

Idaho Department of Fish and Game

draft

**Manual of Standardized Procedures for Counting
Chinook Salmon Redds**

compiled by

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1.0 INTRODUCTION

Every year Chinook salmon (*Oncorhynchus tshawytscha*) return to Idaho's waters on their spawning migration from the Pacific Ocean. These adult spawners represent the survivors of environmental conditions experienced during their life. Also, these fish have passed through a number of ocean 'and Columbia River' fisheries, and have negotiated eight dams on the lower Columbia and Snake Rivers during their migration.

Contemporaneous management of Idaho's anadromous Chinook salmon requires an annual estimation of spawning escapement to the state's waters. The spawning escapement represents a quantitative evaluation of the cumulative effects of nature and man on these fish.

The estimation of spawning escapement is difficult and has been the focus of numerous management and research activities (see Symons and Waldichuck 1984). It is especially difficult to enumerate all salmon returning to Idaho waters due to the vast and diverse habitat used by these fish and limited access to the habitat. In response to this situation the Idaho Department of Fish and Game has developed a program to index spawning escapement by enumerating redds produced by spawning salmon in selected areas.

Redd counts provide a useful index of the spawning escapement and subsequent production of anadromous fish. Redd counts were determined more suitable than live fish counts to estimate escapement in Washington coastal streams and the Strait of Juan de Fuca (PFMC-SSC¹). These Washington systems are characterized by unstable hydrologic regimes but good water clarity. Similar conditions exist in Idaho where significant changes in stream discharge may occur during the spawning season but water clarity generally is very good. Therefore redd counts are considered an appropriate index of salmon spawning escapement to Idaho's waters.

1.1 Purpose of the Redd Count Program

The redd count program is designed to provide a relative and comparable measure of the number of adult Chinook and steelhead spawning in trend areas each year. It is also designed to establish the relationship between the number of adult spawners and the number of redds produced, which can then be compared to the resulting number of juveniles. Annual counts in key areas provide information to evaluate habitat protection and enhancement measures, impacts of outmigration conditions, and harvest management practices. Management decisions on stock viability and the direction of major programs are influenced by available redd count data.

¹ Pacific Fishery Management Council - Scientific and Statistical Committee (SSC). Draft SSC review of Washington coastal and Puget Sound coho salmon escapement estimation methodologies: summary and recommendations. January 19, 1990.

Redd counts in Idaho are not intended to be a definitive measure of total escapement. The total count for a given trend area and year is only a total of the transects surveyed that year, not the entire system.

1.2 Purpose of the Redd Count Manual

The purpose of this manual is to define a set of redd counting methods which can be followed over time to maintain the consistency and accuracy of redd count data. It is impossible for each year's data to be collected under the same conditions as in previous years. New observers are recruited over the years and hydrologic events can suddenly change the condition of redd count areas. Thompson (1948) addressed variations in counts by different observers and suggested that standardized methods be used. By following the standardized procedures contained here, biases caused by observer changes and hydrologic events can be minimized.

This manual is organized into sections describing trend areas where counts are made and methods to be used when making counts. These methods should be followed each year when making counts. The manual is designed to allow for future program changes to be included in the manual.

2.0 HISTORY OF REDD COUNTS IN IDAHO

2.1 Salmon River and Snake River Drainages

Counts of Chinook redds in Idaho were first made in 1947 as aerial surveys of fall Chinook salmon spawning in the Snake River from Swan Falls dam downstream to Marsing, Idaho (Zimmer 1950, Schoning 1953). The first reported redd counts in the Salmon River drainage, aerial surveys made in 1951, were completed as Dingell-Johnson projects (Hauck 1951). Counts in the Salmon and Weiser rivers drainages were continued in 1952 and 1953 (Hauck 195? and 195?).

In July of 1953 the Idaho Department of Fish and Game entered an agreement with the U.S. Army Corps of Engineers to enumerate and document seasonal occurrence of salmon and steelhead in the Snake River and its tributaries (Pirtle 1957). As a result of this agreement salmon spawning escapement to Idaho was assessed using aerial and ground redd counts in 1954, 1955, and 1956. These surveys included counts in the Snake River and its tributaries and the Salmon River and its tributaries. Surveys were continued in 1957 as part of the Columbia River Fisheries Development Program, covering the Salmon River and Weiser River drainages (Metsker 1958). Redd counts in the Snake River and its tributaries (Weiser River) were discontinued in 19XX following completion of the Hell's Canyon dam complex. This dam complex prevented salmon from reaching historic spawning areas above the dams. Annual redd counts in the Salmon River drainage have continued since 1957 and have been expanded in various years.

