Otolith Thermal Marking

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Steve Schroder
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1970

Early investigations into the impacts of environmental change on otolith structural attributes.

1980

Campana et al., 1985 Nielson and Geen,1985
Moosegaard, 1985; Brothers, 1985

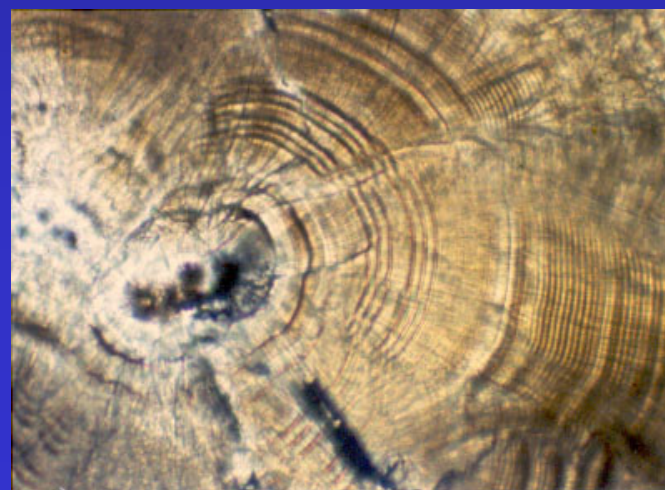
1990

Brothers, 1990; Eschenroder et al., 1990; Volk et al., 1990

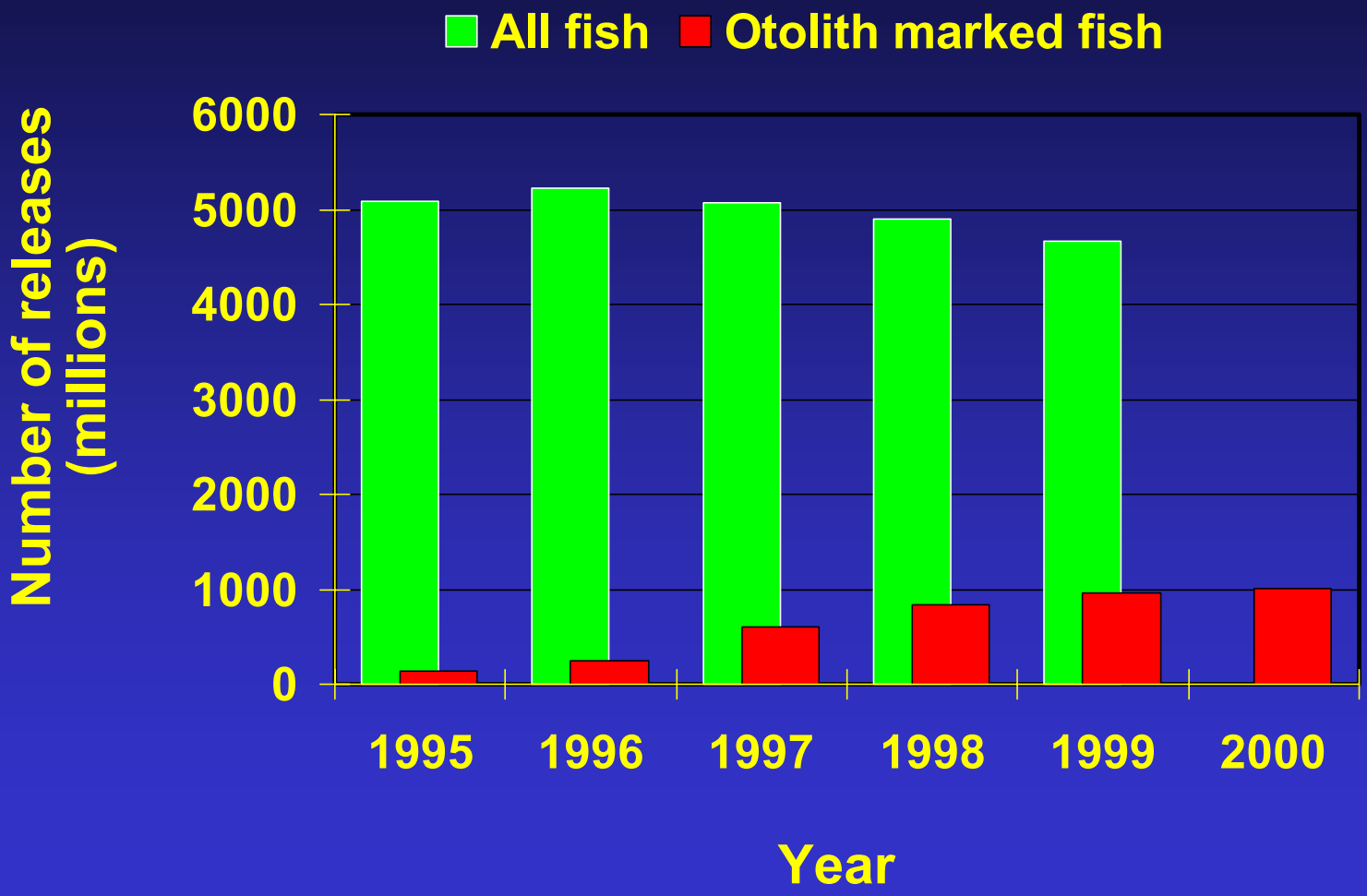
Hagen and Munk, 1994
Volk et al., 1994
Hagen et al., 1995
Achinicheva and Rogatnykh, 1996
Munk and Geiger, 1998
NPAFC technical working group
Numerous documents and reports

