OBSERVATIONS ON THE ACCURACY OF REDD COUNTING TECHNIQUES USED IN THE COLUMBIA BASIN

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INTRODUCTION

Spawning ground surveys are one of the primary methods used to estimate the abundance of naturally spawning anadromous fish populations. Fisheries managers have also relied on these surveys to make indirect assessments of historic salmonid productivity (Horner and Bjornn 1981), production potential (U.S. v OR 1985), the quality and quantity of habitat (Matteson 1948), and as predictors of future run sizes and acceptable harvest levels (Conley 1985). Redd counts may be calibrated to convert index counts (counts from assigned indicator areas) into estimates of absolute escapement in tributaries and, through aggregation, in sub-basins (Fulton 1968, WDG 1984, Howell et al. 1985).

In the Columbia River basin, spawning ground surveys, made since the mid-1950's, have mainly been of the 'peak count' type. Peak count surveys are made once annually and are intended to coincide with, or to closely follow, the period of maximum spawning activity of a particular fish run. Usually each Columbia River sub-basin, and in some cases each tributary, is assigned a yearly survey date based on historic observation and counting procedure. The primary assumption of the surveys is that a constant percentage of the spawning population will be sampled annually.

The accuracy of spawning surveys, the assumptions inherent in their application, as well as the usefulness of the resultant

data have been considered by a number of observers (Orell 1977, Biedler and Nickelson 1980, Horner and Bjornn 1981, Ames 1984, Mundie 1984, Hartman 1985). Studies such as these have brought the utility of the typical peak count spawning ground survey procedures into question. The reliability and usefulness of spawning ground surveys have become of particular concern in the Columbia region because development there of a system-wide approach to anadromous fish management has precipitated the need for more accurate estimates of escapement in each of the major sub-basins.

The objective of this paper is to evaluate the accuracy and primary assumptions of the typical peak count spawning survey procedure used in much of the Columbia basin. The Yakima River basin will be the study area used for this evaluation.

The Yakima basin (Figure 1) was chosen for this evaluation because it is one of the few sub-basins in the Columbia watershed where several different types of spawning ground surveys have been conducted. The accuracy of single peak count surveys can be tested by comparing their results to data from survey methods considered to be more complete and reliable. Three redd count spawning survey methods will be referred to and are further described below: single annual peak count surveys, multiple total river surveys, and modeled peak count surveys.

