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SCALE AGING MANUAL FOR UPPER COOK INLET SOCKEYE SALMON

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PREFACE

Sockeye Salmon Scale Reading in Upper Cook Inlet

This report presents the training program for scale readers in Upper Cook Inlet.

The manual is divided into three sections. Section I contains a history of scale reading in Upper Cook Inlet. Section II is the training manual to show why and how scales are read. Eight sockeye systems are discussed in detail, with illustrations. Section III describes quality control. This section outlines expectations of the training program and the level of accuracy required.

The objectives of this manual are training and quality control. Standardization of terminology and careful description of techniques will improve the ability of all personnel to recognize annuli.

A set of 400 scales accompanies the manual. The scale samples are for testing purposes after the training program is completed.

SECTION I

BACKGROUND

The Upper Cook Inlet (UCI) management area is presently divided into two major fishing districts, the Central and the Northern, which include all waters north of the latitude of Anchor Point. The Central District is subdivided into five subdistricts. The Northern District consists of two subdistricts, the East Side (Eastern Subdistrict) and the West Side (General Subdistrict). Drift gillnet fishing is limited to the Central District. Set gillnet fishing is permitted in all subdistricts except Lower.

The UCI commercial fishery harvest is made up of mixed stocks of sockeye salmon. Major systems are the Kenai, Kasilof, and Crescent Rivers located in the Central District and the Susitna River in the Northern District. Other significant sockeye salmon producing systems include: Packers Creek in the Central District and Fish Creek in the Northern District. Since 1972, the Kenai River has had an average annual sockeye salmon production of 3,286,000 fish, Kasilof 789,000 fish, Crescent 286,000 fish, Susitna 710,000 fish, Packers 107,000 fish, and Fish Creek 183,000 fish.

The first collection of scale samples from salmon harvested in the UCI commercial fishery occurred in 1961. Subsequent sampling occurred but results were not formally reported until 1965 (Davis 1966). Since then, scales along with sex and size data, have been collected from salmon harvested in the commercial fisheries and escapements of UCI. Unfortunately in these early years (1961-78) the collection of salmon scales was sporadic. From 1979 to present, emphasis has been placed on conducting a scientifically defendable program which results in tens of thousands of scales being collected annually.

Salmon scale patterns are used to estimate the age of the fish. In UCI age information assists biologists, to some degree, in determining stock-specific run strength (e.g. Kenai River age-1.3 sockeye salmon tend to be larger on average than other river systems). Also age at maturity information can be of value in recognizing specific stocks of fish where one age class tends to be dominant (i.e. age-1.2 fish in Hidden Creek a tributary of the Kenai River). Certain stocks in UCI have unique scale patterns (i.e. Fish Creek - large freshwater).

Age composition data, used in conjunction with salmon abundance estimates, are used to develop brood tables, estimate long-term production and build yield models for individual river systems.

SECTION II

ABSTRACT

This section aims to explain the rationale and method of reading sockeye salmon scales from Upper Cook Inlet. Why scales are read and what data from scales are important to biologists are questions of rationale. How scales may be read and what criteria are available for judging ages are questions of method.

This section describes characteristics of sockeye salmon scales in eight systems, with illustrations of the major age classes from each system.

Two objectives of the manual are training and quality control. Standardization of terminology and careful description of techniques will improve the ability of all personnel to recognize annuli.

KEY WORDS: Alaska, salmon, scale reading

INTRODUCTION

Rationale for Reading Scales

Since 1961, scales, along with sex and size data, have been collected from salmon harvested in the major commercial fisheries and escapements in Upper Cook Inlet (UCI). The scale samples collected from the commercial fishery represent a mixture of stocks from all systems in UCI.

The primary use of the scales is for judging age, which assists biologists in determining stock-specific run strength. Since certain stocks have characteristic age patterns, a collection of that age class in season could indicate what stocks are being caught by the commercial fishery.

Post season age computations are used to build brood tables. Brood tables are production tables where the number of fish produced from a spawning stock is calculated for each age class of fish. Brood tables show how total return or production relates to number of spawners.

Overview of the Cook Inlet Fishery

The UCI management area is divided into two major fishing districts, the Central and the Northern, which include all waters north of Anchor Point. The Central District is divided into a drift fishery and seven set net fisheries. The Northern District consists of two set net fisheries, the East Side (Eastern Subdistrict) and the West Side (General Subdistrict; Figure 1).

The commercial fishery in UCI harvests a mixed stock of sockeye salmon from the major salmon producing rivers. The Kenai, Kasilof and Crescent Rivers are located in the Central District and the Susitna River and tributaries in the Northern District (Figure 2). Other sockeye salmon producing systems covered in this manual are Packers Creek in the Central District and Fish Creek in the Northern District.

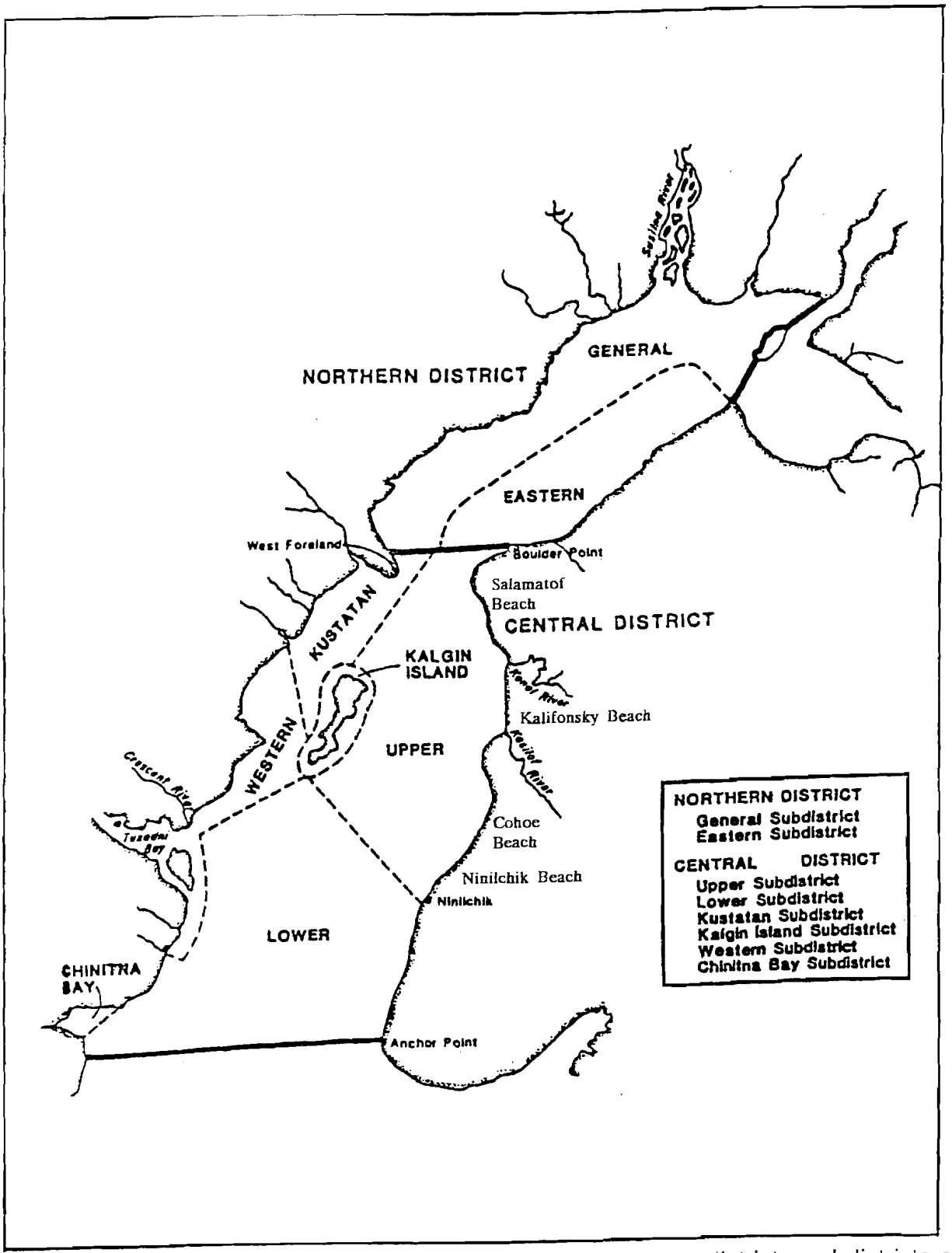

Figure 1. Map of Upper Cook Inlet showing the commercial fishing districts, subdistricts and Upper Subdistrict beach fisheries.

