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# Implications of Legislative Directives to Mass Mark

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## Introduction

State and federal legislation in the U.S. has directed that hatchery coho and chinook[1] salmon be mass marked to enhance prospects for mark-selective fisheries and, to some extent, improve the ability to discriminate between hatchery and natural origin spawners in the escapement. These legislative directives will have coast wide effects on the coded-wire-tag (CWT) program.

The focus of this paper is to summarize those impacts, focusing on cost implications for operation of the CWT program, including conversion to electronic tag detection sampling programs, double index tag (DIT), and data analysis/reporting. The final presentation contrasts the program operating costs with and without the mass marking directives.

No attempt is made herein to quantify or characterize the positive effects of these legislative mandates, i.e., the benefits resulting from improved access to hatchery fish for some fisheries.

## Pacific Salmon Treaty CWT Program

The memorandum of understanding that accompanied the 1985 Pacific Salmon Treaty obligated the Parties to maintain a coded-wire tagging and recovery program designed to provide statistically reliable data for stock assessments and fishery evaluation. This goal and obligation subsequently has served as the guide for the development and operation of the coast wide CWT program.

In 1985, the chinook and coho technical committees of the Pacific Salmon Commission (PSC) initiated the Chinook and Coho Indicator Stock programs to monitor impacts of fishery regimes under the Pacific Salmon Treaty (PST) on specific populations. Stocks were selected that were representative of particular basins or regions of production. The intent was to utilize indicator stocks to monitor and evaluate the effectiveness of the management measures prescribed by the PSC. Several criteria were considered when stocks were initially selected for inclusion in the program (Morishima, 1986):

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[1] Mass marking legislative directives: 1997 Washington State Senate Bill for Coho, 1998 Washington State Senate Bill 6264 for chinook, and 2003 and 2004 United States Congress Department of Interior's Appropriations Bill language for Pacific salmon released from federally operated or federally financed hatchery facilities.

1) In aggregate, indicator stocks should represent all major regions and racial types that are of interest to the PSC.
2) The stock must be sufficiently abundant and easily tagged so that the agency responsible can make a long-term commitment for tagging the stock;
3) The agency responsible for tagging the stock must make a commitment to sample and estimate the escapement of tagged fish and report the results to the Pacific States Marine Fisheries Commission (PSMFC) in a timely manner;
4) Reliable estimates of catch and escapement must be available.

The indicator stocks selected for monitoring changes in fishery harvest rates and stock exploitation rates are summarized in Table 1. The indicator stock program reflects a long term commitment by the associated management entities for the tagging and sampling of these stocks. All of these indicator stocks now have long term data sets that are proving invaluable for understanding biological characteristics of different populations and monitoring trends in fishery impacts.

For three decades, the CWT program has provided an efficient and cost effective method for stock-specific assessment. Useful information could be obtained by tagging a small portion of hatchery releases, sampling fisheries coastwide for CWTs, and reporting both releases and recoveries to centralized databases. To facilitate sampling and tag recovery, the adipose fin clip was sequestered as a visual cue to indicate the presence of a CWT.

In the late 1990's, legislative directives began to require mass marking of coho and chinook hatchery production in the Northwest. The mark of choice was the adipose fin clip because of its ease of application and minimal mortality loss. The huge increases in the number of fish with clipped adipose fins appearing in the catches and escapements meant that visual sampling was no longer practical. Hence, sampling programs must examine all fish and use electronic tag detection equipment to recover CWTs.

Prior to the advent of significant mark-selective fisheries, fishery managers assumed that the unmarked fish were subjected to the same exploitation patterns as their associated CWT release groups. This permitted managers to use recoveries of CWT release groups to make inferences on associated unmarked hatchery and wild fish. Under mark-selective fisheries, marked fish are retained while unmarked fish are released. Consequently, the exploitation rates of coded wire tagged fish with adipose fin clips would no longer be representative of the exploitation rates of unmarked fish.

