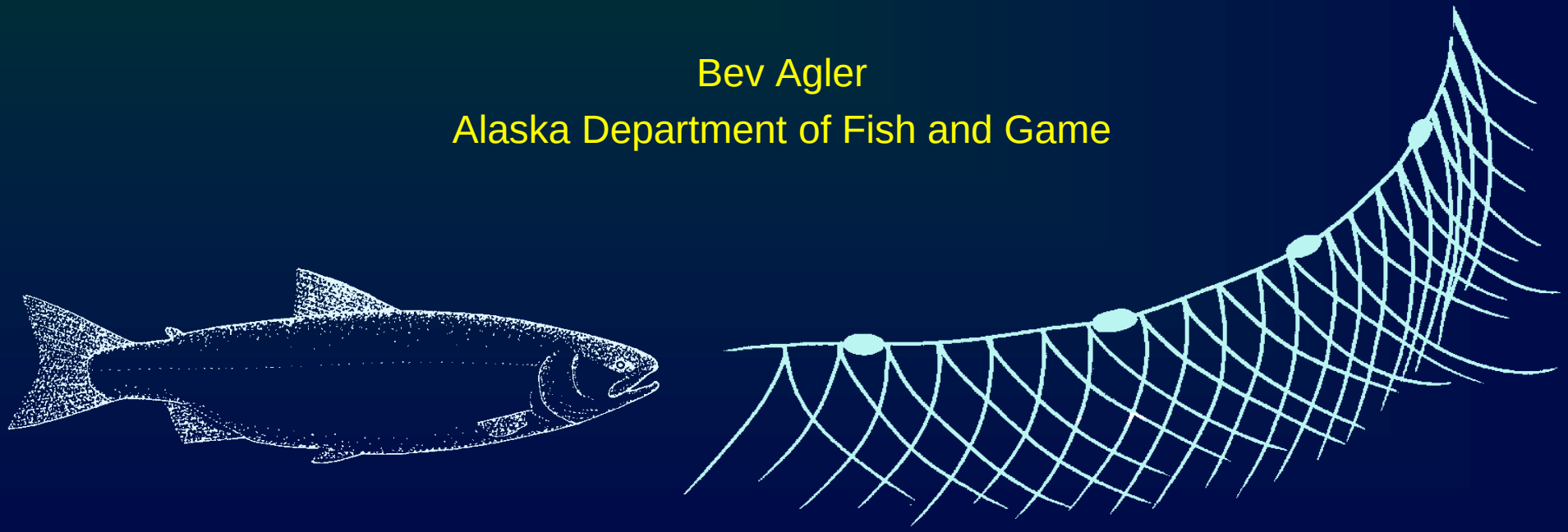
Thermal marking in Alaska and the North Pacific Ocean: Its Application to Management of Pacific Salmon

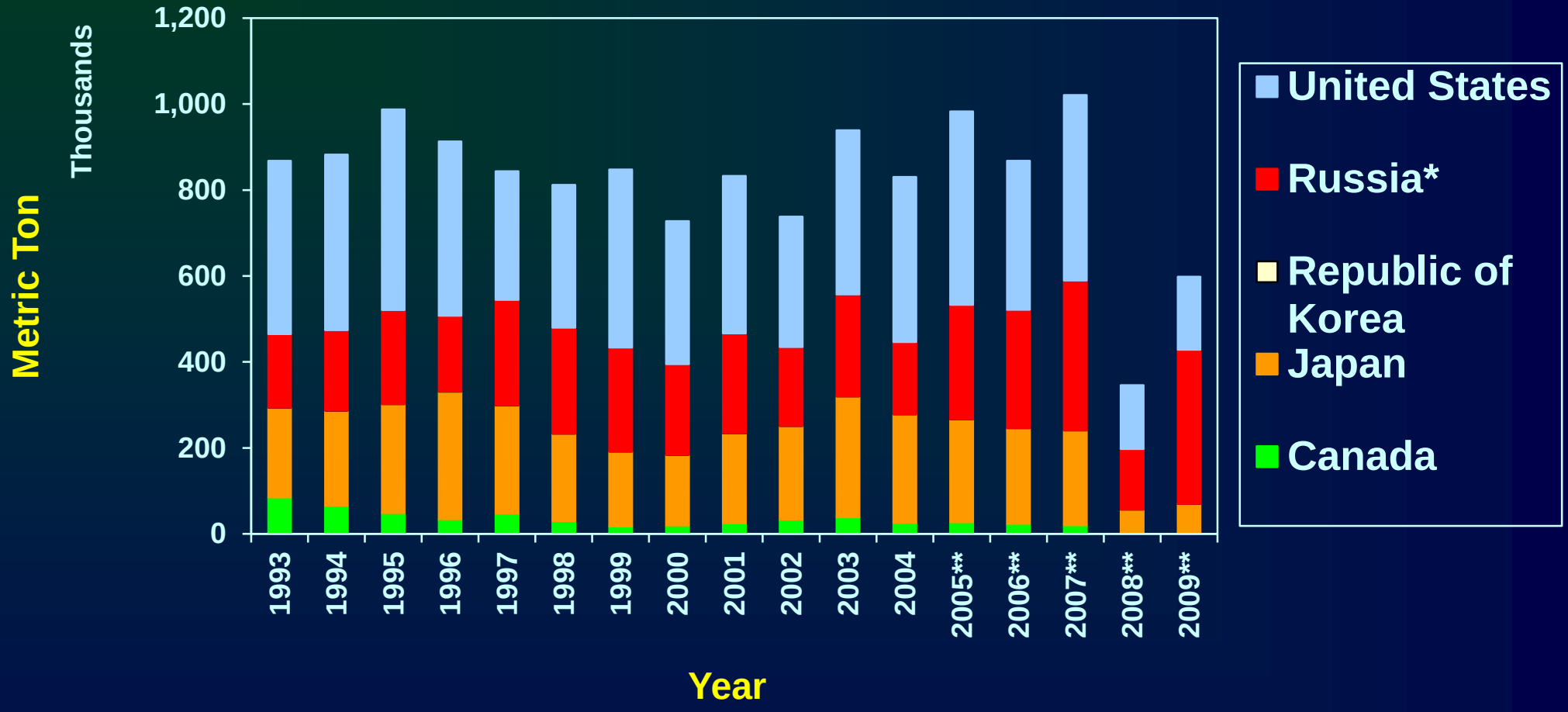
Bev Agler
Alaska Department of Fish and Game



Why Mark Fish?

- Manage salmon fisheries
  - 1992 Convention for the Conservation of Anadromous Stocks in the North Pacific (formed NPAFC)
  - 1985 Pacific Salmon Treaty: US – Canada
    - Transboundary Rivers
- Special projects
  - High seas distribution & migrations
  - Survival
  - Hatchery production
    - Test feeding strategies

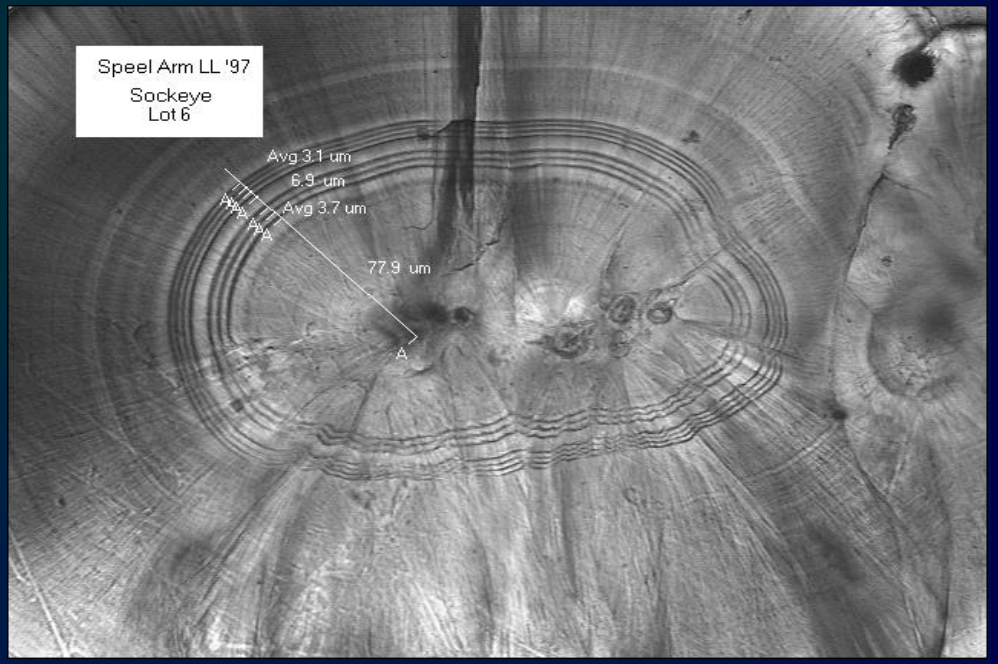
NPAFC Commercial Catch



Average: ~872,000 metric tons per year since 1993

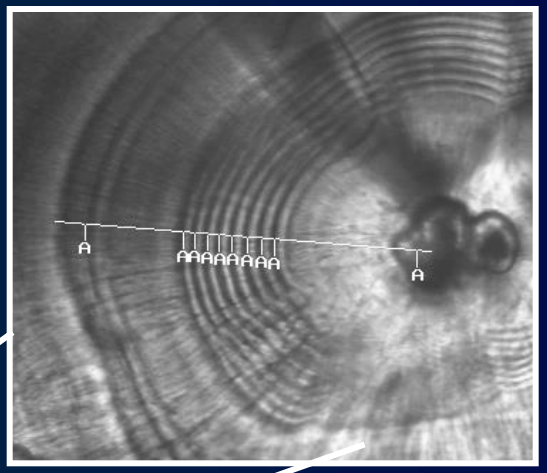
Mark Technologies

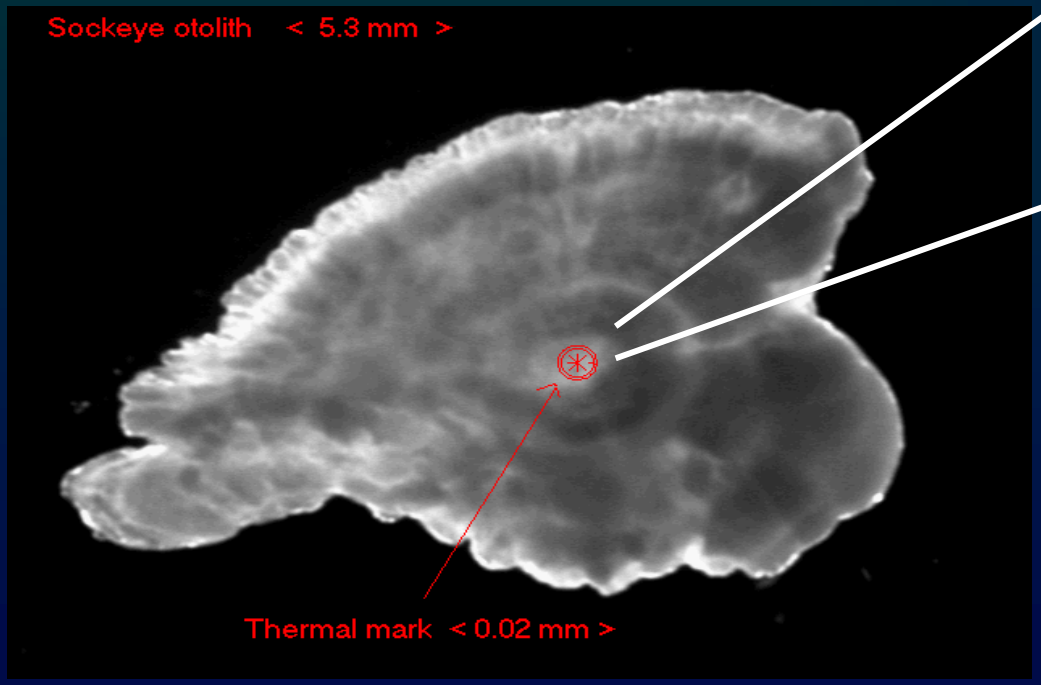
- Otolith Marks
  - Thermal
  - Dry
  - Chemical
    - Calcein
    - Alizarin
    - Strontium
- Tags
  - Coded wire
  - PIT
  - Streamers