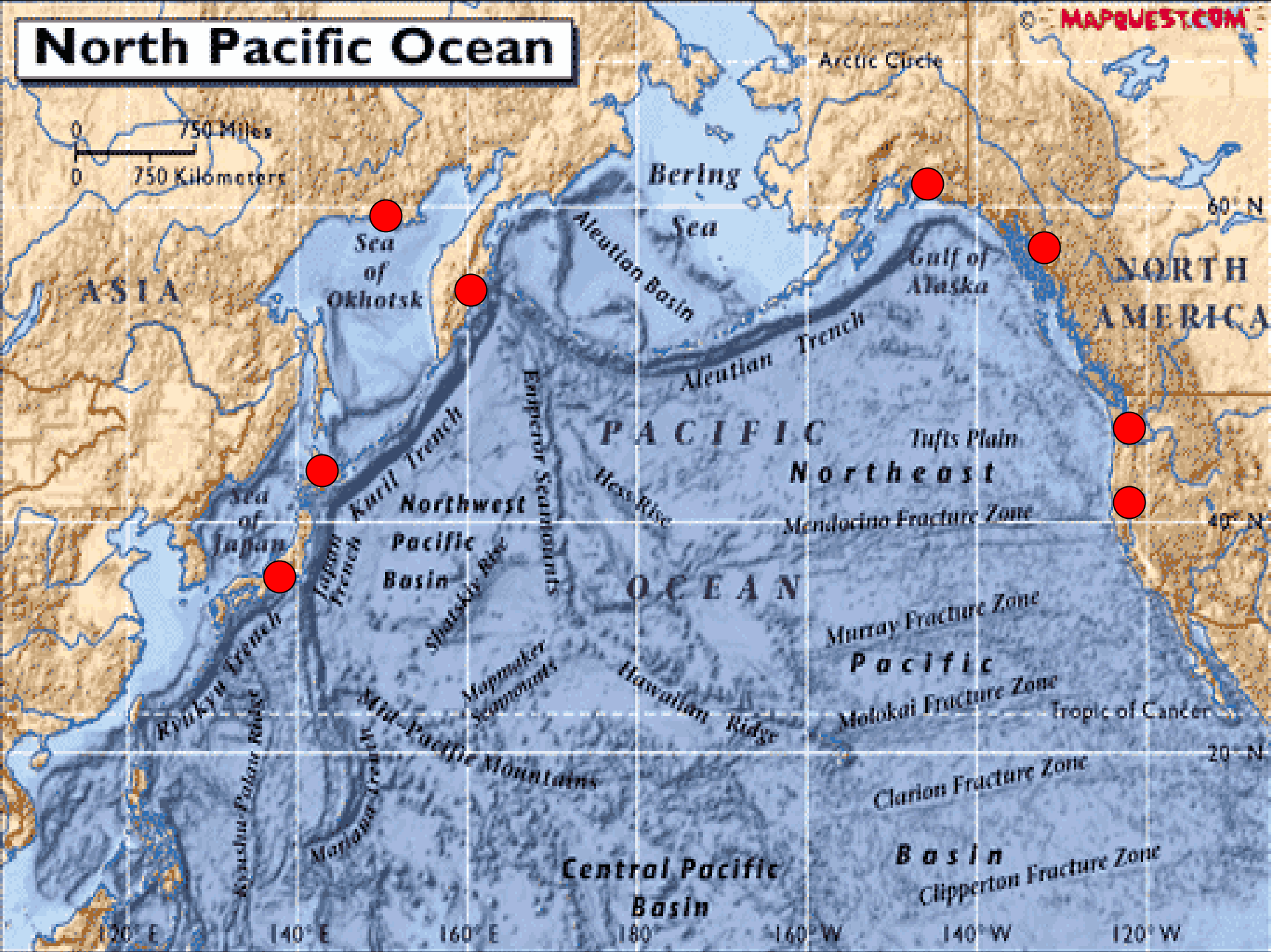
2000

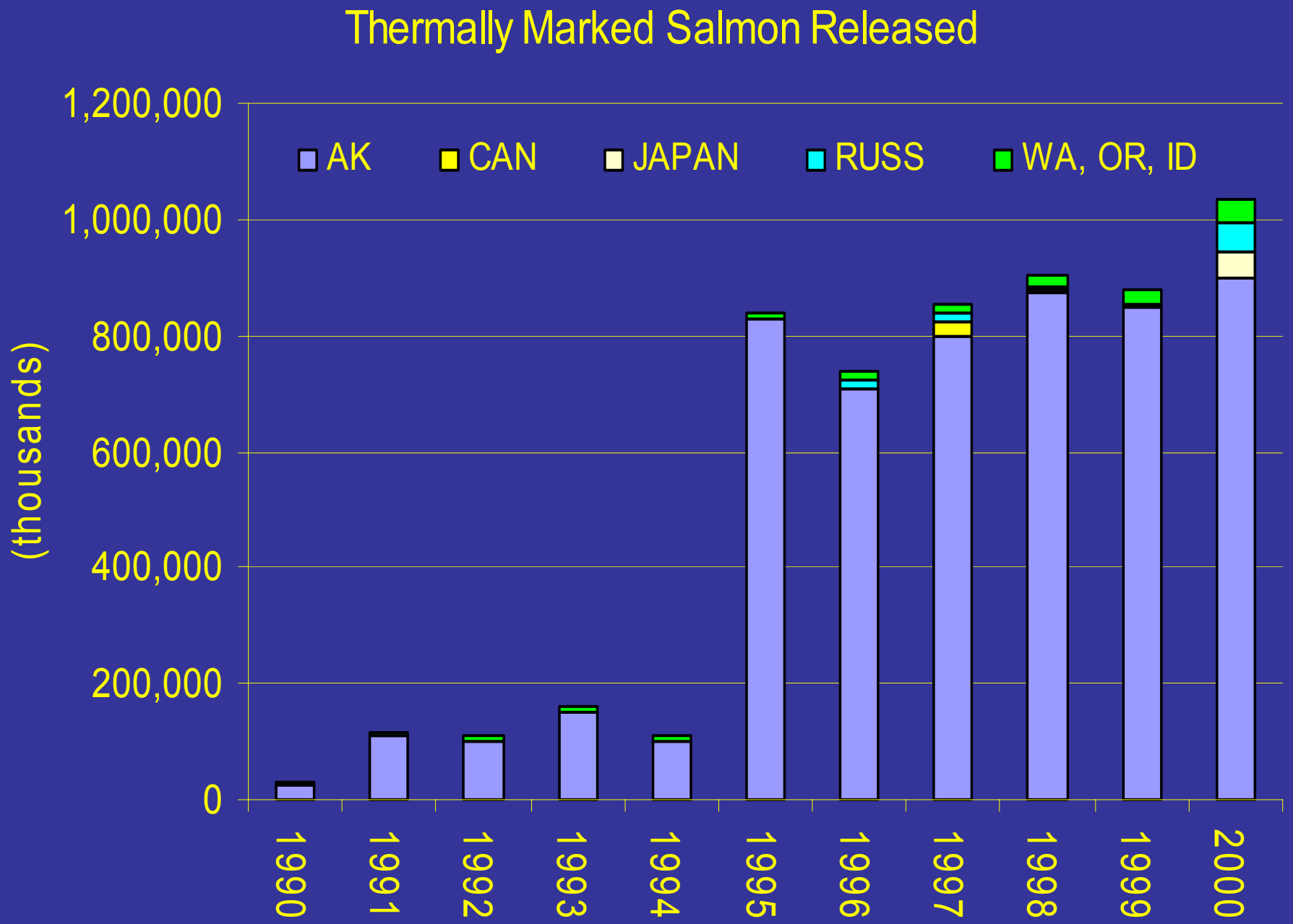
Volk et al., 1999
Blick and Hagen, 2001
Otolith marking symposium, 2001
Volk et al., 2004 in Stock ID Methods



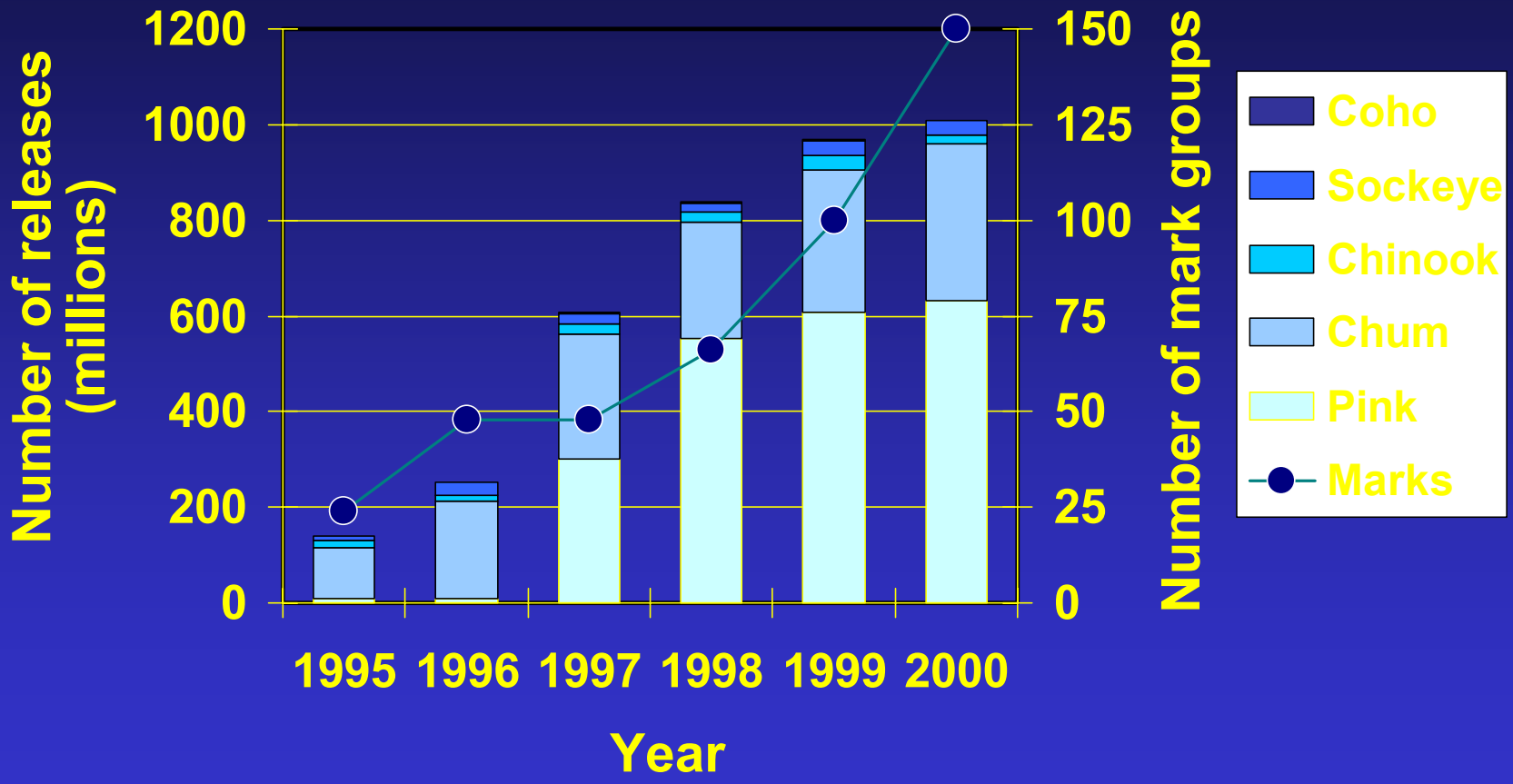
Number of salmon released from hatcheries in the North Pacific Rim, 1995-2000

