Otolith Workshop 2011: Decoding the Otolith

April 19 – 20, 2011

Juneau, Alaska

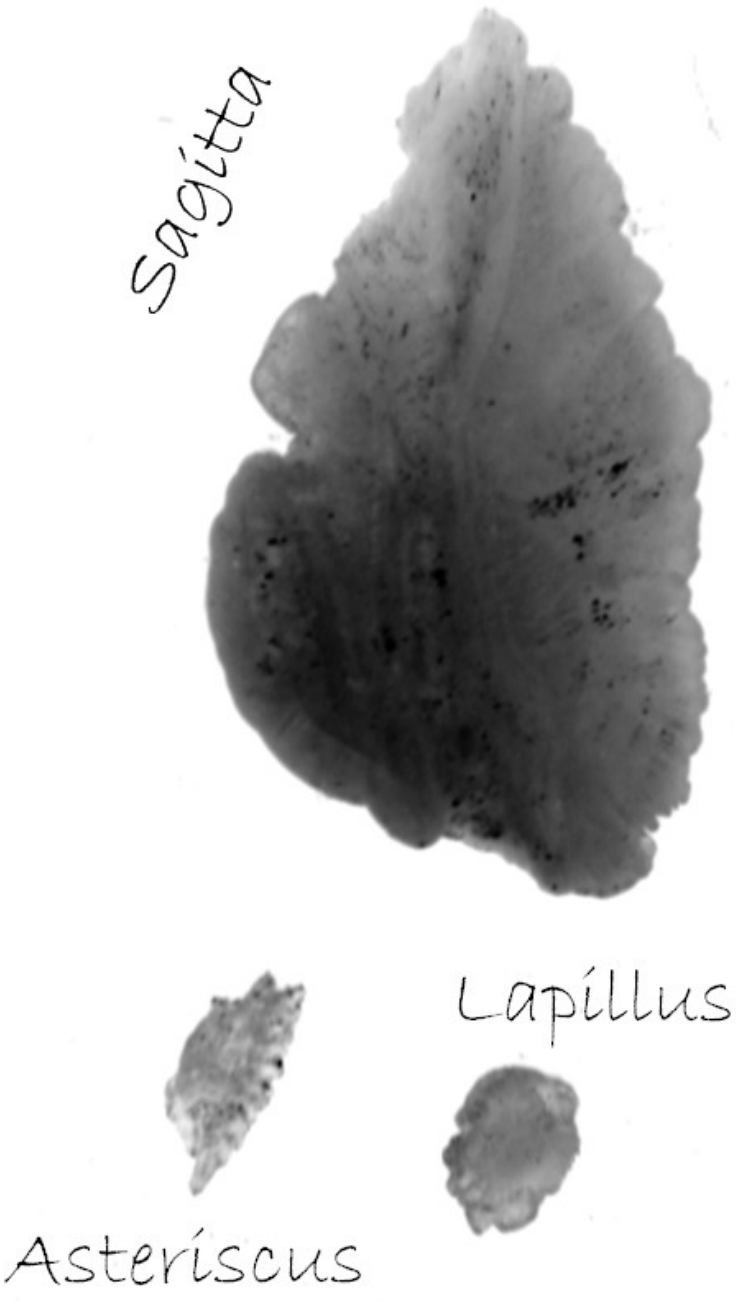
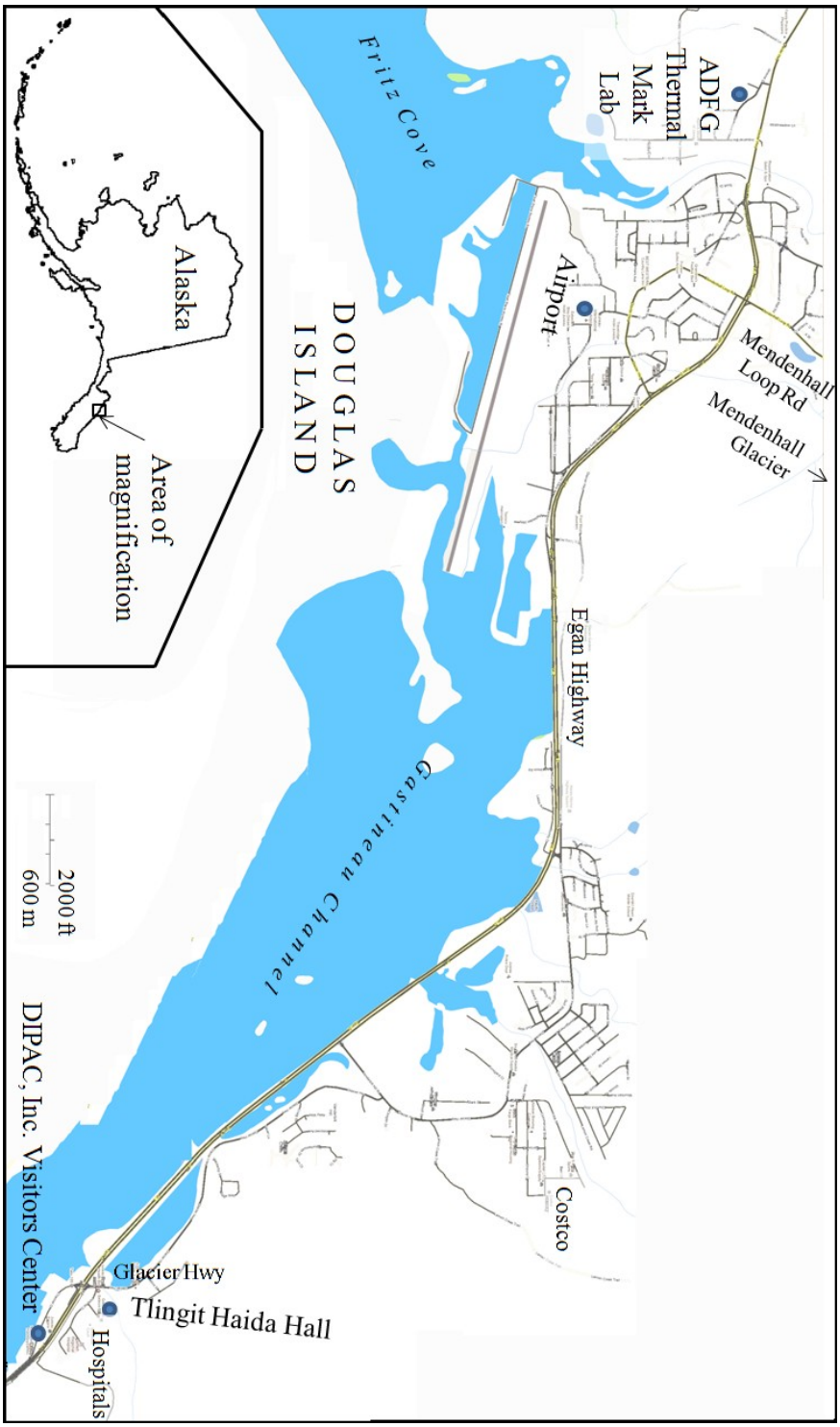


