Report on the 1996 Tests to Electronically Detect Coded-Wire Tags

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1. Introduction

During the summer and fall of 1996 a program was conducted to investigate the use of electronic detection for finding coded-wire tags (CWT) in coho salmon in commercial fisheries and hatchery escapements. This program was divided into two areas of investigation: 1) the reliability of equipment available for electronic CWT detection; and 2) the feasibility of integrating electronic detection systems into existing adipose-clip mark sampling locations. The first area focused on evaluating the eight-inch tubular detector (R8) and diverter gate attachment manufactured by Northwest Marine Technologies (NMT). The second area focused on developing equipment which would facilitate the integration of the R8 detector into fish handling operations at commercial landing sites and hatcheries.

2. Reliability of the Electronic Detection Equipment

NMT has developed and manufactured a tubular device designed to detect CWTs in large scale sampling operations. This detector, designated as the R8, descends from a line of field and laboratory CWT detectors with known capabilities, but will be expected to operate under more demanding conditions. As of mid-1996, the R8 had not yet been extensively field tested.

A diverter gate and automatic counters have been combined on a single unit (gate system) designed to fit onto the exit of the R8 (Photograph 5). During the 1996 testing, there was only one prototype gate available. It was shared by WDFW and NWIFC as well as Fisheries and Oceans Canada. As a result there was limited opportunity to evaluate it.

Two sites where relatively large numbers of adipose-clip marked coho are encountered in regular CWT sampling operations were selected for the testing: Neptune Fisheries in Ucluelet with landings of commercially harvested coho (Photographs 1-3); and Chilliwack Hatchery with both live surplus and spawned coho (Photograph 4).

2.1 Methods

2.1.1 Methods Used to Test the R8 Tube Detector

At each location the R8 was set up and operated according to procedures outlined in NMT's R8 Operating Manual (January 1996). In all trials, the detector was powered with battery-supplied direct current. The LED threshold display was turned on and the volume control turned to maximum. In one trial, an LED attached to the output connector on the detector was also used as a CWT alert signal. The R8 was inclined at approximately 20° for all trials. This was not sufficient to achieve minimum required velocity with gravity alone, so technicians pushed fish through the detector. The gain control was usually set so that coho without a CWT generated a signal that was about 0.6 times threshold strength (the minimum signal strength needed to indicate the presence of a CWT) and coho with a CWT generated a signal that was about 1.3 times threshold strength. This was considered to be a conservative setting that would minimize the likelihood of missing a CWT.

There are four cases to consider in describing how the R8 detector responds to an individual fish. They depend on whether the fish is clipped or unclipped, and whether the R8 gives a positive or negative result for the presence of a CWT.

	Adipose fin	
R8 result	Clipped	Unclipped
Positive	Case 1	Case 2
Negative	Case 3	Case 4

Case 1. R8 result assumed to be correct

Case 2. R8 error suspected

Case 3. R8 error suspected

Case 4. R8 result assumed to be correct

During the tests at Ucluelet, only the Case 3 potential errors were isolated for retesting. The heads of these fish were removed and sent to the dissection lab, where they were passed through an NMT 4-inch tubular detector. During the tests at Chilliwack Hatchery, both types of potential errors were re-tested onsite, using an NMT FSD-1 detector.

2.1.2 Methods Used to Test the Diverter Gate

Except for one demonstration use of the gate and counter at Neptune Fisheries, testing was conducted exclusively at Chilliwack Hatchery on three dates. The system was not actively tested on November 29 because of an internal short circuit in the diverter gate power coupling and an ineffective deflector wedge in the exit box. Active tests were conducted on December 4 and 11 after the short circuit was corrected.

In these tests the R8 rotary dwell setting, which governs the duration of electrical current sent to the gate solenoid after a CWT has been detected, was rotated one-quarter turn clockwise from the base setting. Observations were made on 1) the response of the gate to signals from the R8 and 2) individual fish going through each side of the gate to investigate the combined operation of the gate, its latch and automatic counters.

2.2 Results

2.2.1 Results of the R8 Tube Detector Tests

A total of 15,333 coho were put through the R8 tube detector at the two locations. Tables 1 and 2 (at the end of the report) show the results on a daily basis. Summary tables are below.