2.2 Clearwater River Drainage

The history of redd counts in the Clearwater River drainage is much shorter than for the Snake River or Salmon River drainages. Lewiston dam, constructed in 1927 near the mouth of the river and removed in 1973, was thought to nearly eliminate Chinook salmon from the Clearwater basin. Poor design of the fish ladder at the dam was thought to preclude fish passage after the spring runoff had passed the dam. Modifications to the ladder in 1939 were thought to allow for Chinook passage, but complete dam counts were not started until 1950.

Reintroduction of Chinook salmon to the Clearwater basin began in 1947 with fingerling plants in the Little North Fork of the Clearwater River. Fingerling plants were continued through 1953. A second reintroduction effort was initiated in 1961 with eyed-egg plants. Between 1961 and 1964 3.5 million eggs were planted in Bear Creek (tributary to the Selway River) and 3.7 million eggs were planted in the Selway River. The Clearwater River Subbasin Salmon and Steelhead Plan (NPPC 1989) contains a more detailed documentation of reintroduction efforts in the Clearwater basin.

Following the reintroduction efforts annual redd counts were started in 1965 in Crooked Fork River (tributary to the Lochsa River) and in 1966 in the Selway River. Since that time additional areas have been included in the annual spawning surveys.

3.0 LOCATION AND CLASSIFICATION OF TREND AREAS

3.1 Locations

To index salmon spawning escapement the number of redds in various "trend areas" is counted each year. Areas surveyed are those which are important production areas for various stocks and are indicative of a major habitat or gradient type. Also considered when selecting areas was access and the potential to complete the count in a reasonable period of time. Counts are continued in those areas which historically have been surveyed.

A single trend area typically consists of a stream system or part of a stream system. The trend area may be divided into a number of small transects, each of which is counted. Different count methods might be used on different transects within a trend area. Counts over all transects within a single trend area are summed to provide one value as the index of spawning escapement for that trend area. Transect boundaries are constant from year to year. A complete description of all transects within each trend area is provided in Appendix A and maps of all trend areas are provided in Appendix B.

3.2 Classification

Trend areas are categorized by survey history as traditional areas and non-traditional areas. Trend areas also are categorized based on the stock of fish present (spring versus summer Chinook) and the past stocking history of the system (wild, natural, and hatchery influenced). A full description of each of the categories follows; the classification of each trend area is listed in Appendix A.

3.2.1 Classification by Survey History

Trend areas are categorized based on the history of surveys done. Those trend areas with a long history of surveys are considered "traditional trend areas" or are referred to as "trend areas" in the annual redd count reports and Appendix A. In most cases the traditional trend areas in the Salmon River drainage have been surveyed annually since the 1950's and those in the Clearwater River drainage since the mid-1960.

As more information on Idaho's anadromous salmon resources was obtained and the need to more closely monitor these populations developed, other areas were surveyed in addition to the traditional trend areas. To render the historic and current counts as comparable as possible these new areas were not included with the traditional counts. The new survey areas are classified as "nontraditional trend areas". Salmon River drainage nontraditional trend areas have been counted annually since 1985 (8 areas) or 1987 (4 areas). Five nontraditional trend areas have been established in the Clearwater River drainage and have been counted since 1987.

3.2.2 Classification by Fish Stock

In the Salmon River and Clearwater River drainages Idaho recognizes two distinct stocks of Chinook salmon, spring and summer. This designation is based on the time of adult migration and arrival on the spawning grounds. It is assumed that evolved stock differences preclude mixing of spring and summer stocks on the spawning grounds. Chinook crossing Bonneville dam on the Columbia River beginning in March and ending on May 31 are considered springs. Chinook in the Middle Fork Salmon River drainage and the upper Salmon River drainage (above the confluence of the Yankee Fork and Main Salmon rivers) are classified as spring Chinook salmon. All salmon in the Clearwater drainage are classified as spring Chinook.

Chinook salmon crossing Bonneville dam between June 1 and July 31, inclusive, are classified as summers. Summer Chinook are found in the South Fork Salmon River drainage and the main stem of the salmon below its confluence with the Yankee Fork.