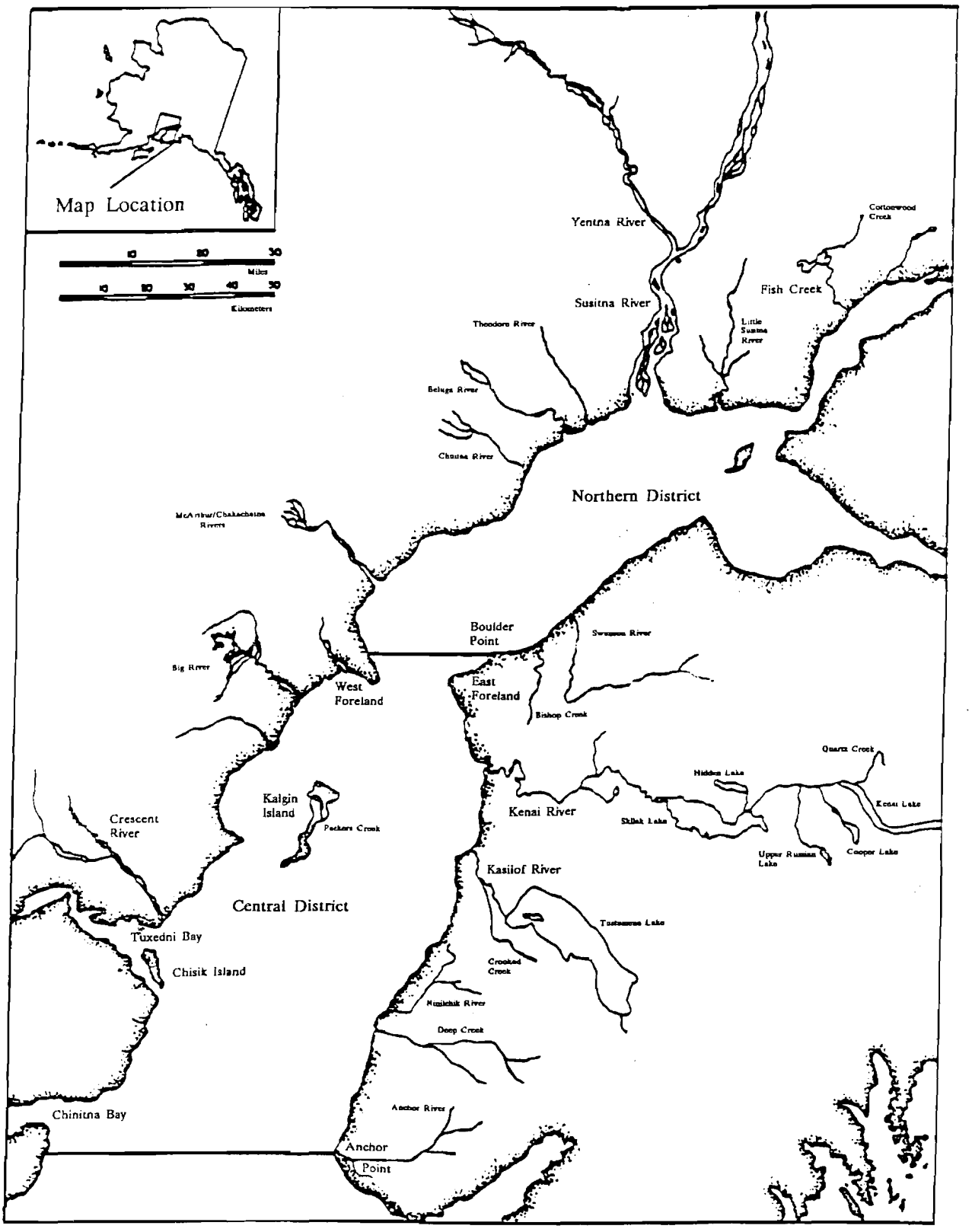

Figure 2. Map of Upper Cook Inlet showing locations of the Northern and Central Districts and the primary salmon spawning drainages.

General Principles of Scale Reading

Freshwater and marine sections are visible on each sockeye salmon scale. Sockeye generally spend one to two winters in fresh water and from one to three winters in the ocean. A circular pattern of growth starts as the scale is formed when the fry is approximately 38mm in length (Clutter and Whitesel 1956).

Growth during summer months increases the size of the scale and is discernible as widely spaced circular rings (circuli; Figure 3). These circuli are concentric ridges separated by valleys.

During the winter months, when growth is slow, the circuli are narrowly spaced, compressed and broken. These distinctive circuli form a record on the scale of each winter of life. This winter growth zone is known as the annulus, or "true" check.

The center of the freshwater section of the scale contains the most closely formed rings, as growth even in the summer in freshwater systems is limited. When the salmon smolt begin their life in a marine environment, food is more plentiful and growth increases dramatically, as indicated on the scales by the more widely spaced circuli. Even in the marine environment, however, the winter growth is less productive and the circuli on the scale are more compressed and can be distinguished (Figure 3).

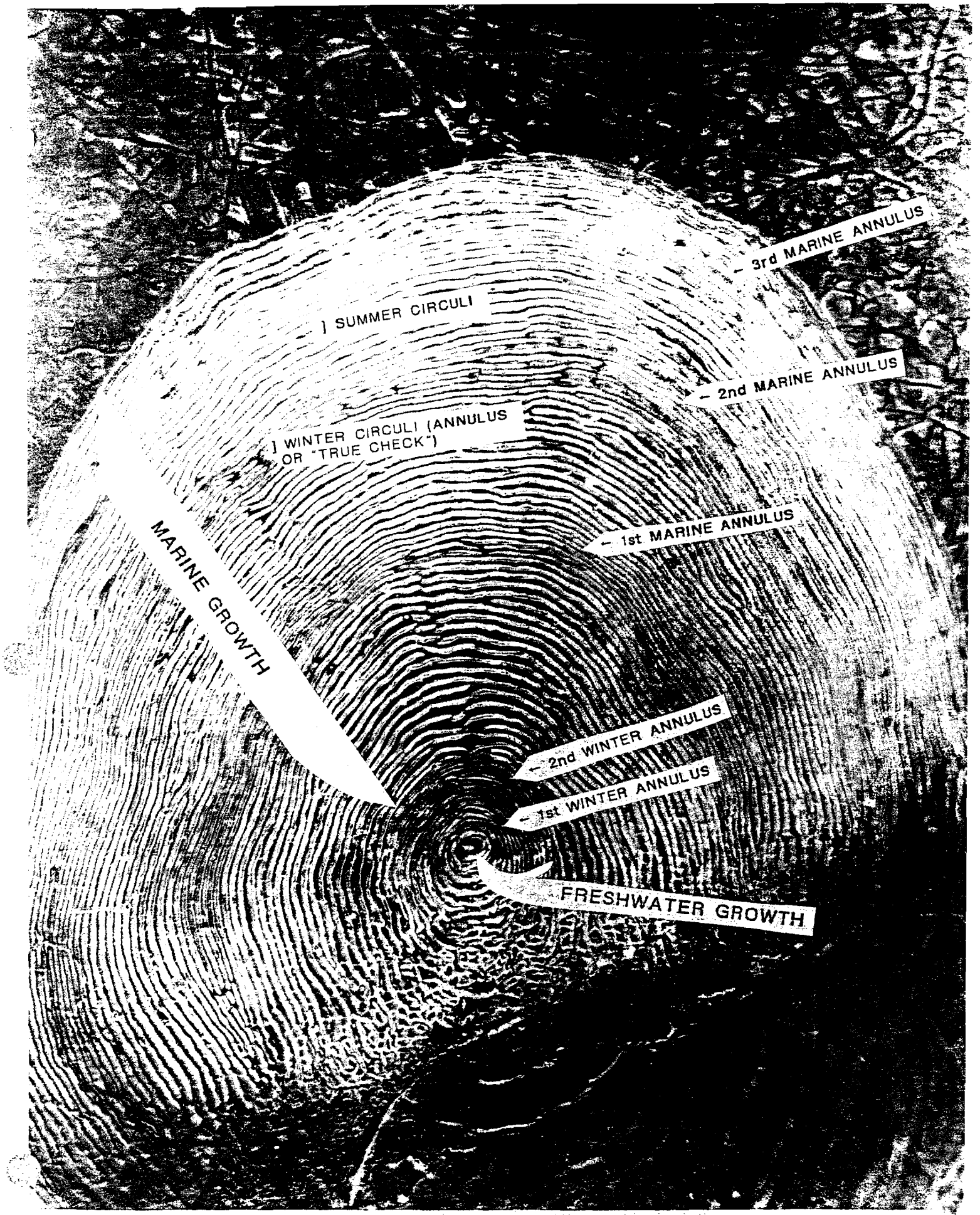

Figure 3. Sockeye salmon scale showing freshwater and marine growth zones

APPROACH TO SCALE PATTERN ANALYSIS

Sampling of Scales

Scales are collected from the left side of a fish approximately two rows above the lateral line and on the diagonal row from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Koo 1955). This area is commonly called the "preferred area" (Figure 4). The anterior portion of the scale consists of circuli which represent a pattern of growth.

Scales are put on gum cards and pressed onto an acetate card using heat and pressure (Clutter and Whitesel 1956). The acetate card shows a mirror image of the scale which can be read with a microfiche at a variety of magnifications.

Age Notation

Ages are recorded in European notation as discussed in Koo (1962) and Mosher (1969). Each age has two components distinguished by an intervening point. A numeral preceding the point indicates the number of freshwater annuli, while the numeral after the point denotes the number of marine annuli. The total age of the fish is the sum of the numbers plus one. For example, an age 1.3 sockeye spent one winter in fresh water, three winters in salt water and is a five year old fish. The first winter of its life was as a developing egg in the gravel of its home stream or lake (Table 1).

Sex and Length Data

Sex of the fish is determined by morphological characteristics. Fish length is measured from mideye to the fork of the tail and recorded in millimeters.

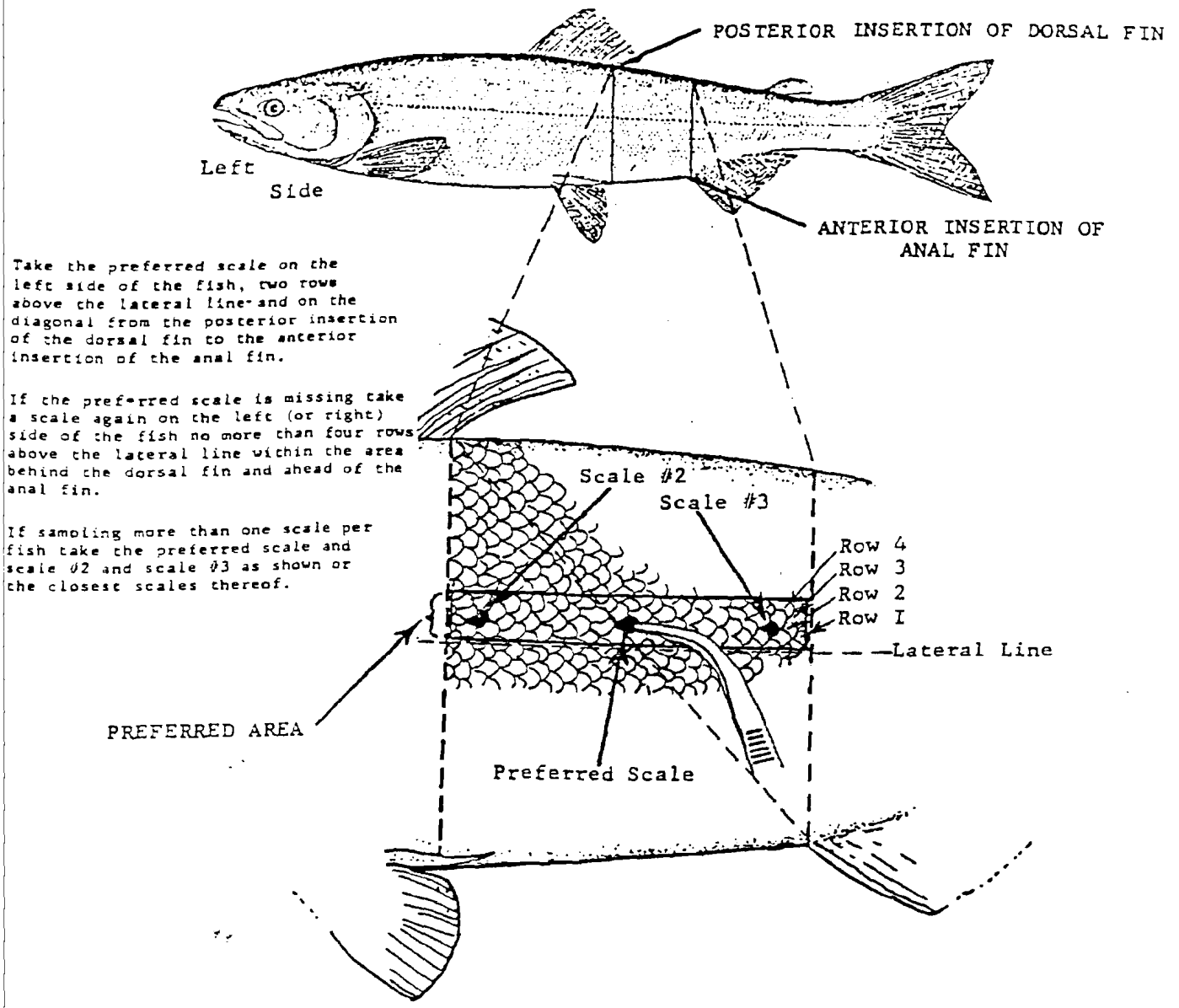

Figure 4. Sockeye salmon scale preferred area.

