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MEMORANDUM (ISAB 2005-4A) July 29, 2005

TO: Melinda Eden, Chair, Northwest Power and Conservation Council

FROM: Eric J. Loudenslager, ISAB Chair

SUBJECT: ISAB Clarification on Mass Marking and Mark-Selective Fisheries

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Purpose

On July 12, 2005, the ISAB report on harvest management of Columbia River Salmon and Steelhead was summarized for the Northwest Power and Conservation Council (Council). In response to several questions raised by Council members during the ISAB presentation, this briefing paper summarizes technical issues surrounding the impacts of mass marking and mark-selective fishing.

Background – the critical importance of the Coded-Wire Tag (CWT) system

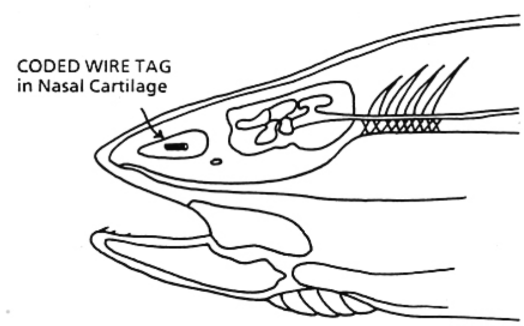

FIGURE 1.—Longitudinal section through the head of a juvenile salmonid showing the correct placement of a coded wire tag in the nasal cartilage. (After Koerner 1977.)

Coded-Wire Tag (CWT) data are central to the management of natural stocks of Chinook and coho salmon. These species are impacted by a variety of commercial and recreational fisheries at various stages of the life history throughout their migratory ranges, making efficient coastwide data collection systems essential for stock and fishery assessments. Current fishery regimes for Chinook and coho salmon are inextricably linked to the CWT system. In his introductory remarks to a CWT Workshop, convened by the Pacific Salmon Commission in June 2004, Larry Rutter from the National Marine Fisheries Service described this relationship as follows:

"Over the past thirty years or so we have constructed an elaborate and interdependent fishery management and stock assessment scheme that is heavily reliant upon data comprised of CWT recoveries. Billions of CWTs have been placed in salmon over the years, mostly in Chinook and coho salmon. And, through an elaborate,

coastwide sampling program that sifts through escapements and catch in fisheries far and wide, millions of CWTs have been recovered. Over time, we have accumulated what surely must be one of the most extensive fishery management data sets found anywhere in the world. This data set is analyzed and manipulated with increasingly complex models and algorithms; the results of these analyses provide the backbone of our system for managing Chinook and coho salmon fisheries coastwide."