The vast majority of coho and chinook harvest management regimes are directed at conservation needs for wild stocks. To obtain information on fishery impacts on these stocks under mark-selective fisheries, the Ad-Hoc Selective Fishery Evaluation Committee (ASFEC) developed the concept of Double Index tagging (DIT). DIT requires paired groups of coded-wire tagged fish from the same brood stock and year to be reared and released under identical conditions. Adipose fins are removed from one group of fish (marked), but not the other (unmarked). The unmarked component of the DIT pair is assumed to be exploited in the same manner as the un-marked fish that the

indicator stock is intended to represent. For indicator stocks subject to mark-selective fishing, the differential recoveries between the DIT pairs allows for the estimation of fishing mortality attributable to mark-selective fisheries. However, the capability of assigning mortality to specific fisheries and/or age classes when there are multiple mark selective fisheries remains problematic.

Table 1 – Exploitation Rate Indicator Stocks

| Coho | Chinook |
|---|---|
| Big Qualicum River | Alaska Spring |
| Chilliwack River | Kitsumkalum |
| Goldstream River * | Robertson Creek |
| Inch Creek | Quinsam |
| Quinsam River | Puntledge |
| Coldwater River * | Big Qualicum |
| Robertson Creek | Cowichan |
| Nooksack River * | Chilliwack * |
| Skagit River * | Skagit Spring Yearling * |
| Skykomish River * | Nooksack Spring Yearling * |
| Green River * | South Puget Sound Fall Yearling |
| Puyallup River * | South Puget Sound Fall Fingerling * |
| Quilcene River * | George Adams Fall Fingerling * |
| Quilcene Bay Pens * | Samish Fall Fingerling * |
| George Adams * | Squaxin Pens Fall Yearling |
| Elwha River * | Hoko Fall Fingerling |
| Solduc River * | Elwha Fall Fingerling |
| Queets River * | White River Spring Yearling |
| Quinault River * | Queets Fall Fingerling |
| Satsop * | Sooes Fall Fingerling |
| Forks Creek * | Cowlitz Tule |
| Lewis River * | Spring Creek Tule |
| Tanner Creek (Lower Columbia) * | Columbia Lower River Hatchery |
| Sandy * | Lewis River Wild * |
| Tanner Creek (Umatilla R.) * | Columbia Upriver Brights |
| Tanner Creek (Yakima R.) * | Hanford Wild |
| Nehalem River * | Lyons Ferry Columbia River Summers |
| Salmon River (Oregon) * | Willamette Spring * |
| Rock Creek * | Salmon River |
| Rogue River * | |

* Double Index Tag (DIT) groups

An overview of how changes in the CWT program associated with marking and recovery efforts follows:

***a) Tagging and Marking Costs***

Twenty-nine chinook and thirty coho indicator stocks have been maintained to monitor fishery impacts on chinook and coho stocks. The PSC Technical Committees have recommended that CWT release groups be no smaller than 30,000 for coho and 200,000 for chinook.

With mass marking and DIT groups, the number of fish to be tagged for these indicator stocks would have to be doubled. However, costs of increased tagging alone would not

reflect potential consequences of mass marking. It may not be feasible to maintain some indicator stock programs that involve either tagging wild smolts or collecting wild broodstock and rearing progeny in hatchery facilities prior to release. For some indicator stocks, especially the wild stock indicators, the increased minimum tagging levels associated with the DIT method may exceed the capability of the brood stock program to fulfill (stocks without asterisks in Table 1).

In addition to the double index tagging of indicator stocks, all hatchery production except the unmarked DIT releases and fish that are produced to rebuild or supplement wild production, must now be marked. This will require mass marking of many million more coho and chinook.

The number of fish that would be mass marked and associated costs is depicted by region in Table 2.