Table 1. Age of Sockeye Salmon using the European formula.

Age	Winters in Freshwater	Winters in Ocean	*Total Age
0.3	0	3	4
1.2	1	2	4
1.3	1	3	5
2.3	2	3	6

*To determine total age, an additional year is added to represent the first winter of life spent in the gravel.

CRITERIA FOR AGING SCALES

1. A true winter annulus or check should have the following characteristics:

   a. compression of circuli which shows all around the scale.

   b. breakage on parts of the compressed circuli. Where breakage occurs, circuli either end abruptly or "braid" into other circuli.

2. In a scale that has two checks in the freshwater zone, there should be a similarity in the numbers and pattern of circuli in each annulus. In other words, the freshwater annuli should look alike. Saltwater annuli should also have similar winter patterns.

3. Spacing between freshwater annuli tends be relatively uniform with a pattern of summer growth between winters. The same holds for the saltwater annuli (Figure 5).

4. Scales that are not clean and clear of slime should not be used for aging. Accuracy depends on quality.

5. A regenerated scale is a scale that grows back after loss or damage to the original scale. The center of that scale is missing to some degree, so a true age cannot be assigned (Figure 6).

6. A resorbed scale is one that is missing some of its marine growth and can be recognized by a uneven border and a smaller size, as compared to scales of fish of comparable length (Figure 7).

Scales that are regenerated, or badly resorbed cannot be accurately read.

Figure 5. Sockeye salmon scale showing freshwater and marine annuli.

Note: Freshwater and Marine annuli are marked by compression and breakage. These distinctive patterns are used to age scales.

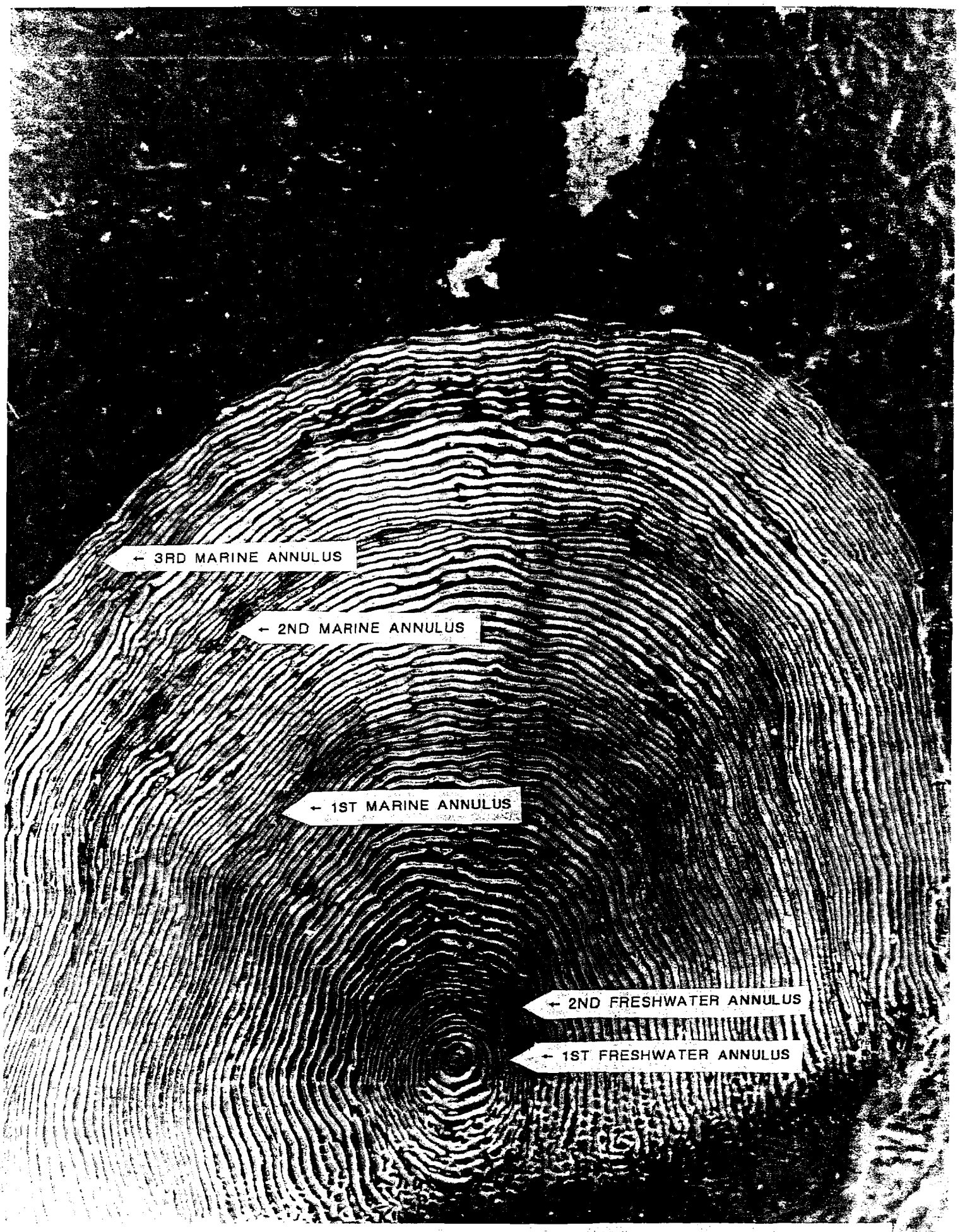

Figure 5. Sockeye salmon scale showing freshwater and marine annuli

Figure 6. Sockeye salmon scale showing regeneration in the center of the scale.

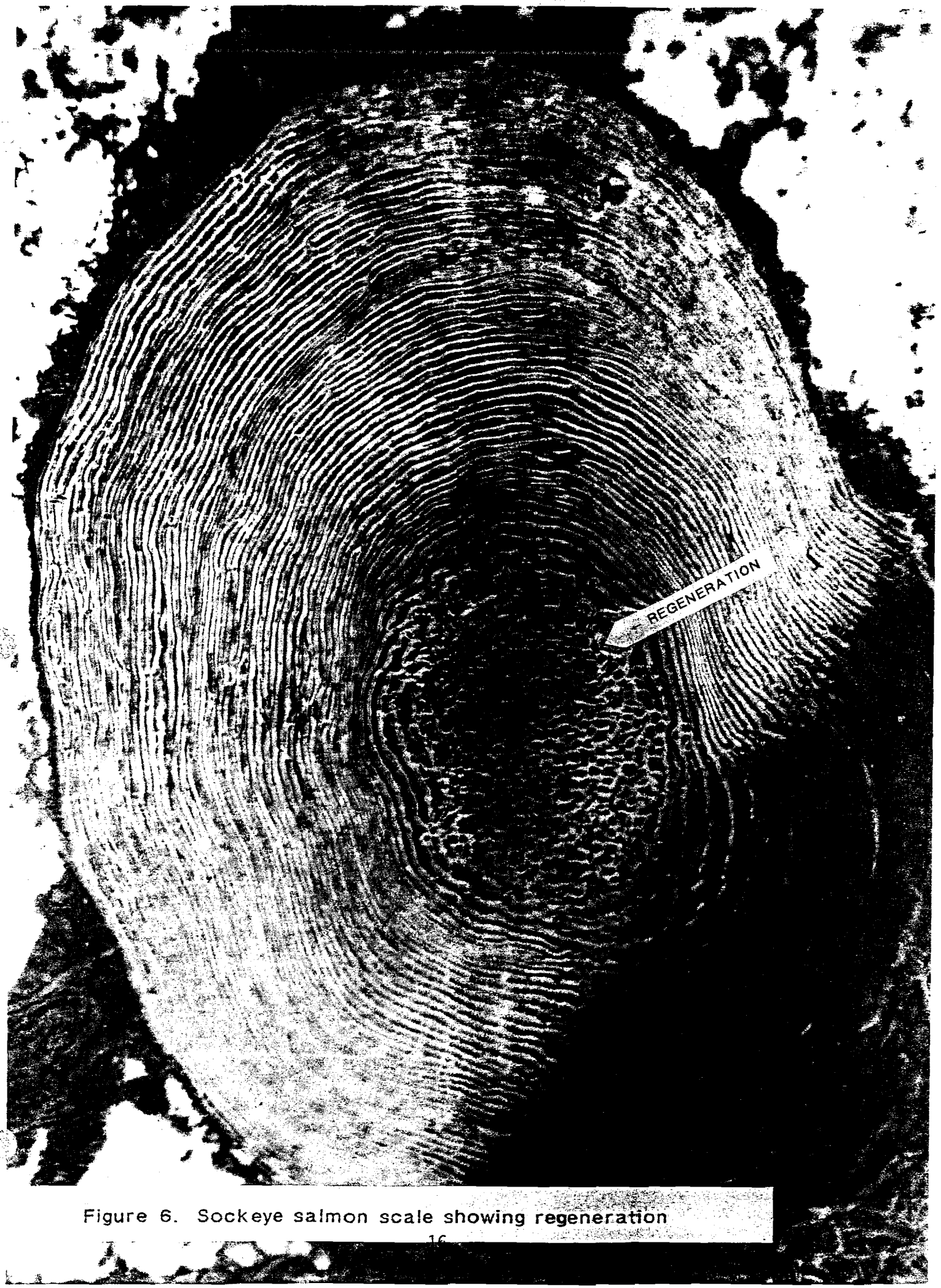

Figure 6. Sockeye salmon scale showing regeneration

Figure 7. Sockeye salmon scale showing resorption

Note: The outside of the scale has been reabsorbed into the body of the fish.