TABLE OF CONTENTS

WORKSHOP GOAL

Advance knowledge of otolith thermal marking techniques, otolith laboratory specific processes, and research related to otolith marking techniques and applications.

LOCATION



Directions from Egan road near the airport:

Drive south on Egan Dr (a.k.a. AK highway 7) 4.8mi

Turn left onto the Glacier Hwy, drive 300 ft

Turn right onto Hospital Drive, drive 300 ft

Turn left into the Tlingit Haida Hall parking lot

Addresses:

Tlingit Haida Hall

3235 Hospital Drive

Douglas Island Pink and Chum
Ladd Macaulay Visitor Center

2697 Channel Drive

SCHEDULE

Tuesday April 19

Location: Tlingit Haida Hall

	Time		Topic
	9:00-9:30		Opening remarks
Applications	9:30-9:50	Bev Agler	Eighteen years of thermal marking in Alaska
	9:50-10:10	Kathleen Jensen	Using thermal mark information in inseason fisheries management
	10:10-10:30	Malika Brunette	Using thermal marks to assess wild salmon migration routes and run timing
	10:30-10:50	Andrew Munro	Alternative methods for marking otoliths: enriched stable isotopes and calcein
			BREAK
Management	11:00-11:20	Joe Orsi	Southeast coastal monitoring (SECM) surveys to determine hatchery stock-id
	11:20-11:40	Andy Piston	Hatchery chum salmon straying in southeast Alaska
	11:40-12:00	Lorna Wilson	Chum salmon thermal mark detection and readability in southeast Alaska
	12:00 - 1:40		LUNCH
Hatch codes	1:40-2:00	Ron Josephson	Thermal mark assignment
	2:00- 2:20	Bev Agler	Voucher imaging and analysis
	2:20-2:40	Susan Doherty	Use of dichotomous keys for identification of salmon otolith hatch codes
			BREAK

Data	3:00-3:20	Tim Frawley	eOto: Otoliths in the 21st century
	3:20-3:40	Mike Wunderlich	DIPAC's thermal marking program
	3:40-4:00	Krysta Williams	Quantifying reader accuracy for thermal mark identification of Pacific salmon through the use of single blind pre-season test samples.
	4:00-5:00		Workshop activity/roundtable discussion
	6:00 - end		Social at Ladd Macaulay Visitors Center at Douglas Island Pink and Chum, Inc.

Wednesday April 20

Age /growth	9:00 - 9:20	Dion Oxman	Who says fish can't be sensitive?
	9:20-9:40	Brian Walker	Growth increment formation using otolith and scales of juvenile Chinook salmon
	9:40-10:00	Kris Munk	Biological pattern interpretation – aging – of long-lived species
			BREAK
Alternate methods	10:20-10:40	Ken Severin	Strontium mark detection and other methods of otolith analysis available at the Advanced Instrumentation Laboratory, University of Alaska Fairbanks.
	10:40-11:00	Karen Spaleta	Results from preliminary analysis of Mg marking trials on sockeye salmon otoliths with LA-ICP-MS.
			Concluding remarks
			Juneau and laboratory tours