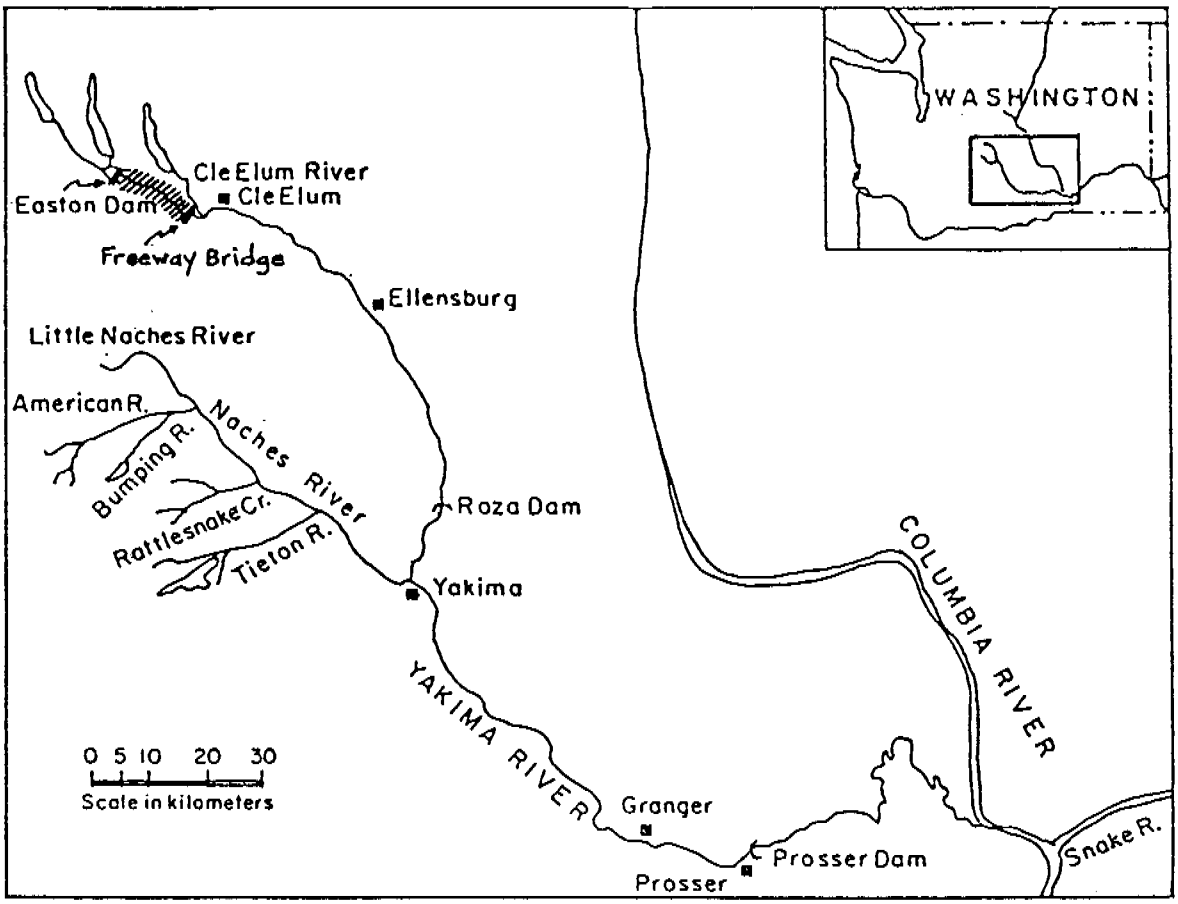

Figure 1. Map of the Yakima River Showing Easton Dam (R.M. 202) to Freeway Bridge (R.M. 191) Index Area.

The principal survey method used in the Yakima basin before 1981 was a single annual peak redd count made in several designated index areas. In redd count surveys (as opposed to fish counts), salmonid spawning nests called 'redds' are visually identified and counted. Yakima River surveys were usually made on or about September 21 (Major and Mighell 1969, Tuck 1984) and were conducted by the Washington Department of Fisheries (WDF), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and Confederated Tribes and Bands of the Yakima Indian Nation (YIN).

Multiple count total river surveys have been made in the Yakima basin since 1981. In these surveys, essentially all spawning habitat in the river is included. Counts are made throughout the spawning season, usually on a weekly basis, and as many as seven separate surveys are made on some tributaries. To avoid duplicate counts, each redd identified is marked with a flag so it will not be re-counted in subsequent surveys (Hollowed 1984). Accuracy of multiple count total river surveys in the Yakima River is substantiated by their relative agreement with adult counts made at Roza Dam during the same years (Barth 1985).

METHODS

It was not possible to compare actual single peak survey counts to multiple survey data because one-time peak surveys have not been made in the Yakima basin since 1981. It was therefore necessary to develop a model of peak spawning ground surveys that was constructed from multiple count field survey information. The study years chosen were 1981 through 1984. One of the historic index redd count areas, the upper Yakima River from Easton Dam (R.M.202) to the Freeway Bridge (R.M. 191) (Figure 1), was selected as the study area for this model. Field survey data from post 1981 multiple surveys were compiled and counts for the index study area were extracted (Hollowed 1984, Schwartzberg and Roger 1985). An interpolated count for September 21 (the historic single survey date) was then computed for each year based on the cumulative totals of redds counted both before and after the peak counting date. The interpolated count represents an estimate of redds that would have been annually recorded in surveys made on or before September 21. These modeled peak counts were then compared to the total of the redds actually counted in multiple surveys made in the index study area.

An assumption made in this model is that redds observed on the peak counting date of September 21 in any of the four years would include redds deposited earlier in the spawning period and counted in earlier surveys (September 6 in 1984's survey is the earliest). This assumption was made because of the general timing of spring chinook spawning and the approximate 40 day duration of redd visibility in the Yakima River (Tuck 1984).