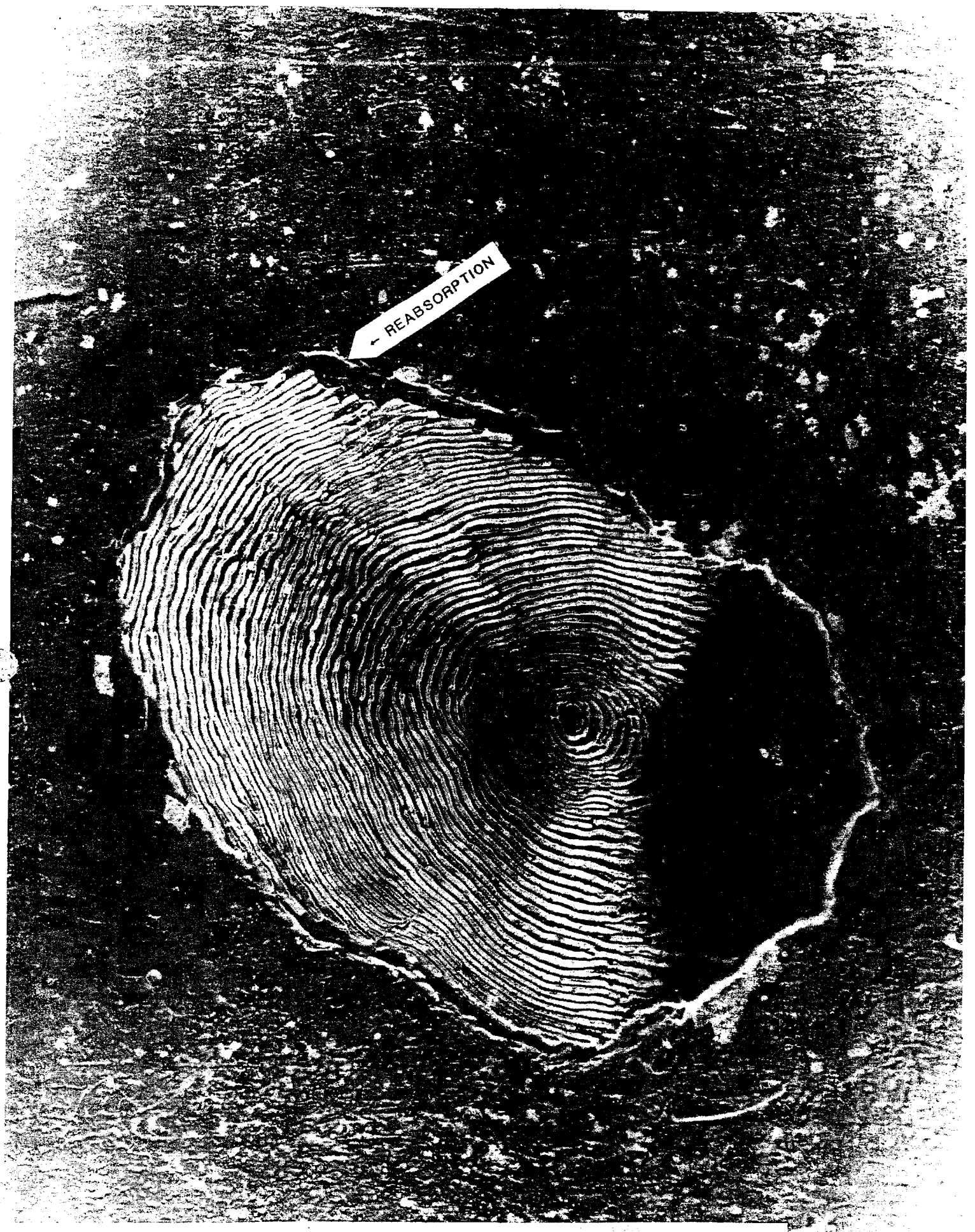

Figure 7. Sockeye salmon scale showing resorption

OTHER CONSIDERATIONS

Size

Fish length is helpful in determining age when the outer marine winter is questionable, also when the fish are young. Size is also important in determining that the right scale card and data sheet are being used, as the younger, smaller fish will coincide with smaller scales.

"False Checks"

Compressed circuli that:

a. do not show all around the scale, or
b. do not contain breakage or braiding, or
c. do not look similar in pattern, size or spacing to other annuli

represent a "false check. "Such a "false check" does not represent a winter, but rather some period of slow growth. The period of slow growth appears on the scale as an area of slightly compressed circuli.

This commonly happens:

a. when juvenile salmon first enter the ocean and adjust to the new environment (Figure 8).
b. when the juvenile or adult salmon is injured.
c. when for any other reason food is unavailable or scarce during a period of time during the salmon's life.

"Plus Growth"

The area of growth on a scale between the last freshwater winter and entry into the marine environment is commonly called "plus growth". In some systems this is a relatively large area.

The point where the fish enters the marine environment is distinguished by a slight compression of the circuli. In many scales the circuli flare out at the posterior end of the scale (Figure 8).

The size of the "plus growth" depends on the amount of time the sockeye smolt takes to reach the ocean. A large area of plus growth may be due to the fact that the broodstream is a great distance from the ocean. The fry may also spend part of the summer in the broodstream or lake before reaching smolt size, then migrate out.

Resorption, Otoliths, Lengths and Scale Size

After returning to its native stream, the sockeye salmon stops feeding and relies on protein and fat stored in the body. This results in the resorption of its scales which often makes the outside or last marine check difficult to read. To age resorbed scales, the length of the fish and size of scales can be used to improve the estimate of age.

Otoliths are preferable for determining age in salmon that are spawning or ready to spawn. Otoliths are the inner ear bones of the fish, which are composed of calcium carbonate and proteins. The otoliths show annular rings which are unaffected by resorption. The accuracy of otolith readings is therefore higher than the accuracy of reading resorbed scales. Otolith samples cannot always be obtained because of the time involved in taking them and because the fish have to be sacrificed.

Figure 8. Sockeye salmon scale showing "plus growth" and a possible "false" check

Note: "Plus growth" is the area of growth from the last freshwater check to the area of slight compression resembling an annuli. Often circuli flare out when marine growth begins.

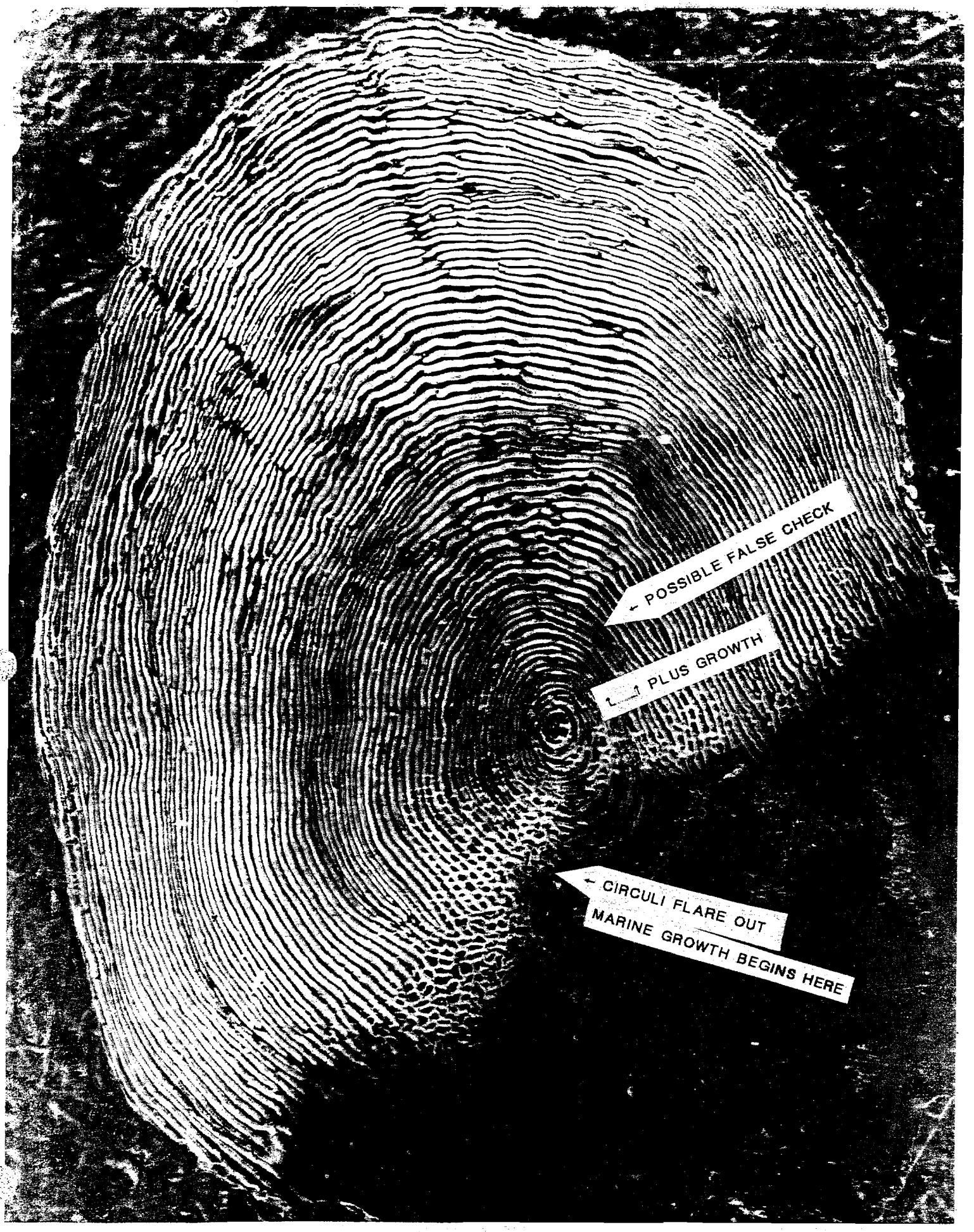

Figure 8. Sockeye salmon scale showing "plus growth" and a possible "false check"

Haste Makes Waste

In order to achieve the most accurate reading:

a. scale samples must be prime.

b. criteria for aging must be followed carefully.

c. knowledge of the systems must be taken into consideration.

