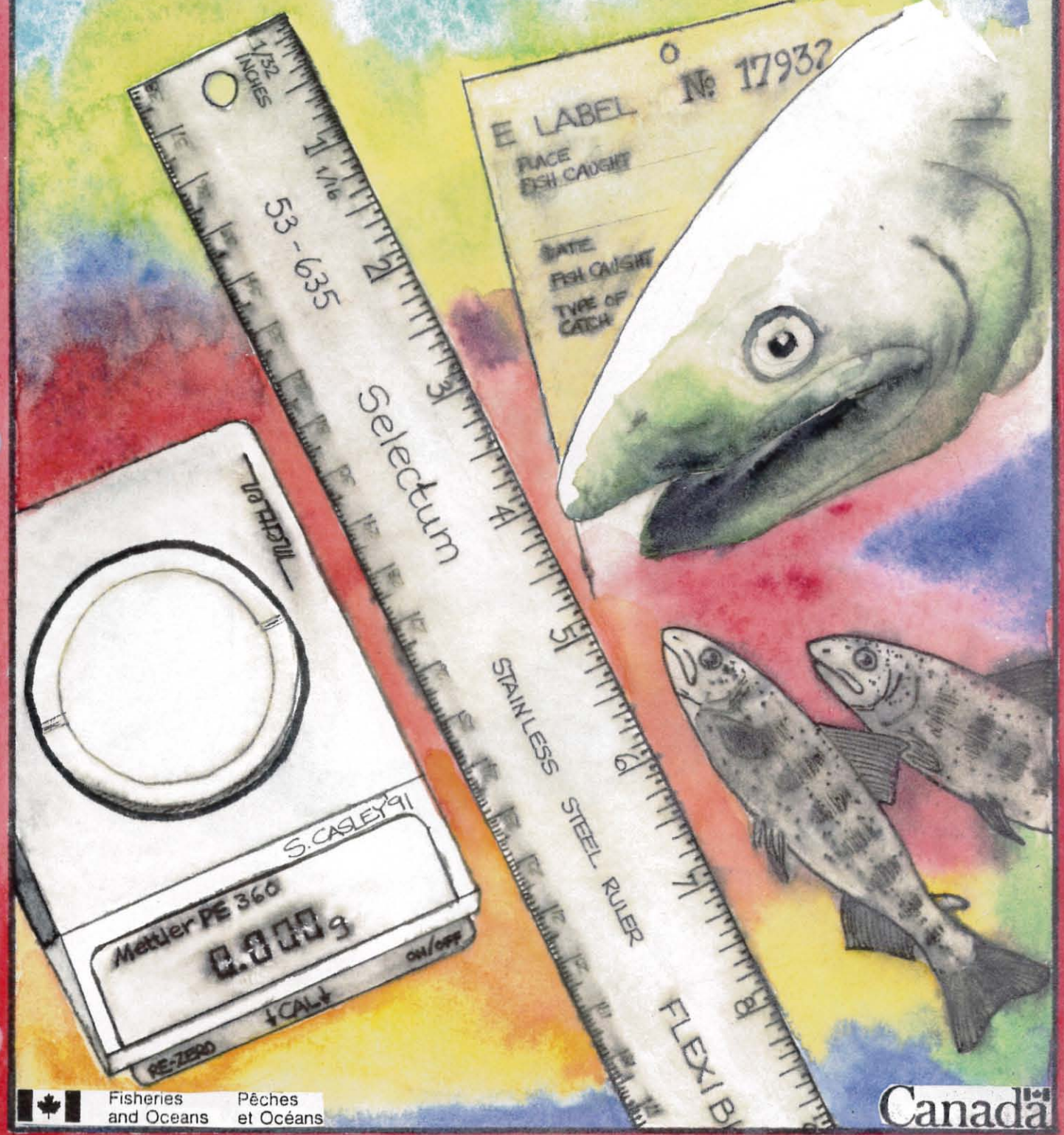
SALMONID ENHANCEMENT PROGRAM

ADULT / JUVENILE SAMPLING MANUAL



Fisheries and Oceans Pêches et Océans

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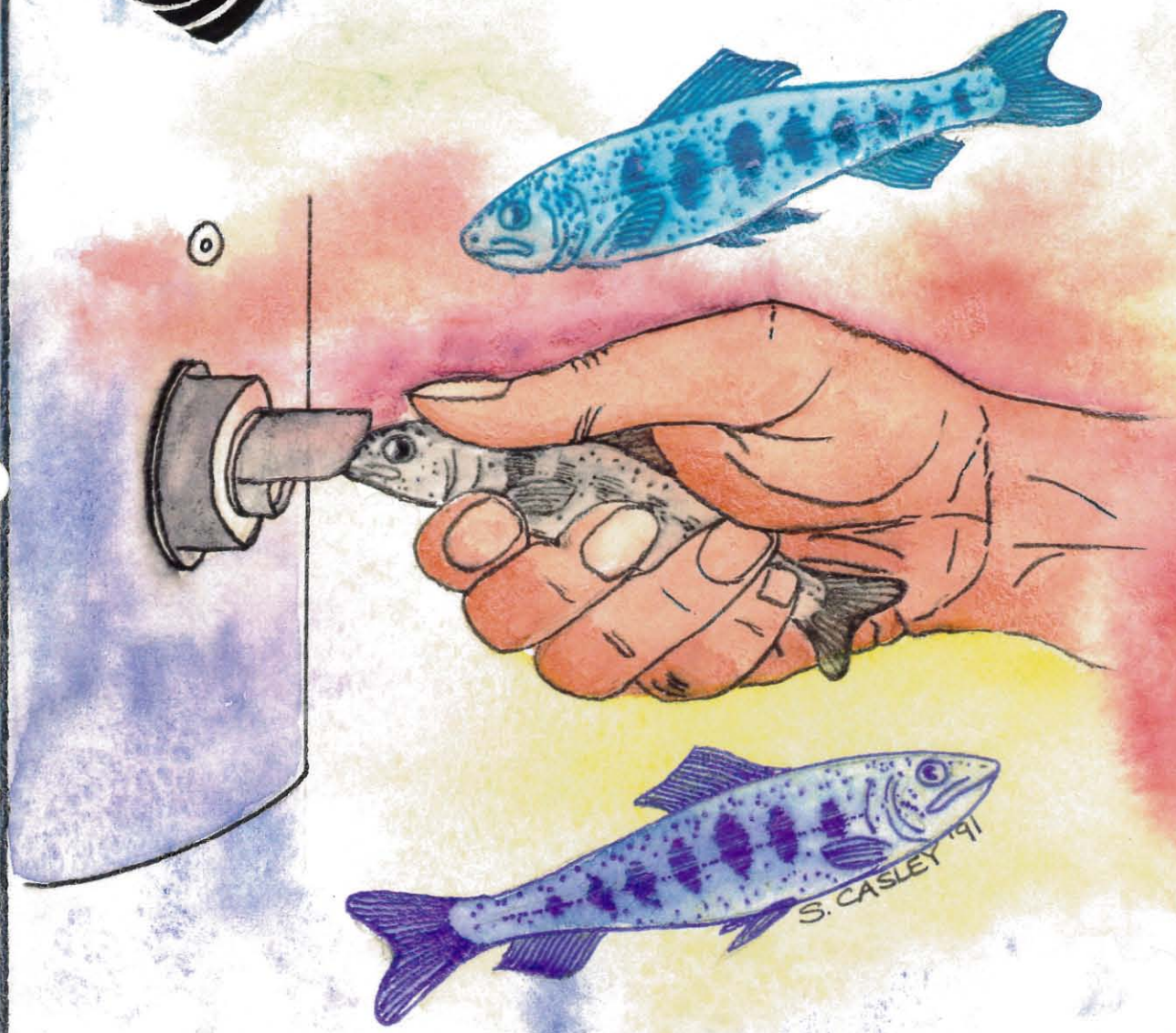
SALMONID ENHANCEMENT PROGRAM

JUVENILE MARKING MANUAL



Fisheries and Oceans Pêches et Océans

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MANUAL FOR CODED-WIRE TAGGING AND FIN CLIPPING OF JUVENILE SALMONIDS AT ENHANCEMENT OPERATIONS FACILITIES

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by

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FOREWORD

by D.D. Bailey

With the rapid expansion of hatchery facilities as a result of the Salmonid Enhancement Program, there were no specific guidelines to ensure high quality and consistent marking at all facilities. Procedures were passed on by the staff from the more established facilities and by contract marking with a few contractors who had specialized in this area. Written guidelines were scarce but those that existed, including Bams (1979) guidelines for fin clipping quality and the Alaska Department of Fish and Game Manual (Moberly et al. MS 1977), were being used. Procedures and guidelines varied among facilities, and adult returns began to show a wide variation in mark quality that was reflected in the relative percentage of good marks and tag loss rates. In 1986 the incidence of regeneration on ventral clipped chum salmon caught in the Nitinat commercial fishery was very high resulting in low hatchery contribution estimates based on marks recovered. If hatchery output marking was to provide a basis for estimating hatchery contribution and corresponding fishery management, it was clear that procedures and quality control must be both standardized and improved.

As a result, the Bioprogram Coordinator Division awarded a marking evaluation contract to provide advice and guidelines for the improvement of quality of marking programs at Enhancement Operations facilities. The evaluation was to be conducted through a review of available information and on-site observations. The contract work was conducted between July 1, 1987 and December 31, 1988 and included the design and distribution of a marking questionnaire to evaluate the procedures used at Enhancement Operations facilities. From the results of this questionnaire, hatcheries were selected for visitation by the contractor and in some cases the Scientific Authority. Hatcheries were selected based on species, geographic location, fin clipping versus coded-wire tagging, established versus new facilities, degree of hatchery involvement in marking, "good" and "problem" hatcheries, and visitation opportunity. Results and concerns were discussed with the hatchery manager during the visit and followed up by a written evaluation by the contractor to the Scientific Authority. The result of the visits, questionnaires, literature search, and the contractor's (T. Nichols) personal experience have been detailed in this marking manual. In addition, the contractor has included within this manual the results of the Tagging Machine Maintenance Workshop held April 27, 1988, as was previously agreed with the Scientific Authority and the workshop organizers (Shary Stevens and Pete Campbell).

This manual is a revised version of a draft which was distributed to hatchery staff for comment. It is hoped that additional discussion can result on marking quality guidelines, and that these are applied consistently throughout all hatcheries. It is hoped that individual hatcheries will add sections unique to their own particular situations as well as recommendations to ensure high quality marking at all facilities. This publication will hopefully evolve into a comprehensive marking manual for use at all facilities.

INTRODUCTION

The purpose of this report is to describe the best practical methods for coded-wire tagging and adipose and ventral fin clipping. These types of marks are used to identify the vast majority of marked Pacific salmon stocks. Marked salmon recoveries form the basis of commercial and sport salmon fishery management, hatchery production strategies, experimental design and international negotiations. It is critical that marking be performed with precision and care so that mark mortality, fin regeneration and tag loss rates are minimized. To achieve this goal, marking equipment and crews must be efficiently organized and managed.

There is some evidence that current juvenile fish handling and marking procedures are not providing adequate recovery data from adult fish. Surveys showed that from 10% to 15% of adipose clipped salmon in the Mark Recovery Program did not contain coded-wire tags, while in one test, approximately 75% of adult fish with "stubby" adipose fins did contain coded-wire tags (J. Thomas, J.O. Thomas and Associates, Vancouver, pers. comm.). Furthermore, of the chum ventral fin clip marks recovered in the Nitinat fishery in 1986, approximately 25 had regenerated to at least 25% of full size and a further 24 marks regenerated to 50% of full size (MacKenzie MS 1987). Clearly, controlling tag loss and fin regeneration is paramount to the success of the marking program.

FISHERY OBJECTIVES - CODED-WIRE TAGGING

Coded-wire tag data from surviving adult salmon have a variety of uses. Coded-wire tags provide tangible evidence that catchable adult fish were produced by a given hatchery, thereby demonstrating effective fish production. Tag recovery data are also expanded statistically to derive survival rates from release to adult capture and to adult recovery on spawning grounds, so that different production strategies and/or experimental groups can be compared. Furthermore, since coded-wire tags identify a mix of stocks within a fishery, harvest managers are able to examine the run timing and harvest rates of different stocks and develop improved harvest strategies.

Ensuring that fish are tagged effectively is an essential part of this information system. When a tagged fish is recovered, expansion factors are applied to estimate the proportion of tagged fish within the surveyed population, and subsequently the tagged proportion within the unsurveyed population of captured fish. Different expansion factors are applied to the commercial and sport fleet, as survey patterns permit. Depending on the application of the data, several multipliers can be used so that one tag recovery may represent many more that may be present in the catch. Regenerated adipose fins and/or high rates of tag loss can confound the recovery system and render much of the data useless.

In most cases, economics demand that only a portion of the hatchery's output be tagged. Unless special experimental groups are present, the tagged fish must represent the entire hatchery production group. It is therefore imperative that the marking crew organize a non-selective operation. Accordingly, there should be no pre-tagging selection for "optimum" fish size, condition or timing pattern among the tagged group only.

Sufficient numbers of fish should be tagged to ensure that, given expected survival rates, enough tags will be recovered to provide a statistically reliable data base for resource managers. Most hatcheries mark a minimum of 75,000 fed chum fry, 75,000 coho fry, 50,000 juvenile chinook, and 10,000 coho smolts. Some hatcheries may mark more fish to compensate for lower survival rates that are inherent at upriver production sites (e.g. Quesnel Hatchery), or are the result of smaller size at release (e.g. chum tagging) or expected overwinter mortalities (e.g. coho tagging for later release). In addition, multiple tag codes can be used on large groups of fish to determine statistical variation in survival among identical groups and to evaluate different experimental groups within a hatchery population.

FISHERY OBJECTIVES - FIN CLIPPING

Adipose and ventral fin clipping is often used as a way of marking anadromous fish where fish size is too small and where the cost is too high for coded-wire tagging; this applies especially to pink and chum fry. Note, however, that Alaskan agencies tag these fry at 0.75 g and smaller (J. Kallshian, Northwest Marine Technology, pers. comm.). Since only a few fin clip codes are available (ventral, adipose, maxillary bone), most of the fin clipping performed by the Department of Fisheries and Oceans (DFO) is used for distinguishing between hatchery and non-hatchery fish in target fisheries. Examples of this strategy are chum marking at Pallant, Conuma and Snootli hatcheries.

Fin clipping is also used in freshwater studies to examine populations and compare stocks. For example, Hurst and Blackman (1988) used fin clips to assess coho fry outplanting into various habitat types, both barren and containing indigenous (unmarked) fish, and to compare the freshwater behaviour of hatchery and non-hatchery stocks. Ocean distribution was not a primary concern in these studies. Clipped juveniles were identified visually and returned live to the system.

Since the DFO uses adipose and ventral fin clips almost exclusively in fin clipping operations, this report does not discuss maxillary, half dorsal or other fin clips that may be applied for experimental purposes.

METHODOLOGY

This manual presents field techniques developed to improve marking quality and efficiency. The manual is based on personal experience, on-site evaluations, interviews with numerous technical authorities and questionnaire responses. The practical work for this manual was conducted by T.L. Nichols and all references to "the author" in the following pages refer to that particular author.

It is expected that not everyone will agree with the contents of the manual, since the best technical advice possible is necessarily judgemental. The benefits from using this manual will differ as well. Some locations may achieve the utmost in quality marking with only slight modifications from the present system. Others may want to revise completely their current operation to achieve this goal. We believe that even extensive changes are well worth the effort.

WHAT DO I NEED BEFORE I START?

1. PERSONNEL

Fish tagging is performed using an assembly-line system, including one, two or three tagging machines and a crew complement of taggers, fin clippers and supervisors. The operation should be continuous throughout the day and proceed consistently for days or weeks until all the fish are marked. In personnel terms, it is important to ensure that the team is appropriately organized, that everyone is well trained and directed, and that sufficient supervision is provided to ensure adequate quality control and operational efficiency.

Team Organization

Each site potentially has a different team organization based on different methods of hiring workers and assigning responsibilities. Where a contractor is retained, a tagging supervisor from the hatchery should be in charge since the tagging crew does not report to the hatchery manager. It is critical that the tagging supervisor closely communicate with the hatchery management, not only to ensure that the marking quality and numbers are achieved, but to coordinate the tagging rate with strategies for starving and holding the fish to be marked. In this way, the tagging and hatchery components can be coordinated to ensure a smoothly run operation.

For coded-wire tagging, the ratio of clippers to taggers should be 2:1, or two clippers for every tagger. Therefore, if three tagging machines are used, six clippers are required. The importance of a 2:1 ratio is based on the efficient use of the taggers' time and also ensures that the clippers have sufficient time to maintain quality clips. If the ratio is 1:1, the clipper cannot maintain pace with the tagger. Either the clipper must speed up, in which case fin clip quality suffers, or the tagger must slow down. At one hatchery where a 1:1 strategy was used, an incidence of 75% poor clips and a marking rate of only 12,000-13,000 fish/day was reported for a two-machine set-up, which is at least 4-5,000 below the average rate obtained with a 2:1 clipper/tagger ratio using a similar set-up.

Personnel requirements for fin clipping operations do not differ greatly from those required for coded-wire tagging, except that fin clipping operations are more loosely organized since no need exists to coordinate with machine speeds. It is important, however, that all new personnel be trained properly, and that each clipper be taught the proper technique. It will be expected that during the first few days of training, the clipping speed will be below average, but it will increase with time. Clipping quality can be controlled with good supervision so that the only variable between crews should be clipping speed as related to previous clipping experience.

Job Descriptions

Taggers: Taggers should be experienced. They must be able to handle fish properly, and recognize correct machine operation and correct tag placement. When training new taggers, higher tag loss and higher mortalities should be expected.

Clippers: Clippers must be able to handle fish carefully, clip the fin properly and size-sort the clipped fish. It is not mandatory that fin clippers be experienced at the start of the operation. They can be trained in one hour to make a quality clip. Those unable to do so, probably lack sufficient manual dexterity and should be replaced at the end of the day. Speed should not be encouraged until high quality clips are regularly obtained. Once this occurs, speed will increase naturally, usually without a loss in clip quality.

Supervisor: The supervisor must ensure that 1) the tagging operation is properly planned and organized, 2) the equipment and fish are ready for tagging, 3) the personnel are adequately trained and monitored, 4) the quality control standards are effectively and consistently in place, and 5) the data are collected in an orderly manner.

2. CONDITION OF FISH

The most important aspect of preparing fish for coded-wire tagging is establishing the seasonal timing of the tagging activities. Tagging usually takes place from late February to early July, with the exception of overwintered coho which may be tagged in mid-winter. Preparing fish for fin clipping is similar to preparing them for coded-wire tagging, except that much smaller fish can be fin clipped.

The primary factors to consider are water temperature and fish size. Since each hatchery has its own temperature regime and subsequent growth curves, the following weights and temperatures are provided to assist in estimating appropriate site-specific timing for tagging operations.

Species	Minimum Weight (g)	Maximum Temperature (°C)
Chinook	1.0	14
Coho	1.0	15
Chum	0.8	14

In general, even if the fish size criteria are met, marking should not be undertaken if 1) water temperature is above the determined critical level for the hatchery in question, 2) fish are being treated for disease, or 3) fish are smolting. Each of these major concerns, as well as fish size, are discussed below.

Water Temperature

Maximum water temperatures during tagging can vary among sites and stocks. For example, Hartley Bay fish were tagged at water temperatures ranging from 20°C to 25°C with approximately 10 mortalities reported each year (100,000 coho tagged in each of 3 years). Normally, tagging at these temperatures at other locations would kill the fish. However, the Hartley Bay fish are hatched and reared at high water temperatures and are released into a warm-water lake. In contrast,

chinook at Quesnel Hatchery are reared in cold water and have a maximum tagging temperature of only approximately 12°C. At more southerly hatcheries it may be possible to tag chinook safely at 15°C or 16°C. Therefore, each hatchery should conduct its own experiments to determine the critical temperature for tagging under site-specific conditions (Table 1).

When determining the critical temperature for each site and species, it is important to assess the past history of tagging operations to determine the actual temperatures at marking, the mortalities at that time, and whether or not differences in the daily mortalities coincided with even a slight change in temperature.

If it becomes necessary to tag fish at water temperatures higher than the considered maximum, **it is especially important not to clip too deep, as this will guarantee fungus growth on the fish.** Furthermore, the hatchery management should consider increasing the numbers of fish tagged in order to compensate for expected higher than normal mortalities.

In locations and at times of the year when warm water temperatures may create handling and tagging problems, variation in the daily timing of tagging may help avoid working in the heat of the day. For example, tagging shifts from 5:00 am to 11:00 am and from 6:00 pm to 8:00 pm daily, or from 6:00 am to 2:00 pm could take advantage of cooler daily air and water temperatures. The primary problem with this scheduling is that government hatchery crews work from 8:00 am to 4:00 pm so that a special effort would be required to coordinate the different shifts of hatchery and marking crews. Often a 6:00 am to 2:00 pm shift works well; the tagging crew gets a 2-hour head start on the regular hatchery activities, and when they leave for the day, the hatchery crew has a few hours to inspect the tagged fish and move untagged fish into containers prior to the next day's marking.

Fish Size

Tables 2, 3 and 4 provide an overview of the coded-wire tagging programs for chinook, coho and chum respectively, at the surveyed hatcheries. Annual mean sizes at tagging ranged widely for chinook (0.8-14.8 g) and coho (1.6-30.0 g) but not chum (0.9-1.8 g).

For scheduling purposes, a 2.5 g average size is considered optimal for tagging, as the fish are relatively uniform and at a convenient size for handling and grading. At this size, two tagging machines can be set up to obtain optimal tag placement, one machine covering the 1.8 - 2.5 g size range, and the other the 2.5 - 4.0 g size range. Note that fish tagged at a larger size (e.g. 6 g average) will show a larger size variation (1-12 g) and consequently will require more grading and nose-mold adjustments. This will make it more difficult to obtain good tag placement. Tagging scheduling should include getting the fish to an optimum tagging size of 2.5 g in such a way as to coincide with natural migration and any other timing factors that the hatchery is considering.

Table 1. Comparison of maximum water temperatures for marking at the surveyed hatcheries.

Area	Hatchery	Maximum Temperature (°C)
FRASER RIVER	Capilano	14 - 15
	Chehalis	12
	Chilliwack	11
	Clearwater	14
	Inch	13[a]
	Shuswap	9[a]
SOUTH COAST	Big Qualicum	15
	Little Qualicum	14
	Nitinat	10
	Puntledge	16
	Quinsam	14
	Robertson	12 - 13
NORTH COAST	Kitimat	<12[b]
	Pallant	12 - 13
	Snootli	12

[a] Highest temperature that has occurred.
[b] Preferably below 10°C.

Table 2. Chinook sizes for coded-wire tagging at the surveyed hatcheries.

Division	Facility	Brood Year	Number Marked	Chinook Weight (g) Max.	Min.	Avg.
FRASER RIVER	Capilano	1984	502,090	8.00	2.50	5.25
		1985	126,399	8.00	2.50	5.25
		1986	170,998	8.00	1.80	4.90
	Chehalis	1984	150,000	1.00	1.00	1.00
		1985	200,000	0.80	0.80	0.80
		1986	200,000	2.00	1.00	1.50
	Chilliwack	1984	92,000	8.00	4.00	6.00
		1985	200,000	10.00	3.00	6.50
		1986	165,000	10.00	4.00	7.00
	Clearwater	1984	260,000	4.00	3.00	3.50
		1985	377,000	4.00	3.00	3.50
		1986	359,000	4.00	3.00	3.50
	Eagle	1984	457,000	3.40	3.20	3.30
		1985	359,000	3.50	3.40	3.45
		1986	360,000	2.60	2.10	2.35
	Inch Creek	1986	47,538	6.00	6.00	6.00
	Quesnel	1984	1,123,000	2.50	2.50	2.50
		1985	970,000	2.00	2.00	2.00
		1986	850,000	3.20	2.10	2.65
	Shuswap Falls	1984	103,500	5.00	3.50	4.25
		1985	84,200	4.00	2.40	3.20
		1985	84,500	5.00	3.00	4.00
		1986	102,064	3.03	3.03	3.03
		1986	52,786	3.77	3.77	3.77
	Spius	1984	267,000	4.00	4.00	4.00
		1985	285,000	4.00	3.00	3.50
		1986	350,000	5.00	3.50	4.25
	Tenderfoot	1984	90,000	2.00	2.00	2.00
		1984	112,000	4.00	1.00	2.50
		1985	90,000	2.00	2.00	2.00
		1985	91,000	4.00	1.00	2.50
		1986	98,000	4.00	1.00	2.50
		1986	90,000	3.00	3.00	3.00
NORTH COAST	Kitimat	1984	98,715	11.10	10.20	10.65
		1984	49,765	8.30	8.30	8.30
		1984	49,445	9.30	9.30	9.30
		1985	79,698	11.20	11.20	11.20
		1985	79,900	10.20	10.20	10.20
		1985	50,661	7.80	7.80	7.80
		1986	78,784	10.50	10.50	10.50
		1986	79,078	9.70	7.40	8.55
		1986	53,438	8.80	8.80	8.80
	Pallant	1986	40,000	2.50	2.50	2.50

Table 2 (cont'd.)

Division	Facility	Brood Year	Number Marked	Chinook Weight (g) Max.	Min.	Avg.
	Snootli	1984	80,731	1.80	1.50	1.65
		1984	203,148	2.90	2.00	2.45
		1985	76,145	1.80	1.50	1.65
		1985	208,402	2.90	2.00	2.45
		1986	50,453	1.80	1.50	1.65
		1986	209,006	2.90	2.00	2.45
SOUTH COAST	Big Qualicum	1984	254,000	3.00	6.00	4.50
		1985	260,000	3.00	6.00	4.50
		1986	216,000	3.00	6.00	4.50
	Chemainus	1984	78,630	4.50	4.50	4.50
		1985	75,610	5.50	5.50	5.50
		1986	80,307	4.50	4.50	4.50
	Little Qualicum	1984	80,000	4.00	3.50	3.75
		1985	76,000	4.00	3.50	3.75
		1986	75,000	4.00	3.50	3.75
	Nitinat	1984	37,464	2.54	2.54	2.54
		1984	37,900	2.73	2.73	2.73
		1984	36,699	2.80	2.80	2.80
		1985	26,557	2.17	2.17	2.17
		1985	26,324	2.19	2.19	2.19
		1985	26,737	2.37	2.37	2.37
		1985	26,249	2.88	2.88	2.88
		1985	27,713	3.00	3.00	3.00
		1986	52,940	3.95	3.95	3.95
		1986	52,942	4.00	4.00	4.00
	Puntledge	1984	166,689	5.50	5.50	5.50
		1985	646,291	5.50	5.50	5.50
		1986	336,441	5.50	5.50	5.50
	Quinsam	1984	128,000	3.10	3.10	3.10
		1984	227,000	14.00	14.00	14.00
		1985	25,000	3.00	3.00	3.00
		1985	48,000	10.30	10.30	10.30
		1985	181,000	14.80	14.80	14.80
		1986	179,000	8.34	8.34	8.34
	Robertson	1984	263,523	2.31	2.31	2.31
		1985	211,823	3.28	3.28	3.28
		1986	393,705	2.93	2.93	2.93

Table 3. Coho sizes for coded-wire tagging at the surveyed hatcheries.

