctic cisco are widely distributed in the southeast Beaufort Sea of the ISR. Harvested historically and today along the entire coastline of the ISR where harvesters are present or they target them in their seasonal runs in specific areas (Tuk harbor being one of the places).
-They are more tolerant of their salty environment that other fish that concentrate from time to time in waters that are fed by fresh water which flows into the Beaufort Sea (fishing with gill nets has been done to capture them at different times in locations that have been identified in different seasons during open water and under the ice).
-The youngest mature fish is 6 years old, but most mature at age 7 or 8.
-Spawning is located in the major tributaries in the Peel, the Arctic Red, Great Bear, and the Liard Rivers.
-In the spring the Arctic cisco eggs hatch and the larvae are swept downstream. Once the young reach the Beaufort Sea the prevailing winds supposedly determines which side of the

Mackenzie River system they will concentrate to come to maturity and go reproduce when they are ready upstream of the Mackenzie River.

-The Arctic cisco tend to over-winter in harbors and bays that has a certain amount of freshwater that flows into it and there is some discoloration in the water due to this out flow.

-Seasonally the Arctic cisco move around and migrate into different areas in large numbers which produces the runs making ideal for harvesting.

-In July the Arctic cisco that are not mature and not able to spawn tend to go feed out in the sea while the mature go upstream to spawn.

-In the fall the fish that spawned then come back to the Beaufort and distributes itself to their original habitat areas (Canadian and Alaskan waters) to feed and stage.

Traditional knowledge of the Arctic Cisco within the Tuktoyaktuk area

Throughout generations the Inuvialuit were distributed across the coastline and inland waters in large harvesting communities as well as camps with smaller family groups between the major harvesting communities of that time. Fishing for targeted fish species (Arctic cisco being one of them) while on site and also targeting specific seasonally migrating animals, mammals, and birds. Arctic cisco was harvested in large numbers due to the different ways of preparing it for traditional foods. Gill nets made out of sinew were used historically to catch the Arctic cisco in sheltered harbors and bays throughout the ISR. When the weather permitted the nets were set on the outside shores of the coastline where there was no protection from the elements and monitored closely to keep from losing the valuable nets. The cisco (*qaktuq*) were harvested in large numbers, when made into dry fish (*bipsi*) eaten at the time much like what goes on today with folks eating chips and the other junk food due to it being so handy and preserved in oil.

July was the season for making the dry fish when there was 24 hours of daylight, temperatures are hot and the first run on *qaktuq* were harvested. When drying the *qaktuq* smoke from driftwood (*nin-u-a-luit*) was used to keep the blue flies from laying their eggs on the dry fish, the smoke from the wood produced a flavor that made it more delicious. Three days later they were cut into bite size pieces and put into containers; then the container filled with oil to preserve it, then stored. The *qaktuq* when in season were cooked on open fire continuously throughout the harvest both in July and September for daily meals. They were scaled and hung in smoke houses, made into *ba-aut-si-aq* in large numbers and eaten like sushi that the Japanese eat. *Ba-aut-si-at* was made in large quantities and some stored for use during the rest of the year until the *qaktuq* run returned the next year. Before freeze-up in the fall harvest when the *qaktuq* returned to the harbors in large numbers, they were gill netted and stored in pits made just for the purpose of fermenting the fish and made into *di-paq-dut*. This was done when the weather cooled off and the blue fly season was over.

During the fall and winter the *di-paq-dut* was a delicacy and eaten frozen or raw with oil and/or muk-tuk. After freeze-up the *qaktuq* are gill netted under the ice until they leave the harbor or the ice gets thick and the extreme cold weather sets in for the winter. These fish that are harvested are frozen and eaten as fresh *qu-aq*. There was no need to transport the *qaktuq* from camp to camp because the numbers harvested were so great at each location. Each camp or harvest community stored enough for their own use as well as for visitors from the surrounding ISR that came at certain times for gatherings and festivals. We have to understand that at the time of this part of our history there were no stores as we know them today, the only food available was from what was harvested, *qaktuq* being one of the fish species targeted. Being on site in various parts of the ISR made sure that the harvest of *qaktuq* was done to the greatest extent.

Harvesting of *qaktuq* today and the distribution

Today, 2003 that value of the *qaktuq* for food hasn't changed and it is still required by the Inuvialuit prepared the traditional style. During the July run and while hunting the beluga whale in the harvest locations the *qaktuq* are still targeted and prepared for the family and their immediate family and friends. The families that have or take the time are just a fraction of the harvesters that do this activity from the historical numbers. Historically our Inuvialuit population in the ISR was anywhere from six to eight thousand. We now have those numbers back in the population but as mentioned the families that harvest *qaktuq* are very few. Most families harvest and store enough *qaktuq* product for themselves their immediate families and some friends and then turn to other activity that now occupies their time. Most are too busy working for wages or don't have the equipment so they make a deal with active harvesters to prepare the food for them. To make it short the harvest from historic levels has dropped down considerably but the demand for the traditional food is still there by the majority of the Inuvialuit population. Those of us that make a living by our harvest and country food preparation can't keep up with the demand especially with the changes that are taking place with the runs and cycle of fish distribution we are experiencing today.

The utilization of the ISR for the *qaktuq* harvest has been reduced due to the community setup of our time. Only areas close to the communities are at the moment utilized. The community of Tuktoyaktuk is still at one of the historic locations of the major hunting community and we still harvest and prepare *qaktuq* in fairly large numbers. Population is 90% Inuvialuit. Because of the *qaktuq* being within the Tuk harbor and other smaller sheltered harbors being close by the demand for *qaktuq* and the fish being prepared for food the traditional style there is a great demand for our harvest. *De-paq-duk*, *pip-si*, and *ba-au-chi-aq* are in great demand. All the surrounding Inuvialuit communities expect those active harvesters from Tuk to have the *qaktuq* products available for sale or trade. The amount of *qaktuq* harvested by the residents of Tuk doesn't come close to the harvest levels that were historically harvested even with the harvesting of *qaktuq* with a sweep net for the dog teams of local members. When sweeping for the *qaktuq* we can select the fish for quality and size that we put aside for human consumption.

Impact of the local fisheries due to the Oil/Gas activity (1960s - 2003)

The industrial activity has affected the harvest in the Tuk harbor especially when there was dredging permitted by the GNWT/Federal Government. Dredging was done to make the channel to the Beaufort deeper for supply vessels to get to the oil exploration facilities offshore. Coupled with the dredging for landfill for community use when the GNWT had control over the lands and industrial activity. There was a huge amount of dredging in the shallower waters of the Mackenzie basin offshore of the Mackenzie River in the 1970s and part of the 1980s. Locally we don't know the impact the dredging had on the sea and the resources at that time since we didn't have our IFA and Inuvialuit had no authority over any the way the industrial activity was conducted within the region and offshore. The impact from the dredging in Tuk harbor was the only development that we could get an idea from of how much impact the disturbance of dredging the seabed could have on the *qaktuq* distribution. Since the dredging of Tuk harbor the fishing and harvesting hasn't been close to the levels we were accustomed to harvesting. All the dredged areas within the harbor produce less of a harvest and the fish concentration that comes into the dredged area don't seem to stay too long once the run has started.

The size of the fish caught has reduced in size, too, the large fish only seem to come into the harbor for a few days then they are gone. The gill net fishing where the seabed was undisturbed close to the mouth of the channels in Tuk harbor still harvest at a decent level and there is high

concentration of nets in the *qaktuq* run in those areas. To harvest without too much competition a harvester has to leave Tuk to locations in other harbors farther along the shoreline and usually there are a large number of other species of fish that are harvested as well. There are more and more Inuvialuit on the wage economy and that demands a service from the active harvesters. Those working for the industry, local contractors and the municipal governments as well as others without their own equipment all place a demand for the harvested *qaktuq* resource.

The region also demands or expects the active harvesters from Tuk to meet their nutritional needs. Almost for any country food besides the *qaktuq* demand, the community of Tuk is expected to meet all the nutritional needs of the region to a certain extent. The only problem for the time being is that the residents from Tuk are still trying to adjust to the change in the fishing at Tuk harbor. Just like anything else one hopes that the next season or year will produce a better harvest in the Tuk harbor but if there is any improvement we can't clearly and honestly see results since the time of the last dredging activity. When the supply vessels used to be active in using the channel before the dredging, the fishing nets adjacent to the channel used to catch large numbers when they were chased out of the channel, so the noise level and the large volume of water displacement played a big part of the distribution at certain times in a confined place.

Technical and local Traditional Knowledge working together on studies

Since the IGC/JS (Joint Secretariat) was recognized through the IFA there has been great improvement in the way industry and the governments at all levels are looking to achieve the best results from research activity within the ISR especially in specific and identified areas of interest to the Industry and the regulating agencies. Harvesters are utilized as much as possible by all those involved to help the research and try to extend the dollar value by managing the project more effectively. DFO has worked with the FJMC and now know the local harvesters that could be used with a certain amount of training to do as much fieldwork as possible on the fish as well as other wildlife species. DFO now has in-place Inuvialuit and/or their families that are on site of the research areas working together with technical personnel. The Arctic cisco is one of the research projects that has been successful. DFO finds the funds to finance the research and harvesters being employed sizing, weighing, documenting and taking samples required by the technical resource to evaluate the results that can be read and traced. Technical and Traditional Knowledge (TK) are working together and recognized for their respective expertise. The cisco research tagged a large number of cisco from the Tuk area to try and determine the movements and the distribution of the Arctic cisco. Due to lack of funding and the vastness of the ISR the cisco research was confined to the Tuk harbor and vicinity. The evaluation of the technical personnel and the locals with the TK still has to go farther in working together and answer more questions and TK gaps that were not considered while the research project was conducted.

ALASKA BEAUFORT ARCTIC CISCO BIOLOGY AND POPULATION TRENDS

Bob Fechhelm
LGL, 1410 Cavitt St., Bryan, TX 77801
(979) 775-2000, FAX (979) 775-2002, E-mail: bfechhelm@excite.com

For nearly 22 consecutive summers, fishery-monitoring studies have been conducted in coastal waters near Prudhoe Bay, Alaska. The fish start showing up around August 15. The principal sampling gear is the fyke net which is a live-capture device that fishes 24 hours a day. The fyke net is set along the shore. Fish swimming along the shore are diverted seaward where they enter a series of traps. Once a day, a boat crew empties the net into floating holding pens. Fish are then identified, counted, and for important species like qaaktaq, measured. All fish are then released.

Over the years, fishermen began noting that in some summers nets would suddenly be filled with very small Arctic cisco measuring from 65-80 millimeters (mm; 2.5-3.0 inches) in length. Aging studies showed these fish to be young-of-the-year (age-0), or fish hatched that very summer. In other summers, nets would be fished throughout the summer on into September and yet no age-0 fish would be caught. By the late 1980s, researchers realized that age-0 were caught in summers characterized by strong east winds whereas no fish were caught in summers characterized by weak east winds or net west winds. These data were consistent with the hypothesis of Gallaway et al. (1983), which proposed that Arctic cisco found in Alaskan waters actually originate from spawning grounds in the Mackenzie River system. They theorized that in spring, newly hatched young-of-the-year (age-0) fish are flushed down the Mackenzie River to ice-free coastal waters adjacent to the Delta. In summers characterized by strong and persistent east winds, large numbers of these fish are transported westward by wind-driven coastal currents. Once in Alaska, they take up overwintering residence the Colville River. Arctic cisco remain in the Colville River until the onset of sexual maturity beginning at about age 7, at which time they are believed to migrate back to the Mackenzie River to spawn. Fish aged 5-8 support the Colville River subsistence fishery.

As studies proceeded into the 1990s, the wind-recruitment relationship became more obvious. In summer when the average wind speed was from the east a greater than 3 mph large numbers of age-0 fish were caught in the fyke nets. In summers when average easterly wind were less than 3 mph, or from the west, catches were low. This pattern has persisted for 22 years. This same pattern is evident in the Helmericks fishery, which has maintained catch records since the late 1970s. Fish hatched in years of poor east winds never contribute strongly to the fishery. However, some year classes hatched in years of strong east winds contribute to large harvests while others do not. Note in Figures 2 and 2 that the 1985-year class was strongly recruited into Alaska yet did not contribute strongly to the fishery. Strong recruitment as age 0 fish but poor representation in the fishery may indicate high mortality during the years following their arrival. Fish must survive the 5-6 years it takes for then to grow to harvestable size.