Experience, the Best Teacher

Important as abstract criteria are, nothing can replace experience. Each system's realities are represented on the scales in ways that are specific to that system. Knowledge of the systems helps a reader make decisions on a mixed stock scale sample or on questionable scales. There will always be a percentage of scales subject to more than one interpretation.

COOK INLET SYSTEMS AND INTERPRETATIONS

Scale patterns from eight Cook Inlet sockeye salmon producing systems are discussed in this section (Figure 9). The scales reflect the growing conditions encountered in each system and in the marine environment.

Noteworthy scale characteristics from the freshwater systems include:

a. size of the freshwater growth

b. number of years of rearing in the freshwater system

c. relationship of the size of growth from the first year to the second in systems where salmon rear for two years.

To judge this relationship, these considerations are most important:

1) number of circuli during each year

2) width of circuli

3) how close the first annulus is to the center of the scale.

Noteworthy scale characteristics from the marine environment include:

a. size of the marine growth

b. number of years in the ocean before returning to their brood stream

c. size differences between marine annuli.

While growing conditions vary from year to year, there tend to be patterns of growth which are constant and can be recognized as belonging to specific systems.

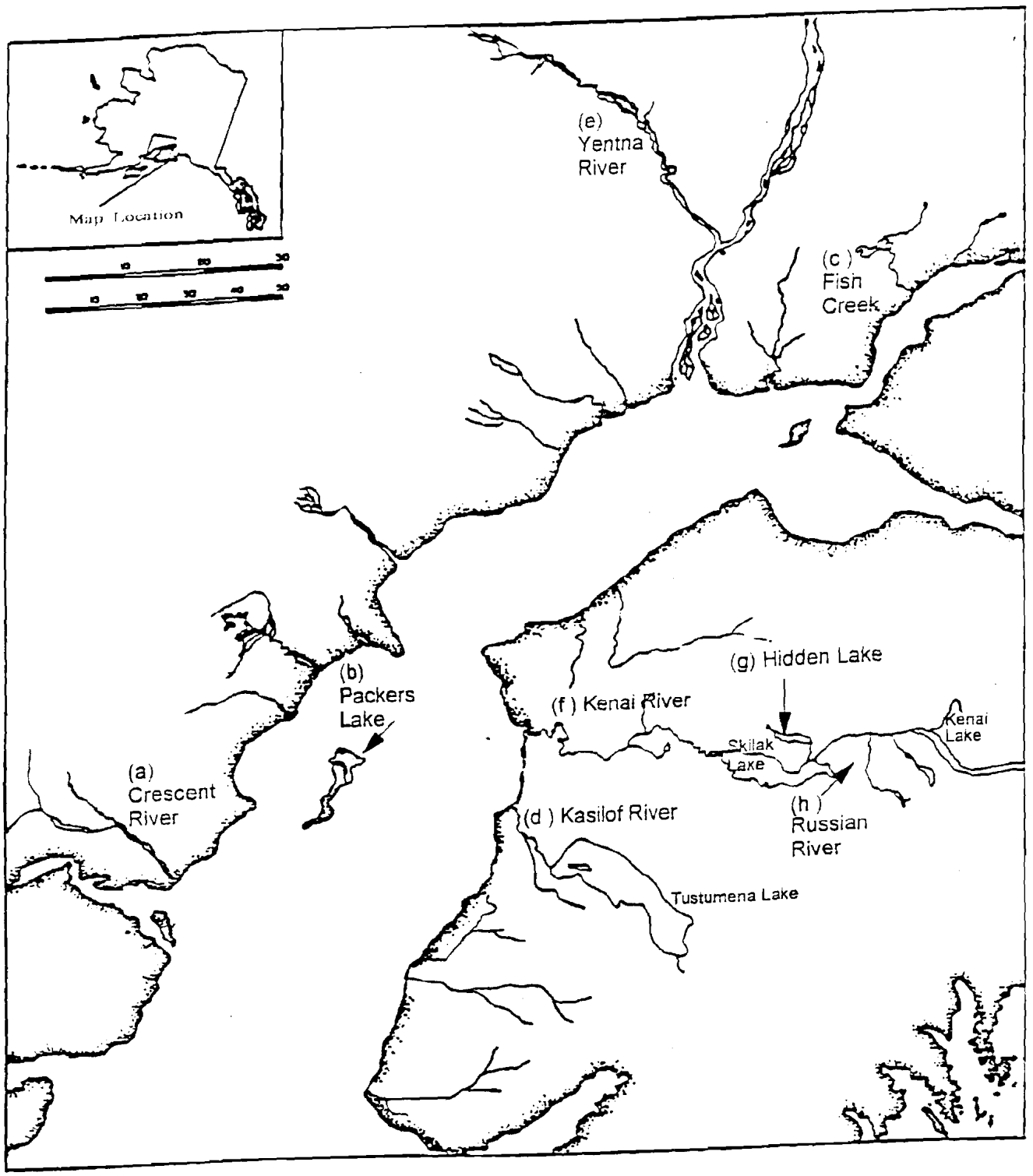

Figure 9. Map of Upper Cook Inlet tributaries.

Crescent River

Crescent River is located on the west side of Cook Inlet. Crescent River scale samples are collected by fishwheel at the Commercial Fisheries sonar site at Mile 2 of the Crescent River (Figure 9a).

The majority of Crescent River sockeye have two years of fresh water and either two or three years of marine growth (Age 2.2 or 2.3).

The fresh water growth on Crescent River scales is small, but the annuli are clear and pronounced. Circuli are very fine lined. In some cases the second year fresh water annulus is close to the first with very few circuli between (Figure 10).

Marine checks tend to be spaced equally apart.

It is very important that scales taken from a system such as Crescent River, with a small freshwater growth be extremely clean (Figures 10-13).

Figure 10. Age 2.2 sockeye salmon scale from Crescent River (Male, 473mm)

Note: 1st and 2nd freshwater annuli are close together.

Figure 10. Age 2.2 sockeye salmon scale from Crescent River

Figure 11. Age 2.3 sockeye salmon scale from Crescent River (Female, 607mm)

Note: The first freshwater check is close to the center of the scale.

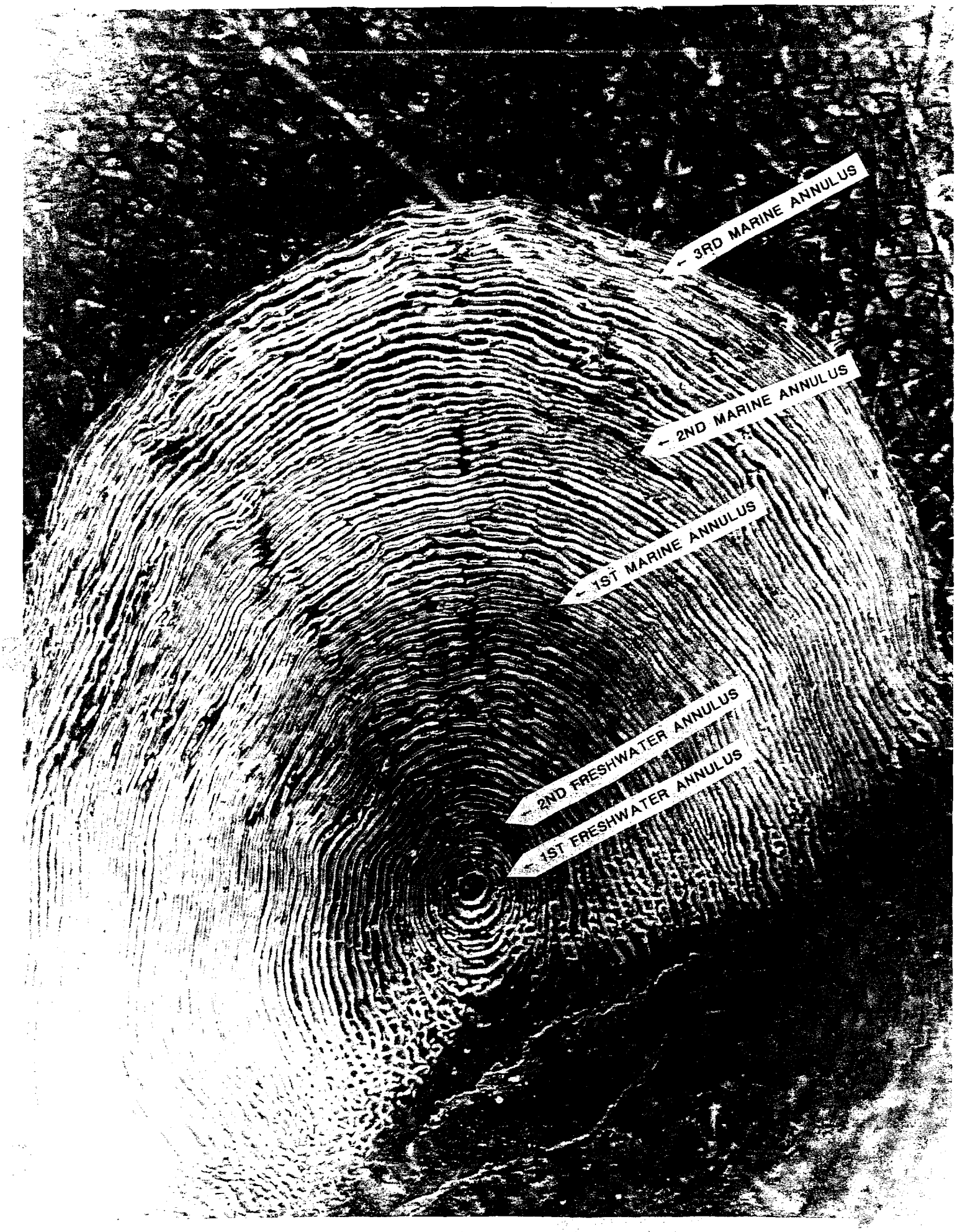

Figure 11. Age 2.3 sockeye salmon scale from Crescent River

Figure 12. Age 1.2 sockeye salmon scale from Crescent River (Male, 442mm)

Figure 12. Age 1.2 sockeye salmon scale from Crescent River

Figure 13. Age 1.3 sockeye salmon scale from Crescent River (Female, 593mm)

Figure 13. Age 1.3 sockeye salmon scale from Crescent River

Packers Lake

Packers Lake is located at the Northern end of Kalgin Island in Cook Inlet. Packers Creek drains into Cook Inlet on the east side of the island (Figure 9b). Cook Inlet Aquaculture Association collects the sockeye salmon scales from Packers Lake at the weir they operate at the outlet of Packers Lake.