Table 2 – Mass Marking and Double Index Tagging [a] Costs [b]

| Region | Species | Type of Activity | Production Level [a, c] | Application Cost / 1000 [d] | Total |
|---|---|---|---|---|---|
| Southern British Columbia | Coho | Mass Mark | 9,100,000 | $26 | $236,600 |
| | | DIT | 254,900 | $130 | $33,100 |
| | Chinook | Mass Mark | --- | $26 | --- |
| | | DIT | 197,600 | $130 | $25,700 |
| Puget Sound | Coho | Mass Mark | 12,510,000 | $26 | $325,300 |
| | | DIT | 367,300 | $130 | $47,700 |
| | Chinook | Mass Mark | 33,000,000 | $26 | $858,000 |
| | | DIT | 1,428,800 | $130 | $185,700 |
| Washington Coast | Coho | Mass Mark | 7,100,000 | $26 | $184,600 |
| | | DIT | 289,100 | $130 | $37,600 |
| | Chinook | Mass Mark | 4,450,000 | $26 | $115,700 |
| | | DIT | 400,000 | $130 | $52,000 |
| Columbia River | Coho | Mass Mark | 18,300,000 | $26 | $475,800 |
| | | DIT | 201,600 | $130 | $26,200 |
| | Chinook | Mass Mark | 81,024,000 | $26 | $2,106,600 |
| | | DIT | 244,500 | $130 | $31,800 |
| Oregon Coast | Coho | Mass Mark | 1,300,000 | $26 | $33,800 |
| | | DIT | 107,400 | $130 | $14,000 |
| | Chinook | Mass Mark | --- | $26 | --- |
| | | DIT | --- | $130 | --- |
| | | | | Subtotal | $4,790,200 |
| Capital costs for additional tagging and marking trailers [d] | | | | | $11,954,000 |
| | | | | Grand Total | $16,744,200 |

[a] DIT levels reported are unmarked groups only.

[b] Estimates not included for all areas potentially implicated by mass marking mandates, e.g., California and Idaho.

[c] Source SFEC 2002, NWIFC 2004, and USFWS 2004.

[d] Source for marking trailer application cost ODFW 2002. Source for automatic tagging trailer application cost Mark Kimbel, WDFW, personal communication.

[e] Source of capital costs David Knutson, Northwest Marine Technologies personal contact and Olson 2000.

The initial additive cost for mass marking and DIT groups is $16,744,200. This cost is broken down into application and equipment costs. Application costs reflect the increase in annual operating costs involved to mass mark previously unmarked hatchery production and tagging the unmarked portion of the DIT groups. These costs cover CWTs, labor for applying the tags and marks, as well as trailer maintenance and transport to and from facilities. The application cost is a function of applying the rate of cost for marking trailers ($26/1000) or tagging trailers ($130/1000) to the corresponding hatchery production intended for mass marking or tagging by region.

The equipment costs reflect one time capital costs to purchase the additional trailer capacity required to mark and tag this additional volume of hatchery production. These are expenditures that the affected management entities have, or anticipate will be, incurred to tag and mark this volume of hatchery production. Collectively, 17 manual and 12 automatic trailers have or will be added to the existing trailer fleet (Olson 2000, David Knutson Northwest Marine Technology, personal contact). The costs of the new generation of trailers are: manual marking $80,000, manual tagging $200,000, and automatic tagging $835,000. The long term maintenance cost for these new automatic trailers is unknown; however, the initial fleet trailers have exhibited a life span of 20 years.

***b) Sampling and CWT Processing Costs***

Mass marking hatchery production has necessitated a change in the sampling programs and protocols within the migratory range of this production. To maintain the viability of the CWT system as a management tool, the PSC recommended that electronic detection be used to identify fish with CWTs. For coho, the transition to electronic tag detection is complete within Oregon, Washington, and southern British Columbia. The sampling program for northern California requires modification to complete coverage for the Oregon Coast DIT groups. For chinook, regional implementation was initiated in 2001, with the effective coverage range similar to what has been achieved for the southern coho stocks. Additional adjustments in the sampling programs and protocols are required for central and northern British Columbia and southeast Alaska to complete the coverage throughout the migratory range of the DIT groups and mass marked chinook production.