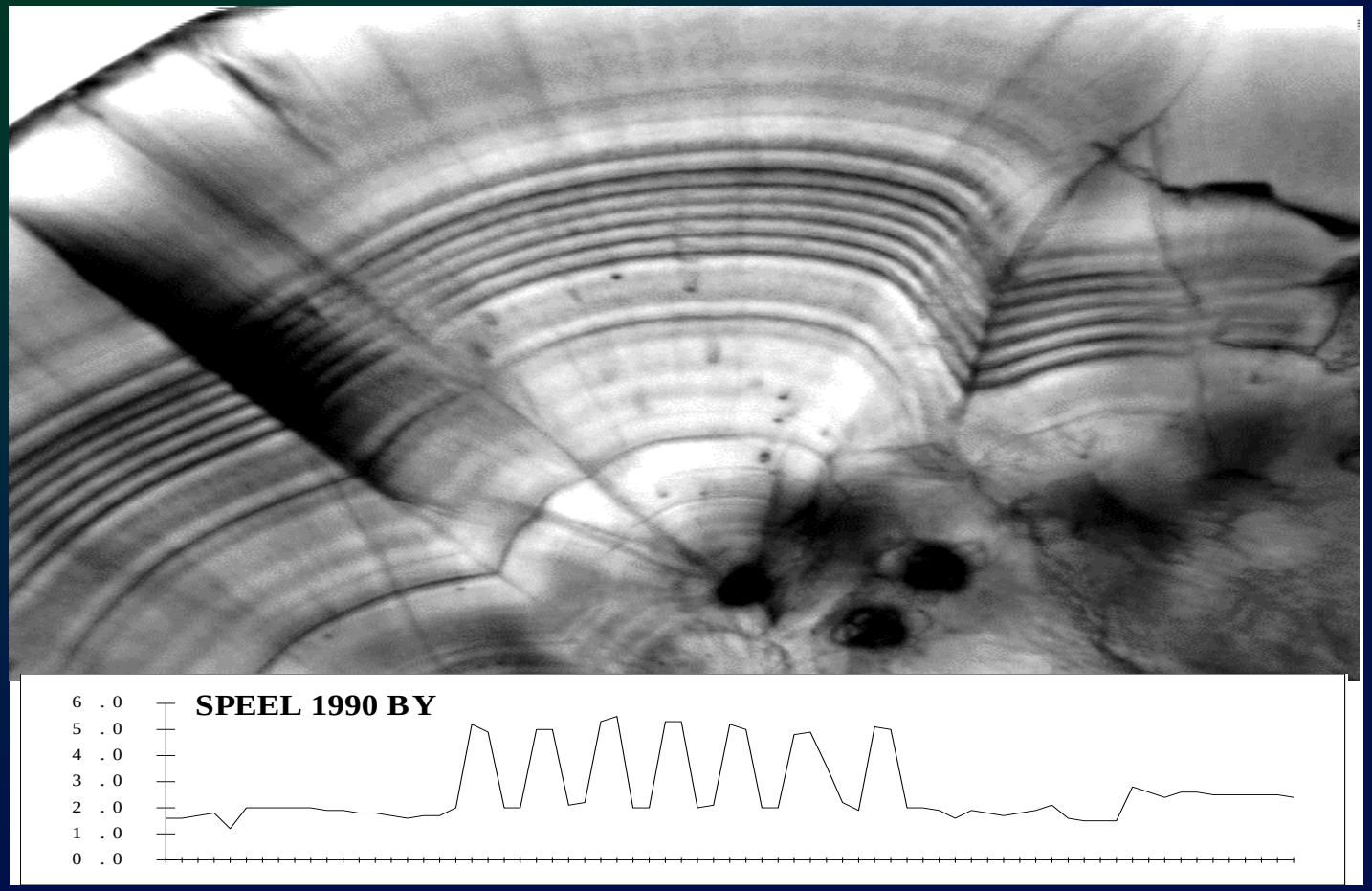
Otolith Marking

- Thermal Marking
- Alternative marking methods



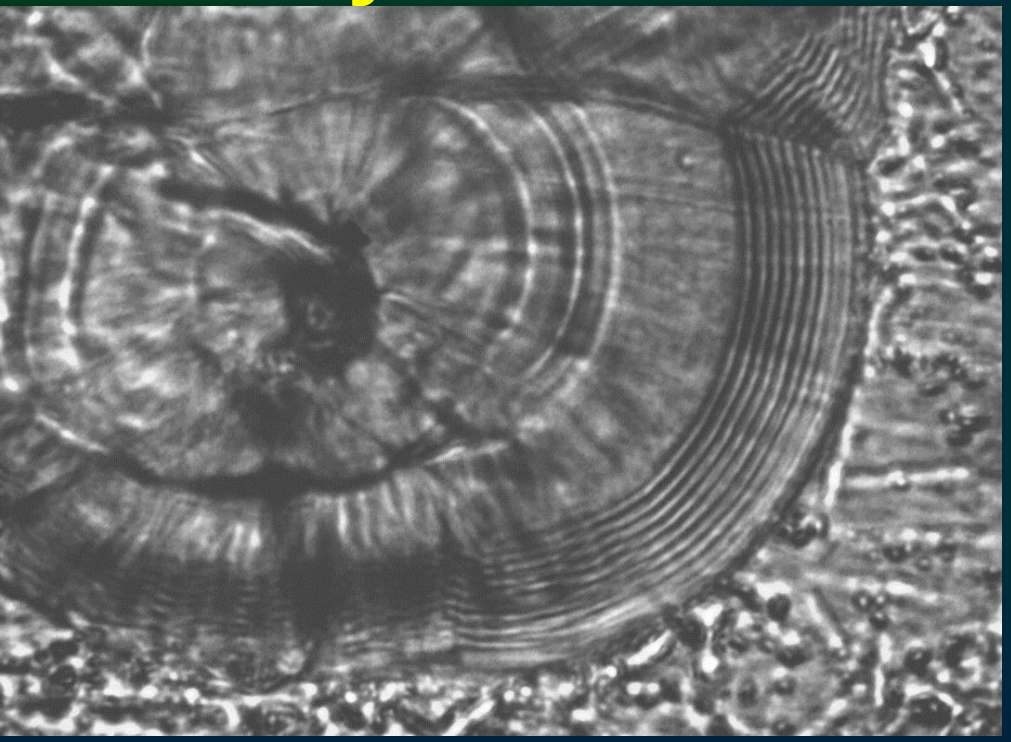


Thermal Marked Otolith



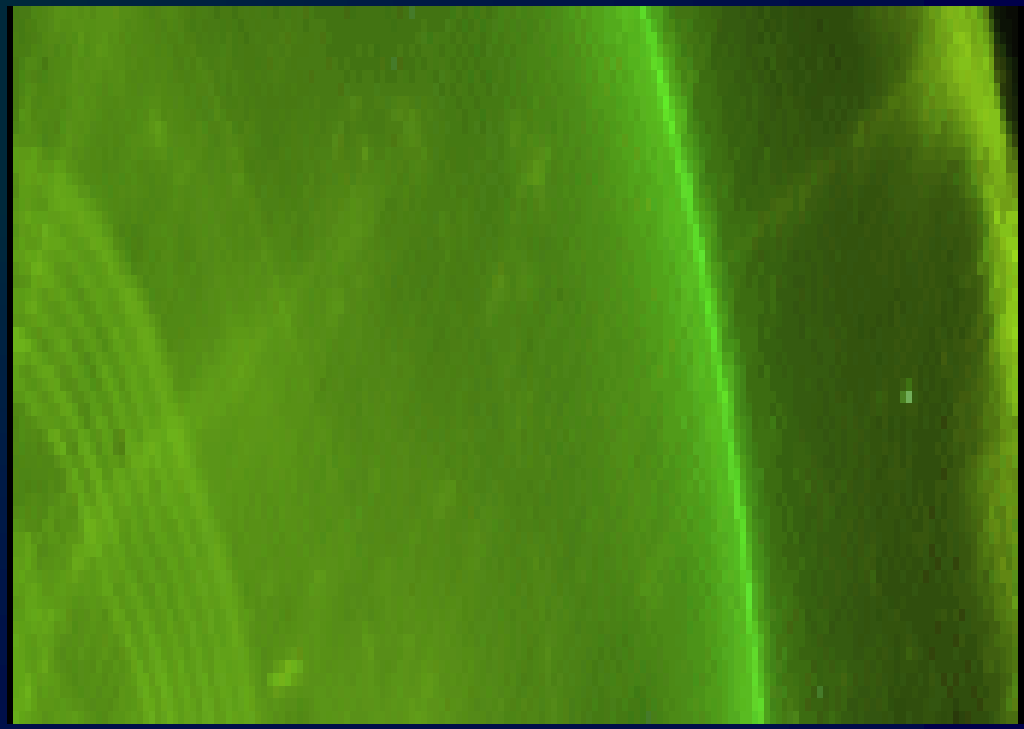
Visible under normal light

Dry Mark



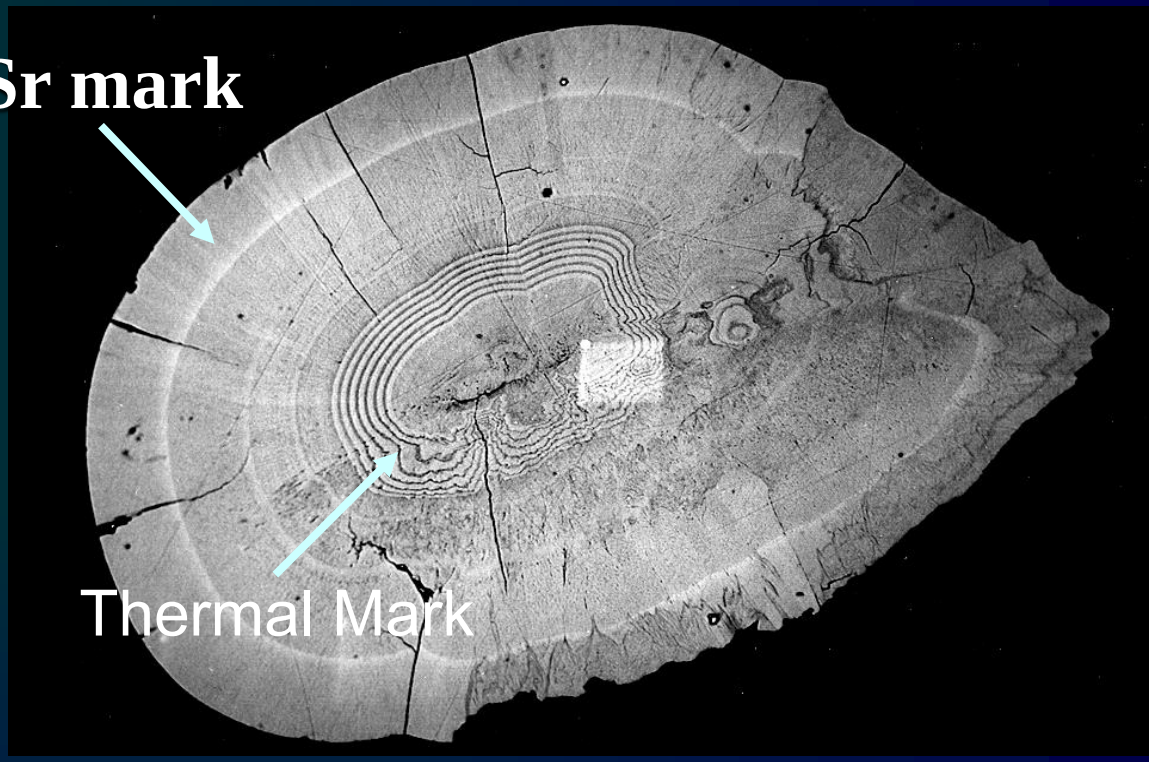
Visible under normal light

Calcein Mark



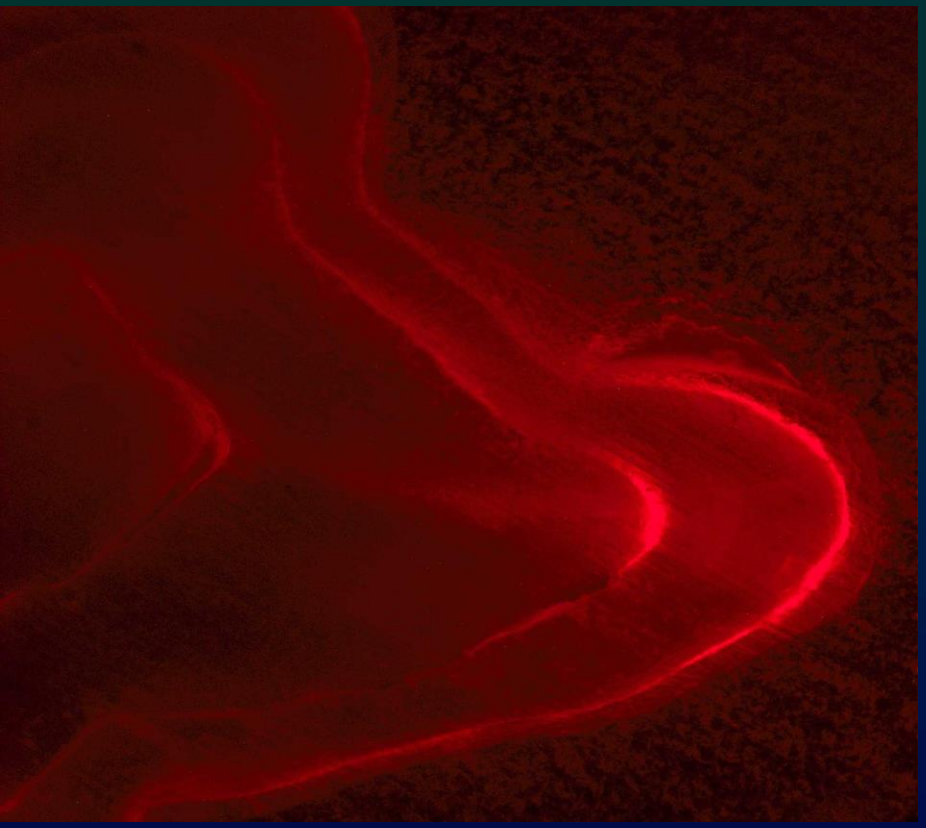
Visible under ultraviolet light

Strontium Mark



Visible under electron microscope

Alizarin Mark

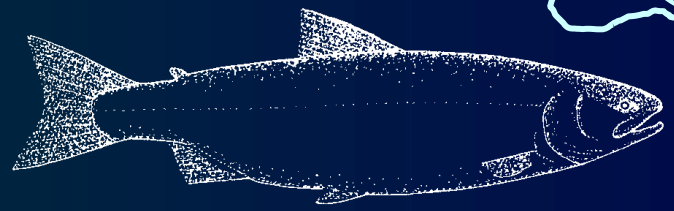


Visible under ultraviolet light


Tags or Marks ?

