Chinook Salmon Scale Age Determination Standards & Procedures

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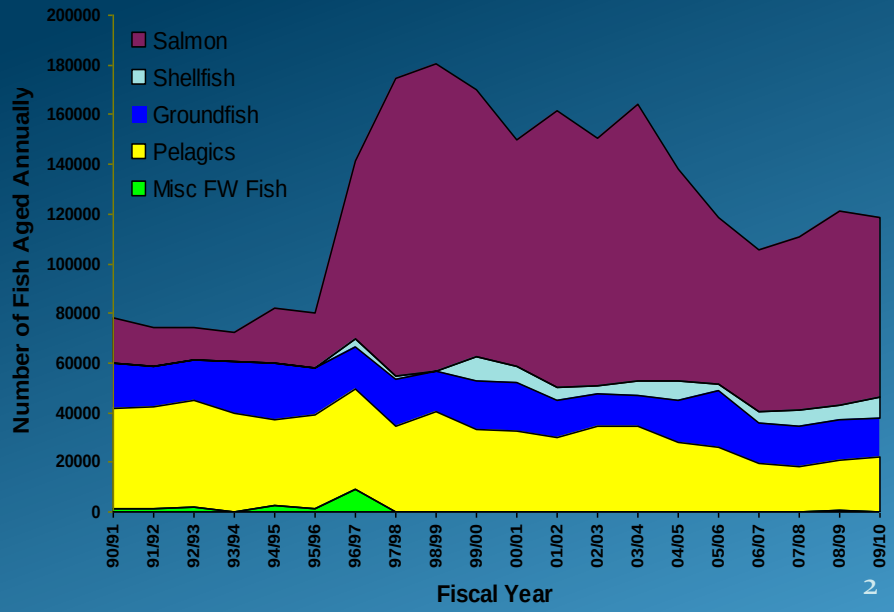
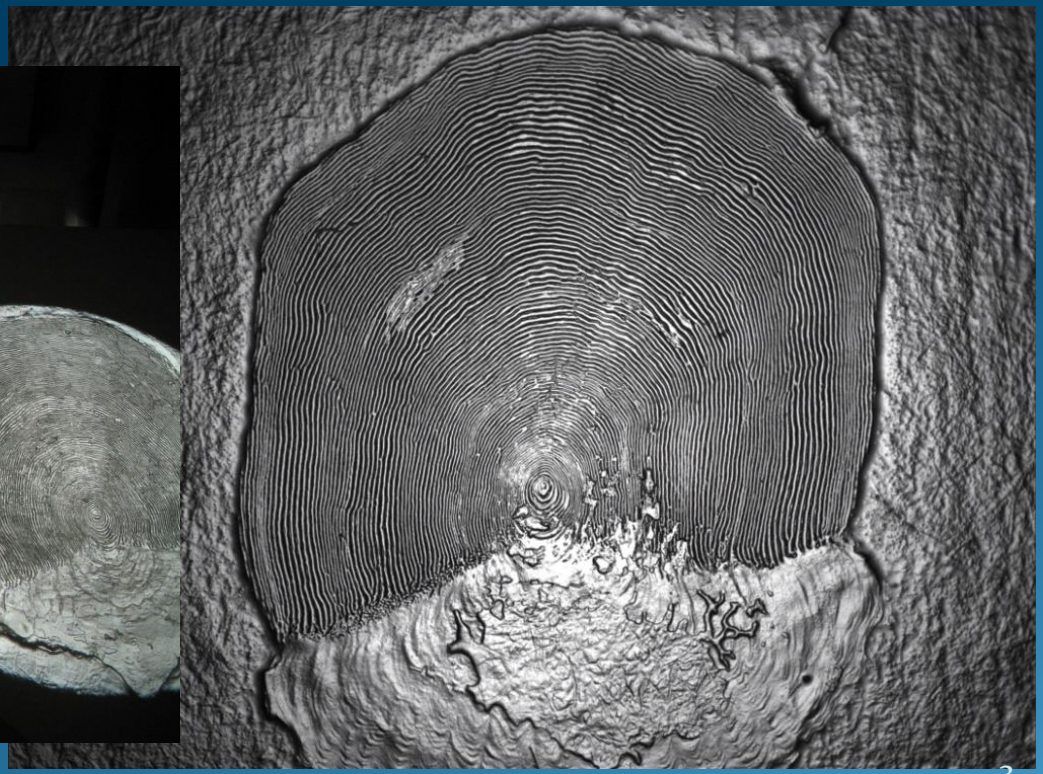
SCL - Production Ageing Lab

- Age ~ 120,000 fin/shellfish/yr. ~ **80K salmon**
- Aged 1.7M salmon since 1990 – **636K chinook**
- Started ageing salmon in early 1980's
- Took over all DFO Pacific Region salmon ageing in 1996
- 10 Staff :
  - Program Head & Biologist (30-50% of time ageing fish)
  - 7 Technicians (80% of time ageing) & 1 Salmon database technician
  - 1 Retired alumnus (Shayne) - research projects, writing , manuals, etc.



SCL objectives

1. Produce best quality data possible
2. Meet high volume requests in timely manner
3. Maintain deep & broad pool of expertise



Age determination protocols

- QA/QC system regulates all SCL ageing activities
- Standard practises promote continuity, precision & accuracy
- SCL spends ~20% of its time:
  1. Developing new methods/standards
  2. Validating methods
  3. Data management

SCL Salmon scale archive

- Custodians of vast collection of salmon scales
- Nothing is thrown away
- Dates back to early 1900's
- Each sample represents a unique point in time & space
- Represents long-time series useful for historical reconstruction studies:
    - ❖ Stock
    - ❖ Growth
    - ❖ Recruitment
    - ❖ changing oceanographic conditions
    - ❖ environmental indicators

SCL QA/QC System

QA = All we do to promote & ensure age data quality

QC = Standard practices to ensure best quality

1. Equipment & ergonomic standards
2. Reference material
3. Training & development system
4. Production ageing system
5. Scale age determination method

1. Equipment & ergonomic standards

*Most chinook are aged with Neopromar projector (10-40X mag.) & ergonomic scale workstation

Leica MZ7.5 stereo-scope with transmitted light base & KL2500 LCD fiber optic light source

Leica DFC295 camera & M205C stereo-microscope; with Leica Applications software for image capture

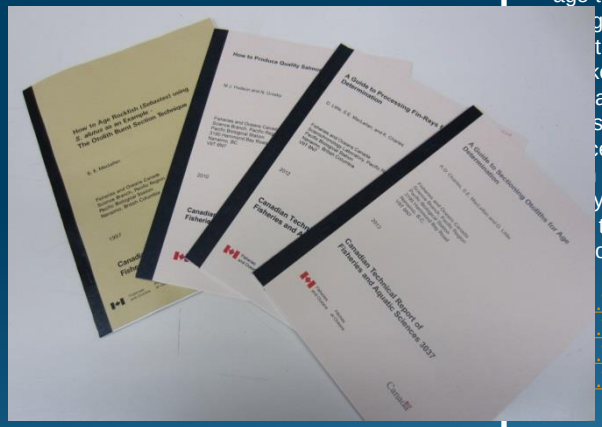
2. Reference material

Written & image documentation – WHY?

Promotes Continuity & QC – prevents reader drift

How?