The Prudhoe Bay fyke net studies represent about a 5-6 year leading indicator of qaaktaq population status in the Colville River. As stated above, the Colville River fisheries rely largely on fish age 5 to 8. Based upon catch data at Prudhoe Bay, the 1993 fishery was expected to be good because three of the four year classes susceptible to the fishery were strongly recruited into Alaska. The 1993 fishery was indeed one of the strongest in the historic record. Conversely, the 2001 fishery was expected to be poor because three of the four year classes susceptible to the fishery were poorly recruited into Alaska. The 2001 harvest was poor. The 2003 fishery was

expected to be good because three of the four year classes susceptible to the fishery were strongly recruited into Alaska. The 2003 fishery has picked up considerable compared to the past few years.

Another goal of the Prudhoe Bay fyke net studies is to monitor the health and status of year classes that are strongly recruited into Alaska. Figure 1 illustrates catch rates of different year classes of qaaktaq. The method of calculation is based upon the aging of fish apportioned into overall catch data, the analytical details of which are far beyond the scope of this presentation. However, one can get a feel for the strength of different year classes overwintering in the Colville River over time. The 1986, 1987, and 1990 year classes remained relatively strong into the 5-8 year age range. All three of these year classes contributed strongly to the fishery. The 1982 and 1984 year classes were poorly recruited into Alaska and never contributed to the qaaktaq harvest. Through the summer of 2002, the 1997-year class remains one the most abundant ever recorded in the 22-year history of the fyke net surveys. We expected this year class to enter the fishery in 2002, but it did not. It is suspected that slow growth may have delayed their entry by a year. This year class is likely responsible for the stronger fishery in 2003. Strong back-to-back 1997 and 1998-year classes should provide good fishing for several more years.

There has been no recruitment of qaaktaq into the Prudhoe Bay area in 2001, 2002, and 2003 because of poor wind conditions. The absence of these year classes is expected to result in a very poor fishery beginning in 2006 and lasting for several years.

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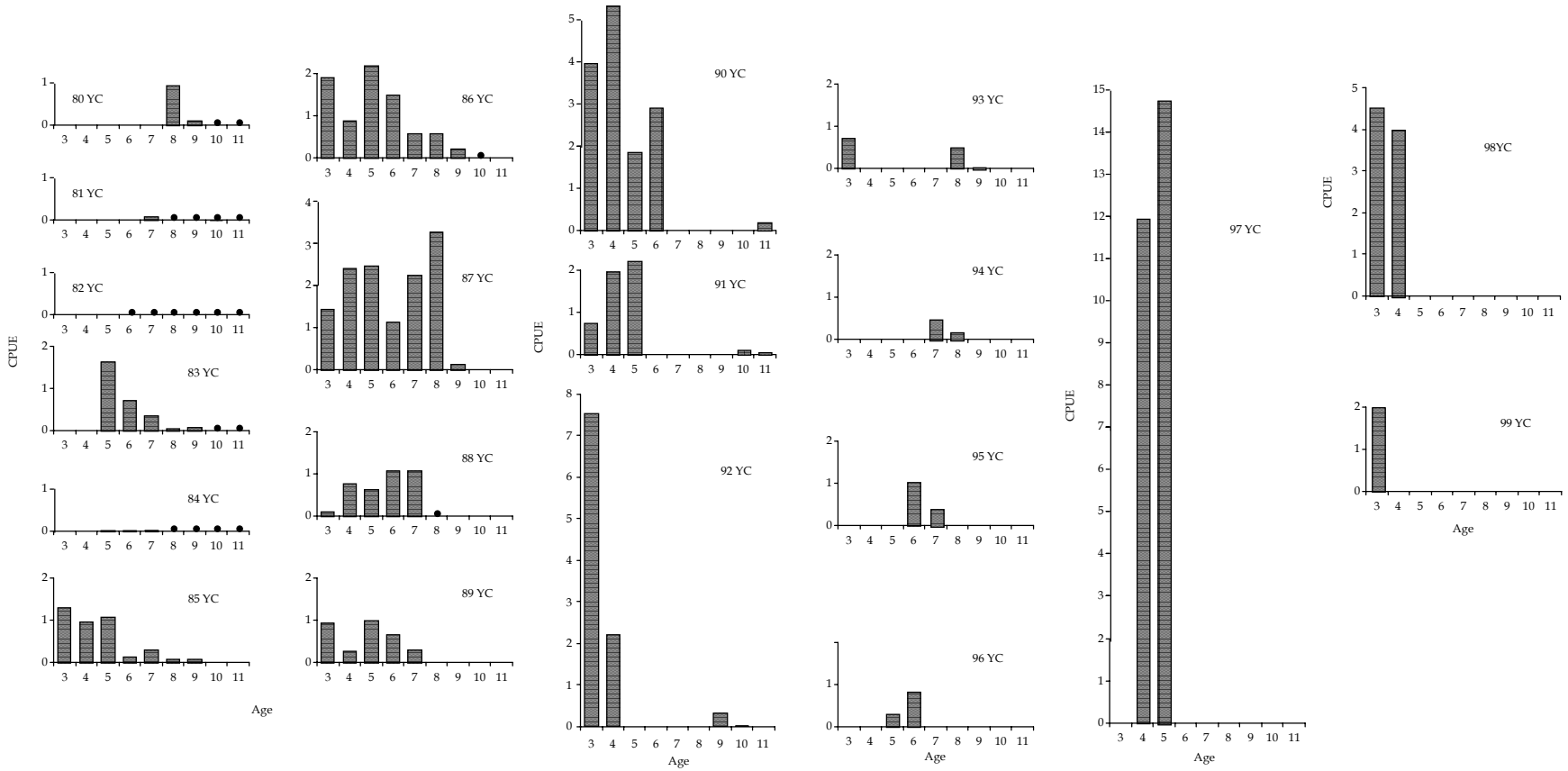

Figure 1. Catch-per-unit-effort (CPUE = fish/net/24 hr) for individual year classes (YC) of Arctic cisco by age based upon 1988-1996 and 2001-2002 aging analysis. No histogram means no estimate could be made. Estimates where CPUE is very low to zero are denoted by the symbol (●). For example, the first panel illustrates how the 1980 year class was represented in the years 1988-1991; in 1988, the 1980 year-class was age 8 and the catch was approximately 1 fish/net/24 hr. Years denoted by boxes indicate no data available because no aging studies were conducted from 1997-2000. Source: Fechhelm.

COLVILLE RIVER ARCTIC CISCO POPULATION TRENDS

Lawrence L. Moulton
MJM Research, 1012 Shoreland Drive, Lopez Island, WA 98261
(360) 468-4821 E-mail: lmoulton@rockisland.com

Arctic cisco catch rates from the commercial fishery in the Colville Delta show substantial fluctuation between 1967 and the present (Figure 1). Monitoring of the Nuiqsut catch rates began in 1985. Since that time, catch rates for both the village and commercial fishery have fluctuated in a similar manner, indicating that the catch rates are reflecting changes in regional abundance of Arctic cisco (Figure 2).

Regional abundance of Arctic cisco in the Alaskan Beaufort Sea is a function of sporadic large recruitments of young-of-the-year that originate in the Mackenzie River. When winds are favorable, young-of-the-year Arctic cisco are transported into the Alaskan Beaufort Sea, where they establish in the Colville River and remain until they reach maturity in 7 or 8 years. When they reach harvestable size, typically at 5 to 7 years, they support targeted fisheries until they mature and leave the region.

The cyclic nature of the recruitment process allows some prediction of the harvest rates in the village and commercial fisheries that target Arctic cisco. High recruitments result in high fishery catch rates after a 5 to 6 year lag, while low recruitments result in low catch rates. Since Arctic cisco are important food items in the region, the years of low abundance cause considerable concern among the user groups.

Abundance indices developed from catches of juvenile Arctic cisco by fyke nets in Prudhoe Bay allow pre-season predictions of catch rates so that residents will have some idea of what to expect from the upcoming season. Harvest predictions based on fyke net indices of summer abundance are still subject to considerable error because changes in brackish water in the delta during the fishing season will change the distribution of Arctic cisco in relation to the main fishing areas. Arctic cisco seem to orient to salinities in the range of 15-25 parts per thousand (ppt), which are commonly found in the lower portion of the delta during the fishery, from mid-October to late November. In some years, however, the water will remain fresh, and Arctic cisco do not enter the areas being fished, even though substantial numbers may be present. The highest catch rates have been recorded when high abundance coincides with a favorable salinity distribution during the fishing season.

Discussion

Question – How far up the river does the salt water go?

Larry Moulton – Some years the salinity goes up past the Itkillik River mouth.

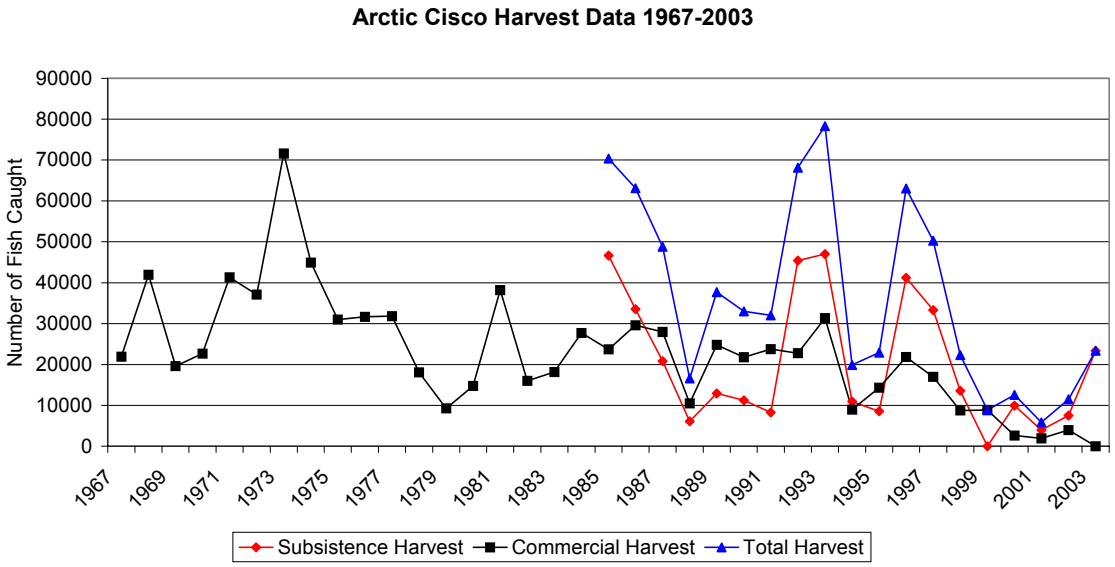

Figure 1. Arctic Cisco Harvest Data, 1967 to 2003. Source: Larry Moulton.

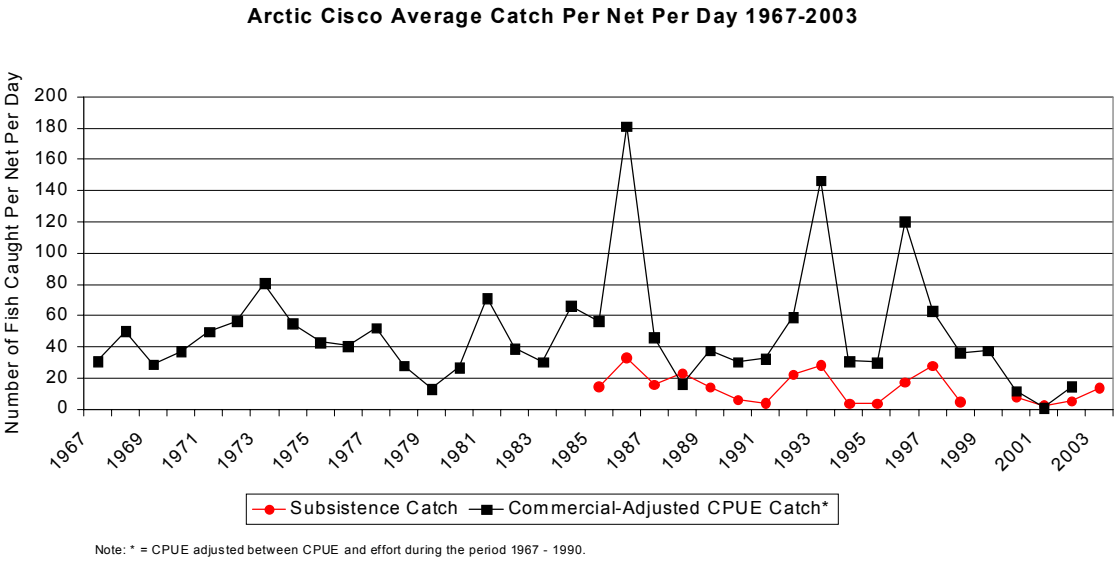

Figure 2. Arctic Cisco Catch Per Net Per Day, 1967 to 2003. Source: Larry Moulton.