There are significant numbers of all age classes in Packers Lake.

The second year fresh water annuli of Packers Lake sockeye is close to the first in some cases (Figure 15).

The third year of the marine growth in the older fish tends to be close to the second (Figure 17).

The salmon in this system tend to be quite mature when they enter the lake, so scales at the weir can be reabsorbed and hard to read. Length should be taken into consideration in this case, and scales should be examined closely for an additional marine check near the outer edge (Figures 14-17).

Figure 14. Age 1.2 sockeye salmon scale from Packers Creek (Female, 480mm)

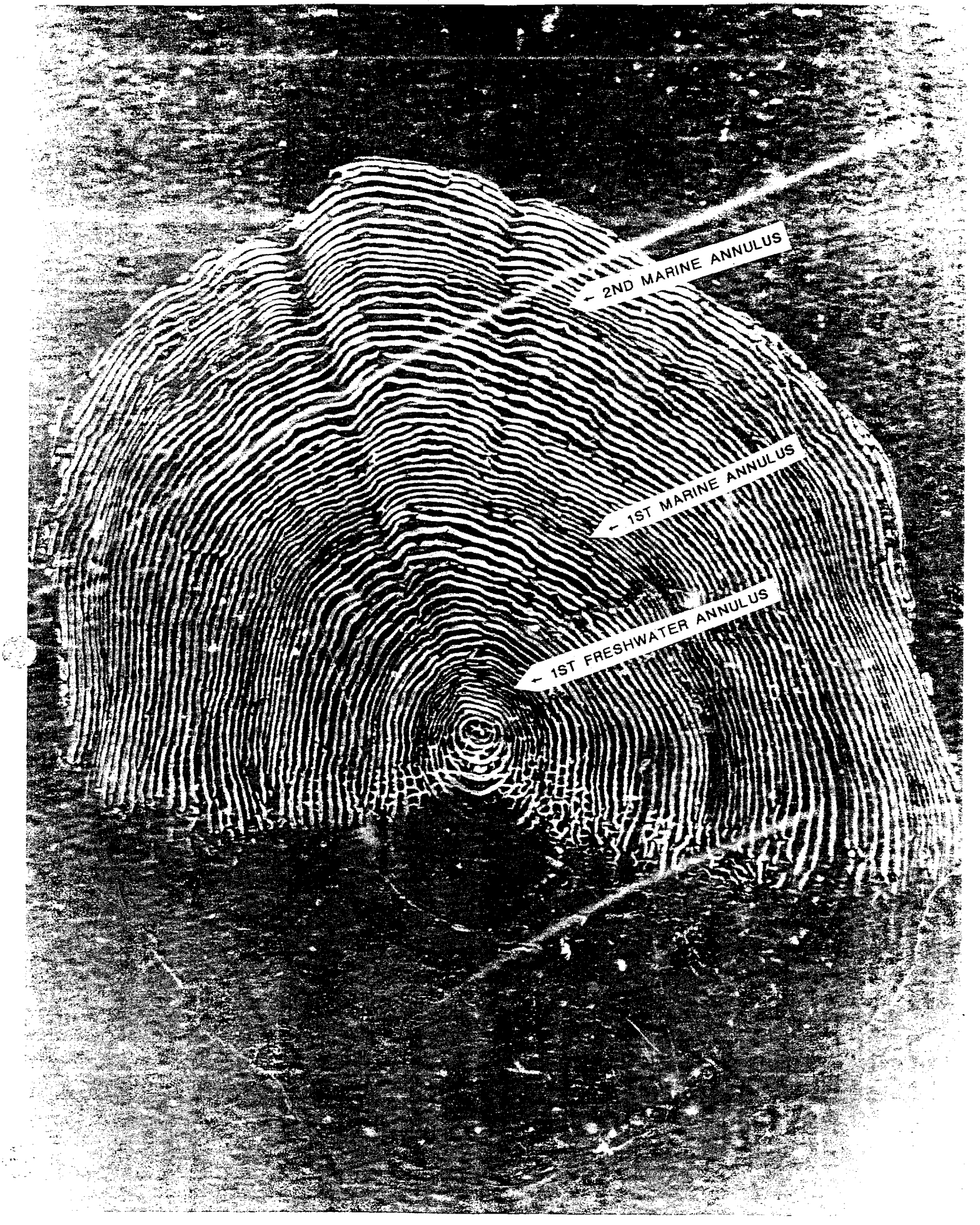

Figure 14. Age 1.2 sockeye salmon scale from Packers Creek

Figure 15. Age 2.2 sockeye salmon scale from Packers Creek (Female 487mm)

Note: 1st and 2nd freshwater annuli close together.

Figure 15. Age 2.2 sockeye salmon scale from Packers Creek

Figure 16. Age 1.3 sockeye salmon scale from Packers Creek (Female, 533mm)

Figure 16. Age 1.3 sockeye salmon scale from Packers Creek

Figure 17. Age 2.3 sockeye salmon scale from Packers Creek (Female, 527mm)

Note: Resorption of the scale results in part of the 3rd marine check being missing.

Figure 17. Age 2.3 sockeye salmon scale from Packers Creek.

Fish Creek

Fish Creek is located in the Northern District. The sockeye returning to the system spawn in Big Lake or its tributaries. Sockeye scales are taken from Fish Creek at the weir located approximately one mile from Cook Inlet (Figure 9c). Most of the juvenile sockeye salmon migrating up Fish Creek probably rear in Big Lake.

Normally the majority of the run returns as smaller four year old fish with one freshwater check and two marine checks (age 1.2) (Figures 18-21).

This clear water system is very productive and sockeye have a lot of freshwater growth. Such large freshwater growth with numerous circuli may at first view seem to represent two years of freshwater growth. Close examination however, reveals that most of these sockeye actually have only one true freshwater annulus (Figures 18 and 20).

The sockeye of Fish Creek are similar in pattern to Hidden Creek sockeye, which are mostly four year olds with unusually large freshwater growth.

The Fish Creek sockeye that rear two years in fresh water have a different scale pattern. Since the freshwater growth area on these scales is much smaller and annuli are closer together, they apparently rear in a less productive area than the age one freshwater salmon (Figures 19 and 21).

Most of the Fish Creek sockeye remain the ocean for two winters.

Figure 18. Age 1.2 sockeye salmon scale from Fish Creek (Female, 501mm)

Note: Large freshwater growth.

Figure 18. Age 1.2 sockeye salmon scale from Fish Creek

Figure 19. Age 2.2 sockeye salmon scale from Fish Creek (Male, 555mm)

Figure 19. Age 2.2 sockeye salmon scale from Fish Creek

Figure 20. Age 1.3 sockeye salmon scale from Fish Creek (Female, 570mm)

Figure 20. Age 1.3 sockeye salmon scale from Fish Creek

Figure 21. Age 2.3 sockeye salmon scale from Fish Creek (Female, 530mm)

Figure 21. Age 2.3 sockeye salmon scale from Fish Creek

Kasilof River

The Kasilof River is located on the east side of Cook Inlet and drains Tustumena Lake (Figure 9d).

Kasilof River scales are taken by fishwheel at mile 11 of the Kasilof River at the location of the commercial fisheries sonar site. With the exception of some Kasilof mainstream spawners, the majority of the sockeye stock passing through this site originate from tributaries of Tustumena Lake. The sockeye from all these systems rear in Tustumena Lake and have similar growth patterns.

Approximately thirty percent of the sockeye salmon returning to Cook Inlet are Tustumena Lake broodstock.

Significant numbers of four, five and six year old sockeye are found in the Kasilof composite sample.

Kasilof River sockeye salmon scales demonstrate good compression in both freshwater and marine annuli. If Kasilof River scales are in prime condition they are generally not difficult to read (Figures 22-25).

Figure 22. Age 1.2 sockeye salmon scale from Kasilof River (Female, 490mm)

Figure 22. Age 1.2 sockeye salmon scale from Kasilof River

Figure 23. Age 2.2 sockeye salmon scale from Kasilof River (Male, 510mm)