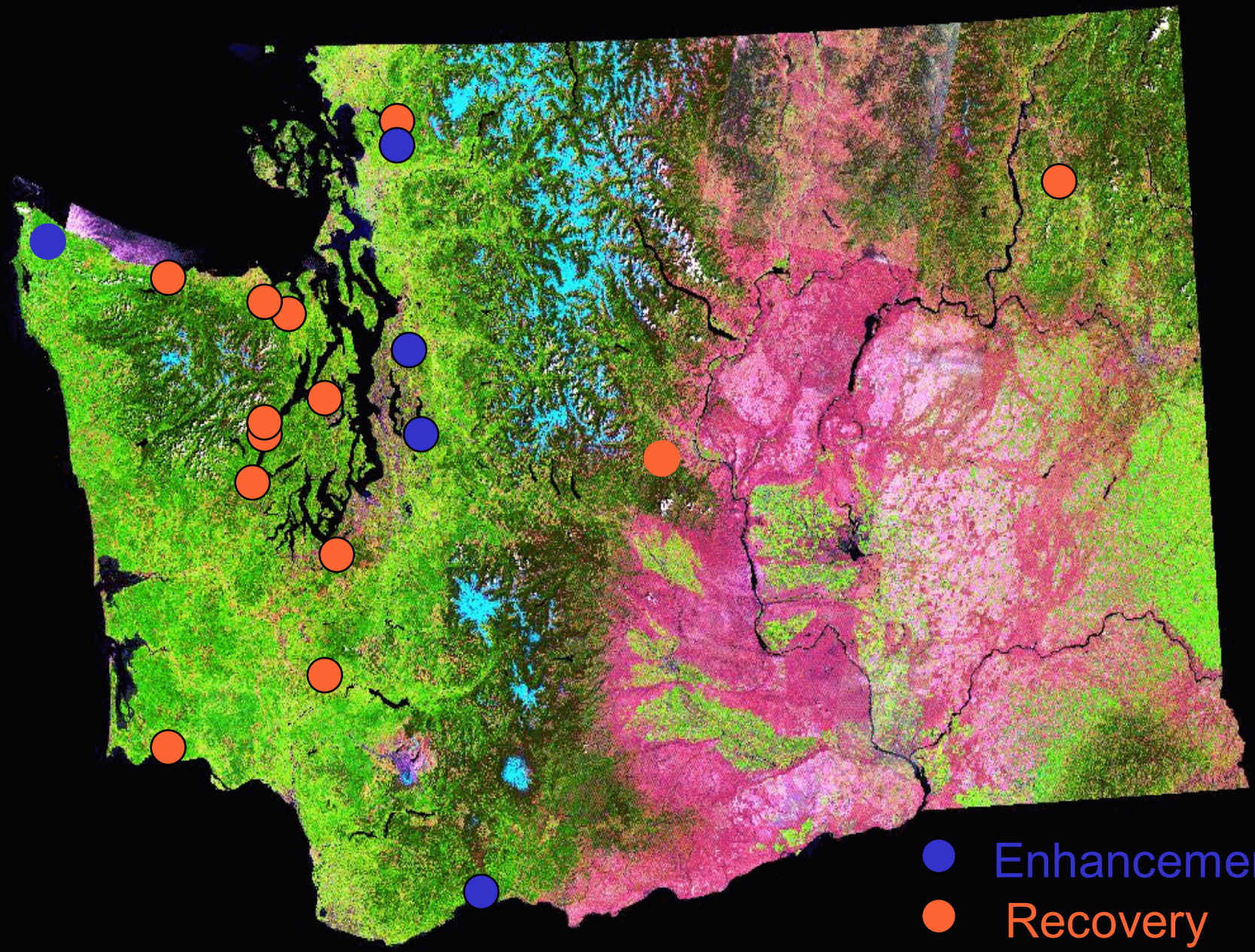



North Pacific Ocean
© MAPQUEST.COM
0 750 Miles
0 750 Kilometers
Arctic Circle
Bering Sea
Aleutian Basin
Gulf of Alaska
Sea of Okhotsk
ASIA
NORTH AMERICA
Aleutian Trench
Emperor Seamounts
Kuril Trench
PACIFIC OCEAN
Tufts Plain
Northeast Pacific Basin
Hess Rise
Mendocino Fracture Zone
Sea of Japan
Japan Trench
Shatsky Rise
Northwest Pacific Basin
Murray Fracture Zone
Ryukyu Trench
Mid-Pacific Mountains
Hawaiian Ridge
Molokai Fracture Zone
Tropic of Cancer
Clarion Fracture Zone
Central Pacific Basin
Clipperton Fracture Zone
60° N
40° N
20° N
120° E
140° E
160° E
180°
160° W
140° W
120° W


Thermally Marked Salmon Released
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
(thousands)
AK
CAN
JAPAN
RUSS
WA, OR, ID
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000

Hatchery releases of otolith marked salmon by species, and number of mark groups in the North Pacific rim countries, 1995-2000