- Reference
- Training
- Demonstration
- Publication



Atnarko Mark Recapture Program Samples:

2009 fish were sampled Sept 9 – Oct 8. The majority were aged 0.3 along with some 0.2, 0.4, 0.5, and some 1.3 & 1.2. All scales were resorbed and a year was added when the + growth was 2 or more. *The resorbed scale criteria for Atnarko was changed this year (see below), this change was supported by CWT ages. **Scales with + growth of 1² or less remained the same age, those with 2¹ growth were given only a FW age and a year was added to scales with ≥2 + growth.* 09/12/23 DL/KC/DG

2010 Atnarko Mark Recapture samples were collected Sep 14-30. Scales were about 2/3rds OFWA and 1/3rd 1FWA. There were many 0FWA with very strong Transition check (TC) that didn't look strong in the posterior and the circuli in the 1st SW year were fairly regular and even in formation. Usually the FWA were quite distinct. The sample was overall fairly resorbed but was also very Wet with lots of regenerate and some upside down scales. I used the Resorption criteria from 2009
11/02/25 SEM

Precision results were fairly good at 87% agreement. Howev
age to CWT age in samples was 73% agreement. Most diffe
gning a FWA when the CWT indicated it would be a chec
the other difference would be that the scales were under-
ked at all CWT differences and took some photos to show
are occurring and how prominent the FW transition check
s like in the Atnarko. Generally feel that the 1FW fish hav
ced FW circuli (cutout) with breaking and pinching circuli a
0FW fish, the 1st SW year tends to be smaller or about th
year and the circuli are more closely spaced than in the 2
the circuli after the focus can be wide with just a few clos
of FW with less pinching and breaking at the posterior ma
(11/03/03 DG)

..\..\Images\Salmon\Chinook\chin119.jpg
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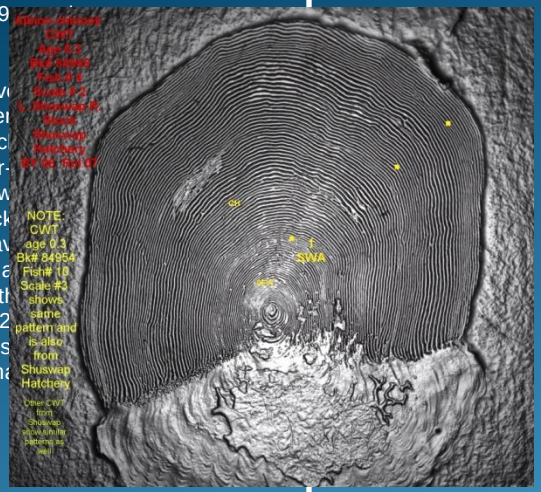
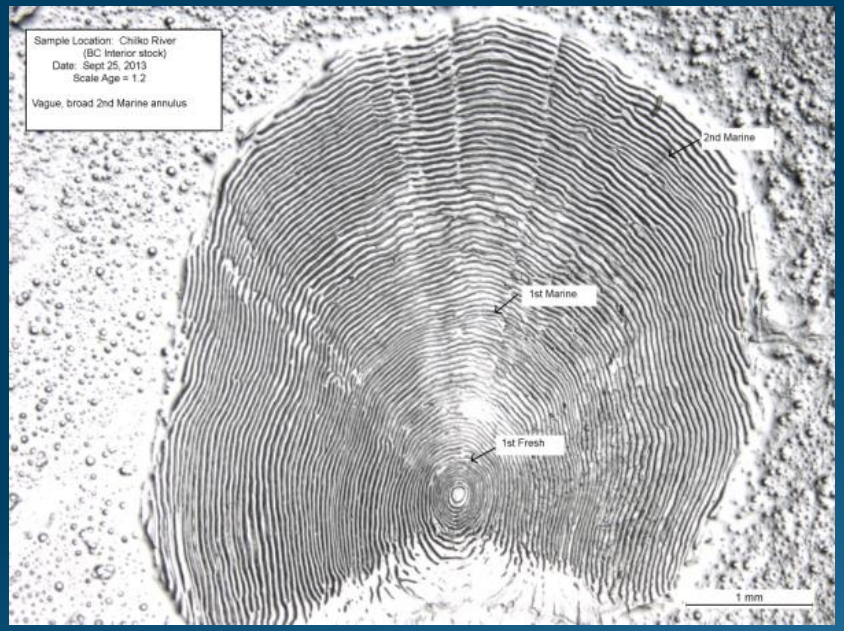


Chinook scale documentation

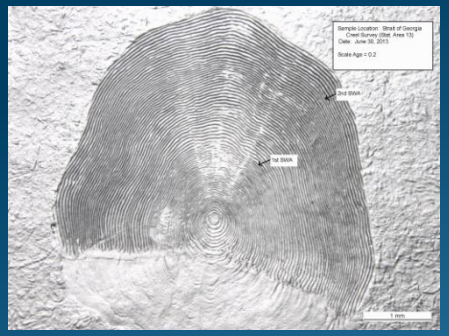
A. Criteria is often stock specific
   - FWA
   - SWA
   - Checks
   - Resorption

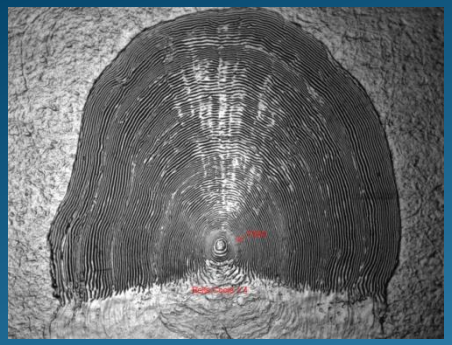


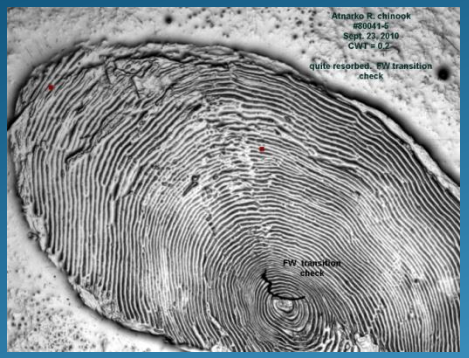
B. SCL readers review before ageing each stock sample
C. Promotes consistency between readers & between stocks from year to year

3. Training & development system

- 100's chinook stocks in B.C. &Yukon
- 2-3 yrs to gain **deep** & **broad** expertise in all stocks/life histories
- Easy scale patterns > complex life histories & scale resorption
- 3 stage training plan provides clear goals & expectations
- Assess 2 key technical competencies - quality & quantity
  - Precision/accuracy target = **80% agreement**
  - Productivity= **40-80fish/hr**
- Reader must know limits of methods/criteria employing







4. Production ageing system

A. Sample management process
B. Salmon age data sheet standards
C. Salmon age designation system
D. Productivity standards
E. Data quality standards

A. Sample management process

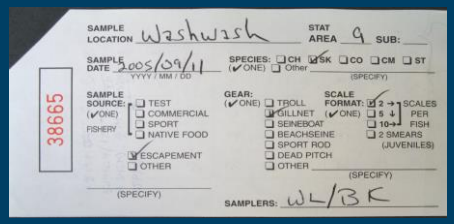
- **Monthly workplan** identifies samples, readers & priorities
- Team of 2/sample - 1st reader & precision tester
- **Sample Tracking system** logs sample progress, QC results & processing times