Division	Facility	Brood Year	Number Marked	Coho Weight (g) Max.	Min.	Avg.
FRASER RIVER	Capilano	1984	236,620	20.00	10.00	15.00
		1985	132,469	20.00	10.00	15.00
	Chehalis	1984	80,000	9.00	6.00	7.50
		1985	50,000	8.00	7.00	7.50
		1986	50,000	10.00	8.00	9.00
	Chilliwack	1984	145,000	15.00	12.00	13.50
	Clearwater	1984	122,000	4.00	3.00	3.50
		1985	130,000	4.00	3.00	3.50
		1986	108,000	4.00	3.00	3.50
	Eagle	1984	342,000	2.20	1.80	2.00
		1985	337,000	2.40	2.10	2.25
		1986	332,000	1.80	1.70	1.75
	Inch Creek	1984	40,102	19.00	17.00	18.00
		1984	10,080	20.00	20.00	20.00
		1984	9,994	17.00	17.00	17.00
		1984	10,200	17.00	17.00	17.00
		1984	10,016	17.50	17.50	17.50
		1985	20,073	16.00	16.00	16.00
		1985	9,367	17.00	17.00	17.00
		1985	10,158	14.00	14.00	14.00
		1985	10,073	14.00	14.00	14.00
		1985	9,895	13.00	13.00	13.00
		1985	10,089	16.00	16.00	16.00
	Quesnel	1985	20,000	2.50	2.50	2.50
		1986	30,000	4.00	4.00	4.00
	Spius	1984	51,000	2.00	2.00	2.00
		1985	140,000	4.00	3.00	3.50
		1986	150,000	4.00	2.50	3.25
	Tenderfoot	1984	44,000	20.00	20.00	20.00
		1985	69,000	20.00	20.00	20.00
		1986	Unknown	20.00	20.00	20.00

Table 3 (cont'd.)

Division	Facility	Brood Year	Number Marked	Coho Weight (g) Max.	Min.	Avg.
NORTH COAST	Kitimat	1984	47,209	20.40	18.10	19.25
		1985	70,924	21.70	20.00	20.85
	Pallant	1984	97,000	1.60	1.60	1.60
		1985	31,000	1.60	1.60	1.60
		1985	156,000	1.90	1.90	1.90
		1986	31,000	3.50	3.50	3.50
		1986	61,000	1.70	1.70	1.70
		1986	94,000	2.50	2.50	2.50
	Snootli	1985	20,919	3.00	3.00	3.00
		1986	50,216	2.70	2.70	2.70
SOUTH COAST	Big Qualicum	1984	160,000	14.00	14.00	14.00
		1985	120,000	14.00	14.00	14.00
	Little Qualicum	1984	16,200	20.00	20.00	20.00
		1985	1[illegible],350	20.00	20.00	20.00
		1986	20,550	20.00	20.00	20.00
	Nitinat	1986	103,607	3.41	3.41	3.41
	Puntledge	1984	100,076	2.26	2.26	2.26
		1984	40,000	17.00	17.00	17.00
		1985	166,016	4.00	4.00	4.00
		1985	58,145	13.46	13.46	13.46
		1986	21,013	2.25	2.25	2.25
	Quinsam	1984	100,000	6.80	6.80	6.80
		1984	81,000	30.00	30.00	30.00
		1985	43,000	25.00	25.00	25.00
	Robertson	1984	47,940	13.10	13.10	13.10
		1985	43,581	11.70	11.70	11.70

Table 4. Chum sizes for coded-wire tagging at the surveyed hatcheries.

Division	Facility	Brood Year	Number Marked	Chum Weight (g) Max.	Min.	Avg.
FRASER RIVER	Chehalis	1984	230,000	0.95	0.75	0.85
		1985	150,000	0.95	0.75	0.85
		1986	80,000	0.95	0.75	0.85
	Inch Creek	1985	103,811	1.10	0.95	1.03
		1985	34,340	0.95	0.95	0.95
		1986	151,724	1.25	1.00	1.13
NORTH COAST	Kitimat	1985	36,062	1.40	1.40	1.40
	Pallant	1984	35,000	1.70	1.70	1.70
		1984	76,000	1.40	1.40	1.40
		1984	38,000	1.00	1.00	1.00
		1985	133,000	1.70	1.70	1.70
		1986	87,000	1.80	1.80	1.80
SOUTH COAST	Puntledge	1984	154,080	1.00	1.00	1.00
		1985	104,097	1.00	1.00	1.00
		1986	55,632	1.00	1.00	1.00

Although fish can be tagged at a minimum size of about 1 g, long-term tag retention will be lower on smaller fish. For example, although the 24-hour tag loss is comparable between 1 g fish and larger juveniles, the long-term tag loss among returning adults is considerably higher among the smaller tagged fish (up to 20% compared to the normal level of 15%). Therefore, in order to maximize long-term tag retention, it is recommended not to tag below 1.8 g for chinook and coho.

Reaching the minimum size of 0.8 g can be a problem for chum salmon, as chum fry are frequently released before they reach this size. Often, when chum are held until the tagging size is reached, they begin to smolt which may prohibit their marking. One effective strategy used at the Pallant Hatchery, consists of holding chum fry in seapens until tagging, then transferring them to fresh water for coded-wire tagging and fin clipping, and finally returning them to salt water for recovery.

Fish over 20 g should not be coded-wire tagged. However, they often are, especially in the case of overwintered coho in order to avoid significant overwintering mortality. Such large fish take much longer to tag with considerably more stress to the fish, and show higher tag losses. For example, 25,000 large fish will require two full days to tag using a 2-machine, 6-person crew set-up, compared to 1.2 days required to tag smaller, 2.5 g fish using the same crew and set-up. However, while it is generally recommended to tag fish earlier and at a smaller size whenever possible, it is cautioned that this approach will require greater numbers of fish, especially coho, to be tagged to accommodate overwintering mortality. This approach will also reduce the confidence level in estimating mark ratio at release due to the uncertainty in estimating post-tagging mortality prior to release (e.g. mortality of coho due to cannibalism).

Disease Treatment

Fish being treated for disease should not be marked, as the extra stress from tagging will probably result in high mortalities. It is recommended to wait one week after termination of treatment before commencing tagging, to ensure full recovery from both the disease and treatment.

While fish should not be treated for disease immediately before marking, all equipment (e.g. nets, brushes, bowls, tables, buckets, etc.) should nevertheless be disinfected before marking begins and while handling different groups of fish. Even when obvious disease signs are not apparent, tagging stress can precipitate a disease outbreak which could spread rapidly through the hatchery by way of contaminated equipment.

Smolting Fish

Fish should not be tagged if they are in the process of smolting. The physical characteristics of smolting fish are difficult to notice when the fish are in hatchery containers but will become apparent when the fish are anaesthetized and handled. Smolting fish lose their parr marks and "silver up". The developing small, fragile scales come off easily when the smolting fish are

handled, as during adipose fin clipping when the scissors are moved up the back of the fish. The loss of scales and clip wounds render smolting fish much more vulnerable to fungus infections of affected areas. Smolting fish are also more readily anaesthetized. For example, presmolts of approximately 2 g size can remain in the MS-222 anaesthetic bath for 30 seconds after the anaesthetic takes effect with no mortalities, while smolting fish, if not immediately removed, will overdose. Therefore, if during tagging a group of fish is found to be smolting, extra care must be taken in their handling and anaesthetic dosage.

3. EQUIPMENT

Tagging Machines

The only coded-wire tag machines available in British Columbia are provided by:

Northwest Marine Technology,
Shaw Island
Washington State
U.S.A. 98286

Telephone (206) 468-3375 or 468-2340

Most surveyed hatcheries have blue MKII or MKIII model machines designed and manufactured by Northwest Marine Technology. These machines are several years old and due for replacement. The following discussion focuses on these older tagging machines that hatcheries must keep repaired and operable. The reader is referred to Appendix A for more detailed information from the manufacturer on machine assembly, general use, cleaning, maintenance and troubleshooting. Appendix B provides similar information for machine model MKIV.

For any coded-wire tagging operation, the following spare parts are considered essential:

1. Control boxes for tag injector and QCD (see below)
2. Head molds (large selection: at least 2 of each size for two machines)
3. Power cable
4. Power pack
5. Tag injector parts:
   - Wire guide
   - Cutter
   - Set of drive rollers
   - At least 3 or 4 needles
   - Blank spool (low-cost wire for setting up machines and negotiating breakdowns and jams; these spools are normally available from the manufacturer)
6. Tool box
7. Touch switch (dampness will make it sticky and sunlight will cause it to expand)

Generally, machine jams can be repaired on site by changing the cutter edge, installing new rollers, adjusting wire length, etc. However, in about 25% of the cases, the problem involves the tag injector control box. In such cases, at least 10 days will be required to ship out the control box for repairs. Therefore, if possible, a spare control box for the tag injector should be on site (cost: $2,000 U.S. from manufacturer). Similarly, it is worthwhile to have a spare control box for the QCD (cost: $600 U.S.). Although the QCD control boxes fail less often than the tag injector control boxes, it is just as vital to keep the QCD operating properly at all times.

Scissors

There should be twice as many scissors as there are clippers. That is, four clippers should have at least eight pairs of scissors on site, and preferably 12 pairs. The reason is that often half the scissors do not work, as for example, when they are sent out for resharpening over the winter and are not tested right away for success rate. Also, some scissors may have to be sent out for resharpening in the middle of the clipping operation.

The length of scissor blades does not appear to be a determining factor regarding scissor suitability for different types of fin clipping. Individual clippers have their own preferences as to what they find easiest to handle. Therefore, a variety of scissor blade lengths should be made available to clippers so that they can choose a pair that is easiest for them to handle.

The sharpness of scissor tips is a factor to consider. Scissors used only for adipose fin clipping should have blunted tips. Otherwise, if clippers are careless, they may easily stab themselves or the fish. More importantly, scissors with blunted points survive longer when accidentally dropped since they bend and break less easily; in the course of a tagging program each worker will drop the scissors two or three times. On the other hand, scissors that are used for ventral fin clipping require sharp points to clearly separate the fins. Clippers that are seated are less likely to drop the scissors and damage them.

It is important that during the clipping program, each pair of scissors be stored separately. This is because each pair is slightly different, and clippers become used to a certain pair of scissors because of the specific cutting, holding and other scissor characteristics. If the scissors are switched around each day, the clippers must relearn how to best use and hold a new pair, often resulting in deep or incomplete clips. The precaution of storing each pair of scissors separately becomes an important factor when considering the clipping quality.

At the end of each day the scissors should be placed in a small plastic tray containing "instrumilk" (trade name for a lubricating solution for fine instruments). This will keep the scissors lubricated and rust-free (although the scissors are made of stainless steel, they will rust at the point where the screw enters), and in general will keep them in a clean, smooth operating condition. At the end of each season, the scissors should be cleaned, dried and lubricated with a fine machine oil.

Sharpening of scissors results in an approximately 50% success rate per pair, even when sent directly to the manufacturer for this service. At least one hatchery has successfully used local services that sharpen hairdressers' scissors. Prices for resharpening may range from $3 to $6 per pair.

The scissors (surgical iris scissors) vary greatly in price, from $50 to $135, but all appear to perform equally well regardless of price. It is recommended that the DFO purchase clipping scissors in bulk in order to stabilize price and availability. Questionnaire returns indicate that a hatchery may replace 5 to 10 pairs annually, so that the DFO should consider a pre-season purchase of approximately 200 pairs. Table 5 shows the number of scissors used and replacement rates at each of the surveyed hatcheries.

HOW DO I DO IT?

1. PREPARE THE FISH

Preparing the fish for tagging involves proper fish starving and containing procedures.

Starving Fish

Prior to tagging, the fish should be starved for at least 24 hours and preferably 48 hours. Starvation will allow stomach evacuation in the first day resulting in reduced output of ammonia and excretory by-products associated with stressful fish handling and tagging. Also, it is noted that the fish will "firm up" with starvation. Fish that are not starved before tagging have a noticeably softer nose cartilage, resulting in increased tag loss. For extended tagging operations (e.g. Quesnel Hatchery: 850,000 chinook coded-wire tagged over a 20-day period), low-ration feeding and starvation routines must be carefully planned in order to avoid increased tag loss in the fish that are tagged first and undue stress in the fish that are tagged last.

Containing Fish

In organizing hatchery space and activities in preparation for marking, two major concerns stand out: 1) minimizing fish handling before tagging begins, and 2) providing suitable holding and recovery containers during tagging of multiple groups of fish while supplying cool, clean water at all times. These concerns are discussed below.

Fish that are not being marked immediately should be kept as comfortable as possible prior to tagging. Minimizing fish handling before tagging begins can be done by avoiding disturbing the entire large raceway in order to obtain one dipnet of fish. This factor is important given the large numbers of fish tagged each year at a given hatchery. For example, the Quesnel Hatchery has net pens within the raceways, so that a portion of the fish can be isolated and starved without disturbing the rest of the population. Similarly, large channels or earthen ponds holding fish should have net pens within them to isolate groups of fish appropriately, rather than seining out large numbers of juveniles, and holding and starving them as one group. For hatcheries using Capilano troughs,

Table 5. Comparison of numbers of scissors used and replacement rates at the surveyed hatcheries, as determined from questionnaire returns.

Hatchery	Pairs of Scissors Used per Season	Pairs of Scissors Replaced per Season
Big Qualicum	8	8
Capilano	3 - 6	2 - 4
Chehalis	6	6
Chemainus	-	-
Chilliwack	6 - 12	6
Clearwater	20	None to date
Conuma	20	5
Eagle	9	2
Inch	12 - 20	6
Kitimat	12	4
Little Qualicum	10	3 - 4
Nitinat	12	2 - 3
Pallant	15 - 20	2
Puntledge	12	6
Quesnel	8	1 - 2
Quinsam	16	3 - 4
Robertson	12	3
Shuswap	5	None to date
Snootli	10	1 - 2
Spius	1 pr. per person	None to date
Tenderfoot	6	-
	203 - 225	60 - 67

the trough should be divided in half, so that at any one time, only half the fish are crowded, moved around and subjected to swirling dipnets while the remaining fish can be shaded and isolated.

Wherever possible, fish should be brought into the tagging area the previous evening and left to acclimatize overnight before the next day's pre-tagging crowding and handling. (In some hatcheries, such as the Eagle River, this step is not possible due to the water system design that would place the fish at an unacceptable risk.) Similarly, the manner in which fish are brought into the tagging area (e.g. number of fish in a bucket) can be a source of stress, its level governed primarily by species, fish size, water temperature and other site-specific factors (this concern will not be discussed here).

In general, all the above measures to minimize fish handling should be observed. However, each hatchery has its own site-specific configuration that requires individual assessment.

The second concern involves holding and recovery containers. These should be sufficiently large to contain several hours' or a whole day's supply of fish, in order to avoid overlapping stresses. Fish held in too small a container will be stressed from being moved into the tagging area without having a "settling down" period before the additional stress of tagging. At one hatchery, a 2' x 2' holding box was used that had to be refilled with fish every half hour. This method resulted in excessive handling in a brief time period and may have affected the long-term survival of fish.

2. PREPARE THE AREA

Tagging Area

A comfortable and well lit tagging area is an important ingredient in achieving quality fin clipping and tagging. The area should be warm and dry, with portable electric heaters made available to individual markers. Heaters are also useful for warming hands when working in cold water conditions. Good lighting in the tagging area is essential, especially for fin clipping. Since most hatcheries do not have sufficient lights available, additional portable lights should be on hand and ready for use during tagging.

Inflow Water Quality

Ideally, the inflow water supplying the tagging table should be tested for pH and dissolved oxygen. However, this is not usually done since marginal water quality is reflected in the condition of the fish during rearing. Nevertheless, pH and especially dissolved oxygen should be monitored before and not after, mortalities occur.

Equipment Set-up

It is difficult to compile a standard list of the required marking equipment since each hatchery has its own facilities. For example, at one hatchery tagged fish may be deposited directly into a special recovery trough constructed in the tagging area for that purpose, with the tag rejects diverted

into a net within the trough. At another site, all tagged fish may be dropped into buckets, then removed periodically and placed into recovery containers. Therefore, an equipment list for the first hatchery would include net liners, and for the second hatchery a set of specialized buckets.

Although the physical set-up of the area for coded-wire tagging will vary for each hatchery, each operation should include:

1. Transfer troughs with flowing water so that size-sorted fish can be sent to different machines. These troughs should have about a 3" diameter and a U shaped cross-section, and should pass within easy reach of each of the fin clippers.

2. Leg adjustments on the QCDs. The legs provided by the manufacturer are about 6" too short, creating a back problem for most workers, especially those standing. The manufacturer can adjust the QCD legs for less than $60 per machine. Likewise, the height of the tagging table is paramount to taggers' comfort and should be considered to be a primary factor governing tagging success.

3. Generally, the entire coded-wire tagging crew should be standing. Taggers sitting behind the machines may not be able to reach around and tag the fish adequately due to an awkward arm movement and a slow tagging speed. However, if the tagging machines are appropriately adjusted for height, both taggers and clippers can remain seated. For example, the tagging machines at some hatcheries are mounted directly on a table at a level where taggers can sit and operate comfortably.

Most hatcheries have their own tagging table set-up in a configuration that is appropriate for them, and it is not our intention to encourage unnecessary changes. For the benefit of those who are building new tables for an existing operation, and for those who are just starting a new operation, Appendices C and D are provided as a guide. Figures 1 and 2 show a possible tagging table set-up for two and three machines respectively.

For fin clipping which usually involves small-sized fish, clippers should be seated comfortably, their arms resting on the marking table if he or she prefers. High quality stools with adjustable seats and backs should be purchased; otherwise, uncomfortable back problems may develop and fin clipping quality and speed may deteriorate. As mentioned earlier, the crew must have a dry, warm area for operating since physical comfort has a major effect on the marking speed and efficiency.

When clipping fish, many clippers prefer to use magnifiers. These should be included with the normal fish handling equipment (i.e. basins, net liners, scissors, anaesthetic, etc.). In the author's experience, good lighting around the clippers usually reduces the need for magnifiers. However, magnifiers should be made available. When clipping small fish, such as pink and chum fry, magnifiers may be a necessity as they provide good lighting exactly where needed and remove the need for harsh room lights overhead. In fact, it may be advisable to turn off overhead lights if glare on the magnifiers is a problem.

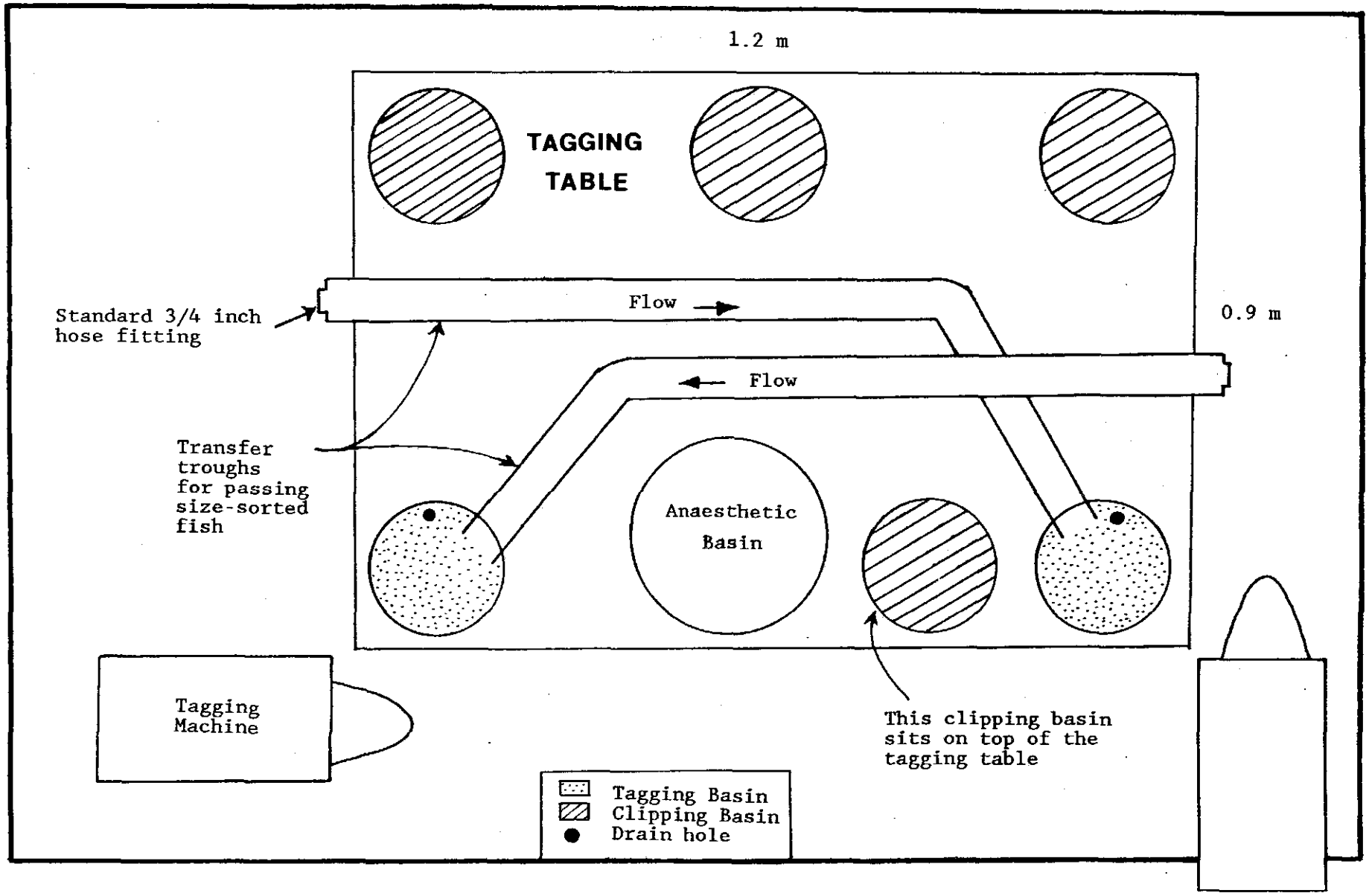

Figure 1. Tagging table set-up for two machines (top view).

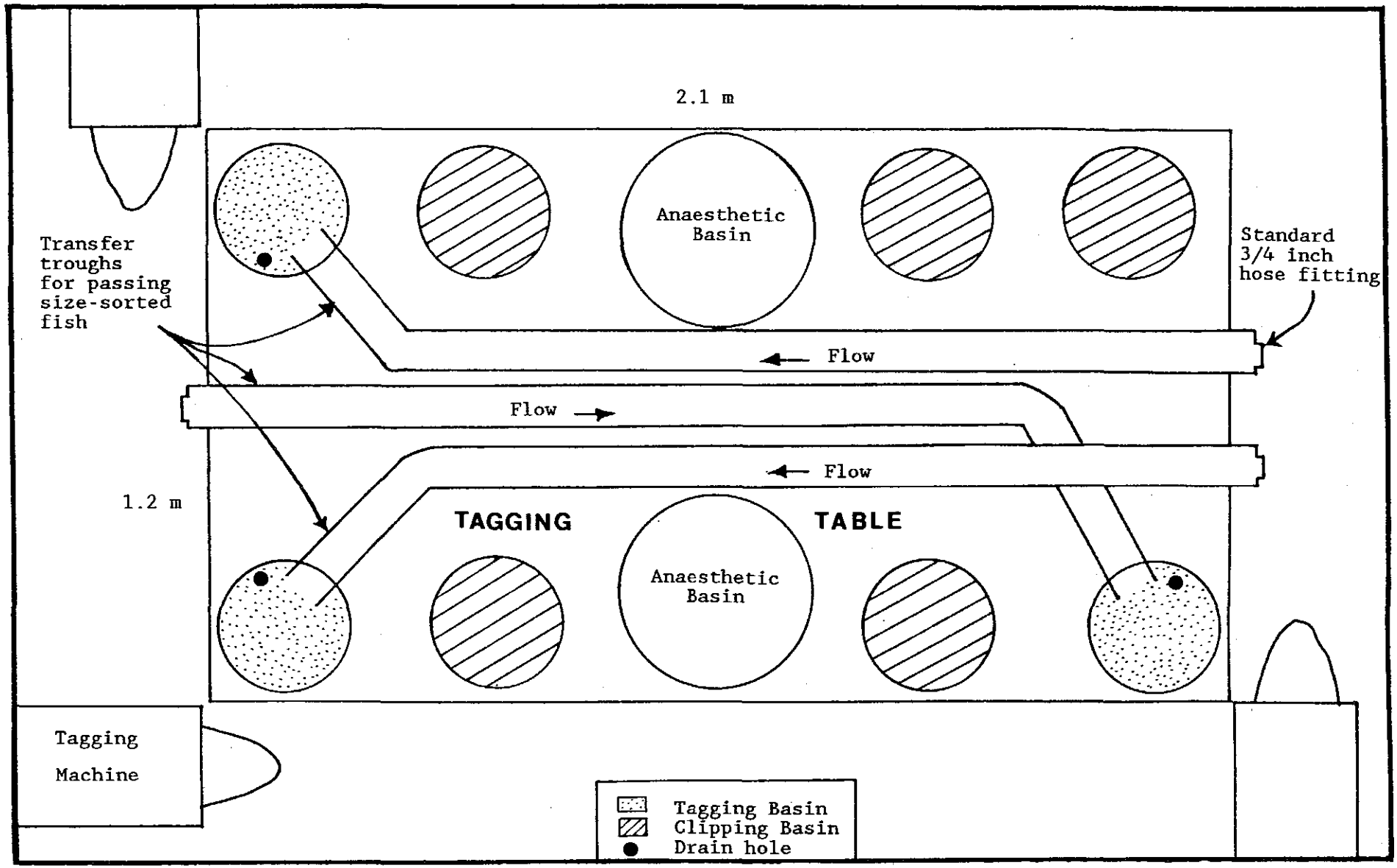

Figure 2. Tagging table set-up for three machines (top view).