CANADIAN BEAUFORT NEARSHORE OCEANOGRAPHY AND MACKENZIE RIVER WINTER HYDROLOGY

David Fissel
ASL Environmental Sciences Inc., 1986 Mills Road, Sidney BC Canada
(250) 656-0177 x112, FAX (250) 656-2162, E-mail: dfissel@aslenv.com

Physical processes in the Canadian Beaufort Sea and the Mackenzie River are discussed and presented in terms of their possible influence on the population of Arctic Cisco within the Alaskan North Slope Rivers and adjoining coastal areas.

The Mackenzie River is one of the great rivers of the world (ranked number 10 by drainage area and number 15 by total annual discharge. Unlike most Arctic rivers, the Mackenzie River discharges water continuously throughout the winter (5,000 cubic feet per second [cfs]) and spring months, since its drainage basin extends as far south as latitude 53° N in western Alberta. During the freshet period, water discharges increase considerably, and water levels rise by an average of 5.5 m. The freshet results in flooding of the Mackenzie Delta, beginning in late April to early May at Red River due to snowmelt in southern reaches of Mackenzie drainage area. As river discharge increases, water overflows onto ice covered channels due to ice jams, onto lakes and ice in lower delta and ocean bays. The Mackenzie Delta has about 25,000 lakes in addition to the complex pattern of river channels. Two-thirds of the lakes are flooded every year during spring freshet and most of the rest are flooded every 2 to 5 years. Discharge peaks and flooding can also occur in the summer due to major rainstorms upstream of the Delta, as well as high water levels in the lower Delta due to high sea levels.

Mackenzie River discharges into the ocean occur onto a shallow continental shelf extending 60 to 80 km offshore. In spring, the shelf is nearly entirely covered by floating ice, with extensive ridging of sea ice occurring along the shelf break and anchored “landfast” ice covering the inner reaches of the coastal shelf. During the spring freshet, the fresh river water floods the landfast ice and extends offshore to the ridged ice at the shelf break as well as over 100 km to the northwest along the coastline, to the area of Herschel Island. The heated Mackenzie River water significantly advances the dates of break-up and clearing of the coastal ice cover by up to 2 weeks by comparison with adjoining areas to the west. Break-up and dispersal of the sea ice cover usually occurs between mid-June and mid-July over the Mackenzie shelf region.

Water properties over the continental shelf are highly variable in both spatial pattern and with time. The freshwater discharged from the Mackenzie River, as well as lesser contributions from other smaller coastal rivers, result in brackish and comparatively warm bands of water, initially located along the coastline. Much colder and more saline Arctic Water is also present over much of the shelf area. The spatial distribution of these highly distinct water types is determined by the combined and time-varying influences of: river discharges; wind patterns; and the proximity of the landward edge of the Arctic Ocean ice pack to the coastline. Ocean currents over the shelf are pre-dominantly wind driven.

The regional winds are bi-modal in nature, and dominated by: easterly winds (generally of light to moderate speed); as well as westerly-northwesterly winds, having moderate to strong speeds but usually of shorter duration. Easterly winds move the brackish and warmer riverine influenced waters to the west, although under strong easterly winds, this water mass is displaced offshore and can be replaced by colder water up welled from below in inshore areas. Westerly or

northwesterly winds concentrate the warmer and brackish water along the coastline with a pronounced easterly movement.

Sea ice distributions over the continental shelf are highly variable from one summer to another, and within the summer season. In some years, major incursions of pack ice onto the shelf result in much colder surface water temperatures and reduced wind driven circulation. The coastline itself also has a significant effect on coastal currents and water properties. Herschel Island, and the nearby Mackenzie Canyon, has a pronounced effect on the circulation patterns. The extensive network of lagoons and barrier islands along the coastline, to the west of Herschel Island, also results in significant alterations to coastal water properties and transport.

Discussion

David Fissel – The Mackenzie River discharges 5,000 cfs throughout the winter and spring. The spring flooding starts at the Red River in late April or early May. The spring flooding is consistent within a week but there is considerable variation in the volume of flow from year to year. The ridge at the landfast ice contains the fresh waters when the Mackenzie River floods.

The east winds favor Arctic cisco moving into the Colville River. The westerly or northwesterly winds also increase the sea level.

What is the effect on fish? July 1 to August 15 is about 46 days for fish to move from the Mackenzie to Prudhoe Bay. In a good year the east wind is about six miles per hour and could transport fish about 200 miles. In a bad year the east wind can average 0.6 miles per hour, resulting in only 20 miles of transport. If the fish were swimming, they could swim about 200 miles. In a good year they could swim 200 miles and be moved 200 miles by wind or 400 miles total to the east. In a bad year they could swim 200 miles and be transported another 20 miles by wind or 220 miles total.

Potential disruptions to westward movement include blockage, such as in 1973 and 1975 when no fish moved past the ice, resulting in poor fishing in the late 1970s and early 1980s. Other disruptions could be reduced wind fetch, or unfavorable water qualities. With industrial development, causeways might have a disrupting effect.

James Patkotak – What is the water depth within the Mackenzie Delta?

David Fissel – Approximately 30 miles offshore the depth is 20 m; whereas, the water within the first 5 miles offshore is very shallow.

James Patkotak – What about silt accumulation?

David Fissel – Siltation is a natural process within the delta. We dredge our important navigational channels regularly.

Leonard Lampe, Sr. – It is illegal to dredge here in Alaska.

Isaac Nukapigak – It is up to the Army Corps of Engineers.

Leonard Lampe, Sr. – Is there evidence or proof that causeways or bridges disturb the migration of the cisco?

David Fissel – In Canada we use floating devices instead of causeways so I am unable to comment on that question.

Bob Fechhelm – I feel that causeways don't result in blockage. We haven't noticed this as being an effect among the young-of-the-year Arctic cisco. They just follow the current that goes around the causeway like they would along the coastal land points. Swimming fish could be affected.

Leonard Lampe, Sr. – So you are saying that if there are 10 fish in the area, all 10 fish will go around the obstruction and all 10 fish will be present on the other side?

Bob Fechhelm – The first year of a fish's life is that of a planktonic stage and therefore I believe that all 10 fish would make it to the other side.

Bill Steever – I believe that there is no difference between either side of the causeways. What types of dams or bridges are found within the Mackenzie Delta?

David Fissel – There are no dams or bridges within the area of the delta. Once there was a proposed dam but got turned down because of the disruption of migration patterns. I don't know very well where they spawn. Fish have been seen as far north as the Liard River but I don't know the numbers.

Bob Fechhelm – They spawn in the Peel and Red rivers, fairly close to the delta.

BEAUFORT OCEANOGRAPHY AND COLVILLE RIVER HYDROLOGY

Kate Wedemeyer
Agency Coordinator for Arctic Fish Studies, US Minerals Management Service
949 E 36th Avenue, #308, Anchorage, AK 99508-4363
(907) 271-6424, FAX (907) 271-6507, E-mail: kate.wedemeyer@mms.gov

Because our Alaskan oceanographer had a family medical emergency, I was "volunteered" to make this presentation. I know that there are many in this room who know more than I about the Beaufort Sea and the Colville River, so please correct any misstatements I may make.

Because the Pacific water level is higher than the Atlantic, surface water generally flows from the Pacific Ocean, through the Arctic Ocean to the Atlantic Ocean at least on the surface. The Beaufort Gyre, called the flywheel of the Arctic Ocean, is like a giant eddy in the Arctic Ocean. Other currents include the warm, less salty, nutrient rich Alaska coastal current, the weak tidal current (range of 2-4 inches) and the warm fresh water currents moving out of the two biggest rivers, the Mackenzie and Colville, toward the west.

We believe that, along with the winds, these spring river freshets play a major role in carrying the arctic cisco larvae from the Mackenzie west to the Colville or east to Tuktoyaktuk harbor. The freshwater (<5 psu) river plumes flow out under or over the shorefast ice in surface sheets about four feet (1.5 meters) thick and can carry sediments at least 20 km offshore under the ice.

It is the wind, predominantly from the northeast and the southwest, which drives the dynamics of the Beaufort Sea nearshore waters (<130 feet or 40 meters deep) more than the currents, freshwater discharge, ice melting, depth, or the shape of the coast.

Wind speeds average 11 miles per hour (mph) (5 meters per second [mps]) or about 50 times faster than the current speeds of 0.05 to 2 mph (2.5-10 cm/sec). Wind speed > 18 mph (8 mps) can fully mix the freshwater sheets into the water column. The water is pushed about 3-5% of the speed of the wind and is affected within 1-3 hours of a wind change. Northeasterly winds that move the water to the west toward the Colville are typically more persistent in June and July. As the open-water season progresses, southwesterly winds that move water to the east toward Tuk harbor are more frequent. They also move water to or from shore, gradually warm brackish water to or from shore, keeping it concentrated or spreading it out.

We know the wind direction and speed are very changeable and we know the winds, river plumes and coastal currents all have complex density and circulation fields, such as fronts meanders and eddies that can accumulate or rapidly disperse across and along the shelf. For instance, local residents have testified at MMS meetings about the very high strong winds nowadays at Cross Island and Sara Kunakana indicated that a warm breeze and warming temperatures in the summer are indicators of an impending major storm. However, though these are levels of complexity that are quite likely to affect Arctic cisco, recording stations are too far apart and we are unable model their dynamics.

The major Alaskan Arctic cisco overwintering is in the Colville River, midway between Barrow and Kaktovik. The Colville drains 29% of the North Slope of Alaska. The Colville and the Mackenzie, another important Arctic cisco river, are two of the 8 major rivers with significant freshwater input to the Arctic Ocean and the two largest rivers in arctic North America.

Peak flow is typically between mid-May and mid-June and main channel is free of ice within a few days before or after this peak. The river's volume and heavy sediment load produces a dynamic deltaic system characterized by numerous shallow lakes and pond, sandbars, mud flats, sand dunes and low polygons. The two main delta channels, the *Kuupigruaq* (the "big big river" or east channel) and Nechelik carry 60-80% and 20-40%, respectively, of the total discharge flows. The waters of the Colville have been estimated to churn up the sediments about 5 feet deep, and up to as much as 9 feet deep. While measures of the winter flow have yielded velocity readings of zero, since current meters do not detect flows of 0.1 feet per second (fps), the flow could be as much as 10,000 cubic feet per second (cfs).

In places, the east Colville channel is wide enough that wind driven waves can be whipped up and erosion can average just over a foot per year compared to coastal erosion averages of 5-3 feet per year. Individual storms, however, may cause erosion up to 30 feet on the coast or within the river delta. Erosion seems to be least in straight sections of the channels and greatest along the eastern banks of the East Channel because southwesterly winds are most common during summer storms.

The seasonal cycle begins as rivers flood over the nearshore sea ice in late May. The river floodwaters drain from the surface of the sea ice in early June. The floating and grounded land fast ice breakup, water opens along the coast and water warms in the Colville River in early to mid-July. Winds are often mixing the nearshore less salty water with the more salty water by August. The shore ice forms, the river deltas freeze, frazil, brash and grease ice form in bays and near the coast in September. Smoothed, first year ice forms within bays and near the coast in mid-October and the sea ice covers more than 97% of the Beaufort Sea shelf November through May.