RESULTS

Table 1 demonstrates the modeled relationship between single and cumulative redd counts described above. It includes a breakdown, by survey date, of 1981-1984 spring chinook redd counts in the upper Yakima River mainstem index area (Easton Dam [R.M. 202] to Freeway Bridge [R.M. 191]) and shows how counts made during the historic counting period might proportionally relate to actual counts for each year that multiple surveys were made. The relationship between estimated peak redd counts and total redds counted is also graphically illustrated for the years 1981-1984, in Figures 2 through 5, respectively.

TABLE 1. A Comparison of the Proportional Relationship Between Hypothetical Peak Index Redd Counts[1,2] and Total Index Redd Counts in the Yakima River, 1981-1984.

SURVEY DATE	1981 New Redds	1981 Cum. Total	1982 New Redds	1982 Cum. Total	1983 New Redds	1983 Cum. Total	1984 New Redds	1984 Cum. Total
9/6							32	32
9/8	3	3	10	10	10	10		
9/13							77	109
9/15					33	43		
9/16	30	33	165	175				
9/21		80[3]		228[3]		87[3]	169	278[3]
9/22	57	90			51	94		
9/23			74	249				
9/27							57	335
9/29					17	111		
9/30	67	157						
10/4							30	365
10/6					21	132		
10/7			3	252				
10/8	4	161	22	274				
10/11							4	369
10/13			1	275	3	135		
10/18			21	296				
12/7					1	136		
HYPOTHETICAL PEAK (REDDS)[3]		**80**		**228**		**87**		**278**
CUMULATIVE TOTAL (REDDS)		**161**		**296**		**136**		**369**
RELATIONSHIP OF PEAK TO TOTAL (%)		**50**		**77**		**64**		**75**

1/ Historic Index - Easton Dam (R.M. 201) to Freeway Bridge (R.M. 191) 11.0 miles.
2/ Historic Peak Count Date - 9/21.
3/ To determine the hypothetical peak, cumulative counts include an interpolated figure for 9/21 from 1981-1983. In 1984, an actual count was made on 9/21.