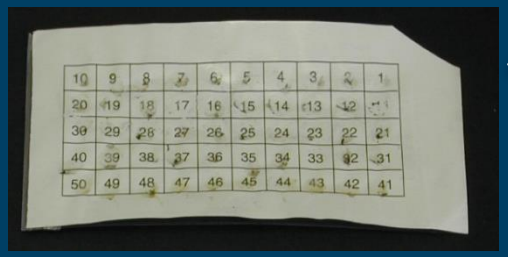
II. SALMON

Date Started	Species	Sample #	Project Description	# Fish	# Structures Scales	Otos	Fins	% Agreement Scales	Otos	Fins	Prec. n	Agers Initials	Time (hrs.) 1st Read	QCt	QCn	CWT % CC agree.	Date Complete	Comments
14/01/03	Chinook	2013/0333	Lower Shuswap Chinook Keystream	103	1030			90			21	KC>JM	4.00	0.75	29	100	14/01/21	CWT n = 11
14/01/03	Chinook	2013/0404	Harrison River Chinook Enum. - Keystream	353	1765			93			71	AT>CC	7.75	1.75	77		14/01/15	
14/01/03	Chinook	2013/0436	WCVI SEF (Tranquil Creek)	54	540			100			10	JG>KC	2.50	0.50	15		14/01/31	
14/01/06	Chinook	2013/0414	Cowichan Adult Enumeration/Productivity Study	320	1600			91			62	JM>MH	4.50	1.00	71	88	14/01/15	CWT n= 41
14/01/06	Chinook	2013/0347	WCVI Chinook Escapement - Leiner River	102	510			95			21	CC>DG	3.00	0.50	26		14/01/07	
14/01/07	Chinook	2013/0348	WCVI Chinook Escapement - Gold River	71	490			100			14	CC>DG	2.00	0.50	16		14/01/09	sample had both 10A and 5A format
14/01/08	Chinook	2013/0407	Chilliwack River Chinook	103	515			90			20	MH>JM	1.75	0.25	22		14/01/22	
14/01/09	Chinook	2013/0339	Quinsam River Project	90	450			100			18	BC>JM	1.50	0.25	21		14/01/13	
14/01/07	Chinook	2013/0233	Chilko River Adult Chinook (M/R)	209	2090			76			42	DG>KC	9.25	4.00	76		14/01/31	
14/01/09	Chinook	2013/0394	Albion Chinook Test Fishery	290	1450			76			55	CC>AT	10.00	2.00	88		14/01/13	
14/01/09	Chinook	2013/0405	Harrison River Chinook Enum. - Keystream	384	1920			84			77	AT>CC	8.00	2.00	80		14/01/16	
14/01/08	Chinook	2013/0408	Chilliwack River Chinook	284	1420			91			56	MH>JM		1.00	64		14/01/15	
14/01/09	Chinook	2013/0332	Lower Shuswap Chinook Keystream	143	1430			93			29	JM>KC	4.00	0.75	32	94	14/01/31	CWT n = 20
14/09/09	Chinook	2013/0412	Chilliwack River Chinook	125	625			84				MH>JM	1.75	0.50	29		14/01/22	
14/01/13	Chinook	2013/0395	Albion Chinook Test Fishery	277	1385			95			55	CC>AT	10.00	1.75	73		14/01/14	
14/01/10	Chinook	2013/0335	Lower Shuswap Chinook Keystream	103	1030			81			21	JM>KC	2.50	0.50	26	94	14/01/15	CWT n = 19
14/01/13	Chinook	2013/0328	Lower Shuswap Chinook Keystream	54	540			100			11	JM>KC	1.25	0.25	11	100	14/01/20	CWT n = 15
14/01/14	Chinook	2013/0329	Lower Shuswap Chinook Keystream	120	1200			92			24	JM>KC	2.75	0.50	27	100	14/01/20	CWT n = 33
14/01/15	Chinook	2013/0331	Lower Shuswap Chinook Keystream	218	2180			84			44	KC>DG	5.50	1.25	67	100	14/01/22	CWT n = 48
14/01/15	Chinook	2013/0235	Chilko River Adult Chinook (M/R)	215	2150			88			43	DG>KC	8.00	2.00	51		14/01/31	
14/01/15	Chinook	2013/0411	Chilliwack River Chinook	266	1330			91			53	JM>MH	3.00	1.00	61		14/01/16	
14/01/15	Chinook	2013/0410	Chilliwack River Chinook	232	1160			97			46	JM>MH	2.75	0.75	50		14/01/17	
14/01/16	Chinook	2013/0406	Harrison River Chinook Enum. - Keystream	403	2015			91			81	CC>AT	10.00	1.50	95		14/01/22	
14/01/16	Chinook	2013/0334	Lower Shuswap Chinook Keystream	182	1820			97			36	JM>KC	3.75	0.50	38	91	14/01/20	CWT n = 34
14/01/20	Chinook	2013/0330	Lower Shuswap Chinook Keystream	162	1620			88			32	KC>JM	3.75	0.75	48	93	14/01/24	CWT n = 32
14/01/20	Chinook	2013/0343	Big Qualicum River Project	250	1250			88			50	BC>AT	3.25	1.50	66		14/01/27	
14/01/20	Chinook	2013/0354	W.C.V.I Chinook Escapement - Tlupana R.	31	155			90			31	CC>DG	0.50	0.00	12		14/01/21	
14/01/22	Chinook	2013/0336	Lower Shuswap Chinook Keystream	97	970			84			19	DG>JM	2.50	0.25	24	100	14/01/22	CWT n = 15
14/01/20	Chinook	2013/0344	Big Qualicum River Project	250	1250			82			50	BC>AT	3.50	1.75	64		14/01/27	
14/01/21	Chinook	2013/0409	Chilliwack River Chinook	247	1235			92			50	MH>JM	3.75	0.50	55		14/01/22	
14/01/22	Chinook	2013/0355	W.C.V.I Chinook Escapement - Gold River	179	895			78			36	CC>DG	5.50	0.75	53		14/01/27	
14/01/23	Chinook	2013/0476	Chilliwack River Recreational Fishery	53	265			100			10	MH>DG	1.00	0.25	12		14/01/27	
14/01/23	Chinook	2013/0356	W.C.V.I Chinook Escapement - Burman River	286	1430			93			57	CC>DG	8.00	0.75	66		14/01/29	
14/01/22	Chinook	2013/0337	Lower Shuswap Chinook Keystream	58	580			75			12	DG>JM	1.50	0.25	17	100	14/01/24	CWT n=6
14/01/22	Chinook	2013/0353	Conuma River Hatchery	230	1150			87			46	JG>JM	4.00	1.25	61		14/01/29	
14/01/27	Chinook	2013/0352	Conuma River Hatchery	206	1030			90			41	JG>JM	4.00	1.00	54		14/01/29	
14/01/30	Chinook	2013/0413	Cowichan River CID	123	615			83			24	MH>JM	1.50	0.50	28		14/01/30	
14/01/31	Chinook	2013/0383	Wannock (Owikeno) Co-Mgmt Program									KC>						

B. Age data sheet & scale book standards

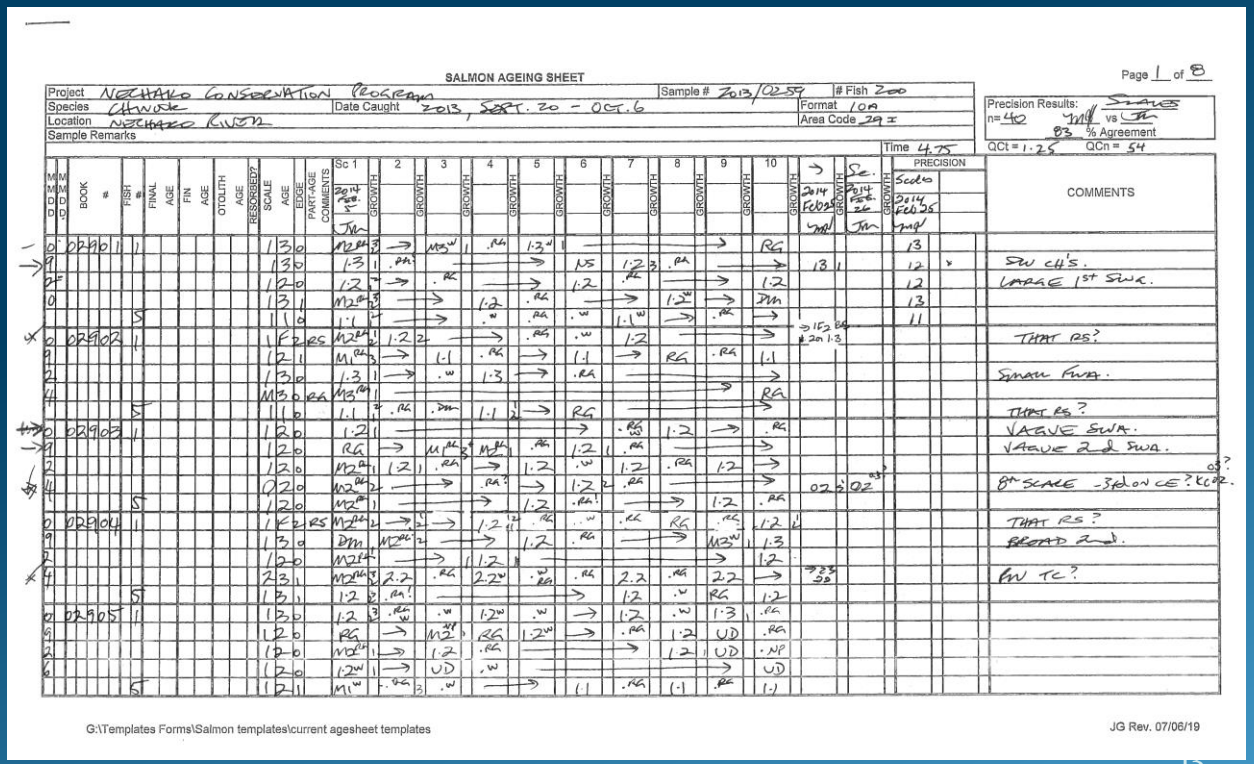
Scale book front – sample info.