ARCTIC OCEAN CLIMATE CYCLES

Kate Wedemeyer
Agency Coordinator for Arctic Fish Studies, US Minerals Management Service
949 E 36th Avenue, #308, Anchorage, AK 99508-4363
(907) 271-6424, FAX (907) 271-6507, E-mail: kate.wedemeyer@mms.gov

Several MMS studies have looked at Arctic climate cycles in the Beaufort and Chukchi Seas from 1940 to 2000. Figure 1 is a graph of cyclonic and anticyclonic climate cycles is based on sea level pressure which is used to estimate wind speeds–which I just said have more influence on the waters than the currents or salinity or temperature differences.

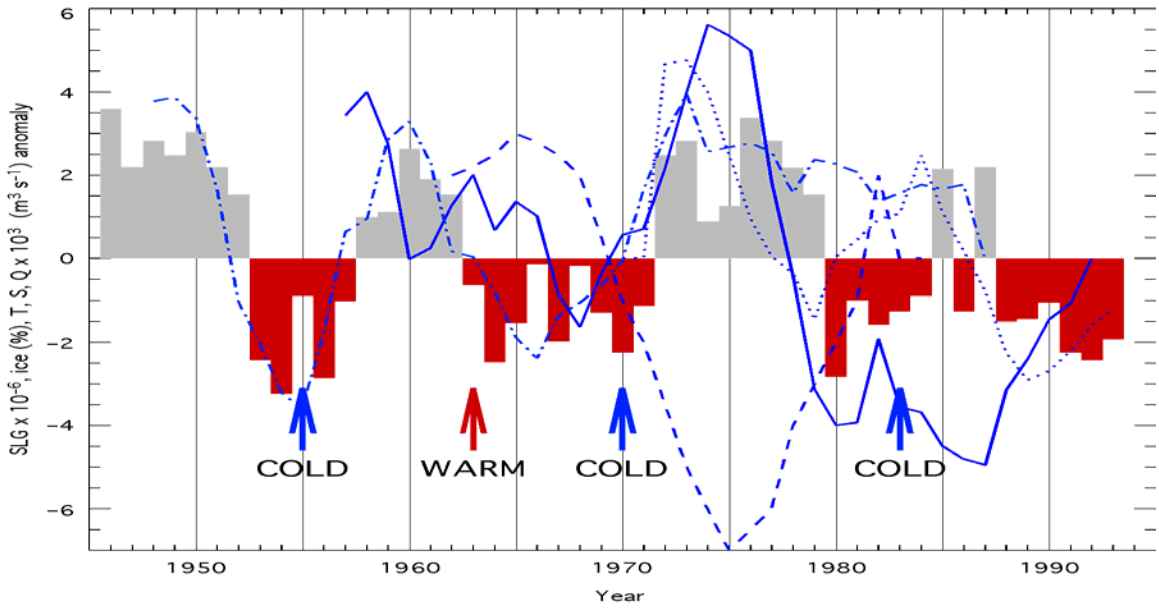

Figure 1. Cyclonic and anticyclonic climate cycles in the Beaufort Sea. Source: Proshutinsky, et al., MMS 2003-024.

Anticyclonic or clockwise "winter" cycles circulate with the Beaufort gyre circulation and are represented by positive light shaded bars on the chart where zero equals the average of all years. The warmer, windier Cyclonic "summer" cycles circulate opposite the Beaufort gyre. (The blue dash-dot line represents high or low annual river runoff into the Arctic Ocean). The grey anticyclonic cycle, or "winter" years, include: 1946-52, 58-62, 72-79, 84-88, and 98-2001. The red cyclonic or "summer" years are: 1953-57, 63-71, 80-83, 89-97, and 2002.

Most of the 1990s (89-97) and the year 2000 were in cyclonic "warmer" cycle years, so it may be useful to look at how cyclonic conditions, in particular, differ from the overall average conditions in the Beaufort.

The most significant aspect of these cycles for Arctic cisco is that the biggest difference in the wind circulation is primarily in summer when Arctic cisco larvae are being blown to and fro. In

the cyclonic years (the1990s and 2000), the summer winds blew counter clockwise, west to east. Furthermore, cyclonic wind speeds averaged (0.9 miles per hour [mph]) (0.4 meters per second [mps]), about 10% faster, than anticyclonic cycle winds. In August they averaged 2.4 mps (1.1 mps) faster! Buoy drift speeds in the Beaufort averaged 1 centimeter per second (cm/sec) faster overall with increasing differences from July (0.25cm/sec;.005 meters per hour; 0.1 miles per day) through October (4cm/sec; ~0.1 mph).

Arctic cisco seem to prefer warm, semi-fresh or brackish water. Average summer salinities are slightly lower. Average water temperatures are slightly higher in early summer but slightly lower in late summer during cyclonic cycles.

Cyclonic cycles may also have some positive significance for Arctic cisco as increased spring runoff may reduce the coastal salinity. Precipitation in cyclonic "summer" years increases over the Arctic Ocean (actually >70° latitude which is Nuiqsut and north) for all seasons and decreases over land only in summer. While we have only a few estimates of Colville River discharges, they are probably more similar to the Mackenzie River than to other smaller rivers on the Beaufort coast. The high and low periods of Mackenzie River discharge relates well to the cyclonic and anticyclonic cycles over the past 30 years. Therefore there may be more favorable conditions in the coastal nearshore summer foraging habitat from the Mackenzie to the Colville.

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Discussion

Kate Wedemeyer – Some major unanswered questions about the nearshore and the Colville River include: How do the smaller scale complexities of the winds and ocean currents affect Arctic cisco? Do Colville River flows completely cease in all or some years? Are sediment berms in the Colville delta Arctic cisco migration barriers? Are there temperature or salinity barriers to young or adult fish migrating into the Colville? Could an ice bridge across a delta affect salinity in a river channel and exaggerate physical or chemical barriers?

Sara Kunaknana – In April, springtime, the Arctic cisco move into higher salinity water.

Ruth Nukapigak – The fall season brings in saline water in conjunction with the west wind. Currents also get strong this time of year.

Kate Wedemeyer – Cyclonic warmer, summer winds blow from west to east. This was observed in 1953-1957, 1964-1971, 1980-1983, 1989-1997, and 2002. Did those years seem like warmer winds from the west occurred?

Ruth Nukapigak – I noticed more saline waters along the coast. The west winds are warmer and I noticed the tide rose within the river.

Kate Wedemeyer – If the cyclonic cycles were responsible, Arctic cisco age classes 6 and older would have had low numbers in 1959-1963, 1970-1977, 1986-1989, 1995-2003, and would be projected to be low in 2008. Did anybody notice this trend?

Johnny Ahtuangaruak – Before development began the abundance of fish was higher and the fish were fatter. Since the development started there has been a low recruitment of fish and they have become skinnier over the years.

Isaac Nukapigak – From 1997-2002 I noticed a decline in cisco.

Eli Nukapigak – There was lots of activity in the Beaufort Sea that even affected the bowhead whale migration.

Johnny Ahtuangaruak – With the development of the seawater treatment plant, I could tell that a decline occurred. Also the fish have changed in size.

Dora Nukapigak – I have noticed that when seismic activity is occurring during the hunting season, the whales were found about 30 miles off Cross Island. The first year after the activity stopped, the whales were found one mile off the island.

Joeb Woods, Sr. – Pumping of the seawater at the plants I feel tends to suck fish into the plant.

Bill Steever – There was a study done in Prudhoe Bay and though the plants sucked some larval fish in, it was found not to be a significant amount.

Larry Moulton – Another study was done focusing on large fish species. It was found that the seawater plant does not suck in any large fish, only small ones.

Isaac Nukapigak – The sucking of the plant has an effect on the current of the water and this should be further looked at.

Larry Moulton – Studies have been conducted at the low flow-through pump located at the screen.

Leonard Lampe, Sr. – Only one Arctic cisco was ever found in the screen in the last 20 years.

Joeb Woods, Sr. – The outer screen prevents fish from going into the plant and only one fish was found within.

Leonard Lampe, Sr. – To clarify, only one fish was found within the inner screen.

Joeb Woods, Sr. – Is there data for the outer screen studies?

Larry Moulton – Prudhoe Bay studies indicate very few fish come into the forebay. This was determined utilizing video analysis.

Leonard Lampe, Sr. – The pipelines that lay on the ocean floor are heated so that the oil can flow through them. Fish are sensitive to temperature. Does this temperature change around the piping have an effect on the migration of the fishes?

Chuck Mitchell – There are entrainment and fish impingement studies that determine the abundance of fish that enter into the plants; these are EPA studies. In February 2004, new regulations will be set forth for "process waters."

POSSIBLE GLOBAL WARMING AND ARCTIC OSCILLATION IMPACTS ON SMALL FISH STOCKS

Two Crow (AKA J.D. Schumacher)
Two Crow Environmental, Inc, 288 Ivan Rd. Friday Harbor, WA 98250
(360) 370-5591, FAX (360) 370-5591,E-mail: twocrow@rockisland.com

Since the 1960s and increasing in the 1990s many dramatic changes have occurred throughout the Arctic (e.g., Carmack and Macdonald 2002, SEARCH SSC 2001). Most notable is warming of air temperatures, together with marked changes in atmospheric pressure patterns, circulation, cloudiness, and likely in precipitation and evaporation. In response to these changes in atmospheric phenomena, sea ice has decreased in extent and thickness while ocean currents and ice drift changed. North America has experienced a decrease in snow cover, changes in permafrost temperatures, an increase in runoff (increased rain) of some major rivers, and changes in the time of river ice breakup and the onset of the summer peak in river flow. What portion of the warming is due to global warming (an increasing trend due to greater concentrations of human generated green house gases, e.g., Levitus et al. 2001), and how much can be attributed to natural cycles (e.g., seasonal, interannual, decadal like the Arctic Oscillation, and longer) is moot. Regardless of cause, warming is occurring: the climate of the Arctic is changing.

How might this climate change impact small stocks of fish, e.g., Arctic cisco in the Colville River system? As the atmosphere, oceans and rivers change, all life in them is affected. Populations of fish change as elements of the ecosystem that affect their survival change. Food may become more/less available (changes in production and/or competition), predation may change (changes in predator populations, and/or new species), parasites and diseases may become more/less prevalent, and/or physiological stress due to temperature and salinity may change.

One strategy is to construct reasonable scenarios of ecosystem change based on physical/biological fluctuations that are most likely to occur as climate changes (e.g., Carmack and Macdonald 2002), and that will impact fish. For example, between 1970-1991 summertime winds were often alongshore, providing the hypothesized transport mechanism for moving age-0 ciscoes from the Mackenzie River to the Colville (Colonell and Gallaway 1997). If under climate change these winds diminish or reverse, then recruitment to the Colville by this pathway will cease. A requirement for this approach to be successful in forecasting impacts is a working knowledge of the fish and their accompanying physics. Even before successfully forecasting fish population changes, this process allows us to determine where our knowledge of biology and/or physics is insufficient or lacking. This, in turn, allows us to prioritize information needs that dictate what research should next be undertaken.

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Discussion

Isaac Nukapigak – I noticed an earlier thaw, earlier break up, and a later freeze up. We are already observing some of the conditions that you were just describing. Natural runoff from the foothills could be found around the "pipes" heat.

Two Crow – Yes, and with the increased runoff, you will get more problems with silt build-up as was talked about earlier. Winds, especially in summer, will get stronger; landfast ice will not go out as far as 60 feet deep.

Ruth Nukapigak – I noticed strong currents last July when we were traveling along the ice. When multiple currents hit together, it is turbulent and causes icebergs to break-up. Ice broke off and we were traveling with the ice pack. This was the first time I have seen a current so rough with no wind. I saw the iceberg and needed to get to shore but there wasn't any wind. It took one hour to get to shore because the waves were so big and they had come out of nowhere.

Bill Streever – Do you think we are seeing this now, the effects of global warming with these weak east winds?

Two Crow – Yes, I believe since 1970 the effects are being observed. These changes include decreased ice cover (less production and food items), more storms and higher sea level from higher temperatures (and changes in upwelling), changing fronts and currents that affect fish migrations and distributions, and altered habitats.