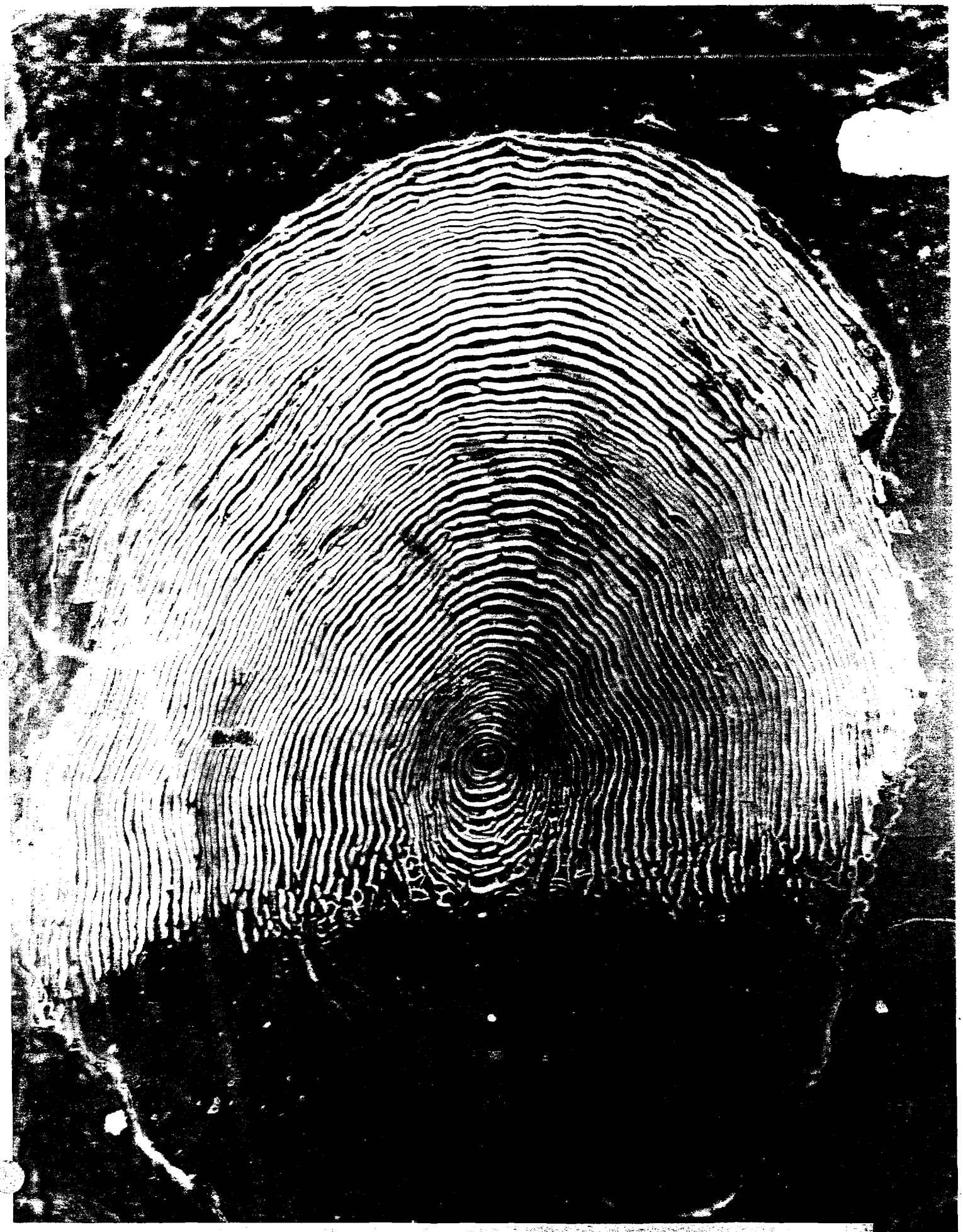

Figure 23. Age 2.2 sockeye salmon scale from Kasilof River

Figure 24. Age 1.3 sockeye salmon scale from Kasilof River (Female, 545mm)

Figure 24. Age 1.3 sockeye salmon scale from Kasilof River

Figure 25. Age 2.3 sockeye salmon scale from Kasilof River (Male, 560mm)

Figure 25. Age 2.3 sockeye salmon scale from Kasilof River

Yentna River

Yentna River is a tributary of the Susitna River which produces the majority of sockeye salmon in the Northern District. Yentna River is located approximately 26 miles from Cook Inlet (Figure 8e). It has been estimated that as much as 50% of the Susitna sockeye run may go up the Yentna River.

Scales are collected at the Commercial Fisheries sonar site located six miles up the Yentna River. There are numerous systems with different rearing areas that join into the Yentna, which gives the sample a mixture of scale patterns.

The Yentna River is one of the most difficult systems to age. The freshwater annuli on many of the age 1.3 and 2.3 sockeye salmon scales are subtle and unobtrusive. They show very little breakage and compression. Growth is smooth and consistent (Figures 26 and 27).

The smaller salmon which stay two winters in the ocean have scales that show much more pronounced breakage (Figures 28 and 29). This breakage is prominent in both the age 1.2 and 2.2 salmon, which suggest they rear in a different system from the larger 1.3 and 2.3 stock.

A few Yentna River scales are classified as age 0 freshwater. These scales show no apparent freshwater annulus (Figure 30). There are three possible explanations:

1) The sockeye fry returned to the ocean without spending a winter in a freshwater system.

2) The sockeye fry was so small during its first winter that no scale had formed.

3) The annulus formed so close to the center of the scale it could not be detected.

Looking at a number of scales and getting used to the system before starting to determine ages is important. Experience and extra time are needed when working on Yentna samples.

Figure 26. Age 1.3 sockeye salmon scale from Yentna River (Female, 545mm)

Note: Freshwater annulus shows very little compression or breakage.

Figure 26. Age 1.3 sockeye salmon scale from Yentna River

Figure 27. Age 2.3 sockeye salmon scale from Yentna River (Female, 550mm)

Note: Freshwater annuli with very little compression and breakage.

Figure 27. Age 2.3 sockeye salmon scale from Yentna River

Figure 28. Age 1.2 sockeye salmon scale from Yentna River (Female, 455mm)

Figure 28. Age 1.2 sockeye salmon scale from Yentna River

Figure 29. Age 2.2 sockeye salmon scale from Yentna River (Male, 510mm)

Figure 29. Age 2.2 sockeye salmon scale from Yentna River

Figure 30. Age 0.3 sockeye salmon scale from Yentna River (Female, 540mm)

Note: Yentna River freshwater annuli show very little compression and breakage. If the scale were identified as a Yentna River scale it might be called a 1.3. However the annuli does not follow the criteria established for compression all around the scale, and has very little breakage.

Figure 30. Age 0.3 sockeye salmon scale from Yentna River

Kenai River Composite

The Kenai River is the major producer of sockeye in the Upper Subdistrict of Cook Inlet. The Kenai River flows 50 miles from Kenai Lake to Cook Inlet. Numerous stocks combine to make up the Kenai River composite stock (Figure 9f). (Two tributaries, the Russian River and Hidden Creek will be discussed separately).

Kenai River sockeye are taken by fishwheel at mile 19.4 at the Commercial Fisheries sonar site.

Kenai River escapement scale samples comprise mainstream spawners and numerous tributaries' spawners. Kenai and Skilak Lakes are the main rearing areas of juvenile sockeye salmon in the Kenai River. The major age class found in the Kenai composite scale samples are the five year old, age 1.3 sockeye.

There are many scale patterns in each age class in the Kenai River composite scale samples, because of the many systems and rearing areas in the entire river system (Figures 31-35).

Upper Kenai River sockeye, rearing above Kenai Lake in tributaries such as Ptarmigan Lake and Quartz Creek demonstrate a large plus growth area and breakage when entering the ocean. The larger plus growth could be due to the distance it takes to smolt through Kenai and Skilak lakes, or a late smolt outmigration.

When reading these scales it is important to pay special attention that the false check is not called a second fresh water annulus. A true second annulus should be as well defined as the first (Figure 35).

Figure 31. Age 1.3 sockeye salmon scale from Kenai River composite (Female, 550mm)

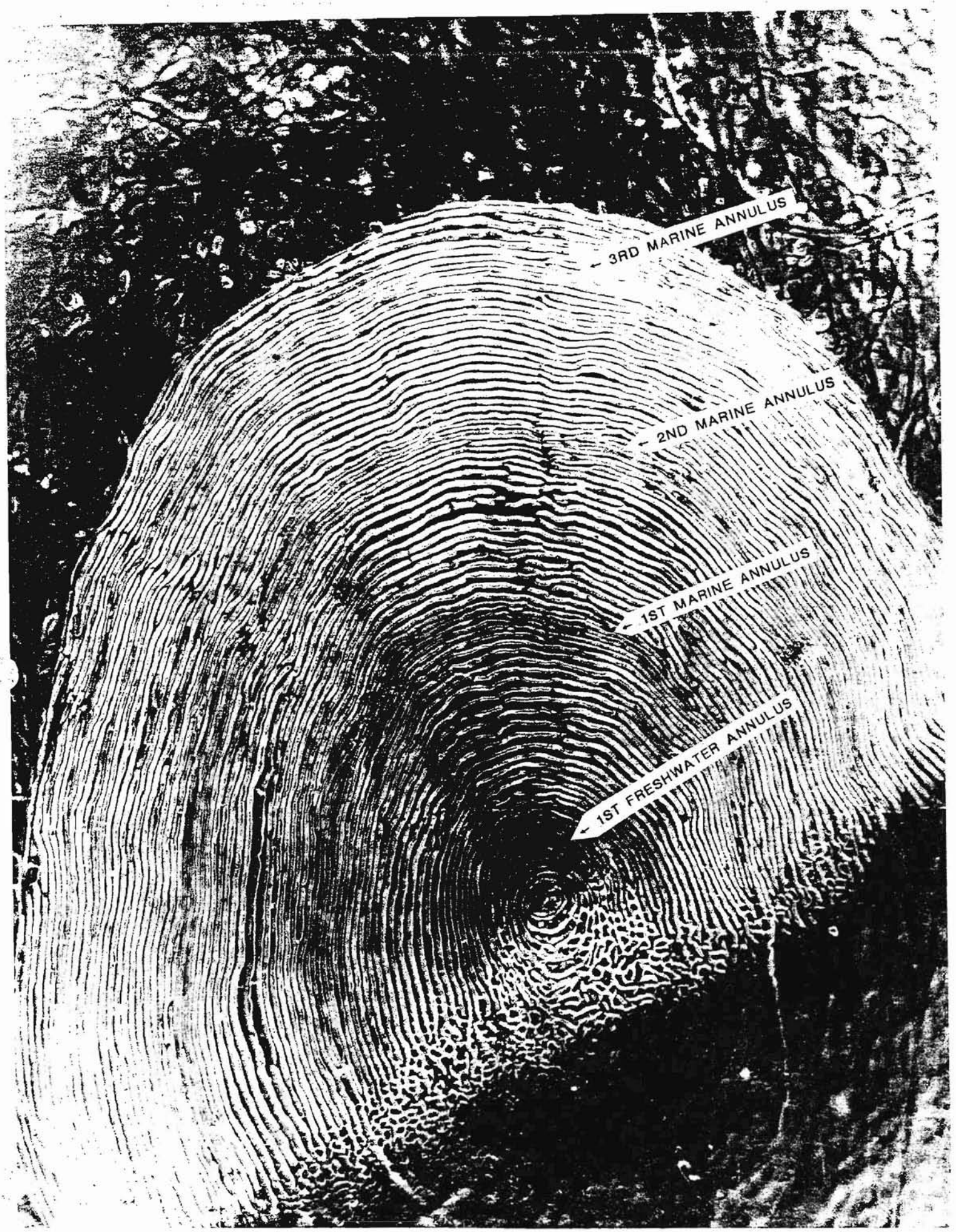

Figure 31. Age 1.3 sockeye salmon scale from Kenai River Composite

Figure 32. Age 1.2 sockeye salmon scale from Kenai River composite (Female, 465mm)

Figure 32. Age 1.2 sockeye salmon scale from Kenai River Composite

Figure 33. Age 2.2 sockeye salmon scale from Kenai River composite (Male, 505mm)

Figure 33. Age 2.2 sockeye salmon scale from Kenai River Composite

Figure 34. Age 2.3 sockeye salmon scale from Kenai River composite (Male, 655)

Figure 34. Age 2.3 sockeye salmon scale from Kenai River Composite

Figure 35. Upper Kenai River age 1.3 scale showing freshwater plus growth (Female, 561mm)

Figure 35. Upper Kenai River age 1.3 sockeye scale with freshwater plus growth

Kenai River System

Hidden Lake

Hidden Lake is a very productive clear water system which drains into the Kenai River just as it empties into Skilak Lake (Figure 9g). Scales are taken at the Hidden Creek weir, located a mile from the inlet of Hidden Lake.