Back – scales mounted on gummed number grid

- 1, 2, 5 or 10 scales/fish collected
- Ages recorded on salmon age data sheets based on scale format
- 1st reader records age/code for each scale



C. Salmon age designation system

Conversion table for salmon age data: European to Gilbert-Rich Designation								
European system				Gilbert-Rich system				
Age designation	No. FW annuli	No. SW annuli	Total age	Age designation	Yr of life caught	Yr of life went to sea	Year caught	Brood year
0.0	0	0	0	1_1	1	1	2002	2001
0.1	0	1	1	2_1	2	1	2002	2000
0.2	0	2	2	3_1	3	1	2002	1999
0.3	0	3	3	4_1	4	1	2002	1998
1	1	0	1	2_2	2	2	2002	2000
1.1	1	1	2	3_2	3	2	2002	1999
1.2	1	2	3	4_2	4	2	2002	1998
1.3	1	3	4	5_2	5	2	2002	1997
2	2	0	2	3_3	3	3	2002	1999
2.1	2	1	3	4_3	4	3	2002	1998
2.2	2	2	4	5_3	5	3	2002	1997
2.3	2	3	5	6_3	6	3	2002	1996
3.0	3	0	3	4_4	4	4	2002	1998
3.1	3	1	4	5_4	5	4	2002	1997
3.2	3	2	5	6_4	6	4	2002	1996
3.3	3	3	6	7_4	7	4	2002	1995
3.4	3	4	7	8_4	8	4	2002	1994
4.0	4	0	4	5_5	5	5	2002	1997
4.1	4	1	5	6_5	6	5	2002	1996
4.2	4	2	6	7_5	7	5	2002	1995
4.3	4	3	7	8_5	8	5	2002	1994

SCL standard is European

Provides total age

- DFO salmon biologists use Gilbert Rich
- Provides brood year
- Gives yr of life went to sea & year of life caught

e.g. 1.2 = 4_2

D. Productivity standards

Species	Ageing Method	Sample size (99/00-04/05)	Average reading avg. rate targets (#/hour)	Reading rate ranges (#/hour)
Chinook	scales	186,682	60	40-80
Chum	scales	86,816	98	60-125
Coho	scales	82,096	81	60-120
Sockeye	scales	176,834	80	50-90

Chinook slowest ageing rate of 4 salmon species

E. Data quality standards

Expected to meet minimum 80% agreement target

Precision = Repeatability

- Measured through blind precision tests
- 20% of each sample tested

Accuracy = Closeness to true age

- Measured through CWT's & DNA analysis

QC - Precision test procedure

1st Reader:

- Make up separate precision data sheet for tester
- Roll dice to ID 1st scale book to start test on
- Then followed by every 5th book

Tester:

- Transfer test ages to 1st reader's sheets
- Calculate % agreement & look for any age biases
- Resolve test differences, bias issues & fish flagged by 1st reader
- If <80% agreement some/all fish in sample re-aged
- Return ageing sheets to 1st reader if any unresolved fish

1st Reader & Tester:

- If 1st reader can't resolve on own work with tester to finalize age
- Both readers must agree on final age

5. Scale age determination method

A. Terminology standards
B. Standards to generate age data
   - Date of capture
   - Location
   - Jan 1st birthdate
C. Basic Chinook scale ageing criteria
D. Challenges ageing Chinook scales
   i. Prominent FW & SW checks
   ii. Indistinct annuli
   iii. Resorption
   iv. Disproportionate growth years
   v. Unfamiliar stocks (US stocks in mixed fisheries)

A. Terminology standards

Summer zones

- form during the late spring, summer and early fall months
- represent a time of faster growth

Winter zones & associated Annuli

- form during the fall, winter and early spring months
- represents slower growth
- annuli form only once a year
- On scales, the Annulus is defined as the last closely spaced circulus of the winter zone

Checks

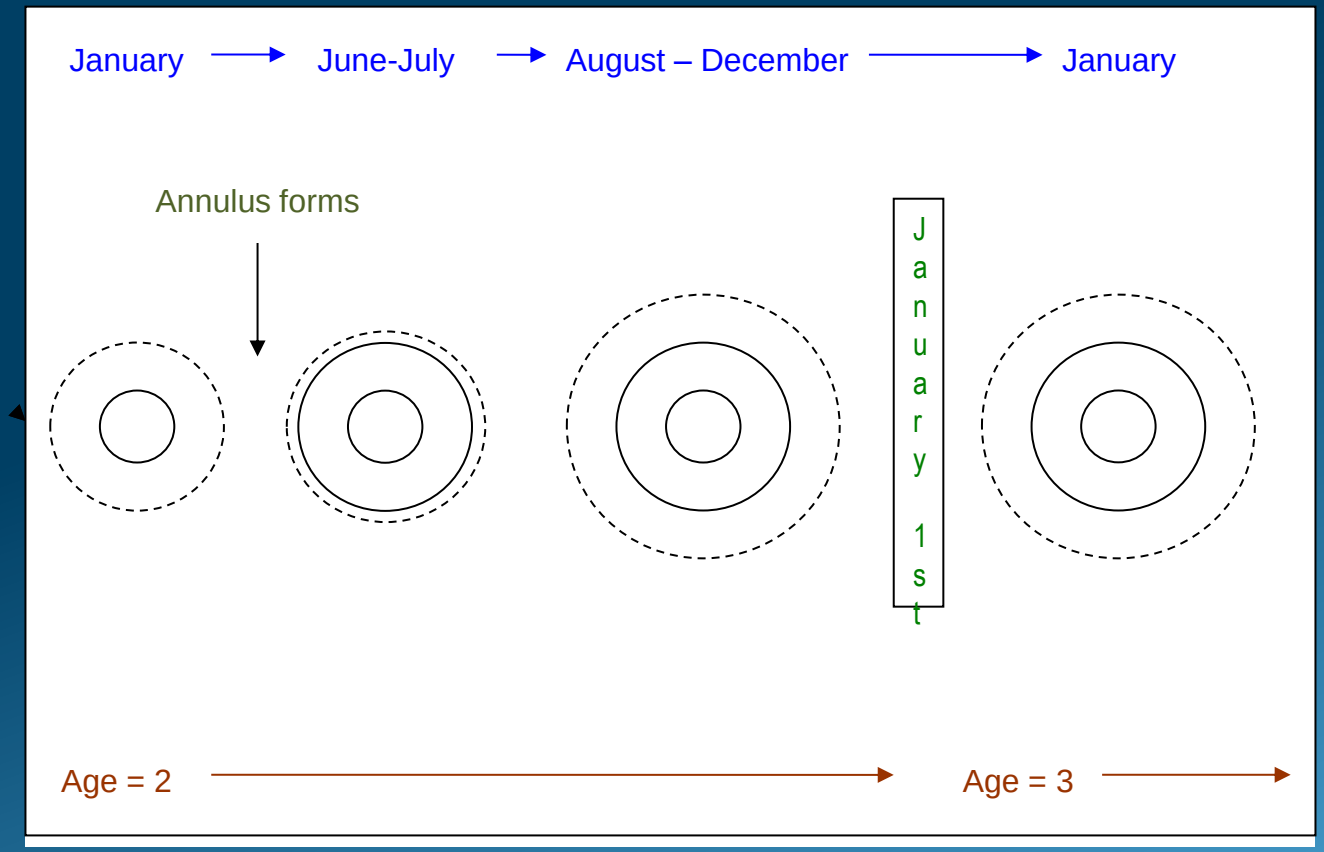
- form within the normally fast-growing summer zone
- represent a slowing of growth due to some kind of stress

Annual zone = 1 summer zone + 1 winter zone

B. Standards to generate age data

- Date of capture
- Location
- Jan 1st birthdate

NOTE: SCL readers do **not** have access to biological data (length/sex) while ageing as it is considered to be biasing.

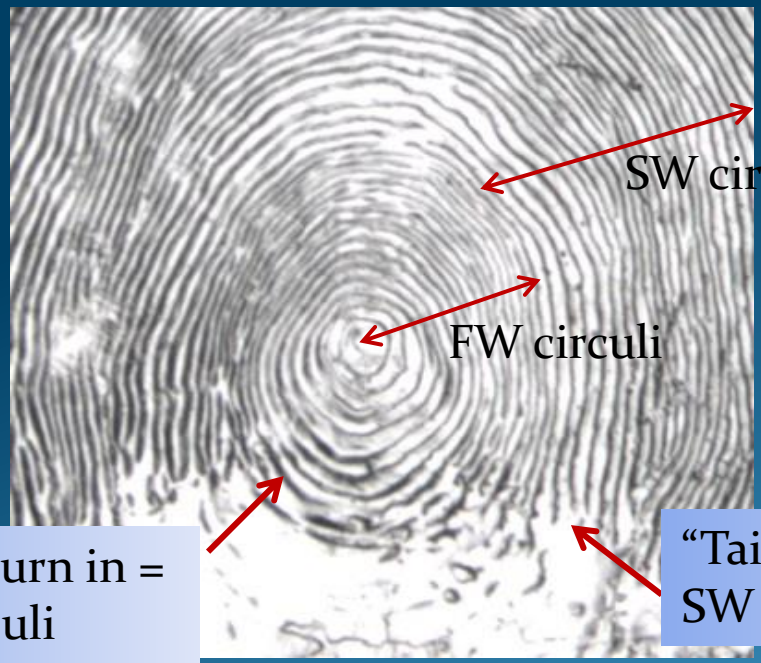


C. Basic chinook scale ageing criteria

1. Identification of Freshwater vs Marine growth:

- FW circuli - occur near the scale focus; are generally finer, closely-spaced; circuli "tails" turn in at posterior margin.