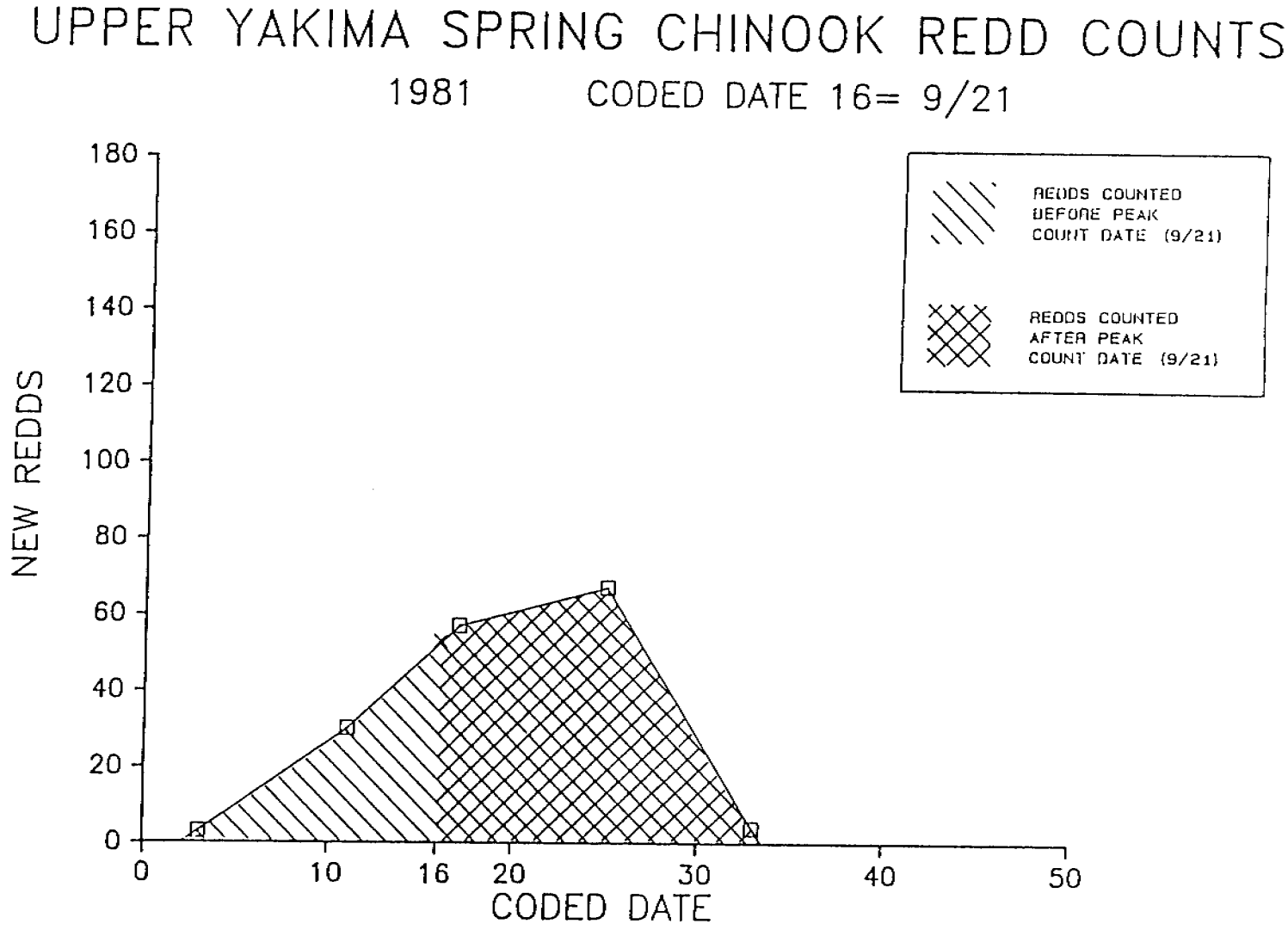

Figure 2. Graph of 1981 Upper Yakima River Index Redd Counts Showing Relationship of Redds Counted Before and After September 21. Index Boundaries are Easton Dam (R.M. 202) to Freeway Bridge (R.M. 191).