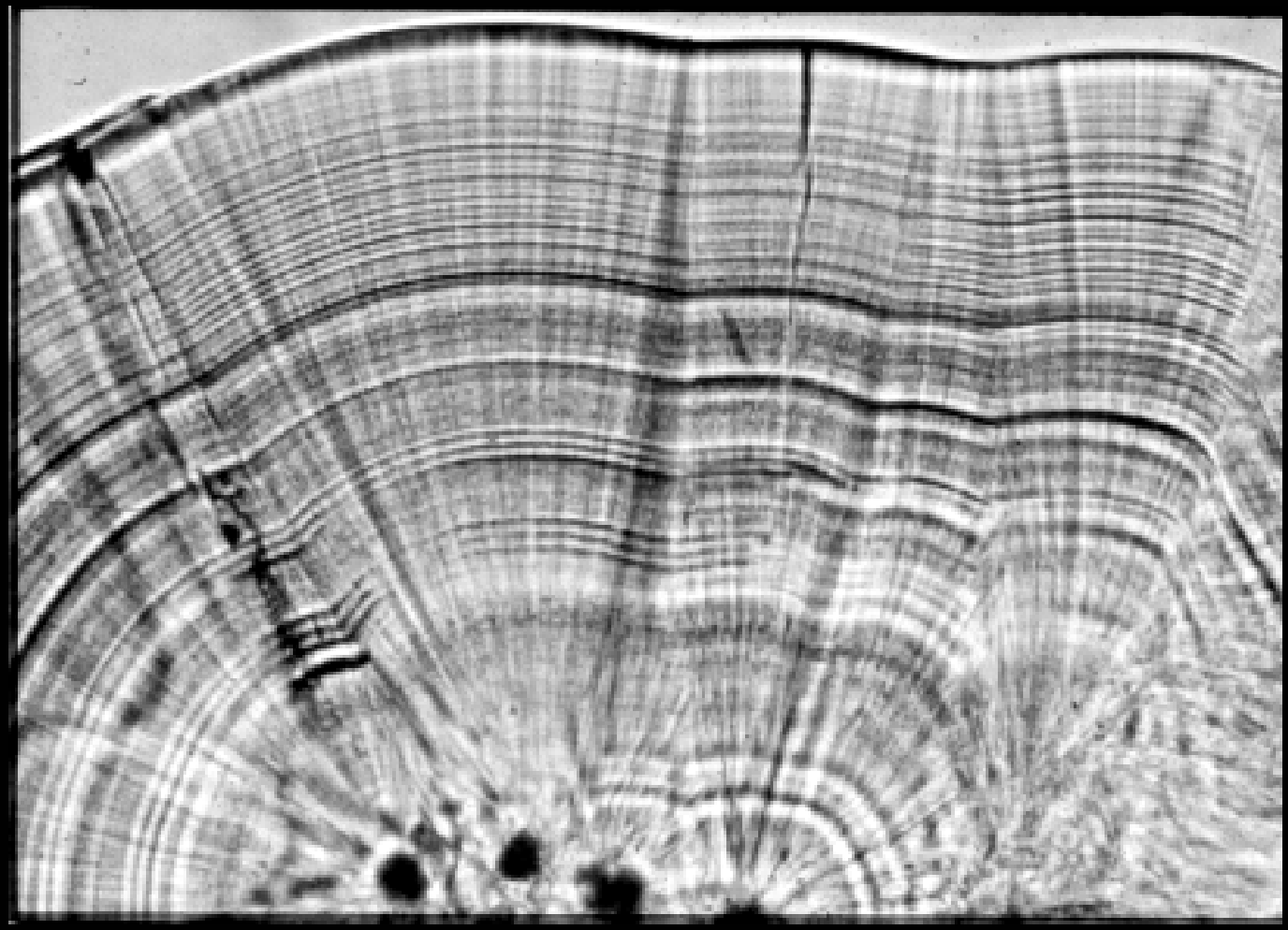




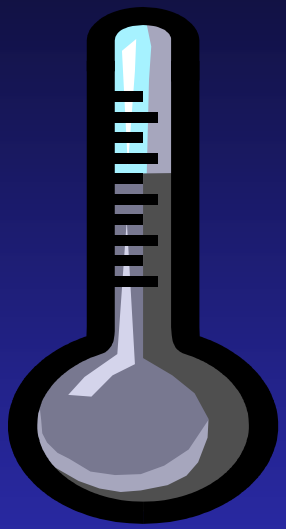
Washington from Space - Landsat TM data - Wash. Gap Analysis, Jan. 1995

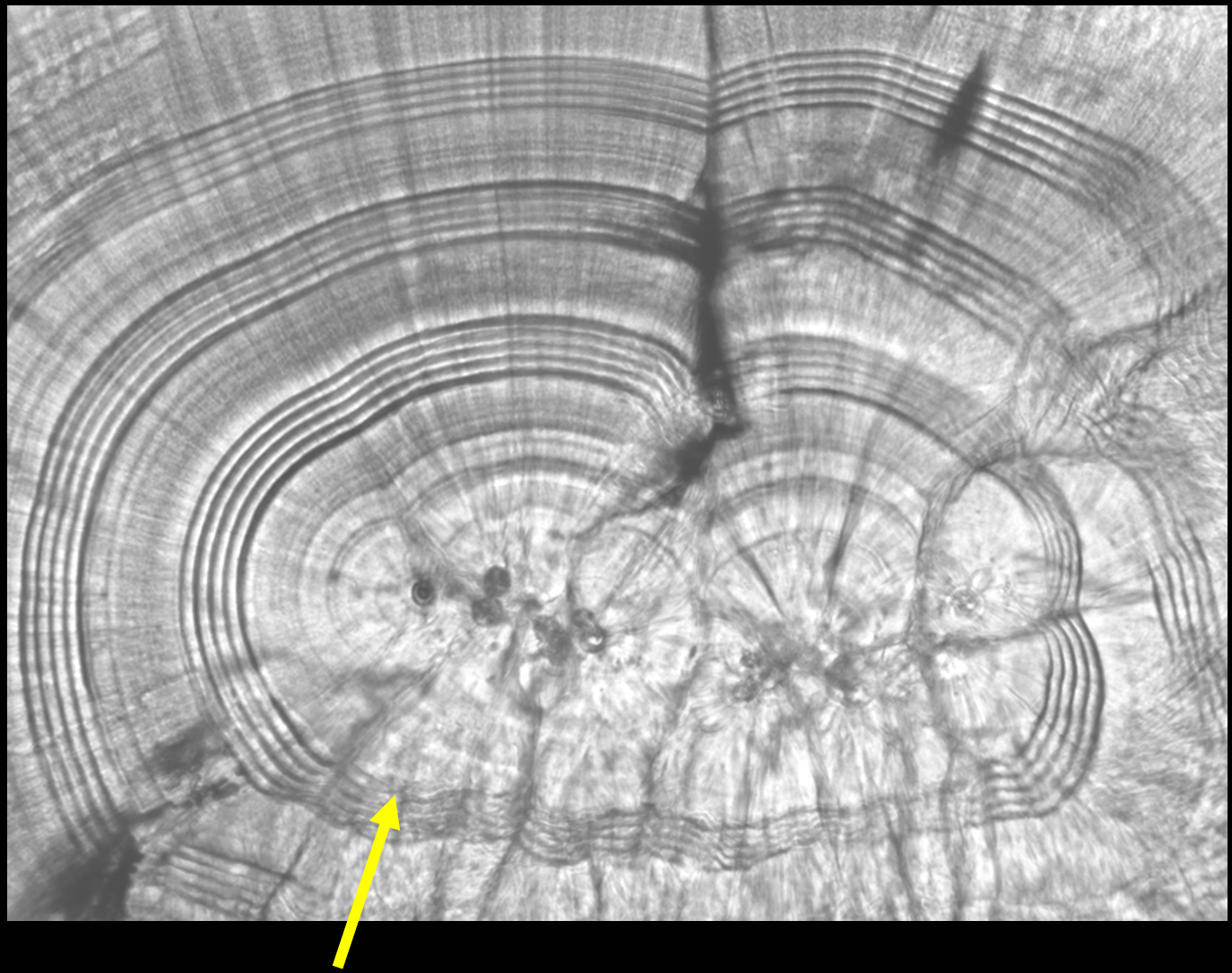
Otolith Thermal Marking

- Conceptually Simple
- No Specialized Equipment
- Method is Freely Available
- No Permits Necessary
- Amenable to Situation Specific Adaptation
- 100% Marking *(a true mass-marking method)
- Appears to Cause no Harm