Coded Wire Tags

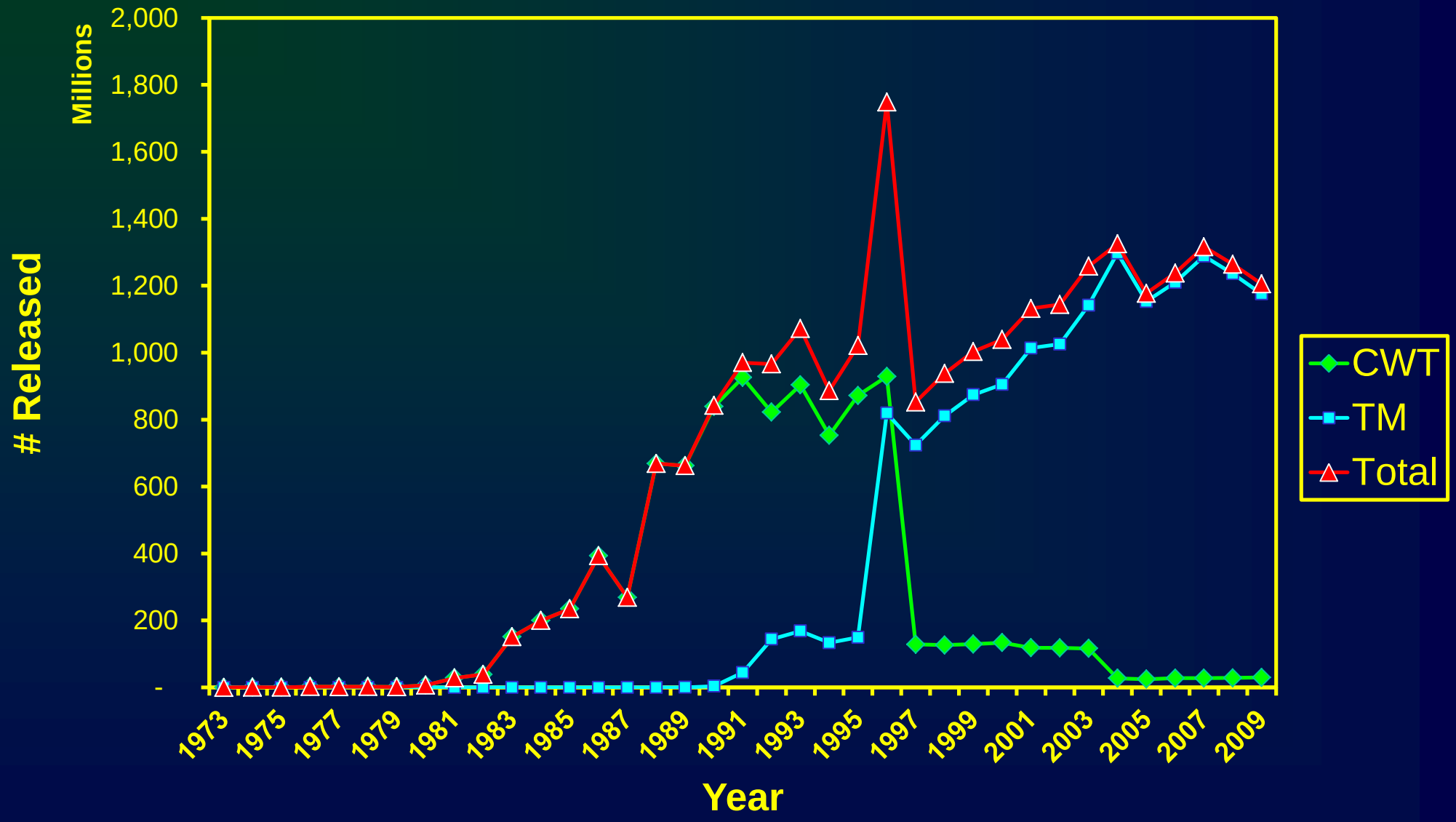
- Can use on wild fish
- Know exact fish by its tag
- Problems
  - All landings must be examined
  - $$$$
  - Limited # of fish can be tagged
  - Conflict with Lower 48 re: adipose-clipped fish
  - Does tag affect return?
  - Tag loss



Thermal Marks

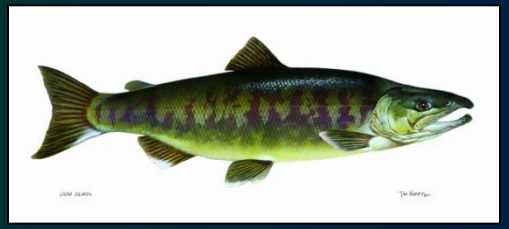
- Mass marking – lg numbers
- No tag loss
- Relatively low cost
- Dynamic allocation used for sampling effort
  - Less $ & effort required
- Problems
  - Some samples unreadable
  - Only on hatchery fish

Total Alaska Hatchery Releases

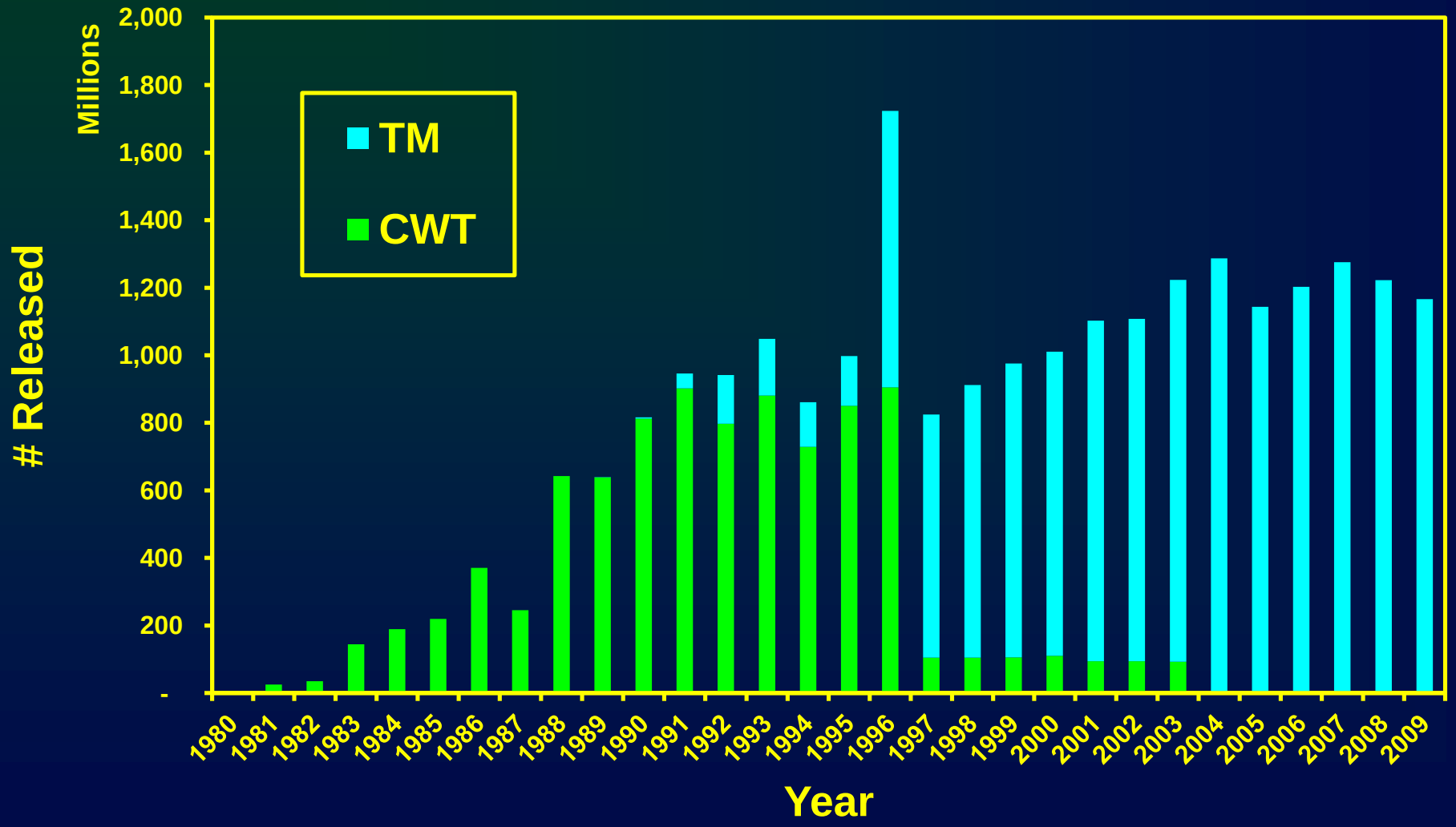


Pink

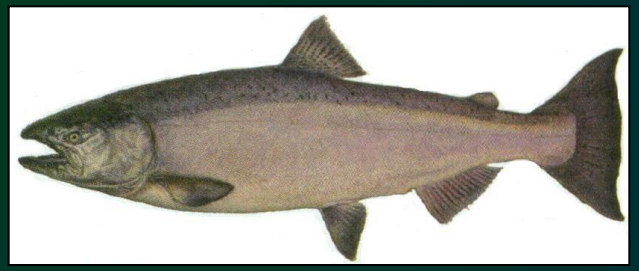
Chum



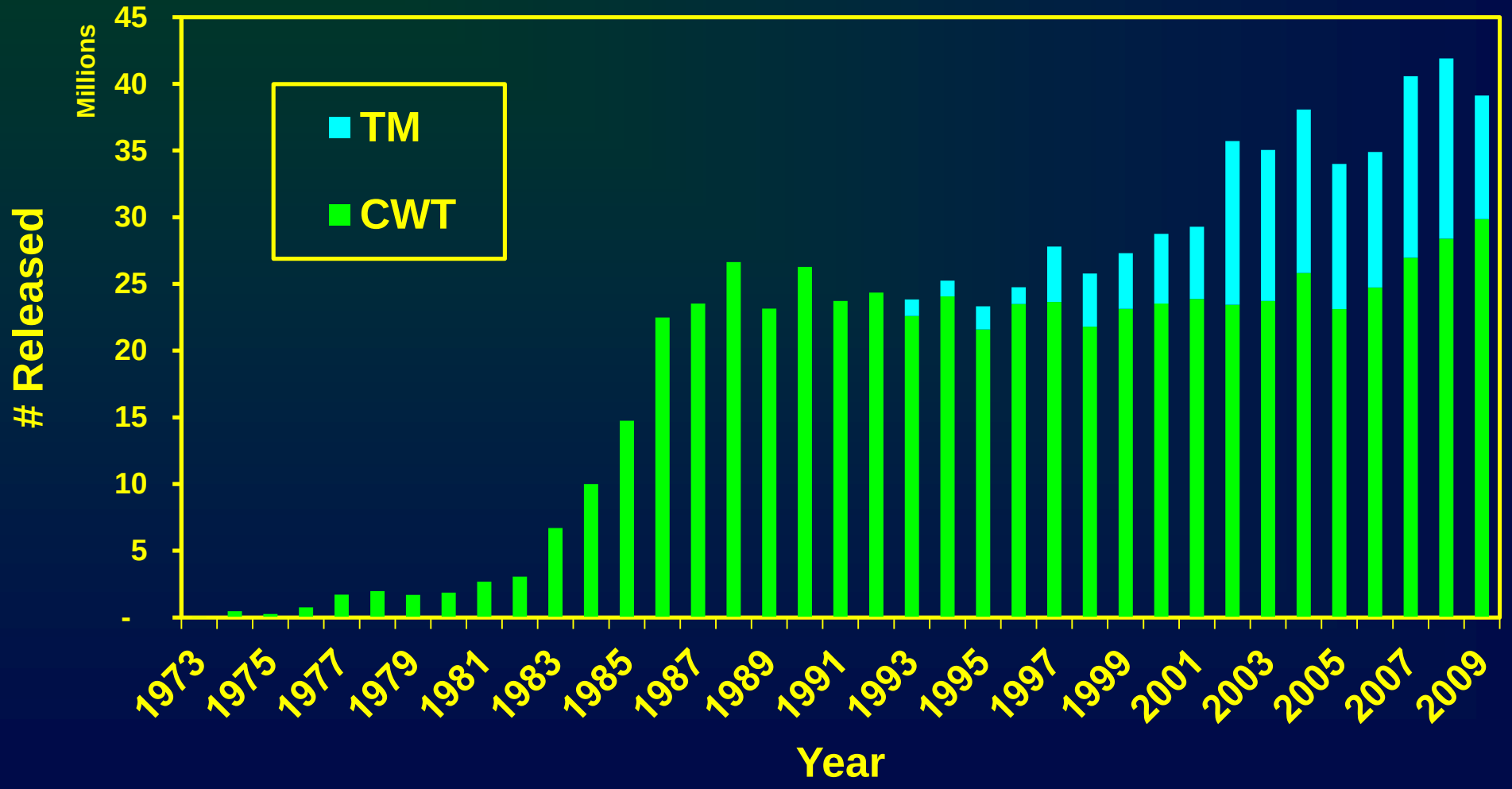
Sockeye



Chinook



Coho



>69 billion salmon released by NPAFC country hatcheries since 1993.

