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Yukon Salmon Escapement
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Yukon Area Salmon Escapement Aerial Survey Manual

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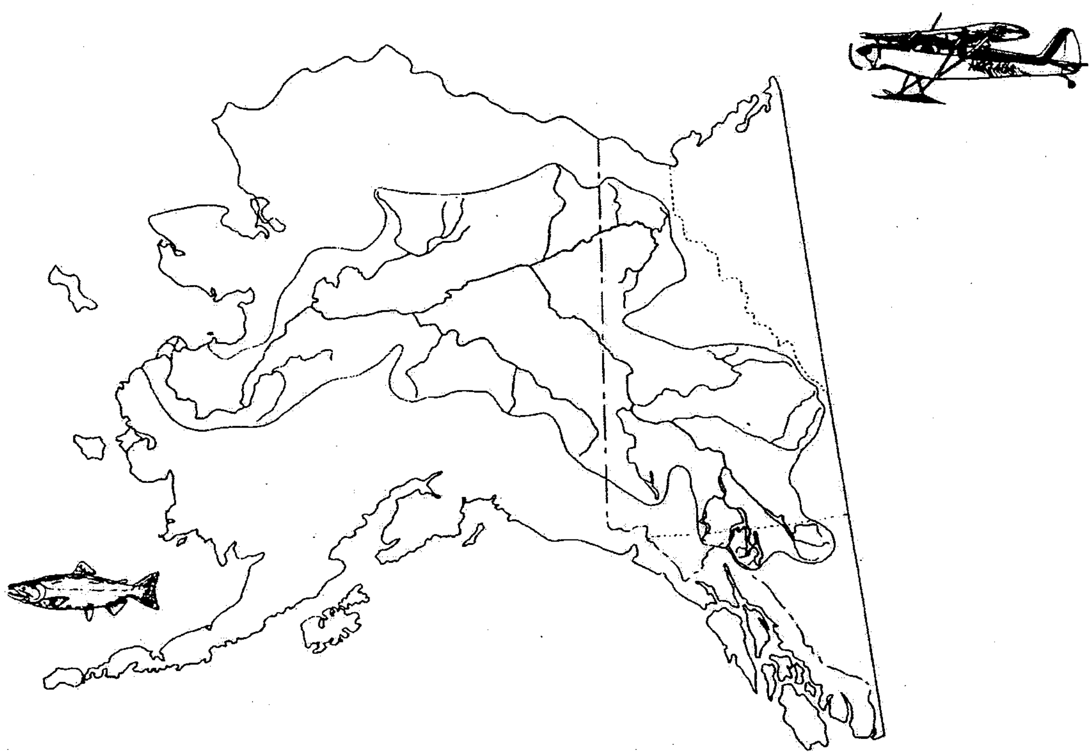

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INTRODUCTION

The purpose of this manual is to describe aerial survey techniques associated with documenting salmon spawning escapement throughout the Yukon River drainage. Standardization of techniques will result in a more quantifiable data base from which annual comparisons can be made.

There are both advantages and disadvantages in estimating salmon escapement by aerial surveys. Perhaps the greatest advantage, as it pertains to the Yukon River drainage, (330,000 square miles) is the cost effectiveness for obtaining escapement information throughout a vast area, much of which is remote. Another advantage to aerial surveillance is that real or potential habitat-related problems arising from natural or man-induced causes can be readily identified. Among the disadvantages are that results may be highly variable if non-standardized procedures are used.

Variability in accuracy is dependent upon a number of factors such as weather and water conditions (turbidity), timing of surveys with respect to peak spawning, type of aircraft, survey altitude, experience of both pilot and observer, and species of salmon being enumerated (Cousens et al. 1982). It is generally recognized that aerial estimates are lower than actual stream abundance due to these factors. Also, aerial estimates in a given stream may demonstrate a wide range in the proportion of fish being enumerated from year to year (Buklis and Barton 1984). Further, it has been shown that peak spawning abundance measured by aerial survey methods, is significantly lower than total season abundance due to the die-off of early spawners and arrival of late fish (Gangmark and Fulton 1952, Bevan 1961, Neilson and Geen 1981).