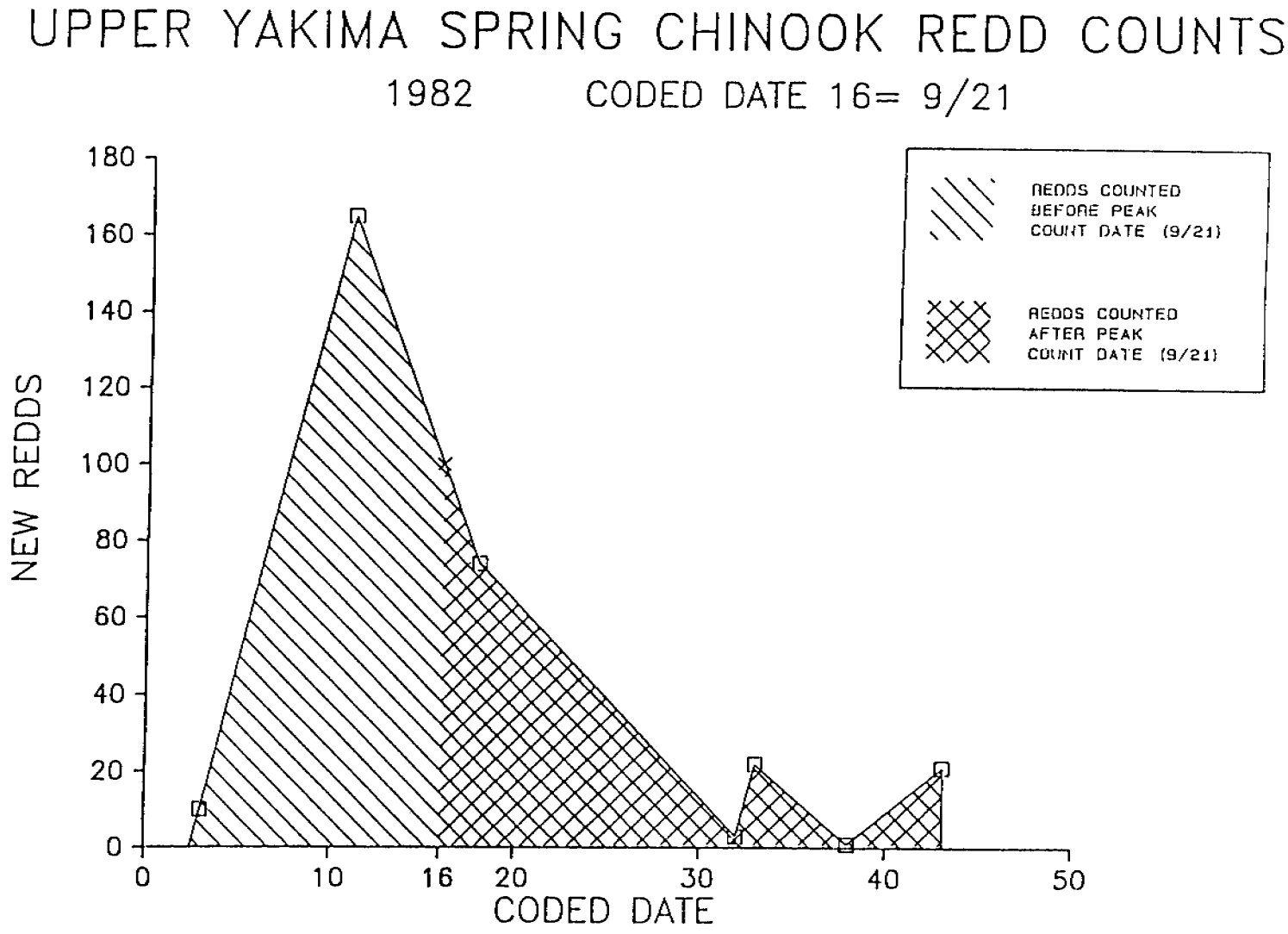

Figure 3. Graph of 1982 Upper Yakima River Index Redd Counts Showing Relationship of Redds Counted Before and After September 21. Index Boundaries are Easton Dam (R.M. 202) to Freeway Bridge (R.M. 191).