Ucluelet tests

	Adipose fin	
R8 result	Clipped	Unclipped
Positive	457	11
Negative	93	11589
Total	550	11600

Chilliwack tests

	Adipose fin	
R8 result	Clipped	Unclipped
Positive	76	39
Negative	9	3059
Total	85	3098

Of 550 adipose-clipped coho put through the R8 at Ucluelet, 457 were correctly identified as having a CWT (positive R8 result) and 93 as not having a CWT. All 93 negative results for clipped fish were confirmed in retesting. One of the 11 unclipped fish which were identified as having a CWT was observed to have a metallic filing on its surface. The other 10 results were unverified. At Chilliwack, of the 85 adipose-clipped coho put through the R8, 76 were correctly identified as having a CWT and 7 as not having a CWT. One CWT was missed by the R8 (discovered in retesting) and one fish was unverified. Of the 39 unclipped fish which gave a positive R8 result, only 10 were confirmed as positive on retesting. These 10 fish did not carry CWTs, however; in all cases fishing hooks were found either in the mouths or stomachs.

2.2.2 Results of the Diverter Gate Tests

A total of 1710 live fish, mostly coho, were put through the gate to test its response to command signals from the R8. Thirty-five positive R8 results were correctly shunted by the gate. Three positive R8 results were incorrectly shunted into to the grading area. Fish jammed on the deflector wedge on three occasions, all of which were easily and quickly cleared. All the 1672 negative R8 results were correctly passed through the non-CWT gate.

	R8 Result	
Gate Response	Positive	Negative
CWT side opened	35	0
Non-CWT side opened	3	1672

A summary of the tests comparing the automatic counters on the gate system to visual counts is shown below. The details of individual tests are in Table 3 (at the end of the report).

Counting method	Adipose fin	
	Clipped	Unclipped
Visual	19	791
Automatic	29	820

2.3 Discussion

2.3.1 Discussion of Test Results for the R8 Tube Detector

The retesting which was done on the 39 unclipped positive R8 results showed that none of those fish carried a CWT. Either there was some other metal object in or on the fish, or the gain setting on the detector was too high. Unless sampling protocols included the retesting of all R8 positive results, the heads of these fish would be removed and sent to the dissection lab needlessly, and classified there as "no-pins".

There was only one known instance of the R8 missing a CWT, discovered in retesting because the fish was clipped. It is possible that the fish moved too slowly or too quickly through the tube (specified range is 1.5m to 6m per second). Another possibility is that the orientation of the CWT relative to the axis of the tube made it difficult to "see".

The retesting which was done on the 102 clipped-negative R8 results confirmed the R8 results in all but 2 fish. The 100 confirmed negative results could be explained either by naturally missing adipose fins, or by CWTs being shed after tagging. If electronic detection is used, the heads of these fish would not be needlessly removed as they are with visual sampling.

2.3.2 Discussion of Test Results for the Diverter Gate

Counts made by automatic counters were 5% to 6% higher than the visual counts. Some sources of the errors were easily identified. Two or three fish were counted by the automatic counters as one fish 11 times. These errors occurred when fish entered the detector in quick succession from the receiving table. This was partly corrected by moderating the rate at which fish were fed into the detector. However, some live fish still moved into the detector of their own accord. One fish was counted by the automatic counters as two fish 21 times. These errors occurred when the gate bounced far enough out from its frame to register a second count, as it returned after a fish had gone through. A fish which was unclipped, giving a negative R8 response, hit the latched CWT gate and was counted by the automatic counter on that gate one time. A video record of testing activities viewed at slow speed unexpectedly revealed a fourth possible source of counting error which occurs too quickly to observe directly. This error occurs if a CWT is detected and the electrical signal from the R8 sent to the gate latch stops while the CWT fish is still moving through the exit system. The latch will return to its default position thereby releasing the nonCWT gate so that an erroneous count may register if this gate is pushed open by the fish moving past it. A fifth possible source of counting error, specific to commercial troll landings, was identified during the demonstration of the gate system at Neptune Fisheries. Lumps of ice, used to cool fish onboard trollers during a trip, were counted by automatic counters when they fell from the body cavities of some coho as they were loaded onto the receiving table and slipped through the diverter gate.

2.4 Evaluation

2.4.1 Evaluation of the R8 Tube Detector Tests

Because the sample sizes in this year's testing were small, it is possible that the R8 test results are not representative of what might be experienced in full-scale use of the equipment. Some consideration should be given to three factors which might have affected the results: 1) it is likely that not all possible CWT orientations and positions were tested through the R8; 2) the two testing environments may not have presented typical challenges related to extraneous noise or magnetic influences; and 3) the technical aptitude of personnel involved in this year's testing may not be typical of CWT samplers in general.