Aerial survey estimates can produce quantifiable results through careful standardization of procedures. Peak counts can serve either as indices of relative abundance for estimation of total escapement from base year data by established expansion factors, or they may be used to apportion tributary spawning distribution to a mainstem total escapement estimate obtained form sonar or tower counts (Cousens et al. 1982). As the potential advantages tend to far outweight the disadvantages, aerial surveys are used extensively throughout the Yukon River drainage.

BASIC OBJECTIVES

Aerial survey escapement estimates are made of as many salmon spawning streams as possible within the confines of weather, personnel, and fiscal constraints. In addition, an effort is made to ensure that representative spawning areas are surveyed annually to provide an index of escapement abundance. Specific objectives of the aerial survey program for the Yukon Management Area are:

1. Estimate the abundance of spawning salmon by species in selected spawning streams.

2. Estimate the timing and distribution of spawning salmon by species in selected spawning streams.

3. Monitor and protect fishery habitats.

MANAGEMENT APPLICATIONS

Management of the Yukon River salmon fisheries is made difficult due to the complexity of the salmon runs, character of the fisheries (e.g., allocation problems between unriver and downriver fishermen), and size of the river drainage. Although various fisheries are scattered over 1,400 rivermiles the majority of commercial harvests are made in the lower 200-300 rivermiles. These fisheries are harvesting mixed stocks usually several weeks and hundreds of miles from their spawning grounds.

Although escapement information collected on many streams is often not useful for direct in-season management, monitoring in-season escapements is the basis for adjustments to regulatory and management strategies on a post-season basis. Escapement data provides annual escapement trends for evaluation of the effectiveness of the management program for justifying proposed regulatory changes to the public and Board of Fisheries. Further, information is provided for developing, updating, and continually evaluating escapement objectives and salmon production in the Yukon River drainage.

Finally, escapement surveys provide information for updating the anadromous fish stream catalog as required by Alaska Statute 16.05.870 as well as a means for monitoring and protecting fishery habitats from natural and human-induced threats.

AIRCRAFT AND PILOT

Preferred Aircraft

Helicopters are seldom used for survey work in the Yukon Area due to high operating costs and limited flight range (fuel capacity). Consequently, the following discussion pertains only to fixed-wing aircraft.

Aerial surveys should be flown in two-place or four-place, single engine aircraft. Low-wing aircraft should not be used because of obstruction to the observer's view. Survey aircraft are generally equipped with wheels or wheel-skis (in the case of late fall surveys). Float-equipped planes are infrequently used as they are heavier than when on wheels and in-flight maneuverability is greatly lessened as a consequence. Bubble windows are an important asset, particularly in larger four-place or float-equipped aircraft, allowing the observer improved downward vision. However, bubble windows should always be inspected for bad distortion before accepting aircraft. Any aircraft selected should be properly maintained and not overdue on maintenance schedules.

The most preferred survey aircraft by the Fairbanks staff is the two-place, PA-18 (Super Cub) equipped with long-range fuel tanks (up to 9 hours), tundra tires, and high performance prop. Although relatively slow for point-to-point flying (90-95 mph), the Super Cub has great maneuverability in the hands of an experienced survey pilot. This feature, together with easy view from either side of the aircraft and relatively low survey airspeed capabilities, make the Super Cub an excellent survey plane. This is particularly true for rivers or streams which meander to a great extent or those possessing several channels (such as often characterize fall chum salmon spawning areas). Further, the Super Cub can be easily landed on gravel bars in remote areas for periodic rest stops, an essential element for maintaining accurate survey results on extended survey trips.

A second choice is the four-place Helio Courier. Helio Couriers possess wing slats and spoilers to provide increased maneuverability and control at extremely low airspeeds (50-55 mph). The Helio Courier is a difficult plane to handle when flown under the type of conditions which accompany aerial surveys (i.e., low airspeeds and steep turns). Consequently, it is absolutely essential that a skilled Helio Courier pilot be used to fly this plane. The Helio Courier is relatively fast for point-to-point flying (140-150 mph) and it has the added capability of very short take-off and landing requirements, making it also a good plane in which to schedule periodic rest stops in remote country. However, the observer may want to sit in the back seat (as in other four-place aircraft) in order to view from either side of the plane as conditions dictate.