Three areas in the Salmon River drainage are not classified by Chinook stock, and therefore are included in the annual redd count reports as "unclassified". These areas are Camas Creek, Lower Yankee Fork River, and West Fork Yankee Fork River. Annual counts have been made in these areas since 1972.

3.2.3 Classification by Stocking History

Hatchery-reared fry and smolt Chinook have been planted in various areas to rebuild depressed runs. Trend areas also are classified based on past releases in or near the trend areas. Three types of areas are recognized: wild, natural, and hatchery influenced. Although any of the two types of areas may lie in close proximity to one another it is assumed fish from the two areas do not mix because of spatial and temporal separation in spawning.

3.2.3.1 Wild Areas

Wild areas are those where hatchery reared fish have never been released, and thus represent the wild, native runs of salmon to these areas. Wild areas exist for both spring and summer Chinook stocks in the Salmon River drainage. No wild areas exist in the Clearwater River drainage.

3.2.3.2 Hatchery Influenced Areas

Hatchery influenced areas are those where hatchery reared fry or smolts are released to supplement returns to the areas. Returning adults may be the direct result of hatchery plants or the second or subsequent generations of hatchery plants. Both the Clearwater River and Salmon River drainages include hatchery influenced areas. Also, in the Salmon River drainage hatchery influenced areas exist for both spring and summer Chinook stocks.

3.2.3.3 Natural Areas

Natural areas are intermediate between wild and hatchery influenced areas. Adults returning to these areas were produced by naturally spawning fish. These areas are classified as natural because at some point in time releases of hatchery reared fry were made to rebuild depressed runs. Following the releases of hatchery reared fry all spawning and production has been natural.

4.0 REDD CONSTRUCTION AND IDENTIFICATION

4.1 Redd Construction

Before describing the physical characteristics of a typical Chinook salmon redd it is necessary to understand the process involved in the construction of the redd. Salmon begin constructing a redd by test digging small pockets (0.5 m to 1.0 m). If test digging reveals unacceptable conditions, such as bedrock or buried debris, the site likely will be abandoned. Test diggings can be identified by their small size, the presence of fine sediment and periphyton, and the degree of gravel looseness. Test pockets do not have a large pillow of loose gravel downstream of the pit, characteristic of true redds, and should not be counted as redds.

If substrate conditions are suitable redd construction continues and spawning ensues. The initial pit (or pan) is excavated about 0.3 m to 0.5 m deep. Following egg release and fertilization the female moves upstream and continues digging, which covers the eggs with gravel. This process is continued until spawning is complete. The female frequently dresses up the redd site with weak, low intensity digging upstream of the redd.

The overall shape of the redd may vary as a function of stream size, substrate size and composition, water velocity, and flow pattern. Redds can appear circular, ovoid, or elongate (similar to an ironing board). Physical characteristics of the stream must be

considered when determining the presence of a redd at a particular site, as they influence the size and shape to the redd.

4.2 Single Redds

The classic Chinook salmon redd is elliptic~ in shape, approximately 1.0 to 1.3 m wide and 2.0 to 2.5 'ln long. Burner (1951) listed the average redd size of Columbia River summer Chinook as 6.1 square yards and Columbia River spring Chinook as 3.9 square yards. Chambers et al. (1954) listed the size of spring Chinook redds as 13 (???) square yards. Size of an individual 'redd varies with physical conditions of the stream and size of the fish constructing the redd, therefore these factors must be taken into consideration when identifying redds.

From a distance the redd appears as an area of streambed lighter in color and with a different particle size distribution than surrounding areas. This is a result of cleaning of periphyton from the substrate during the construction process and particle sorting. Sorting of substrate particles results from the water currents as the fish disturbs the substrate.

The location of a disturbed area in the stream is often evidence of whether the area is a true redd. Developing eggs need a continuous supply of flowing water to deliver oxygen and remove metabolic wastes. Spawners will often select a redd site that has a hydraulic difference or "head" over it. These sites usually occur where the gravel aggrades at the tail of a pool or run.

Redd construction produces a "pillow" or slightly raised area of substrate at the downstream end of the redd which may raise the water surface over the redd. This pillow further acts as a hydraulic control forcing water down through the redd and past the eggs. The raised water surface over the redd can often be seen from a distance. The morphology of a typical Chinook redd is shown in Figure X.