ABSTRACTS

Eighteen years of thermal marking in Alaska

Beverly Agler, Lorna Wilson, and Megan Lovejoy

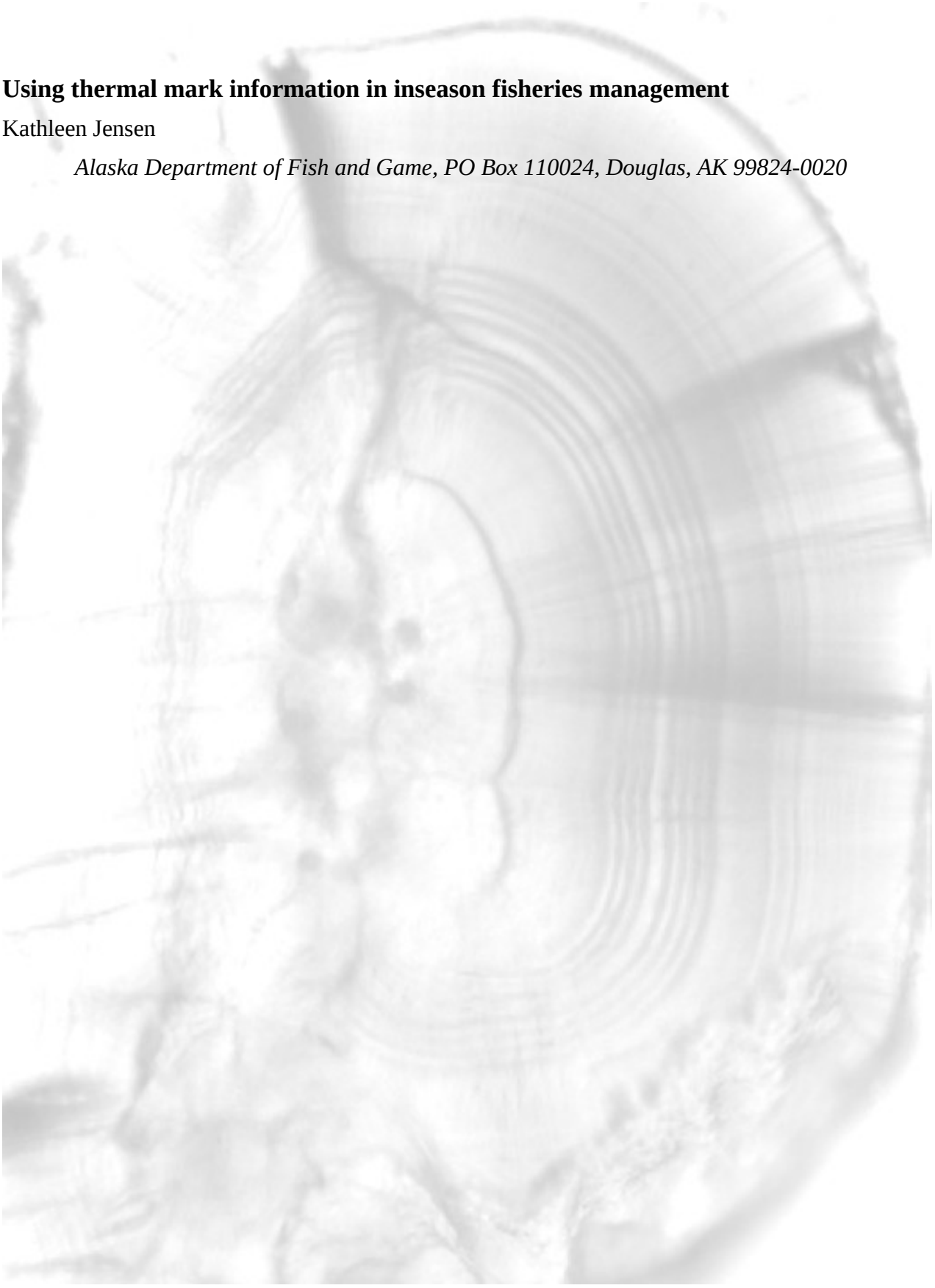
Mark, Tag, and Age Laboratory, Alaska Department of Fish and Game, 10107 Bentwood Place, Juneau, AK 99801, 907-465-3498

For the past 18 years, the Alaska Department of Fish and Game has been using otolith thermal marking of hatchery-raised salmonids to distinguish stocks and assist with management of mixed-stock fisheries. In addition, thermal marked otoliths have provided insight into the high seas distribution and movements of salmonids in the North Pacific Ocean and the Bering Sea. Analysis of thermal marked otoliths has replaced coded-wire tags in several instances. Alaska released approximately 1.3 billion thermal marked salmon (43% chum, 52% pink) in 2010, and the ADFG Thermal Mark lab processes ~20,000-30,000 otoliths per year from returning adult salmon. Within Alaska, several smaller labs exist at the hatcheries and the ADFG Cordova office to examine thermal marks on site and provide timely information for management of local fisheries. In addition, ADFG co-coordinates the North Pacific Anadromous Fish Commission Working Group on Salmonid Marking to facilitate and coordinate thermal marks throughout the North Pacific Ocean. The number of thermal marks ADFG applied to salmonids has increased steadily until 2001. From 2001-present ADFG has marked 62-78 different mark groups each year. Digital images of otolith thermal mark patterns and release information for all NPAFC countries are available on the Internet. Due to the fact that there are not “known” otoliths, thermal mark lab staff second read at least 50% of each year’s samples. Then Kappa and Latent Class statistics are used to compare and assess inter-reader accuracy. In this talk, I will the ADFG and NPAFC internet sites and discuss how thermal marks have been applied to fisheries research during the past 18 years.

Using thermal mark information in inseason fisheries management

Kathleen Jensen

Alaska Department of Fish and Game, PO Box 110024, Douglas, AK 99824-0020



Using thermal marks to assess McDonald Lake sockeye salmon migration routes and run timing

Malika T. Brunette, Andrew W. Piston, and Steven C. Heinl

2030 Sea Level Drive, Suite 205, Ketchikan, Alaska 99901

While most Alaskan thermal-marked salmon will return to their respective hatchery release sites, we will use lake-stocked, hatchery-reared fish as a proxy to assess the migration routes and run timing of wild McDonald Lake sockeye salmon. McDonald Lake supports an annual personal use fishery and contributes tens of thousands of sockeye salmon to the commercial net fisheries in Districts 1–7. At the 2009 Board of Fisheries meeting, McDonald Lake sockeye salmon were classified a management stock of concern, due to a series of escapements below the revised sustainable escapement goal of 55,000–120,000 fish. An Action Plan was adopted that contained measures to reduce harvest and improve stock assessment. Using information from CWT studies (1985, 1989, and 1990) and preliminary genetic stock identification data (2007), areas of high McDonald Lake sockeye salmon abundance were identified and area and time restrictions were developed to allow more McDonald Lake sockeye salmon to pass through the commercial fisheries. To supplement the wild stock and provide updated migration and run timing information, Southern Southeast Regional Aquaculture Association (SSRAA) collected eggs from Hatchery Creek, McDonald Lake's main spawning tributary, from 2007–2009 and reared the fish to full-term smolt at Burnett Inlet Hatchery. Smolts were returned to McDonald Lake, held in net pens at the mouth of Hatchery Creek for up to 24 hours, and released each spring from 2009–2011. All fish were thermal otolith marked allowing them to be tracked through the commercial fisheries when they return as adults in 2011–2014. ADF&G port sampling staff will collect heads from sockeye salmon intercepted in the District 1 drift gillnet fishery and Districts 1, 2, 4, 5, and 7 purse seine fishery for otolith dissection and mark determination at the Mark lab in Juneau. Otolith data from ongoing transboundary sockeye salmon studies in the District 6 and 8 drift gillnet fisheries will be incorporated into the analysis to help evaluate the Action Plan's effectiveness at reducing the commercial harvest of McDonald Lake sockeye salmon.