Other aircraft less often used for conducting aerial salmon surveys throughout the Yukon River drainage include the Cessna 180, 185, 170, and 172. Due to aircraft weight and required distance for take-off, fewer suitable landing areas in remote country will be found for the Cessna 180 or 185, by comparison with the Super Cub and Helio Courier. These are four-place aircraft, and like the Super Cub and Helio Courier, they are "tail-draggers" (i.e., they do not have a nose gear). A word of caution: planes with a nose gear (e.g., Cessna 172) should not be landed on gravel bars due to danger of the nose gear collapsing. Although the Cessna 180 and 185 allow for relative fast point-to-point travel, they also require more airspeed during surveys to make turns; as such, this often results in the observer becoming more prone to vertigo or air sickness.

Preferred Pilot Qualifications

It should be realized that low-level aerial surveys flown in any fixed-wing aircraft can be extremely dangerous. This extends far beyond the dangerously low altitudes from which surveys are flown. Maneuverability and low airspeeds associated with aerial surveys often result in the plane and pilot performing extremely close to their limitations. Inexperience and incompetence have caused a lot of accidents. Consequently, selection of a good (hopefully survey-experienced) pilot is absolutely essential. Most area offices have knowledge of preferred survey pilots and aircraft as well as names of individuals to avoid. If preferred pilots and aircraft are unavailable, the observer should check with Department personnel in other divisions for recommendations of other pilots and their qualifications. Note: Flying sheep, moose, or caribou surveys are different than flying salmon surveys, but it is better to pursue this course first rather than attempt flying with someone of whom little is known.

Regardless of experience, a pilot who has never flown salmon surveys cannot be expected to perform adequately until such skills are acquired. Prior survey flying experience (not necessarily of salmon surveys, although desired) in aircraft type desired should be a minimum qualification. This is of particular concern with Helio Couriers or any float-equipped aircraft. Pilots without any or with only nominal fish survey experience need to be "taught" a few basic survey techniques. You do not have to know how to fly an airplane to know how an aerial survey should be flown. Explain basic survey flying maneuvers and procedures to the pilot (see portions of following sections). Do not "press" the pilot to make optimum performance maneuvers on the first few flights. Remember that each pilot has his own limitations and he knows better than the observer (hopefully) what they are. Just because one individual can make a particularly difficult maneuver, or gravel-bar or river landing safely, does not mean someone else can. At the same time, do not hesitate to inform a pilot not to make a particular maneuver or landing if you are not confident he can safely perform it. The same applies to instructing a pilot to return home if you know weather conditions are not safe. This is generally not a problem with experienced Alaskan pilots; however, such situations may infrequently arise.

In-flight Supplies and Equipment

Aircraft: The observer should ensure that the survey aircraft is equipped with an operating radio, emergency locator transmitter (ELT); operable radio navigation equipment (an automatic direction finder (ADF), although not required by FAA, is desirable for navigation in remote locations); required survival gear (food, firearm, shelter, etc.); fire extinguisher; and FAA flight maps of the area(s) to be flown. Ensure the aircraft is not overdue for its "100-hour" maintenance inspection. The observer should ensure the pilot has cleaned aircraft windows before departing on a survey. Note: Light application of a scuba mask defogger to aircraft windows may help eliminate fogging during fall surveys.

Observer: The observer should review the following check list for essential survey and personal survival equipment prior to departing on any survey:

1. a listing of survey streams and respective index areas (current year operational plans)
2. topographical "lap" maps (1:250,000 showing index areas)
3. tape recorder (test recorder before departure - make sure it works)
4. extra batteries and tape cassettes
5. Polaroid sunglasses
6. ear plugs or protectors
7. aerial survey form legend (survey codes)
8. motion discomfort containers (barf bags)
9. field notebook and pencil
10. State TR book (if appropriate)
11. camera for photo-documenting habitat-related problems
12. wrist watch
13. lunch and drink
14. fire-retardant (NOMEX) suit
15. personal survival gear:
    a. sleeping bag
    b. firearm (unloaded)
    c. space blanket or one-man tube tent
    d. flare gun and flares
    e. waterproof matches

f. 200 feet parachute cord
g. bottle halizone tablets (water purification)
h. insect repellent
i. chap stick
j. knife
k. signal mirror
l. mosquito head net
m. first aid kit and manual
n. small stove or sterno fuel
o. cooking container
p. freeze-dried food
q. locator beacon with battery
r. compass
s. hatchet or axe
t. small section of variable mesh gillnet