Two features must be present if a disturbed area is a true redd: 1) a pit resulting from excavation of the redd and covering of the eggs and, 2) a pillow of loose substrate material immediately downstream of the excavated pit. If both conditions are met the area should be considered a true redd and counted as such.

4.3 Multiple Redds

Often times large areas of freshly dug substrate will be encountered. These areas may be indicative of several fish spawning in close proximity or two or more fish spawning in the same location at different times. A female may construct more than one "false redd" before actually depositing her eggs. Briggs (1953) observed that over three-fourths of the redds constructed in Prairie Creek, California were false redds. Ortman and Richards (1962) enumerated the female spawners passed above a weir on the South Fork Salmon River and counted the number of redds produced. Forty-nine females were passed above the weir. When normal counting procedures were used (determining the number of redds in a multiple redd) they counted 106 redds. If each multiple redd was counted as one redd the total number was 57 redds.

In 1986, Payette National Forest personnel cleaned small areas of spawning substrate prior to Chinook salmon spawning. They observed that cleaned areas were used more than uncleaned areas. It appears that Chinook salmon may be more likely to spawn in cleaned or disturbed areas than in undisturbed areas, thus increasing clustering of redds even in underseeded spawning areas. Careful attention to size of the area, number of pits or depressions, overlap of pillows, and orientation of the redds or margins of the redds will help in determining the number of redds present.

When the possibility of multiple redds is encountered, the observer should first try to determine the likely chronology of spawning activities and decide if more than one female deposited eggs in the area, either adjacent to or on top of another. If it appears that only one fish has spawned in the area the disturbed area should be counted as one redd. If it appears that more than one fish has spawned in the area the observer should make an attempt to count individual egg pockets and or pillows. When the egg pockets (and pillows) are sufficiently distinct and separate to indicate they were constructed by different fish they should be counted as individual redds, provided they meet the criteria for single redds.

In instances where a large area contains several closely spaced pockets not distinctly separate from each other or no distinct egg pockets exist, the following criteria should be used to determine the number of redds. Where several fish have spawned across the stream the number of redds is the whole number obtained by dividing the width of the spawned area (in meters) by 1.4. For example, if the width of the spawned area is 5.5 m, the number of redds is calculated as $5.5/1.4 = 3.93$ or 3 redds. Where several fish have spawned behind one another, the number of redds is the whole number obtained by dividing the length of the spawned area (in meters) by 1.4. If the observer decides fish have spawned beside, behind, and on top of one another the number of redds is the number of times a 1.4 m by 1.4 m area will fit into the spawned area.

5.0 TIMING OF COUNTS

Proper timing of counts is important so information gathered each year is comparable with other years. Two types of information are gathered during each survey, the number of redds observed and sex and lengths of fish observed on the spawning grounds. Timing of the survey will affect each type of data.

An individual count of fish at some point in time does not provide the total number of spawners (Atkinson 1944t Bevan 1961). Bevan (1961) stated that a count of the maximum observed abundance {fish} could be used as an index of the total number of spawners provided that "...length of life of individuals on the spawning grounds is constant from year to year...". In Idaho redds rather than live fish are counted at the time of maximum abundance to provide an index of spawning escapement.

The redd count is timed so all redds constructed within a transect are counted. Each transect is assigned a target date for the count, selected when the ratio of redds to live fish is greater than one to one. At this time all redds are either completed or well under construction and fish are in the immediate vicinity. All redds should be visible at this time. Actual count dates may vary from the target date due to weather conditions. Since the redd count is an index of escapement rather than an absolute measure,

counts made close to the target date, just after the peak of spawning activity, should be comparable from year to year.

Information on sex ratio and lengths of spawners may be significantly influenced by the time of collection. Richards (1960) found a differential die-off rate between males and females through the spawning season. He found dead females to be more numerous during the later surveys on sections of the South Fork Salmon River. Ortman and Richards (1962) found the male to female sex ratio of Chinook on the South Fork Salmon River spawning grounds (0.9:1) was different than the ratio of fish allowed to pass above a weir to these spawning grounds (3.2:1). They concluded smaller fish, jacks and males, were more difficult to locate than females, which typically were larger than males. Recovery of proportionately fewer Chinook males than females on spawning grounds also was documented by a tagging study in California (Anonymous 1959). As time constraints limit the ability of biologists to collect information on all spawning systems throughout the spawning period, care must be taken in interpreting sex ratio and length-frequency data collected during spawner surveys.