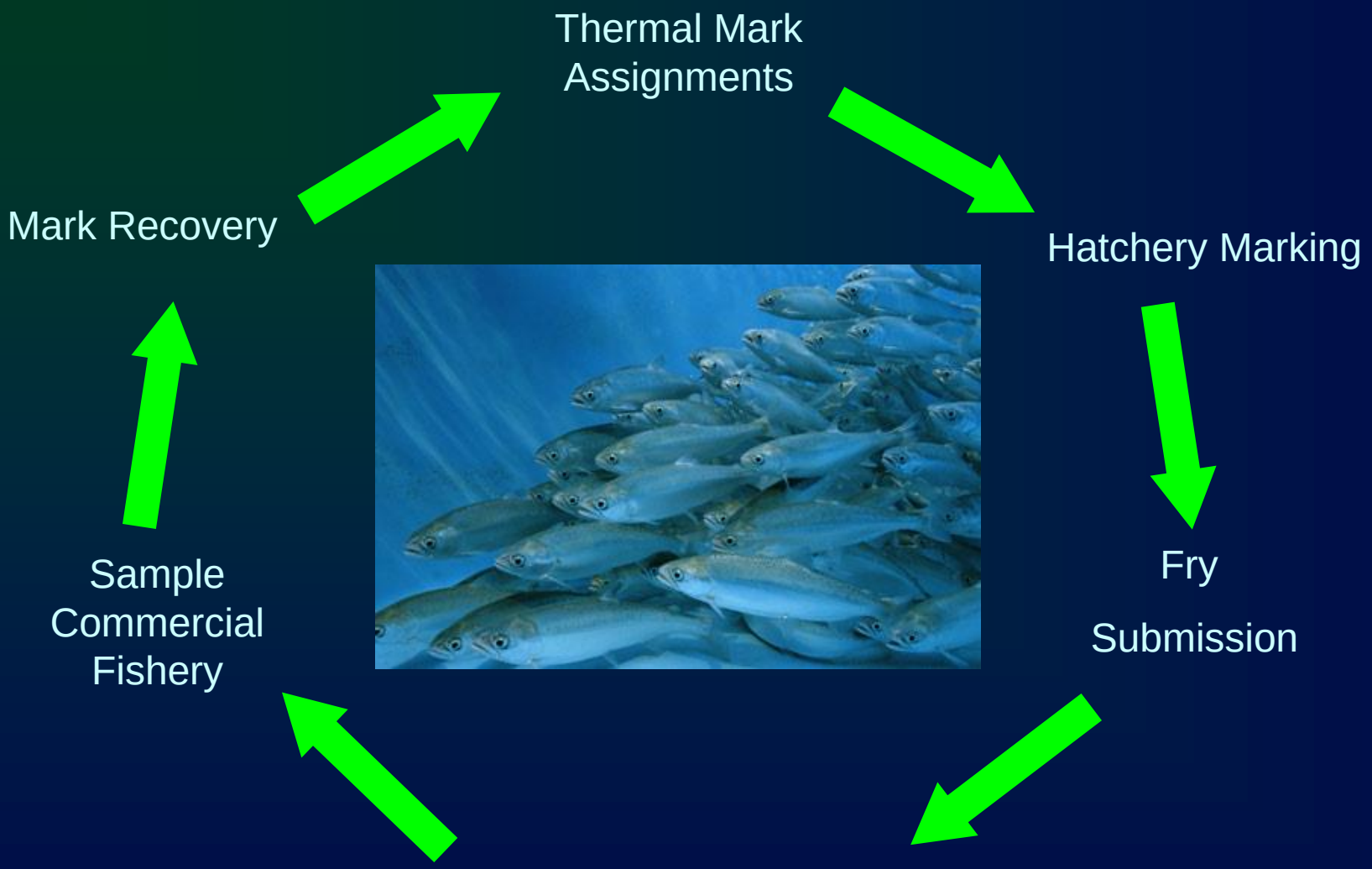
~16.3 billion (24%) Thermal Marked salmon released by all countries.

~14.1 billion (87%) Thermal Marked salmon released by Alaska.

Thermal Mark Lab – What do we do?

- Assign thermal marks to hatcheries
- Thermal mark recovery for in-season management of SE Alaska sockeye fishery
- Internet accessible database of all Alaska hatchery releases
- Special projects – high seas recovery, straying
- Coordinate marks with NPAFC
- Technical assistance to hatcheries
- Research on new technology

Otolith Mark & Recovery Cycle



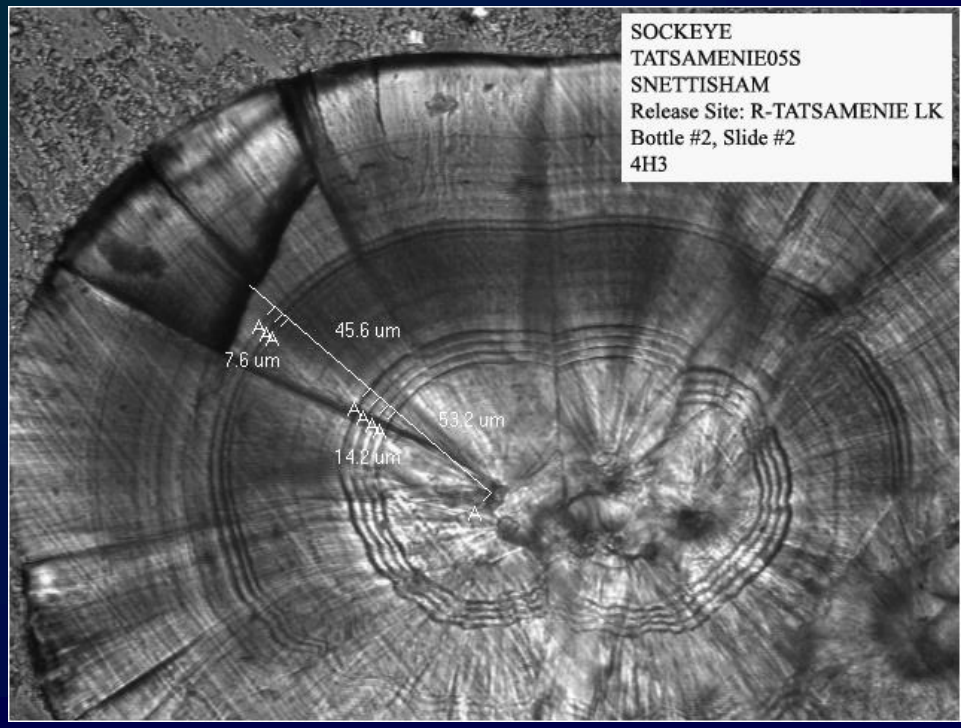
Reference or Voucher Collection

- Hatcheries provide fry & smolt samples
- Images and data entered into Internet-accessible database.

Primary functions:

1) Assists in mark ID
   Reference samples

2) Provides feedback to hatchery



NPAFC Working Group on Salmon Marking

http://npafc.taglab.org/

Provides access to all North Pacific thermal mark patterns & images

NPAFC Mark Detail

Local Mark Name: JP04-37 NPAFC ID: JP04-37

General Information

Country:	JAPAN	Species:	SOCKEYE
State/Province:	HOKKAIDO	Brood Year:	2004
Region:	WEST PACIFIC COAST	Run:	WEST PACIFIC COAST
Agency:	NSRC		
Facility:	SHIZUNAI HATCHERY	Stock:	ABIRA / SHIZUNAI RIVER

Mark Information

Otolith Mark(s):

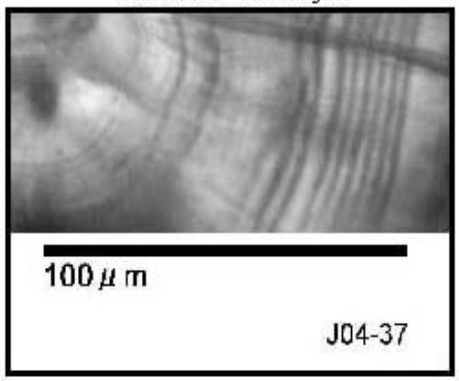
☐ A ☐ C ☐ D ☐ S ☒ T ☐ x

Fin Mark(s):

☐ AD ☐ AN ☐ CD ☐ D ☐ FB ☐ LM ☐ LP ☐ LV
☐ RM ☐ RP ☐ RV

Coded Wire Tag(s):

Otolith Master Image:



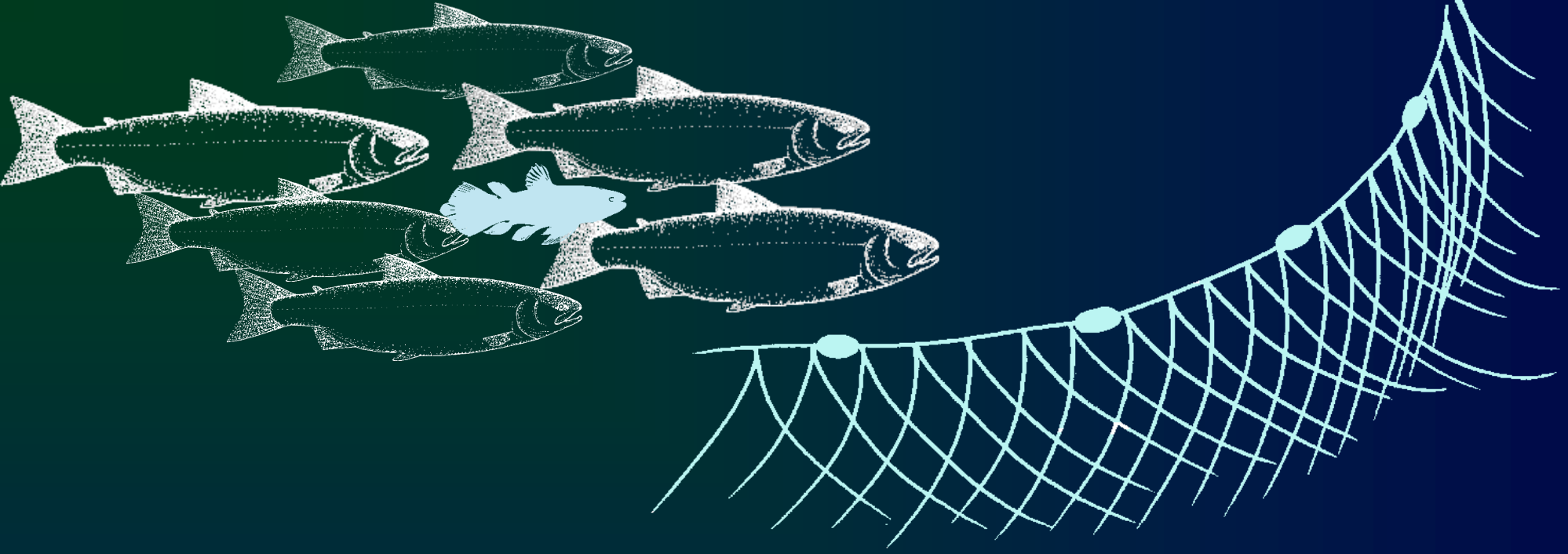
Hatch Code: 2,6H
RBr: 1:1.2,2.6
Thermal Mark Schedule: (1X)24C:24H,(1X)24C:48H,(6X)24C:24H
Temperature Shift: down (10-6°C)

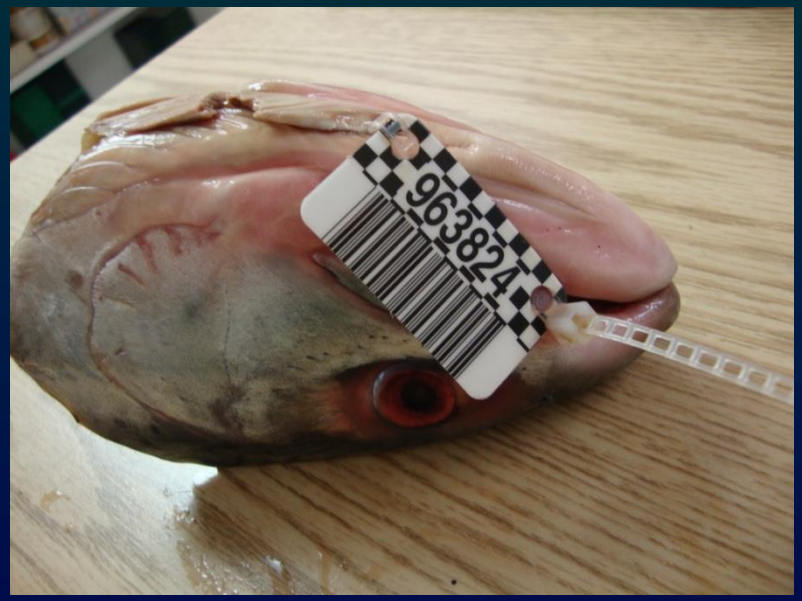
Mark Comment:

Release Information

Responsible Person: M. KAWANA
Contact Email: KAWANA.MORIHIKO@SALMON.AFFRC.GO.JP
Date Last Released: 6/9/2005 Stage: FED FRY
Release Year: 2005 Length: 84 mm
Number Released: 198,200 Weight: 5.49 grams

All Sites: SHIZUNAI RIVER

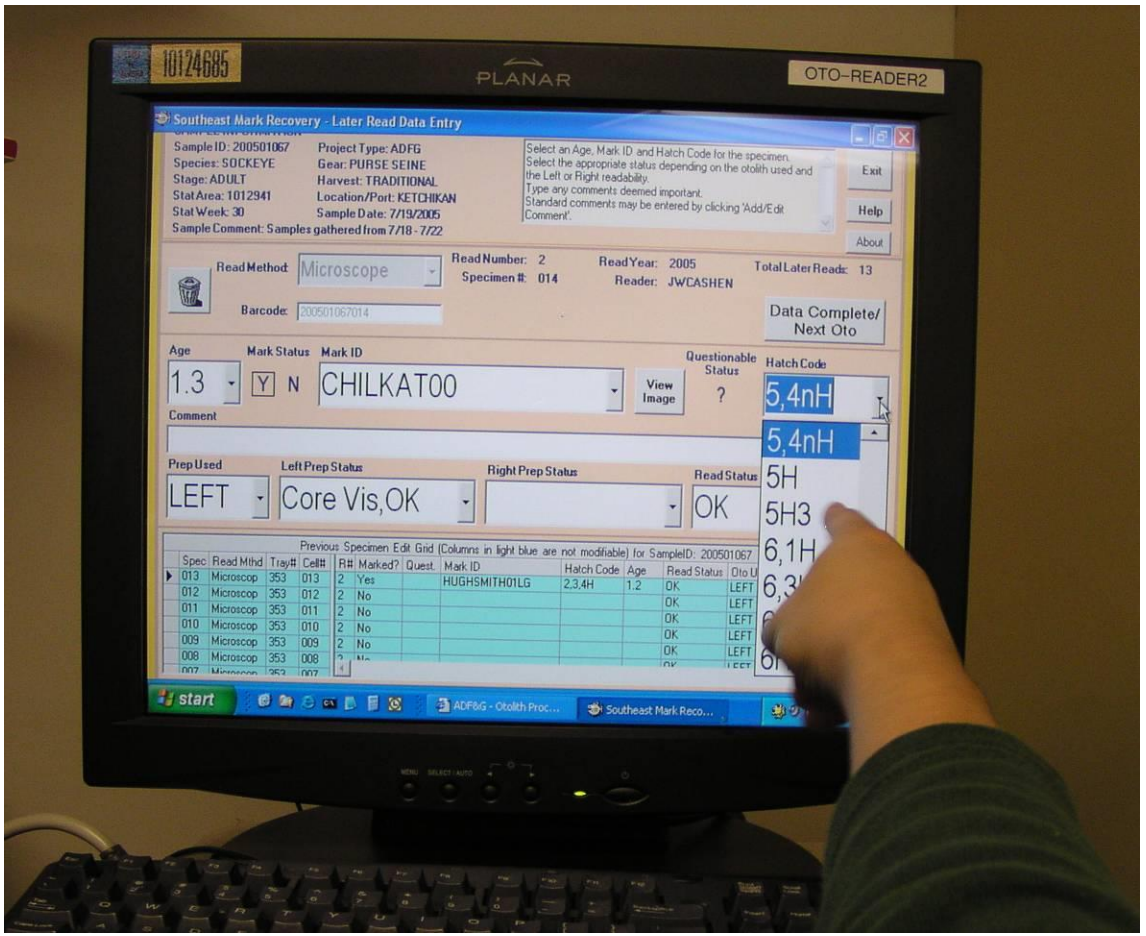


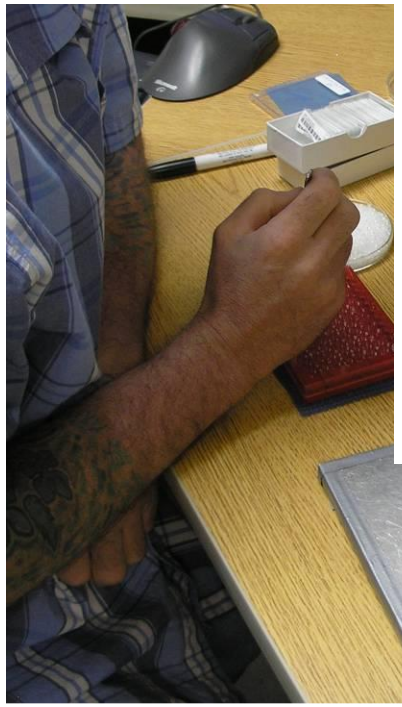

963824

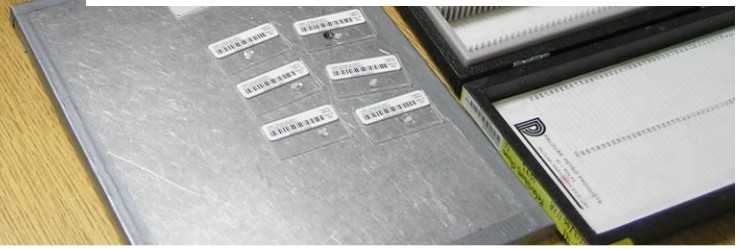

E-Mail


EMERGENCY
EYEWASH


LAB 2B Series


10124685
PLANAR
OTO-READER2
Southeast Mark Recovery - Later Read Data Entry
Sample ID: 200501067
Species: SOCKEYE
Stage: ADULT
Stat Area: 1012941
Stat Week: 30
Project Type: ADFG
Gear: PURSE SEINE
Harvest: TRADITIONAL
Location/Port: KETCHIKAN
Sample Date: 7/19/2005
Sample Comment: Samples gathered from 7/18 - 7/22
Select an Age, Mark ID and Hatch Code for the specimen.
Select the appropriate status depending on the otolith used and the Left or Right readability.
Type any comments deemed important.
Standard comments may be entered by clicking 'Add/Edit Comment'.
Exit
Help
About
Read Method: Microscope
Read Number: 2
Specimen #: 014
Read Year: 2005
Reader: JWCASHEN
Total Later Reads: 13
Barcode: 200501067014
Data Complete/ Next Oto
Age
Mark Status
Mark ID
Questionable Status
Hatch Code
1.3
Y N
CHILKAT00
View Image
?
5,4nH
Comment
Prep Used
Left Prep Status
Right Prep Status
Read Status
LEFT
Core Vis,OK
OK
Previous Specimen Edit Grid (Columns in light blue are not modifiable) for SampleID: 200501067
Spec Read Mthd Tray# Cell# R# Marked? Quest Mark ID Hatch Code Age Read Status
013 Microscop 353 013 2 Yes HUGHSMITH01LG 2,3,4H 1.2 OK LEFT
012 Microscop 353 012 2 No OK LEFT
011 Microscop 353 011 2 No OK LEFT
010 Microscop 353 010 2 No OK LEFT
009 Microscop 353 009 2 No OK LEFT
008 Microscop 353 008 OK LEFT
5,4nH
5H
5H3
6,1H
start
ADF&G - Otolith Proc...
Southeast Mark Reco...



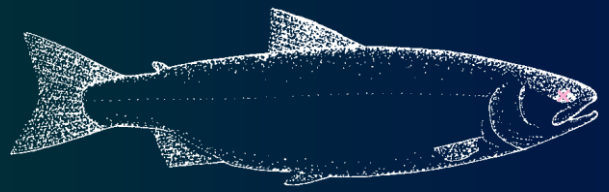


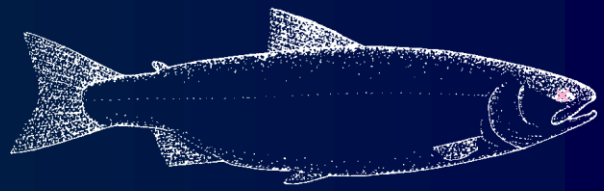
Total Otoliths Examined for Thermal Marks in Alaska

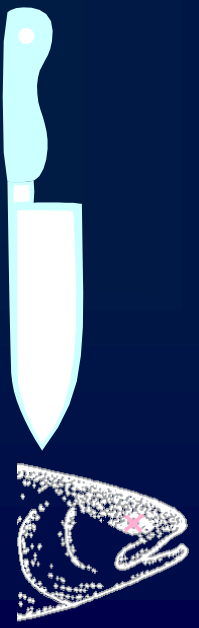
~**630,000** reads since 1994. 300,000 of these by Statewide Thermal mark Lab

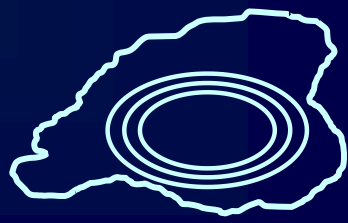
What do we know about each fish?

- Age from otolith & mark
  - Brood Year
  - Release Year from records
- Hatchery
  - Feeding strategy
  - Release site
  - Stock
  - Date last released
- Location of return
- Proportion of harvest or proportion of escapement
- Matched samples
  - Age from scale
  - Sex
  - Length
  - Brain parasites
  - Genetic lineage







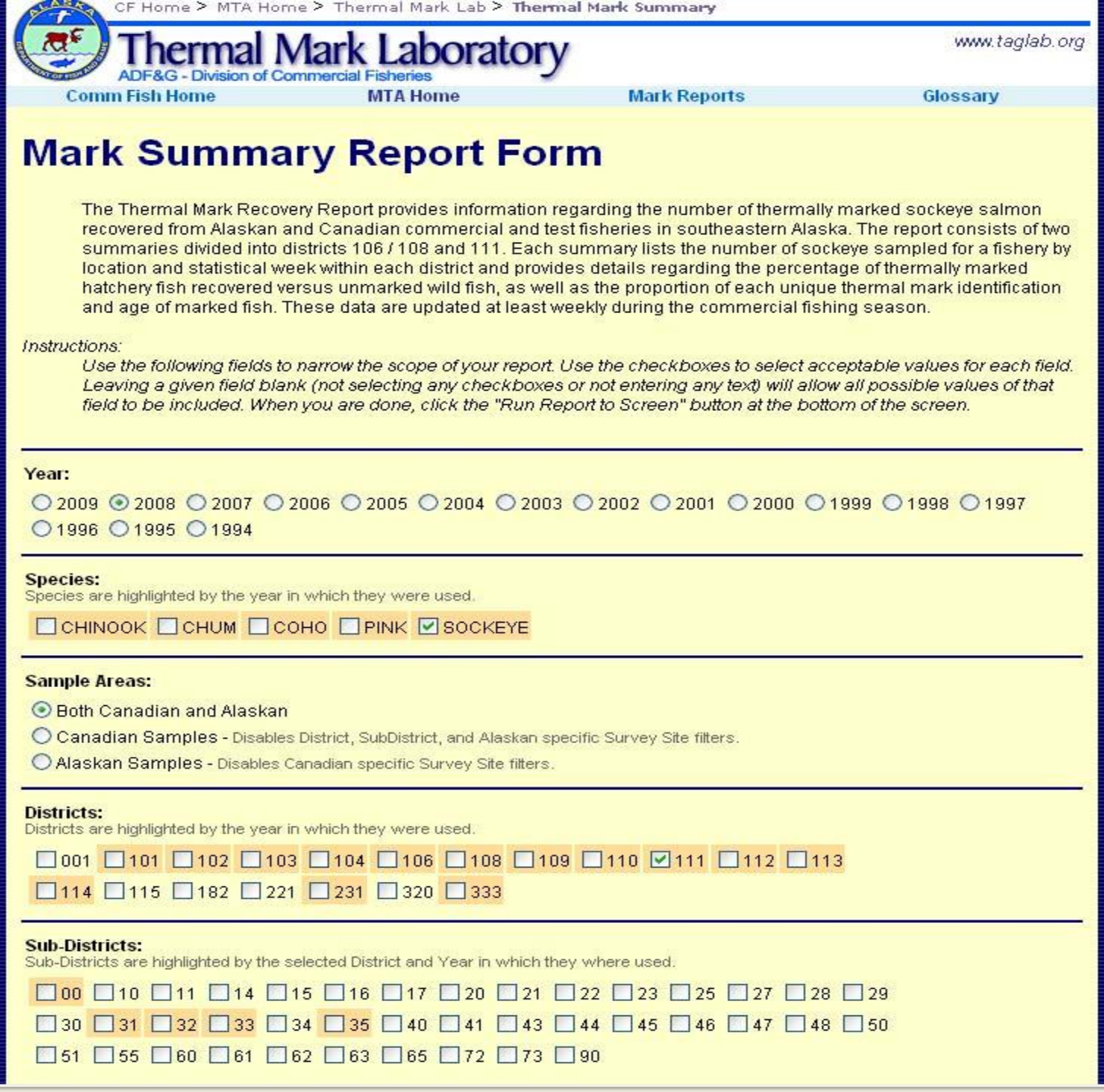


Alaska Thermal Mark Data

www.taglab.org

Provides live access to Alaska data. Mostly SE.