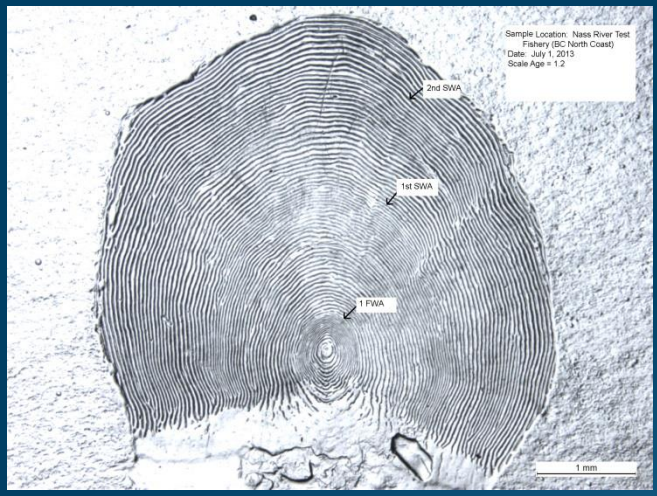
- Marine circuli – often further out from scale focus, are generally thicker, wider spaced; circuli "tails" turn outwards at posterior margin.



2. Presence of FWA or not:

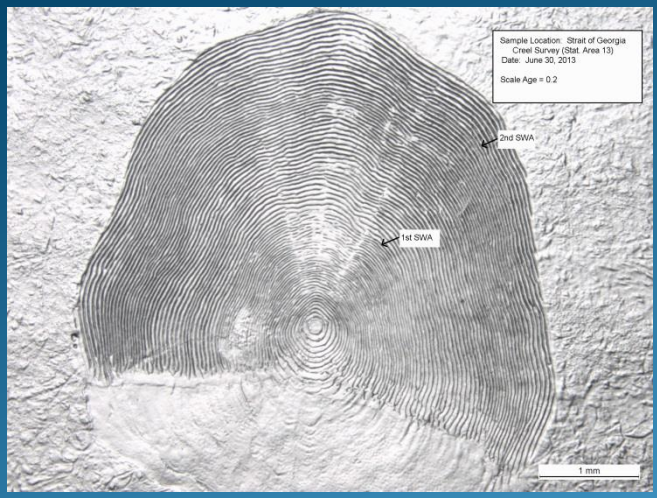
a) Stream-type pattern (FWA present):

- FW circuli pinch in at posterior margin;
- Presence of additional FW spring plus growth circuli after FWA
- Wide SW circuli immediately after FWA
- Focus to 1st SWA ≥ size of 2nd SW yr.



b) Ocean-type pattern (no FWA present):

- FW circuli do not pinch in at posterior margin
- Gradual shift in circuli spacing & thickness from FW to SW
- Focus to 1st SWA ≤ size of 2nd SW yr



FWA criteria rules (in descending order of reliability)

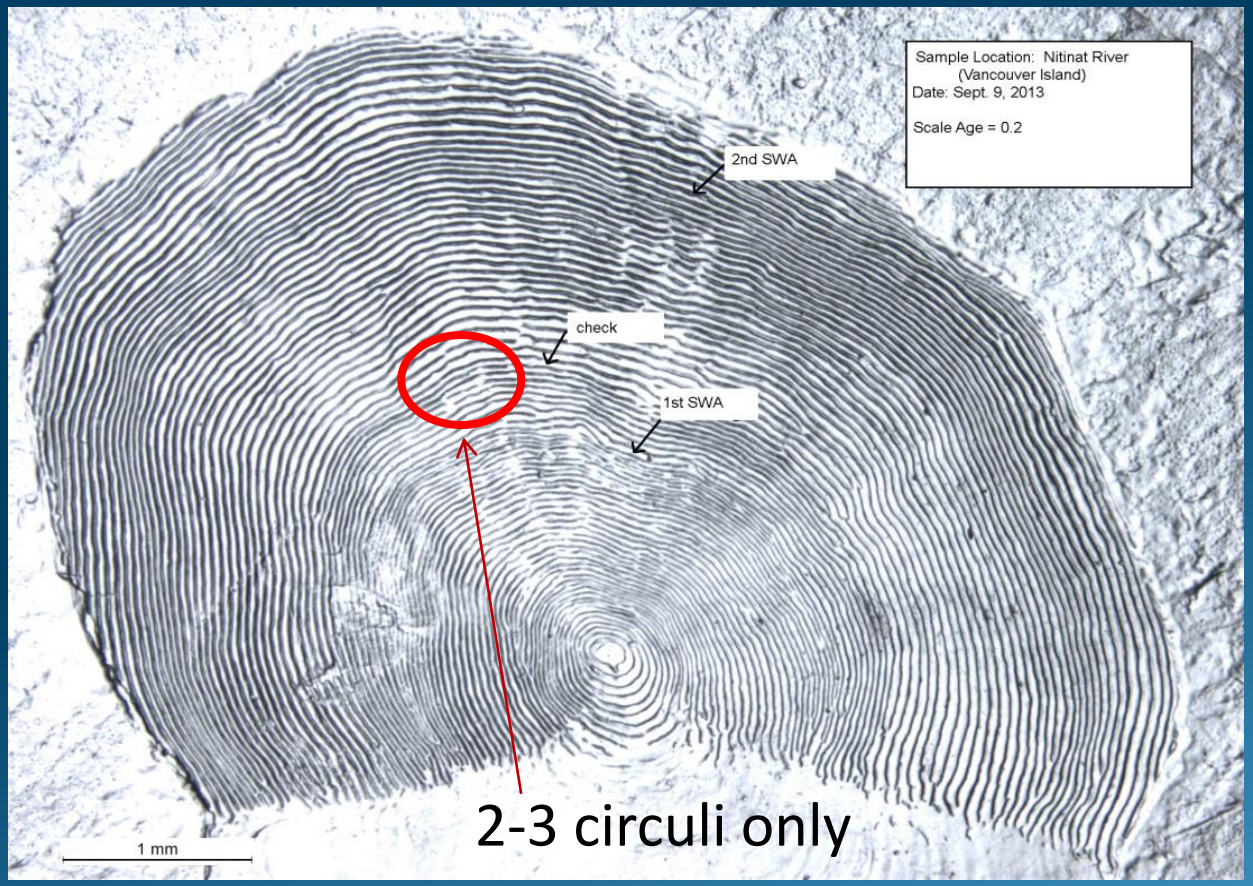
1. Presence FW spring + growth beyond FWA
2. "Cut-out " - many FW circuli densely packed together
3. FWA followed by significantly thicker & wider-spaced SW circuli.
4. Distance from focus -1st SWA > 1st SWA -2nd SWA
5. FW annual zone usually consists ≥8-10 circuli
6. Circuli spacing in 1st SW summer zone ≈ spacing in 2nd SW summer zone
7. Presence prominent striation extends into the posterior part of the scale - mirrors FWA

Reliability is usually stock based.