Alternative methods for marking otoliths: enriched stable isotopes and fluorescent dyes

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2: *Southern Seas Ecology Laboratories, DX 650 418, School of Earth and Environmental Sciences, University of Adelaide, South Australia 5005, Australia*

3: *Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, 123 Brown Street, Heidelberg, Victoria 3084, Australia*

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Over the past 30 years, more than 60 million native freshwater fish have been bred in captivity and released into the Murray-Darling Basin, Australia to enhance fish populations. Although stocking of hatchery-reared fish continues to be used as a major management tool for inland fisheries, very little is known regarding the fate of stocked fish or their impacts on resident fauna because there has not been a practical method available to distinguish between hatchery-produced fish and wild fish. We tested and refined new methods of marking fish and their otoliths with the goal of developing techniques that could be used routinely in hatcheries with minimal interruption to standard culture methods. Fish at two life stages (larvae and fingerlings) were reared in water with various concentrations of enriched barium for different exposure periods to mark their otoliths. We also attempted to mark the otoliths of fish indirectly by injecting the maternal parent with enriched isotopes. Lastly, osmotic induction methods (immersion of fish in hypersaline water prior to marking with fluorescent dyes) were investigated to determine if osmotic stress could be used to speed up and/or enhance the marking process. In addition, we developed a portable detection unit to allow for routine, non-lethal detection of calcein marked fish in the field. Costs and benefits of each method were estimated and compared to those of more traditional marking methods (e.g. thermal marking, coded wire tags). Our results suggest that any of these methods could be an effective means of mass-marking hatchery-reared fish.

Southeast Coastal Monitoring (SECM) surveys to sample otolith-marked salmon stocks

Emily A. Fergusson[1], Joseph A. Orsi[1], and Molly V. Sturdevant[1]

1: *Alaska Fisheries Science Center, Auke Bay Laboratories, 17109 Pt. Lena Loop Rd., Juneau, Alaska 99801*

Researchers from the Southeast Coastal Monitoring (SECM) project have been studying juvenile salmon and their associated marine ecosystems since 1997. This annual research project collects time series data related to juvenile salmon in order to: 1) better understand the early marine ecology of juvenile salmon in marine ecosystems, 2) forecast adult salmon returns, 3) determine stock-specific migration and growth rates, and 4) examine hatchery-wild stock salmon interactions. Addressing many of these objectives is made possible through the at-sea recovery of otolith-marked juvenile salmon captured along seaward migration corridors. Most of these otolith-marked recoveries are from chum and sockeye salmon released months earlier from Southeast Alaska (SEAK) hatcheries or remote release localities. To date, the SECM project has analyzed over 21,000 juvenile salmon for otolith marks in the northern and southern regions of SEAK from June to September. This presentation will review the information obtained from sampling otolith marked juvenile salmon at sea.

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Marine Fisheries Service, NOAA.

Hatchery chum salmon straying in southeast Alaska

Andrew W. Piston

Alaska Department of Fish and Game, Division of Commercial Fisheries, 2030 Sea Level Drive, Suite 205, Ketchikan, Alaska 99901

Hatchery production of chum salmon in Southeast Alaska increased dramatically over the last three decades, from 8.7 million fry released at eight locations in 1980, to 380 million fry released at 21 locations in 2008. Hatchery fish accounted for an average of 79% of the commercial harvest of chum salmon—86 million fish—over the 10 years, 1999–2008. Alaska's Sustainable Salmon Policy states that "wild salmon stocks and fisheries on those stocks should be protected from adverse impacts from artificial propagation and enhancement efforts (5 AAC 39.222)." High rates of straying of hatchery fish into streams would make it difficult for fisheries managers to monitor wild chum salmon populations through standard survey techniques, thereby reducing the ability of the Alaska Department of Fish and Game (ADF&G) to formulate meaningful escapement goals and test whether those goals are being met for wild chum populations as required by the Sustainable Salmon Fisheries Policy. Chum salmon spawning abundance is currently monitored though a series of peak survey estimates at 88 index streams upon which escapement goals are based. An obvious criticism of this approach, however, is that trends in the escapement indices may have been affected by an increase in hatchery strays. From 2008–2010, ADF&G collected otoliths from chum salmon at index streams throughout Southeast Alaska in an effort to better understand the geographic extent of hatchery chum salmon straying and to determine how hatchery strays were affecting estimates of wild chum salmon abundance. Sample sizes of greater than 50 fish were collected from 33 of the 81 summer chum salmon index streams in Southeast Alaska and the proportion of hatchery fish was over 5% in 21 of these systems. In 2010, we estimated that approximately 14% of the chum salmon in the Northern Southeast Inside Subregion escapement index (63 streams) were hatchery fish. The widespread presence of hatchery fish in the region's chum salmon index streams will require the department to qualify estimates of wild chum salmon abundance and periodically reassess the proportions of hatchery fish in the escapement indices.