Optional (for foot surveys)

1. "blood cell" counters (tally wackers)
2. thermometer
3. hip boots
4. firearm and ammunition
5. AWL sampling equipment (as may be required)
6. insect repellent

SURVEY TECHNIQUES

Proper aerial survey techniques which will produce the best results can be learned and improved through training, experience, and personal diligence.

Preflight Planning and Review

1. The observer should thoroughly examine the current year Yukon River Salmon Escapement operational plans. He should familiarize himself with time of peak spawning, spawning distribution by species, and index areas for each stream to be surveyed. This should include a good review of survey maps as well as escapement goals for selected streams. Such preparation gives the surveyor an overall idea of what to expect and how to prioritize surveys with respect to existing weather conditions.

2. The observer should be cognizant of distances to and from areas of planned surveys and departures should be scheduled so as to arrive at index areas during optimum times of the day (i.e., best illumination periods). He should discuss streams and index areas (i.e., map review) to be surveyed with the pilot in light of weather conditions, fuel consumption and periodic rest stops.

3. Although the pilot is required to do so, the observer should ensure a flight plan is filed with FAA and he, too, should know the basic plan actually filed. It is wise to have the pilot specifically inform FAA you will be conducting "ADF&G" surveys. Be sure the pilot gets a recent weather check for the area(s) to be surveyed. Note: Whenever

the air temperature and dew point are reported to be within one or two points of each other in a region to be surveyed, you can expect fog.

4. The observer should ensure the local staff is informed of the planned survey itinerary, including time of return. Stick to the plan. If a change is made in-flight, ensure the pilot informs FAA via radio of that change.

5. Finally, the observer needs to ensure he has survival gear, maps, and other necessary in-flight survey supplies prior to departure.

Optimum Survey Performance

1. Altitude: Cousens et al. (1982) point out that inexperienced aerial observers tend invariably to overestimate numbers of fish, and usually choose too low an altitude, thereby reducing the period of time available for enumeration of each group of fish. Generally, most surveys are flown from an altitude of 300-500 feet if terrain and weather permit. A higher altitude may be required as a safety measure if turbulence is a factor. Remember that accuracy of estimates decreases as altitude increases above 600 feet, though rough subjective estimates are possible at higher altitudes.

2. Airspeed: Survey airspeed will vary according to aircraft type and wind conditions. "The slower the better" is a good concept within reason at first glance; however, it is a dangerous one. Speedreading courses, skeet shooting, video games, etc., have shown that with practice people can do things that appear impossible to the inexperienced. Observers should learn to make and record observations at safe airspeeds. A nominal cost for training will save enormous costs of accidents. Given favorable weather conditions, Super Cub survey airspeeds are about 55-65 mph. Upon arrival at a given survey stream, it is often convenient to fly at higher airspeeds at low altitudes until fish are first encountered. Airspeed should then be reduced and the survey begun. Periodically, long stretches of a river or stream may occur in which no fish are present. On such occasions, airspeeds can be increased until fish are once again observed.

3. Wind velocity and direction: Best survey conditions exist when there is little or no wind (less than 5 mph). Windy conditions not only result in turbulent surveys but also create ripples on the water's surface which greatly reduce water visibility and increase glare. If wind is a factor it is safer to survey into a headwind than to survey with a tailwind. In addition to being safer, surveying into a headwind provides for a slower ground speed, increasing fish observability. Tailwinds make survey maneuverability difficult by "pushing" the aircraft through turns. Thus, steep turns become more hazardous as airspeed can be reduced dangerously close to stalling speed. It is best to abort a survey if tailwinds are encountered which cannot be avoided.