Soon access to PWS data as well



Mark Summary Report – Taku Inlet

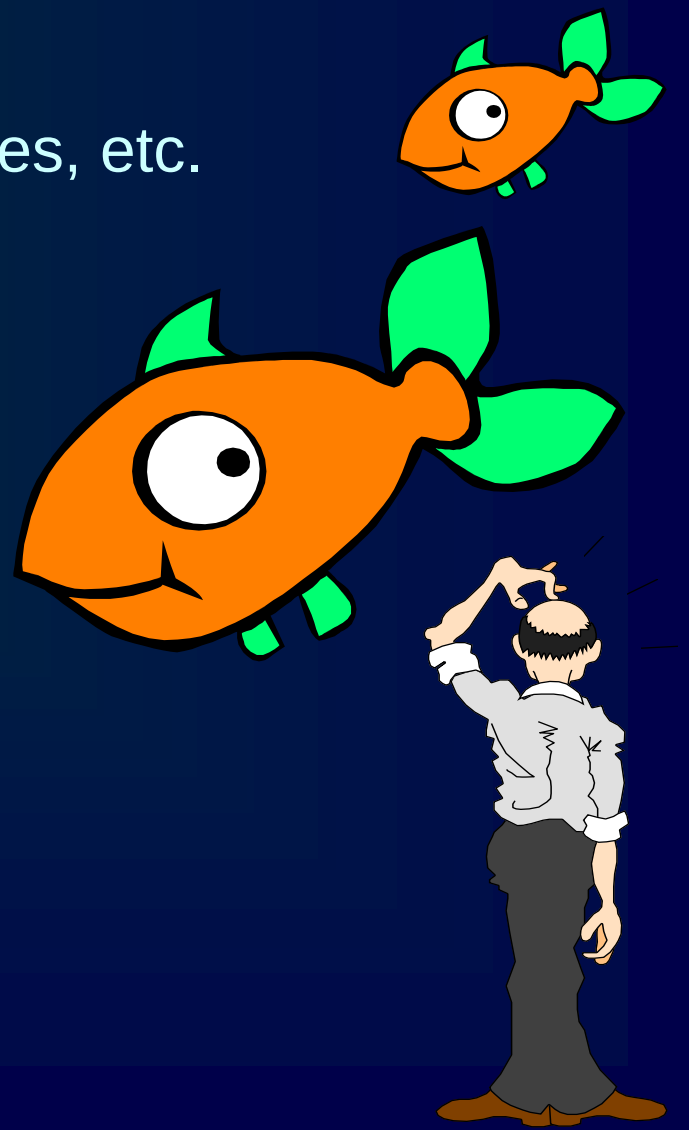
Stat Week	Stat Area	Harvest	Sample Date	Gear	Survey Site	# Rcvd	# Preps	Not Marked	Marked	% Marked
26	11132	TRADITIONAL	6/20/2004	DRIFT GILLNET	TAKU INLET	392	389	386	3	1%
27	11132	TRADITIONAL	6/27/2004	DRIFT GILLNET	TAKU INLET	371	370	364	6	2%
28	11132	TRADITIONAL	7/4/2004	DRIFT GILLNET	TAKU INLET	464	460	431	29	6%
29	11132	TRADITIONAL	7/11/2004	DRIFT GILLNET	TAKU INLET	305	300	269	31	10%
30	11132	TRADITIONAL	7/18/2004	DRIFT GILLNET	TAKU INLET	325	323	235	88	27%
31	11132	TRADITIONAL	7/25/2004	DRIFT GILLNET	TAKU INLET	375	369	211	158	43%
32	11132	TRADITIONAL	8/1/2004	DRIFT GILLNET	TAKU INLET	317	317	198	119	38%
33	11132	TRADITIONAL	8/8/2004	DRIFT GILLNET	TAKU INLET	274	269	179	90	33%
34	11132	TRADITIONAL	8/15/2004	DRIFT GILLNET	TAKU INLET	309	306	98	208	68%
35	11132	TRADITIONAL	8/22/2004	DRIFT GILLNET	TAKU INLET	89	89	31	58	65%
						3221	**3192**	**2402**	**790**	**24.75%**
						3221	**3192**	**2402**	**790**	**24.75%**

2008 SE AK Sockeye Mark Recovery:

- 16,800 otoliths read from 7 fisheries
- 34% thermally marked.

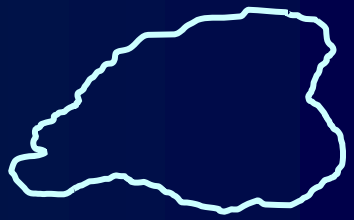
Issues

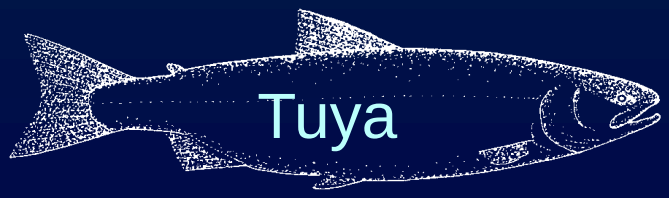
- Natural marks occur
- Wide variation within a group
  - Accidents happen due to power failures, etc.
- Interference from “noisy patterns”
  - Creates “false positives”
- Differences among readers
  - Training and skill levels
  - Creates “false negatives”
- Constraints on thermal codes
  - Marking window limited
  - Expense of heating or chilling
  - Hatchery design

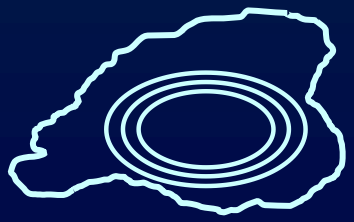


Quality Control

- **NO Known** or “Gold Standard”
- **So**
  - Study vouchers
  - Work together
  - Blind second read
  - Use Indices of agreement to analyze results
- Kappa
- Latent Class models
  - Classification errors for each reader are estimated
  - True error rate is unknown







What are Mark Recovery Results Used For?

Abundance-based Management

Pre-season forecasts

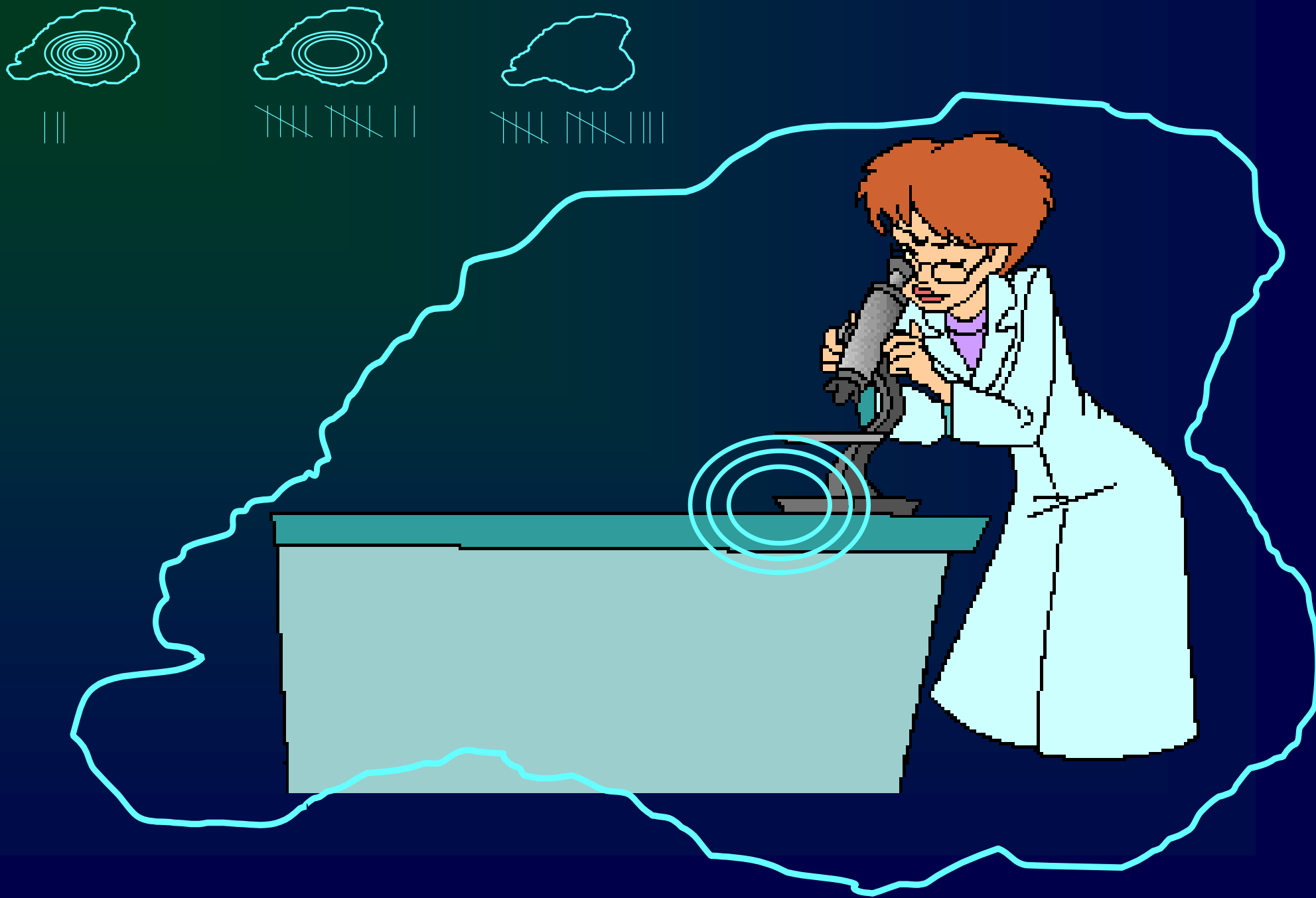
In-season run assessment

Post season run reconstruction

Assess survival - smolt to adult

Evaluate accuracy of other stock id methods

- Scales
- Genetics

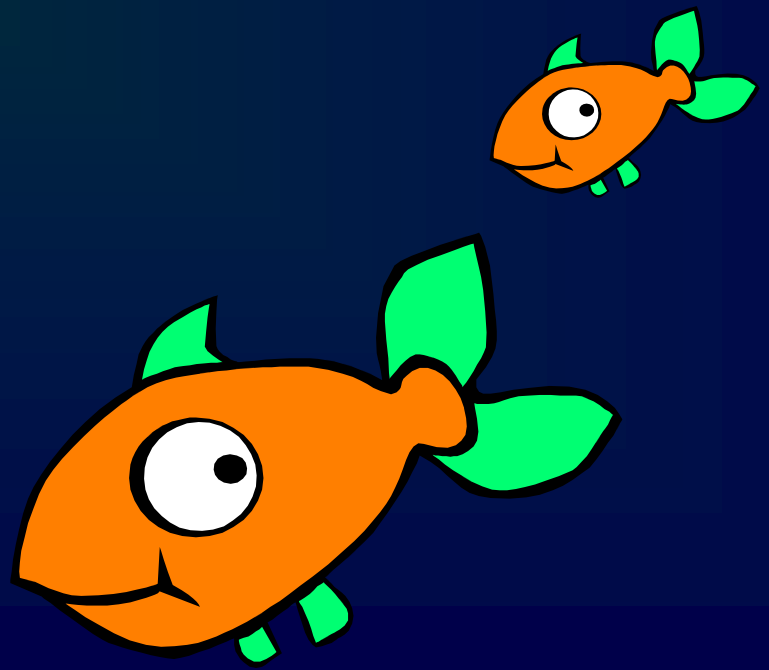


Map of Stikine

Map of Taku

Other Types of Marking

- Coded Wire Tags – CWT
  - Expensive
  - Does not mark all fish – thus may underestimate
  - Does tag affect return?
  - Can be used on wild fish
- Chemical markers
  - Strontium
  - Alizarin
  - Calcein

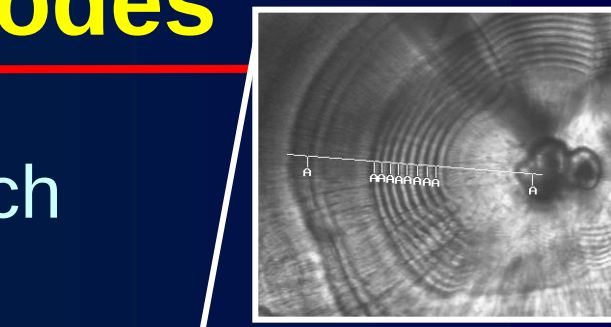


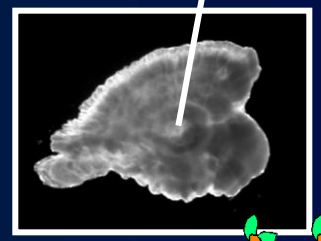
No “Gold Standard”

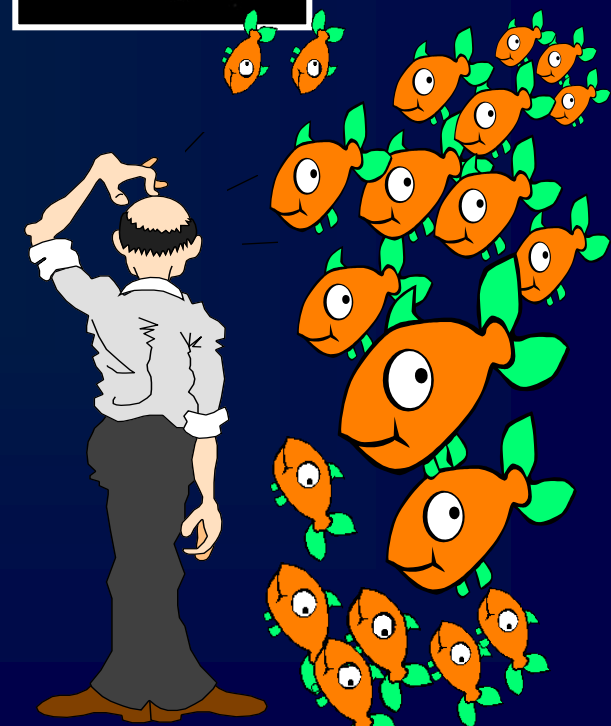
- Assess reliability with NO standards?
- Proportion of hatchery marks when there is disagreement among readers?
- How proportion influenced by classification error?