The majority of Hidden Creek sockeye are four years old, age 1.2 with two marine checks instead of three as in the main Kenai River component.

Because Hidden Lake is so rich in food, the large fresh water growth defines the scale immediately. There are numerous circuli until the first winter annulus. The growth in one summer is larger than most two year old sockeye in the other Kenai River systems.

It is important to know that an area of freshwater growth that large can occur in one summer. At first view such extensive growth may be mistakenly read as two years' growth rather than one (Figure 36). As mentioned above, this feature of extensive freshwater growth within a single year is shared by samples of Fish Creek and Hidden Creek.

Hidden Creek sockeye are a late run of lake spawners which enter the system in late July and August, yet do not spawn until September or October. Hidden Creek sockeye are still fresh when they reach the creek and there is generally not a problem with reabsorbed scales, as in other systems in the upper Kenai (Figures 36-39).

Figure 36. Age 1.2 sockeye salmon scale from Hidden Creek (Male, 540mm)

Note: Large freshwater growth

Figure 36. Age 1.2 sockeye salmon scale from Hidden Creek

Figure 37. Age 2.2 sockeye salmon scale from Hidden Creek (Female, 540mm)

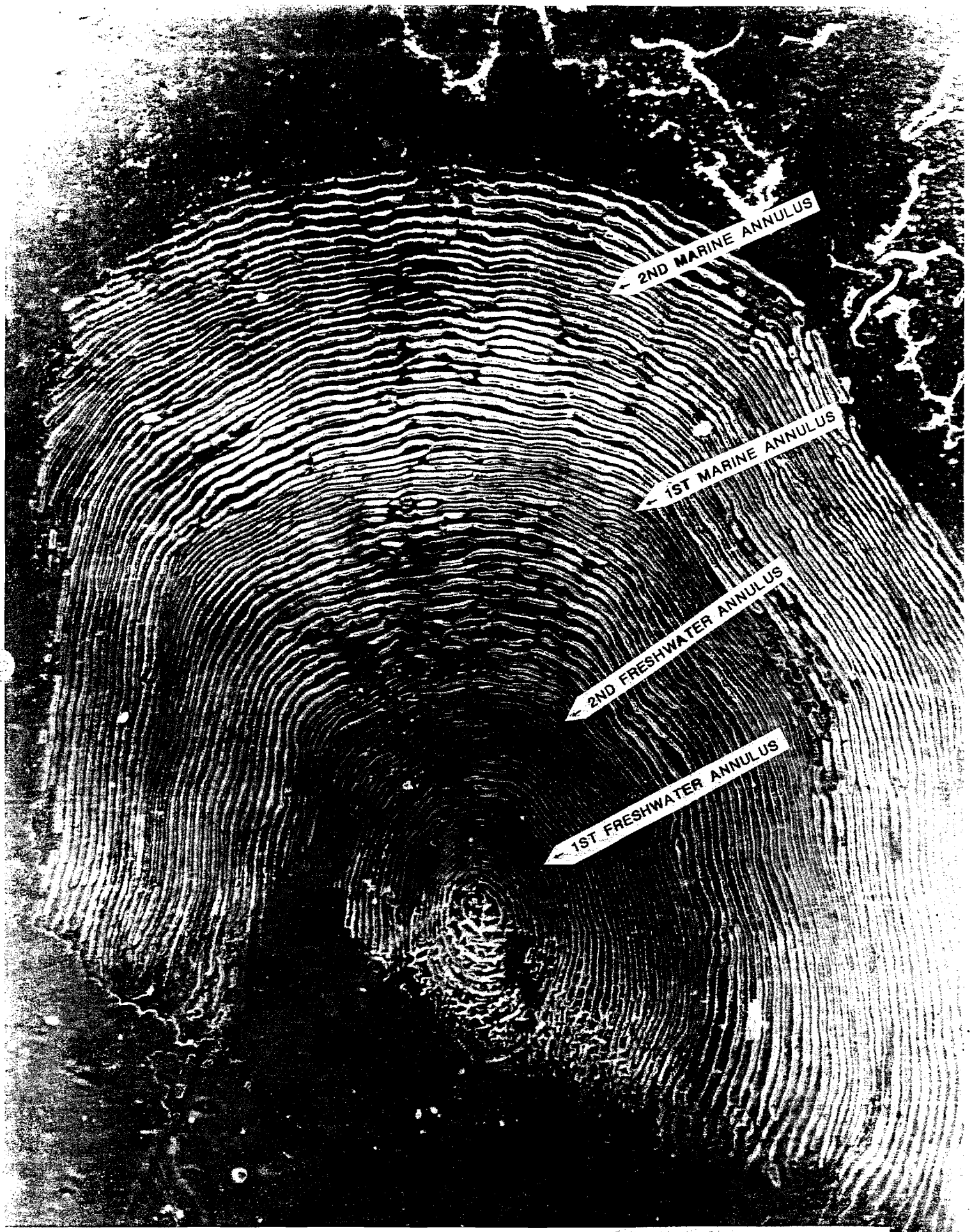

Figure 37. Age 2.2 sockeye salmon scale from Hidden Creek

Figure 38. Age 1.3 sockeye salmon scale from Hidden Creek (Male 530mm)

Figure 38. Age 1.3 sockeye salmon scale from Hidden Creek

Figure 39. Rare age 2.3 sockeye salmon scale from Hidden Creek (Female 542mm)

Note: First year of freshwater growth small, uncharacteristic of Hidden Lake sockeye, also has very slow marine growth.

Figure 39. Rare Age 2.3 sockeye salmon scale from Hidden Creek

Kenai River System

Russian River

The Russian River is located at mile 73 of the Kenai River (Figure 8h). A main sockeye producing tributary of the Kenai River, it receives 10-30% of the sockeye returning to the Kenai River.

The scales taken in the Kenai River composite sample include the second run of Russian River sockeye. The first run goes through before the sonar counters are installed, and are not intercepted by the commercial fishery. Scales from the second run of sockeye in the Russian River are taken by Sport Fish Division at three locations:

1) the confluence of the Russian River and the Kenai River,

2) in the Russian River itself, and

3) at the weir located at the mouth of Lower Russian Lake.

Most of the sockeye salmon scales from the Russian River show two years of freshwater growth. The freshwater growth area on Russian River scales is usually fairly small, with the second year freshwater annulus very close to the first in many cases. In other words, the second year of rearing in fresh water can result in very little additional growth. This pattern seems to persist in four, five and six year old fish (Figures 40-43).

The majority of the scales taken from the Russian River drainage show some degree of reabsorption. This makes the marine age very difficult to determine. Lengths must be taken into consideration and careful examination of the scales is needed to arrive with a fairly accurate age computation. In a system like this it is helpful to take a subsample of otoliths periodically to confirm the marine age of the salmon.

Figure 40. Age 1.2 sockeye salmon scale from Russian River (Male, 520mm)

Figure 40. Age 1.2 sockeye salmon scale from Russian River

Figure 41. Age 2.2 sockeye salmon scale from Russian River (Female, 530mm)

Figure 41. Age 2.2 sockeye salmon scale from Russian River

Figure 42. Age 1.3 sockeye salmon scale from Russian River (Male, 615mm)

Figure 42. Age 1.3 sockeye salmon scale from Russian River

Figure 43. Age 2.3 sockeye salmon scale from Russian River (Female, 585mm)

Figure 43. Age 2.3 sockeye salmon scale from Russian River

SECTION III

QUALITY CONTROL

In order to achieve the most consistent age determinations of a scale sample, training should adhere to the following guidelines.

1) The trainee will become familiar with the aging criteria and interpretations of the Upper Cook Inlet systems as outlined in this manual.
2) Once familiar with the aging criteria, practice sessions will be conducted using samples of scales from various river systems in Cook Inlet.
3) Additional practice sessions will be conducted using samples of mixed scales from the commercial drift fishery.
4) When the trainee's readings substantially agree with experienced readings of the drift sample, he will be tested on a sample of 400 scales from the major river systems in Cook Inlet.

A contingency table of observed numbers for each age class and total will be made to determine accuracy. To be acceptable, the relative error by age class should be within $\pm 10\%$ of the standard.

A minimum of 5 days should be allowed for orientation and training.

Additional reference publications (Clutter and Whitesel 1956; Koo 1962; and Mosher 1969) will be made available for the trainee.

GLOSSARY

ACETATE CARD	The type of card that is used for scale reading. Scales are transferred from a gum card to an acetate card, using heat and high pressure. The acetate card then receives an imprint that is the mirror image of the scale. The scales can be read directly from the acetate card using a microfiche reader.
ANNULI	Circular rings on a scale which are narrowly spaced, compressed and broken and indicate a winter's growth.
BROODSTOCK	The genetic stock from which a salmon is produced.
CIRCULI	Circular growth rings on a scale which can be widely or narrowly spaced.
"FALSE" CHECK	An area of the scale showing some compressed circuli indicating a short period of slow growth which may be mistaken for an annulus. This usually appears after the salmon leave freshwater and enter the marine environment.
FOCUS	The central zone on a scale
LATERAL LINE	A line running lengthwise along the sides of a salmon, approximately midway between the dorsal and ventral fins.
OTOLITH	The earbone of a fish which can be used to determine age.
"PREFERRED" AREA	The ideal area to take scales from a fish. On the left side of the fish, two rows above the lateral line and on the diagonal row from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.
REGENERATION	When a scale has grown back after loss or damage to the original scale. The circuli in the center of the scale are missing, so no freshwater age can be determined.
RESORPTION	A condition that occurs on a scale when the adult salmon is ripe or nearing spawning condition. The scale is breaking down to supply the salmon with nutrients. The outer part of the scale is missing, so marine age is difficult to determine.

GLOSSARY (Continued)

SMOLT	The period of time in a salmon's life cycle when it is ready to leave its freshwater rearing area and migrate to the ocean.
"TRUE" CHECK	A winter growth zone on a scale. An annulus.

FOOTNOTES

To illustrate patterns of the four major age classes in each system, scales in prime condition were selected from the 1993 sampling data. Between 100 and 200 scales were examined from each age class for each system. Over 3,000 scales were examined in making this selection.

Length and sex data were also consulted for the scales selected, to ensure that illustrations were truly representative.

Pictures were taken with a model "277" 3M microfiche reader with camera mount.

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