Sara Kunaknana – I am now 82 years old and can remember since the time I was 9, when there used to be slow transitions from cold conditions to warm conditions. Now, these transitions from cold to warm are fast and abrupt. Fall used to freeze fast and now it is the reverse, the fall freeze is slow. I also used to fish along the shore for qaaktaq all summer and I used to catch bigger and fatter fish.

Two Crow – Wind-driven upwelling brings the nutrients and phytoplankton. If winds from the east diminish, then there may be little or no recruitment of Age-0 qaaktaq to the Colville River, and upwelling will decrease, meaning there is less food for the fish. With increased river discharge, faster currents could potentially transport Bering cisco to the Colville River region in less than two months.

Eli Nukapigak – This fall there we had a lot of west wind and we saw both Arctic cisco and Bering cisco.

Two Crow – If water temperature increases, then production and species change will occur. Given that other salmonids already exist in the region, the habitat becomes more favorable for them and they can out-compete ciscoes. There are also a lot of jellyfish in the Bering Sea.

Isaac Patkotak – We need a plan of action. The oil companies need to get off our garden.

Two Crow – There is a lot of basic life history knowledge that we need to collect to better understand these fish. What young of the year eat; what eats Arctic cisco. We do not know a lot about the nearshore Beaufort Sea. What is going on within ten miles of the shore is very complex. Like Sara said, all these turbulent currents when there are no winds. Another gap in our knowledge is about the processes. How do nutrients get into the nearshore zone? Especially what is happening under the ice? My elder told me when you see a problem; you need to think of a solution.

To gather this information we need a network of permanent observation. Traditional knowledge comes from hundreds of years of observing. The observations made by people every day can help us to better understand the cisco.

EXPLOITATION DYNAMICS OF SMALL FISH STOCKS LIKE ARCTIC CISCO

Jennifer Nielsen
BRD/USGS, 1011 E. Tudor Rd., Anchorage, AK 99503
(907) 786-3670, E-mail: Jennifer_Nielsen@usgu.gov

Potential impacts to the Arctic cisco population fall into both demographic and behavioral categories. Possible demographic impacts include stock recruitment effects, limited escapement into marine habitats, and variable age-class reproductive success. Potential behavioral impacts involve migratory patterns, variable life histories, and strategies for seasonal feeding. Arctic cisco stocks are highly susceptible to over-exploitation due to our limited basic knowledge of the highly variable Arctic environment and the role they play in this dynamic ecosystem.

Our knowledge of potential demographic changes is very limited, and it is necessary to determine the abundance and recruitment of the hypothesized Mackenzie River source population, the extent of the coastal migratory corridor, growth patterns, and coastal upwelling and mixing effects on population dynamics for this species. Information needed to answer some of the demographic questions includes basic evolutionary history and molecular genetics of Arctic cisco (for instance, are there contributions to the Arctic cisco stock from the Yukon?), what is the effective population size (i.e., breeding population size), and potential links to changes in climate.

The basic behavioral questions include migratory and variable life history questions. For instance, the extent of movement back and forth between freshwater and the sea, age-specific differences in food web dynamics, and nearshore brackish and high salinity habitats are topics that should be studied. Life history data should be gathered to understand the variation in age at reproduction, salinity tolerance, scale and duration of the freshwater stage, survival, and adult migration.

Both molecular and ecological tools should be integrated to manage the Arctic cisco stock(s), such as understanding global climate changes on patterns of harvest and recruitment, and the genetics of population structure and colonization. Perhaps other populations are contributing to the population within the Colville River other than only the Mackenzie River population. This needs further exploration. By examining otolith microchemistry, unique transitions from freshwater to sea can be identified for these stocks. This may shed light on why some fish arrive at the mouth of the Colville River, while others don't.

Discussion

Jennifer Nielsen – Do the elders remember such demographic changes in fish numbers and changes in the wind that I mentioned earlier?

Johnny Ahtuangaruak – Just recently these changes have occurred. It hasn't happened before. Prior to the pipeline being built, there was lots of fat fish offshore. Changes in body shape could be the result of a change in diet. Fish travel into the Colville River from waves out in the ocean. Animals migrate and travel in circles; they go all over.

Comment – I think there are changes in what they are eating.

Bill Streever – You had indicated that there are DNA data indicating that not all the Colville cisco come from the Mackenzie River but are from other sources?

Jennifer Nielsen – That is correct. There are three studies; one uses allozymes, that was done in the early 1980s; another more recent one used mitochondrial DNA; and one that looks at genome size. All the studies gave the high proportion of populations could be attributed to a Mackenzie source.

Bill Streever – What are the other possible sources?

Jennifer Nielsen – I have no idea what the other sources are, and the researchers have no idea. But genetically they were found not to come from the same source. All of the fish that were studied were taken from the commercial fishery. There could potentially be different stocks within the Mackenzie River. This is something that needs further studying and perhaps only a certain stock from the Mackenzie is in fact reaching the Colville.

Bill Streever – I guess another question is that are there any other rivers that are a potential source stock of cisco?

Larry Moulton – The fact is we haven't looked east of the Mackenzie River. Some Canadian scientists are interested in this.

Bill Streever – Nobody is suggesting that the fish are spawning within the Colville?

Jennifer Nielsen – Correct, that is not being suggested. What is being suggested is that there are other source populations other than the Mackenzie or that there is a variable population within the Mackenzie River. If fish come from other places, how important are they, especially if something changes in the Mackenzie?

Craig George – Warren Matumeak thinks some Arctic cisco spawn in the Dease Inlet rivers, Ikpikpuk for instance. I think we have hit on a key question that needs further studying. We need to identify the source populations and also look at site fidelity. That is a key question that we don't know the answer to. Are the sons and daughters of the fish that went back, returning here?

Jennifer Nielsen –I feel that genetics is the tool we can use to try to find answers to these questions. I want to know if the young-of-the-year (y-o-y) do not make it into the Colville River, why don't they come back as 2, 3, or 4 year olds?

James Patkotak – I want to know what Warren Matumeak thinks?

Craig George – Warren Matumeak has always held out and said that he thinks that some qaaktaq have their babies in the Ikpikpuk as well as the Mackenzie. He thinks they spawn near Barrow as well. He can't prove it. But that is what he thinks.

Kate Wedemeyer – Jack Colonell, an oceanographer who was unable to attend, also believes there may be a source population to the west.

Bob Fechhelm – We think if we have winds like recently, we couldn't get any Arctic cisco here. The past two years we have seen back–to-back west winds. Yet a few young-of-the-year do always show up in our sample nets. There has never been a complete absence of an age class. I want to know where are those fish coming from?

Gordon Brown – Is it possible that Arctic cisco could be coming from Russia?

Bob Fechhelm – I think an oceanographer would better be able to answer that question. They would need to calculate to determine if it is possible for the fish to come all that way through the Bering Straight.

Jennifer Nielsen – It could be possible.

Two Crow – There is a strong coastal Siberian coastal current along the northern coast of Russia. Dr. Tom Weingartner did work on that. It is very strong, about 20 miles a day.

Jennifer Nielsen – I was just at a global change meeting where a lot of oceanographers were talking about Arctic change. We worked with a model that hypothesized that Atlantic salmon could make such a migration as a result of shifts in the Arctic currents and changes in ice cover. We need to look across scales – linking molecular and ecological tools, changes in climate and how the animal behaves.

MODELING APPROACHES TO UNDERSTANDING VARIABILITY IN SMALL FISH STOCKS

Terrance J. Quinn II
Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks,
11120 Glacier Highway, Juneau AK 99801-8677
(907) 465-5389, FAX (907) 465-8461, Email: Terry.Quinn@uaf.edu

Assessment of exploited fish populations involves: (1) collection of data from the fishery and from biological surveys, (2) mathematical and statistical modeling of the data to understand the population's dynamics, and (3) development of biological reference points related to management to ensure sustainability of the population.

Useful types of data collected from the fishery include the total amount harvested each year and composition of the harvest in terms of length, age, and sex. It may be possible to develop an index of abundance called catch-per-unit-effort from harvest and fishing effort information. Biological sampling entails measuring abundance of the population and its composition. Various methods exist to measure abundance, including mark-recapture, transect, removal, and survey sampling. It is also important to learn about key population parameters, such as natural and fishing mortality, growth, recruitment, movement, and reproductive parameters (maturity, fecundity).

Modeling connects the data and the features of a population's dynamics. The abundance of the population this year is equal to the population from the previous year, subtracting removals from natural causes and fishing, and adding new individuals from recruitment or migration. When little information is available, surplus production models can sometimes be used to understand a population's productivity. More satisfactory models include information about length, age, and/or sex composition. A key aspect of population modeling is describing the relationship between recruitment and other variables. Recruitment is related to previous spawning abundance, environmental factors, and other potential causes (e.g., other species, pollution). Modeling provides a means for understanding the factors affecting the population and a means for forecasting the population into the future.

The fishing mortality that produces maximum sustainable yield (MSY) is the standard biological reference point for management. It requires the specification of the relationship between spawners and recruits. When this relationship is uncertain, many researchers favor biological reference points related to preserving reproductive potential of the population on a per recruit basis. In particular, the fishing mortality $F_{40\%}$ that preserves spawning biomass or egg production per recruit at a level of no less than 40% of an unfished population is commonly used. A different type of biological reference point is a population threshold. If the estimated population drops below the threshold, then all fishing is curtailed. A population threshold at 10 to 25% of the unfished population is often recommended.

An example of this three-stage process for stock assessment is the humpback whitefish population in the Chatanika River (Merritt and Quinn 2000). Data included harvest at age, estimates of exploitable abundance from a mark-recapture experiment, and perceptions of data quality from the fishery manager. The best age-structured model was chosen by examining the fit of the model to the data, parameter uncertainty, conservatism of forecasts, and plausibility of results. The management policy set a threshold at 10,000 fish and increased exploitation rate up to a maximum of 15% as population size increased. Application of the model showed that sustainability depends on the presence of periodic strong year-classes. If there is a linear relationship between spawners and recruits, then the probability of falling below the threshold in six years was high. The main feature of this three-way assessment process is to provide a tool for incorporating various types of data into a structured framework to quantify the risks to the population associated with various harvest strategies.

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WORKING GROUP DISCUSSIONS AND RECOMMENDATIONS

The preceding Traditional Knowledge and scientific presentations provided excellent information. There was a wealth of expertise and knowledge represented at the workshop. At the end of the scientific presentations, Moderator Mitchell asked several of the workshop attendees to share some of the more significant or surprising things they had learned in the community forum.

General Comments

James Patkotak – We need a plan of action for the wellness of the community. The oil industry needs to leave our garden alone and allow it to flourish.

Two Crow – I think what strikes me is that how little we know about the whole system between the Mackenzie and this river: just the dynamics, the food, why is it growing, what the little guys are eating, what's eating them. The whole thing seems to be rather nebulous.

Larry Moulton –What was new to me was the input from the elders on the dynamics of the slush at the mouth of the river during the freeze up period and early winter when the fish are moving in. And the explanation on how complicated that process is, it just doesn't freeze up and everything is the same every year. There is a lot of interannual variability.

Craig George – It is amazing that the fish make it here at all. The journey is so great. They have to travel 300 miles down the Mackenzie and 400 miles this way. It looks like we are right on the edge of their distribution. After hearing about global changes, I am worried about the future of the Arctic cisco fishery here.

Bob Fechhelm – I enjoyed listening to the elders talking about the location of the fish places in the past and where they are located now. After hearing Two Crow speak about Arctic oscillation, we can start to see things in more of a time frame. It puts things into perspective listening to stories from many years ago and looking at pure science.

Chuck Mitchell – I would like to hear from the elders. What did they find surprising or notable?

Marjorie Ahnupkana – I learned about what could potentially be within the water. I moved to Barrow in 1950 and then back to Nuiqsut 25 years later and noticed a great change from when I had originally left.

Ruth Nukapigak – I can validate everything that has been said over the last couple of days. I have observed these trends first hand. We have known for a long time that changes have been occurring. I will be 79 in January, I have seen a lot and know a lot, and agree with what has been said. I became aware when I was a small child, and have chosen to live my lifestyle in accordance. I make observations about what is occurring around me within the environment. I don't travel when the west wind is blowing because you never know how dangerous they could be.