Chum salmon thermal mark readability and detection in southeast Alaska

Lorna Wilson

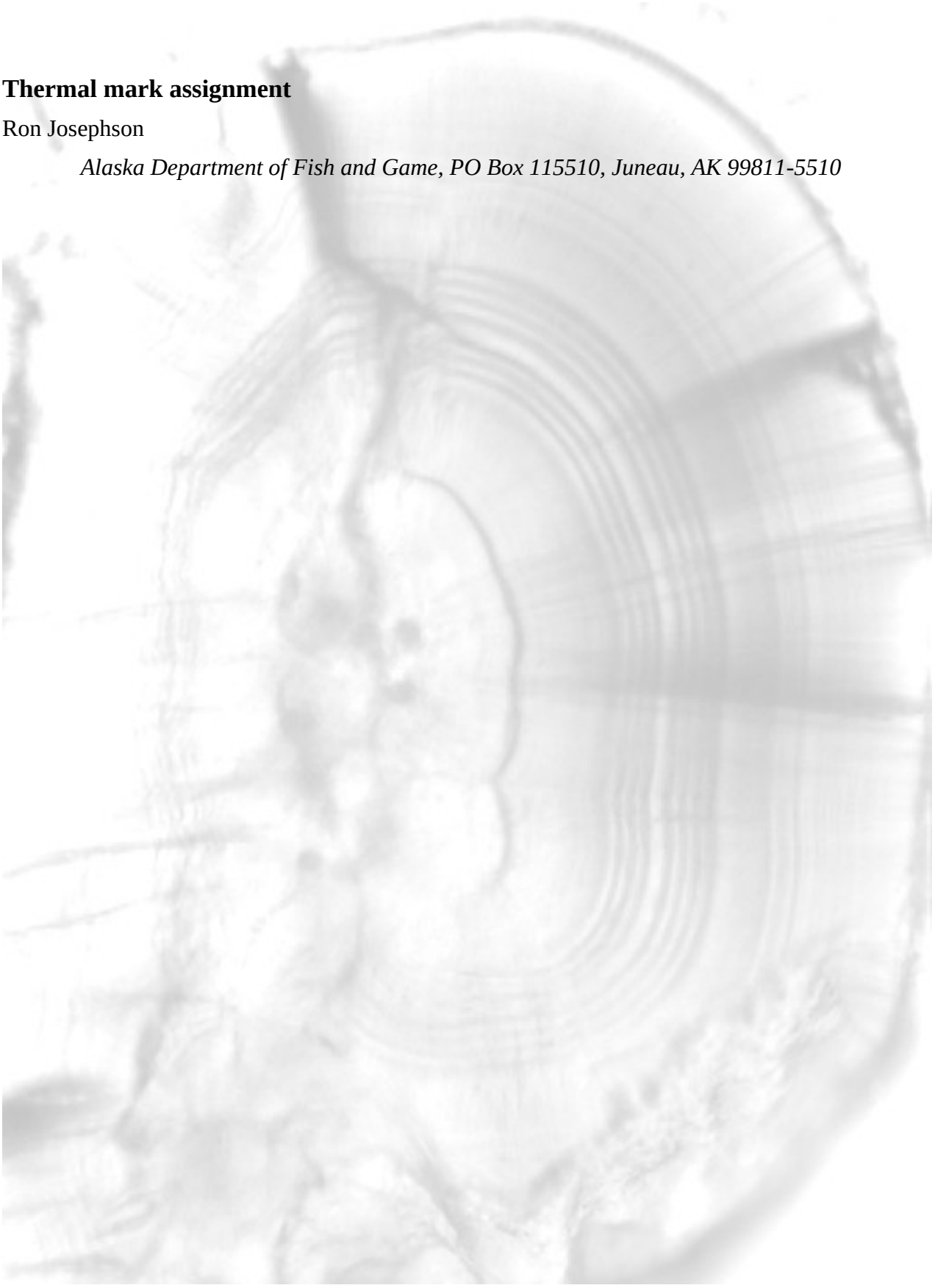
Alaska Department of Fish and Game, Division of Commercial Fisheries, Mark, Tag and Age Laboratory, Thermal Mark Lab,10107 Bentwood Place, Juneau, Alaska 99811

Thermal marks on chum salmon otoliths are difficult to read due to natural variation in ring structure. Correct identification of marks, however, is essential for meaningful management action by the state. The Alaska Department of Fish and Game (ADFG) thermal mark laboratory maximizes the accuracy of information provided to the Alaskan fisheries managers by including two independent reads with a third read to resolve any differences. Douglas Island Pink and Chum, Inc. (DIPAC) and Southern Southeast Regional Aquaculture Association, Inc. (SSRAA) maintain their own laboratories and have their own criteria for mark determination. Otoliths from the Ketchikan, Juneau, Tenakee, and Sitka regions were examined by the ADFG, DIPAC and SSRAA labs to assess mark identification reliability in for mark recoveries in the 2009 and 2010 seasons. Latent class models were used to assess the reliability and proportion of thermal mark presence for each sample region. The *Kappa* statistic was used to indicate how well individual marks were identified by readers as the level of reader agreement for groups of marks. Initial results from SSRAA and ADFG readers show high agreement among mark groups, areas, labs and readers. These initial results suggest that there is high reliability in mark identification for chum salmon otoliths, even though they are difficult to read.

Thermal mark assignment

Ron Josephson

Alaska Department of Fish and Game, PO Box 115510, Juneau, AK 99811-5510



Voucher imaging and analysis

Bev A. Agler[1] and Megan W. Lovejoy[1]

1: Alaska Department of Fish and Game, Division of Commercial Fisheries, Mark, Tag and Age Laboratory, Thermal Mark Lab,10107 Bentwood Place, Juneau, Alaska 99811

Accurate thermal mark identification depends greatly on the analysis and imaging of voucher samples: marked eggs, fry and smolt. These samples are sent to the Thermal Mark Lab in Juneau after inducing a thermal mark. The Thermal Mark Lab uses these samples to catalog, analyze and image each unique mark group. The mark group variability is quantified using appearance, ring counts and distances. Annotated images and measurements are entered into an online reference collection that assists in the identification of thermal marks and creates feedback describing mark quality to hatchery managers.

Use of dichotomous keys for identification of salmon otolith hatch codes

Susan K. Doherty[1], Michelle A. Leitz[1], Alan J. Murray[1]

1: SSRAA, 14 Borch Street, Ketchikan, Alaska 99901

An identification key, also known as a taxonomic key, is a useful tool for identifying unknown organisms. Keys are constructed so that the user is presented with relevant information in a structured form.