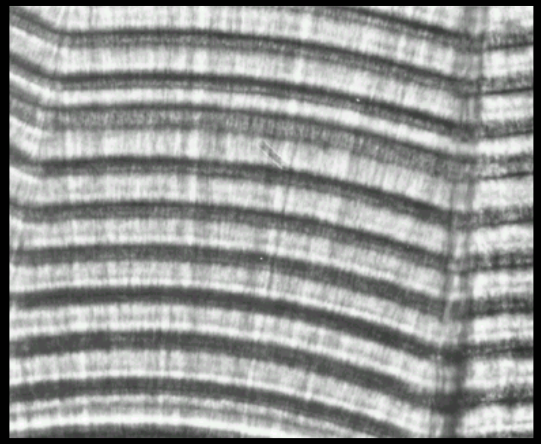


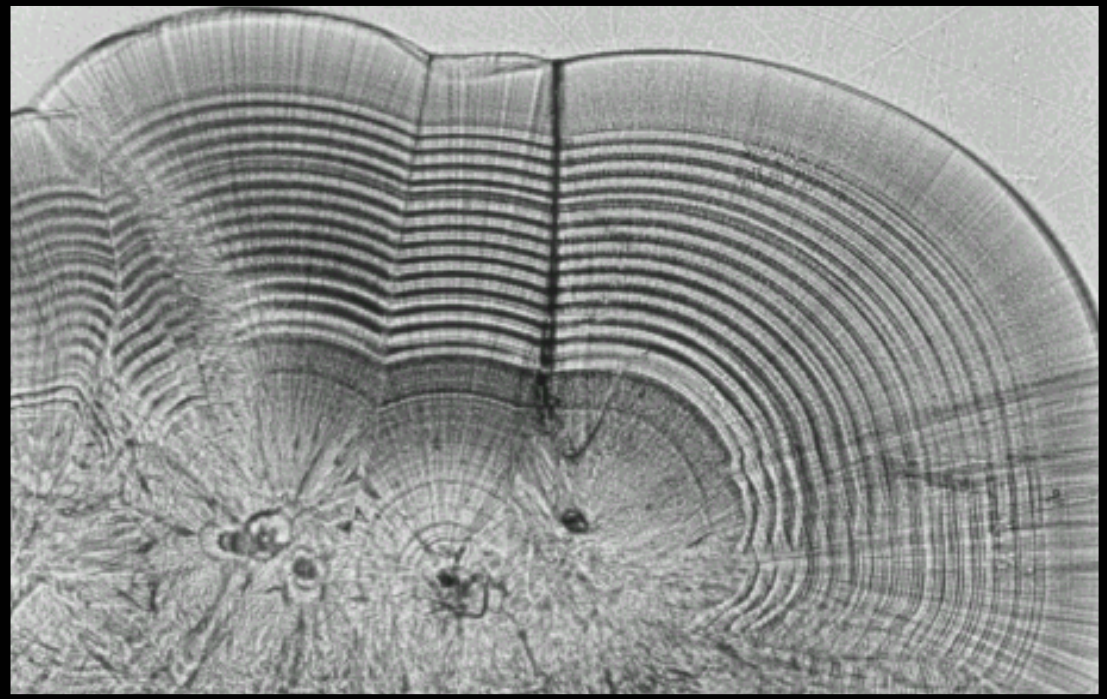
Otolith Thermal Marking



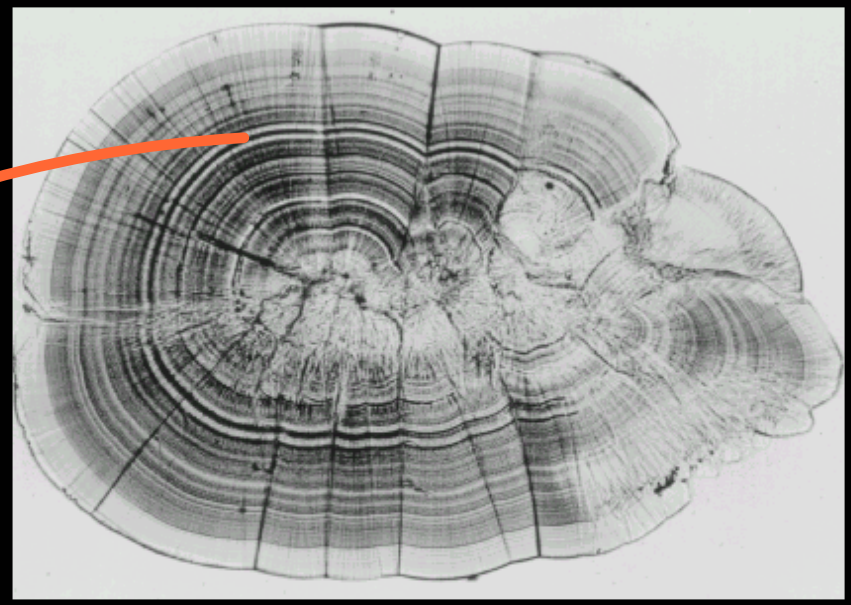


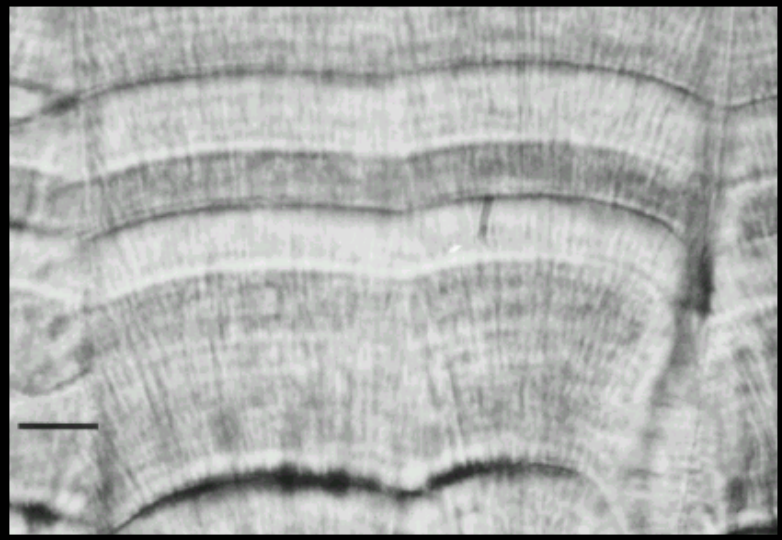
8 hours cool / 16 hours ambient 5 events