Hand cream and plastic gloves should be made available to markers, providing their use does not hinder the marking performance. In the author's experience, most markers who have tried these aids do not like them; however, this option should be made available.

Counters used in ventral fin clipping, should be cleaned and oiled regularly, and checked for accuracy and ease of operation. To keep the counters dry and prevent their rusting, each counter should be enclosed in a small, plastic sandwich bag and the bag closed firmly. These bags are inexpensive and can be changed daily or more often as required.

3. PREPARE THE MACHINES

Unit Assembly

Coded-wire tagging machine units consist of three principal components: the tag injector, the quality control device (QCD) and the power supply. The system is shipped essentially ready to operate, providing a few simple assembly steps are followed. Note that the following instructions relate to Model MKIII tagging machines and may differ somewhat from Model MKIV instructions.

1. Plug the power supply into a 3-wire 120V AC supply line; use of a grounded supply line is vital. The system may be operated from batteries or a generator by using an adapter.

2. Run a large ground wire (at least 14 gauge) from the post on the power supply to a ground clamp on the nearest cold water pipe. Wet conditions while tagging require extra grounding.

3. Connect the power cable first to the power supply and then to the injector control box.

4. Assemble the QCD by installing the supporting legs, attaching the funnel inlet and flexible water lines, and connecting the water supply.

5. Connect the other power cable between the tag injector and the QCD; then connect the touch switch to the injector.

6. Remove the blank head mold base which is protecting the needle and replace it with an appropriate-sized mold for the fish to be tagged; be careful not to over-tighten the screws.

At this point, the tagging machine is assembled correctly according to instructions. To ensure proper fish tagging, special attention must be paid to appropriate fish size-sorting, head mold size, needle penetration setting, machine speed, and careful monitoring of tag placement and tag loss.

Machine Preparation

When a tagging machine is taken out of storage for the spring tagging program, it must be prepared and adjusted for effective operation. The following steps are recommended:

1. Put the rollers back on. New machines allow for a pressure-release switch that separates the rollers (normally tight-fitting) for storage. If the rollers are left pressed together, they will develop a flat spot during the storage period, resulting in erratic tag placement.

2. Clean the cutter assembly with isopropyl alcohol and Q-tips prior to installing the cutter.

3. Insert the cutter assembly. Check that a good cutter edge is present.

4. Load a spool of blank wire for testing; blank wire is available in limited quantities from Northwest Marine Technology (Telephone: 206-468-3375). Have the wire protrude approximately 3/4" out of the front of the needle. Turn the machine on, then make 3 or 4 cuts. Put the interrupt switch "on".

5. Push the tag button once; this indicates the needle depth into the head mold. Push the button a second time and ensure that the tag just falls off the end of the needle. This ensures accurate tag placement. Any longer or shorter needle depth will result in improper tag placement.

6. Ensure the machine settings are appropriate for the needle length. Each machine has a 2-number setting (for "tens" and "units") which describes how far each tag is inserted down the needle and into the fish. The "tens" setting refers to 10 standard half tag lengths (i.e. 0.5 mm x 10), and the "units" setting refers to half a tag length (i.e. 0.5 mm). At a correct machine setting, the tag should just fall off the end of the needle when the touch button is pushed twice. If this does not happen (i.e. needle depth is too shallow or too deep), adjust the tens/units settings, remembering that each unit number upward or downward is equal to half a tag length forward or backward. Normally, the settings should be between 47 and 49. Larger needles have been installed in some of the newer machines and also in those sent back for servicing. In this case, a setting of 52 or 53 may have to be used.

7. Do a test tag with a nose mold. Replace the blank wire spool with the correct coded spool. Cut it two times and turn on the "interrupt" switch. Push the button once to extend the needle and leave it in this position. Estimate the correct size of head mold to be used for the size of fish to be tagged, and place the mold in position. Turn off the "interrupt" switch. Insert an anaesthetized test fish and push the button again to tag the fish. Slice

lengthwise the head of the tagged fish and check for the correct tag placement (also see section below on Tag Positioning).

4. CHOOSE THE ANAESTHETIC

It is the author's opinion that proper use of the anaesthetic is a primary factor in avoiding fish mortalities and in facilitating proper fish handling during the tagging operation. Since new drugs and techniques are rapidly developing, new biotechnical data should be made available to the tagging operators as soon as possible. In addition, a special effort should be made to improve communication between hatcheries and ensure that written records of past experiences are available in order to train new personnel effectively and avoid repeating past mistakes.

At permanent marking stations it is desirable to circulate water or refrigeration lines around anaesthetic basins. This measure reduces the risk of temperature shock to the fish and allows longer use of the anaesthetic before changing it. Good aeration of the anaesthetic solution is also vital since anaesthetized fish cannot pass water over their gills except by opercular movement. For this reason, dosages should be sufficiently low to allow for opercular movement and a recovery time of less than five minutes.

Several different anaesthetics are used for tagging, the most common being 2-phenoxy (2-phenoxyethanol) and MS-222 (Tricane methanesulfonate). While these and other types anaesthetize fish effectively, they differ in chemical composition and elicit different physiological responses in fish. These and other concerns are discussed below. The reader is also referred to Bell (1967, 1987); Bell and Blackburn (1984); Britton (1984); and Turvey and Genoe (1984).

2-Phenoxyethanol

2-phenoxy is an oil-based drug and therefore must be mixed correctly by pouring it vigorously back and forth five or six times between two buckets. This requirement can be a nuisance if the anaesthetic baths are changed every half hour. A concern that the oil-based drug may cause the injectors to jam, is unfounded. In fact, since the machines are cleaned every 3 or 4 days, the choice of anaesthetic does not seem to be a factor in machine jamming.

It is characteristic of 2-phenoxy that the fish will still twitch after being anaesthetized. This can be a problem as the fish may "jump" away from the clipper's hand or the head mold at a crucial moment, thereby resulting in deep clips or improper tag placement.

2-phenoxy is the preferred anaesthetic for fin clipping, especially for chum salmon, as the fish can tolerate a longer time period in the anaesthetic bath. That is, fish can be safely anaesthetized in a 4-5 minute period and then left in the bath for a further 10 minutes without any apparent ill effects. This allows about 200 fish to be anaesthetized at a time instead of a smaller group of perhaps 20. Note that although 2-phenoxy appears to be harmless in the short term, the sublethal and long-term effects are unknown. Therefore, it is cautioned that daily immersion of taggers' hands in the anaesthetic-filled clipping basins may lead to unknown health hazards.

The dosage of 2-phenoxy depends on the species and fish size, and on the amount of water and its temperature. As determined from the questionnaire returns, the recommended dosage at a pH range of 6.3 to 8.1 is 1 ml of 2-phenoxy per Imperial gallon of water (i.e. 1:4,546). The dosage should always be tested before beginning operations to adjust for site-specific factors. Some facilities anaesthetize in a separate container at full dosage, then distribute anaesthetized fish to clipper basins at half the dosage strength.

MS-222 (Tricane methanesulfonate)

MS-222 comes in a powdered form and is more easily mixed than the 2-phenoxy. A stock solution is mixed using 100 g MS-222 and 1.0 litres of water. Subsequently, 10-12 ml of stock solution are used for a 4.5 litre pail of water, giving a concentration of 222-267 mg/l. The contents are then buffered with approximately 3 g (or half a teaspoon) of baking soda.

If the water temperature is high (over 14°C), DO NOT BUFFER since high fish mortalities may result. However, without the buffering agent, the time to immobilization will be longer. This can be remedied by increasing the anaesthetic strength (using up to 14 ml/4.5 litre bucket) and lengthening the fish immersion time in the anaesthetic bath.

MS-222 anaesthetizes fish somewhat faster than the 2-phenoxy (1 minute for the above stock solution and pail size). Therefore, smaller batches of fish (e.g. 80) must be immersed at one time. Fish should not be in the anaesthetic longer than 2 minutes, and less than that if the water temperature is above 10°C. While this procedure requires more rapid handling of fish compared to using 2-phenoxy, it provides better health conditions for the clippers since clipping basins should contain only fresh water with anaesthetized fish.

Marinal

Marinal is a new fish anaesthetic that evidently has no residual effects on adult fish. Therefore, broodstock adults that have been anaesthetized with Marinal can be immediately killed and used for human consumption. Presumably, Marinal is also safer for the tagging crew who are constantly absorbing anaesthetics through skin contact.

The author conducted preliminary tests on Marinal using three different dosages on both chinook and coho salmon. All fish were anaesthetized very quickly but required a long time (6 - 8 minutes) to recover. Reducing the dosage to very low levels did not shorten the recovery time, and the fish twitched, similar to the effects of the 2-phenoxy anaesthetic. Since Marinal appears to be a stronger drug than either 2-phenoxy or MS-222, it is possible that accidental overdoses will occur more frequently unless the operation is carefully monitored. Also, the cost alone will inhibit the use of Marinal; it is retail-priced at $400 per 100 g, compared to $29 per 100 g for MS-222.

Carbon Dioxide

Dissolved carbon dioxide is presently used as an anaesthetic at the Robertson, Tenderfoot and Big Qualicum hatcheries where it appears to be a

successful alternative. Dosages used are 200 - 300 ppm bubbled in with O_2 gas. The anaesthetic solution is changed 1 to 4 times daily.

The primary beneficial aspect of CO_2 is the lack of residual effects which are apparent with MS-222 and 2-phenoxy. The Robertson Creek Hatchery has used CO_2 successfully for a three-year period but the available information is insufficient to provide an adequate data base. More information will be forthcoming in the future.

As with any new technique, it is necessary to learn how to use it in an operational sense. At the Tenderfoot Hatchery, a recirculating system was used initially to maintain dissolved gas levels, but this approach resulted in temperature increases. To counteract this problem, blocks of ice were placed in the recirculating system. This measure, however, resulted in considerable uncontrolled temperature change. At the Robertson Creek Hatchery, a water chiller was purchased which can keep the anaesthetic bath water at a constant temperature (ideally 8-10°C). However, at this hatchery, warm water temperatures are a constant problem. As a result, chilled anaesthetic water may be considerably below the ambient hatchery water in which the fish were reared and to which they may be returned, resulting in a secondary temperature shock. In spite of the above problems, it is clear that a controlled temperature water bath is vital for the use of dissolved carbon dioxide as a fish anaesthetic.

Recommendations on the Choice of the Anaesthetic

Overall, MS-222 is recommended as the best workable anaesthetic for coded-wire tagging, by virtue of its ease of mixing, low cost, short fish immersion time, and minimal exposure for the tagging team.

Where the marking set-up allows, and at those locations which have a system that can be adapted, carbon dioxide gas provides a viable alternative. This method should be explored by each facility individually.

Human Health Hazards

Human health hazards are a further consideration when recommending one anaesthetic over another. Both 2-phenoxy and MS-222 have residual effects to the extent that adult fish anaesthetized with these drugs are not permitted to be sold for human consumption. Also, presumably potential health hazards exist for workers who have their hands immersed daily in either of these two drugs. The exposure time is different for on-site hatchery workers tagging their own fish, since such workers are exposed for only a few weeks each season, compared to travelling crews who are exposed daily for up to 10 months each season. At present, no concrete information exists on actual and potential health hazards, or how these may vary with exposure time and working conditions.

Carbon dioxide, while appearing to be the safest of all the anaesthetics described, will cause headaches in the tagging crew if the tagging area is not well ventilated, as the gas will eventually bubble into the air. Marinal may prove to be a very safe workable alternative but it has yet to receive sufficient field testing to demonstrate its adequacy.

5. CODED-WIRE TAGGING

Basic Operations

1. Fish are dip-netted from the hatchery holding container into a portable bucket equipped with an aeration system (one or two airstones, or a continuous water flow into the bucket). About 700 - 800 fish can be held in a 5 gallon pail, assuming a 2.5 g average fish size, with fewer fish at a larger size. Fish removed from this container are subjected to an anaesthetic bath where they should remain for no more than a few minutes, depending on the anaesthetic used. The senior tagger or tag supervisor nets the anaesthetized fish and distributes them in groups of 20-30 into each fin clipper's basin.

2. Each clipper, while the fish are still anaesthetized, gently picks up individual fish and clips off the adipose fin (see section below on Fin Clipping). The fish is then judged by the clipper to be either "large" or "small" and placed in the appropriate transfer trough (Figs. 1 and 2).

3. While the clipped fish is still anaesthetized, each tagger gently picks up the fish with one hand (head protruding between thumb and forefinger) and inserts the snout into the nose mold of the tagging machine. With the other hand, he/she presses the tag eject button to insert the tag into the nose cartilage and then drops the tagged fish into the QCD funnel of the tagging machine.

4. The quality control device of the tagging machine (QCD) then separates the untagged from the tagged fish. Fish with a tag is directed by a water jet into the tagged container. Fish not tagged or accidentally dropped, automatically goes into the reject container. The number of fish tagged and the number of rejects are recorded automatically and separately by the counting device on the QCD machine.

   Note that the QCD only identifies that there is a tag somewhere in the fish. The only way to determine whether or not the tag placement is correct is to sacrifice the fish and cut into the nose cartilage. Improperly tagged fish may have the tag close to the surface of the snout or deep in the eye socket resulting in subsequent tag loss.

Establishing Fish Size Ranges

As part of the set-up procedure, test fish which were previously sorted for size by the clippers, are tagged and then killed to verify the correct tag placement i.e. in the centre of the nose cartilage. At this point, various sized nose molds are tested to ensure correct tag placement for the likely size range of fish being handled. The killed fish are then laid on the table for the crew's reference during fish sorting, so that the appropriate fish size for a given nose mold is visible to the entire crew. Correct tag placement is also checked at least every two hours throughout the tagging period (see section below on Tag Positioning).

Fish size is an important factor that influences primarily tagging speed and efficiency. Fish that are smaller than the optimum 2.5 g size are often harder to hold and handle by the clippers and taggers, thereby slowing down the operation. Also, fish that encompass a relatively wide size range or are unsorted, result in inefficient use of the tagging machines. That is, if one machine is set up to accommodate 60% of the fish and another to accommodate 40%, then one tagger remains idle more frequently than the other. Optimally, when using more than one tagging machine, the size range should overlap so that the middle range can be handled by either machine, thus maintaining a steady pace throughout. For this reason, a two-machine system with an overlapping size range is considered to be very efficient.

It is important to tag a random sample of the hatchery fish regardless of their size so that a representative size range of the overall hatchery production is marked. If the fish are graded prior to marking so that all small and large individuals are excluded and only the medium-sized fish are tagged, a non-representative group of hatchery fish will be traced through the CWT returns in the recovery system. This defeats the purpose of tagging. For example, in some observed cases, fish were sorted prior to tagging so that large and small fish were set aside, and only the mid-sized fish were retained for marking. This approach allowed more accurate tag placement and better overall tagging success. However, the statistics generated from these tag returns did not reflect the majority of the hatchery population, most of which consisted of either larger or smaller fish which may have experienced different survival rates from the mid-sized fish.

Tag Positioning

Tag positioning should be checked by slicing open the fish head longitudinally with a scalpel. The nose tag should be positioned squarely in the centre of the nose cartilage (Fig. 3). One fish should be sacrificed hourly for each tagging machine to avoid missing a gradual change in fish size which can easily go unnoticed by the crew. Frequent tag positioning checks will also monitor whether the taggers are getting "ahead" of their machines.

Of all the hatchery sites visited by the author, not one tagging operation was using the correct head mold size for the size of fish being tagged, or getting the correct tag placement. Typically, the small fish were tagged too deep and the large fish not deep enough. Yet the questionnaire returns indicated that all the hatcheries knew what the correct tag placement was. Two possible reasons may explain this problem: 1) not knowing what the correct tag placement looks like when examining the freshly killed fish at the tagging site, and 2) not sorting the fish for size prior to tagging. It is the author's opinion that not sorting the fish properly for size was the primary reason for poor tag placement. This omission is best illustrated by an example. At one hatchery, a special tagging area was designed and constructed that included a tagging table with allowance for fish transfer troughs to lead to each of the two or three tagging machines. Although it would have been a simple task for the clippers to place large, medium and small sized fish into different troughs in order to size-grade the fish for each machine, this was not done. Consequently, fish of all sizes were passed to all the machines. This resulted in small fish being tagged too deep and larger fish tagged not deep enough, as determined by random

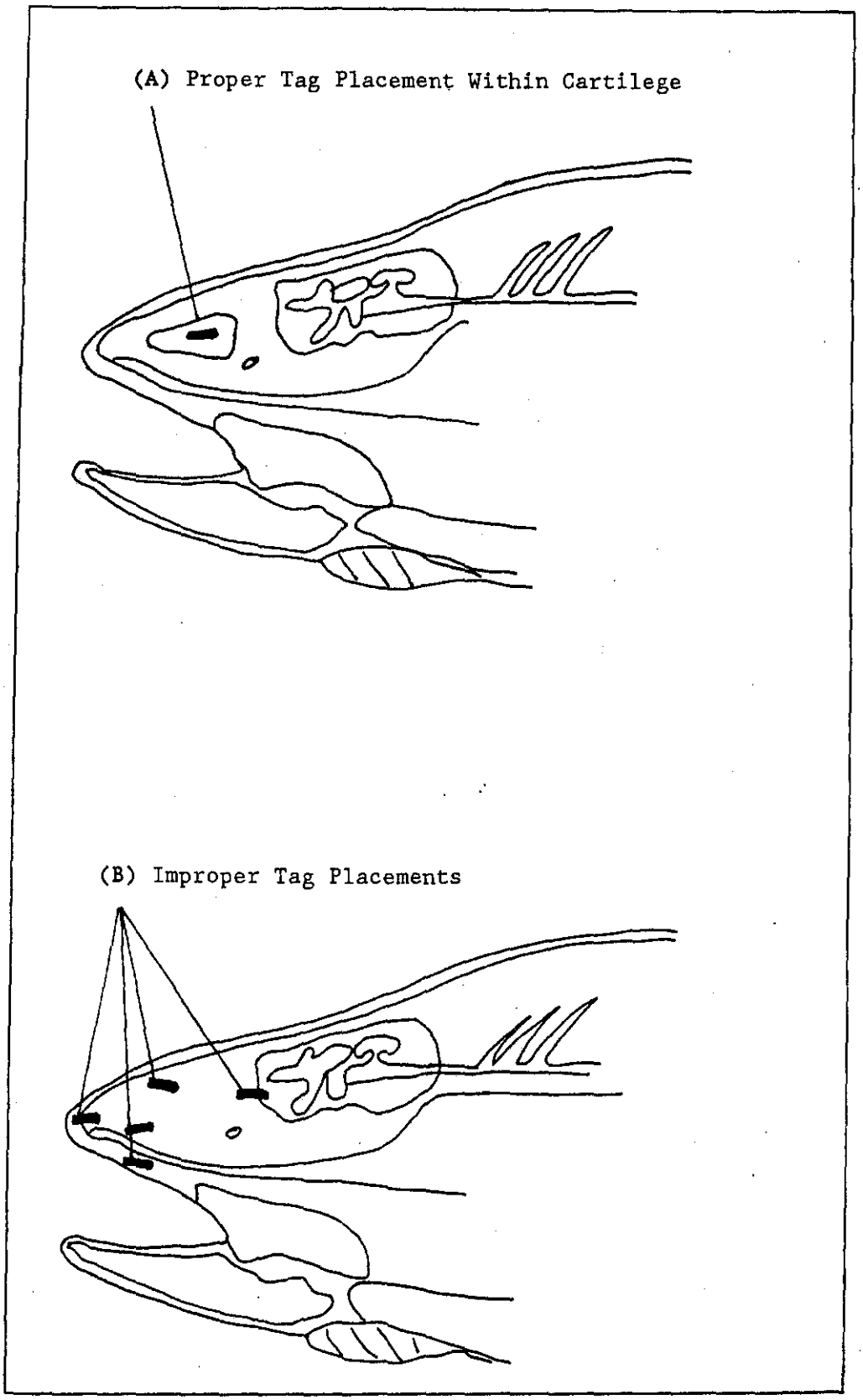

Figure 3. Proper (A) and improper (B) coded-wire tag placement.

checks for tag placement at each machine. Similarly, at another hatchery, fish were sorted prior to tagging so that very small fish were graded out. The remaining population (90%) ranged from 1.5 g to 4.5 g. When the tagging operation commenced, no further size grading was conducted by the clippers so that the same problem of incorrect tag placement occurred despite two machines operating. Random tag placement checks showed that although medium-sized fish were tagged correctly, they represented only 50% of the population. In fact, a 48-hour examination showed a 6% tag loss in the overall group. In both the above examples, the fish were healthy and of an appropriate size for tagging, so that no tag losses need have occurred.

It is imperative for the fin clippers to sort the fish for size during the tagging operation, to ensure that fish sizes and head molds are closely matched. Failure to do this will result in poor tag placement and increased tag loss rate.

We recommend the following measures to correct tag placement:

1. If the nose tag is not placed squarely in the centre of the nose cartilage but rather is too high or too low, change the head mold. A placement that is too high usually indicates too big a mold, while a placement that is too low usually indicates too small a mold.

2. If the tag is centered but placed too deep, pull out the head mold accordingly.

3. If the tag is placed too shallow, push the mold in. Mark the position on the mold with a pencil to know where you started from.

4. If unsure which head mold is best for a group of fish, anaesthetize a random sample of fish and test all the head molds on all the fish sizes. Try and fit the fish to the mold sizes available.

The manufacturer provides nose molds that come with each machine. For the majority of CWTed fish, the following molds are appropriate:

Fish Size	Head Mold
0.7 - 1.0 g	700/lb
2.0 - 3.0 g	200/lb
3.0 - 4.5 g	120/lb
10.0 - 20.0 g	30/lb

Note that head mold size is stamped in base of mold, and that colour of mold may change.

The following head mold sizes are available from the Northwest Marine Technology:

Species	Stock Head Mold Sizes
Coho/Chinook	5,10,15,30,65,120,200,550,1100/lb
Steelhead	2,3,5,7,11,20,36,80/lb
Rainbow	5,8,12,18,27,50,90,200/lb
Chum	700/lb
Pink	2000/lb
Sockeye	60 mm, 90 mm length
Atlantic	7,9,11,15,25,30,50,100,120/lb
Lake Trout	5,8,12,18,27,50,90/lb
Walleye	55,65,125 mm length

The best head molds are often those that are custom-made by the hatchery staff for a particular group of fish. Each group of fish, especially chinook and coho salmon, has its own distinctive head and body shape that differs according to stock, and probably other factors as well. In the author's experience, only about 10 - 15% of the fish tagged in British Columbia are passed through the manufacturer's head molds; the rest are tagged using head molds custom-fitted by the hatchery staff. Head mold making would make an excellent workshop subject. Note that the Northwest Marine Technology has an instructional video and head mold fabrication kit for those who want to make their own molds (J. Kallshian, pers. comm.).

Handling Rejects

The presence or absence of fish in the "reject" bucket is used as an indication of the overall tagging success. Therefore, taggers should not remove rejects from the "reject" bucket during tagging. Instead, the quality control supervisor should closely monitor the number of rejects. Large numbers of rejects are the first sign of tagging problems, and both the machines and the tagged fish should be checked immediately and adjustments made.

Fish in the "reject" bucket should be re-anaesthetized and passed again through the QCD. (Note that unanesthetized fish can actively swim against the water jets and may be improperly directed). If the QCD shows that the fish are indeed not tagged, then they are re-tagged and the numbers adjusted to reflect the total numbers of fish tagged that day. The number of rejects per machine per day can be determined by recording the tag injector numbers prior to tagging the rejects and again after the rejects are tagged. Tag reject rates should be recorded daily for each machine.

If large numbers of fish are found in the "reject" bucket (more than 30 or 40 per day per machine), three items should be checked:

1. QCD problem: Is the QCD machine able to distinguish accurately between the presence and absence of a metal tag? Check the "gain" setting on the machine. Occasionally the QCD will not sort fish properly due to a poor adjustment of the water jets. The jets can

be adjusted to stay on longer to accommodate larger fish, slower tagging rate and/or weaker water pressure.

2. Machine problem: Is the tagging machine not inserting the tag properly? Improper head mold size, improper needle position, etc. may be at fault.

3) Tagger problem: Is the machine operator not tagging correctly? Taggers do have bad days, and the tagging supervisor should monitor how the fish is held, how it is inserted into the head mold, and whether the hand-machine coordination is appropriate (i.e. is the tagger getting "ahead" of the machine).

[Also, do not forget to check whether tag spool has run out.]

Other

Return all left-over wire and empty spools to the DFO Coded-Wire Tag Coordinator or to the Program Coordination and Assessment Division. Do not re-use left-over wire for tagging other species or stocks, or for setting up your tagging machine. If you need wire for machine set-up, Northwest Marine Technology (206-468-3375) will provide, free of charge, wire coded with our agency (02) only.

6. FIN CLIPPING

Hand Movement

The following sections describe how to hold and manipulate the fish during fin clipping.

Adipose fin: The fish should be held in the palm of the left hand (for a right-handed person), with the head of the fish in the centre of the palm, and the tail of the fish protruding between thumb and forefinger (Fig. 4). Wrap the hand around the fish and hold it firmly but gently so that only the tail is protruding. Slide the scissors parallel to and up the back of the fish under the adipose fin until the scissors stop. Then gently close the scissors to make an even, smooth cut. The clipping motion should be slow so that the scissors are closed carefully over the fin. A motion that is too quick may cause incorrect angle of the scissors in relation to the fish, and may result in a poor clip. For example, if the scissors are pointed down, a deep clip will result; if pointed up, a shallow clip with a peak left over will result. Figure 5 shows acceptable and unacceptable adipose fin clips.

Sometimes clippers hold the fish upside down so that they almost have to turn their hand over to get at the adipose fin. This is a very awkward hand movement and results in a poor clip. Furthermore, when tagging the last few fish in a batch, some fish will start reviving from the anaesthetic and will require

Figure 4. Holding and clipping the adipose fin, prior to coded-wire tagging.