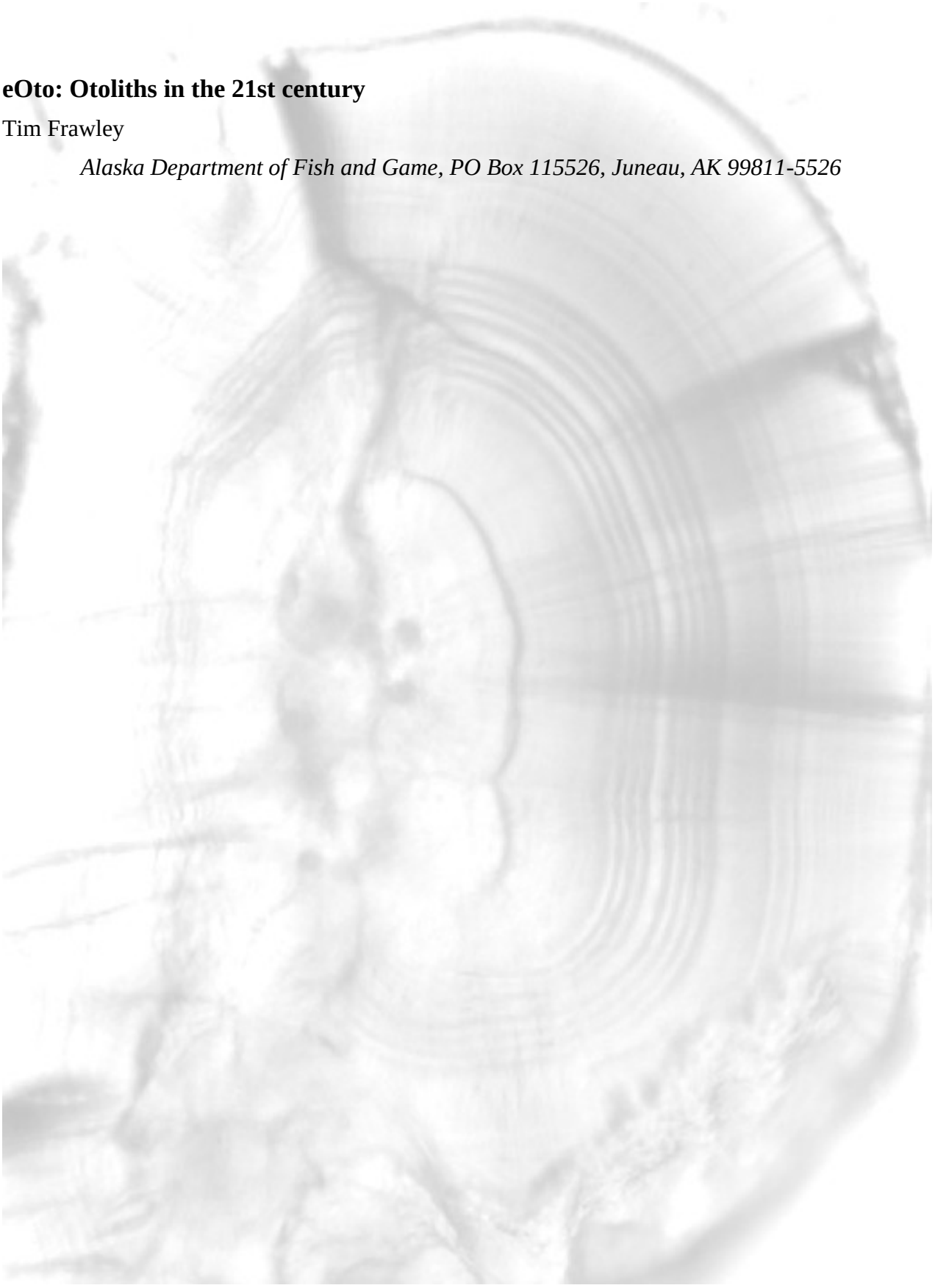
Keys that are based on subsequent choices between two character states are called dichotomous keys. Such keys are written using pairs of contrasting characteristics (known as couplets), where the choice of one character state leads to another couplet until the organism is identified.

Thermal mark readers may find this format useful in identifying hatchery origin when identical hatch codes are used for multiple brood years or at differing sites and where uneven spacing makes band separation less obvious (i.e. 4,2,2H looks like 4,4H). Besides aiding in the reading processes, an agreed upon structure and set of characteristics that have been developed by multiple readers at the beginning of a reading season can lead to more consistent reads of difficult marks between readers.

eOto: Otoliths in the 21st century

Tim Frawley

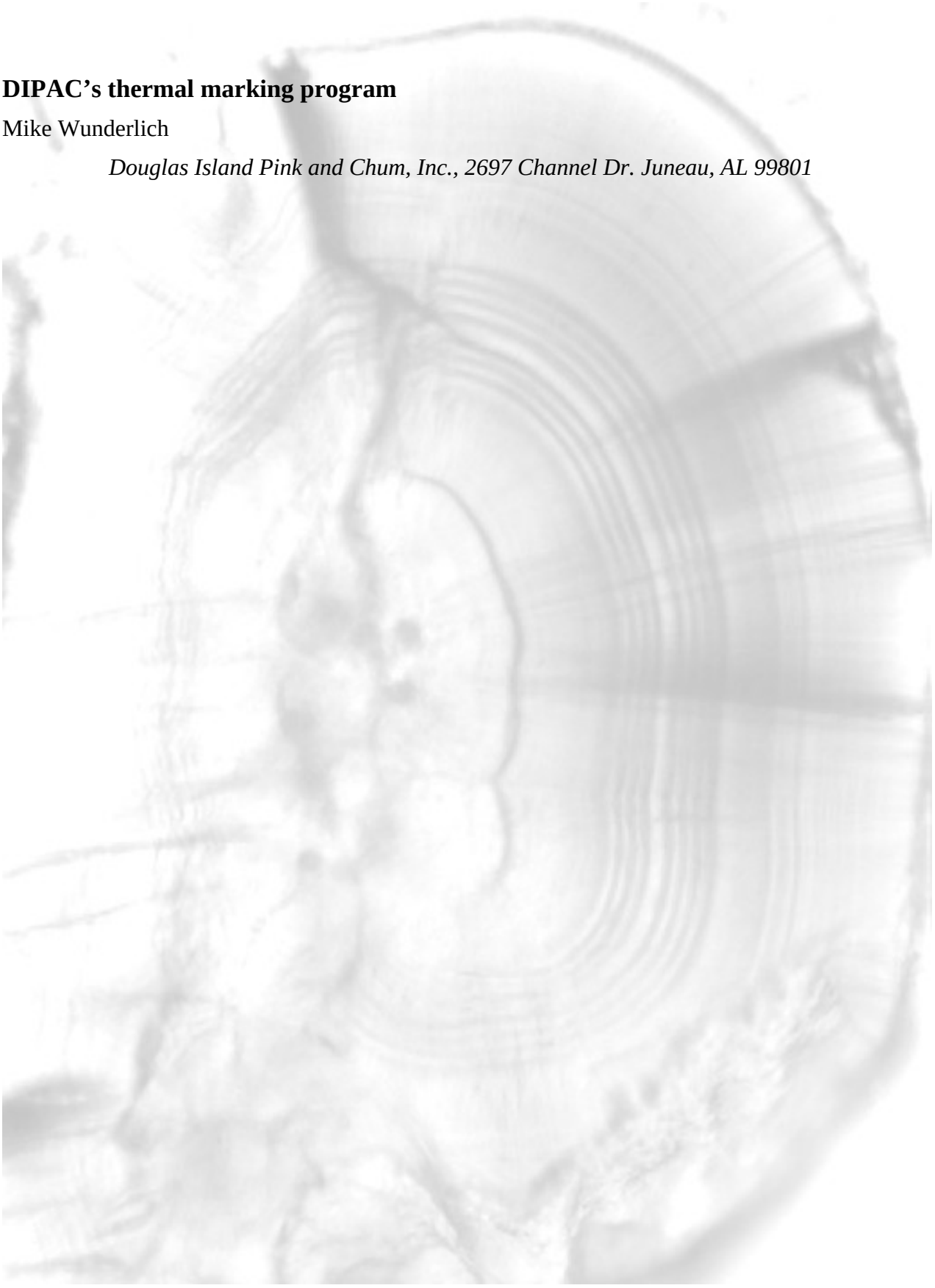
Alaska Department of Fish and Game, PO Box 115526, Juneau, AK 99811-5526