The Regional Fishery Managers will determine the actual dates for counts in their respective regions each year. Count dates should be on the target dates indicated in Appendix A, or as close to the target date as possible. If extenuating circumstances require the count to be made outside the seven-day window prescribed in Appendix A, a written explanation should be attached to the redd count form.

6.0 GROUND COUNT STANDARD PROCEDURES

Counting salmon redds from the ground is the most accurate count method used in Idaho. Ground counting allows the observer to see most or all of the redds in a transect. Opportunities for errors exist that can cause significant variability unless standard procedures are followed.

Counting redds from the ground is not difficult. The observer merely walks in or near the stream, moving in a manner that allows good visibility of the streambed and both stream banks. Redds are enumerated, and live fish are enumerated and classified as jacks or adults. Dead fish are sexed and the fork length measured. Specific procedures to be followed are described below.

6.1 Equipment and Pre-count Preparation

Prior to making the count determine which transects are counted by ground (Appendix A). Make sure all transect boundaries are known. Use the trend area maps included in Appendix B and verify the transect boundaries with the descriptions listed in Appendix A. The following equipment is recommended when making ground counts. Polarized sunglasses should be worn to reduce glare. Carry a wading staff to be used when walking in streams and wear appropriate footwear. A Write-In-The-Rain notebook should be used for recording all information.

6.2 Specific Procedures for Counting Redds

6.2.1 Weather Conditions and Starting Time

Select a day with good sunlight. Avoid extremely overcast, rainy, or windy days as visibility is significantly reduced under these conditions. The count should be delayed until the sun is in a position as to provide adequate light for good visibility and contrast. Depending on stream orientation, canyon steepness, arid vegetative cover, the appropriate starting time is 0900 to 1030 hours. Counts should be completed by 1500 hours.

6.2.2 Direction of Count

Determine the direction of the count, upstream or downstream, before starting. The direction to proceed is determined by stream flow, substrate conditions, and the sun's position. Some streams cannot be waded upstream due to high velocities. Downstream wading in streams with large amounts of fine sediment is not advised due to the increased turbidity caused by wading. Where possible the sun should be to the counters back to reduce glare.

6.2.3 Counting Process

Proceed in the direction decided upon, enumerating all redds observed. Maintain continuous visibility of the streambed and both stream banks to prevent overlooking redds and fish. Each stream presents its own set of difficulties. Some streams are too steep or turbulent to walk in for extended distances. Others have dense vegetative cover preventing good visual coverage, and some are too wide to allow observing the entire stream from one position. Take advantage of the area between the vegetation and waterline and utilize high banks for better visibility. Follow game trails through dense cover frequently accessing the stream and/or traverse the stream in a zig-zag fashion to obtain complete coverage.

Often, two or more observers can divide the transect into smaller segments and complete the count by "leap-frogging" one another. A vehicle can be used to reduce travel time to the next segment to be counted. Surveyor's ribbon or other highly visible markers should be used to mark the transect segments and avoid overlapping counts.

Take your time. Closely inspect areas of recently disturbed streambed material. Closely examine areas of redd clustering, superimposition, or possible multiple redds and determine the number of redds present. Be careful not to count false redds resulting from test digging by females. Examine gravelly tailouts (riffles at the downstream ends of pools) and undercut banks for hidden redds.

All live fish observed during the count should be enumerated. If possible determine the sex of the fish and determine if it is a jack or an adult. Any fish less than

61 cm (24 in) is considered a jack. Also determine which fish are greater than 81 cm (32 in) if possible.

All count data should be transferred to trend area maps at the end of the day. Copies of these maps should be made from the originals in Appendix B prior to making any counts.

6.2.4 Procedures for Spawner Carcass Surveys

Carcass surveys should be completed when making the redd counts. Additional carcass surveys can be completed as determined by the Regional Fishery Manager. Attempt to recover all carcasses by inspecting all parts of the stream including deep holes, log and debris jams, rocky riffles, and gravel bars. Inspect riparian vegetation if the smell of decaying fish is detected, as animals will drag carcasses out of the water.