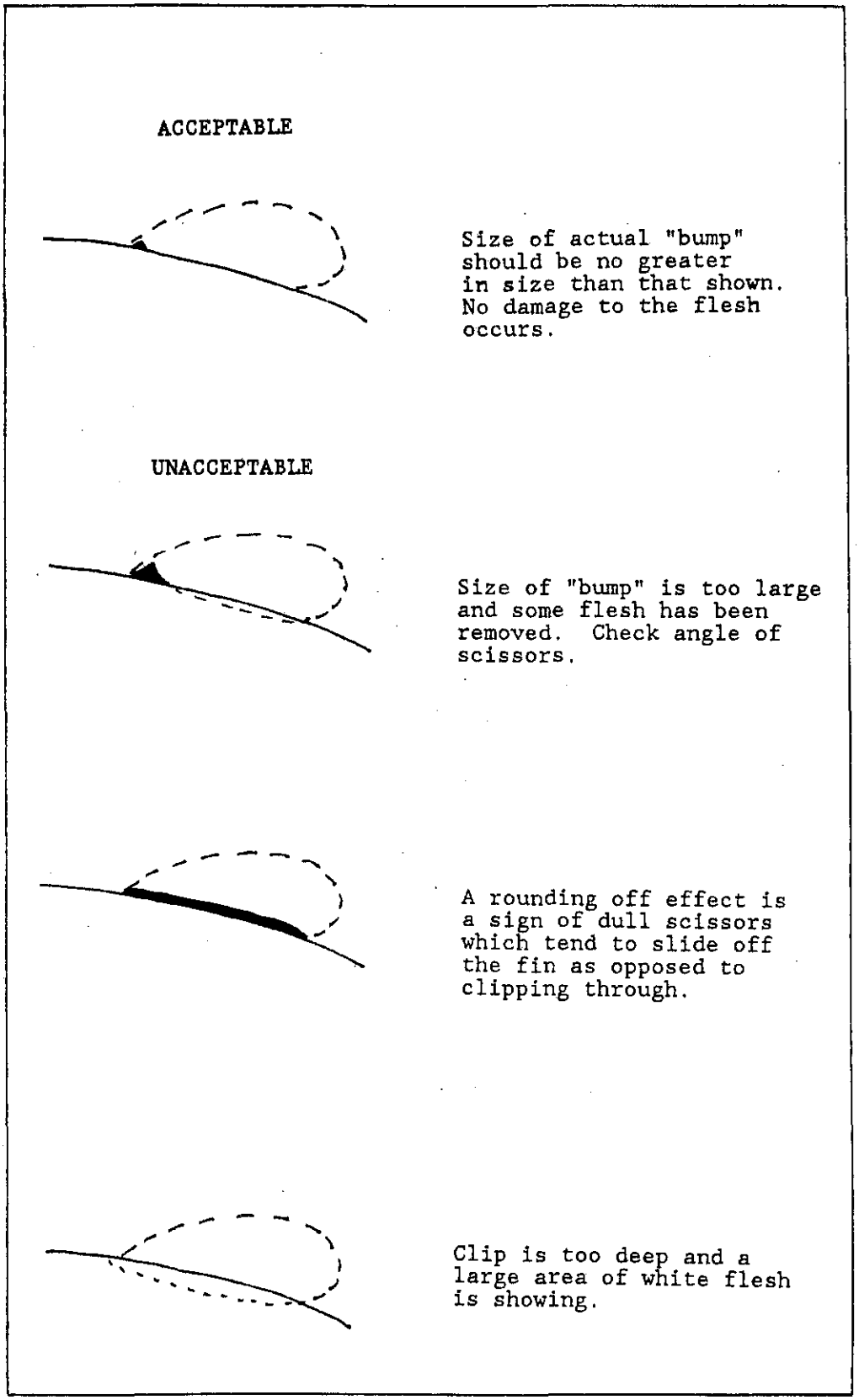

Figure 5. Acceptable and unacceptable adipose fin clips.

a very firm hold. If the hand movement is incorrect, the fish may wiggle at a critical clipping moment, often resulting in a deep clip.

Ventral fin: Ventral fin clipping is the most common marking alternative to adipose coded-wire tagging. The fish is held upside down in the palm of the left hand (for a right-handed person) and supported with the thumb and first two fingers, the thumb holding the head and the belly pointing out. Other workers prefer to hold the fish with the fish's head held firmly by the thumb and first two fingers, with the entire body of the fish, from the gills down, suspended in the air. Either position can be used depending on the clipper. When the fish is in position, slide the scissors up the belly toward the fins, separate the two fins and make the cut. **Note that in order to take off the left ventral fin, the fin on the left (upper) side of the fish must be taken off since the fish is upside down.** It is surprising how many clippers forget this.

A good ventral clip involves clipping the fin at the joint where the fin articulates with the body, so that the fin clipper can feel the "crunch" of scissors cutting the bone rather than the fleshy fin.

Conduct a "clip check". After the initial cut, slide the scissors back up to the fin and check that the entire ventral fin is cut off. Often a strip of fin that is next to the centre line of the fish (the button-up line) is difficult to remove and clip checking is worthwhile to ensure that this "tail" is cleanly cut-off.

Adipose and ventral fins: When clipping both the adipose and ventral fins some workers may clip the adipose first and then the ventral or vice versa. A common method for holding the fish when clipping both the adipose and ventral fins, is to place the fish farther down the hand in the groove between the first and second fingers, with the thumb holding the head. Then after clipping the adipose fin, the fish is turned with the thumb, flipped over on its back, and the ventral fin clipped. Those clippers who hold the fish between their fingers usually use their thumb to turn the fish to clip the second fin, while those who hold the fish with the body suspended in the air usually twist the hand to clip the second fin.

WHAT SHOULD I BE LOOKING FOR?

1. QUALITY CONTROL CHECKS - GENERAL

Always conduct quality control checks. It is human nature that better tagging performance will be obtained with frequent quality control checks. Check frequently tag positioning, tag retention, fin clip quality, mortality levels and marking speed. These quality control checks are summarized below.

1) Tag positioning: Coded-wire tag placement in the nose cartilage of the fish should be checked most frequently. One fish should be sacrificed hourly for each machine, and the sampled fish laid out for better size-referencing while sorting (see also section above on Tag Positioning).

2) Tag retention: It is important to check for tag retention every 24 hours and correlate tag loss rates with each machine. Coded-wire tag retention estimates serve to evaluate the quality of the tagging operation while it is in progress, rather than just to adjust the numbers of tagged fish released. Tag retention estimates are an important part of quality control on each machine and tagger, and provide a fast indicator of tagging success.

3) Fin clip quality: For adipose fin clipping, both the marking supervisor and the taggers should check clips constantly and make the clippers aware of any problems immediately. For ventral fin clipping, a minimum of 10 fish per clipper four times per day should be checked visually. Ideally, this monitoring will require one full-time person conducting constant quality control checks.

4) Fish mortality: Daily fish mortalities can vary from several hundred to one or two per marker. In most cases, no mortalities need occur if proper fish handling and anaesthetic techniques are used. A marking operation that has from 50 to 100 mortalities per day indicates a problem and the reasons should be closely examined. It is therefore important to keep an accurate ongoing count of mortalities.

5) Marking speed: The overall pace of the tagging operation should increase only after quality control standards are safeguarded. For a two-machine coded-wire tagging operation and a standard 8-hour work day, 14,000 - 20,000 fish per day is a reasonable rate.

It is recommended that one hatchery worker be assigned during the marking operation to supervise the supply of fish to markers, perform quality control checks, summarize data, and transfer marked fish back to the rearing containers. This person should also be the one ultimately responsible for the success of the marking operation and should at least participate in, if not be responsible for, the hiring and assessment of the contract markers and the overall performance of the marking contractor. Quality control checks involving tag retention, fin clip quality, fish mortality and speed of tagging are discussed in separate sections below.

2. CODED-WIRE TAGGING

Tag Retention

Tag retention checks indicate whether or not the fish are retaining their coded-wire tags. Both short-term and long-term tag retention checks should be conducted. These are very important as the consequences of high tag losses are substantial. D. Bailey (pers. comm., DFO, Vancouver) estimated that it cost at least $30 to grow each fish, tag it, recover it in the fishery, dissect the

head and enter the statistical information. All of this work and expense is nullified if no tag is found inside the fish to decode. In addition, it becomes impossible to determine the true fishery contribution of a hatchery production group if a biased segment of the adult population is recovered (e.g. if all the large fish lost their pins or only one size group was tagged).

Short-term tag retention: Tag loss estimates are made by taking a random sample of 100 tagged fish and passing them down the spout and into the QCD. If any of the fish enter the reject bucket they are then passed again through the system, and once again unless they clearly indicate a tag. This level of repetition is necessary since the QCD cannot be totally relied on for a variety of reasons. For our purposes, the term "tag loss" refers to the percent of the 100 fish that are definitely untagged. The term "tag retention" is its reciprocal (i.e. if there is 2% tag loss, then there is 98% tag retention).

It is recommended that short-term tag loss estimates be conducted every 24 hours. If there is a 48-hour delay before finding out that tag losses are high, a day is lost in which to correct poor tag placement involving perhaps 14,000 to 20,000 fish. **Daily tag loss estimates also provide a good immediate indication of the overall success of the operation.**

Short-term tag loss estimates should be conducted on each machine separately i.e. if four machines are operating, then four separate batches of fish should be checked. This approach is essential to isolate the reasons for poor tag placement since the reasons are often machine- or tagger-specific (e.g. incorrect head mold, poor size-sorting of fish and improper handling by tagger). Therefore, if machine #4 shows a 4% tag loss while machines #1 and #2 show a negligible tag loss, then the supervisor can concentrate on the machine #4 and its tagger to find the problem.

Long-term tag retention: Long-term tag loss estimates should be performed just prior to release of the fish, and compared to the 24-hour results. It is the author's experience that in properly tagged fish, any tag loss will occur in the first 24 hours, so that the long-term tag loss just before release should be at the same level as the 24-hour loss. For example, at the Quesnel Hatchery, tag loss was estimated daily on four machines, and also prior to release from the hatchery (i.e. up to 2 months after tagging). In this example, the difference between the long-term and the 24-hour tag loss estimates was virtually zero. The average fish size at tagging was 1.8 g indicating that large numbers of 1.0 g fish were also tagged with nearly 100% long-term tag retention. In fish this small, the area of nose cartilage exposed to the head mold is also small so that the use of the right head mold and proper size-sorting of fish are vital.

The Enhancement Operations Division has expressed the following concerns to Stock Enhancement Officers regarding the need for long-term tag retention sampling (C. Cross, DFO Memo, December 29, 1989):

> "Recent work has suggested that our current tag retention sampling is inadequate. Studies from other agencies have indicated that we should be sampling a minimum of 500 and, if possible, up to 2,000 marked fish, depending on the tagged population size, and that the long-term tag retention checks should be conducted no sooner than one month after

tagging. Recommended sample sizes for each species and tagging "block" (i.e. all tag codes pooled) are as follows:

Total Tagged Population (tagged fish only with all tag codes for one species pooled)	Recommended Number of Tagged Fish to Retain for Long-Term Tag Retention Check
10,000	500
20,000	1,000
30,000	1,500
40,000 or greater	2,000

We would like to begin incorporating more rigorous long-term tag retention check procedures for all species receiving CWT's. A suggested sampling regime is to pool a portion of each day's tagging from each tagger in a small container held separately from the rest of the population in e.g. a Capilano trough, or a small floating net pen in the raceway. Note that a separate container for each tagger and day is not required. Rather, all of these "subsamples" can be pooled together to provide a larger composite sample in the one separate container. For a given species, all tag codes and stocks can be pooled to make up the sample but the representation of each tag code should be proportional to that tag code's representation in the total tagged population. If it is desired to maintain stocks of a species separately, the above table can be used to calculate the sample size.

Check the fish for tags with a tag detector as they are collected for the sample and record the number of fish both with and without tags. Do not remove or re-tag fish which are not tagged. Conduct the final tag retention check on the whole sample 4 weeks (minimum 3 weeks) after the last group of tagged fish was added to the sample. This may mean retaining the sample for a short time after the rest of the group has been released. As you conduct the tag retention check, you should also count and record the number of fish which are carrying a tag but not carrying a recognizable adipose clip.

Pooling all marks in this way will generate a single long-term tag loss rate for the entire species, with each tag code having the same tag loss rate. This is the tag loss rate you should use in the release reports.

For operational purposes, you will probably want to continue your 24-hour retention checks to ensure that taggers are maintaining tag placement and general tag quality standards."

At a tag loss rate greater than 2%, it is unlikely that a random sample of the total fish size range is tagged. In the author's experience, a 0.5% tag loss rate is a normal performance standard and a zero tag loss (or 100% tag

retention) should be the ultimate goal of taggers. In reality, many hatcheries report considerably higher tag loss rates (e.g. 4 - 5%, Table 6) and are apparently unaware that they could do better. It is important that the reasons for the higher tag loss rates be examined and understood since most factors (e.g. correct fish sorting, correctly sized head molds, tag placement checks, frequent tag loss estimates) are under the control of the tagging crew and can be easily corrected once the problem is identified.

3. ADIPOSE FIN CLIPPING

Clip Checking

Both the supervisor and the taggers should check adipose clips constantly and alert the clippers immediately of any problems. The tagging supervisor should check the adipose clips visually by taking fish out of the taggers' basins prior to coded-wire tagging, or if possible, from the sorting troughs so that individual clippers can be identified. Adipose fins are best inspected by placing an anaesthetized clipped fish in a water-filled vial, holding it up to a light source and viewing with a naked eye or through a magnifier. The taggers can check for poor clips during the tagging process. Although deep clips are usually not apparent to the taggers, peaks or bumps of adipose fins will often be noticed when glancing at the anaesthetized fish in the basin prior to tagging.

Determination of Good and Poor Adipose Clips

A good adipose clip is one which is cut neither too deep nor too shallow, and where no evidence exists that the fin was ever present when viewed under a dissecting microscope or through a magnifier. (For correct fin clipping technique, see section above on Fin Clipping - Hand Movement.)

The two most commonly encountered problems in adipose fin clipping are clips that are too deep or too shallow. Too deep a clip will be visible as a white spot in the clipped area indicating that some skin was taken off (Fig. 5). Since any scalping of the back of the fry may result in fish mortality, such clipping should be discontinued. A proper clipping technique will not eliminate deep cuts completely, but will reduce their incidence to perhaps 10 to 20 fish per day, instead of 15-20% of the total group or, in one documented case, over 50% of the fish tagged.

Too shallow a clip will appear as a peak or a bump of an adipose fin left on the clipped fish and will be visible when the fish is turned sideways (Fig. 5). The most common problem is to leave a tip at the anterior part of the adipose fin. Such an incomplete clip, especially on small fish, will likely result in regeneration.

Adipose Fin Regeneration

The degree of regeneration of an incompletely clipped adipose fin is still unclear. At the Capilano Hatchery, it appears that coho fry coded-wire tagged but left with a considerable bump on the fin have matured to adults with the adipose fin remaining as a large bump, without any apparent regeneration. However, since no control studies were conducted to identify how many fish with

Table 6. Comparison of tag loss and fish mortality rates considered acceptable at the surveyed hatcheries.

Hatchery	Species	Weight (g)	% Tag Loss 24 hr - 96 hr	% Mortality
Capilano	Coho	10 - 20	5[a]	<0.25
	Chinook	2.5 - 8	5[a]	<0.25
Chehalis	Chum	0.9	3	0.5
	Chinook	1.5	3	0.5
	Coho	9	3	0.5
Chilliwack	Coho	15	2 - 5[b]	<0.1
	Chinook	6	2 - 5[b]	<0.1
Clearwater	Chinook	>3.0	<5	0
	Coho	>3.0	<5	0
Conuma	Coho	10	1 - 2	0.5
	Chinook	3 - 5	1 - 2	0.25
Eagle	Chinook	2.1	2	<0.5
	Coho	1.6	3.5	<0.5
Inch	Chum	0.9 - 1.1	5	0.5
	Coho	13 - 20	5	0.5
	Chinook	5 - 10	5	0.5
Kitimat	Chinook	10	1 - 2	0
	Chum	1 - 2	5 - 10	<1.0
	Coho	20	1 - 2	0
Little Qualicum	Chinook	4	0 - 5	1.0
Nitinat	Chinook	2.2 - 4	0 - 3.5	0.1 - 0.2
	Coho	1.2 - 5	0.4	.05
Pallant	Chum	1.5 - 2.5	<2 - 5	<2.0
	Coho	2	<2 - 3	<1.0
	Chinook	2.5	<2 - 3	<1.0
Puntledge	Coho	2.25	2	0.1
	Coho	15	2	0.1
	Chinook	5.5	2	0.1
	Chum	1	2	0.1
Quesnel	Chinook	2	1	0.4
	Coho	5	1	0.4
Quinsam	Chinook,Coho		0 - 2[c]	0
Robertson	All Species		1 - 2	0.1
Snootli	Chinook	2 - 5	6 - 10[d]	0.4[e]
	Coho	1.5	3	
Spius	Chinook,Coho	2.5 - 5	4 - 7[f]	<0.05
	Chinook	3 - 5	1	<1.0

[a] Over a 2-week period.
[b] Up to one month holding period.
[c] Over a 7 to 10-day period.
[d] Up to 10% loss after 5 days.
[e] Per week.
[f] Over an 8-month period.

complete adipose fins also contained coded-wire tags, it is impossible to say what proportion of the fins did or did not regenerate. J. Thomas (Mark Recovery Program, pers. comm.) indicated that chum and pink adults which are tagged at a very small size (<1 g), commonly show substantial adipose tip regeneration. (See also section below on Ventral Fin Clipping - Fin Regeneration.) Therefore, while a very minor peak is acceptable, anything larger may lead to regeneration, and a large peak is not acceptable. It is very difficult, especially with small fish, to reclip properly a second time since this often results in too deep a clip. This emphasizes the importance of clipping properly the first time.

Other Concerns

The Enhancement Operations Division has expressed the following concerns to Stock Enhancement Officers regarding adipose fin clipping (C. Cross, DFO Memo, December 29, 1989):

> "With the exception of steelhead, international agreement dictates that adipose clips are ONLY to be used in conjunction with coded-wire tags. Adipose clips are not to be used as a primary and independent mark. If there are fish in a tag group which you feel are too small to tag, don't tag or clip them at all. Never apply an adipose fin mark (except in combination with another fin for chum and pink) without attempting to insert a coded-wire tag.
>
> Note, however, that "adipose only" fish which result from shedding of coded wire tags, are an expected and acceptable component of coded wire tag programs."

4. VENTRAL FIN CLIPPING

Responsibilities

In a fin marking operation where six clippers are involved, between 250 and 300 fish will be checked each day for ventral fin clip quality. Ideally, the quality checks should be performed by both the regular hatchery supervisor and the contractor's marking supervisor. It is also best that in such a large operation, quality checking be a major part of the marking supervisor's duties. The clipping supervisor anaesthetizes fish, portions them out to the clippers, conducts quality control checks at frequent intervals (see below), conducts a similar number of fish count checks (see below), and updates the data records. However, from a competitive bidding viewpoint, contract marking crews usually budget for a marking supervisor who clips half the time in addition to performing quality control checks. Whether or not a full-time quality control worker should be budgeted for, is a matter for the hatchery management to decide.

Container System

Quality control checks are based on the following container system as practised at the Nitinat Hatchery. Each fin clipper places his or her clipped fish into a separate recovery basin with a net liner capable of holding up to 1,500 fish. A random sample of clipped fish is removed every few hours from each clipper's recovery basin and checked for clipping quality (see section below on

Frequency of Checks). If the quality of fin clipping is satisfactory for the particular batch of fish, the supervisor will move these fish to a larger container. If the quality is considered unsatisfactory, the supervisor has the option of requesting that the fin clipper reclip that group of fish.

Frequency of Checks

The marking supervisor should conduct quality control checks as often as possible, and at least four times/day/clipper (or just before morning coffee, lunch, afternoon coffee, and the day's end). The supervisor takes a random sample of at least 10 fish from each clipper's recovery basin, re-anaesthetizes them and checks for ventral fin clip quality. Under this system, each fin clipper will have at least 40 fish sampled randomly each day from his or her work, and checked for fin clip quality. This means that, given a standard crew size of six clippers, a total of at least 240 fish will be re-anaesthetized and checked daily. A sample greater than 10 fish per clipper is normally unnecessary as poor ventral clips are usually repeated sufficiently often that they are evident in a sample of 10. Sampling 20 fish per clipper rarely changes the outcome of the quality control checks. However, more frequent checks are very desirable, as long as the checks are done at the end of the period when the entire production for each clipper is subject to sampling. In general, there are never enough quality control checks.

Count Checks

A count check taken by the supervisor is recommended to ensure that both the clipper and the counter provide accurate counts. This should be done for each clipper at least twice daily at random times. Fish count checks will also serve to discourage competitiveness among clippers to clip more fish than their team-mates. Such competitiveness usually leads to substandard clips and sometimes inflated numbers. While on the job, clippers are able to see only their own counter and basin. The supervisor records the numbers from each counter and then resets it to zero. It is human nature that workers will want to see the supervisor's clipping records to compare their own performance with that of the other clippers. It is recommended that the records remain confidential, and that clippers ask their supervisor for ways in which they could improve.

Visibility of the Ventral Fin Clip Area

When checking for ventral fin clip quality, a small number of anaesthetized fish should be placed in a water-filled glass vial, and viewed under a magnifier with a good light source. The vial should be turned around in the light to allow the curve of the glass to magnify the fins sufficiently to look at the completeness of the clip. Although dissecting microscopes also have been used for this purpose, they usually result in slower checking (i.e. require more adjustment time), and cause more eye strain. Also, microscopes generally do not allow accurate viewing of the fin clip area.

Determination of Good and Poor Ventral Clips

When the ventral fin is clipped properly, the clipper should feel a small "crunch" indicating that the joint of muscle and bone tissue (where the fin meets the body of the fish) has been amputated. After completing what feels like a proper clip, the clipper should visually check that the cut has not been too deep. In a deep cut, the body cavity may be exposed and such fish will succumb fairly quickly after handling. If the clipper feels that he or she is cutting air, then the critical wad of tissue has probably been missed.

If the clipper is getting poor clips, the problem can be corrected in the vast majority of cases by fixing or changing the scissors. It is poor economy to hire a team of clippers to mark thousands of fish, yet place the work quality in jeopardy through lack of good scissors.

However, if the scissors prove to be adequate, then the individual clipper is at fault and should be monitored for the following: how the fish is held, whether the scissors are held at the proper angle, what part of the scissors is used for clipping (perhaps the tips are used when the back of the scissors might be better), and whether clipping is done too fast. The clipping supervisor must be prepared to re-instruct the clipper, accept slower speed, and carefully check virtually every other fish until a correct clip is obtained. At times, however, an individual worker simply does not have the patience or manual dexterity to do the job, and should be replaced.

The determining factor for good or poor ventral clips is the appearance of the returning adults. Generally, the Mark Recovery contractor is fully experienced in identifying clips. In fact, the present contractor has taken great pains to ensure whether a clip is present or not, including feeling for the bumps on the ventral fin rays where regeneration may have occurred. However, when large numbers of fish are being checked for marks (usually the case with pink and chum), it is easy to miss questionable fin clips. Also in hatchery situations, checking for marks is rarely the only activity, and both questionable and good marks can often be missed by the busy and perhaps inexperienced staff.

In most situations, it is fairly easy to determine a true ventral clip. Occassionally, the ventral fin may be obviously misshapen in the returning adult. In the case where the "tail" of the ventral fin remains, the evidence of a clip is unquestionable despite a partial regrowth of the fin. In this case, the ventral "tail" remaining on the fish should be considered a good clip. When in doubt, the bumps on the fin rays where the fin regenerated are usually obvious on close inspection. In questionable situations, bite marks and other scars are often present on the fish body wall to indicate naturally-missing fins rather than true clips.

It is recommended that during clipping all ventral fin clips be judged either good or poor, and the clip counts adjusted accordingly. This approach rejects the 4-zone system that had been used previously to judge ventral fin clips. The 4-zone system determined percentage reductions in clip counts based on the zone of the fin where the clip was made and the likelihood of regeneration. If a portion of the fin was left unclipped, it was possible that the fin would regenerate in such a way that it was obvious it was clipped.

Hence, a partial clip could be just as effective a mark as having the whole fin missing. However, the degree to which the clip counts should be adjusted was questionable (i.e, should 25% of the counts be discounted if 1/4 of the fin remains?). On the other hand, with a good/poor system, if a clip is judged as poor, it should be clearly discounted.

Thus, during a quality control check, if 1 in 10 fish is judged to be a poor clip, then the number of fish clipped in the 2-hour batch that was sampled is adjusted down by 10%. This will ensure that at least 90% of the fish are known to have good clips, with no chance of regeneration. Therefore, if a clipping team clips 56,000 fish but quality control checks indicate an overall 10% incidence of poor clips, the records will show that only about 50,400 fish were definitely released with good clips.

Fin Regeneration

Data on fin regeneration rates are scarce, at least partly due to the time lag between juvenile marking and adult recovery. Unlike coded-wire tagging where tag losses can be monitored after 24 hours, fin clippers must wait a period of years to obtain any tangible evidence of their clipping effectiveness. At this time, two examples of fin regeneration can be considered.

The effectiveness of pink salmon fin clipping was examined by Bams (1972, 1979). In this case, 85,000 Headquarters Creek fry and 77,000 unfed hatchery fry (weights approximately 0.24 g) were released with AdRV and AdLV fin clips respectively. Returning marked adults survived at 1.24% (hatchery) and 1.19% (creek), as determined by recovering marked adults from commercial canneries at Vancouver and Namu and from the spawning area. Subsequently, the published data were re-examined for differential regeneration rates of the two fin types. Results indicated that the mean regeneration rate was 3.53% for the adipose fin and 1.11% for the ventral fin. This indicated a significantly higher regeneration rate for adipose compared to ventral fins over the four brood years of study. The study also found that, as the marking crew gained experience over the four brood year period, the total rate of fin regeneration (adipose and ventral fins combined) dropped from 9.50% to 1.77%.

In recent years, the Nitinat Hatchery also had an opportunity to examine ventral fin clip regeneration. This survey was made easier by very large returns of chum salmon to local waters in 1985. In the 1985 fishery, a mark recovery program was initiated in the Area 21 commercial catch to establish the proportion of hatchery fish present (MacKenzie MS 1987). Samples taken from high-volume conveyor belts showed a high incidence of regenerated ventral fins:

	Number of Regenerated Ventral Fins	Degree of Regeneration	Regenerated Fins As % of All Clips Recovered
	123	1/4	25%
	120	1/2	24%
	45	3/4	9%
Total	288		58%

In response, the hatchery staff have improved quality control which led to much lower fin regeneration rates as evidenced in current fishery recoveries (D. Bailey, pers. comm.). It is unfortunate that fin clipping conducted previously did not apply discount factors to poor clips, so that the 4-zone and percent discount system could be evaluated.