DIPAC's thermal marking program

Mike Wunderlich

Douglas Island Pink and Chum, Inc., 2697 Channel Dr. Juneau, AL 99801



Quantifying reader accuracy for thermal mark identification of Pacific salmon through the use of single blind pre-season test samples

Krysta D. Williams[1] and Steve D. Moffitt[1]

1: *Alaska Department of Fish and Game, Cordova Otolith Laboratory, PO Box 669, Cordova, Alaska 99574*

Effective management of Pacific salmon species in Prince William Sound depends on accurate and timely analysis of otoliths for mark status and mark identification. To ensure reader proficiency, all Cordova Otolith Laboratory staff read a minimum of 100 randomly selected juvenile Pacific salmon otoliths prepared in a single-blind format where mark status and mark identification are known. Separate blind tests are conducted for each species and only otolith marks from brood years expected to return in the upcoming season are examined. Readers' results are analyzed for accuracy by mark status, marking facility, and mark identification. In addition, results are compared among readers. Before reading specimens with unknown mark status and unknown mark identification, most readers correctly identify mark status for 99–100% of specimens in a given blind test sample. Through this process we are able to maximize the benefits of individualized training and identify specific marks and variants that warrant additional attention by all team members prior to production reading.

Workshop activity

This workshop is intended to be inclusive, educational, interactive, collaborative, and consensus building. There are two main parts and a conclusion:

Part 1

Step 1. Group into sitting around a specific table that shows the subject area most interested in/knowledgeable about (these subjects may include: lab specific processes, chum salmon thermal marks, data management, data integrity/quality control, alternative marking techniques, otolith aging, laboratory collaboration).

Step 2. List specific areas of research/interest/concern within the subject area listed at that table for a set amount of time.

Step 3. Each group then moves to the next table's subject area and provides additional comments to that table's specific areas of research/interest/concern for a set amount of time.

Step 4. Continue to move as a group until all groups visit each table.

Part 2

Step 1. Groups return to their original subject area and suggest specific methods for addressing these areas of interest/concern.

Step 2. Groups then move to the other subjects, visiting each table for a set amount of time.

Step 3. Each participant is given 3 sticky tabs per subject area. These sticky tabs will indicate votes for the most effective, interesting, and useful methods for addressing the areas of interest and concern for each subject.

Conclusion

At the conclusion, a spokesperson from each group summarizes the three top areas of interest/research/concern and the collaborative methods for addressing these areas.

The outcome from this activity is an outline of areas of research/interest/concern as well as specific methods for addressing those areas.

Who says fish can't be sensitive?

Dion Oxman[1]

1: *Alaska Department of Fish and Game, Division of Commercial Fisheries, 10107 Bentwood Place, Juneau, Alaska 99811*

Exposure to stress of often used to the mark otoliths of hatchery reared salmon so that they can be distinguished from their wild counterparts if they are recovered from a mixed stock fishery. Little is known, however, about how that stress affects fish development and health. This presentation will discuss some preliminary investigations into how hatchery-induced stress deriving from temperature fluctuation and hybridization affects fish physiology and otolith morphology.

Growth increment formation using otolith and scales of juvenile Chinook salmon

Brian M. Walker[1], Trent M. Sutton[1]

1: *University of Alaska-Fairbanks, School of Fisheries and Ocean Sciences, 905 Koyukuk Drive Fairbanks, AK 99775*

Freshwater growth of juvenile Chinook salmon *Oncorhynchus tshawytscha* has been found to strongly influence survival and recruitment to the adult population. Retrospective analysis using daily increments on otoliths and circuli on scales has emerged as a tool to measure salmon growth at previous ages. Fish size and growth is assumed to be accurately reflected by otolith increments and scale circuli, but this assumption is rarely validated. We will validate the relationship between body size and growth and width between otolith growth increments and scale circuli in juvenile Chinook salmon. Twenty-four 110-L aquaria will be stocked at densities of 10 or 20 fish (12 aquaria for each density) and tanks will be assigned a feeding ration of 1%, 2%, or 4% of total fish body weight to simulate low growth, maintenance, and high growth conditions, respectively, during the 122-d experiment. Growth increments on the otoliths and scales will be counted and measured to examine the periodicity of otolith increment and circuli formation and to determine the effects of density and food ration on increment and circuli deposition. This study will assist fisheries managers by testing the accuracy of the assumption that fish body size and growth is reflected by otolith and scale size and growth-increment formation. If the relationship between body size, hard structure size at age, and growth chronology can be validated, the findings of my study can be used to ascertain body size at past ages and interpret the meaning of retrospective growth.

Biological pattern interpretation – aging – of long-lived species

Kristen Munk

Alaska Department of Fish and Game Age Determination Unit, PO Box 115526, Juneau, AK 99811

The ADF&G Age Determination Unit is a statewide data service responsible for producing ages for over 25 species of groundfish and 5 species of invertebrates. The age structures arise from commercial and research harvests, and our age data are returned to State fishery managers. Many of the species we encounter have maximum ages which exceed 100 years; all species have maximum ages over 30 years.