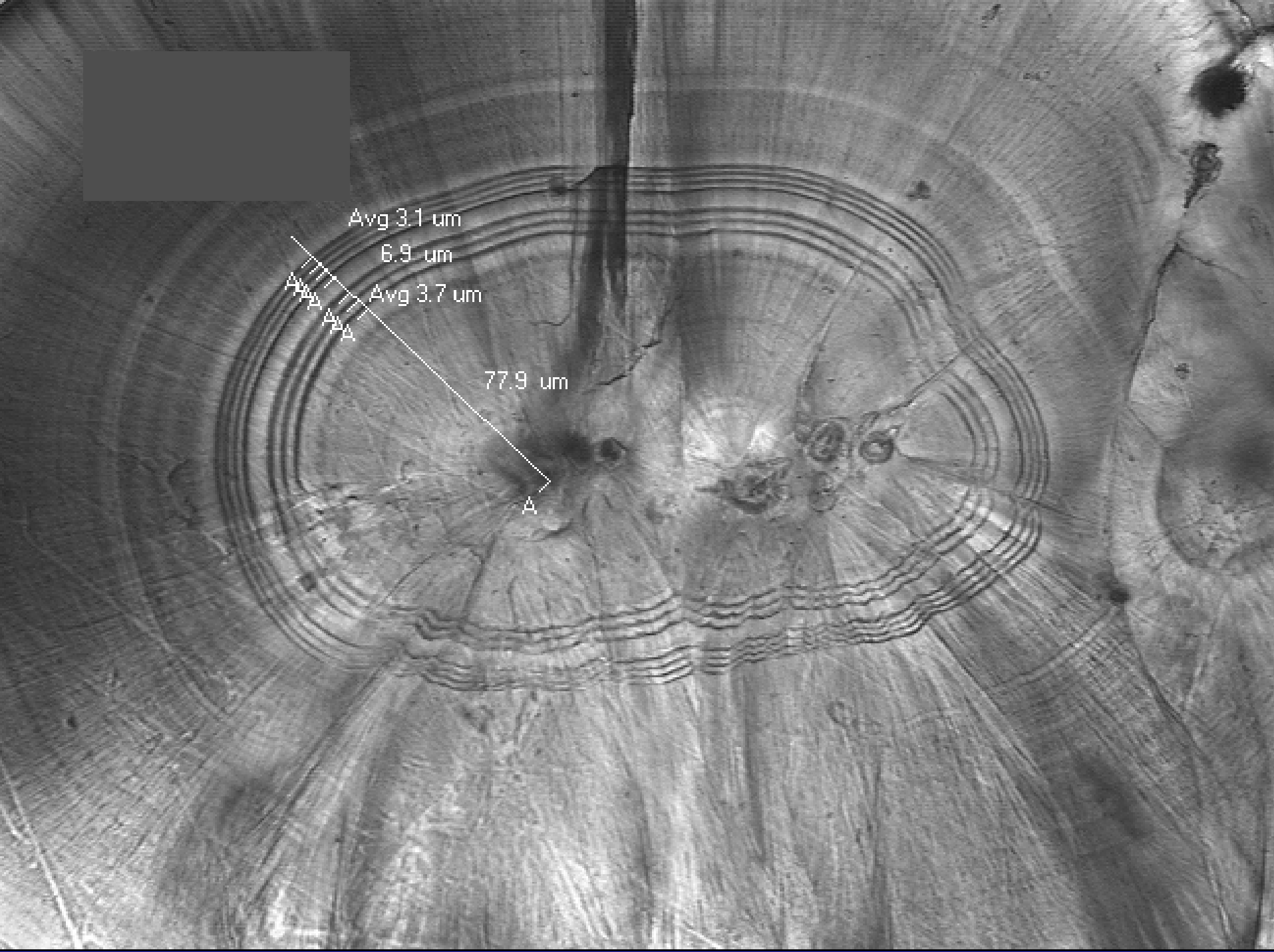


2 days cool / 2 days ambient



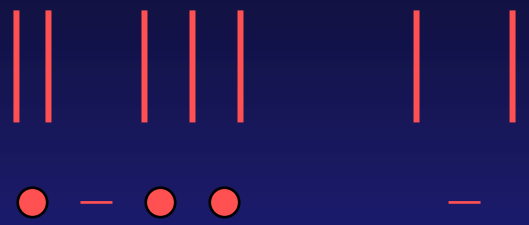


Warm
Ambient
Warm


Avg 3.1 um
6.9 um
Avg 3.7 um
77.9 um

Thermal Mark Coding Schemes

Morse Code
Brothers, 1990



Bar Code
Volk et al., 1994

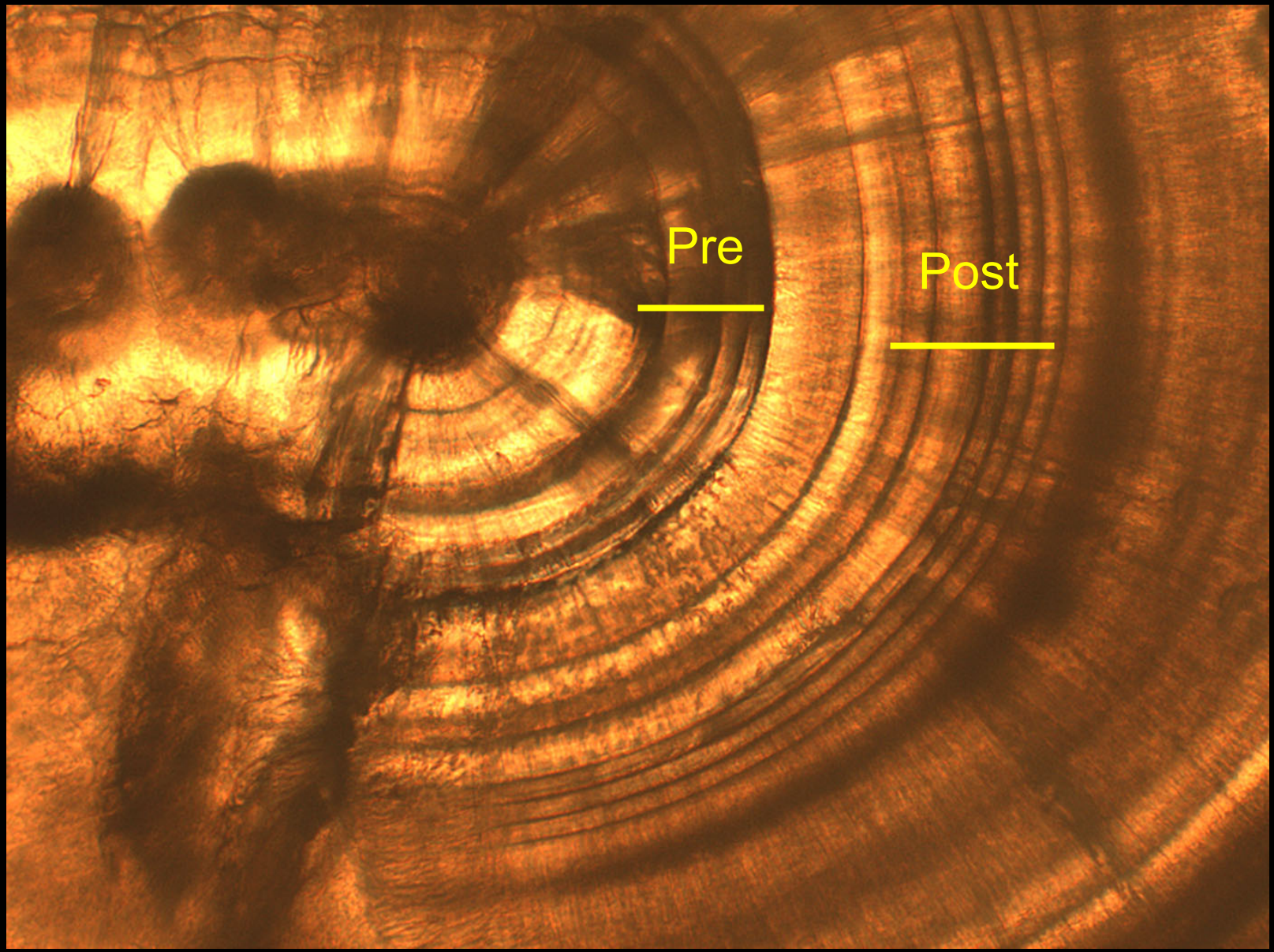
NNWNW

00101

RBr Code
Munk and Geiger

Variations on a Theme

Typical Adult Chinook Salmon Otolith T Mark



Factors Influencing Mark Detection Errors

Mark Quality

Interaction of planned events with ambient

Natural Mimics of Patterns

Clerical Errors

No “Gold Standard” for Evaluation

Agreement measures between readers to evaluate precision of mark determinations

Blick and Hagen, 2002

Important Considerations for Otolith Thermal Marking

Some modification of facilities usually required
Power, Water, Space

Meshing with normal hatchery operations

Recovery of marks requires specimen preparation

Lethal sampling *

No external mark *

Otolith Thermal Marking

Fisheries Research 43 (1999) 205-219

and

In: Stock Identification Methods (2004)

Eric C. Volk, Steven L. Schroder and Jeffrey J. Grimm

Washington Department of Fish and Wildlife
Otolith Laboratory
Olympia, WA

Why consider Otolith Thermal Marking??