Data to be collected from each carcass includes fork length, to the nearest centimeter (Fig. 1), and sex. Examine all carcasses for any external marks or tags, including brands and fin clips. Indicate any marks on the data sheet. Remove any external tags from the fish and cross-reference the tag information with the length and sex of the fish. Absence of the adipose tin indicates the fish has been coded-wire tagged. The snout should be recovered from all fish with missing adipose fins by cutting the head behind the eye. Cross-reference the snout with the length and sex information. Record any scars or wounds observed on fish. Examine all females to determine whether they are spent (all eggs extruded) or the approximate percent of eggs retained. After gathering all information from the carcass, completely cut off the tail (Fig. 1) to indicate the carcass has been examined.

In some years or in some trend areas you may be required to collect a scale sample from the fish. Scales should be collected from the second and third scale rows above the lateral line on the left side of the fish, along or near the diagonal scale row extending from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Figure X). If scales can not be collected from this area on the left side of the fish, examine the right side to determine if scales can be collected from the same area. When scales can not be collected from either side in the desired location, collect them from the side where they can be collected as close to the desired location as possible. Remove five to ten scales from the area selected, place them in a scale envelope and code the envelope with all pertinent information.

Record all information as it is obtained; avoid storing data in your head. Include on all data sheets the data, survey time, transect name and location, weather conditions, observer name, and any other information deemed important. Return all data and comments to the crew leader or Regional Fishery manager as soon as possible after the count is completed.

6.3 Advantages of Ground Counts

Ground counts provide the most accurate count of the number of redds in a transect, and typically can be completed when meteorological conditions, especially wind, prevent aerial counts. Ground counts are more accurate in streams with abundant

vegetative cover which shades and conceals redds from aerial observers, and streams in which the substrate is especially clean. Redds constructed in small streams tend to be near the banks and are difficult to see from the air. In cold headwater streams, periphyton is scarce, and the contrast between disturbed and undisturbed substrate is indistinct.

Ground counting allows identification of the structural components of a redd which are not easily seen from the air. Clustering and superimposition of redds can be more completely and accurately evaluated by close inspection from several angles unavailable to aerial observers.

The observation of live fish on or near a redd aids in identifying redds. Classification of living jacks and adults provides additional data on year class composition. Ground counting allows the gathering of physical data from dead fish observed in the transect. Additionally, ground counters can recover information from tags, and determine the presence of fin clips, brands, and coded-wire tags.

6.4 Disadvantages of Ground Counts

Ground counting demands considerable time and occurs within a critical time period of a limited field season. Ground-counted transects must be short. Surveys on entire streams longer than 10 kilometers requires more than one man-day. Because of the time involved in ground counting and the limited time frame available for counting, multiple counts are unlikely.

7.0 AERIAL COUNT STANDARD PROCEDURES

Helicopters and fixed-wing aircraft can be used to count salmon redds from the air. Aerial counts typically are not as accurate as ground counts. Bevan (1961) states that any aerial surveys have value only as an index and not as a total count. Bevan further states that aerial surveys should not be used to determine differences less than 50% unless the variance in the observer's estimates is carefully considered.

Since the objective of performing redd counts in Idaho is to provide an index of spawner escapement (entire systems are not surveyed) aerial methods are appropriate. Aerial counts are made on the same transects in the same manner each year and thus provide comparable indices of escapement from year to year. Caution must be exercised when comparing ground and aerial counts. Aerial counts underestimate the number of redds in any trend area. A comparison between aerial and ground counts has been done in Idaho in various years (Table X). Results of these comparisons indicate aerial counts average XX% less than ground counts over the same transects.

7.1 Department Policy on Mountain Flying

Idaho Department of Fish and Game policy A-17.04 specifies the "Low Altitude Aircraft Operating Procedures and Safety Policy". The Policy Manual should be consulted each year prior to making preparations for aerial surveys. Obtaining preflight approval is mandatory as indicated in the Policy Manual.

7.2 Flight Equipment

Department policy A17.04 identifies items that must be taken on all redd count flights. Items include clothing, flight suits, helmets, first aid kits, survival kits, etc. This policy must be adhered to during redd count flights.

Items needed to keep accurate records of redds include a book or clipboard listing each counting transect, extra pencils, and at least two mechanical tally counters. The higher speeds required in aerial counts demand that data entry procedure be predetermined. Polarized sun glasses are an absolute necessity. The observer should wear a billed cap to keep the polarized glasses shaded.