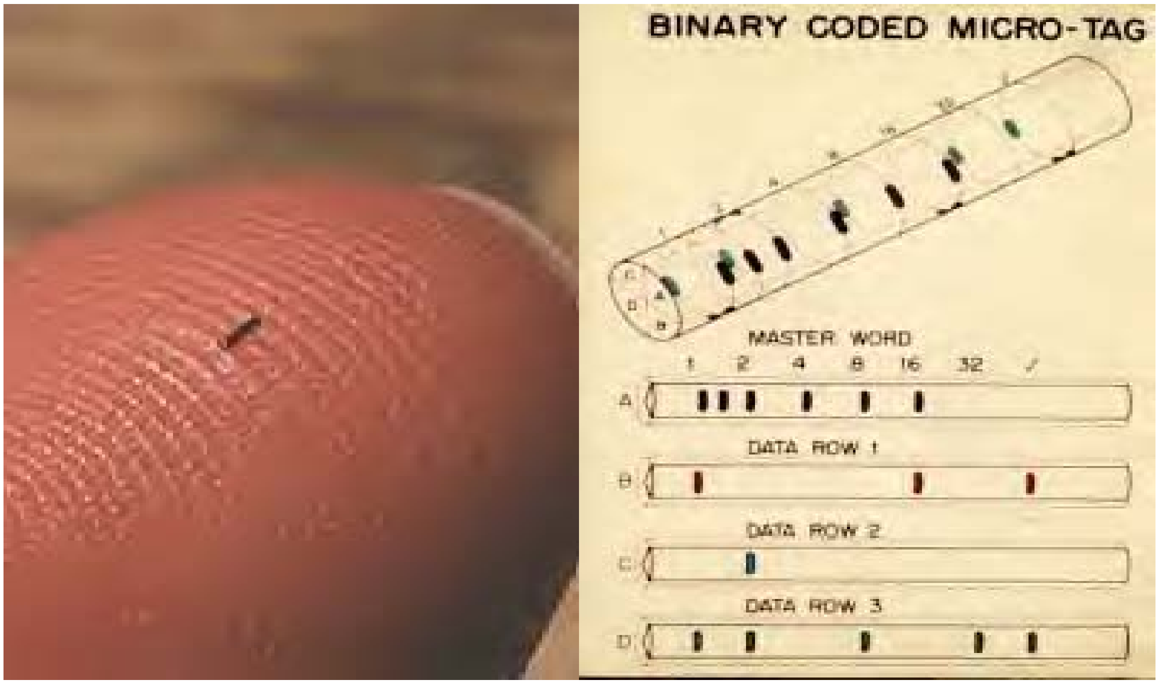

Fig 2. CWT size and coding system.

Harvest management regimes for *natural stocks* of Chinook and coho salmon are largely based upon data collected through a system of CWT releases of hatchery indicator stocks that are selected to represent specific natural stocks and are based on brood stock and rearing/release strategies.[1] Direct tagging of wild fish is rarely performed due to the costs and logistics of marking and recovering sufficient numbers of fish; hatcheries provide large concentrations of juvenile salmon for tagging and represent convenient places where mature salmon can be recovered.

Prior to the advent of mass marking and mark-selective fishing, both the hatchery indicator stocks and the natural stocks they represent were subject to the same fishing patterns (locations and exploitation rates). Consequently, estimates of fishery impacts derived from cohort reconstruction (e.g., maturation rates, fishery-age exploitation rates) of CWT hatchery indicator stock groups could be employed as surrogate measures for naturally spawning populations (i.e., the hatchery indicator and the associated natural

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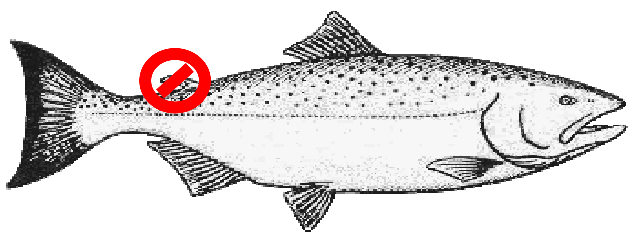
[1] Wild smolt tagging experiments in Puget Sound, southern British Columbia, and the Washington Coast support the belief that hatchery indicator and wild coho salmon stocks are subjected to similar fishing patterns. This relationship is less clear for Chinook salmon, but tagging experiments with progeny from wild and hatchery brood stock suggest that the use of indicator stocks is reasonable, but not certain.

stock were assumed to experience the same exploitation history and impacts). The advent of mark-selective fishing, however, can seriously compromise the ability to make inferences regarding fishery impacts on natural stocks from CWT data.

Mass Marking and Mark-Selective Fisheries

When survivals plummeted in the early 1990s, conservation concerns resulted in several natural stocks being listed under the Endangered Species Act (ESA). To a large degree, the data necessary to establish jeopardy standards for ESA listed stocks and monitor compliance is provided by the CWT system through the use of hatchery indicator stocks.



In fisheries that exploit complex stock mixtures, mass marking and mark-selective fishing developed as a means to increase utilization of hatchery fish within constraints established to protect natural stocks of concern. Currently, mass marking involves clipping the adipose fin to provide a visual cue that allows differential retention of marked fish while requiring unmarked fish to be released in mark-selective fisheries. While some of the unmarked fish will die as a result of stress and injury when caught and released in mark-selective fisheries, some will survive. In theory, the lower mortality suffered by natural fish enables more hatchery fish to be caught while allowing more natural fish to escape to their natal streams and increase the spawning abundance.