5. MORTALITY

Acceptable Mortality Level

An acceptable tagging mortality level is 100 - 200 mortalities for every 100,000 fish tagged, or 0.1 - 0.2% of the tagged population. At the surveyed hatcheries, acceptable tagging mortality levels ranged from 0% to <2.0% (Table 6). In fact, it is possible for only 10 or 20 fish in a group of 100,000 to succumb during a tagging operation. Normal rates should be about 5 mortalities per day and if this increases to about 40 per day, both the tagging supervisor and the hatchery manager should begin looking for specific problems. The marking procedure itself does not result in marking mortalities. However, fish handling during tagging may be incorrect, or the fish may be smolting, or not fully recovered from a recent disease treatment, or unhealthy as indicated by increased mortalities prior to tagging. Specific fish handling concerns that should be checked when mortalities occur include anaesthetic mis-use, deep clips and poor water quality. These and other mortality factors are discussed individually below.

Anaesthetic Mis-use

Anaesthetic mis-use is the primary cause of fish handling mortalities. The length of time the fish are left in the anaesthetic bath and the concentration of anaesthetic are the primary concerns. Note that:

1. Leaving the fish in an anaesthetic bath too long will result in fish kill.

2. Not changing the anaesthetic frequently enough will result in oxygen depletion and increase in the bath temperature, both factors leading to fish stress and possible mortality. It is the author's experience that the anaesthetic bath temperature can rise 2°C within just over half an hour. This increase is sufficient to shock the fish but this state is not apparent when they are immobilized.

Assuming correct anaesthetic concentration, the following precautions are recommended to minimize tagging mortality from anaesthetic mis-use:

1. Carefully monitor the length of time that the fish are immersed in the anaesthetic bath.

2. Change the anaesthetic bath every half hour, and provide constant aeration and temperature monitoring to assure adequate oxygen levels and an even ambient temperature in the anaesthetic bath.

Since a proper anaesthetizing procedure is a crucial part of the marking operation, retain the same person in charge of the anaesthetic throughout the operation if that person shows ability to keep the fish alive. See also section below on Poor Water Quality.

Deep Clips

Deep clips sustained during adipose fin clipping will expose muscle tissue which can become fungussed and possibly result in long-term mortality especially in smolting fish. Normally, it will take a few days for the injured area to become covered with fungus and form a visible white spot. Therefore, it is important that the marking supervisor check for deep clips both on the clipping table and in the recovery pens several days later.

Deep clips sustained during ventral fin clipping may expose the body cavity and kill the fish, usually within 24 hours. This form of mortality is more immediate compared to the longer-term and far less frequent mortality associated with deep adipose clips.

Although good quality clipping of ventral fins should take priority over any remedial post-marking treatment, the following treatments may reduce mortality. A Malachite Green dip following marking can be used to control fungal growth, especially in the event of large numbers of deep clips or multiple clips where the fish are more mutilated (e.g. ventral clips in addition to adipose clips and coded-wire tagging). Dosages are approximately 1:20,000 (or 1 g per 5 Imperial gallons of water) for a 10-second dip. Such a dip is not recommended as a preferred practise, as it is now known that Malachite Green is a carcinogen affecting human health. This practice is now illegal in the United States.

Fungal growth on clipped fish may be controlled also with antibiotics (in particular terramycin) wherever water temperatures are high, providing the fish are already under treatment for disease, or they show other signs of stress. However, it is recommended that post-marking treatment not include antibiotics, as such treatment could encourage the growth of resistant fungus strains.

Poor Water Quality

Water quality can deteriorate rapidly during the course of a tagging operation, causing fish stress and increased mortalities. Water quality testing should be conducted on 1) source water used at tagging tables, 2) anaesthetic bath, and 3) receiving water.

1) Source water used at tagging tables (e.g. water pumped from the head tank)

   Check the following:

   i) Clarity - should have no suspended solids.

   ii) Dissolved oxygen - should be at or near saturation level. Increase low oxygen levels with aeration.

iii) pH - if it is below the hatchery norm, buffer the anaesthetic bath.

iv) Temperature - see Table 1 for maximum temperatures during tagging. Note that having different temperatures in different holding containers can also stress the transferred fish.

2. Anaesthetic bath (see also section above on Anaesthetic Mis-use)

The anaesthetic bath should be changed at least every half hour, primarily to maintain ambient temperature, but also to ensure a constant dosage level. Rising temperatures will affect the potency of the anaesthetic and increase the speed at which the fish succumbs. Water temperature in the anaesthetic bath can change very rapidly, especially when operating outdoors in warm weather. A temperature change of 1-2°C is normally within operational limits but beyond this level the anaesthetic solution must be changed. Recirculating water is primarily intended to maintain a constant temperature but such water often heats up nearly as much as standing water, as indicated by thermometer checks. A thermometer should be kept at the bottom of the anaesthetic bath and in each of the clipping basins.

In addition to temperature checks, conduct pH and dissolved oxygen checks hourly in the anaesthetic bath. Buffer with sodium bicarbonate when necessary, and ensure that all anaesthetic bath water is aerated.

3. Receiving water

Receiving water for tagged fish also should be checked for dissolved oxygen, pH, and temperature. In particular, water in small receiving containers should be aerated. If water testing is not done, any evidence of stressed fish should initiate water testing and immediate corrective action.

Other Factors

Assuming that the anaesthetic procedure, deep clips and water quality are not a problem, a comparison of daily pre- and post-tagging mortalities should indicate whether or not a disease factor is affecting fish health. This step is necessary since severity of the disease may be aggravated by the added stress of tagging and possibly high water temperatures (e.g. 14 - 15°C). If tagging cannot be postponed until water temperatures decline and/or disease factors abate, the only option left is antibiotic treatment. It is recommended that 10 days of terramycin treatment be undertaken after tagging in order to keep other infectious agents reduced until the fish recover (G. Hoskins, Pacific Biological Station, pers. comm.).

Incorrect tag placement itself usually does not cause immediate mortality, although the long-term effect of improperly placed tags is unknown. However, if the tag is placed too deep in the fish, that tag will normally come out through the eye socket, resulting in both tag loss and possible fish blindness.

6. SPEED AND EFFICIENCY STANDARDS

The overall pace of a marking operation should increase only after quality control standards are safeguarded. The first one or two days of marking should focus on training workers to tag and clip properly, while closely monitoring tag placement, tag loss and mortalities, and accepting a lower than normal tagging rate. Once quality marking is assured, the speed of the operation will improve so that the overall average numbers marked per day will likely be acceptable.

Minimum accepted speed standards for ventral fin clipping are not provided here specifically, since this is an individual variable -- once quality clipping is demonstrated, speed will increase. However, the supervisor should determine whether or not a worker has sufficient manual dexterity. According to questionnaire returns (Appendix E), the average speed per clipper for single clips is approximately 600 per hour, and for double clips (i.e. adipose-ventral) is 400 per hour.

Unlike the fin clipping programs, coded-wire tagging is a team effort and some speed and efficiency standards are appropriate:

No. of Machines	No. of Taggers	No. of Clippers	Number of Fish CWTed per Day
1	1	2	6,000 - 10,000
2	2	4	14,000 - 20,000
3	3	6	26,000 - 28,000

The primary factors affecting the tagging speed are the experience of the crew (especially the taggers), the level of teamwork they exhibit, and the speed of the tagging machines themselves. Minimum marking standards should be about 1,000 fish tagged per machine per hour, or about 7,000 fish daily for a one-machine operation and 14,000 fish daily for two machines. Note that this standard will be reasonable for some operations but not for others. In particular, a hatchery that undertakes tagging for only one or two months every year will have difficulty assembling an experienced crew and maintaining optimum tagging conditions. By comparison, a contract tagging crew that is operating perhaps eight or nine months every year should be expected to show a greater degree of efficiency. It is possible for an experienced crew to reach an average of 8,500 - 9,000 fish per day per machine,and thus tag 18,000 fish per day using two machines while still maintaining 100% tag retention.

Smaller fish (2 g to 10 g) can be tagged at a minimum speed of 14,000 per day for two machines (as above) but in reality the operation should be reaching 16,000 to 18,000 per day for a moderately efficient crew. Very large fish (15 g and up) are tagged more slowly, so that minimum speed standards are about 12,000 fish per day for two machines.

It is assumed that at the above speed standards, tagging mortalities and tag losses are closely monitored and kept to a minimum. That is, speed must be a secondary consideration to the quality of tagging. Whenever tag losses reach more than 1%, the crew should slow down and correct this problem before continuing. The tagging objectives are better served by a team that tags 17,000 fish per day with no tag loss than one that tags 20,000 fish per day with 3% or 4% tag loss.

7. DATA RECORDING

It is important to keep accurate and complete records of each tagging operation as the tagging proceeds. Such records facilitate quality control and enable comparison among hatcheries. Based on the author's experience in many different hatcheries, records should include tag loss rates, mortality rates, and tagging speed and efficiency standards. These records will allow workers to have a yardstick against which to measure their own performance. It is also important to record the numbers of small, diseased or otherwise damaged fish that are removed from the tagged population, and to adjust the release population accordingly.

The Enhancement Operations Division has expressed the following concerns to Stock Enhancement Officers regarding CWT data recording (C. Cross, DFO Memo, December 29, 1989):

> "Please make a brief comment on the release report for any group of fish which you feel are sufficiently unhealthy at release as to have lower survival than normal. Flagging unusual conditions such as this can assist data users from other agencies.
>
> Keep tagging data (e.g. number tagged, number unmarked, etc.) separate for each tag code. Do not sum these data over two or more tag codes as it can potentially ruin the data for any adult analyses. The only exception to this is a common tag loss rate for several tag codes for a given species, where all tag codes and stocks are pooled to make up a representational tag retention sample."

It is recommended that standardized data forms be used, so that they can be easily interpreted by the Headquarters staff, resulting in better communication and follow-up throughout. Appendix F contains proposed data record sheets for coded-wire tagging operations, based on the Quesnel Hatchery format. Appendix F also includes a proposed data record sheet for fin clipping operations, based on the Chilliwack Hatchery format, and provides sample data. A standardized fin clipping form is necessary to provide a proper interpretation of the clipping results. The form must show evidence of quality control checking, frequency of poor clips, and clearly show the number of good clips that have been released.

TAGGING MACHINE TROUBLESHOOTING

1. CLEANING AND MAINTENANCE

Frequency of Cleaning

While the manufacturer generally recommends daily cleaning, this is usually not necessary. Machine cleaning takes too long at the end of the working day, and often the machine will jam after it has been cleaned so that the tagging operation itself is placed at risk. Normally, when the equipment is set up, everything is cleaned and sterilized, and a thorough machine cleaning will often be done at the end of each tagging week. In the interim, the machines should be left "on" 24 hours each day in order to keep the parts warm and dry and thereby render the cutters less likely to seize up.

The ideal frequency of cleaning tagging machines should be about every three days, providing that the machines can be left with the power on for 24 hours each day. If the tagging site is remote and requires a generator so that the power will be turned on and off, then the machines should be cleaned daily.

Cleaning Procedure

Equipment maintenance is based on cleanliness. Always ensure that the needles and needle carriers are clean and free of grime. Also ensure that the cutter motor, cutter housing and the cutter itself are clean. When cleaning a tagging machine, the primary area is the tag injector. The QCD is basically uncleanable, except for removing surface dirt and grime, and ensuring that the electrical connections are dry and rust-free. The following steps are provided for cleaning the tag injector:

1. Remove the face plate and then remove the needle carrier by undoing 1 or 2 screws (Figure 6). Some machines have the original push arm assembly (2 screws) while the newer models have a single arm action (1 screw). Remove the bar assembly and take out the cutter (note which edge is in place for re-installation later). Soak all the pieces in isopropanol.

2. While the parts are soaking, dip a Q-tip in isopropanol and clean out the cutter assembly (i.e. motor that the cutter fits into). Also, clean underneath the assembly where water drips in.

3. The front of the motor drive assembly where the needle goes in and out of the cutter can be cleaned with fine steel wool and buffed so that the needle has an easy entry into the cutter assembly. Steel wool is also used to buff the back of the needle carrier to make sure that it is clean and smooth so that the needle has an easy entry and exit in that area. Note that the manufacturer does not recommend the use of steel wool for cleaning the above parts.

4. The cutter, face plate, needle and needle carrier, after soaking for a few minutes, should be dried on a paper towel. **It is important that these pieces be dried thoroughly before they are reinstalled in the machine.**

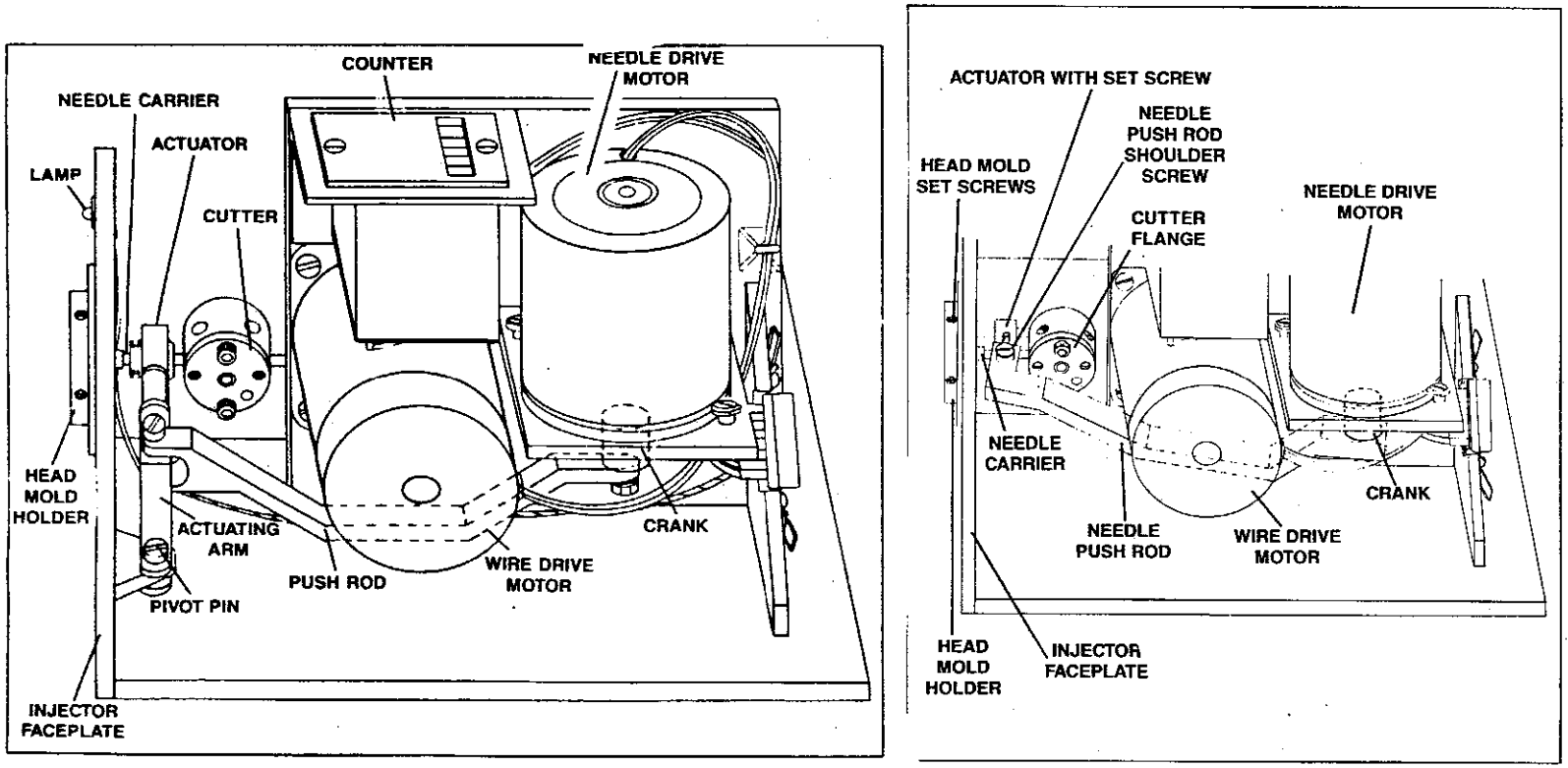

Figure 6. Coded-wire tag injector mechanism showing push arm assembly (2 pieces) and single arm action (1 piece).

If they are inserted in a wet condition, they will seize, simply because of the very tight fit of the moving parts.

5. The cutter should be installed by paying careful attention to aligning it with the same cutting edge as before cleaning. This is done by noting which edge it was on when first removed. Each cutter pin has a notch on the top or the bottom, and on one side so that one can determine proper alignment by the position of the notch and by the plus or minus switch on the control box. Put the screws back in the cutter.

6. Slide the needle carrier back into the cutter motor assembly. Place the drive arm back into the socket on the needle carrier, and put the screw back on. Carefully position the face plate back on (if not done carefully, the plate can bend the needle). Continue with additional assembly details as outlined in the NMT Instruction Manual (Appendix A).

7. Machine is then loaded with blank wire, put in the "on" mode and run several times to make sure it is not jamming. If it is jamming, take it apart and put it back together again as this action usually solves the problem.

Keep a record of edges on the cutter and of the number of cuts per edge in order to get the most use out of this piece. If the cutter is not re-assembled using the same edge, that edge can be wasted by abandoning one side after only 10,000 cuts when it could have provided 100,000 cuts.

Appendices A, B and G contain information from the manufacturer on cleaning and maintenance of the tagging machines, and describe fully the machine parts and their assembly. Refer to these appendices for further details.

2. TAG INJECTOR

Tag Injector Jamming

Jamming is not a major issue, provided the workers are competent at fixing the problem. Remember that the machine will jam rarely with regular maintenance, i.e. keeping it clean, making sure the back of the needle funnel provides a smooth, clean entry for the needle, examining the cutting edge and examining the tags being cut (i.e. looking at the cut tag edge under the microscope to assure that it is a clean cut). Sometimes a machine will jam all day long and then perform well for the next two weeks.

Why does a machine jam?

- If a machine is not clean.
- If the needle is bent.
- If the funnel where the wire feeds into the needle has the slightest scar or dent on it (Fig. 7).
- If the cutter edge is worn out and bending the rear of the cut tag.
- If the rollers have a worn out spot so that they are not pushing the wire out properly.

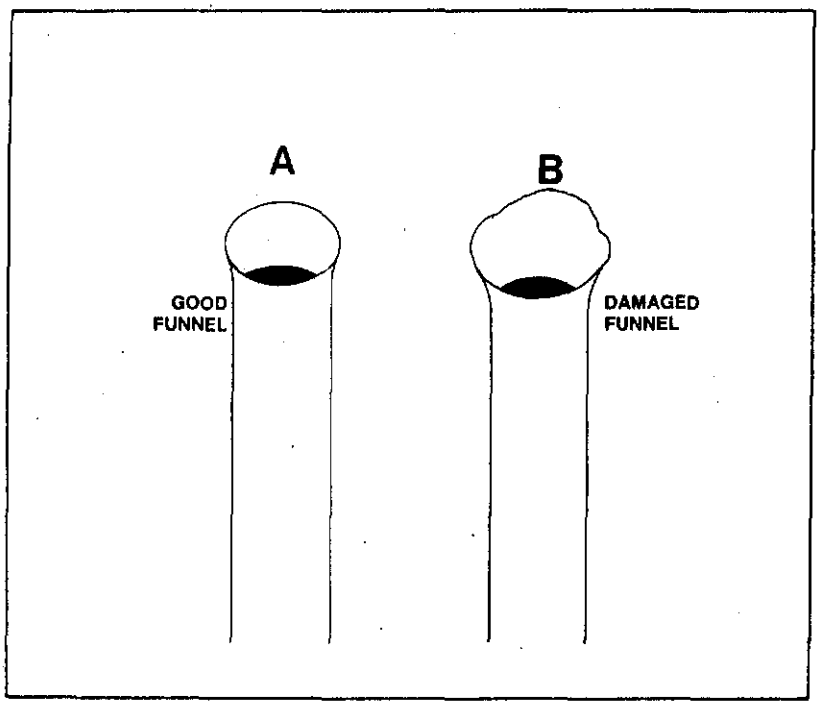

Figure 7. Needle funnel showing new (A) and worn (B) condition.

- If there is a power surge or outage and the machine is in the middle of cycling.
- If the wire is not coming out the needle far enough and is sucked back in.
- If a piece of wire is jammed in the wire guide.
- If everything is going too well and you haven't had a problem all day.

Fixing a jam is a process of elimination:

1. The first step is to load the wire again. Often this will solve the problem, but if the machine jams a second time or if you can't reload, examine the cutter edge and check the cut wire for a clean cut. Also review your information on how many cuts have been incurred on that edge. That is, if 112,000 cuts on that edge were recorded, chances are the cutter is at fault, and you should move to edge two, three or four.

2. Clean out the jam, the cutter and the needle. Reload some blank wire and try again. If you are not getting a good cut and a minimum of 25,000 cuts are recorded on that side, then try a new edge. If you try a cutter edge that you know is absolutely new and the machine still jams, then it is time to look for another reason.

3. Next, check the funnel at the back of the needle. If there is the slightest scar or dent in that surface, the wire will not feed properly and will cause a jam. Take the needle out and examine the funnel surface to see that it is clean and smooth. Note that the needle must extend out the back of the needle carrier at least 1/16th of an inch. If the needle is flush with the back of the needle carrier, the likely reason for jamming is that the wire cannot feed in, i.e. there is too great a gap between the back of the needle and the front of the cutter.

   Therefore, first try a new cutter edge. If that doesn't work, check the funnel at the back of the needle for scars, and at the same time ensure that the needle is protruding the correct 1/16th of an inch.

4. If the machine is still jamming, examine the rollers. Do they have deep ruts that could be causing the roller to slip and not push the tag out properly, and instead are possibly sucking the tag back in? Check also the drive roller alignment/adjustment, and replace rollers if necessary.

5. If jamming continues, look at how far the wire is coming out. Every time a new needle is put in, check the setting on the tag depth (units and tens) since every needle is a slightly different length. Also, ensure that the tag is just falling off the end of the new needle when the machine is in the interrupt mode. If after all the checking the machine still jams, the problem is more serious.

6. Change the cutter one last time.

This final point is important. Consider a machine jam where the machine would tag five fish and then jam although everything was cleaned and replaced

3 or 4 times. As it turned out, the brand new cutter was faulty but because it was new, no fault was suspected until the very end. Chances are that everything else was fine but at that point all the other pieces were changed anyway. Therefore, do not give up until the cutter edge has been changed one last time, even if this does not appear to be the problem initially.

Poor Wire Feed

Sometimes the wire is not feeding into the tag injector properly, or when it does, it comes through very stiffly. If this happens, clean out the wire guide (see next paragraph) since the following problem is suspected. When the wire comes through the rollers, it immediately goes through the wire guide before entering the cutter. It has happened several times that a piece of wire can actually be jammed in the end of the wire guide so that the wire cannot be fed properly. Therefore, if the machine is jammed for no obvious reason but you know that the wire isn't being fed properly, chances are that a piece of wire is stuck in the wire guide. The wire guide must then be removed and cleaned.

To clean out the wire guide, remove the rollers and also loosen the hexagonal nut on top of the cutter motor assembly. Then, pull out the wire guide at the back of the cutter motor assembly, clean it and put it back in. Note that the wire guide is about one inch long, costs about $50.00 and is extremely brittle. If it is dropped, pulled too hard or twisted, it will break. Without the wire guide the machine is inoperable. For this reason, the suggested list of spare parts includes a wire guide.

Occasionally, the fish are not being tagged although the machine is cycling properly. In this case, check the spool wire and see that it is not snarled or wound too tight. Remove the spool, carefully loosen the wire and replace with a new spool, or leave the spool off the post and peel off 6 - 8" of wire before proceeding with tagging.

No Power

On occasion, the tagging machine will be set up and the power switched on but no power will reach the machine and QCD, as evidenced by the red indicator light. In such a case, check the fuse in the power pack, although usually the fuse does not need replacing. If it is determined that the cord carries power but none is reaching the machine, try a different power pack. If this measure works, send the non-working power pack to the Northwest Marine Technology for repairs as it cannot be fixed on site.

Poor Cycling

Occasionally when the machine is plugged in and the power is on, the machine will not cycle although the lights are on. The first step is to try a new touch switch. If this does not work, then the control box within the tag injector is likely at fault. Use a spare control box. If this measure succeeds, send the faulty control box for repairs to the Northwest Marine Technology as this unit cannot be fixed on site.

Sometimes the machine will run erratically, particularly in a situation where the power source is a generator that may not be providing close to 120 V. The machines do not require all of 120 V (they will run on 115 V) but if the generator is providing, e.g. 103 V, the tagging machines will not run properly. The cycle will be fast on one fish and slow on the next, with no consistency as to how fast the tag injector is cycling. Also, the QCD will often start clicking for no apparent reason; it will detect one fish but not the next. Again in this case, the generator may not be providing sufficient power. It may be that although the generator is a 3,500 watt unit, it needs a tune up or perhaps needs to be run faster in order to reach the 120 V required. Since the tagging machines will continue to operate (although erratically) on low voltage, it is sometimes difficult to determine the cause of erratic performance unless there is a voltage regulator on the generator that shows that the output is below the required 115 - 120 V.

Head Mutilation

After a fish is tagged, a half-moon shape should be visible with the naked eye at the point where the needle went in, rather than a round, white hole. The latter type of hole indicates that the needle has become blunted with use and perhaps has developed a straight edge instead of an angle. Sharpen the needle and increase the angle to provide a good clean entry into the fish head. Besides causing a fungus problem, a blunted needle will leave an easy exit path for the tag that was just injected.

Improper Tag Length

Grooved rollers can result in the tag being cut off at the wrong length since the tag was not pushed out all the way. The correct remedy is to replace the rollers entirely when they get a groove or a rut in them, then recheck for correct tag cut off length. It is a mistake to remove the rollers, shave them down to eliminate the groove and then reinstall them, since the diameter of the rollers determines the tag length. That is, a smaller roller will result in a shorter tag length cut.

Occasionally, the tag injector will load properly, the wire will be extended but not cut off. In this case, the cutter is seized and the remedy is to remove it, clean it by soaking in isopropanol, and reinsert it.

3. QUALITY CONTROL DEVICE (QCD)

The control box within the QCD has three screws: a gain, delay and pitch. The gain is used to detect the tag, the delay to determine the amount of time that the water jet stays on, and the pitch is merely the horn device on the QCD.

The QCD should be operated with the lid open, and with the jet mechanism clearly visible so that the operator can adjust water flow, delay and even the gain without disturbing the operation. This approach is more efficient for conducting QCD repairs than having to remove the tag injector, opening the lid, removing the solenoid, cleaning, replacing the solenoid, putting the lid back on, etc. Note, however, that the manufacturer recommends that the QCD lid remain

closed, since an open lid allows more water on the QCD control box, and this is a major cause of failure.

When troubleshooting the QCD, first ensure that the gain, delay and pitch settings are appropriate, as described in the following sections.