4. Illumination and Cloud Cover: Quality of illumination is an important consideration; surveys made late in the day at low sun angles require continual transition between sunshine and deep shade, and result in

poor estimates. The observer should time departures so as to arrive at survey areas at optimum times of the day. This is particularly true of fall surveys conducted from late September through early November. During this period of the year low sun angles may prevent penetration of sunlight into some or all portions of the stream bed (even at midday). Thus, the duration of "good illumination" periods is less on late fall days than on summer days. High overcast or cloudy conditions nearly always result in glare off the water's surface, which greatly reduces water visibility and survey accuracy. Polaroid sunglasses should always be worn when conducting aerial salmon surveys. It is wise to carry two pair of Polaroid sunglasses; one with green-tinted lenses and one with brown-tinted lenses. Depending upon the degree of illumination, amount of glare, stream bottom colorations, and coloration of spawning salmon being enumerated, one pair of glasses may provide better contrast than the other pair.

5. Position of Aircraft: To avoid glare, a survey should be flown in such a manner that the observer is between the sun and the objective. Many steep turns and crossings-over of the stream channel is required for an accurate survey of streams which meander to a great extent. It is especially important on such streams that the pilot be constantly aware of his position and ensure the observer does not duplicate sections already surveyed. The observer should concentrate on fish counts. This also applies to multiple-channel (braided) rivers, which often typify fall chum salmon spawning areas. A two-way intercom between pilot and observer is highly desirable under these circumstances. It is desirable to survey meandering streams in a series of loops. This greatly reduces the frequency of steep turns as well as shortens survey time. If the observer is in a four-place aircraft he may position himself in the back so as to have easy view from either side of the plane. Otherwise, if seated up front, it can be a tedious, long, and nauseating survey for both pilot and observer on this type of stream (more so for the observer). It is helpful to have the pilot be on the lookout for index area boundaries and so inform the observer as appropriate. Do not hesitate to instruct the pilot to recircle or fly back over an area as the need arises. A word of caution: Pilots who tend to place an aircraft in a skid to provide a better view for the observer should be avoided. A skid increases an aircraft's stall speed and is unnecessary to make accurate observations. A skid maneuver is performed by applying opposite rudder pedal and aileron simultaneously.

6. Fatigue: Fatigue has been found to reduce efficiency of both the pilot and observer. Fatigue is especially common when surveying in a Super Cub. It is not unusual for surveys to require six to eight hours of air time per day in the Yukon area. Some have continued up to 11 hours. Consequently, landing for periodic short breaks should be made to minimize fatigue. When surveying in a Super Cub, the observer should ensure his feet do not interfere with the pilot's use of the rudder pedals, as most survey pilots fly by "feel."

7. Air sickness: Dramamine, Bonine, or other non-prescription tablets may prevent air sickness. Most generally require 30 to 40 minutes

before they are effective and many result in drowsiness, which can affect overall survey accuracy. However, this may be the best prevention of air sickness for people who cannot tolerate turbulence or frequent, sudden aircraft maneuvers. Nearly all observers will experience some degree of nauseation or vertigo at one time or another if conducting numerous surveys. Following are a few suggestions which may be helpful as preventive measures:

a. Do not fly surveys on an empty stomach.
b. Do not overheat in the aircraft. Crack window or vent for fresh air.
c. Land for periodic rest breaks.
d. Do not drink liquid with high acid content (e.g., coffee, cola drinks, orange or pinneapple juice, etc.).
e. Snack on saltine crackers. Chewing gum, grapes, or raisins may also help.
f. To help overcome vertigo, ask the pilot to break off the survey and "level out" for a few minutes. Focus on the horizon or distant objects.

Each observer will, through experience, decide what works best. However, if all else fails, have a ready supply of "Motion Discomfort Containers" in a convenient location. Do not use the pilot's shirt-collar!