Normally, a daypack is carried on board containing lunch, emergency food items, and typical survival items for the backcountry. The counter should be equipped to survive a high-country overnight stay if an emergency landing occurs.

Air sickness can be a problem and can interfere accurate redd counts. Bevan (1961) concluded that significant interactions among observer, airplane, and streams in one experiment were the result of one observer becoming airsick in a specific plane over one stream. Several over-the-counter prescription motion sickness prevention medicines are available. Most of these can have unpleasant side effects. Turbulent air can be encountered in canyons during the middle of the day, and watching the ground can cause air sickness. Personnel that are prone to airsickness should take measures to prevent air sickness or not attempt aerial counts.

7.3 Preflight Briefing

A pre-count pilot-observer briefing is advised to discuss redd count objectives and needs. Redd count flying is strenuous for the pilot; a short communication break on the ground prior to the flight can be beneficial. It should be understood that the pilot or the observer can have the last word and authority to abort the mission whenever weather or other circumstances prevent completing the mission. Fish counts are to be postponed or canceled if flying conditions are unsafe.

7.4 Flight Planning, Refueling, and Procedures

A flight plan should be laid out on a map and flight time estimated. This will permit the most efficient use of the machine's flying time and allow the planning of fuel stops. In many cases, airports are on counting routes and fuel stops can be made there. In cases where backcountry flying is being conducted, fuel barrels must be spotted on site. This responsibility is assumed by IDFG personnel renting the craft. Route distance and flight time will dictate the need for and amount of fuel spotting.

Pilots should have a minimum of 100 hours of backcountry and mountain flying prior to flying redd counts. Pilots need to be familiar with the area and be proficient at landing at backcountry airstrips en-route or adjacent to the counting areas.

Communication with the pilot is mandatory. The aircraft must be equipped with an intercom system for the pilot and each passenger that allows clear communications.

Where possible, flights should be made in the downstream direction during full sunlight with the sun to the counters back. The direction of the flight should be consistent from year to year. If possible, it is a good idea to fly the stream at moderate elevation on the way to the starting point. Tight areas of canyons, cables, and problem areas can be noted in this manner. Prior to the survey, it is essential for the pilot to look over any stream he has not flown redd counts on previously.

7.5 Type of Aircraft Used

Aerial counts will be conducted by helicopter whenever possible. Because of lower cost and better availability fixed-wing aircraft may be used for some counts, The type of aircraft to be used on each transect is listed in Appendix A. The count method used (ground, helicopter, fixed-wing) should not be changed unless it is proven that another count method will produce the same results.

7.5.1 Helicopter Counts

Redd counts can easily be done from the helicopter speeds from 30 to 50 mph. Altitude above the stream vary depending on the size of the stream, the cover, shading, and light conditions. Small streams with riparian tree cover may require tree top elevation. A large river such as the upper Salmon River can be easily counted from several hundred feet elevation. When counting redds from a helicopter, the option to hover over the redd for a better view is available. A diameter of 1.4 meters for a single redd can be used to gauge the number of redds in a multiple spawning bed if the pits cannot be discerned.

The two most important criteria that must be considered when choosing the type of helicopter to be used to conduct redd counts are flying capability and visibility. Most redd counts in Idaho are flown at elevations between 4,000 and 7,000 feet above sea level and often in narrow canyons limited turn-around or landing opportunities. The machine must have enough power and lift to climb out of canyon tributaries and over ridges to minimize travel time and fly the most direct routes to counting areas, fuel supplies, or back to base.

The observer must have good visibility out of machine. In most cases, it is necessary to be able to view the count area directly ahead and below at a steep angle. A machine that has a clear Plexiglas bubble in front of the passenger and pilot is needed to allow an unrestricted view.

At the present time, there are two basic models that fit the criteria of visibility and power that are generally available within Idaho: the Bell 47G3B-I or B-2 and the Hiller 12E. Either of these machines can have the Soloy engine modification, which increases power and lift capacity. A French-made machine, the Allouette Lama is becoming more popular in use and has excellent power capabilities and visibility. It has a high fuel consumption rate, however, and is quite expensive to operate.

Machines, such as the Bell Jet Ranger, have adequate power, but metal or fiberglass structural components block some of the view directly forward and below the horizon level. A Jet Ranger can be used in wide river valleys, allowing viewing from side

windows. It necessitates flying to side of the river, which can be unsafe or impossible in narrow stream courses, difficult on meandering rivers, and sometimes not compatible with the angle of the sun.