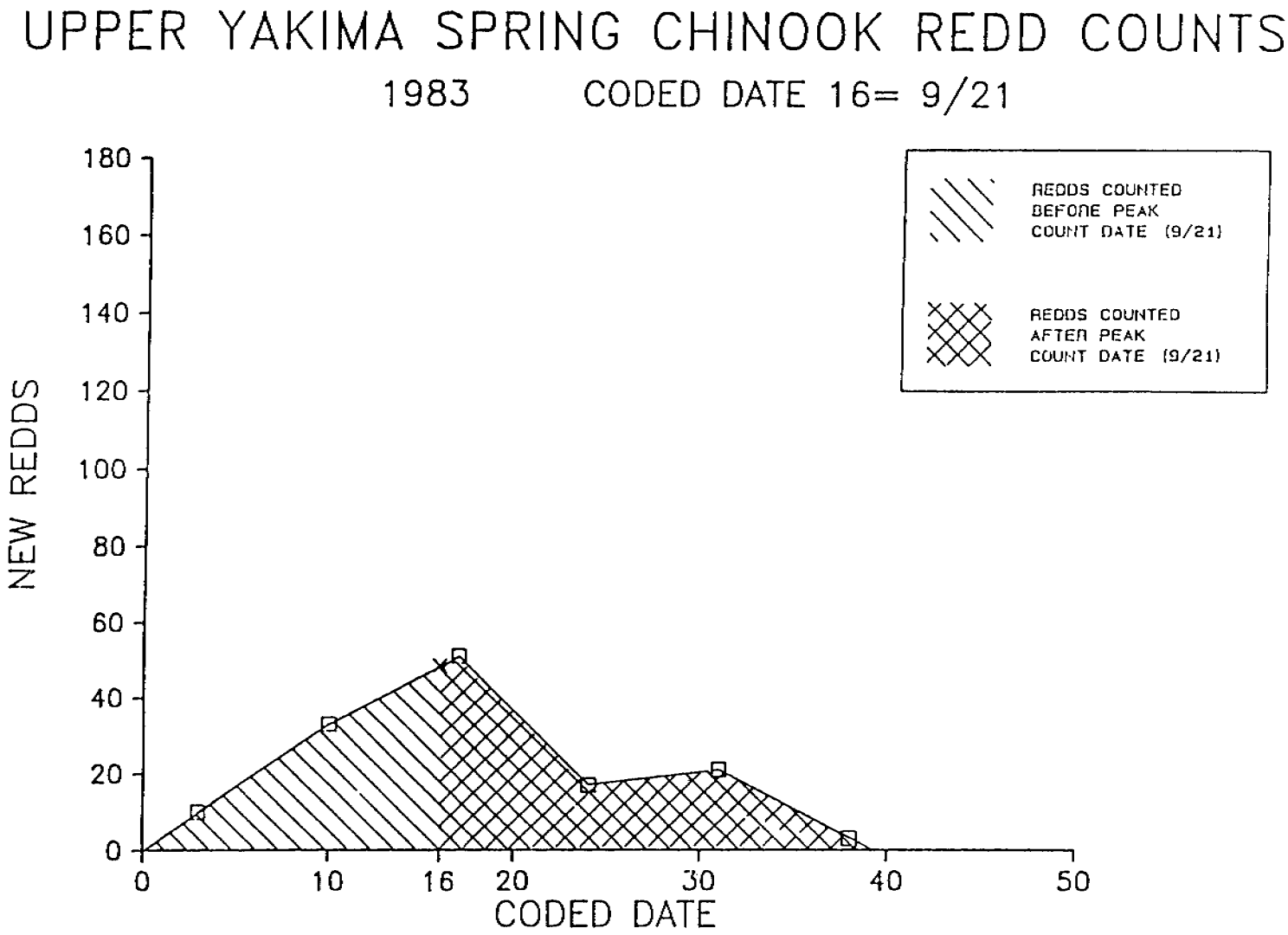

Figure 4. Graph of 1983 Upper Yakima River Index Redd Counts Showing Relationship of Redds Counted Before and After September 21. Index Boundaries are Easton Dam (R.M. 202) to Freeway Bridge (R.M. 191).