In-flight Observations

All survey observations should be made into a tape recorder. The major advantage of tape recorders (versus other methods of recording in-flight data) is that more detailed survey information can be recorded without disrupting fish observations. The major disadvantage is equipment failure. The solution is to carry back-up supplies (batteries, cassette tapes). The observer should be careful so as not to continue recording after a tape runs out. He should periodically play back the tape during a survey for a couple of seconds to ensure the unit is functioning. Tape recorder selection should ensure the unit is compact (easily fits in hand), has a unidirectional speaker (picks up less background engine noise), and has no "lag" when record lever is activated. A locking feature on the record-play lever will prevent accidental operation of the unit. Both the Norelco NT-IV and Dictaphone 10 have these features; the latter may no longer be available. Data to be entered on tapes for each stream surveyed include:

1. Date
2. Aircraft type
3. Pilot and observer names
4. Weather conditions (wind, cloud cover, precipitation, etc.)
5. Water clarity and visibility
6. Stream bottom coloration
7. Time survey begins and ends
8. Precise location where survey(s) begins and ends on each stream. When an index area or other landmark is passed, record that and the time, maintaining a continuous record of location, distance and time. The more landmarks which are noted, the easier it will be to apportion counts if an index area boundary should be missed while counting. It is extremely important to be aware of location as often as possible.

9. Each count or estimate of fish actually observed. Record both live and dead salmon by species. Separate surveys may be necessary.
10. Fish and spawning distribution. Note the upstream limit at which fish were last observed. Pay particular attention to fish distribution in areas of close proximity to placer mining operations (e.g., the South Fork Koyukuk and Bearpaw rivers).
11. Degree of spawning activity (before peak, peak, after peak).
12. Evidences of predation by bears, wolves, eagles, etc. Also, make bear, wolf, and moose counts for the Game Division if requested.
13. Presence of other fish species such as whitefish, grayling, char, etc.
14. Habitat-related problems, whether from natural or man-made sources. Pay particular attention to placer mining operations.
15. Any information which may have an effect on survey accuracy.
16. Overall survey rating for each stream surveyed (good, fair, poor) if possible. However, be precise; some surveys may have been good for estimating one species while poor for another, e.g., good survey for chums but too early for kings. Any comments in this regard should go in the remarks section of the escapement forms. Note: Survey conditions may also vary by stream section.

IMPROVING ACCURACY AND COMPARABILITY

1. A new observer should initially train with an experienced observer and pilot. Among the things a new observer will glean from this experience are:

   a. What a typical salmon spawning stream appears like from the air and how to identify different channel features such as pools, riffles, glides, spring areas, etc.

   b. How to identify different salmon species and "key" stream channel features which should be more intensely examined than others when surveying for a particular species.

   c. How to estimate numbers of fish when they are encountered in large concentrations.

   d. The degree to which some factors affect survey results (e.g., glare from cloud cover or inappropriate sun angles; shadows from timber; contrast between stream bottom types and salmon species be enumerated; etc.)

   e. How a survey should be flown safely and aircraft maneuverability for optimum observer visibility.

   f. How to read topographical maps and identify streams and stream index areas.

   g. How to subjectively rate an overall survey's effectiveness.

2. Practice is a key element for all surveyors. Surveyors should practice quick counts of various objects such as birds in a flock,

cars in a parking lot, biologists at a meeting, thrown beans or rice. The latter is especially helpful because of the size of the objects to the observer. Also, by mixing a few brown or red beans with the smaller white rice, one can practice estimating both. This simulates surveys where smaller numbers of king salmon are commonly encountered with larger numbers of chum salmon. Training aids can also be used, including photographs or video tapes. Ground counts made in conjunction with aerial counts in the same area(s) is a valuable training aid or for verification in small selected spawning areas. Finally, surveyors should fly streams with weirs, counting towers, or sonar and compare results. One needs to constantly check himself to keep sharp. Every shooter, every pool player, in fact, every pro knows top performance depends on regular practice. Project leaders often overlook this in the interest of economy. However, the value of air survey time could be greatly enhanced by working out training and practice programs.

3. Accuracy should improve with experience and practice will help ensure consistency in method(s) of making fish estimates is maintained. Flying replicate surveys of selected spawning areas is one of the best methods of addressing the latter issue (i.e., consistency). Thus, it is important that the same observer survey the same streams each year, if possible.

4. The observer should make notes on fish distribution which often varies by species, time of season, stream, etc. It is extremely important to know where fish are likely to migrate, stage, or spawn in order to locate them and obtain a good count on large streams.