Costs of sampling and processing heads to recover CWTs are presented separately in Tables 3 and 4.

The electronic sampling cost for southern British Columbia and the states of Washington and Oregon is estimated at $7,307,700. Conversion to electronic tag detection sampling increased labor costs and required the purchase of new equipment. Actual sampling time increased as the presence of mass marked fish and DIT groups requires both marked and unmarked catch to be sampled for CWTs. The utilization of DIT groups also requires that hatchery rack returns and adjacent spawning areas be electronically sampled to ensure full CWT recovery. The increased sampling effort and equipment maintenance associated with this transition to electronic sampling increased the annual operating costs for the sampling programs by $152,900 (Table 3).

Electronic sampling requires that all processing plants, hatcheries with DIT groups, and fishery/port samplers be outfitted with electronic tag detection equipment. The cost of the new electronic tag detection equipment is significant with the hand wands priced at $7,300 and the sampling tubes at $29,700. Adequate backup equipment also must be kept available to avoid potential gaps in sampling coverage during the sampling season. Electronic equipment costs reflect one time capital expenditures for hand wands and sampling tubes by the various management entities to establish the initial program. An additional cost not reflected in Table 3 is associated with the processing facilities where space has had to be created for installment of the CWT sampling tubes and diversion gates within the processing lines. These were not simple or minor modifications at some facilities.

Table 3 – Additive Electronic Sampling Costs

| Increased Costs | Southern British Columbia | Washington State | Oregon State | Total |
|---|---|---|---|---|
| Fishery/Port Sampling [a] | $136,300 | $230,000 | $158,000 | $524,300 |
| Hatchery Rack and Spawning Ground Sampling [b] | $150,000 | $950,000 | $450,000 | $1,550,000 |
| Equipment Maintenance [c] | $20,400 | $34,500 | $23,700 | $78,600 |
| | | | sampling sub-total | $2,152,900 |
| Electronic Equipment [d] | $1,332,800 | $2,330,000 | $1,492,000 | $5,154,800 |
| | | | Grand Total | $7,307,700 |

[a] Source for British Columbia provided by Doug Harriet, Canadian Department of Fisheries and Oceans (DFO), personal communication, State of Washington State provided by Doug Milward, Washington Department of Fish and Wildlife (WDFW), personal communication, State of Oregon taken from Olson 2000.

[b] Cost estimates generated by assumption of $50,000 for labor to conduct sampling per indicator stock.

c Annual repair and maintenance cost rate estimated at 15% by WDFW (SFEC 2004).

[d] Source for British Columbia provided by Doug Harriet, DFO, personal communication, States of Washington and Oregon taken from Olson 2000.

The processing cost of the CWT program increases with the conversion to DIT groups as the DIT method requires at least twice the number of CWT releases than utilized by the single indicator tag group method. For purposes of this analysis, the additive cost of mass marking to the processing costs is assumed to be the cost to decode the tag recoveries from the unmarked DIT groups (Table 4). This estimate was generated by applying the average cost to decode CWTs to the expected proportion of CWTs from the unmarked DIT group releases that would be recovered. Based on the recent average tag recovery rates from selected indicator stocks, the additional increase to the annual cost for processing CWTs is estimated at $384,700.

Table 4 – Additive CWT Processing Costs

| Species | DIT Unmarked Releases | Average CWT Recovery Rate [a] | Decoding Cost/Head [b] | Total Processing Cost |
|---|---|---|---|---|
| Coho | 1,220,300 | .024914 | $11 | $334,400 |
| Chinook | 2,270,900 | .001615 | $11 | $40,300 |
| | | | Grand Total | $384,700 |

[a] CWT recovery rate for coho was determined by average tag recovery rate observed for brood years 1997-1999 for Green, Quinault, Cowlitz, and Skagit indicator stocks. CWT recovery rate for chinook was determined by average recovery rate observed for brood years 1995-1997 for Cowlitz, Nisqually, Queets, Samish, and Stillaguamish indicator stocks.