3. Identification of Saltwater Annuli vs Checks:

SW Annuli - Pinch in at posterior margin, gradual slow down of growth towards the annulus; wide growth after annulus; annual growth usually proportional in size

Checks - Not as prominent as annuli; don't pinch in at posterior margin
- Usually consists of only a few circuli; annual growth would not be proportional if counted



D. Challenges when ageing chinook scales

i. Prominent FW checks

ii. Prominent SW checks

iii. Indistinct SWA

iv. Scale resorption

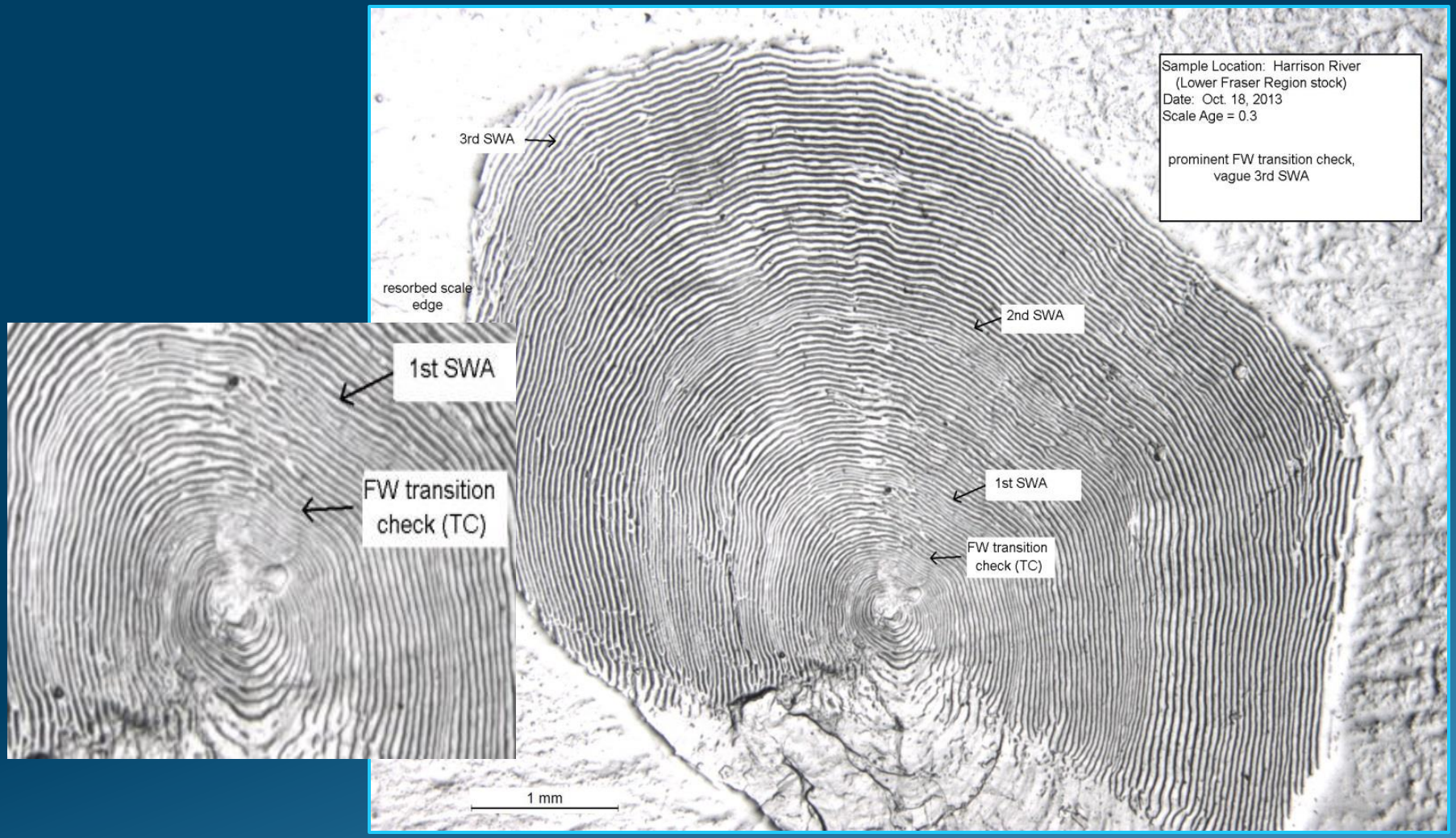
v. Disproportionate Growth

vi. Scales from unfamiliar (US) stocks

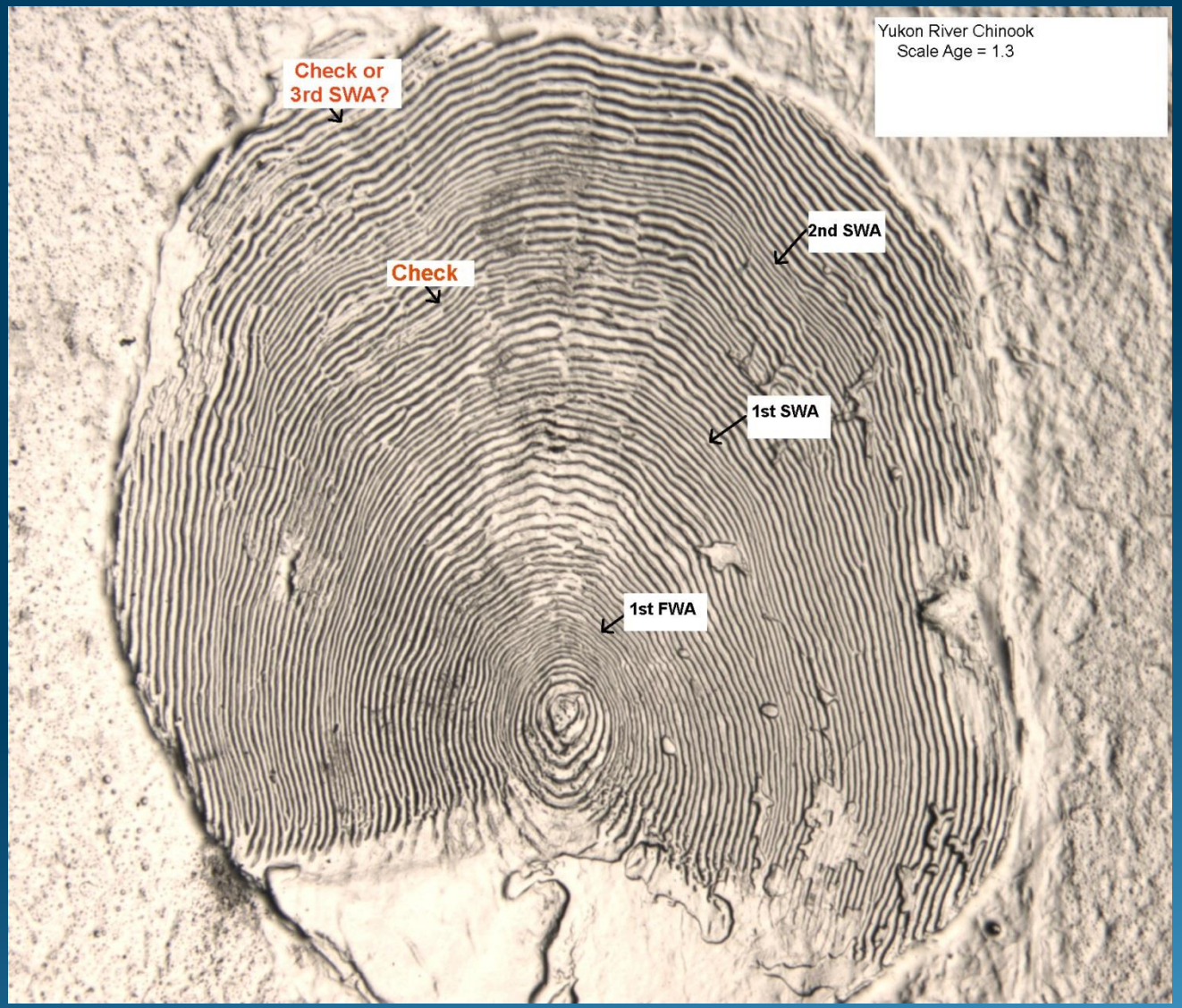
Over-ageing