5. The observer should count or estimate numbers of fish actually observed. Occasionally, the observer may estimate numbers of salmon (usually chum or pink salmon) based upon a large aggregation of visible redds; the fish themselves may or may not be entirely visible due to turbidity caused from spawning. However, expanded counts or educated guesses of total escapement can be recorded in the remarks section of survey forms if desired. If a surveyor is very familiar with a stream, expanded counts may be possible at times for very short distances if spawning is uniform (e.g., a small section unsurveyed due to shadows from timber).

6. An attempt should be made to obtain an actual count of individual chinook salmon. However, for other species such as pink or chum salmon, which may be present in extremely large numbers, the observer must often estimate numbers in large schools by groups of 50, 100, or 1,000 (or more) fish. To increase accuracy, estimate the number of fish in moderately size schools (100-200 fish) and then count individual fish as the aircraft circles the school.

7. Accurate counts or estimates of both live fish and carcasses are equally important, particularly in the case of chinook salmon. It takes a very high level of concentration to make separate counts for each category of fish on the same survey, particularly when large numbers of fish may be present in one category or the other. Although carcasses are generally easier to see, the observer tends to train his

eye more on counting fish in the category in which fish are most abundant. As a consequence, without a high level of concentration the category with the fewest fish tends to be underestimated. If extremely large numbers of salmon are present in a stream it is often convenient to tally both live fish and carcasses together and estimate after completing the survey the percentage of fish in each category. This same technique may also be convenient at times in estimating species composition where two or more species may be encountered during a survey. In the case of chinook salmon, it may be possible in some situations to count or estimate the number of redds (i.e., if a survey is flown well after peak spawning).

8. Timing of aerial surveys with respect to peak salmon spawning activity is extremely important. Optimum counts are normally made on streams in the Yukon River drainage during peak spawning dates (i.e., prior to major die-off). This is when a majority of fish are no longer migrating and are present on the spawning grounds. Counting is enhanced since most spawners have developed contrasting coloration and spawning generally occurs in shallow water. Spawning dates for a particular species usually do not vary greatly from year to year unless very unusual run timing or stream conditions occur. Information obtained from current year operational plans, historical records, and field station or reconnaissance surveys should confirm when peak spawning occurs. Selected streams may need to be surveyed two or three times during the season if survey conditions permit to ensure the best possible peak count for a given species is obtained. Such streams will be identified in current-year salmon escapement operational plans for the Yukon Area.

9. Surveyors should be both flexible and opportunistic. Vendors and pilots should be put "on call" during the critical peak spawning periods so that some surveys can be flown even if the good weather lasts for only part of a day. This is particularly so in the case of fall surveys. Further, it is best to fly a survey prior to peak spawning instead of waiting for improved weather or stream conditions that may never improve during the remainder of the season. This is a judgement call which generally applies when inclement weather has persisted for much of a season.

10. There are several factors (e.g., spatial and temporal distribution, body color and size) that will help in identifying salmon species in mixed species spawning populations.

    a. Chum salmon spawn throughout the Yukon River drainage with summer chum populations primarily spawning in run-off tributaries in the lower Yukon River (late July-August), including the Koyukuk and Tanana River drainages. Fall chums primarily spawn in spring-fed areas of the upper Yukon River, particularly the Porcupine and Tanana River drainage (late September-early November). Chum salmon are uniformly sized fish and spawning coloration is calico in nature, being characterized by reddish or dark streaks or bars with large pale blotches. Although the overall impression of schools of chum salmon will appear as light to dark gray fish, careful examination will usually reveal much mottling of individuals. Chum salmon usually migrate and spawn in large groups; 25 to 100 is common. Much larger groups (several hundred, plus) are often encountered in streams with good escapements. It is extremely important to examine all slough areas in large braided rivers, such as the Chandalar, Toklat, and Sheenjek, when conducting fall chum salmon surveys. Such areas typify fall chum salmon spawning habitat and are generally characterized by clear, upwelling ground water. Sloughs may vary in length from a few yards (frequently on the downstream end of gravel bars) to in excess of a mile of meanders. These are often the most tedious surveys to fly due to the extensive amount of braiding of these large rivers and consequential necessity of numerous tight circlings of the aircraft to find and examine all slough areas. It is also important to note the extent of snow and ice cover associated with fall chum salmon surveys. Such an observation helps assess the accuracy of carcass counts. Due to differences in spawn timing and distribution among salmon species in the Yukon River drainage, smaller numbers of chinook salmon will often be observed with spawning populations of summer chums while small numbers of coho salmon are sometimes observed with spawning populations of fall chums. In these instances there may be a tendency for the low number of chinook and coho salmon to go unnoticed by the observer while he is estimating the larger aggregations of chum salmon. Consequently, separate surveys may be necessary to accurately enumerate each species.