The United States and Canada share common issues that exert pressure for the wider application of mass marking and mark-selective fisheries in management of Chinook and coho salmon. Both countries have experienced severe fishery restrictions resulting from the need to conserve natural stocks. Both countries have large investments in hatchery infrastructure to mitigate for destruction of fish production due to damage to habitat and to provide harvest opportunity for fisheries. Both countries are suffering from intense budgetary pressures for fiscal austerity. Both countries recognize that if investment in their hatchery programs is to continue, then some means must be found to provide harvest opportunity that relies upon hatchery production to support economically and socially viable fisheries, while constraining impacts to wild salmon stocks at levels appropriate for their conservation and rebuilding.

Canada and the United States currently mass mark millions of hatchery coho salmon each year. The United States has also mass marked millions of Chinook salmon in recent years (Canada has not mass marked Chinook salmon). New technology has been developed to automate the process of mass marking and/or inserting CWTs into large numbers of hatchery-produced Chinook and coho salmon. The concept of mass marking to support mark-selective fisheries has become so appealing to some that it recently found its way into federal legislation in the United States in the 2004 appropriation bill for the U.S. Fish and Wildlife Service (USFWS) (Bowhay 2004), regardless of potential adverse consequences for the future viability of the CWT system. Under the provisions of the appropriations bill, the USFWS is directed to *" ...implement a system of mass marking of salmonid stocks, intended for harvest, that are released from Federally operated or Federally financed hatcheries including, but not limited to fish releases of coho, chinook, and steelhead species. Marked fish must have a visible mark that can be readily identified by commercial and recreational fisheries.*" As a consequence of this legislation, many millions more Chinook and coho salmon originating in the Pacific Northwest will be mass marked.

In the early 1990s, when mass marking and mark-selective fisheries were in their infancy, the Pacific Salmon Commission (PSC) found itself at the center of heated policy and technical debates over potential impacts of mass marking and mark-selective fisheries to the CWT system. Recognizing the reality that political pressures would press for continued implementation of mass marking and mark-selective fishing and that these methods could adversely affect the viability of the CWT system that has been essential to Chinook and coho salmon management for three decades, the Pacific Salmon Commission ultimately adopted an "Understanding of the PSC Concerning Mass Marking and Selective Fisheries" and established a permanent Selective Fishery Evaluation Committee (SFEC) in 1998. This committee has addressed the technical issues surrounding mass marking and mark-selective fisheries and has documented the extent and magnitude of mass marking and mark-selective fisheries in various reports (http://psc.org/publications_tech_techcommitteereport.htm#SFEC).

Issues Pertaining to Mass Marking and Mark-Selective Fisheries

Differential fishery impacts on natural fish and their hatchery indicators

Because marked hatchery fish and unmarked natural fish are no longer subject to the same patterns of exploitation under mark-selective fisheries, CWTs on hatchery indicator stocks can no longer serve as suitable surrogates to evaluate and monitor fishery impacts on natural stocks. In the presence of mass marking and mark-selective fisheries, impacts on natural stocks cannot be inferred from direct samplingbecause unmarked fish must be released. In addition, analytical results increasingly rely upon new assumptions on fishery impacts that are difficult to validate (e.g., assumed values for release and drop off mortality rates, plus mark retention and unmarked recognition error).

A concept termed Double Index Tagging (DIT) has been proposed as a means to provide data to help evaluate the impact of mark-selective fisheries on natural stocks. With DIT, two groups of fish with CWTs are released, identical in every respect except that: (a) the groups carry different CWT codes; and (b) only one of the groups is mass marked. When these fish are subjected to mark-selective fishing, fish from the unmarked DIT pair are released while fish from the marked DIT pair are retained. In mark-selective fisheries, only CWTs from the marked DIT pair can be recovered while in non-mass-selective fisheries, CWTs from both marked and unmarked DIT releases could be collected.