Gain Setting

The setting on the "gain" screw allows detection of the tag. Under normal conditions, if the screw is turned all the way to the right, set, then turned back 1/4", this process usually achieves an ideal setting for the machine to detect the tag. However, if the crew is working under fluorescent lights, the lights tend to throw off the QCD somewhat, so that it may be necessary to turn the gain switch down another 1/4" because the QCD may click and detect a fish when none is present.

Occasionally the QCD will not detect a tag, although a clearly tagged fish passes through. In this case, the gain should be checked to ensure that it is turned on fully, then turned back 1/4". It is possible that somehow the "gain" screw has been turned back and is not capable of detecting the tag. However, if this measure is unsuccessful, the only other possibility is that the QCD control box has malfunctioned. To test this, switch control boxes with another machine and if the problem is resolved, send the faulty control box for repairs. In summary then, if a fish is dropped through the QCD, and no clicking noise results, check the "gain" screw and failing that, switch control boxes from a QCD that works.

In the event that the QCD begins clicking for no apparent reason and a generator is used as a power source, check if the QCD is receiving sufficient power.

Delay Setting

The setting on the "delay" screw determines the amount of time that the water jet stays on in order to sort the tagged from untagged fish. If larger fish are being tagged, the delay must be set at a longer jet which can push a larger fish through. If smaller fish are being tagged, the delay can be set at a shorter jet with a very fast action so that the tagger is not slowed down unnecessarily. It is recommended to set the delay switch at the highest speed possible that will still enable the tagged fish to be pushed over to the correct side. In practice, turning the "delay" screw to the left decreases the duration in which a jet ejects a marked fish, so that smaller tagged fish can be pushed over quickly with little water. Turning the screw to the right increases the duration up to two or three seconds in which the jet ejects a marked fish.

Finally, the direction of the water jets on the QCD can be adjusted by hand. The jet can be moved left, right, raised or lowered, to ensure that the fish goes into the tagged passage with a 99.9% sorting success. Watch the fish pass down the system and adjust the jets so that the water first hits the fish on the head, then moves down the fish body.

No Water Jets

Sometimes when a tagged fish is dropped through the QCD, the click of the solenoid is heard but the fish still passes into the reject bucket. In this case, the solenoid is probably plugged up and no water jet comes on to force the fish into the other stream (the QCD is designed so that the water always runs into the reject bucket). In this case, it is necessary to take the solenoid out and unplug it. This action is time consuming. The solenoid is very sensitive and it takes only a very small grain of sand to make it inoperable. This situation can be avoided by taking two precautions:

1. Purchase a water filter from the manufacturer ($125). Use of a water filter has been very effective in reducing the downtime of solenoids.

2. Increase the water pressure running through the QCD. This measure will help flush through any residual sand or grit particles that may be in the system. Caution: there is some evidence that water pressure greater than 40 psi to the QCD (i.e. 25 psi to the solenoid) may be detrimental to the solenoid, since the spring-loaded core within the solenoid can be jammed shut. If this happens, lower the water pressure.

Pitch Setting

The pitch is the horn device on the QCD. If there is more than one QCD in a room, each machine can be distinguished by its own pitch tone when it is rejecting fish. It is permissible to cut the wires leading to the speaker as there is no need to hear the beeping noise all the time. The taggers know when the machine is rejecting fish because they don't hear the clicking noise of the solenoid turning the water jet on.

4. CUTTERS

Selecting an Edge

Each cutter edge must be carefully selected and used in order to maximize the number of cuts obtained and monitor cutter performance. To set the cutter on a given edge, note that the inner core of the cutter has a slash mark on it, indicating which edge is being used. If the slash mark is up, the machine is using either edge #1 or #2; if the slash mark is down, the machine is using either edge #3 or #4. To use cutter edge #1, insert the cutter so that the slash mark is up, then set the control switch on the control box to "+" so that the machine will select edge #1.

Recording Number of Cuts

A cutter maintenance book should be kept at each injector box to ensure that the operators keep a record of cutter use. Most importantly, when other workers borrow tagging machines, they should also be required to keep a maintenance log on the tag injector. This way, when the machine is returned, the original operators can sort out the history of the cutters and determine

whether or not the previous operation is a factor in machine jamming. The maintenance book should contain a log of any changes to the cutters, the number of injector counts when the cutters were changed, the date when new needles or rollers were installed, etc. Figure 8 shows an example of a cutter maintenance log sheet. Note that in the event of poor cutter performance, a cutter log provides valuable reference when dealing with the manufacturer. Table 7 shows that cutter performance was monitored at only eight of the surveyed hatcheries, and that estimated cuts per cutter varied widely from 50,000 to 500,000.

In practise, the taggers should begin with edge #1 by setting the tag injector mechanism as described above, and then recording the start number. If the machine jams, the first option is to reload the wire and try again. If the machine still jams and the cutter has done more than 100,000 cuts, then move to cutter edge #2. This is done by simply changing the control switch on the control box from "+" to "-" and by recording the counter number in the maintenance book. If it is subsequently necessary to change the rollers while using edge #2, then the counter number when this occurs should also be recorded. If the machine begins to jam again and this coincides with, for example 116,000 cuts, then switch to cutter edge #3. This can be done in two ways: 1) take the cutter out and turn the inner core over so that the slash mark is now on the bottom, indicating that edges #3 and #4 can be used, or 2) leave the cutter in place and move the inner core by turning the knob on the cutter motor (arrow indicator). When the cutter is rotated, also change the control switch back from "-" to "+". Most of the time it will be convenient to remove the cutter and replace it manually. This is because cutter edge changes will be associated with jams and wire reloads that require this operation anyway. However, it is possible to change the orientation of the cutter core by simply adjusting the knob on the cutter motor.

Cutter Maintenance

Cutter maintenance essentially involves cleaning. Every two or three days, the cutter should be taken out and cleaned properly by removing it from the unit, soaking in isopropyl alcohol, drying thoroughly, and replacing it into the unit. The slash mark on the cutter core should be in exactly the same position as when the cutter came out.

When the machine is not in active use, the cutter should be taken out and cleaned before storage. Note that the cutter pin and sleeve are a matched set and should not be intermixed during cleaning and storage. The cutter originally arrives from the manufacturer in a cardboard box packed with styrofoam, and should be returned to that box for storage. Make a note on the box which tagging machine the cutter came from, and refer to the maintenance log to indicate which cutter edge was used last and what the tag count was when the cutter was removed.

Hatchery : Tenderfoot Ck. Machine Name/Number : 2

Date	Tag Injector #	Comments
Mar. 16/89	289643	new cutter installed - edge # 1
Apr. 12/89	309946	new rollers installed - needle reamed
May 16/89	346699	cutter changed to edge # 2 - 57,056 cuts obtained off edge # 1
May 31/89	365704	new needle installed
Sept. 4/89	449993	cutter changed to edge # 3 - 103,294 cuts obtained off edge # 2
Oct. 19/89	463357	Machine cleaned/winterized. Cutter to be re-installed on edge # 3

Note: This record sheet has been filled out to give an example of how the records could be kept. This or perhaps a different format, can be adopted. The important point is to have some record sheet which stays attached inside each injector box, to record all information pertaining to that machine.

Figure 8. Proposed record sheet for cutter use and maintenance.

Table 7. Comparison of numbers of machines, cutters, cutter use and machine downtime at the surveyed hatcheries, as determined from questionnaire returns.

Hatchery	Number of Machines			No. of Spare Cutters	Cutter Monitoring[a]	Estimated cuts/cutter	% Down-time
	Used	Borrowed	Spares				
Big Qualicum	2	0	0	2	Y	200-400,000	2%
Capilano	3	0	1	2 - 3	Y	150,000	15-30 min/day
Chehalis	2	1 - 2	1	2	N	150,000	10 - 15%
Chemainus	-	-	-	-	-	-	-
Chilliwack	2	1	1	1 - 2	Y	100,000	2 - 5%
Clearwater	3	0	1	1	N	200 - 300,000	3 - 5%
Conuma	2	1	1	2	N	500,000	2 - 4%
Eagle	4	1	0	5	Y	100,000+	-
Inch	2	0	0	2	N	400,000	< 4%
Kitimat	2	0	0	2	Y	100 - 250,000	approx. 1%
Little Qualicum	2	2	0	0	-	-	1.5%
Nitinat	2	0	0	2	Y	110 - 200,000	1/2 hr/day
Pallant	2	1	1	2	N	-	15 - 30 min/day
Puntledge	2	0	0	2	N	500,000	1/2 hr/day
Quesnel	5	4	1	2 - 4	Y	100 - 400,000	-
Quinsam	2	0	1	2	Y	240,000	-
Robertson	3	0	1	2	N	-	5 - 10%
Shuswap	1	1	0	1	N	-	10 - 15%
Snootli	2	1	1	7	N	50,000	1% over 20 days
Spius	1 - 4	3	0 - 1	1	N	-	4 - 6 hr/20 days
Tenderfoot	2	2	1	2	N	-	5 - 10%

[a] Keeping a record of the number of cuts per cutter edge.

KEY RECOMMENDATIONS

The following key recommendations should be followed at all hatcheries to ensure consistent high quality marking.

CODED-WIRE TAGGING

1. Utilize a 2:1 clipper/tagger ratio.

2. Remove a random sample of the fish population for tagging, without selecting for size.

3. During tagging, size-sort the fish in order to obtain the best tag placement on all size ranges. This is mandatory when marking random samples.

4. Check for correct tag placement by sacrificing 1 or 2 fish hourly per tagging machine.

5. Check for short-term tag loss every 24 hours using samples of 100 fish per machine in order monitor the performance of both taggers and machines. In addition, check for long-term tag loss no sooner than one month after tagging; monitor a minimum of 500 marked fish sampled randomly in order to generate a single tag loss rate for each "tag block" for each species; use this long-term tag loss rate in the release reports.

6. Strive for 100% tag retention.

7. Average numbers tagged per day should not be less than 1,000 per hour per machine. Higher numbers per day can also be achieved.

8. When anaesthetizing fish with MS-222, buffer with baking soda (sodium bicarbonate). However, if marking is conducted at water temperatures higher than 14°C, do not buffer.

9. Have the manufacturer speed up the cycling of control boxes for the tag injectors. Obtain from the manufacturer spare control boxes for Model MKIII for both the tag injectors ($2,000) and QCDs ($1,000).

FIN CLIPPING

1. Provide an adequate supply of good, sharp scissors. DFO should pre-order scissors in bulk before the marking season begins.

2. Use fresh water for clipping basins if possible, since clippers should avoid having their hands immersed in the anaesthetic.

3. Each clipper should have his/her own recovery basin. This basin should be large enough to hold 2-hours worth of clipped fish.

4. Conduct quality control checks on fin clips every 2 hours on each clipper by examining 10 fish from the previous 2-hour marking period. Based on these 10 fish, adjust the actual numbers clipped by that worker during that period.

5. Examine anaesthetized clipped fish in a vial filled with water to provide a quick and easy test check on fin clip quality.

6. All facilities currently fin clipping chum or pink salmon should adopt a good/poor clip rating, i.e. if the fin is not completely removed, it should be discounted 100%. Abandon the previously used system of clip zones or percent discounts.

7. A count check is recommended to ensure that both the clipper and the counter are accurate. This should be done for each clipper at least twice daily at random times.

CODED-WIRE TAGGING AND FIN CLIPPING

1. Quality control checks should be shared between the marking supervisor (whether contracted or not) and the regular hatchery personnel.

2. Consider assigning a specific hatchery staff member to conduct specific duties during marking, such as conducting quality control checks, monitoring anaesthetic strength, and supplying fish to markers.

3. Consider setting up an additional Headquarters quality control program where each hatchery would send a random sample, e.g. 200 fish, of each unique mark release group. These would be checked for fin clip quality against a set standard, while CWT tagged fish would be dissected for tag placement and decoded to ensure correct codes and clean tag cuts with no scratches (D. Bailey, pers. comm.).

4. Consider setting up some formal mechanism with the Mark Recovery Program to obtain annual data outputs showing ventral fin regeneration for clipped pink and chum, and adipose fin regeneration for CWTs (D. Bailey, pers. comm.).

5. Use standardized data forms to record all relevant marking information.

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APPENDIX C

CONSTRUCTION DETAILS FOR A TWO-MACHINE TAGGING TABLE

LIST OF EQUIPMENT AND CONSTRUCTION INSTRUCTIONS FOR A TWO-MACHINE TAGGING TABLE SET-UP

List of Equipment (see Fig. 1 in text)

-One sheet of 1/2" plywood for the tagging table (0.9 m x 1.2 m)

-Fibreglass to make two tagging basins

- One Rubbermaid Dish Basin (14½" x 5½") to make one anaesthetic basin
- 10 Rubbermaid Sink Basins 12" in diameter; of these, 4 will become clipping basins, 4 will become net liners for clipping basins, and 2 will become net liners for tagging basins
- Netting and contact cement for net liners
- 3" schedule 40 PVC piping to make transfer troughs (need two 7-foot sections)
- 45-degree pipe angles
- 90-degree plexiglass supports for transfer troughs, with bolts and wing nuts for attachment to the tagging table
- 5" long piece of stiff black plastic piping
- 3-foot section of clear plastic piping ½" in diameter
- Hose couplings
- Hose clamps
- PVC primer, glue and silicone
- Saw horses
- 5-gallon buckets and perforated aluminum to cover the drain holes

Construction (see Fig. 1)

Tagging table: The tagging table is constructed using one sheet of ½" plywood with a 4" wood edge all around. Six holes are cut out of the table which is then fibreglassed to prolong its life and facilitate keeping it sterile. Of the six cut holes, five are 11" in diameter and will accommodate three clipping basins and two tagging basins. The sixth hole is 13" in diameter and will accommodate the anaesthetic basin.

Clipping basins: Each clipping basin consists of a Rubbermaid Sink Basin 12" in diameter and fitted right into the 11" diameter hole cut in the table. Each clipping basin has a net liner, its rim constructed by cutting off the top of an extra Rubbermaid Sink Basin, also 12" in diameter, to

a depth of approximately 2". This surface is then sanded with fine sandpaper. Sufficient netting is cut out to allow for a ½" overlap to the underside of the basin top. The netting is then glued to the basin top using contact cement.

In addition to the above three clipping basins fitted into the tagging table, a similarly constructed fourth clipping basin, also provided with a net liner, is placed on top of the tagging table next to the anaesthetic basin (Fig. 1).

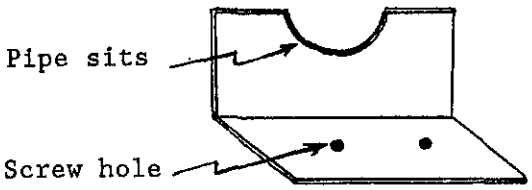
Tagging basins: The two tagging basins are formed fibreglass basins, 11" wide and 4" deep, and each with a ½" drain hole (see below). Each tagging basin has a net liner constructed as described above for the clipping basins.

Anaesthetic basins: The single anaesthetic basin consists of a Rubbermaid Dish Basin (14½" x 5½") placed in the 13" diameter hole cut in the table. Unlike the other basins, the anaesthetic basin has no net liner.

Transfer troughs: Transfer troughs are used for transferring size-sorted fish from clippers to taggers, and are made from 3" schedule 40 PVC piping. Two 7-foot sections of piping are cut in half lengthwise. A table saw with a fine-toothed blade has worked well in the past. After cutting, the rough pipe edges are filed. Laying the cut pipes on the tagging table will help determine at what point to cut the correct length of piping and attach the 45-degree pipe angle which was also cut in half. The piece cut off at the end can then be used to take the fish from the angle to the tagging basin (Fig. 1). The end fitting where the hoses attach consists of a round fitting which allows for a screw cap and a standard hose coupling to be attached. This assembly and all others are glued together with PVC primer and glue. You may also choose to silicone the "gap" where the two pieces of pipe are attached to the 45-degree angle (a depth of about ¼"). This allows for a smoother ride down the pipes.

Pipe supports: The troughs are supported on the tagging table using 90-degree plexiglass supports cut out as shown:

Each trough should have two supports on the table, one about 3" tall and the other about 2" tall. These supports are placed under the troughs as needed: one support usually about two feet from the end where the hose hook-up is located and the other near the angle. In addition to these table supports, two larger supports (12" x 9") are required, one at each table end.



All supports are attached to the table using bolts and wing nuts for easy removal. Having accomplished the above steps, the tagging table is now set up and hooked up to hoses.

Where does the water go, you ask? As mentioned above, each tagging basin requires a ½" hole drilled into it (Fig. 1). Be careful to position this hole away from the tagger's pick-up point. Next take a 5" long piece of stiff black plastic piping that fits through the drain hole and attach it to a 3-foot section of clear plastic piping ½" in diameter (a hose clamp works well). The 5" long piece of piping can be raised or lowered through the drain hole to adjust water height to the tagger's preference. You may need to silicone around the drain hole to avoid heavy water leakage. Take the other end of the clear tubing and attach it underneath the table with a hose bracket: 

The amount of "loop" in this hose will determine the rate at which the water drains into a bucket under the table. The larger the loop, the slower the draining. The water coming down the transfer troughs now drains through this hose into buckets located under the tagging table. One bucket is for holding fish just prior to marking and the other bucket is for holding the unusually small or defective fish. At this stage, each side of the tagging table has a fresh aerated water supply.

Saw horses can be used to support the tagging table. Make sure the table height is comfortable for the taggers.

Buckets: The buckets consist of 5-gallon white plastic containers each with a 2" x 4" hole cut out on each side, near the top of the bucket. Perforated aluminum riveted over the holes works well to cover these openings allowing water to escape.

Additional Information: The author (T. Nichols) will gladly provide additional detailed instructions regarding the construction of a sorting/grading table, and any additional information on the construction of sorting troughs for use with the tagging table. Please do not hesitate to call.

Thyra Nichols 245-7685

A video showing the construction and operation of a tagging table, is also available from the author.

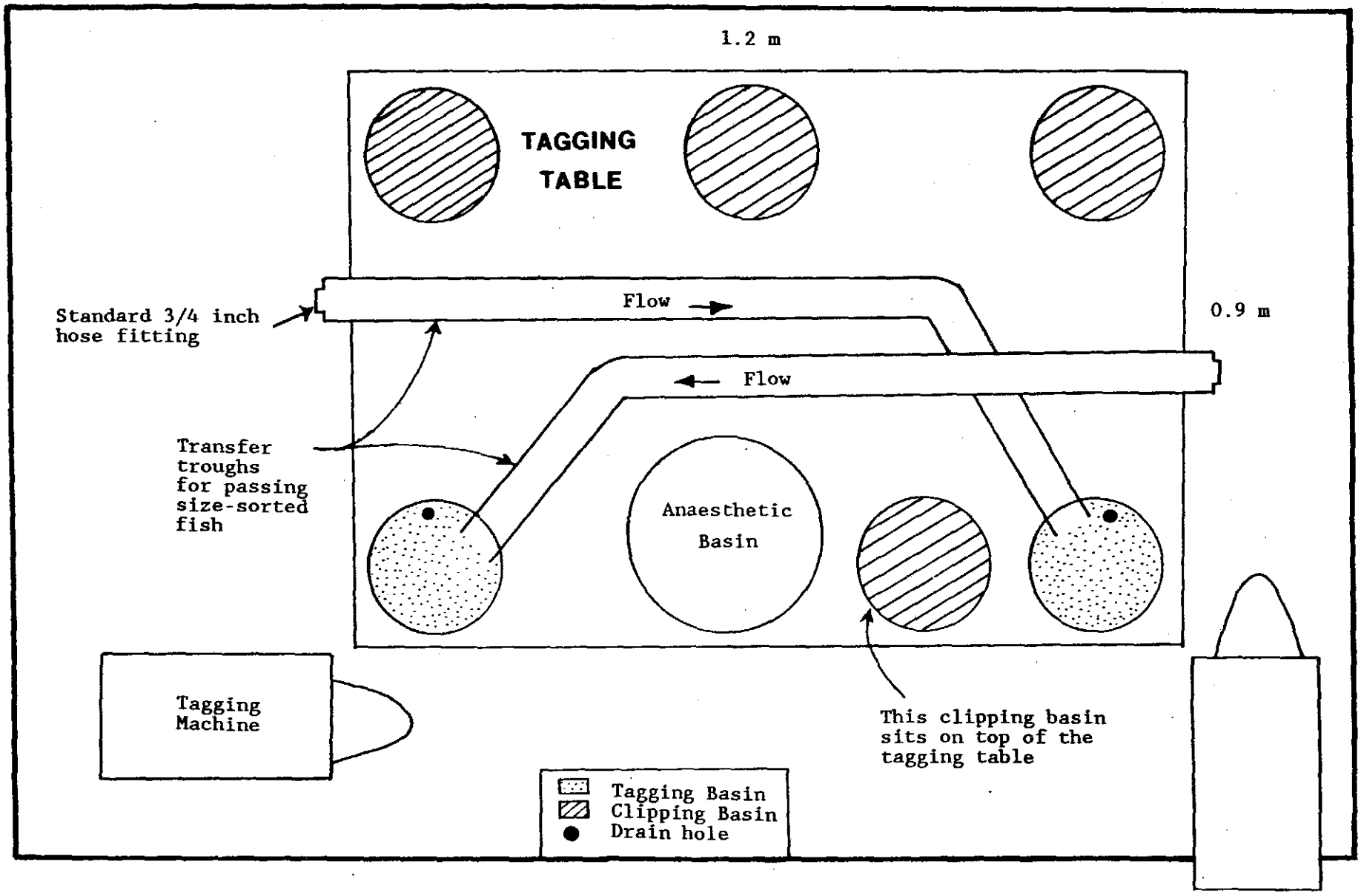


Figure 1. Tagging table set-up for two machines (top view).

APPENDIX D

FIN CLIPPING TABLE DESIGN CRITERIA

(from Chilliwack River Hatchery)

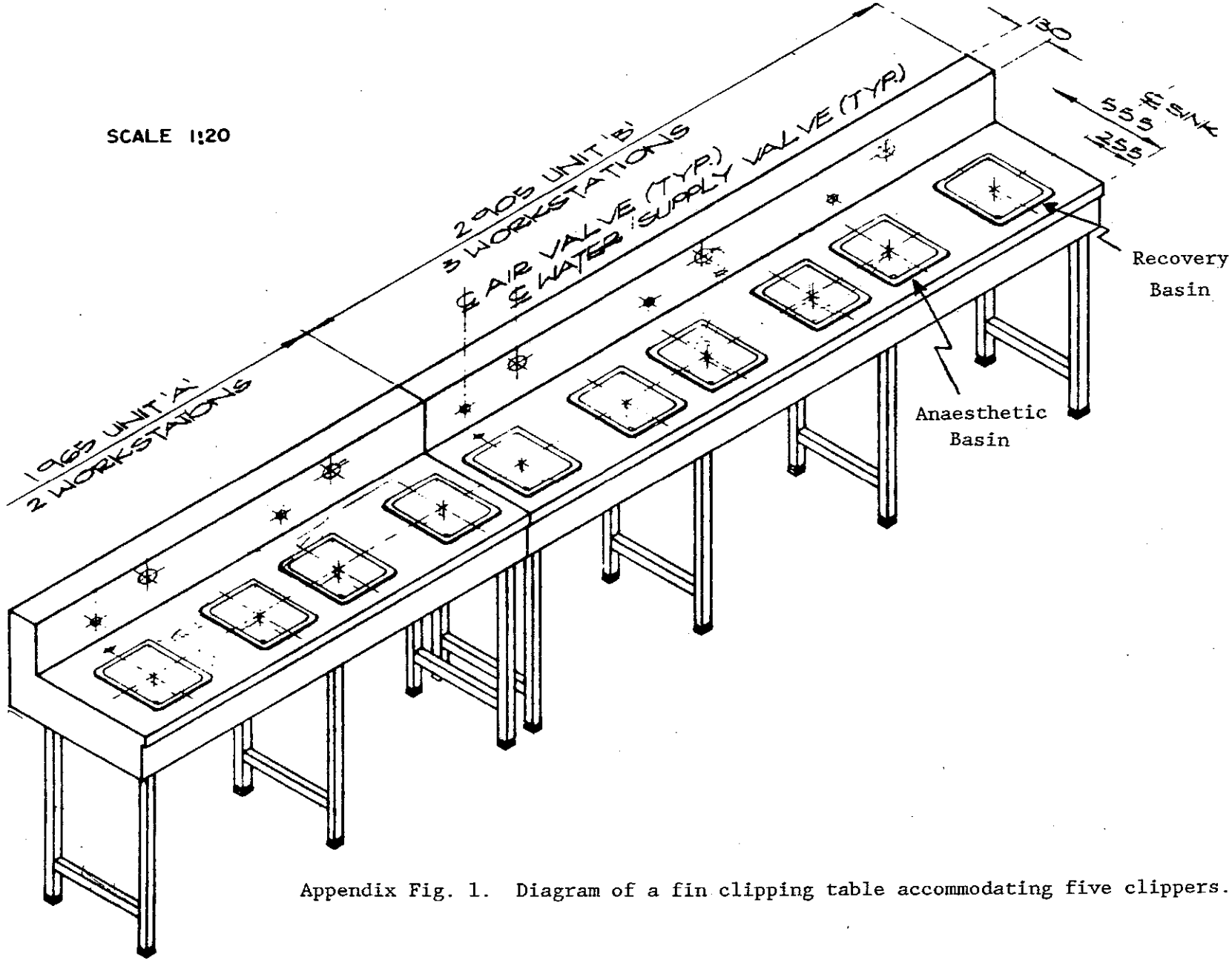
FIN CLIPPING TABLE DESIGN CRITERIA

The following is an operating description of a fin clipping table used at the Chilliwack River Hatchery. Appendix Figure 1 illustrates such a table which can accommodate five clippers. This is an efficient system which does not require an excessive work area.

Each clipper has two sinks, one of which is fitted with a net liner where anaesthetized fish are placed for clipping. After clipping, the fish are placed in the second sink for recovery. From there they pass down a drain pipe to a trough located behind the clipping table. Fish from each clipper are segregated using deep net liners within this trough. This set-up enables the quality control worker to monitor individual clippers.

Note that the worker who performs the quality control checks and count checks, also anaesthetizes the fish and distributes them among the clippers. At no time does the quality control worker disturb the clippers in any way.

Blueprints for constructing a fin clipping table can be obtained from the Chilliwack River Hatchery.



Appendix Fig. 1. Diagram of a fin clipping table accommodating five clippers.

APPENDIX E

SUMMARY OF QUESTIONNAIRE RESPONSES

SUMMARY OF QUESTIONNAIRE RESPONSES

A total of 21 hatcheries, all SEP Operations facilities, were asked to fill out a 14-page questionnaire detailing how their fish marking activities were conducted. All of the contacted hatcheries responded, although not every hatchery answered all the questions. Questionnaire responses are summarized below. Although considerable site-specific variation was noted among facilities, as well as variation in fish characteristics and marking techniques applied, some standardization was possible.