Chuck Mitchell –I would like to add a comment. We are all researchers here, everyone in this room. We are all observers. I think it is important that Ruth Nukapigak is validating the science. If you talk with modelers you know that one of the first things they do after they "build a model" is "ground truth" it. They add real data to see if it works. Does it really reflect what happens in the real world? Ruth is our quality control person. Both scientists and elders have had made similar observations over the years so in effect they have validated each other.

Jennifer Nielsen – It's very important that you keep scientists aware of the human factors. It's easy for scientists to get lost in the data.

The participants divided into two discussion groups. Every attempt was made provide each group with participants of similar experience and knowledge. The stated goal for the discussion groups was to assemble a list of issues regarding Arctic cisco that needed to be addressed in future studies. After informal introductions, each participant was asked for what he or she considered the most important issues or information needs. All issues were listed as the discussion proceeded and when all of the participants had been canvassed, the process was repeated to insure that all issues and questions were recorded and understood. Each participant selected their three most important issues or questions from the group brainstorming list and recorded them in rank order on individual ballots. These ballots were then counted to reach the group's ranked priority list. The two groups used slightly different procedures in the ranking process. Each person in Group A ranked their top three of their complete list of 41 specific questions or ideas. Each person in Group B Ranked the top three of the 16 generalized categories. The group lists are contained in full in the appendices.

The two working groups re-assembled in the full group then reviewed their lists of issues. The meeting chair entertained questions and discussion for clarification.

Final Ranking based on combining all participant votes

Because the two groups used slightly different procedures in the ranking process, after the workshop MMS combined the issues and questions of all participants and calculated the following final ranks.

1. Effects of Development and Human Activities

- Are there effects on Arctic cisco and their migration from offshore exploration and development?
- Are there effects on other fish species besides Arctic cisco (e.g., lingcod) and their migration from offshore exploration and development?
- Continuation of long-term fisheries data compared with recent record. Long term data from Endicott – longitudinal data records.
- Diet of the fish in conjunction with change in industry.
- Are fish migration routes changing in response to industry-related activities?
- Did the loss of the drilling mud during construction of the pipeline crossing affect fish populations and ecology?
- Tagging fish is like "messing with animals," a social "no-no." I wonder if these tagging activities have any effect on the health of the animals that are tagged.
- Detailed maps of the migratory paths of the cisco, including causeways, obstructions, and coastal changes.
- Berries that used to grow in this area (lots in 1970s) and after development of Prudhoe Bay began, they don't grow.

2. Review Previously Collected Canada and Alaska Data, including Elders' information

Previously collected data should be assembled and reviewed to determine possible explanations for the decline in abundance of Arctic cisco at Nuiqsut.

Compare with Canadian Data, including elders' information.

Synthesize all the data we already have, including elders' information for the entire migration of the cisco.

Have both a biologist and an anthropologist together in order to ask the right questions of the elders to gain traditional knowledge?

Details on how many nets are out there, how many total fish were caught this year in comparison to last year.

Find out where the fish are in the Colville River in the fall. Is this changing over time?

Spotted seals used to be seen on the upper reaches of the Colville as they followed qaaktaq and other fish. This no longer occurs.

Data from the Canadians on the lower Mackenzie River; fishermen there harvest the larger fish not necessarily the Arctic cisco. There needs to be communication between the two areas, if our fish count is low with the assumption that the fish went east we need to be able to find out whether there fish counts were really good.

Getting traditional knowledge on paper and comparing it to the science knowledge. Collect data from elders and compare with Canadian elders.

Collect data from Canadian fisheries – compare data.

Comparisons in the Mackenzie and Colville river delta dynamics need to be done.

To what extent has fish size decreased with time, and what is the cause(s) of this decrease?

Look at the change in fish size with age.

3. Arctic Cisco Life History

What are the important/critical life stages, and the habitats necessary for each of these life stages?

What is the basic life history of Arctic cisco? Determine why fish don't return to fishery if they don't recruit in their second or third year.

Identifying the factors that affect survival of 0-5 year old fish.

What does determine the number of young fish in the Mackenzie River?

From Mackenzie to Colville, start monitoring everything both physical and biological. Focus on the native villages.

Are humans the only predators of the qaaktaq? nachiq? beluga?

What do Arctic cisco feed on, and has their diet changed with time?

4. Migration of Young of the Year from Mackenzie River

What movement process(es) occur after dispersal? How do y-o-y leave the Mackenzie River, and do they have to make it to some critical area to survive? Describe overwintering areas. What happens to Arctic cisco that do not make it to that location?

What are the effects of varying wind direction and speed on movement of Arctic cisco?

Identify the spatial extent of the overwintering habitat.

What is going on the Mackenzie River and where exactly do the Colville qaaktaq come from in the Mackenzie River?

What determines how many of those Mackenzie fish get to the Colville River?

Overwintering habitats – what are the conditions with habitats, etc.?

5. Water Quality, Contaminants

What is the extent of contamination in Arctic cisco? What contaminants are in the fish tissue(s), and do these contaminants affect the overall health of the fish?

Concerned about catching fish that appears to be "deformed" or harmed in some way by something either polluted in the environment or by toxic materials being absorbed in the food chain. Can fish be sent somewhere for analysis?

Is there a relationship between rising cancer and other health related issues and industry activities. If so, what is it?

Education program on contaminants, they are everywhere, but what effect do they really have? – put this into perspective.

Water sampling on currents.

Start documenting and gathering data on water quality.

Look at potential pollutants, more than just water quality; tissue samples, sediment cores.

Put out a booklet on the types of pathology, with pictures, normally seen on fish so that one can refer to it and identify.

Need to understand what pollutants are out there and how it affects the fish and us, food chain.

6. Genetics, Source Stocks

Population genetics analyses. Is there more than one source population, and if so, how many and where? Are there genetically distinct populations?

Genetic studies to ascertain spawning stock sources.

Identify spawning areas.

Find the spawning site source.

7. Colville River Dynamics

Are there effects on Arctic cisco from changes in water depth in the Colville River and Colville Delta?

The blockage of the delta, forcing qaaktaq to overwinter outside of the delta. Dynamics of fish and saltwater interface. What happens to fish that are prevented from entering the river by slushy conditions?

8. Ice Roads and Bridges

Do ice bridges impede movement of fishes? Determine effects from ice bridges on current flow; begin by examining the Colville River.

What are the effects on fish stocks of water withdrawal for ice road construction and the use of lake surfaces for airstrips?

9.5 Seismic, Noise

What are the physiological effects from noise/vibrations and seismic activity on various life stages of Arctic cisco?

Are the long-term effects associated with seismic work?

Noise affecting the fish.

9.5 Climate Change

Are there different effects from the different flooding regimes, and what effect has global warming had on Arctic cisco?
Climate change, decrease in ice, food chain changes.
Look at climate change and how it will affect the fish, impact fishery, algae, etc.

11. Socio-Economics

What are the socioeconomic effects in Nuiqsut from changes in the Arctic cisco fishery?

Discussion

Two Crow – Global climate and how it ties in with traditional knowledge is very important. People want to know how much of this is affecting their local world. Do they have any control over it? If it is not industry and it is not ice bridges, if it is global climate, then all we can do is thank God that we are still alive.

Leonard Lampe, Sr.—Will local expertise be involved?

Kate Wedemeyer – We need to continue to gather traditional knowledge with any study conducted. You local residents are the experts with the most knowledge. That is why we came here this week. We want to receive your information and ideas. I think we need to gather that on every study.

Jennifer Nielsen – Why are we prioritizing this list? Is there only so much money for funding? Or are these ideas that you are going to take back to your agencies, saying that these are some of the studies that we need to look at.

Kate Wedemeyer – I hope that tomorrow we can create a prioritized list of studies relevant to MMS responsibilities in off shore oil and gas leasing. I will be able to present the list this group thinks are the most important to MMS and say these are the Arctic cisco studies we should pursue. Then the list goes in with every other type of study that is proposed but at least I'll have submitted what this group has recommended.

Leonard Lampe, Sr. – A fishing association is something we need as a community to protect ourselves. There hasn't been much enthusiasm among the community and individuals to actually say, "Hey, let's do this." There has been only one or two of us and we can't get very far with only us. To me an association would really help the interest of the village individuals. There is an association that protects the whalers if there is an oil spill, but there is nothing that protects the fishermen. There are no clauses for us. Anybody can build at anywhere, any time and that is a problem. We don't have a voice as local fishermen. We don't have the voice like the Alaska Eskimo Whaling Commission (AEWC) about noise disturbance. We don't have that here. We don't have the staff, we don't have the attorneys, and it is very hard for an individual to try to get something started. We need cooperation with the North Slope Borough and other organizations that are supposed to help protect the people and the resources that we depend on. We could go a long ways but it takes more than just a couple of people to say, "Hey, we need this." We have brought this to the attention of Fish and Game and it has not gotten us anywhere.

Jennifer Nielsen – There needs to be a trade off with industry leasing the land and them funding a study.

Leonard Lampe, Sr. – What happens next, when do we find out the results from this workshop? I would like to see a follow up to this meeting and prioritize the studies that have been discussed here. I would like to have Kate return to Nuiqsut to inform the community about what studies have been funded and what results have been obtained from studies once they have started.

Kate Wedemeyer – A future possible study could be another workshop in order to give updates.

Leonard Lampe, Sr. – What about working with Canada? Perhaps another workshop could be held in Canada so that studies can be done on their side.

Kate Wedemeyer – We share information and data with each other to an extent but a more specific type of partnership needs to be formed.

On Day 3, the meeting chair listed the general topics of the two combined lists and presented the composite list of issues to the Workshop participants. Each issue was briefly discussed for clarification. The general subject areas were:

Studies Categorized

1. Contaminants
   - Potential pollutants
   - Stomach nodules in fish
   - Liver problems
   - Associations with body contaminants
   - Health related issues to village
   - Inputs from old sites of industry/waste dumping sites/air pollution
   - If diseased fish is found – how do we go about identifying it (ADF&G)
   - Deformed or harmed fish – why/how
2. Food Webs
   - Diets of fish, are they changing
   - Effects by industry activities
   - Elders report changes in flesh, body weight, size, and amount of fat
   - Change in food habits
   - Possible predators other than humans that could be effecting the local populations
3. Habitat Characterizations
   - Comparisons between Colville and Mackenzie River/Delta
   - Climate changes and impacts to the fishery
   - Canadian elders/Nuiqsut elders: comparison of their traditional knowledge
   - Effects of flooding – natural process, sandbars, formation of slush barriers
   - Effects of ice roads
   - Effects of global warming and long-term trends
   - Odd occurrence of new fish species – occurrence of spotted seals showing up farther within the river at differing time of year
   - Effects of winds on fish movement, not just not of Arctic cisco but other fish species also

- Factors affecting the survival of fish – Colville River; show up or not, if not where are they going, if mortality, why

4. Migration Routes
   - Assemble detailed maps of Arctic cisco migration routes along coast and through the delta at differing times of years, potential industry effects, dredging, causeways, man made pads
   - Then note changes between these routes over time
5. Outreach
   - Communication within and to communities – start education program of contaminants; if fish are found to be contaminates what are the effects that it could have on the villages that consume the meat
   - Concerns about fish diseases – produce a pamphlet that could discuss what it is that they are seeing

     [Craig George – There is a Wildlife Disease pamphlet but I'm not sure if it includes fish. So there may be something already published. However, it would need to be simplified to the Arctic species of this area and also include translations and pictures.]
   - Socioeconomic effects and how the fishery is attributed
   - How should animals be handled

     [Ruth Nukapigak – By tagging fish, we believe that the fish are being "messed" with and that shouldn't be done.]

     [Chuck Mitchell – Perhaps, the native community could put a small handbook together on how the animals should be treated in accordance to native views.]
6. Overwintering
   - What is the spatial extent and magnitude; MMS is looking into this
   - Y-o-y fish, where do they overwinter and how are they surviving
   - What type of conditions are they enduring
7. Spawning Habitat
   - Where are they located
8. Stock Characterization
   - How are the fisheries and what do the populations look like
   - Need long-term data
   - Continue collecting data; from Colville and the Mackenzie Rivers
   - Decreasing size in the fishery; monitor the fishery and find out why this is occurring
   - Better communication between fishermen and researchers; Colville and Mackenzie Rivers
   - Changes between years and compare over a long period of time; every 10-20 years comparisons should be made

     [Craig George – Will weight tell us the condition or will we have to measure for oil content or calories when they say the fish are skinny?]