Under-ageing

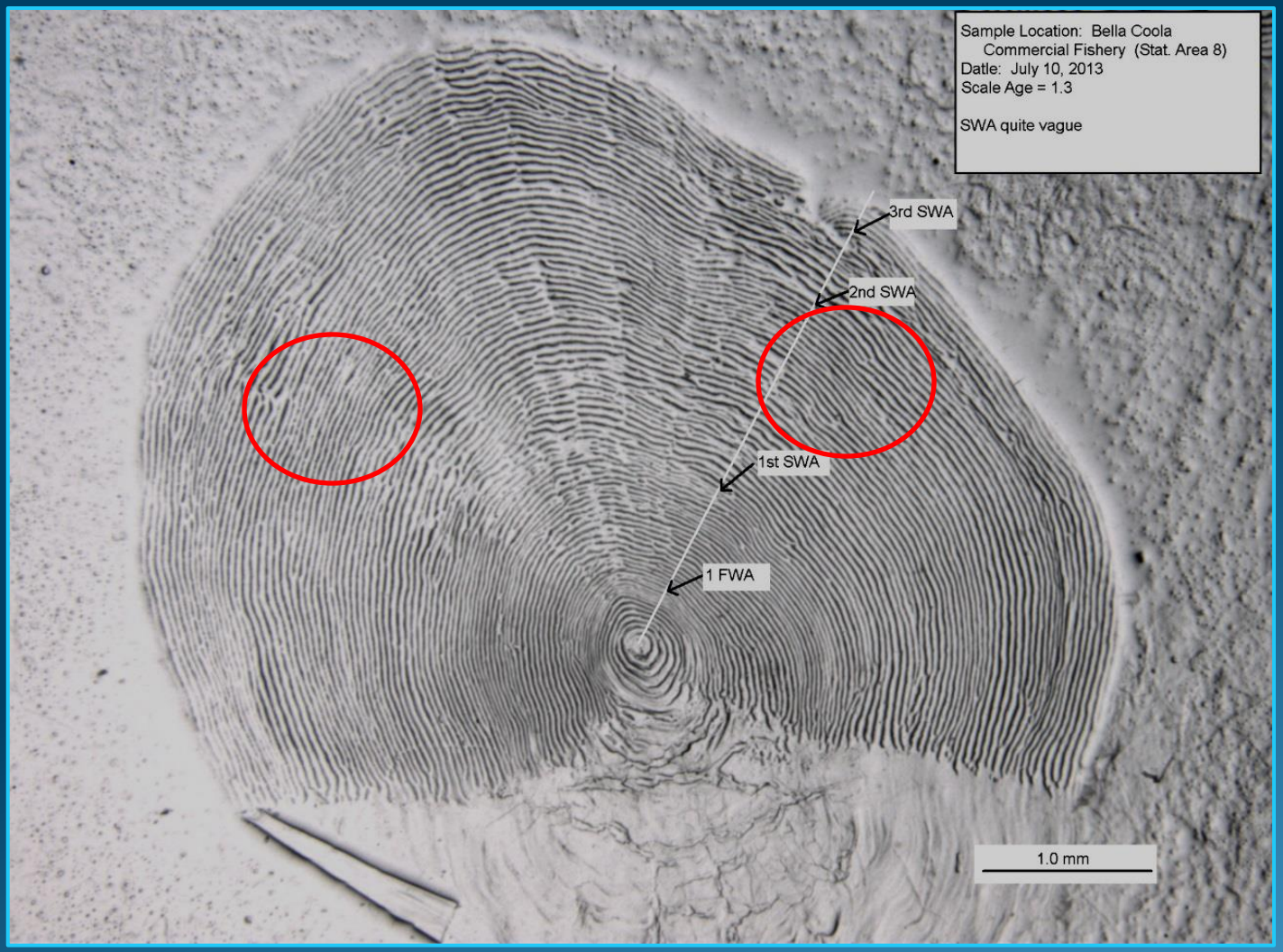
i. Prominent FW checks (Transition Check)



ii. Prominent SW checks



iii. Indistinct SWA



iv. Scale resorption

RS criteria codes for last growth zone on margin:

1= less than ¼ previous year (1-2 circuli)

1^2 = about ¼ previous year

2^1 = just short of ½ of previous year

2 = about half the width of previous year

2^3 = a little more than ½ of previous year

3^2 = just short of previous year

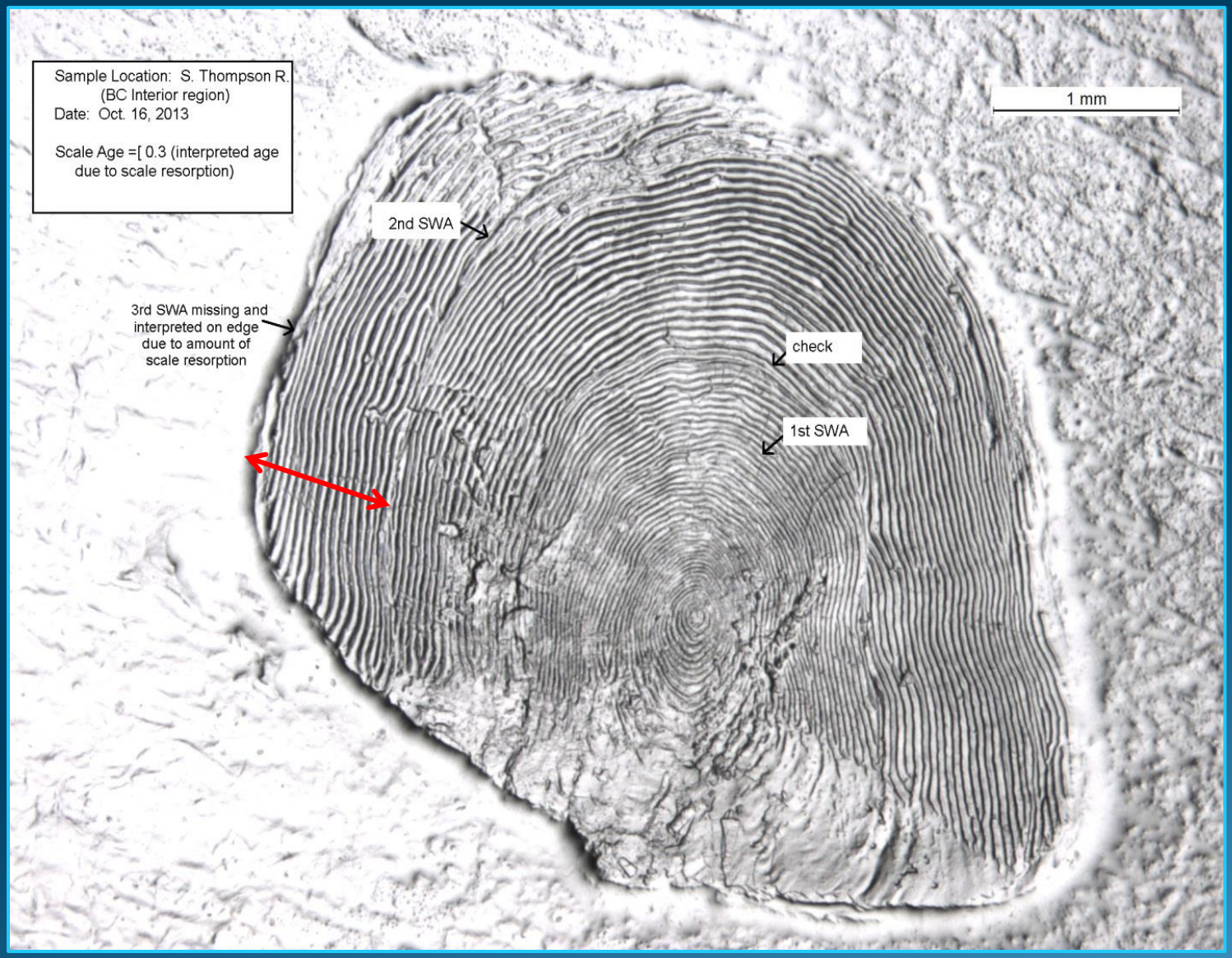
3 = same as previous year

3^+ = more than previous year

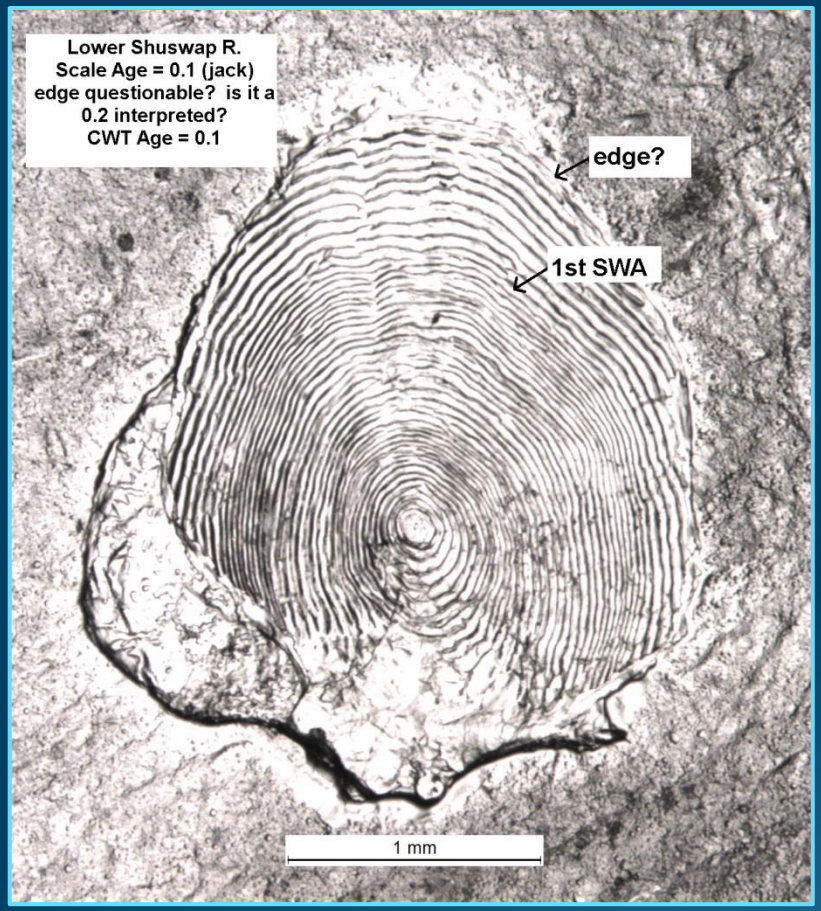
Depending on code & stock 1 year may/not be added to visible age.