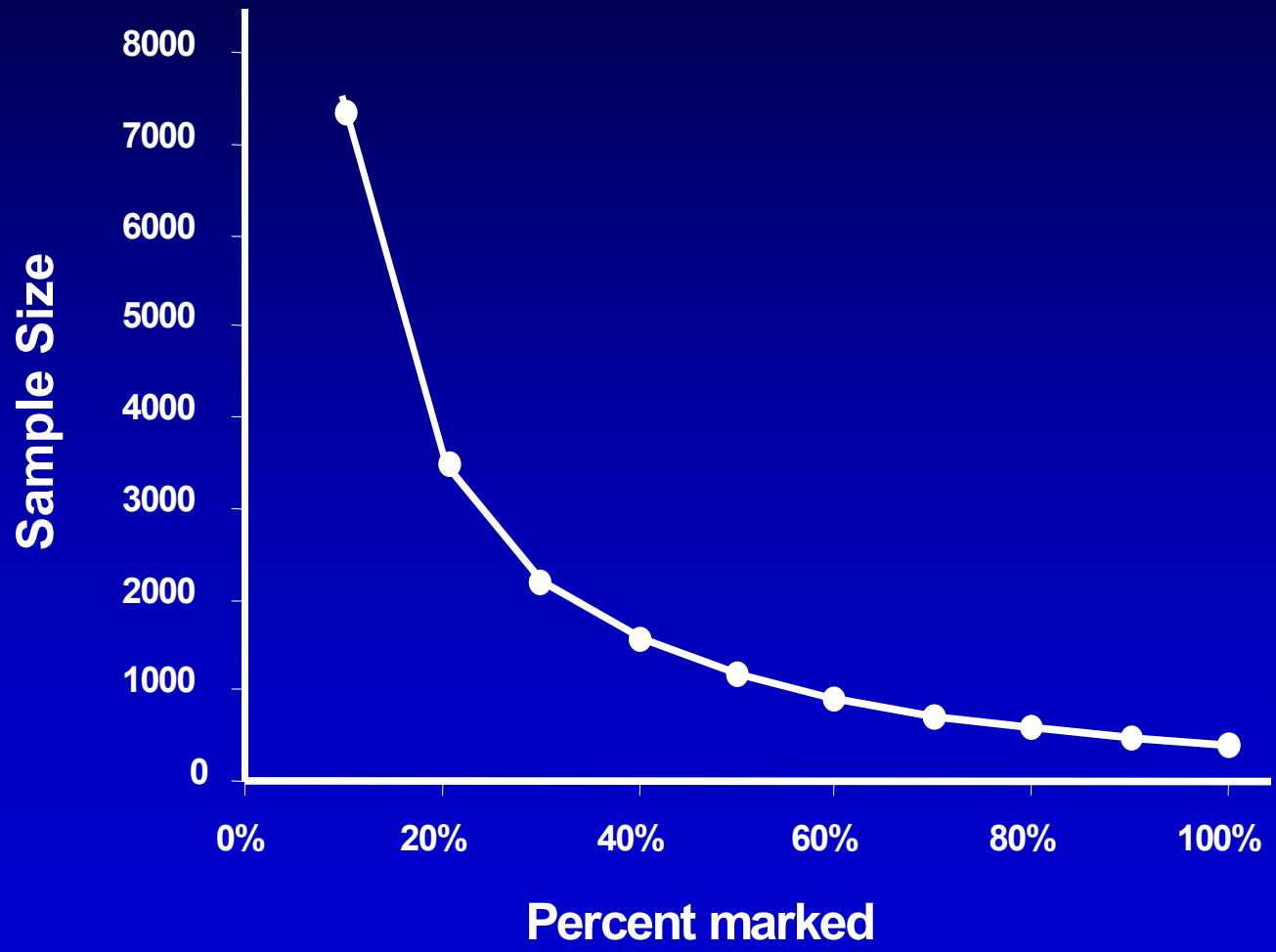
Advantages of 100% Marking

Substantial Cost Savings over Individual Marking Methods such as Coded Wire Tagging

Value added benefits of wide scale Mass marking

Sample size to achieve 95% CI within 5% of estimate as function of marking fraction

From Hagen et al., 2001



Using Thermally-Marked Otoliths to Aid the Management Of Prince William Sound Pink Salmon

Joyce and Evans, 2001

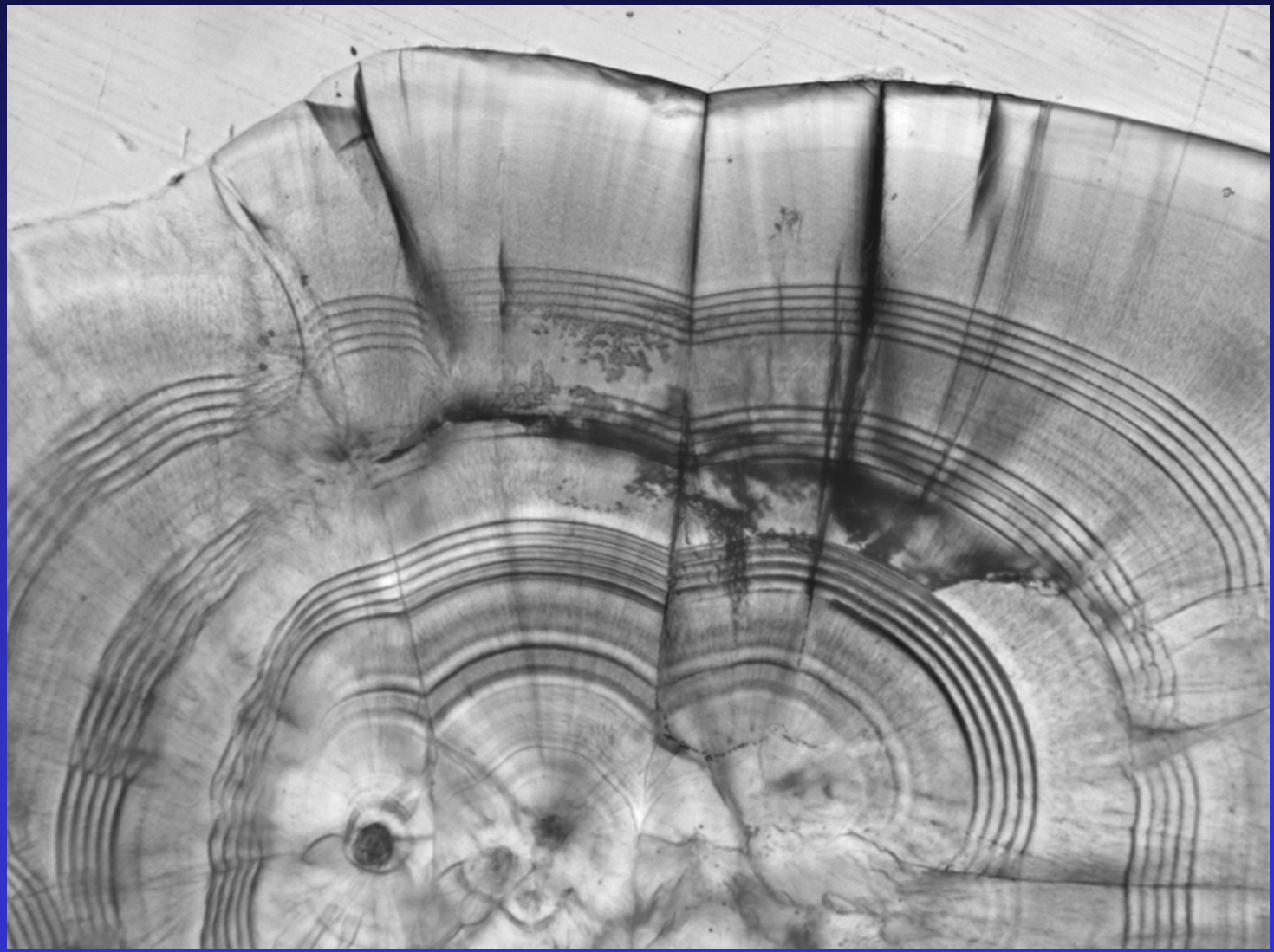
Far smaller sample sizes (N=100's) and greater precision than CWT estimates

Analysis of small samples from test fisheries allowed openings that would not have otherwise occurred

Hatchery contribution estimates available within 24 hours

Increased trust from managers and commercial fishers due to assumption-free nature of estimates from 100% marking

Spring Creek NFH Chinook Salmon



Costs of Marking and Recovery

Otolith Marking

Hatchery water system alterations are situation specific and costs typically range between $10,000 and $150,000 per hatchery, largely depending upon production number and number of mark codes.