9. Source population(s)
   - Reproductive population; need more information
   - Genetic/DNA analysis
   - Determine population along coast, Mackenzie Delta, Colville Delta
   - We think some Colville Arctic cisco do come from other small reproductive populations; where/location

[Paul Okarok – Some fish that are coming from the Mackenzie River have tags. I have noticed that the Artic cisco coming from Canada taste different. They have an oily taste; I can tell this by tasting their eyes.]
[Sara Kunaknana – The Sagavanirktok River current is very strong and there is no way that the Arctic cisco would be able to move up the river. The name means "the one with the most current."]

10. Water Quality/Water chemistry
    - Physical properties such as turbidity
    - Sediment analysis
    - Chemical analysis

Information Sources

The group reviewed the list of potential studies, identifying existing data sources, other researchers, and other research with what little time remained. Partnering opportunities and possible funding sources were also discussed.

The group expressed considerable interest in Arctic cisco genetic studies. Analyses of DNA can provide a great deal of information on stocks at relative low costs. Additionally, tissue samples from past studies can provide historical information without having to field sampling efforts.

Several scientific papers have addressed the genetics of the Arctic cisco stocks of the Mackenzie River. They provide background information on allozymes, genome size, and micro-satellites. Overwintering and stocks source questions would require additional site-specific sampling of adults and juveniles.

A DNA archival system and repository so that future questions can be answered. For instance it is possible to link the genetic stock analysis with otolith microchemistry analysis and investigators could address questions on stock structure and get life history information in terms of migratory patterns. Dr. Larry Moulton has 15 years of archived Arctic cisco otoliths. LGL also has otoliths from 1980s. These otoliths could provide an excellent view of climate changes over time. DNA analysis would be approximately $26 per sample plus $70 per sample for proposal cost and materials. Analysis is approximately $100 per otolith, plus a per otolith charge of $150-200 for data reduction and analysis. Jennifer Nielsen indicated she would like to seek funding to sponsor a graduate student at UAF to do the otolith microchemistry and integrate it into a Master's program.

MMS has funded a genetic study to determine if the Arctic cisco and Bering cisco are different species. Those DNA data are available for inclusion.

The Freshwater Institute in Winnipeg, Manitoba has data from the 1960s on tagged fish that were caught in Nuiqsut the early 1970s. There are data not just on the Arctic cisco but also on a wide range of fish. All data from these studies are archived. However, there hasn't been a great deal of recent work.

The Iñupiaq History Language and Culture Commission has historical interviews and records on file. These archives may yield information on long-term catch trends.

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) database beginning in the 1970s would also provide a variety of information that could be integrated into the Arctic cisco database.

Funding and Partnering

MMS is limited in the types of projects that can be funded. There are however a number of potential state, federal and international agencies or organizations that may be approached for possible funding or partnering. For some concerns such as water quality, ground water contamination, and measurements of body burden levels of possible contaminants in subsistence foods there are existing programs and the community has only to ask for assistance or participation. Particular importance was given to the potential for a cooperative or collaborative effort between the Canadian and Alaskan communities. In addition, the gas and oil industry has funded many of the studies presented at this workshop. It is anticipated that they would continue to support such efforts if justified and requested. Potential participants include:

- Minerals Management Service: Anadromous fish overwintering habitat study (ongoing)
- U.S. Geological Survey/Biological Resources Division: otolith microchemistry
- University of Guelph, Ontario, Canada: Historical data and otolith microchemistry
- Freshwater Institute of Canada: historical data and collaboration from the early 1970s
- Inuvialuit Settlement people: cooperative fishery data exchange with Inuvialuit Science Board training people in Inuvialuit, Tuktoyaktuk Harbor
- Inuit Circumpolar Conference (ICC): ICC is international. It has worked with Canada to get an international agreement
- Native Science Board in Canada
- North Slope Borough Fish and Wildlife Committee

CLOSING REMARKS

Bill Streever – On behalf of BP Alaska Exploration, thanks very much for inviting me to come. I think this is incredibly useful to get the scientists and the local community together. It is just fantastic for me to see and it helps me in my world of BP where I have to make tough decisions about what to fund and what not to fund. It helps me to get this broader perspective. We really appreciate; it especially the native voice on what is going on. Even though we do not have any work going here in the area of Nuiqsut, it is very important for us to understand what you concerns are and to the extent we can, help you with those concerns. Thanks very much.

Marjorie Ahnupkana – It is important that if we find anomalies on the fish, that we contact the scientists right away and keep that communication open. Thank you for coming.

Sara Kunaknana – We should all go home and write reports and digest all that has been said here and look both ways at the information that has been presented. Then we can determine what work needs to be done. I was really excited to hear from Jennifer Nielsen about DNA and genetic studies. I think that that is really important. I also found Terry Quinn's modeling presentation was very fascinating. So think about those things that were said when you go back home. Don't forget about the discussion and questions that were generated here.

Ben Nageak – Talk is cheap. Action is strong, especially for the people who live off these resources. These people have seen changes that we can't even fathom. It is important to obtain the information from the elders while they are still with us.

Marjorie Ahnupkana – I thank you for coming to help the community. I also know that injuries are occurring to the fish such as scars, so keep that in mind. There are a lot of things that can be learned from observations of fish. So thank you again. Please don't forget. We just can't let the communications end today. We need to follow up with actions. Back in the old days the taste of the fish was different. Today you can tell the difference in the taste with everything that has happened in the environment. Back in the old days when there was nothing around in this area, the taste of the fish was great. The taste today is different. There are effects when changes occur within the environment.

Sara Kunaknana – Thank you for coming to share information and listen to us. I know how hard it is for two different peoples to work together especially since this is not your hometown. You are putting forth so much effort to try and recognize what is happening around this village.

Leonard Lampe, Sr. – We Iñupiats have always adapted to change, that is what I have learned from the elders. They have taught us a lot. They have seen big changes during their lifetime, from sod houses, igloos, dog sled teams, and practically nothing. They have seen this, where we can only read about such events or hearing stories about them. I have never been on a dog sled team. They can tell us about the environment and how it has changed so much. There have been big changes that we have seen. We as the people have always adapted to change.

Just look at our history: we went where the caribou went; we went where the fish went. We didn't stay there if there were no animals because we would starve and die. So we always adapted to change. We always followed the caribou. We followed where the subsistence was. We can't do that nowadays; it is not that way now. I can't move my house to where the caribou go. Now you live in a town, you have a home in that town, and raise your family there.

As I said, we adapt to change easily but if this village were to run out of cisco we could adapt but a big part of our culture, of our heritage, of the people who we are would be lost. We are the people of the Colville. We have always been a thriving fishing community, whether it was in this area or the original Nuiqsut village or other spots along this river. We have always adapted to change, no matter where we are. We will always be proud of who we are and our culture.

Like I said, we will not die without the cisco but it will be a big deficit in our culture and our history. Know that you are helping not only Nuiqsut. Not only does this village depend on cisco that we provide but other villages depend on the cisco. A lot of Barrow residents depend on us for the cisco. A lot of Anaktuvuk people depend on us. Point Hope, Point Lay. There are other villages that do subsistence fishing like Barrow and Kaktovik but not as much as this village. Practically the entire North Slope depends on Nuiqsut for the cisco.

Seeing this workshop happen gives us hope that there are actually people who are listening to us about our concerns about the fish. For many years we felt alone and that we were fighting a losing battle.

For nine years as a politician, I felt like I was speaking words and nobody was listening. I was putting a lot of pressure on the Federal government as well as the State government, trying to tell them that a change is occurring here. As agencies, as people, it is our responsibility to find out what is going on and try to determine what can be done to help people adapt to these changes. It used to be easier for them to adapt to changes, nowadays it is harder for us.

And that is why I am very glad that you all came and educated us, and we will try to educate you through the elders. No matter how much we have learned from each other there are people other than us that are depending on the results from this workshop. I just want you to know that you are helping a lot of people, just not the people of this community. You are helping people Slope-wide. You are helping the Iñupiats try to keep a part of their culture. And that is really important and I thank you from the bottom of my heart, all of you, for taking the time to come here and staying the whole three days.

Sara Kunaknana – I have lived and fished here on this river as well as the Prudhoe Bay area pretty much all of my life. But I have never understood where the fish are actually spawning. Because by the time they are here in the fall time, I noticed that their roe begins forming but where they eventually end up spawning is something that I have not been able to figure out.

Leonard Lampe, Sr. – The village is always putting the blame on industry and industry in return is saying, "No it's not us, we are not bothering the cisco." I think they need to put their money where their mouth is and prove to us, the village, that "you" are not affecting the cisco. By funding some of these studies they could tell us whether they are affecting the cisco or not. I think that this is a real vital point to the industry. They want to clear their name. BP wants to clear their name, Conoco-Phillips Alaska wants to clear their name, and in order to do so they will fund these studies. They could fund the study and that way they will be able to say, "Yes we did have something to do with it or no we did not have anything to do with it." They will fund their way in order to get out of those negative public relations. As long as they are in the fields of Nuiqsut they will always be blamed. This is one way for industry to take the blame away from their name by funding some of these studies so they can prove themselves.

Chuck Mitchell – There is always the public perception that because industry funded the study, it is slanted towards their direction.

Ben Nageak – Not if it goes to peer review.

Chuck Mitchell – Yes, we can submit it to peer review, and with the right people involved I think the credibility will increase.

James Patkotak – On that note, I believe that maybe the Iñupiat Community of the Arctic Slope can speed up these studies and issues especially in the gathering of traditional knowledge for each village. I can help in that manner.

Ben Nageak – There has been a request for a follow-up conference in order to keep the community of Nuiqsut informed regarding future plans of action. Leonard Lampe and Rosemary Ahtuangaruak are the contacts that should be kept notified and will represent Nuiqsut.

Chuck Mitchell – Thank you all for your participation. Thank you to the community.

APPENDIX A
Questions and Issues listed by Group

Appendix A - Questions and Issues listed by Group

Ranked Issues and Questions List from Group A:

1. Long term data from Endicott: fyke net data, etc.
2. Long term fisheries catch
3. Genetic data needs to be gathered to ascertain spawning stock sources?
4. Is the diet of the fish changing or being affected by activity from industry?
5. Gather traditional knowledge from elders re: the biology, ecology, etc. of the fish and document it.
6. Identify factors that affect survival from age 0-5.
7. Climate change and global warming and how it may impact fishery, algae, etc.
8. Address concerns with potential pollutants, anomalies in fish.
9. Migration routes; are fish migration routes changing in response to industry related activity.
10. Spawning areas? Where are they?
11. Identify spatial extent of overwintering habitat.
12. Is there an association between rising cancer and other health related issues, i.e., air pollution and industry activity?
13. Did the loss of the drilling mud during the construction of the pipeline crossing affect fish populations and ecology?
14. What determines the number of fish in the Mackenzie?
15. Education program on contaminants needs to be initiated to debunk misperceptions and misinformation about effects on species and humans.
16. Someone synthesize all the data including info from elders covering entire migration area in one place.
17. Communication with fishermen and researchers in Mackenzie Delta to integrate data sets.
18. Compare Canadian and American elder knowledge.
19. Can the sampled fish be sent for analysis?
20. Tagging fish is like "messing with animals," a social “no-no.” I wonder if these tagging activities of animals that are tagged.
21. Where do the Colville River qaaktaq come from in the Mackenzie?
22. What determines how many of Mackenzie fish get to the Colville?
23. Overwintering habitats, what are the conditions with habitat, etc?
24. Continue studies, ABR, LGL, MJM and longitudinal data compared with recent data.
25. Detailed maps of cisco migration route that depicts manmade and natural changes.
26. Are there long term effects associated with seismic work?
27. Spotted seals used to be "spotted" on the upper reaches of the Colville as they followed the qaaktaq and other species; this no longer occurs, why?
28. Gain a better understanding of the fish and salt water interface.
29. Compare early data with recent data "moving baseline".
30. Water sampling.
31. Concern about catching fish that appear to be deformed or harmed in some way by something either polluted in the environment or by toxic materials being absorbed in the food chain, and if so, what?