[b] Average estimated decoding cost for CWT processing.

Although not included in the calculation of Table 3 or 4, mass marking also has a direct cost implication to the visual sampling programs still in place in Northern California, North/Central British Columbia, and Southeast Alaska. The influx of marked fish without CWTs resulting from mass marking has and will continue to increase the sampling time and costs for these programs, as more heads will be collected and process for CWT decoding. The proposed mass marking levels will significantly increase the amount of marked fish in these areas. The sampling program costs for these areas are based on the total number of heads submitted, not just those that actually contain a CWT. Consequently, mass marking is affecting their sampling and processing costs, as well as data quality.

***c) Data Analysis and Reporting Costs***

Currently, the CWT program is the only tool available to estimate and monitor coast wide impacts on individual stocks of natural fish. The ability to use CWT data to estimate age and fishery-specific exploitation rates is critical to implementing both the 1999 chinook agreement and the 2002 coho agreement. Modifications brought on by mass marking will require the development of new analytical methods and tools. However, this represents an ongoing effort and the extent of the problems presented by mass marking and mark-selective fisheries has yet to be fully defined.

The initial costs of DIT releases and mark marking on data analysis and reporting costs are presented in Table 5.

Table 5 - Additive Data Analysis and Reporting Costs

| Activity | Cost |
|---|---|
| Data Analysis | |
| - Analytical Tools [a] | $320,000 |
| - Biometric Support | $510,000 |
| Subtotal | $830,000 |
| Reporting | $225,000 |
| Grand Total | $1,055,000 |

[a] Project proposal total for modifying the PSC Coho Model submitted to the Southern Fund Committee.

The costs for additional data analysis needs were broken down into the development of new analytical tools and increased biometric support. Establishment of mark-selective fisheries requires the modification of existing analytical tools to account for the differential impacts on marked and unmarked stocks. The initial estimate for upgrading the existing fishery impact assessment model for coho to accommodate these changes is $320,000 and reflects a capital expenditure. Future costs will be incurred as this new harvest strategy expands in application, creating the potential need for new algorithms to address such issues as mixed bag retention. Increased utilization of this new harvest strategy also will increase the need for additional research to refine other estimates regarding the fishery such as release mortality. The additional staff support required to address these issues is estimated at one full time staff position per regional jurisdictions, including the regional tribal groups. This assumption translates to 6 staff positions with an average salary/benefit of $85,000 for a total increase of $510,000 in annual operating costs.

The reporting cost associated with the CWT program is reflected by the operation of the regional mark information system administered by the PSMFC. This data base contains the CWT information for Alaska, Washington, Oregon, California, and British Columbia. Data reporting formats and programs have been modified as part of the annual operations to accommodate information relating to DIT releases and recoveries. The additional cost is associated with the increased reporting required from mass marking, DIT releases, and selective fisheries from individual management entities. Initial requests for reporting cost increases relative to the latest mass marking proposals range from $25,000 to $50,000 per regional jurisdiction in the Pacific Northwest (USFWS 2004). The estimate for increased reporting is the midpoint of this range applied to six regional jurisdictions involved for a total increase of $225,000 in annual operating costs.

Mark-selective fisheries add another cost implication to data analysis and management not captured in Table 5, regarding how to compensate for the increased uncertainty and risk. The initial analysis of coho DIT group data yielded mixed results on the ability to measure differential impacts on stock specific DIT groups (NWFRB 2003). There is uncertainty also on the accuracy in which impacts can be determined with the inclusion of multiple mark-selective fisheries or with the involvement of multiple year classes such as with chinook. Still, the application of this new management strategy is increasing in number and scale. If precautionary steps are taken where more conservative management targets are established to lower risk to the resource or insure allowable harvest levels are not exceeded, then this "buffering" represents a cost in terms of foregone harvest opportunity. It is uncertain whether this future cost will be borne strictly by the fisheries employing the new harvest strategy or shared among all fisheries and jurisdictions. This issue will become more prominent as these fisheries represent a greater proportion of the total exploitation rate for a stock.