Both the Hiller and Bell machines will accommodate pilot and two passengers. The performance and range of machine is directly related to the onboard weight. Better performance is achieved with a single passenger than with two. This should be taken into consideration for the type of flying to be done. If tight canyon flying at high elevations is called for, one passenger, rather than two, can provide a performance safety margin. The main observer should ride in the front seat for best visibility. Never carry any more weight than is necessary to complete the mission.

Flying time (fuel capacity) is usually around X hours, depending on the individual machine. Flight requirements should be planned accordingly. Usually one 55-gallon drum spotted in a strategic location along the route will be enough. The empty barrel can be taken out by the helicopter after fueling. Always check with the pilot to determine the proper fuel type and octane. Fuel transfer devices should be planned for. Some machines carry their own fuel pump, hose, and filter system. Others will require this equipment be at the fuel site. For safety, always allow at least 15 to 20 minutes more flying time than is necessary to reach the refueling site.

Prior to making official redd counts from a helicopter, counters should have considerable ground experience. Experience is required to count multiple redds in a consistent manner from aircraft.

7.5.2 Fixed-wing Aircraft Counts

Fixed-wing aircraft used for redd counts should have at least 150 horsepower and a high wing. The best aircraft are the tandem seat Piper Super Cub, Bellanca Scout, Citabria, Christen Husky, and Cessna Birddog. In these aircraft, the observer can sit in the backseat and see out both sides. Aircraft that are acceptable but do not afford good visibility are the PA-12 Super Cruiser with 150 horsepower; Maule 115, M6, or M7 with 180 to 230 horsepower; or the Cessna 180, 182, and 206. Many counts have been flown using the Cessna 182, but the observer must take off the seat belt and slide from window to window across the seat.

Airspeed should be as slow as necessary to accurately count all redds. Normally this is 5 to 10 knots above stall speed. The stall buzzer may sound during tight turns, but will cease buzzing when the plane is returned to its normal attitude. The pilot and observer should both be familiar with the stall speed of the particular aircraft they are in.

The elevation during fixed wing redd counting depends on many variables, including topography, light conditions, air currents, and pilot skill. Ideally, the plane should be slightly to the side of the stream with the sun at the observer's back as he looks out the side window. As the stream turns, so does the plane. Occasionally, it is necessary to "cross over" to the other side, but the plane should attempt to stay on the side toward the sun as much as possible.

A circling technique may be employed to provide the observer with a better chance to observe multiple redds. Multiple redds can be defined from the air by flying

low and counting actual spawning trenches, by comparing the size of the redd to known single redds and by observing the number of fish present.

Prior to making fixed wing redd counts, counters should have considerable experience with ground and helicopter redd counts. Experience is required to count multiple redds in a consistent manner from fixed wing aircraft.

7.6 Advantages of aerial counting

Aerial counts are easily and accurately made in streams or rivers that show high color contrast between disturbed and undisturbed substrate due to sediment deposition, substrate color, and/or algae growth. Redd counting time requirements have been greatly reduced through the use of aerial flights.

7.7 Disadvantages of aerial counting

In certain headwater streams that have little sediment deposition or are too cold to allow significant algae growth, the aerial, two-dimensional view of redds is often insufficient to accurately detect their presence. Also, very narrow, rocky streams with small gravel pockets or a thick overstory make aerial detection difficult. Ground counts may be more suitable in these areas. Movement of sediment onto redd by rainstorms can make redd detection difficult. NQ carcass data can be obtained in areas where aerial counts are done.

The cost of making single aerial redd counts in isolated areas can be expensive. To justify the use of aircraft several redd count transects need to be counted during the flight.

8.0 OBSERVER STANDARDS

Redd count observers will meet minimum experience and training criteria before conducting official redd counts. Required training includes having:

- 1) viewed the Department's redd count training video within one month prior to conducting official redd counts; and
- 2) accompanied an experienced observer on a minimum of three redd counts on three different streams for training purposes.

Prior to making official redd counts from a helicopter, observers should have considerable ground counting experience. Prior to making fixed wing redd counts, observers should have considerable experience with ground and helicopter redd counts. Experience is required to count multiple redds in a consistent manner from aircraft.