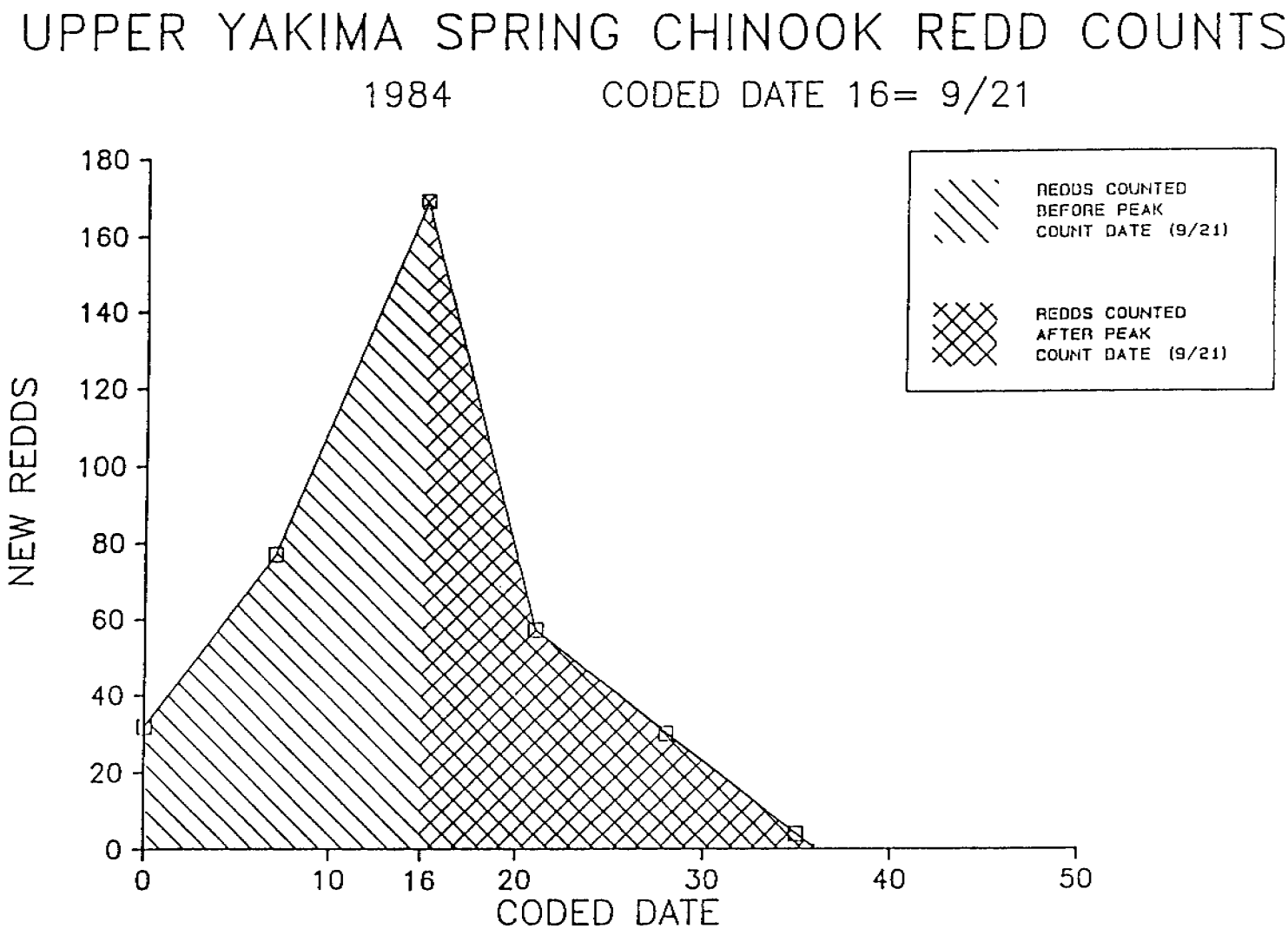

Figure 5. Graph of 1984 Upper Yakima River Index Redd Counts Showing Relationship of Redds Counted Before and After September 21. Index Boundaries are Easton Dam (R.M. 202) to Freeway Bridge (R.M. 191).

DISCUSSION

Timing of anadromous fish spawning is affected by numerous natural and human influences, and thus redd counts based on a single annual survey may often yield misleading results. The preceeding comparison illustrates this point. Hypothetical surveys that might have occurred on the predicted peak date (9/21) in two of the four years studied, 1981 and 1982, do not coincide with or even closely follow the true peak of spawning activity and redd deposition. These one-time surveys, therefore, would be misrepresentative of the proportion of fish spawning in the counting area during the years considered.

Even when one-time surveys do occur at the same relative time of spawning activity each year, Figures 2 through 5 demonstrate another source of potential error inherent in single survey methods. The use of single peak count surveys assumes that each year the curve representing spawning activity is distributed in a consistant manner about a maximum (peak) point. Data for 1981 through 1984 (Figures 2-5), however, exhibit little consistency in either the time of peak spawning from year to year or the temporal distribution of spawning. The one-time counts that might have been made during these years within the index counting area would be poor indicators of total spawner abundance. Biedler and Nickelson (1980) described similar results from comparisons of peak Oregon coastal coho fish counts with more accurate trap counts. In one study area, they found the annual peak/total count ratio to vary between .20 and .74.