Interpreting growth patterns of long-lived species is uniquely different than aging scales or otoliths of short-lived species, or thermal mark decoding. While some aging of long-lived species consists of "counting" of lines —albeit many— most species aged at the Age Determination Unit consists of "interpreting" complex growth patterns. Training to interpret complex growth patterns can take months to years. Age reading error is measured through precision testing and attenuated through calibration efforts between age readers; however, "precision" does not imply accuracy.

Accurate age estimations, and the criteria producing them, are validated or corroborated through a variety of methods. Popular and reliable validation methods include tagging/marking (and recovery) of known-age fish, and the "bomb radiocarbon chronometer". We have extensively applied the bomb radiocarbon method to validate a subset of our age reading of >10 species of fish. We are also developing an "otolith accretion model" for walleye pollock, which documents mean yearly accretion in otoliths of fish now under culture for 5 years. We have also recorded well over 100,000 age structure measurements for over 30 species of fish, and will be modeling these objective measures (by species) in order to create a data filter that will be run against 100% of our age data in order to highlight outliers that might benefit from a second interpretation.

Results from LA-ICP-MS analysis of initial magnesium marking trials of sockeye salmon otoliths

Karen J. Spaleta[1], Gary Martinek[2], Michael (Doc) Dansby[2]

1: *Advanced Instrumentation Laboratory, University of Alaska Fairbanks, PO Box 755780, Fairbanks, AK 99775-5780*

2*: PWSAC Gulkana Hatchery, PO Box 1110, Cordova, Alaska 99574*

The Gulkana sockeye hatchery fish have been marked with strontium (Sr) since 1999. As there are three release sites for the sockeye fry, it would be beneficial from a hatchery management standpoint to be able to track fish to each release site via a marking method that integrated with minimal effort into the current marking and reading protocols. Three test batches of fry were marked in the conventional manner with Sr, and concurrently with 3 different levels of magnesium (Mg) for 24 hours. No mortality was observed. Four weeks post marking, the fry were dispatched and prepared for analysis in the same manner as the Sr voucher samples. After confirming via scanning electron microscopy that the fry otoliths were marked with Sr, they were analyzed via LA-ICP-MS (laser ablation inductively coupled plasma mass spectrometry) for the presence of Mg. Mg & Sr were both detected in the otoliths. The high concentration Mg mark was distinguishable from the two lower concentration Mg marks. This yields the potential of three distinct marks easily integrated into the current procedures: Sr only, Sr + high Mg, and Sr + low Mg. Further trials will include optimizing the Mg levels, and possibly trials with barium.

Strontium mark detection and other methods of otolith analysis available at the Advanced Instrumentation Laboratory, University of Alaska Fairbanks

Kenneth P. Severin[1]

1: *Box 755780, University of Alaska Fairbanks, Fairbanks, AK 99775-5780*

For applications such as real time stock identification, rapid analysis is essential. Sample collection, preparation, data acquisition, and analysis must be considered not only in terms of cost, but also in terms of time.

Since 1999 the Gulkana Hatchery has been marking all sockeye fry with strontium (Sr) by 24 hour immersion in a Sr enriched bath. This creates a Sr-enriched band in the aragonite matrix (calcium carbonate, $CaCO_3$) of the otolith. This band is readily visible using back-scattered electron microscopy (BSEM), allowing for rapid identification of marked otoliths. Sample preparation is relatively simple and consists of sectioning the otolith individually with a series of grinding papers so that the core region is exposed. A trained worker can prepare 6-7 otoliths per hour. After sectioning, the otoliths are given a conductive coating of carbon (approximately one hour) and visually examined. With well prepared samples up to 30 individuals per hour can be read. Recording an image (if necessary) of the otolith takes much longer (up to several minutes) and it is fair to say that record keeping (file names, filling out presence/absence records, etc.) takes as least as much time as the actual reading.

BSEM is only one of several analysis methods suitable for otoliths at AIL. X-rays that allow the determination of the elemental composition of the sample are also produced in the electron microscope. These x-rays are often used in the Gulkana work to verify that a bright mark is indeed the result of Sr enrichment. They can be used for precise quantification of more subtle and complex signals such as those found in anadramous individuals. These signals are more time consuming to collect and interpret, and sample preparation may be slightly more difficult.

AIL also has a laser ablation inductively coupled mass spectrometer (LA-ICP-MS) for compositional measurements at concentrations below detection by x-ray, and a micro-focusing x-ray diffractometer (XRD) for determination of crystal structure (aragonite vs. vaterite). Sample preparation for these methods is similar enough to that used in electron microscopy so that a single sample could be examined by all three methods.

Growth increment formation using otolith and scales of juvenile Chinook salmon

Brian M. Walker[1], Trent M. Sutton[1]

1: *University of Alaska-Fairbanks, School of Fisheries and Ocean Sciences, 905 Koyukuk Drive Fairbanks, AK 99775*

Freshwater growth of juvenile Chinook salmon *Oncorhynchus tshawytscha* has been found to strongly influence survival and recruitment to the adult population. Retrospective analysis using daily increments on otoliths and circuli on scales has emerged as a tool to measure salmon growth at previous ages. Fish size and growth is assumed to be accurately reflected by otolith increments and scale circuli, but this assumption is rarely validated. We will validate the relationship between body size and growth and width between otolith growth increments and scale circuli in juvenile Chinook salmon. Twenty-four 110-L aquaria will be stocked at densities of 10 or 20 fish (12 aquaria for each density) and tanks will be assigned a feeding ration of 1%, 2%, or 4% of total fish body weight to simulate low growth, maintenance, and high growth conditions, respectively, during the 122-d experiment. Growth increments on the otoliths and scales will be counted and measured to examine the periodicity of otolith increment and circuli formation and to determine the effects of density and food ration on increment and circuli deposition. This study will assist fisheries managers by testing the accuracy of the assumption that fish body size and growth is reflected by otolith and scale size and growth-increment formation. If the relationship between body size, hard structure size at age, and growth chronology can be validated, the findings of my study can be used to ascertain body size at past ages and interpret the meaning of retrospective growth.

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