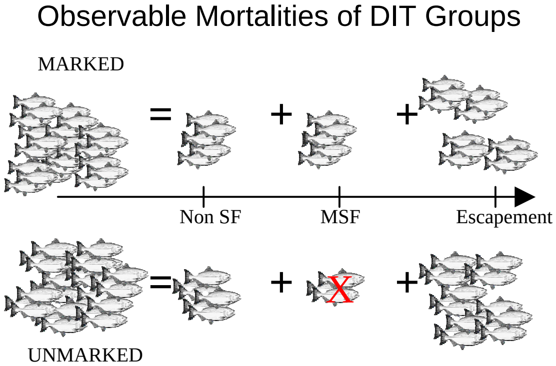


Fig 3. Observable recoveries of Double Index Tag Releases

With DIT, CWT recovery programs for fisheries and spawning escapements now must sample both marked and unmarked fish, and there must be provisions for recovering CWTs in both mark-selective and non-mark selective fisheries on the same stock. In theory, differences in recovery patterns between the DIT pairs would be used to assess the effect of mark-selective fishing.

DIT effectively doubles tagging costs for indicator stocks because now two groups of fish would need to be tagged. The number of fish in each group could not be reduced because of increased uncertainty surrounding recovery statistics.

In addition to differential patterns of fishery impacts on marked and unmarked fish, mass marking also poses an additional problem with the capacity of the CWT system to provide the data necessary to evaluate impacts of mark-selective fisheries and other fisheries. Prior to the advent of mass marking, the adipose fin clip had long been sequestered to indicate the presence of a CWT so sampling programs could efficiently identify fish with CWTs for analysis. With mass marking, the number of fish with missing adipose fins would increase many times over, so electronic tag detection (ETD) has been developed to identify fish containing a CWT. ETD equipment detects the presence of the CWT as magnetized wire. Two main types of ETD equipment are used: a hand-held wand and a tube. Wands are designed for use by field samplers who inspect fish in catches and escapements. They are passed over the head of a fish and a beep identifies the detection of metal. With a tube, the entire fish is passed through and the presence of a tag detected. Tubes are designed to be employed in high-volume installations such as hatcheries and processing plants. ETD technology must be used by trained samplers and employed throughout the migratory range of the stocks to recover the CWTs required for cohort analysis.

Fig. 4. Wand Detector and Tube Detector

Some jurisdictions that do not conduct mark-selective fisheries, however, continue to rely upon the missing adipose fin as the potential indicator of a CWT. Agreement to deploy ETD has not been reached in some areas because of increased cost of equipment and sampling plus unresolved technical or operational concerns. Consequently, since many mass-marked fish migrate to areas where there are no plans to employ ETD, CWT recoveries, particularly for unmarked DIT releases, will be incomplete, resulting in biased estimates of exploitation rates.[2] For many natural stocks, particularly, those listed under the ESA with jeopardy standards tied to exploitation rates, such bias can be problematic since accurate, unbiased estimates of exploitation rates are essential to monitor compliance and evaluate the effectiveness of fishery management measures.

Even with ETD and DIT, however, the capacity to generate the stock-age-fishery specific exploitation rates needed to preserve the viability of the CWT system as a means to estimate fishery impacts on natural stocks remains uncertain. The Selective Fishery Evaluation Committee (SFEC) established by the Pacific Salmon Commission in 1998, noted that no methods had yet been found to generate reliable estimates of mark-selective fishing impacts on unmarked fish when more than one mark-selective fishery impacts, particularly in the presence of substocks[3].

The potential impact of mass marking and mark-selective fishing is situational, depending on the biological characteristics of the stocks involved and the location and intensity of the mark-selective fishery. Under certain circumstances, mass marking and mark-selective fishing could seriously and adversely affect the future utility of the CWT system, which currently serves as the foundation for stock and fishery assessments of Chinook and coho salmon.

<u>Effectiveness of mass marking and mark selective fisheries have not been demonstrated</u>

Despite their "common sense" appeal, mass marking and mark-selective fisheries have not been shown to be an effective management tool to constrain impacts on natural stocks of Chinook and coho salmon to allowable levels. The effectiveness of mass marking and mark-selective fishing has not been evaluated prior to widespread application, and has instead, been blindly accepted as a matter of faith.

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[2] For a given stock, if mark selective fisheries occur in pre-terminal fishing areas, CWTs of unmarked DIT groups will not be recovered in non-selective fisheries that do not employ ETD; consequently, impacts of mark selective fisheries cannot be estimated by differences in exploitation patterns between marked and unmarked DIT pairs.