b. Chinook salmon spawn throughout the entire Yukon River drainage from mid-July through August. They are non-uniformly medium to large salmon with spawning coloration being red, providing good contrast with the stream bottom in most situations. Thus, they (like coho and sockeye salmon) are generally the easiest salmon species to see and are readily distinguishable from the smaller, more cryptic-colored summer chum or pink salmon. Chinook salmon will generally be observed in small schools (2-25). Two to ten larger, redder individuals are typical with a few smaller, darker jacks in association. The surveyor is often cued when chinook salmon will be coming into view by the presence of redds, which are generally readily visible in most chinook streams. These redds often indicate the presence of fish which would otherwise possibly go unnoticed.

c. Coho salmon generally spawn subsequent to about mid-October and in spring-fed areas typical of fall chum salmon spawners. Coho salmon are uniformly medium-sized fish and, like chinook salmon, possess a red spawning coloration. Coho salmon are easily distinguished from the more cryptic-colored fall chum salmon where they occur together. Coho salmon will generally be seen fewer in number than fall chum salmon where they occur together. It would be difficult for the aerial observer to distinguish between chinook and coho salmon, but fortunately, these two species do not spawn at the same time in the Yukon River drainage.

d. Pink salmon are uniformly small-sized salmon and spawning coloration is characterized by white to yellowish belly and side with brown botches. The dorsal area is dark. Often, white belly "flashes" may be seen by the observer. Pink salmon spawn in the lower portion of the Yukon River drainage and coincidental with summer chum and chinook salmon in some streams. Pink salmon are particularly abundant in even-numbered years and where they occur with summer chums, species differentiation can often be difficult. In some instances, separate surveys of each species may be necessary.

e. Periodic, low altitude, slow-speed "spot" checks may be necessary throughout a given survey to estimate percent species composition that can be applied to the total count of all species. Counts can also be adjusted using species composition information from weirs, towers, or ground surveys from the same stream. Such adjustments should be clearly noted on survey forms when information is transcribed at a later date. (In Norton Sound, early surveys are flown to obtain a usable count of chum salmon, which may be masked by large numbers of pink salmon during peak spawning dates.)

11. Separate surveys of each species may be necessary to improve accuracy of escapement estimates in streams where two or more species are observed, particularly when one species is much more abundant. This may also apply to surveys which may be flown late, with regard to spawning, in order to obtain good estimates of both live fish and carcasses. Further, time of spawning may differ by species in a given stream, thus requiring separate surveys.

SAFETY TIPS

1. Wear ear protection.
2. Wear seat belt and shoulder harness at all times.
3. Know the basic radio frequency(s) and how to use aircraft radio in case of emergency.
4. Assist pilot in looking for other aircraft when landing.
5. Keep an eye on the aircraft fuel supply. Although it is the pilot's responsibility for not running out of fuel, there is no excuse for having to make a forced landing due to lack of fuel.
6. Do not stand behind aircraft when engine is running. If unavoidable, protect the eyes from debris.
7. Stay away from helicopters when they are being refueled.
8. Always carry a survival pack, including a sleeping bag.
9. Wear a fire-retardant (NOMEX) flight suit. Ensure trouser cuffs are tucked up inside legs of fire-retardant suit.
10. Be sure a flight plan is filed by the pilot and that the observer notifies fellow employees of this itinerary.
11. Avoid landing on gravel bars in aircraft which have a nose gear.
12. Abort a survey if tailwinds are encountered which cannot be avoided.
13. Avoid pilots who tend to place an aircraft in a skid to provide for better view.
14. Avoid interference with the pilot's use of rudder pedals.

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