Roughly translates to $10-20 per thousand based on real examples

This is a one time cost

CWT

At $130 per thousand, marking 100 million fish costs $13 million ……**Annually.**

Both methods require a staffed and equipped lab and recovery costs are similar, perhaps slightly higher for otolith preparation.

Value Added Benefits of Long-Term 100% Marking

Contribution rates of hatchery stocks to local fisheries

Hatchery contributions to natural spawning populations
Rawson et al., 2001

Hatchery fish stray rates and patterns
Kawana et al., 2001

Exploitation rates for key salmon stocks

Evaluating management actions
Hargraeves et al., 2001

Evaluation of stock recovery efforts
Numerous WDFW studies

Evaluation of biases in other marking methods

Applications

Workshop on Salmonid Otolith Marking

March, 2001

North Pacific Anadromous Fish Commission
Technical Report 3

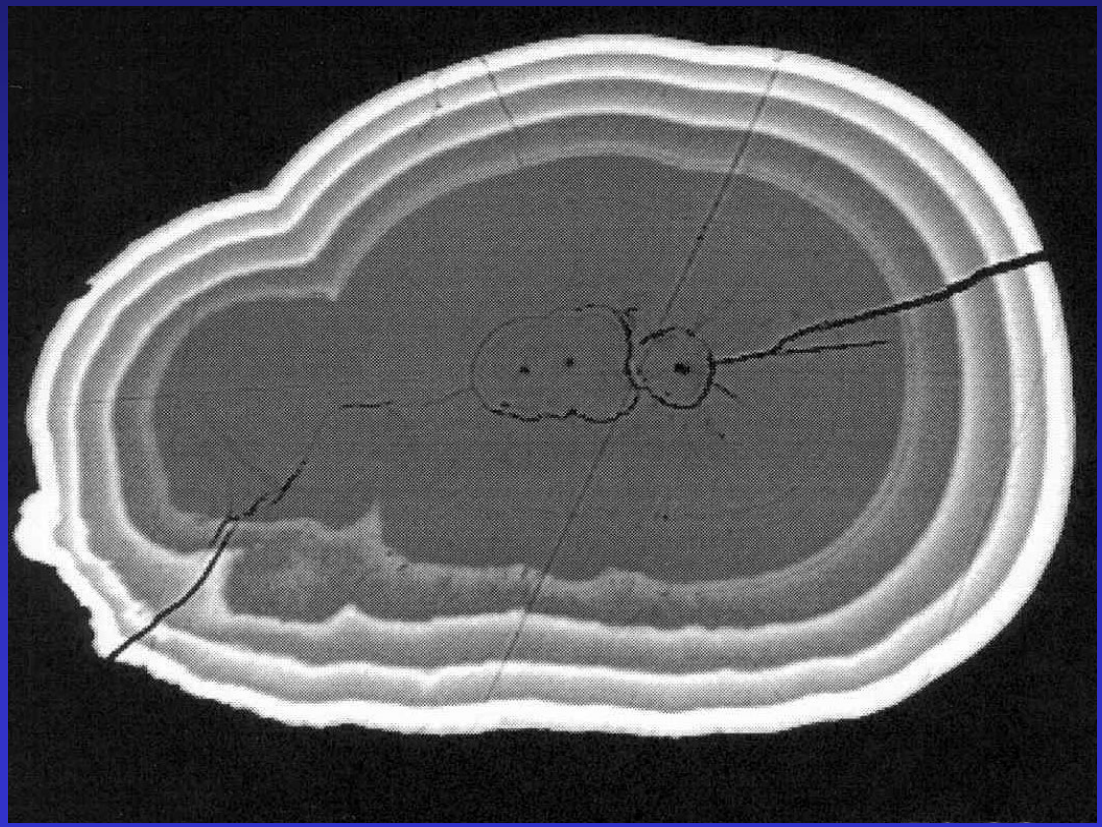
P. Hagen, D. Meerburg, K. Myers, A Rogatnykh,
S. Urawa, and E. Volk

Will we run out of

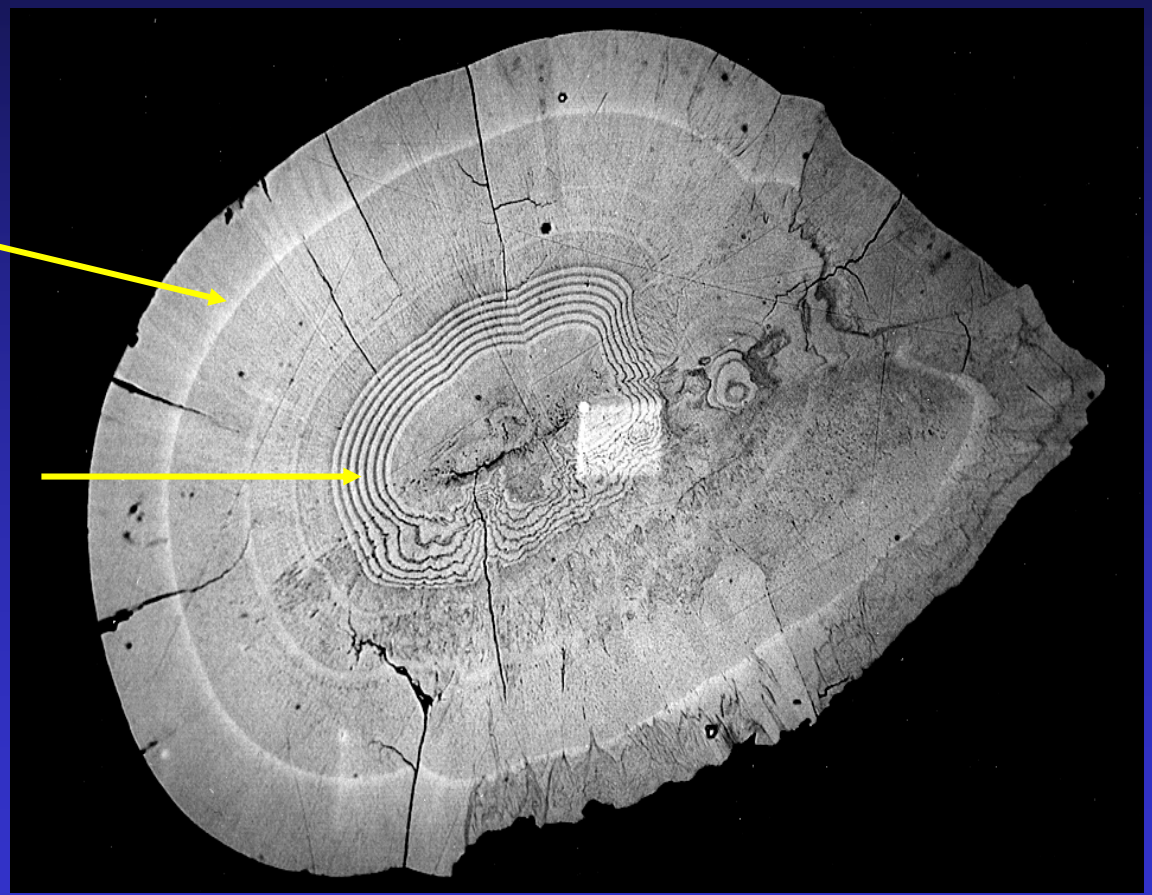
Marking Codes??

Strontium Marking of Salmon Fry

Schroder et al., 1995
Gulkana Hatchery, Alaska
Duncan Creek, WA.



Strontium & Thermal marks



Backscatter SEM