[3] Substocks are portions of a larger population that have different migratory patterns, for example, some coho originating in Puget Sound may reside in Puget Sound, while other portions migrate to the ocean. It is not possible to know in advance which fish will migrate to a given area. In the absence of mark-selective fisheries, the presence of substocks does not matter because marked and unmarked fish are subjected to the same fishing patterns. But when substocks are subjected to different mark-selective fishing patterns, fishery-specific impacts of mark-selective fisheries on unmarked fish cannot be readily estimated.

Management targets have not been adjusted to compensate for increased uncertainty

Statistical uncertainty surrounding CWT-based estimates has two general components, precision and bias. Precision relates to the amount of variability in the estimates, while bias concerns the accuracy of the estimates. Mass marking and mark-selective fisheries increase uncertainty and introduce additional bias in estimates of fishery impacts on unmarked fish due to the necessity to rely upon assumptions (e.g., release mortality rates) that cannot be readily validated. Current management regimes do not adjust allowable exploitation rates on natural stocks to compensate for this increased uncertainty; therefore, the risk that management objectives for natural stocks will not be achieved is increased, and the risk is an added burden on the viability of natural stocks.

Mass marking and mark-selective fishery have increased the cost of the CWT data collection system

DIT, changes in sampling requirements, requirements for ETD, and the need for sampling all fish in all fisheries and escapements greatly increases the cost of maintaining the CWT system. There is a potential for budget pressures resulting from the costs of mass marking and mark-selective fishery to reduce the amount of funding that agencies have available to operate other aspects of their program responsibilities.

The Pacific Salmon Commission's CWT Workshop

Since the early 1980's, the CWT system has served as the foundation for Chinook and coho salmon management in the Pacific Northwest and the scientific basis for the Pacific Salmon Treaty. Concerns over statistical uncertainty, the adequacy of reliance upon hatchery stock surrogates for associated natural stocks, and the impact of mass marking and mark-selective fisheries have been building in recent years. Taken together, these concerns have generated questions regarding the continuing utility of the CWT and associated sampling regimes and analytical tools that the Pacific Salmon Commission has relied upon for decades. As a result, the ability of the CWT system to continue to serve in that capacity is now very much in doubt.

As more and more of the fishing mortality on natural stocks is accounted for by non-landed catch (e.g., shaker loss, drop off, release and non-retention), the capacity of the CWT system to provide the data necessary for stock and fishery assessments is being increasingly challenged. Requirements to constrain exploitation rates on depressed natural stocks are increasing. Although reliable estimates of total mortalities are being demanded, the information systems necessary to provide the required data are deteriorating. Estimates of mortalities on natural stocks are becoming ever more dependent upon assumptions, inferences, and methods that cannot be readily validated, as well as programs for sampling and tag recovery in natural spawning populations whose accuracy is unknown. In June 2004, the Pacific Salmon Commission convened an expert panel to develop recommendations for addressing emerging concerns over the future of the CWT system. The Panel's report is scheduled for release this fall.

Other Considerations

There are other potential adverse impacts of mass marking and mark-selective fisheries, including:

a. the high costs associated with mass marking and sampling could reduce funding available to agencies to perform other program functions;
b. the implementation of fisheries that target the harvest of hatchery fish may reduce the motivation to protect the quantity and quality of habitat for production of natural fish;
c. the potential for agencies to try to increase production of hatchery fish could result in increased interactions that can reduce the survival of naturally produced fish.

Summary and Discussion

The effectiveness of mass marking and mark-selective fisheries as a management tool to constrain impacts on natural stocks to levels that effectively conserve natural populations has not been operationally demonstrated. Instead, that effectiveness in general has been accepted blindly. This change in management effectiveness is completely contrary to the management successes evident during the 1980s when coded-wire tag analyses provided reliable information for the coastwide management and assessment of coho and Chinook salmon populations.