32. Berries that used to grow in this area (1970 lots) and after development in Prudhoe Bay began, they don't grow as they once used to.
33. Change in fish size?
34. Fish disease pamphlet
35. Where in the Colville are they and does it change?
36. Are humans the only predators? What about natchiq, beluga?
37. Comparison of the Colville and Mackenzie delta dynamics
38. What happens to fish that are prevented from entering the river by slushy conditions and what are the dynamics (delta)?

Ranked Issues and Questions List from Group B:

1. Are there effects on Arctic cisco and their migration from offshore exploration and development?
2. Do ice bridges impede movement of fishes? Determine effects from ice bridges on current flow; begin by examining the Colville River.
3. Are there effects on Arctic cisco from changes in water depth in the Colville River and Colville Delta?
4. What are the socioeconomic effects in Nuiqsut from the Arctic cisco fishery?
5. What is the basic life history of Arctic cisco? Determine why fish don't return to fishery if they don't recruit in their second or third year.
6. What are the effects of varying wind direction and speed on movement of Arctic cisco?
7. What do Arctic cisco feed on, and has their diet changed with time?
8. What movement process(es) occur after dispersal? How do y-o-y leave the Mackenzie River, and do they have to make it to some critical area to survive? Describe overwintering areas. What happens to Arctic cisco that don't make it to that location?
9. Population genetics analyses. Is there more than one source population, and if so, how many and where? Are there genetically distinct populations?
10. What is the extent of contamination in Arctic cisco? What contaminants are in the fish tissue(s), and do these contaminants affect the overall health of the fish?
11. Are there effects on other fish species besides Arctic cisco (e.g., lingcod) and their migration from offshore exploration and development?
12. To what extent has fish size decreased with time, and what is the cause(s) of this decrease?
13. What are the important/critical life stages, and the habitats necessary for each of these life stages?
14. Are there different effects from the different flooding regimes, and what effect has global warming had on Arctic cisco?
15. Previously collected data should be assembled and reviewed to determine possible explanations for the decline in abundance of Arctic cisco at Nuiqsut.
16. What are the physiological effects from noise/vibrations and seismic activity on various life stages of Arctic cisco?

APPENDIX B
Attendee List

Appendix A – Attendee List

Ahnupkana, Clarence
P.O. Box 125
Nuiqsut, AK 99789
(907) 480-2740

Ahnupkana, Marjorie
P.O. Box 125
Nuiqsut, AK 99789
(907) 480-2740

Ahtuangaruak, Johnny
P.O. Box 105
Nuiqsut, Alaska 99789

Ahtuangaruak, Rosemary, Mayor
City of Nuiqsut
P.O. Box 148
Nuiqsut, AK 99789
(907) 480-6727, FAX (907) 480-6928

Carpenter, Terry
US Army, COE
CEPOA-CO-R, P.O. Box 6898
Elmendorf AFB, AK 99506-6898
(907) 753-2798
Terry.A.Carpenter@poa02.usace.army.mil

Beck, Shane
MBC Applied Environmental Sciences,
3000 Redhill Ave.
Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840
sbeck@mbcnet.net

Brower, Carl
P.O. Box 89033
Nuiqsut, AK 99789
(907) 480-6618

Brown, Jr., Gordon
P.O. Box 151
Nuiqsut, AK 99789
wolverineman992004@yahoo.com
gordonbrown@north-slope.org

Brown, Randy J.
Fishery Biologist
USFWS
101 12th Avenue, #222, Box 17, MS 651
Fairbanks, AK 99701
(907) 456-0218, FAX (907) 456-0454
randy_j_brown@fws.gov

Cherbone, Christine
MBC Applied Environmental Sciences,
3000 Redhill Ave.
Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840
ccherbone@mbcnet.net

Duvall, Terra
MBC Applied Environmental Sciences,
3000 Redhill Ave.
Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840
tduvall@mbcnet.net

Fechhelm, Robert
LGL
1410 Cavitt St.
Bryan , TX 77801
(979) 775-2000 FAX (979) 775-2002
bfechhelm@excite.com

Fissel, David
ASL Environmental Sciences
1986 Mills Road, Sidney, BC V8L 5Y3
CANADA
(250) 656-0177, ext. 112 (877) 656-0177, FAX
(250) 656-2162
dfissel@aslenv.com

George, Craig
Dept. of Wildlife Management
North Slope Borough
P.O. Box 69
Barrow, AK 99723
(907) 852-0350

Harcharek, Jana
Facilitator
North Slope Borough School District
(907) 852-9674/ 5065
jana.harcharek1@nsbsd.org

Hopson, Adeline
P.O. Box 172
Barrow, Alaska 99723
(907) 852-5025, FAX (907) 852-2601
eskimo@nuvuk.net

Kunaknana, Sarah
Nuiqsut, Alaska 99789

Lampe, Annie
P.O. Box 213
Nuiqsut, AK 99789

Lampe, Sr., Leonard, President
Nuiqsut Tribal Village Council
P.O. Box 107
Nuiqsut, AK 99789
(907) 480-3010, FAX (907) 480-6126
llampe@astacalaska.net

Long, Jr., Frank
Nuiqsut Member
North Slope Borough Assembly
P.O. Box 209
Nuiqsut, AK 99789

Long, Vernon
Kuukpikmiut Subsistence Oversight Panel
P.O. Box 89206
Nuiqsut, AK 99789

Matumeak, Frank
P.O. Box 60
Nuiqsut, AK 997898
(907) 480-2058 (message)

Mitchell, Chuck
President
MBC Applied Environmental Sciences,
3000 Redhill Ave.
Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840
cmitchell@mbcnet.net

Mitchell, Kathy
MBC Applied Environmental Sciences,
3000 Redhill Ave.
Costa Mesa, CA 92626
(714) 850-4830, FAX (714) 850-4840
kmitchell@mbcnet.net

Moulton, Larry
MJM Research
1012 Shoreland Dr.
Lopez Island, WA 98261
(360) 468-4821, FAX (360) 468-4337
lmoulton@rockisland.com

Nageak, Ben
Translator
P.O. Box 914
Barrow, AK 99723

Nielsen, Jennifer
Alaska Biological Science Center
BRD/USGS, 1011 East Tudor Rd.,
Anchorage, AK 99503
(907) 786-3670
jennifer_nielsen@usgs.gov

Nukapigak, Dora
Kuukpikmiut Subsistence Oversight Panel
P.O. Box 226
Nuiqsut, AK 99789
(907) 480-2065

Nukapigak, Eli
Kuukpikmiut Subsistence Oversight Panel
P.O. Box 89206
Nuiqsut, AK 99789
(907) 480-2070

Nukapigak, Isaac
Kuukpikmiut Subsistence Oversight Panel
P.O. Box 187
Nuiqsut, AK 99789
(907) 480-6220

Nukapigak, Ruth
P.O. Box 8
Nuiqsut, AK 99789

Patkotak, James
Natural Resources Director
Iñupiat Community of the Arctic Slope
P.O. Box 934
Barrow, AK 99723
(907) 852-4227, FAX (907) 852-4246
icasnrd@starband.net

Quinn, Terry
Fish/Ocean Sciences
University of Alaska
11120 Glacier Hwy.
Juneau, AK 99801
(907) 465-5389, FAX (907) 456-6320
terry.quinn@uaf.edu

Rea, Caryn
Senior Staff Biologist
Conoco-Phillips
700 G Street
P.O. Box 100360
Anchorage, AK 99510-0360
(907) 265-6515; (907) 223-0850
clrea@conocophillips.com

Schumacher, Jim, “Two Crow”
Two Crow Environmental
288 Ivan Rd.
Friday Harbor, WA 98250
(360) 370-5591
twocrow@rockisland.com

Streever, Bill
Environmental Studies Leader
BP Exploration (Alaska)
P.O. Box 196612
Anchorage, AK 99519-6612
(907) 564-4383, cell (907) 440-8324, FAX (907) 564-5020
streevbj@bp.com

Taalak, James
Conoco-Phillips
P.O. Box 264
Nuiqsut, AK 99789
(907) 480-4001, FAX (907) 480-4002
James.J.Taalak@conoco.phillips.com

Wedemeyer, Kate Fisheries Oceanographer
MMS Agency Coordinator for Arctic Fish Studies
Minerals Management Service
949 E. 36th Avenue,
Anchorage, AK 99508
(907) 271-6424, FAX (907) 271-6507
kate.wedemeyer@mms.gov

Whitman, Matthew
Fishery Biologist
BLM, Northern Field Office
1150 University Ave.
Fairbanks, AK 99709
(907) 474-2249
matthew_whitman@blm.gov

Woods, Sr., Joeb
P.O. Box 203
Nuiqsut, AK 99789
(907) 480-6218

APPENDIX C
Agenda

Appendix C – Agenda

MMS Alaska OCS Region
Arctic Cisco Workshop
November 18 and 19, 2003
Nuiqsut, Alaska

Final Agenda

Tuesday, November 18, 2003

1:00 pm	**Blessing** **Welcome and Introduction** Leonard Lampe, Sr. President, Native Village of Nuiqsut I Kate Wedemeyer, MMS, Alaska OCS Region, Anchorage, AK
1:15 pm	**Life history of Arctic cisco** Larry Moulton, Ph.D., MJM Research, Lopez Island, WA
1:30 pm	**Physical environment and habitat of the Arctic cisco** Bob Fechhelm, Ph.D., LGL Research Associates, Bryan, TX
1:45-3:00 pm	**Traditional Knowledge of Arctic cisco and fishery** Marjorie Ahnupkana, Gordon Brown, Bernice Kaigelak, Isaac Kaigelak, Leonard Lampe, Sr., Gordon Matumeak, Dora Nukapigak, Ruth Nukapigak, George Woods, Nuiqsut, Alaska; Fenton Rexford, Kaktovik, Alaska; Randal and James Pokiak, Tuktoyaktuk Harbor, Canada
3:00 pm	**Break**
3:15-5:00 pm	**Traditional Knowledge possible causes, study suggestions**
5:00 pm	**Dinner Break**
6:00 pm	**Mackenzie River Arctic cisco biology and population trends** Randal Pokiak, Tuktoyaktuk Hunters and Trappers Committee
6:30 pm	**Alaska Beaufort Arctic cisco biology and population trends** Bob Fechhelm, Ph.D., LGL Research Associates
7:00 pm	**Colville River Arctic cisco biology and population trends** Larry Moulton, Ph.D., MJM Research
7:30 pm	**Break**
7:45 pm	**Canadian Beaufort nearshore oceanography and Mackenzie River winter hydrology** David Fissel, ASL Environmental Sciences, Sidney, BC, Canada
8:15 pm	**Alaska Beaufort nearshore oceanography and Colville river winter hydrology** Kate Wedemeyer, MMS, Anchorage, AK
8:35 pm	**Possible global warming and Arctic oscillation effects small fish stocks** Two Crow (J.D. Schumacher, Ph.D.) Two Crow Environmental, Inc., Friday Harbor, WA
9:00 pm	**Adjourn**

MMS Alaska OCS Region
Arctic Cisco Workshop
November 18 and 19, 2003
Nuiqsut, Alaska

Final Agenda

Wednesday, November 19, 2003

1:00 pm	**Exploitation dynamics of small fish stocks like Arctic cisco** Jennifer Nielson, Biological Resources Division, U.S. Geological Survey, Anchorage, AK
1:30 pm	**Modeling approaches to understanding variability in small fish stocks** Terry Quinn, Ph.D., Fisheries and Ocean Sciences, University of Alaska, Juneau, AK
2:00 pm	**Break**

Integrated Arctic Cisco Research Planning

2:15 pm	**Divide into discussion groups**
2:30 pm	**Discussion group break-outs - Topics to be announced**
3:15 pm	**Present to full group**
3:45 pm	**Discussion group breakouts**
4:45 pm	**Present to full group**
5:00 pm	**Dinner break**
6:00 pm	**Reconvene as one group to design priority studies**
9:00 pm	**Closing comments**

APPENDIX D
Arctic Cisco Bibliography

Appendix D – Arctic cisco Bibliography

Arctic Cisco Workshop Reference List

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil, and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely, and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States, and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.