The multiple survey procedure recently used for spring chinook studies in the Yakima basin is a method that accounts for annual variations in spawning timing and temporal distribution of spawning activity. Other techniques have been developed that further refine spawning ground redd count surveys. See, for instance, the work of Orell (1977), McGie (1982), Ames (1984), and Newman (1984). These studies are similar to the Yakima research in that they also incorporate serial multiple surveys. It should be noted that, by designing surveys around redd visibility in each counting area, counts need only be made as often as the length of time the oldest redd deposited remains visible. Frequent multiple surveys would have to be made initially to establish baseline data for such a system, but depending on local conditions, this process could ultimately create substantial savings over sequential weekly counts.

Although this evaluation is primarily concerned with the relationship of survey timing to spawning timing, it should be recognized that another significant factor affecting the potential accuracy of spawning ground surveys is the proportional relationship between index areas and larger, unassessed areas.

Redd counts from index areas are frequently 'expanded' by the application of numeric constants to provide estimates of total spawning and production. An extrapolation process of this type assumes that a constant ratio exists between spawning levels in

an index area and those in larger uncounted areas. The validity of this assumption will not be discussed here, although experimental results and professional opinion seem to indicate that this relationship is specific to, and varies with, streams and sub-species of fish (Biedler and Nickelson 1980, Mundie 1984). Levels of seeding may also substantially affect and change this relationship. Much habitat in the Columbia basin is under-utilized and most of the established survey areas are representative of the highest quality spawning habitat. The use of index redd counts as indices of total fish abundance may, therefore, prove inaccurate, particularly in years of significant population change. Unless entire spawning areas of a sub-basin are included in redd count surveys, as in the Yakima basin, the predictive potential of each index area must be determined for each stream. Single count errors may, of course, be compounded through the expansion process.

Other more random elements that may contribute to undependable counts are: annual variations in visibility (water clarity and in-stream cover as well as duration of redd visibility); spawner distribution; redd density and superimposition; undefined or frequent changes in some index boundaries; survey personnel availability and training; and whether surveys are conducted from the air, by boat, or on foot (Brett 1952, Willis 1964, Solazzi 1984, Hartman 1985).

In the Columbia basin, fisheries biologists are beginning to recognize the importance of a system-wide approach to management

of anadromous fish resources. This management effort will require accurate estimates of total escapement when considering such issues as: comparisons of present and historic inter and intra-basin data; estimations of population, escapement, and production potentials; and the determination of the need for and/or the performance of specific enhancement projects. If spawning surveys are to provide an important contribution to these efforts, minimum data requirements will have to be developed for each production area and standards created for collection of this key information. Sophisticated technical procedures such as biometric modeling will be of little use if data inaccuracies, inconsistancies, and incompatabilities continue to persist.

Spawning ground surveys are useful as indicators of anadromous fish population levels only when they measure a predictably consistent proportion of a spawning population. Reliance on single count methodologies may fail to account for significant, commonly occurring annual variations in adult salmonid migration and spawning patterns. To achieve greater accuracy of estimates, survey methods should be redesigned to account for these variables.

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The **Columbia River Inter-Tribal Fish Commission (CRITFC)** is the coordinating fisheries agency for the Nez Perce, Umatilla, Warm Springs, and Yakima tribes—four Columbia River tribes that **reserved** fishing rights in 1855 treaties with the United States government.

Since time immemorial, Indian people have lived and fished in the Columbia River's vast basin, and salmon and steelhead have always been central to the culture and lifestyles of these Native Americans. Anadromous fish, in addition to being the mainstay of the diet, have great religious significance. Salmon and steelhead, which in prehistoric times were dried for trading to other tribes, have also been of great economic importance.

Court decisions in the 1960s and 1970s reaffirmed not only the tribes' right to fish, but also their right to co-manage this once plentiful renewable resource. To fulfill their responsibilities as co-managers, the Nez Perce, Umatilla, Warm Springs, and Yakima tribes formed CRITFC in 1977 to be these tribes' coordinating technical arm on fisheries issues. CRITFC, through its staff of biologists, policy analysts, law enforcement officers, and other specialists, works closely with state and federal agencies, citizen groups, and other tribes to help restore the Columbia Basin's salmon and steelhead runs.

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