The most striking finding of the questionnaire exercise was that the written responses did not reflect the actual situation in the hatcheries. For example, while everyone indicated that they knew what the correct tag placement was, not one of the hatcheries visited actually had the correct tag placement. Furthermore, the questionnaire responses themselves indicated areas requiring clarification, for example, regarding fish sorting (when and to what extent), crew organization, machine jamming problems, anaesthetic dosages, acceptable speed/quality standards, tag retention checks, and relationship with contractors. Given the complexity of even routine fish handling, it is also possible that the questionnaire itself confused some respondents so that the "right" answer did not always fit the available format.

The following sections summarize questionnaire responses regarding preparation for marking, marking facilities and equipment, staff training, anaesthetic and marking techniques, quality control, and administration.

Preparation for Marking

At all the hatcheries, fish were starved before marking, but in many cases, the length of the starvation period was unknown or showed considerable variability. The starvation period was less than one day in 3 of the 19 responses. To obtain fish for marking, most workers crowded and dipped them from the rearing containers, again showing considerable variability in the method of containing fish.

Respondents were evidently confused by the questions on size-grading, specifically regarding when and how to grade the fish (4 of 10 respondents used grading devices, e.g. perforated aluminum funnel-shaped graders at Inch Creek Hatchery). Most hatcheries selected fish randomly for marking, and all indicated low numbers of pinheads in their fish populations. Consequently, the incidence of pinheads was not considered in subsequent data adjustments. Note that several respondents thought that grading referred only to pinhead removal rather than to size-sorting during tagging.

In deciding whether or not to mark fish at a certain time, the primary concerns were fish size, time at release and disease factors. It is of interest that 5 of 16 hatcheries noted that tagging timing was also based on hatchery activities related to management.

Marking Facilities and Equipment

In general, the respondents indicated that either they did not know what kind of equipment and set-up a contractor used, or that the set-up was too difficult to describe in the context of the questionnaire. Those hatchery staff using a discrete area for tagging (e.g. building or trailer) seemed the most satisfied with their set-up.

Most of the hatcheries responded that their tagging operations were located indoors rather than outdoors. In fact, four sites had a trailer or a separate building for tagging. Also, while most sites were set up as general marking areas, five hatcheries indicated that they used separate locations for each of the coded-wire tagging and fin marking operators. Only three tagging locations were not heated.

Evaluation of the tagging set-up in different hatcheries was made difficult by the large site-to-site variation. However, it is suspected that many of the holding containers were too small to hold more than one or two hours' worth of fish. Also, at about one third of the surveyed hatcheries, dissolved oxygen and/or temperature were not monitored in the holding containers, presumably because the hatchery staff were satisfied with the ambient water quality.

Most of the hatcheries used portable rather than permanent marking tables. There was no clear preference for one surface material over another, although metal tables appeared to be the least common. Approximately one third of the hatcheries indicated that their clippers did not have their own basins, although it was unclear whether this referred to anaesthetic and/or recovery basins. Of the 19 responding hatcheries, approximately half had recirculating water over the marking tables. The majority (15) of hatcheries measured water temperature during tagging and approximately half of these hatcheries used a thermograph or a hand-held thermometer immersed in the water. Of the 18 hatcheries responding, 14 aerated the water while tagging, mostly by bubbling air and/or recirculating water. All the hatcheries indicated the use of overhead fluorescent lights, and seven hatcheries also used lighted magnifying lamps when required.

Regarding the size of the tagging operation, most of the surveyed hatcheries indicated that they normally used two machines; only six hatcheries reported the use or the possible use of more machines (Table 7). Altogether, 49 tagging machines (excluding spares) were used for marking by the 20 surveyed hatcheries; all but five machines were old blue MKII or MKIII models. Of these, 41 were located on site and 19 (including spares) were borrowed from neighbouring hatcheries. Approximately 60% of the hatcheries reported one spare machine. The MKIV tagging machines were used at three hatcheries, and while opinions varied on their tagging speed, these machines were considered "good" for repairs/maintenance and ease of operation.

Of the 19 hatcheries responding, only six indicated the correct ratio of fin clippers to taggers (2:1) while the other 13 hatcheries used fewer than the recommended number of clippers. No hatchery used more than one shift of workers in its marking operation.

Most of the hatcheries had two cutters on hand. However, 60% of the hatcheries did not keep a record of the number of cuts per cutter edge, and the estimated number of cuts per cutter varied from 50,000 to 500,000. Of the three hatcheries that had used the new Tschopp cutters, there was no consensus on their superiority or lack of it. Each surveyed hatchery kept from three to 30 head molds on site, in most cases covering a wide range of fish sizes. The majority of the hatcheries had at least some of their head molds custom-made rather than supplied by the manufacturer.

A contractor was solely responsible for setting up the tagging machines in only four of the 20 hatcheries. Most hatcheries reported a variety of problems when setting up, involving wire jams, tag placement, power supply, water pressure and other items. Machine downtime varied from 1% to 15% (usually 1/2 hour per day), and was attributed largely to machine jamming and dull cutters. The machines were evidently fixed by anyone who was able to do so, whether hatchery personnel, manufacturer or contract staff.

All surveyed hatcheries used surgical eye scissors for fin clipping and required a total of 203 to 225 pairs per year (10 to 11 pairs per hatchery). From one third to one quarter of these scissors were replaced annually (3 or 4 pairs per hatchery). Note, however, that some contractors brought their own scissors and took them away upon completion of the job. All surveyed hatcheries resharpened scissors, but opinions differed as to the effectiveness of resharpening; 35% reported very successful resharpening, 55% moderate, and 10% poor resharpening success. More than one scissors supplier was used, and a wide variation in price of scissors ($60 to $135 per pair) was reported.

Staff Training

Regarding the experience of the marking staff, most of the surveyed hatcheries indicated that their marking supervisors had more than four years experience, taggers from 2 to 8 years, and fin clippers a variable amount of experience. Minimum experience standards for marking supervisors were at least one and preferably two seasons, while for the taggers more than one year was required, as indicated by about two-thirds of the hatcheries. For the clippers, no previous experience was required since manual dexterity and attitude were considered the more important attributes. Of 20 respondents, 16 hatcheries indicated some turnover in fin clippers and eight hatcheries indicated turnover in taggers.

The majority of hatcheries (16 of 20) reported that the marking crew was properly trained. In most cases, training was shared between the contractor and the hatchery staff, and additional training was usually conducted by a senior staff member. Since the tagging programs ranged from five days to 12 weeks each year, one "season" or "year" of experience could be interpreted in different ways since the level of expertise depends on which marking experience was provided. Note that six of 18 responding hatcheries had marking staff that worked only at their particular hatchery. In 14 of 20 hatcheries, marking standards were based on senior staff experience rather than on literature standards or manufacturers' recommendations. Clearly, the marking experience of individual staff members was considered to be the most important training tool.

Training time for new taggers varied greatly from 1/2 hour to 2 days. Similarly, a wide variation existed in the frequency and technique of quality control. Usually, the hatchery staff relaxed quality control standards to normal levels after 2 to 3 days of tagging.

Anaesthetic Techniques

The most commonly used anaesthetics for coded-wire tagging and fin clipping were MS-222 and 2-phenoxy. Most hatcheries (15 of 19) had tried anaesthetics other than 2-phenoxy and MS-222. Thus carbon dioxide gas and Quinaldine were also mentioned, but were usually not the preferred drug.

	Number of Hatcheries Responding	
Preferred Anaesthetic	Coded-Wire Tagging	Fin Clipping
MS-222	9	9
2-phenoxy	5	8
CO_2	1	1
No preference	1	1

Opinions regarding the commonly used anaesthetics varied. The 2-phenoxy was viewed as a product that would either "gum" machines or "lubricate" them. The MS-222 was considered susceptible to greater "use" error, e.g. more critical as to concentrations, compared to 2-phenoxy which was considered to be more "forgiving". Specific problems cited with MS-222 dealt with increasing toxicity of the anaesthetic at increasing temperatures, and the sensitivity of fish to handling when this occurred. The CO_2 gas was considered "slow", i.e. the anaesthetized fish were more active compared to fish anaesthetized with 2-phenoxy. Both 2-phenoxy and MS-222 provoked skin rashes on occasion, and consequently concern for health risks.

There was confusion regarding dosages. The applied concentrations of 2-phenoxy, as given in the questionnaire returns, varied from 1:1,000 to 1:8,000, compared to the recommended dosage of 1:4,546. MS-222 dosage varied from 34 to 300 mg/l, with most values in the 50 - 75 mg/l range; the recommended MS-222 dosage is 222-264 mg/l.

Anaesthetic baths were changed from 2 to 8 times each day. In most cases, visual judgements were made on how quickly the fish became immobilized and how "scummy" the water appeared. Maximum soak time averaged 4.5 minutes (range 1-15 minutes) for 2-phenoxy, and 4 minutes (range 1.5-8 minutes) for MS-222. Maximum recovery times averaged 6 minutes (range 2-10 minutes) for 2-phenoxy and 4 minutes (range <1-8 minutes) for MS-222.

Most tagging operations used water diverted from the regular hatchery water supply inflow and outflow systems. However, in a few cases, pumped river water and some stagnant water was also used.

Most respondents agreed that a water temperature fluctuation of between 1°C and 3°C was acceptable. Of 20 respondents, 13 monitored water temperature in the anaesthetic bath, and most hatcheries reduced the temperature simply by changing the anaesthetic baths frequently. Of 19 respondents, seven hatcheries measured dissolved oxygen levels at least occasionally and nine used oxygenated anaesthetic baths. It was recognized that anaesthetic dosages varied with temperature, but only 5 of 19 hatcheries buffered the anaesthetic even though the pH often dropped below 7.

When asked about actual human health problems associated with fish anaesthetics, five hatcheries reported that such problems existed. Both the 2-phenoxy and MS-222 were implicated in causing skin rashes, some acne and possible other effects on pregnant workers. Health concerns were most often cited as the reasons why a certain anaesthetic was not used, and workers were primarily concerned about skin rashes and unknown carcinogenic effects.

Marking Technique

All of the surveyed hatcheries used disinfectants (iodine/bromine based) during tagging, but 6 of 19 hatcheries did not disinfect between different groups of fish within the hatchery. At approximately half of the surveyed hatcheries, fish were treated after marking, usually with a malachite dip. However, six of 19 respondents reported infection after marking, even among treated groups of fish. The infection incidence was usually 1% or less of the marked population. One third of the surveyed hatcheries attempted handling smolting fish and in most cases problems developed even at relatively low water temperatures (8°C - 9°C).

Holding and mixing strategies differed for different species but most marked fish were held for no more than 3 - 7 days before remixing. In 11 of 19 hatcheries, marked fish were remixed with unmarked fish, often immediately upon recovery from the anaesthetic or within 1 or 2 days of marking. Information on long-term tag retention was available for nine of 21 hatcheries. The general comment was that if tagging was done properly, the long-term tag retention should be stable.

Most respondents considered a desirable holding period before release to be approximately two weeks for all species. This would allow the fish to recover from tagging stress. However, in many cases marked chum fry were not held long enough before release. This was because of the short time interval between the time when the fry reached a proper tagging size and the time for release.

Quality Control

All hatcheries employed their own staff to perform quality control checks throughout the marking operation, even when a contractor also performed quality checks. The frequency of checking varied from 100 fish once daily, to 10 fish five times daily, etc. The majority of clip-checking involved a "vial" inspection (84%) rather than a microscope (16%). Of 18 responses, six had information on fin regeneration.

Nearly all respondents described an acceptable level of good tags as 95% or greater, while only 17% of respondents specifically identified 99% to 100% as acceptable.

A wide variation in fin clipping speeds was reported among the individual hatcheries, although the overall average and minimum speeds were less extreme:

	Single Clips/hr	Double Clips/hr
Average	601	411
Minimum	481	323

Administration

For the 19 hatcheries which contracted a marking crew, 18 different contractors were listed. Most contractors worked for several years at one location. In fact, in only two cases was there clear evidence that the marking contractor was changed over the designated three-year period that the survey encompassed.

The fundamental difference between hiring workers through agency contracts and hiring a separate marking contractor is as follows. In the first case, the primary responsibility for marking success remains with the hatchery staff. In the second case, the authority and responsibility rest with the contractor, at least in theory if not in practice. It is important to note that at most hatcheries (16 of 21), hatchery staff were assigned to supervise marking to some extent, regardless of how the markers and marking team were hired.

All respondents were willing to seek improvement in their marking technique. Most of the hatcheries (17 of 21) wanted an on-site evaluation of their marking programs. In fact, as part of this contract, on-site evaluations were conducted at nine of these hatcheries, and results submitted to the hatchery and division managers. A workshop on tagging machine repair was also universally requested. The workshop was conducted in 1988, and the results included in this manual.

About half of the hatcheries used a reference marking manual. References that were specifically included in the questionnaires are listed alphabetically below.

1. Anon. MS 1986. Instruction Manual for Tagging Unit Model MKII, Model MKIII. Northwest Marine Technology, Shaw Island, Washington 98262. Telephone (206) 468-2340. 16 p.

2. Duke, R.C. MS 1980. Fish Tagging Mobile Unit Operation, Repair, and Service Manual. Idaho Dept. Fish and Game. 58 p.

3. Jenkinson, D.W. and H.T. Bilton. 1981. Additional guidelines to marking and coded-wire tagging of juvenile salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1051: 24 p.

4. Koerner, J.F. 1977. The use of the coded wire tag injector under remote field conditions. Alaska Dept. Fish and Game, Div. Commercial Fisheries, Juneau.

5. Moberly, S.A., R. Miller, K. Crandall and S. Bates. MS 1977. Mark-Tag Manual for Salmon. Alaska Dept. Fish and Game. F.R.E.D. Division. 56 p.

APPENDIX F

PROPOSED DATA RECORD SHEETS FOR CODED-WIRE TAGGING AND FIN CLIPPING

C.W.T. DATA SHEET

Hatchery: _____ Group Health: _____

Specie: _____ Brood Yr. _____ Disease Treatment: _____ Dos.____

Date	Temp. Range	Avg. Size	Hrs.	Mac.#	Location To /From		Data Code	Cutter Edge #	Injector # Begin	Injector # End	Injector # Rej.End	# Rej.	Tag Placement Check #Check/#Acc./% Acc.			Fin Clip Check #Check/#Acc./% Acc.			Morts	TOTAL TAGGED

Hrs. = Tagging hours minus breaks
Morts = Those fish checked for tag placement, TOTAL TAGGED is minus those morts.

USE SEPARATE DATA SHEET FOR EACH TAG CODE OR RELEASE PLAN/GROUP

C.W.T. QUALITY CONTROL

Hatchery: _____

Mac.#	Data Code	# Tagged	24 hr. morts	TOTAL TAGGED	Tag Retentions __hr. __hr. Avg.			Adipose Only	Total Valid Marks	Additional Morts Prior to Release	TOTAL RELEASE	COMMENTS

Tag Retentions will consist of 100 fish; a 24 hr sample is strongly recommended to moniter machines and taggers before two days worth of marking is completed. If required, space is provided to do an additional 48 hr sample. Holding and space constraints may not allow for each machine's marked fish to be held separately for 48 hrs. It is imperative that each machine have a separate tag retention sample. An additional long term tag retention just prior to release is strongly recommended. This form should be attached to the C.W.T. DATA SHEET and the Comments section should include a summary of the average # of fish per hour marked.

DAILY RECORD - FINCLIPPING

Hatchery: ______________________

Stock: ____________ Specie: _________ Clip: ______ Date: __________ Recorded by: _______

CLIP ACCURACY									COUNT ACCURACY				
Clipper	Time	# On Counter	# Checked	Good Clips	Bad Clips	% Discount	# Discount	TOTAL VALID	# On Counter	# Counted	Incorrect Count of	# of Good Clips Overall	Comments

DAILY RECORD - FINCLIPPING

Hatchery: Pallant Ck.

Stock: Mathers Specie: Cm Clip: LV

Date: Mar. 26/89 Recorded by: T.N.

SAMPLE

	CLIP ACCURACY								COUNT ACCURACY				
Clipper	Time	# On Counter	# Checked	Good Clips	Bad Clips	% Discount	# Discount	TOTAL VALID	# On Counter	# Counted	Incorrect Count of	# of Good Clips Overall	Comments
Bob	0900	436	10	10	–	0	0	436	436	436	0	436	
Carol	0900	512	10	10	–	0	0	512	608	608	0	608	
Ted	0900	645	10	10	–	0	0	645	750	749	1	749	
Alice	0900	498	10	9	1	10	50	448	500	500	0	500	
Bob	1000	512	10	10	–	0	0	512	600	600	0	600	
Carol	1000	600	10	9	1	10	60	540	612	610	2	610	
Ted	1000	753	10	10	–	0	0	753	815	815	0	815	
Alice	1000	498	10	8	2	20	100	398	509	504	5	504	
		4454					210	4244			8		

Note:
1. Count checks may not be done at the same time or frequency as the clip checks - if they were than both clip counts and count checks should be the same. (minus any mis-counts)
2. Any counts found incorrect would have that total taken off the "TOTAL VALID" counts.
3. NO % discount for incorrect counts - the assumption is made that only those fish were counted incorrectly. These count checks are excellent for insuring honest counting as well as "counter" malfunction.
4. Records show that "Alice" needs help. More quality control checks and/or re-training is required.

APPENDIX G

NORTHWEST MARINE TECHNOLOGY TECHNICAL BULLETINS

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Northwest Marine Technology, Inc.

☐ Shaw Island, Washington 98286 · 206/468-3375

EXPORT PRICE LIST

REPLACEMENT PARTS

1 January 1991

AMPHENOL CONNECTOR, SERIES 165-33,34,35,36, MKII, MKIII	$US	41.00
BATTERY ADAPTER, MKII, MKIII		230.00
BATTERY ADAPTER, MKIV		115.00
BATTERY, Field Sampling Detector, Tubular Detector, set of 2		18.00
CABLE, POWER & INTERCONNECT, MKII, MKIII		190.00
CABLE, INTERCONNECT, MKIV		185.00
CLAMPING NUT, NEEDLE CARRIER, MKII, MKIII, MKIV		12.00
COUNTER, MKII, MKIII		185.00
CUTTER, MKII, MKIV		1,150.00
CUTTER, MKIII		1,300.00
DRIVE ROLLERS, SET, MKII, MKIII, MKIV		110.00
FILTER ASSY., IN-LINE for QCD MKII, MKIII		115.00
FILTER ASSY., IN-LINE for QCD MKIV		150.00
FILTER SCREEN, for QCD MKIV		25.00
FUNNEL, for QCD, MKII, MKIII, MKIV		300.00
GASKET, MKIV Filter Assembly		10.00
HARD WIRE CUTTERS, plier type		150.00
HEAD MOLD BASE		16.00
HEAD MOLD HOLDER, MKII		135.00
HEAD MOLD FABRICATION JIG		29.00
HEAD MOLD FABRICATION KIT, includes supplies and video		170.00
HEAD MOLD, CUSTOM FABRICATION FROM SUPPLIED SPECIMEN		400.00
HEAD MOLD, Sizes from 2-1800 fish/pound for various species		70.00
HEX WRENCH		12.00
HEX WRENCH INSERT, SET OF 3		6.00
HOSE QUICK-DISCONNECT for QCD		17.00
NEEDLE, MKII, MKIII, MKIV, PACK OF 5		65.00
NEEDLE CARRIER W/ CLAMPING NUT, MKII		185.00
NEEDLE CARRIER W/ CLAMPING NUT, MKIII, MKIV		400.00
NEEDLE REAMER BIT		12.00
"O" RING SET FOR MKII, MKIII QCD SOLENOID		2.00
RING MAGNETIZER		160.00
SCREWS, ASSORTED PACKAGE, MKII, MKIII, MKIV		12.00
SET SCREWS, SMALL OR LARGE, PACK OF 10		12.00
SOLENOID VALVE, for QCD MKII, MKIII		140.00
SOLENOID VALVE, for QCD MKIV		200.00
SOLENOID VALVE REBUILD KIT, MKIV		75.00
SOLENOID VALVE WRENCH, MKII, MKIII		60.00
SPEAKER, for QCD MKII, MKIII		55.00
TAG READING JIG, W/ TWO PENCILS		195.00
TAG READING PENCIL		60.00
TOOL KIT, MKII, MKIII, MKIV		460.00
TOUCH SWITCH, MKII, MKIII, MKIV		270.00

Telex 287944 NWMT UR FAX 206/468-3844 Tax I.D. No. 22-1935793

Northwest Marine Technology, Inc.

☐ Shaw Island, Washington 98286 · 206/468-3375

EXPORT PRICE LIST

TAGGING EQUIPMENT

1 January 1991

MODEL MKIV TAGGING UNIT: Includes Tag Injector, Quality Control Device, Power Supply, Tool Kit and 3 non-custom head molds	$US 14,300.00
MODEL MKIV TAG INJECTOR: Includes Tag Injector, Power Supply, Tool Kit and 3 non-custom head molds	9,000.00
MODEL MKIV QUALITY CONTROL DEVICE	5,300.00
FIELD SAMPLING DETECTOR	3,100.00
WAND DETECTOR	4,000.00
2.5" TUBULAR DETECTOR	4,900.00
4" TUBULAR DETECTOR	8,600.00
6" TUBULAR DETECTOR	11,000.00
CONVEYOR DETECTOR	Quotation
TRANSIT CASE FOR MKIV TAG INJECTOR	450.00
TRANSIT CASE FOR MKIV QUALITY CONTROL DEVICE	500.00
ELECTRONICS PACKAGE for INJECTOR MKII, MKIII	1,400.00
ELECTRONICS PACKAGE for QCD MKII, MKIII	850.00
POWER SUPPLY, MKIV	260.00
POWER SUPPLY, MKII, MKIII	850.00
CONVERSIONS	
Add half-length tag capability to MKII Injector	140.00
1" Insert tube for 2" QCD (1/2 Length Tag)	290.00
Upgrade Field Sampling Detector	450.00
PORTABLE WATER PUMP with accesssories, for use with QCD	400.00

PORTABLE GENERATORS: Contact us for advice regarding portable generators for use in remote tagging operations.

QUANTITY DISCOUNTS AVAILABLE

Telex 287944 NWMT UR FAX 206/468-3844 Tax I.D. No. 22-1935793

Northwest Marine Technology, Inc.

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EXPORT PRICE LIST

TAGGING EQUIPMENT RENTAL

1 January 1991

TAGGING UNIT, MKIV	
Rental	$US 1950.00/month
INJECTOR ONLY, MKIV	
Rental	1275.00/month
QUALITY CONTROL DEVICE, MKIV	
Rental	700.00/month
FIELD SAMPLING DETECTOR	
Rental	400.00/month
WAND DETECTOR	
Rental	500.00/month
TUBULAR DETECTOR	
2.5 Inch:	
Rental	600.00/month
4 Inch:	
Rental	1000.00/month
6 Inch:	
Rental	1300.00/month
ELECTRONIC FISH/EGG COUNTER	
Rental	13% of purchase price/month

RENTAL TERMS

1. One month minimum rental, lower rates available on lease of 10 or more months.
2. Prices are FOB Shaw Island
3. Purchase option - 90% of the rental payments can be applied toward the purchase price.
   -Purchase price will be the published price in effect at the time notice to exercise the purchase option is received by Northwest Marine Technology, Inc.
   -Rental payments used to compute the credit toward the purchase price must be from a single consecutive rental period for each individual piece of equipment.

Telex 287944 NWMT UR FAX 206/468-3844 Tax I.D. No. 22-1935793

Northwest Marine Technology, Inc.
BULLETIN

Head Mold Fabrication

Obtain a specimen which best represents the size and head shape of the group of fish to be tagged. It is best to use a fresh specimen, but one preserved in formalin can be used if necessary. Dry the external surface as much as possible; for example, blot with paper towels. Using an injector needle with the nylon ball removed, impale the specimen along the direction of desired needle penetration during tagging. (Fig. 1) For most salmonoids, better positioning accuracy is obtained by indexing from just the upper jaw. The mouth of the fish will be open during tagging with only the upper jaw fitting the head mold. The head mold, thus, usually is made from a specimen from which the lower jaw has been removed.

Prepare the casting jig with a head mold base. This is done by first filling the two grooves in the head mold base with modeling clay to seal in the casting resin. Trim off any excess with a sharp knife. Put another small lump of clay inside the head mold base to seal the area around the needle; then push the head mold base onto the casting jig.

Insert the base of the needle through the hole in the head mold base and into the hole in the casting jig. Position the specimen so that clearance between the nose and the head mold base is 1 - 2 mm for large specimens. Clearance for very small specimens can be perhaps as large as 6 mm. (Fig. 2)

Carefully apply a band of 2" masking tape around the head mold base to contain the casting resin. For very large specimens, it may be necessary to flare the tape somewhat. (Fig. 3)

Mix the polyester casting resin according to instructions on the container, and pour to a depth of 2 - 3 cm above the tip of the snout. As the resin cures, it will first gel. When it is firm enough to hold its shape, pull out the specimen and remove the tape. Allow to cure in a warm place overnight.

The excess resin can then be removed. A fine hacksaw and coarse and fine files are very useful. Figure 4 shows the nature of the finished product. It is essential to cut away the resin over the area of the eyes of the specimen. The hard plastic will cause damage to the eyes if this is not carefully done.

The final test is to use the mold to implant tags. It should provide reliable placement of tags as determined by disection of tagged specimens.


Figure 1

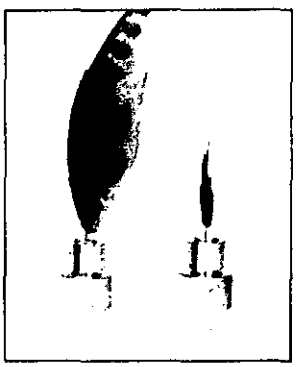


Figure 2

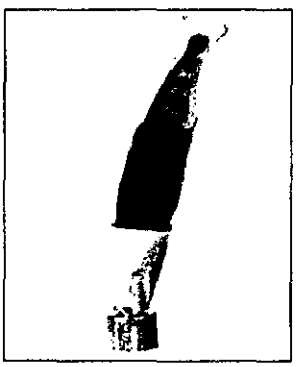


Figure 3

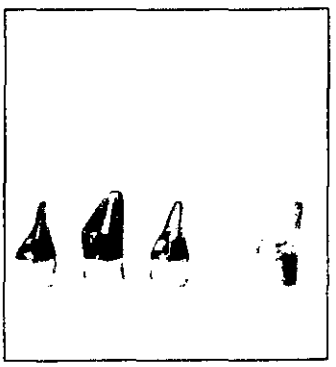


Figure 4

Northwest Marine Technology, Inc.
Shaw Island, Washington 98286 206/468-2340
BULLETIN

MAGNETIZING OR REMAGNETIZING OF IMPLANTED CODED WIRE TAGS

There are occasions when implanted coded wire tags need to be magnetized or remagnetized with something other than the Quality Control Device (QCD) or ring magnet supplied by Northwest Marine Technology, Inc. This situation typically arises if

A The specimen is too large to be passed through the QCD.