Constraints on Thermal codes

- Marking window - prehatch or posthatch
- Hatchery design
- Expense of heating/chilling
- Accidents happen
  - Marks can be challenging to read due to power failures, etc.
- Natural marks also occur







Quality Control: Tools

- So…
  - Blind second read
  - Use Indices of agreement to analyze results

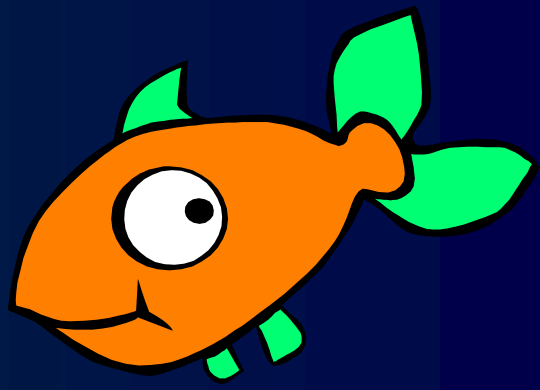
- Kappa
- Latent Class models
  - Classification errors for each reader are estimated
  - True error rate is unknown

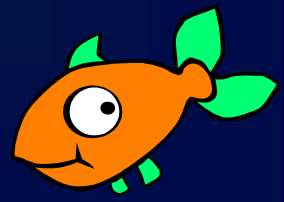
North Pacific Salmon Fisheries Coordination

- US – Canada
  - Pacific Salmon Commission formed under Pacific Salmon Treaty (1985)
- International North Pacific Fisheries Commission (1952-1992)
  - Members: Canada, Japan, and US.
  - Species: Anadromous fish, ground fish, crab, marine mammals
- North Pacific Anadromous Fish Commission (1993-present)
  - Members: Canada, Japan, Korea, Russia, and US.
  - Species: Pacific salmon

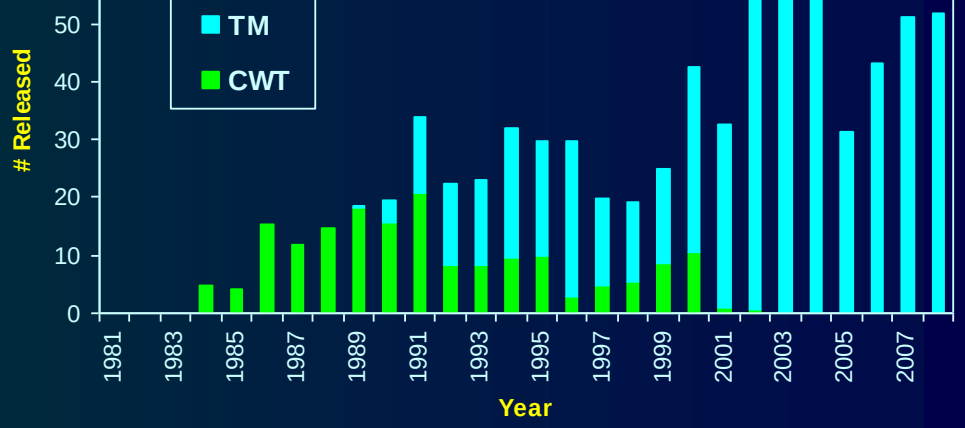
Why Thermal Mark?

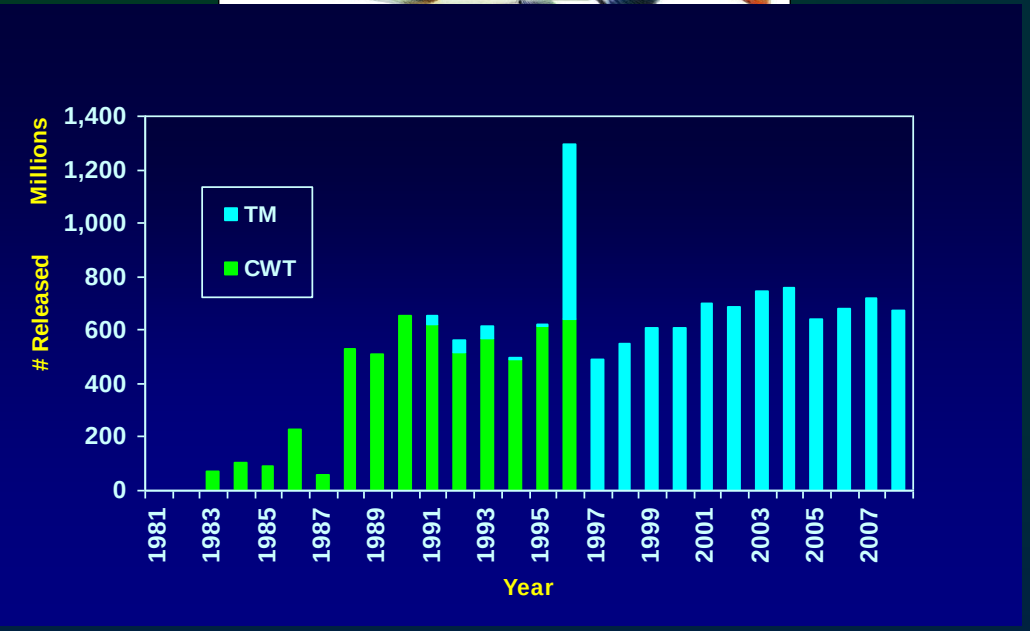
- Mass-marking
  - Can mark large numbers at one time
- Data on growth, migration, survival
- Relatively low cost
- No physiological impact after mark put on
- No chemicals involved
  - Public perception
- Drawback - only can be used on hatchery fish