**Summary**

Implementation of mass marking and mark-selective fisheries has and continues to require significant modifications to the CWT program. The challenges posed by this new harvest strategy to the coast wide CWT program must be addressed. Otherwise, every

management entity risks jeopardizing the integrity of the CWT program, which means the potential loss of key analytical capabilities, comprehensive indicator stocks coverage, and valued long-term data sets.

Conversion to electronic tag detection and DIT group coverage has resulted in significant changes and costs. All three components of the CWT program (tagging/marking, sampling/CWT processing, and data analysis/reporting) have incurred additional costs (Table 6). For comparison, an estimated core CWT program cost is provided. This reflects costs associated with all three components of the CWT program for operating at the minimal tagging levels for all the identified indicator stocks.

Table 6 – Comparison of Core Program Costs to the Additive Costs of DIT and Mass Marking

| Program | Tagging /Marking Component | | Sampling/CWT Processing Component | | Data Analysis/Reporting Component | | Total (million) |
|---|---|---|---|---|---|---|---|
| | Tagging / Marking | Trailer Fleet | Electronic Sampling | CWT Processing | Data Analysis | Reporting | |
| Core CWT | $871,000 | $2,000,000 | -- | $349,600 | $1,020,000 | $493,800 | $4.7 |
| DIT/Mass Marking | $4,790,200 | $11,954,000 | $7,307,700 | $384,700 | $830,000 | $225,000 | $25.5 |
| | | | | | | Grand Total | $30.2 |

The DIT and mass marking costs estimated for the CWT program actually represent only the transition costs, primarily for coho, for southern British Columbia and the States of Washington and Oregon. However, the costs associated with these modifications are more than 5 times the cost of the core CWT program (Table 6). In addition, further modifications are required in Northern California, North/Central British Columbia, and Alaska to complete the transition for coho and chinook. Conservatively completing these modifications could represent an additional $7.4 million based on costs already observed.

Additional funding has been available to facilitate the initial transition to DIT and mass marking. Most notably, these funds have covered the considerable capital expenses of securing the necessary trailers and electronic sampling equipment, which represents two-thirds of the additional costs at $17.4 million. The additional impact to the annual operating cost also should not be overlooked. These costs were estimated at $8.1 million. The continuation of additional funding will be essential to completing the full transition to electronic sampling and DIT group coverage.

The costs of implementing mass marking and mark-selective fisheries are beyond the capacity of the management entities existing budgets. Assessments by technical staff have concluded that the existing sampling programs will require an infusion of capital to maintain electronic sampling capability to adhere to the new sampling protocols, even with current fishery levels (SFEC 2003). In the current budget climate, without an infusion of new monies to address mass marking and mark-selective fishery implementation costs, affected management entities will have to reprioritize within their fixed budgets. This could result in reducing research, sampling, enforcement, or fishery

management programs, or even reducing hatchery production itself to offset these new costs.

In conclusion, mass marking and mark-selective fisheries have become a permanent part of the overall enhancement and management effort directed at Pacific salmon. With this recognition, there needs to be a coast wide effort to coordinate the assessment and monitoring of impacts from these fisheries and marking activities. The development of analytical methods and tools should occur in conjunction with the application of this new harvest strategy. Standardization of monitoring, data recording, and impact assessment needs to occur. The uncertainty interjected into the management process by mass marking and mark-selective fisheries should be quantified and accounted for, to minimize the risk to the salmon resource that the CWT program was originally developed to protect.

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