B Tags are positioned in the specimen in a manner which prohibits axial orientation in the QCD.

C Small quantities of the specimen are tagged without the use of a QCD.

D Remote tagging is performed without a QCD.

Fully magnetized tags are essential to magnetic detection in recovery. Magnetization can be accomplished with a large permanent magnet by following a few simple rules.

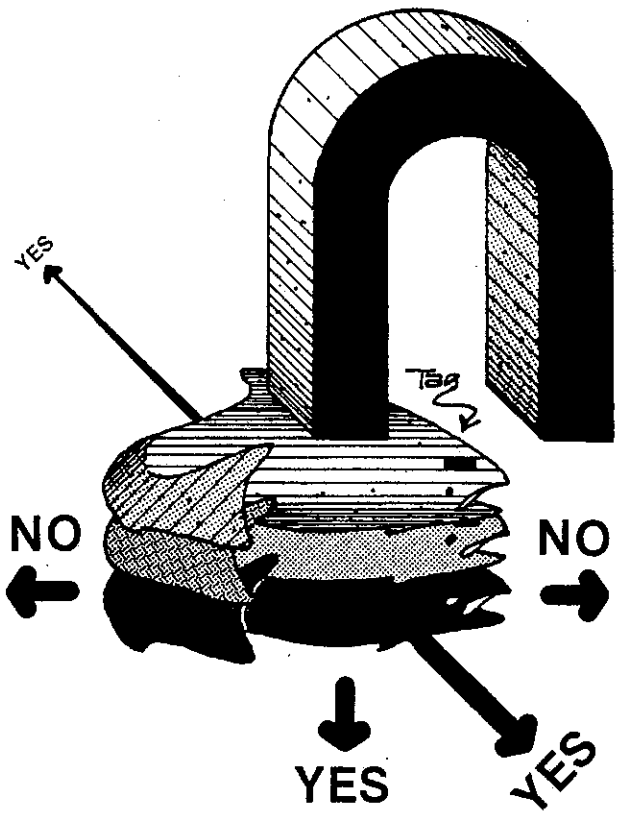
The rules have to do with the fashion in which the tag is removed from the magnetic field. The idea is to position the tag lengthwise across the strongest magnetic field and then remove it without passing through regions in which the field reverses direction. See illustration.

It is important to use a large enough device that, with the largest specimen, the tag can be brought into a sufficiently strong magnetic field.

Tag Depth in Specimen, .5 inches or less:
Horseshoe Magnet
.75" Opening
Part No. 5842K14
Approximately $40.00

Large Specimen or over .5" Tag Depth in Specimen:
Horseshoe Magnet
6.5" Opening
Part No. 5849K17
Approximately $300.00

The above are available from:
McMaster-Carr;
9601 John St.,
Santa Fe Springs, California 90670 USA
Telephone (213) 945-2811



REMOVE FISH FROM FIELD WITHOUT CHANGING ORIENTATION OF TAG WITH RESPECT TO MAGNET

Northwest Marine Technology, Inc.

Shaw Island, Washington 98286 · 206/468-3375 · Telex 287944 NWMT UR
2401 Bristol Court SW, Olympia, Washington 98502 · 206/754-4304

BINARY CODED WIRE TAG READING INSTRUCTIONS
SIX-WORD HALF-LENGTH FORMAT

Introduction to Binary Numbering.

Binary numbering is a method by which numerical values are represented using a series of marks, each mark having a particular value. To determine the value of a number written in binary form you would total up the value(s) of the binary digits.

Consider the number 2065. In decimal-digit format it could be written as:

1000's	100's	10's	1's
2	0	6	5

Said another way it means the sum of 2 thousands, no hundreds, 6 tens and 5 ones. Binary numbers can be written in columns the same way. The number 13 in binary-digit format would be written as:

8's	4's	2's	1's
1	1	0	1

The binary number 1101 thus means the sum of 1 eight, 1 four, no twos and 1 one, or 1011=13 decimal.

How Six-word Half-length Tags Use Binary Coding.

This format of half tag is marked with six lines of binary information or "words" written lengthwise on the wire. The words are equally spaced at 60 degree intervals around the circumference of the wire. The words have the following designations:

Master, Data 1, Data 2, Agency, Data 3, and Data 4

The Master word is always the same and its purpose is to mark the beginning of the Data words and to identify the direction in which they are to be read. The Master word is not used to carry a data value. The other five words, Data 1, 2, 3, 4 and Agency, comprise the actual tag data. Each word on the tag is represented by notches on the wire. Notches are read as binary 1, no notch is read as binary 0.

The data format on the tag is keyed to the Master word which, as stated above, is always the same. It has a unique "in-between" mark called the half-interval mark and looks like this:

The half-interval mark is instantly apparent and is the first thing to locate when reading a tag. Every tag has a Master word although it may start and end in different places, e.g. 111 0 1, as a result of the Tag Injector cutting tags in a random position.

To read a tag find the Master word and orient the tag so that the master word reads in the correct direction, 0 1 111. The remaining Data and Agency words are read using the following convention:

1) The column labels for the Data words are derived from the Master word:

0	1	1	1	MASTER WORD
8	4	2	1	COLUMN IDENTIFICATION

2) With the Master Word on top of the wire tag and running in the proper direction, rotate the tag on its axis so that the Master Word moves up. As the five data carrying words come into view, they are, in order:

Master
Data 1/Parity (Parity is described below)
Data 2
Agency
Data 3
Data 4

When referring to a particular code the convention is to list the Agency code first followed by the Data codes in their respective order. For example if Agency 9 ordered a group of tags with Data 1 = 3, Data 2 = 7, Data 3 = 15 and Data 4 = 1 that code would be described as 9/3/7/15/1.

If you visualize the surface of the above tag unrolled as if it were a flat it would look like this:

8s	4s	2s	1s	COLUMN IDENTIFICATION
*	1	1 1	1	MASTER WORD
1		1	1	DATA 1 = 3
	1	1	1	DATA 2 = 7
1			1	AGENCY = 9
1	1	1	1	DATA 3 = 15
			1	DATA 4 = 1

* = Common parity bit for all fields.

Parity. (also referred to as check)

In order to provide additional protection against coding errors and to assist decoding when tags are damaged or marks are otherwise obscured an odd parity convention is used.

The "8"s position in Data 1 is reserved as the common parity bit for all fields and never has a value. The convention is that the sum of the number of bits in Agency plus the four Data words is odd. Master word bits are not considered in parity. Note that is is the number of bits that must be odd, not the value of the bits. In the above example the number of bits required to form the code is 12. Since the number of bits must be odd the parity bit is added to make the number of bits 13.

Code Position on Cut Tags.

The code information on the six sides of the wire is repeated continuously every four spaces. Since tags are cut slightly longer than four spaces, actual tags may be cut at any point in the word. The previously illustrated tag code 9/3/7/15/1 cut between the 4s and 2s column would look like this:

2s	1s	8s	4s	COLUMN IDENTIFICATION
1 1	1		1	MASTER WORD
1	1	1*		DATA 1 = 3
1	1		1	DATA 2 = 7
	1	1		AGENCY = 9
1	1	1	1	DATA 3 = 15
	1			DATA 4 = 1

* Parity bit as described above.

As always, if you have questions or comments please feel free to contact us.

Northwest Marine Technology, Inc.

Shaw Island, Washington 98286 · 206/468-2340

To: CWT Coordinators and Users
From: NMT Staff
Subj: Coding for half-length (.020") tags

Below is a brief explanation of the coding for half-length (.020") tags. The same principles are used for coding half-length tags and standard six-bit tags:

Column	Check	4	2	1
Master	0	1	1	1
Data 1 = 3 e.g.	1	0	1	1
Agency = 5 e.g.	1	1	0	1
Data 2 = 4 e.g.	0	1	0	0

There are two features in common with the six-bit scheme:

1) The master word contains an immediately identifiable half-interval mark.

2) The three data words use the fourth column as a check bit. The rule is the same as the rule for six-bit tags: the number of <u>1s</u> in any word, including the check bit, must be odd.

This scheme allows 512 different codes. If organized as the example above, that means there are 8 Agency codes each of which has 64 different data codes. The reduced data capacity of the half-length tag compared to the six-bit tag is apparent; however, we do not expect that to be a constraint in the near future.

For your information, all NMT injectors with serial numbers greater than 200 can be modified to implant both standard and half-length tags. The modification consists of a length selector switch on the control box and costs $75.00.

BINARY CODED TAG FORMAT

Data is carried on binary coded wire tags in six binary-digit words, or numbers. Consider the number 1066. It might similarly be called a four decimal-digit word, and can be written in columns as follows:

1000s	100s	10s	1s
1	0	6	6

Said another way, it means the sum of 1 thousand, no hundreds, six tens, and six ones.

Binary-digit words, or numbers, can be written in columns in the same way:

32s	16s	8s	4s	2s	1s
1	1	0	1	0	1

The binary number 110101 thus means the sum of 1 thirty two, 1 sixteen, 0 eights, 1 four, 0 twos, and 1 one, or 110101 binary = 53 decimal.

The binary coded wire tag material is marked with four six-digit binary words written lengthwise on the wire, 90° apart around its circumference. Three of these words carry the data, and following them is a seventh digit in each row which is used as an error check as explained below. The fourth word is known as the master word and is always the same. Its purpose is to mark the beginning of the data words and to identify the direction in which they are to be read.

The information is carried by notches on the wire spaced .0048" apart. Notches are read as binary 1; no notch is read as binary 0. At the standard length of .042", this means that there are at least 8 visible mark positions on a tag. The logic in the coding system is such that tags as short as .030" guarantee unambiguous data recovery. (A similar, but not identical, scheme is used to mark "half-length" or .020" tags. Reading instructions for half-length tags are available on request.)

The data format on a coded wire tag is keyed to the seven-bit word which we call the master word. This word, always the same, is unusual in that it contains an extra, in-between, mark, i.e., the word looks like

0011111

The half-interval mark between the first and second normal marks is instantly apparent. Every tag bears this word, although it may start and end in different places, e.g., 1111001, as a result of the random nature of the cutting process.

To read a coded wire tag, find the master word and orient the tag horizontally so that the master word reads in the correct direction, 0011111. Then the remaining data are to be read according to the following conventions:

1. The column labels for the data words are derived from the master word:

0	0	1	1	1	1	1	1	MASTER
Ck	32	16	8	4	2		1	COLUMN IDENTIFICATION

2. With the master word on top of the wire and running in the proper direction, rotate the tag on its axis so that the master word moves up. As the three data words come into view, they are, in order:

   1. DATA WORD 1
   2. AGENCY CODE
   3. DATA WORD 2

If one were to imagine the surface of the tag unrolled as if it were a sheet of paper, it would look like this:

Check	32s	16s	8s	4s	2s	1s	COLUMN IDENTIFICATION
0	0	1	1	1	1 1	1	MASTER WORD
1	1	0	1	1	0	1	DATA 1 = DECIMAL 45
1	0	0	1	1	1	1	AGENCY = DECIMAL 15
0	1	1	0	0	1	0	DATA 2 = DECIMAL 50

The convention adopted for the seventh column, the check bit, is that the sum of the notches in the three data rows must always be odd. This provides a check against coding errors in the data. For example, if the required number was

101101 (six bit word),

there are four binary ones, or notches; the sum is, therefore, even; and the check bit must also be a one. The data would appear on the tag wire as

1101101.

If the data were to be

010110,

the checked data would appear on the tag wire as

0010110

since the data word already has an odd number of bits, and the check bit must be zero.

The information on each of the four sides of the tag wire is repeated continuously every seven spaces. Since tags are cut off every 8.5 spaces, actual tags may be cut at any point in the word. An example of a tag cut between the 4s and the 8s columns follows:

4s	2s	1s	Ck	32s	16s	8s	COLUMN IDENTIFICATION
1	1 1	1	0	0	1	1	MASTER
1	0	1	1	1	0	1	DATA 1 = DECIMAL 45
1	1	1	1	0	0	1	AGENCY = DECIMAL 15
0	1	0	0	1	1	0	DATA 2 = DECIMAL 50

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Reading Instructions for Replicate Binary Coded Wire Tags (rev 4/88)

Replicate coding is a method for producing several statistically indistinguishable groups of tagged fish from one larger group. Replicate tags are identical to standard binary-coded wire tags with two exceptions:

1) A new Master Word format

2) Parity bits are no longer error check bits. Instead they represent an additional 3-bit binary number (range 0-7).

New Master Word Format

The replicate tag Master Word indicates the presence of replicate coding.

The present standard tag Master Word, 0 0 1 1 1 111

becomes the replicate Master Word 0 0 1 0 1 111

Additional 3-bit Binary Number

If the Master Word is modified as shown above, then the parity bits are no longer error check bits. They are to be interpreted as a 3-bit binary number, (range 0-7) which identifies the replicate number, using the following convention:

Word	DATA2	AGENCY	DATA1		Decimal
Replicate (parity)	0	0	1	=	1
	0	1	0	=	2
	1	0	0	=	4
For example	1	1	0	=	6

At this time we do not use the replicate index number 0 = 000. This allows for a maximum of 7 replicate codes.

Note that aside from the meaning of the parity bits and a new Master Word nothing else changes. The same agency codes will be retained. If a user chooses to ignore the replicate coding, the scheme becomes transparent, having no effect on the data.

Parity Convention

Because replicate format tags use the parity position to represent the embedded replicate number, there is no dedicated check bit on the replicate format tag. In order to give some parity information in the replicate format tag the following convention is used:

Replicate Tag Reading Instructions

Replicate format tags will only be assigned Data 1 and Data 2 codes which can be represented by an odd number of bits. The replicate number position is not considered in the convention. Therefore the reader of a replicate format tag should expect to find an odd number of bits in the Data 1 and in the Data 2 positions. Please note: This does not mean that Data 1 and Data 2 will be odd numbers, but rather numbers represented by an odd number of bits. Since users will be assigned their usual Agency code this convention does not apply to the Agency field.

Valid Data 1 and Data 2 codes for replicate format tags are: 1,2,4,7,8,11,13,14,16,19,21,22,25,26,28,31,32,35,37,38,41,42,44,47,49, 50,52,55,56,59,61,62.

Reading Convention

Since cut tags are slightly longer than a single complete code there is a possibility that two different replicate codes (which will always be different) will be visible on one tag. For tags upon which two replicate codes can be read, a rule is needed for selection of the replicate code to be used. The rule is necessary to prevent biases resulting from a reader choosing the replicate code which is easiest to read, and to assure that an independent reader gets the same answer. The rule at this time is that with the tag in its "normal" orientation, i.e. least significant digits to the right, (see last example below) the right-most legible replicate number is recorded.

Examples:

Replicate=3	1		R	32	16	8	4	2	1	COLUMN IDENTIFICATION
	1				1		1	1	1	1	MASTER
			1			1	1	1			DATA1=14
			1	1	1	1	1				AGENCY=60
						1					DATA2=8
Replicate=7	2	1	R	32	16	8	4	2			COLUMN IDENTIFICATION
	1	1	1			1		1		1	MASTER
	1			1		1	1			1	DATA1=26
				1			1	1			AGENCY=12
	1		1	1						1	DATA2=35
Replicate=5	R	32	16	8	4	2	1	R			COLUMN IDENTIFICATION
				1		1	1	1			MASTER
				1	1	1	1	1		1	DATA1=31
	1				1	1	1				AGENCY=14
	1		1		1			1		1	DATA2=41

To: CWT Coordinators and Users
Subj: Format Change - Half Length Tags

The complete utilization of the relatively small number of codes available (64 per Agency) by some agencies has necessitated a new format for coding half-length tags.

The new format tags are recognizable by virtue of a new master word, indicated in the following example:

Column	8	4	2	1
Master Word-Old Format		1	1	1 1
Master Word-New Format		1	1	1 1
Data 1 = 7 e.g.		1	1	1
Agency = 1 e.g.	1*			1
Data 2 = 15 e.g.	1	1	1	1

*Parity Bit

Note that the new master word is not that reported in the minutes of 1981 Mark-Tag Coordination meeting, PMFC, January 27, 1981. The master word described there, while technically adequate, is unacceptably difficult to read.

The other new feature of the format is the use of a single parity check bit to check the agency code and both data words. This has the effect of allowing four times the previous number of codes for each agency, i.e. 256, while preserving the ability to detect any single-bit error.

Some conventions are necessary to avoid confusion in data management.

1) New format half-length tags will be identified by a prefix "B" before the agency code, on the tag labels. For example, new format half-length tags for the State of Alaska will show Agency = B4.

2) For as long as possible, several years at the present rate of use, new format half-length tags will carry either Data 1 or Data 2 between 8 and 15, thus making their identification implicit.

3) The single parity-check bit, in the "eights" column of the agency word, is set according to the following rule:

   The sum of the marks (ones) in the two data words and the agency word, including the parity check bit, is always odd. In the example, there are three marks in Data 1, four marks in Data 2, and one mark in the agency word. The sum is eight, thus the parity bit is also marked, to make nine.

THEORETICAL ESTIMATE OF WORKER EXPOSURE TO PHENOXYETHANOL DURING FISH MARKING PROCEDURE

GIVEN:

Anesthetic solution $\frac{7 \text{ ml phenoxyethanol}}{5 \text{ gallons water}}$

= 300 parts per million (ppm)

Procedure requires one hand to be either immersed or wet with solution for say 8 hours/day (actually, in practice likely only the fingers up to the second knuckles need be immersed).
- Average hand 350 cm^2

ASSUMPTIONS:

The skin absorption rate for 2-phenoxyethanol is not known. However, methyl n-butyl ketone is also readily absorbed through skin, so as a first approx. use the skin absorption rate for MnBK or 5 $\mu g/min/cm^2$.

A permissible concentration for 2-phenoxyethanol has not been established, so use the NIOSH recommended value of 25 ppm for 2-butoxyethanol (by analogy).

CALCULATIONS:

The absorption rate will be proportional to the solution concentration, therefore assu ed absorption rate for solution could be:

$5 \mu g/cm^2/min. \times 300 \text{ ppm} = 1.5 \times 10^{-3} \mu g/min/cm^2$

Theoretical amount of 2-phenoxyethanol absorbed per day, by dermal route would thus be:

$1.5 \times 10^{-3} \mu g/min/cm^2 \times 350 \text{ cm}^2$ (hand area) $\times$ 480 min/day
$= 272 \mu g/day$
or 0.27 mg/day.

Assuming an individual worker inhales about 10 cubic meters of air per working day, then the above amount absorbed would be equivalent to:

$$\frac{0.27 \text{ mg/day}}{10 \text{ m}^3 \text{ day}} = 0.027 \text{ mg/m}^3$$

or

0.15 ppm of phenoxyethanol in the air.

This value of 0.15 ppm is less than one one-hundredth of the acceptable concentration for 2-butoxyethanol of 25 ppm.

Thus unless the skin absorption rate for the phenoxyethanol was more than 100 times that of the MnBK, skin absorption would not likely present an undue health risk.

Because the actual skin absorption rate is unknown, however, it seems prudent to protect the hands from contact with the solution, if practical and feasible.

(N.B. The vapour exposure of 2-phenoxyethanol is low enough such that the amount of the chemical which evaporates into the air from the anesthetic solutions would be insignificant.)

JM

December 19, 1986

Mr. William E. McLean
Operations Support Biologist
Department of Fisheries and Oceans
Box 467
Campbell River, British Columbia
CANADA V9W 5C1

Dear Mr. McLean:

This letter is in response to your inquiry of November 26, 1986, concerning health hazards associated with prolonged exposure to dilute solutions of 2-phenoxyethanol. As stated on the Material Safety Data Sheet, being sent to you, animal toxicity studies conducted at the Eastman Kodak Company Health and Environment Laboratories, indicate that exposure to the compound produces only slight skin irritation which is not exacerbated by repeated application. There is no evidence to suggest that 2-phenoxyethanol is a skin sensitizer. It is, however, a strong eye irritant. All blood chemistries were normal following repeated ingestion over a 15-day period.

While this data does not indicate significant adverse effects from exposure to 2-phenoxyethanol, studies by Dow Chemical Company found that repeated exposures in rabbits resulted in absorption of harmful amounts of material through the skin. They found that excessive exposure could cause hemolysis, i.e., separation of hemoglobin from red blood cells and therefore, impair the blood's ability to transport oxygen.

We are not aware of any studies specifically dealing with prolonged exposure at low concentrations. Therefore, it is suggested that you take precautions to minimize direct contact with this material until more information becomes available.

I hope this information is helpful. Please let me know if I can be of any further assistance.

Sincerely,

Jacqueline A. Fox
Clinical Toxicology
Health and Environment Laboratories

JAF:ttf
Enc.

MATERIAL SAFETY DATA SHEET

EASTMAN KODAK COMPANY
343 State Street
Rochester, New York 14650

For Emergency Health, Safety, and Environmental Information, call 716 722-5151
For all other purposes, call 800-225-5352, in New York State call 716-458-4014

Date of Revision: 01/27/89 Kodak Accession Number: 904861

PRODUCT INFORMATION

Product Name: 2-Phenoxyethanol
Synonym(s): Ethylene Glycol Monophenylether
Product Use: Laboratory and research chemical
Formula: C8 H10 O2
CAT No(s): 114 3155; 117 5207; 117 5215; 117 5223; 117 5249; 117 5256; 117 5264; 117 5264; 169 4165; 182 1446
Chem. No(s): 04861
Kodak's Internal Hazard Rating Codes: R: 1 S: 3 F: 1 C: 0

Manufacturer:
Eastman Kodak Company
343 State Street
Rochester, NY 14650
USA
For Emergency Information: (716) 722-5151

Supplier:
Eastman Kodak Company
343 State Street
Rochester, NY 14650
USA

INGREDIENT INFORMATION

	Percent	CAS Reg. No.
2-Phenoxyethanol	GT 95	122-99-6

PHYSICAL DATA

Appearance: Colorless to nearly colorless liquid
Boiling Point: 245 C (473 F)
Vapor Pressure: LT 0.02 mmHg @ 20 C
Evaporation Rate (n-butyl acetate = 1): Not Available
Vapor Density (Air = 1): 4.8
Volatile Fraction by Weight: Negligible
Specific Gravity (water = 1): 1.1
Solubility in Water (by Weight): Slight
Heat of Decomposition: -0.59 kcal/g (*)
* Calculated by ASTM Program CHETAH.

FIRE AND EXPLOSION HAZARD DATA

Flash Point: 116 C (240 F) Setaflash closed cup
Extinguishing Media: Water spray; Dry chemical; Carbon dioxide
Special Fire Fighting Procedures: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.
Unusual Fire and Explosion Hazards: None known

REACTIVITY DATA

Stability: Stable
Incompatibility: Strong oxidizers
Hazardous Decomposition Products: As with any other organic material, combustion will produce carbon dioxide and probably carbon monoxide.
Hazardous Polymerization: Will not occur.

TOXICOLOGICAL PROPERTIES

EXPOSURE LIMITS:
ACGIH Threshold Limit Value (TLV): Not Established
OSHA Permissible Exposure Limit (PEL): Not Established

EXPOSURE EFFECTS:
Inhalation: Low hazard for usual industrial handling.
Skin: May be harmful if absorbed through the skin.
Eye: Liquid causes burns.
Ingestion: Expected to be a low ingestion hazard.

TOXICITY DATA:

Test	Species	Result
Acute Oral LD50	Rat (M)	1350 mg/kg
Acute Oral LD50	Rat (F)	1900 mg/kg
Skin Absorption	Guinea Pig	No evidence of absorption at 20 mL/kg
Skin Irritation	Guinea Pig	Slight
Eye Irritation	Rabbit	Strong, washing was palliative

Repeated Skin Application: Slight with no exacerbation.
Skin Sensitization: None sensitized.
Other: Repeated skin application in rabbits of 600 and 1000 mg/kg/day has resulted in severe hematological effects; acute dermal LD50 for rabbits is ca. 2.0 g/kg.

Feeding Study: Rats were given 100, 300 and 1000 mg/kg/day by gavage, 5 days/week, for 11 doses.
Feed Intake: Normal
Weight Gain: Slightly decreased only in high dose group.
Clinical Signs: Reduced activity and general depression in high dose group.
Hematology: Normal
Clinical Chemistry: Slightly increased ALT and AST for high dose group.
Histopathology: Normal

FIRST AID MEASURES

FIRST AID:
Inhalation: Remove to fresh air following overexposure.
Skin: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash contaminated clothing before reuse. If symptoms are present after washing, get medical attention.
Eye: Immediately flush eyes with plenty of water for at least 15 minutes and get medical attention.
Ingestion: If swallowed, induce vomiting immediately as directed by medical personnel or a poison information center. Never give anything by mouth to an unconscious person. CALL A PHYSICIAN OR A POISON CONTROL CENTER IMMEDIATELY.

PREVENTIVE MEASURES

VENTILATION AND RESPIRATORY PROTECTION:
Good ventilation* should be sufficient. Supplementary ventilation or respiratory protection may be needed in special circumstances.

* Typically ten room volumes per hour is considered good general ventilation; ventilation rates should be matched to conditions of use.

SKIN AND EYE PROTECTION:
Protective clothing should be worn.
Goggles or a face shield should be worn.

SPECIAL STORAGE AND HANDLING PRECAUTIONS:
Keep from contact with oxidizing materials.

SPILL, LEAK AND DISPOSAL PROCEDURES:
Absorb material in vermiculite or other suitable absorbent and place in impervious container.
Dispose in an approved incinerator or contract with licensed chemical waste disposal agency. Discharge, treatment, or disposal may be subject to federal, state, or local laws.

ADDITIONAL INFORMATION

WHMIS STATUS: Controlled Product

TRANSPORTATION: For transportation information regarding this material, please phone the Eastman Kodak Distribution Center nearest you: Rochester, NY (716) 254-1300; Oak Brook, IL (312) 654-5300; Chamblee, GA (404) 455-0123; Dallas, TX (214) 241-1611; Whittier, CA (213) 945-1255; Honolulu, HI (808) 833-1661.

PREPARATION INFORMATION

Health and Environment Laboratories
Eastman Kodak Company
343 State Street
Rochester, NY 14650
USA

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