Mass marking and mark-selective fisheries increase uncertainty and bias in the estimates of fishery impacts on natural stocks. Increased uncertainty resulting from different fishing pressures on hatchery and natural stocks, coupled with less than complete coverage of electronic tag detection throughout the migratory ranges of stocks, can substantially reduce the ability to monitor and evaluate fishery impacts on natural stocks. While these problems will exist to some extent in the presence of any mass marking and mark-selective fishery, their severity will vary among different salmon stocks, depending on the location, timing, and intensity of the mark-selective fishery.

Increased costs of implementing mass marking and mark-selective fisheries can adversely affect the ability of agencies to fulfill other responsibilities. In some quarters, there is concern that reliance on mass marking and mark-selective fisheries to sustain fisheries can lead to reduced protection of habitat and survival rates of natural fish. If hatchery production is increased to support mark-selective fishery, there are additional concerns that the accompanying increases in hatchery-wild interactions (competition, interbreeding) will adversely affect the future viability of natural stocks.

The issues associated with mass-marking and mass-mark selective fisheries are technical in nature and can be difficult for the public to appreciate; i.e., what could be wrong with selectively removing hatchery fish while reducing harvest impacts on naturally produced salmon that require increased conservation actions? What seems very logical in words, however, does not guarantee that the desired outcome will be reached. Fundamentally, mass marking and mark-selective fishing together represent a trade-off from what we can now measure and assess versus what we hope will be the case based on largely untested assumptions. The issue is further complicated because the level of concern over mass marking is dependent upon the application and magnitude of the mark-selective fishery. Even though a small, localized, terminal mark-selective fishery will likely have minimal increase in uncertainty, the scale of mass marking being conducted is not consistent with a plan for limited use of mark-selective fishing. Large-scale mass marking and mark-selective fisheries will substantially compromise the technical bases that have been established to assess and manage Chinook and coho salmon. In the presence of mass making and mark selective fisheries, how would an agency assess the role of harvest in the continued decline in abundance of a listed ESU? Will it be adequate to assume that 1) unvalidated values for the incidental mortality rates (e.g., release mortality rates) are accurate and known without error, 2) the incidence of multiple catch-and-release events is inconsequential, and 3) the physiological impact of multiple catch-and-release on reproductive potential of spawning fish is negligible? Will reduced levels of harvest impacts to natural stocks be assumed and risks ignored?

Although technical advisors working on CWT, mass-marking, and mark-selective fisheries have identified these concerns for several years now, the mass marking proceeds, and the benefit of mark-selective fisheries seems broadly accepted without thorough evaluation. These benefits may be realized in the end, but they have not been demonstrated to date.

Accurate, unbiased data are essential to decision-making and cooperative management approaches to conserve naturally spawning stocks of Chinook and coho salmon. In the 1970s and early 1980s, management actions to address declining Chinook salmon spawning escapements were frequently delayed because of uncertainty in the data and the lack of "proof" that particular user groups were contributing to a problem. Very few groups would have believed that total exploitation rates on Chinook salmon exceeded 80% and that many groups contributed to this over-fishing. Reliable CWT programs produced the "hard evidence" that allowed managers coastwide to resolve these issues and ultimately to agree on a coastwide management plan for rebuilding depressed populations of Chinook salmon in the Pacific Salmon Treaty.

In this period where stock rebuilding is given priority, increased uncertainty in outcomes should be explicitly accounted for in fishery regimes, management objectives, and assessment standards. Furthermore, technical debates over CWT data must NOT overshadow the three points noted previously under "Other Considerations." As the ISAB explained in their Harvest Report, harvest is only one component of the impacts imposed on natural populations throughout their life cycle. If the issues associated with the other three H's are ignored due to an assumption that mass marking and mark-selective fisheries will protect naturally spawning stocks, then natural populations may not recover. In addition, if mass marking and mark-selective fisheries continue to be promoted without adequate scientific evaluation, costs for assessments will have been substantially increased, critical information lost, and additional costs imposed on other users groups without obtaining the desired benefits. Resolution of the data concerns merits investment in studies to assess the validity of key assumptions involved in mass marking and mark-selective fishing. These issues will be further developed in the report of the Pacific Salmon Commission's Expert Panel report due in the fall, 2005.