Pink

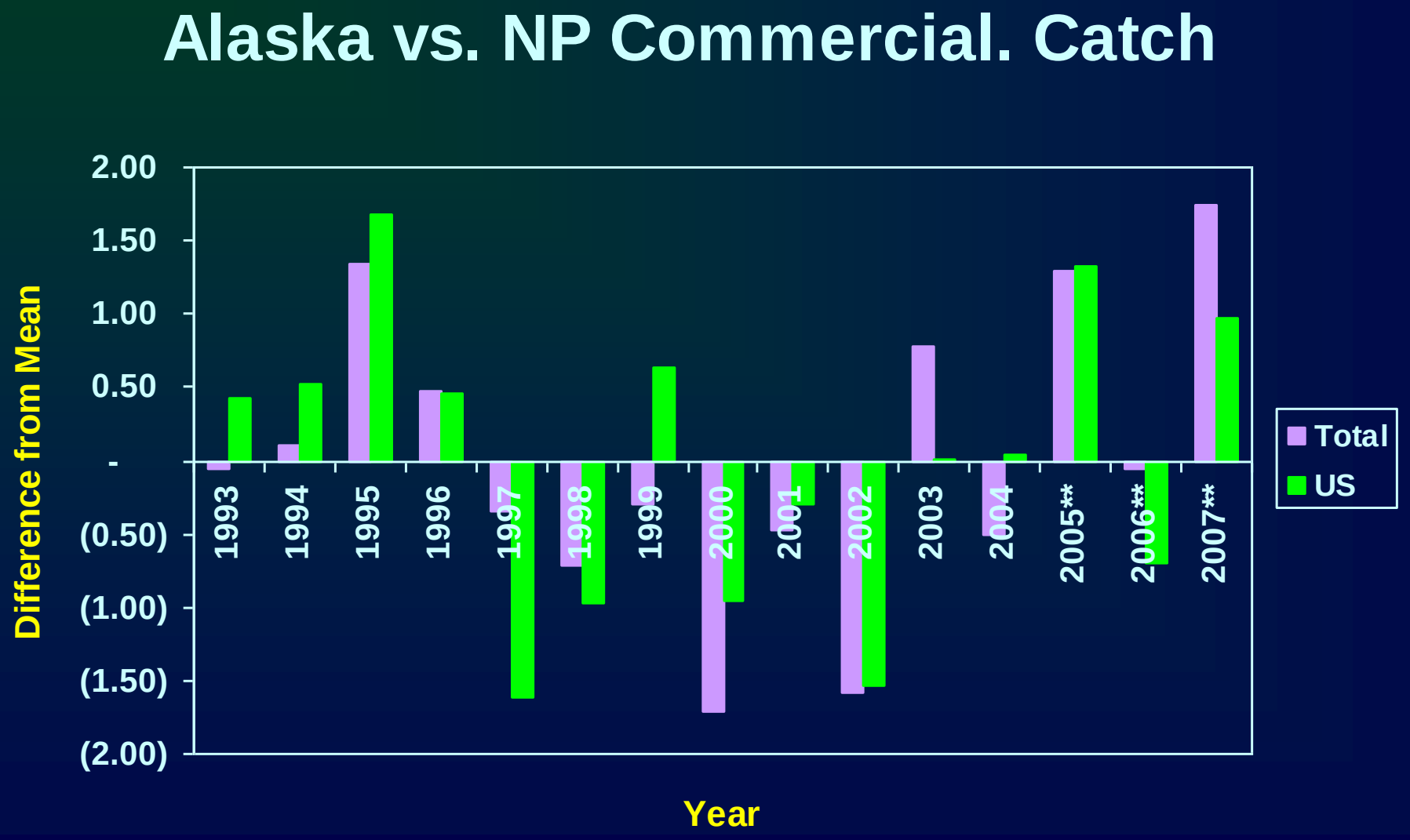


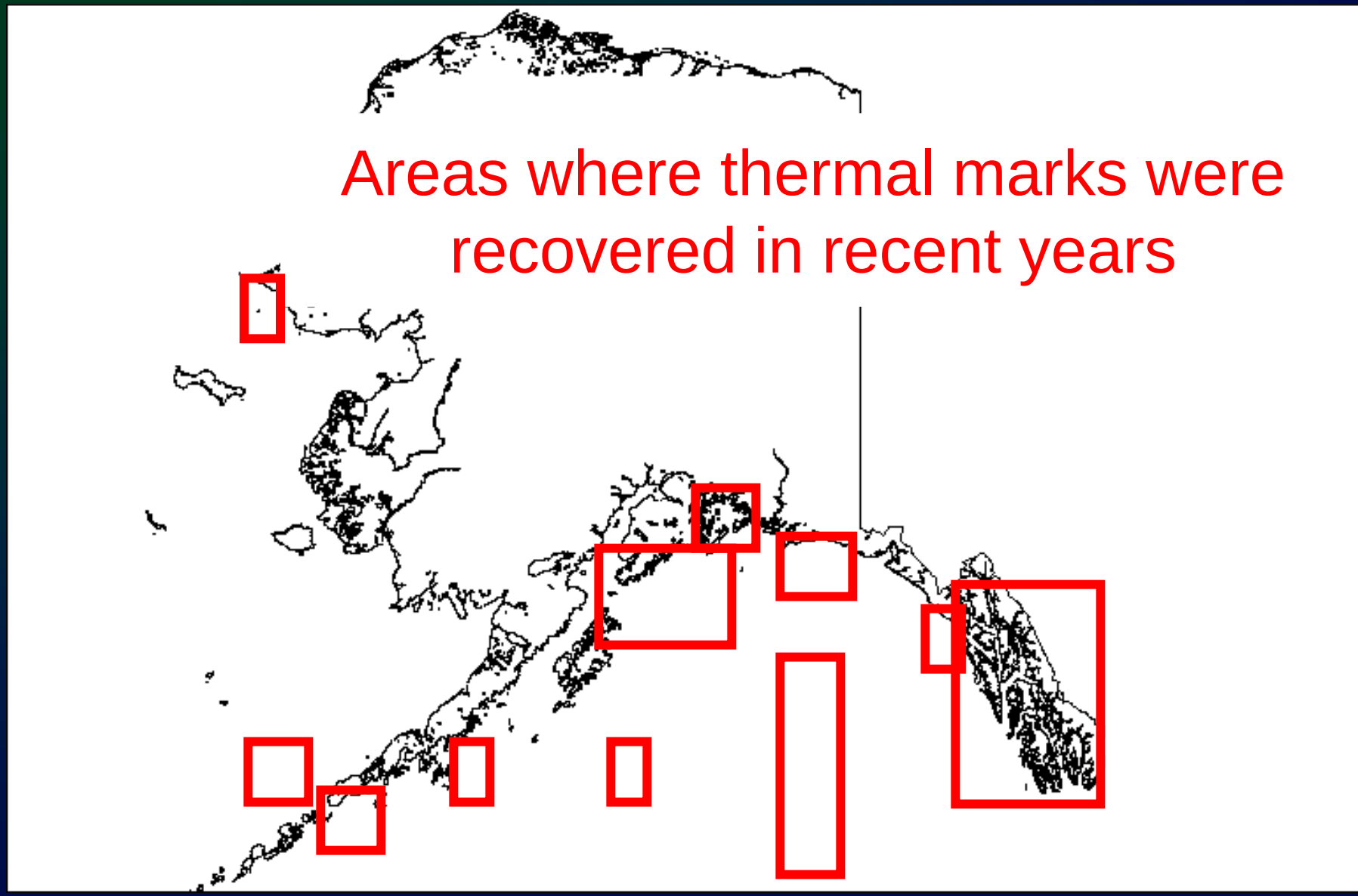


Sockeye

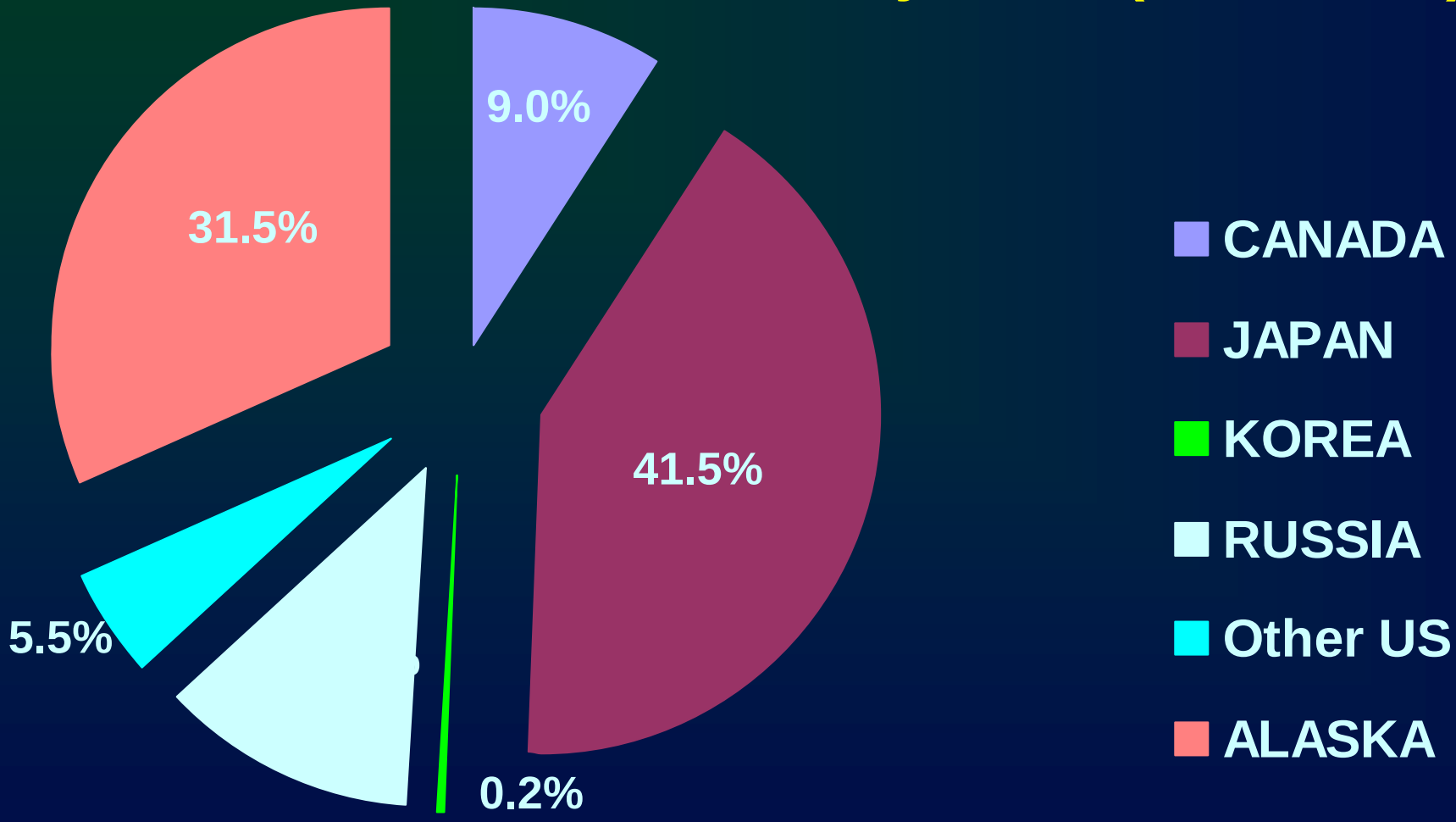
Chum

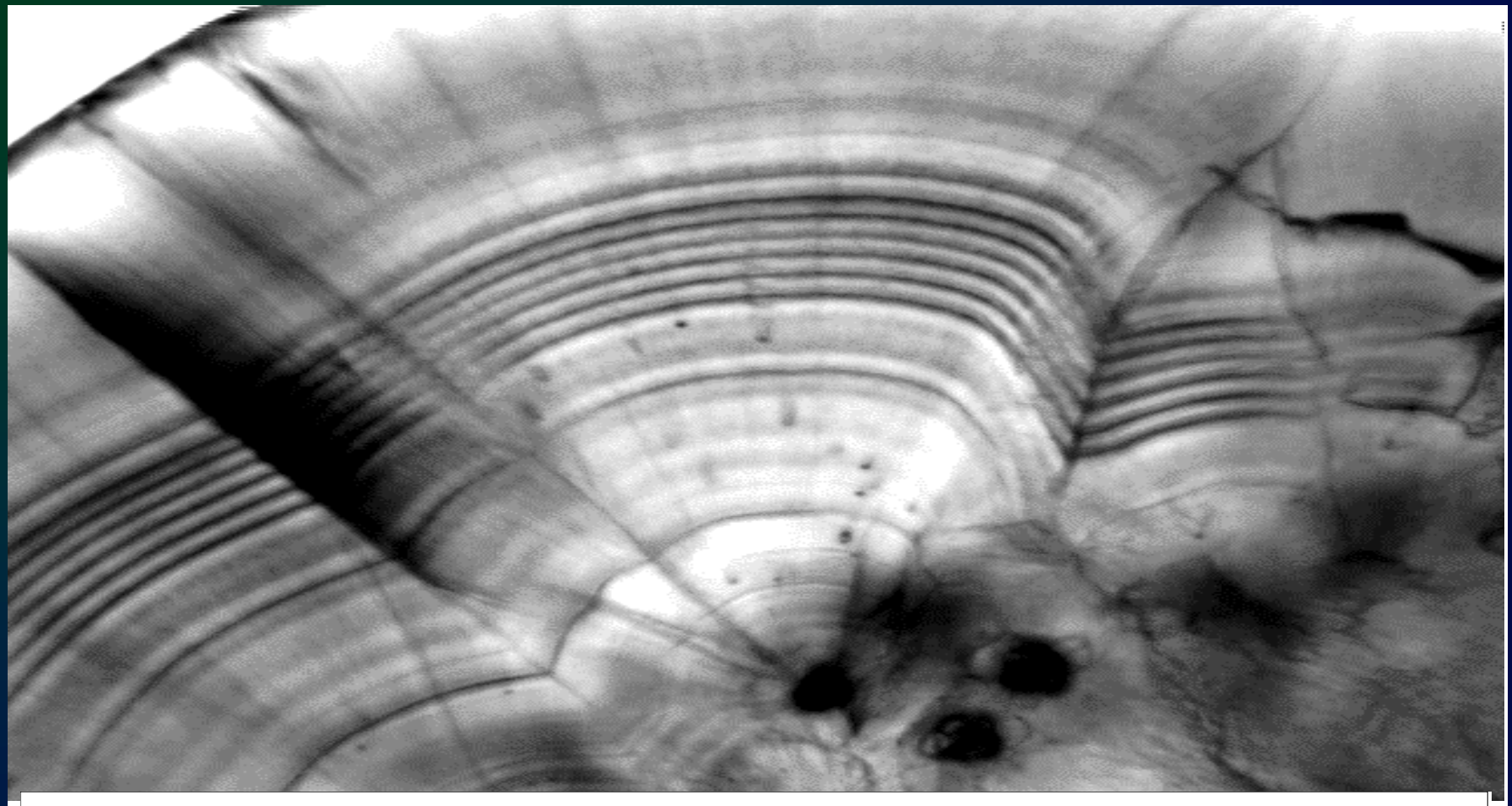
Why is Alaska so involved?

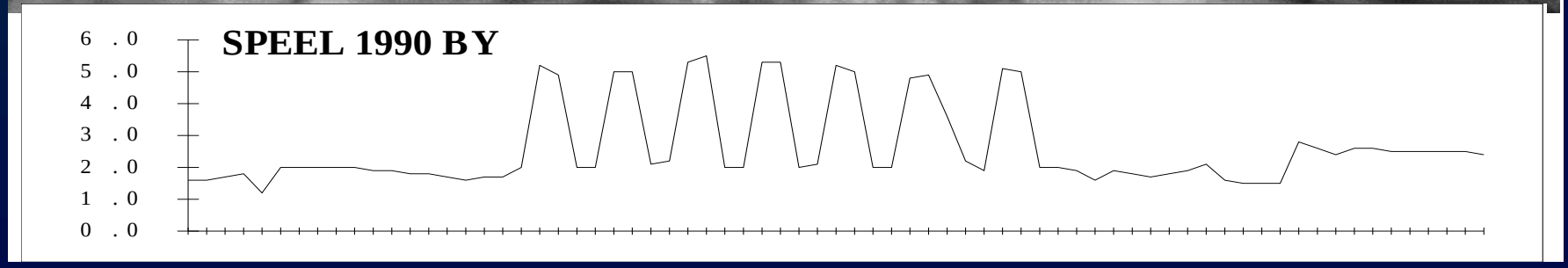


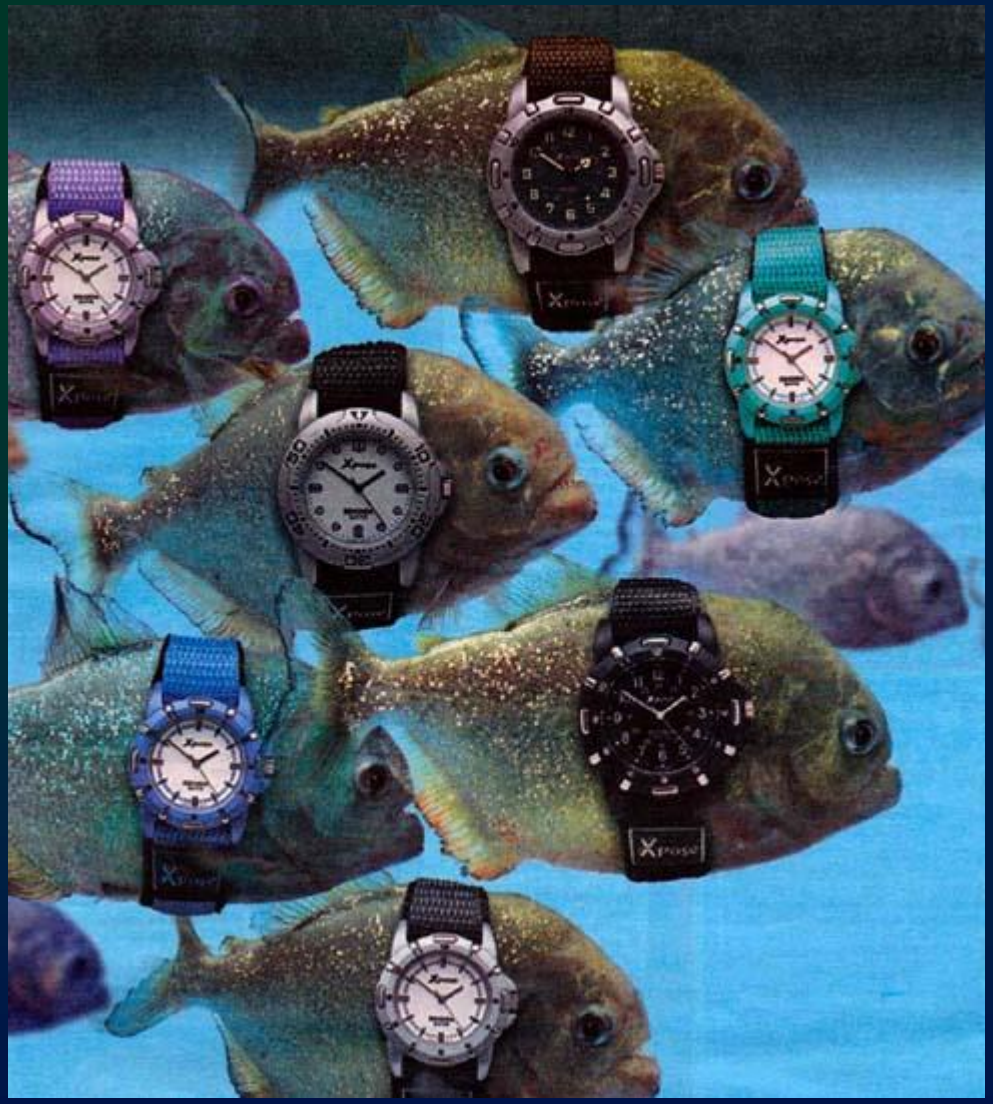

Areas where thermal marks were recovered in recent years

Percentage of Pacific Hatchery Releases by Country/State (1993-2007)






SPEEL 1990 BY
6 . 0
5 . 0
4 . 0
3 . 0
2 . 0
1 . 0
0 . 0



…then we wait…