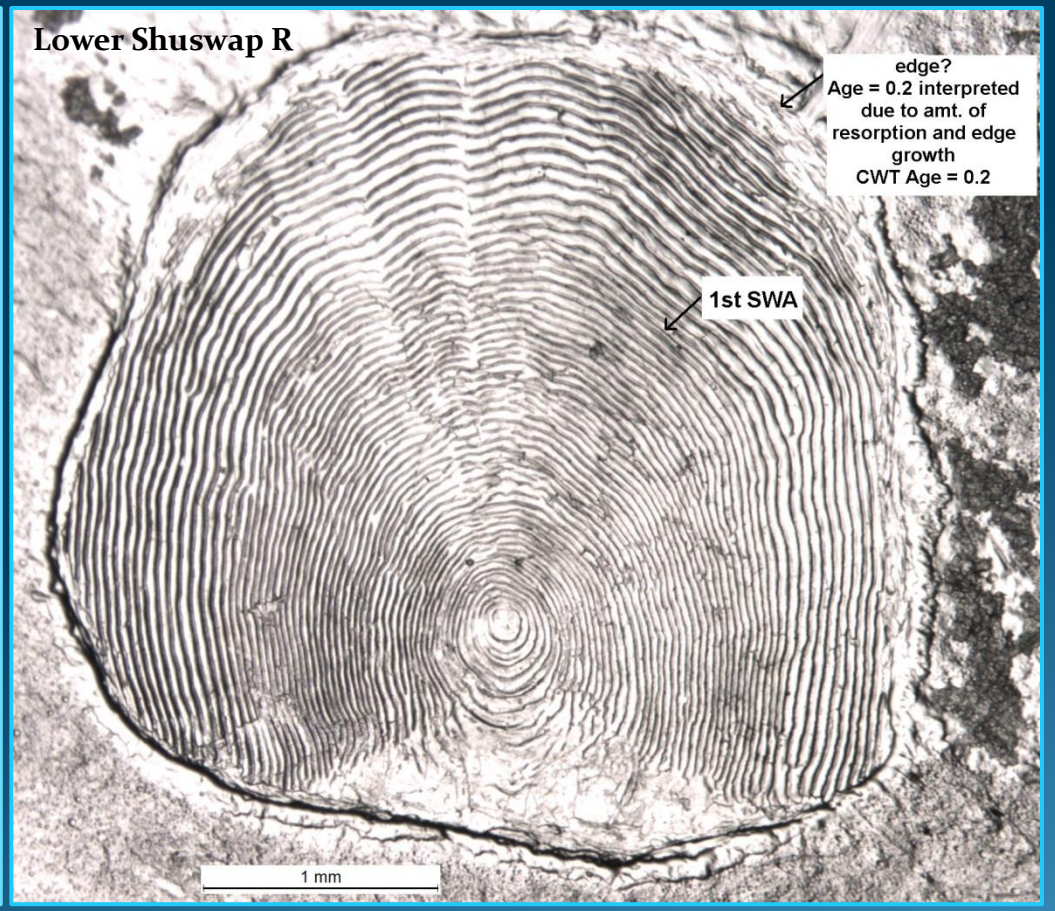
RS criteria only trumped by 2 things: CE & extreme RS

Resorbed scales: Interpreted age



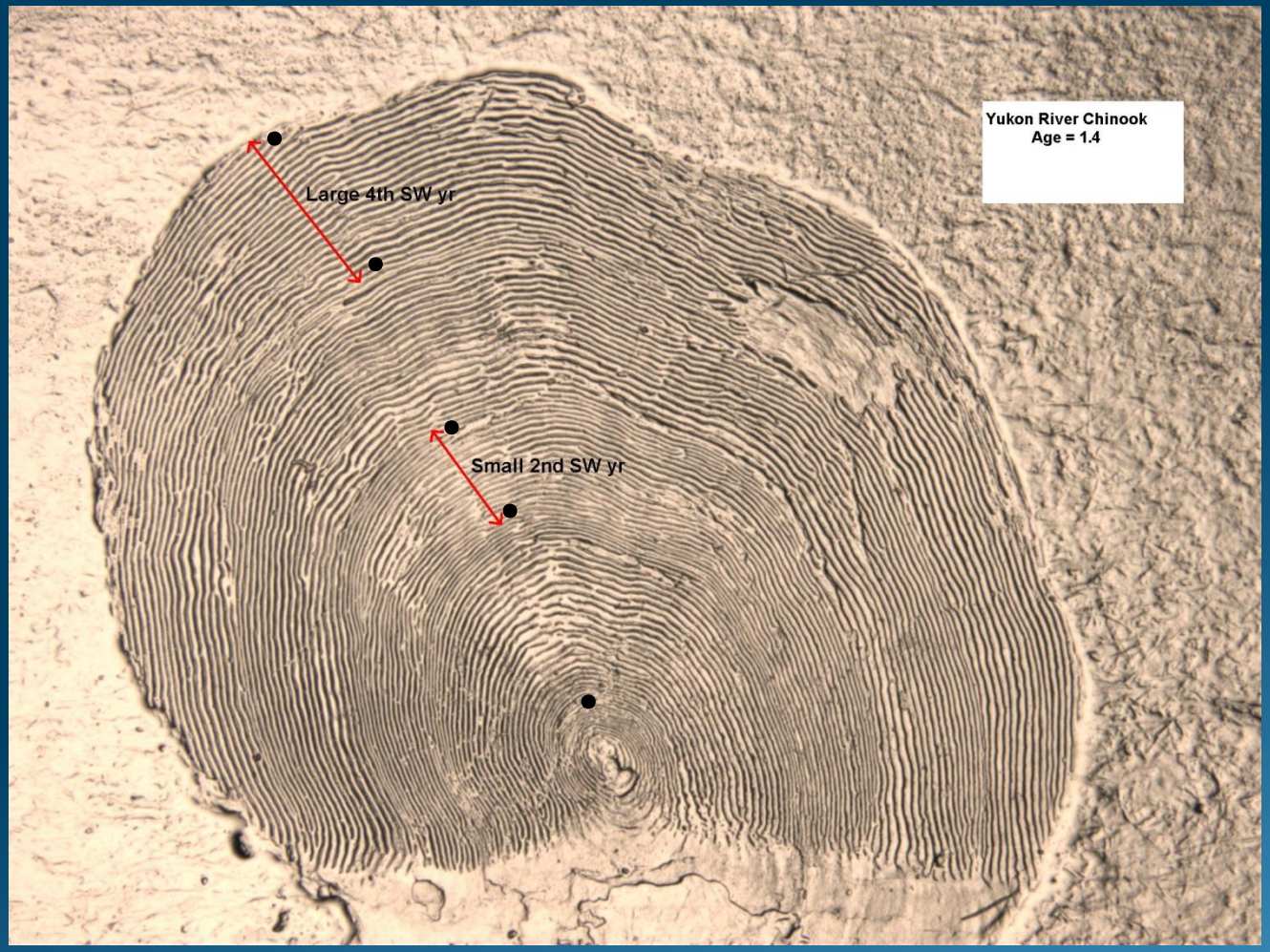
Resorbed scales: 0.1 (jack) vs 0.2 (interpreted age)





Scale size and amount of edge growth sometimes only way to distinguish between the two age classes

v. Disproportionate Annual Growth Zones



vi. Unfamiliar Stocks (US) in mixed fisheries

Queets R., Coastal Washington stock
Age 0.4