The failure of the R8 detector to detect the presence of a CWT is of critical concern to the validity of the CWT database. There was only one known instance of this. It occurred during initial testing at Chilliwack Hatchery on November 4 and was probably caused by a low velocity pass through the R8 detector. The results indicate that the R8 detector is capable of detecting the presence of a CWT virtually 100% of the time, under conditions comparable to these tests in terms of operating environment and expertise of sampling personnel.

Indicating the presence of a CWT where one is not present is an important concern both to the fishing industry and agencies responsible for funding CWT sampling operations. Heads incorrectly removed from fish cause an unnecessary reduction in market value of the catch. These heads also add shipping, handling, and processing costs to sampling programs. Data collected at Chilliwack Hatchery show that 0.88% of coho put through the R8 were incorrectly identified as containing CWTs. If tests conducted on November 4 are excluded, when the R8 gain setting was varied over several trials, this proportion drops to 0.54%. Comparing these results to the current "no-pin" rate of 12-15% (of heads received at the dissection lab) suggests that the number of heads sent to the lab without CWTs would be virtually the same with or without electronic detection.

2.4.2 Evaluation of the Diverter Gate Tests

Tests on the diverter gate at Chilliwack Hatchery and observations at Neptune Fisheries show that the gate system is currently not capable of shunting and counting fish accurately. In addition, there is some concern about its durability with long term use. During limited use in just one season, the power coupling fractured and the solenoid housing became detached. Concerns about long-term durability should be addressed by using heavier gauge materials and couplings, and using more effective means of attaching components. The prototype gate system was designed with a preselected default gate (the gate through which fish pass when no signal is received from the detector) that cannot be changed. In order to support R8 detectors used in a pair, a switchable default gate is needed. These problems and deficiencies have been reported to NMT, which is planning to resolve them.

Other counting errors and incorrect shunts of CWT fish resulting from the premature release of the nonCWT gate can probably be corrected by increasing the dwell setting, but with an increased possibility of nonCWT fish going through the CWT gate. A

comprehensive video record should be made of the gate system shunting fish over a length range anticipated in fishery and hatchery operations to investigate the relationship between fish length, dwell and accurate gate function.

Counting errors resulting from fish entering the R8 in quick succession were partly resolved at Chilliwack Hatchery by modifying the procedure used to feed fish to the R8, however more control over live fish in receiving areas is needed to eliminate these errors.

3. Feasibility of Integrating Electronic Detection Systems into CWT Sampling Locations

It became obvious during a one day trial at Ucluelet during the summer of 1995 that the R8 tube detector is not capable of stand-alone use when large volumes of fish need to be sampled in a timely manner. There is a need for support equipment at both ends of the detector to facilitate the continuous passage of fish though the tube. The resulting electronic detection system must be capable of fitting seamlessly into existing sampling sites, so that there is minimal impact on current fish handling procedures. A major objective of the 1996 testing program then, was to begin an investigation of the types of support equipment that might solve this problem.

3.1 Special Circumstances Affecting Feasibility Investigations

Unfortunately, the landings at Ucluelet during the 1996 season did not present the challenges to the electronic detection equipment that might be expected in a more typical year. The catches were smaller than usual and not as mixed as usual (few non-coho present), due to a combination of factors, including

- non-retention of chinook in virtually all south coast troll and net fisheries; and
- reduced effort because of relatively poor markets for coho and changes in licensing; and
- a low cycle year for Fraser River pink and sockeye.

Nonetheless, some valuable insights were gained regarding design considerations for electronic detection support equipment.

Operations at Chilliwack Hatchery this year, insofar as the testing period covered, were similar to those that are expected in the future. However, no trials were conducted during high-volume coho sales or sales with large numbers of both chum and coho, conditions that are expected to place significantly higher demands on electronic detection support equipment.

3.2 Commercial Landing Operations

CWT sampling at commercial landing sites may be done either

- prior to grading, or
- immediately after grading, or
- after grading and weighing.

The last two options were ruled out for the testing at Neptune Fisheries because they would require handling each grade of coho separately. Instead, a prototype receiving table was designed to receive fish hoisted directly from the vessel and to allow for the fish

to pass through the R8 prior to being graded. No support equipment was designed for the back end of the R8; it was to rest directly on the grading table at the site.

3.2.1 A Description of the Receiving Table

The table was constructed from aluminum. Its working surface is about 2m x 1.5m, with 20 cm edges on three sides. It is supported by four square-stock step-wise adjustable legs. A removable gantry was fitted into hollow square-stock braces between these legs. Two guides were welded diagonally onto the table surface so that they partially converged at an opening on one of the sides. This opening leads into a sleeve which leads into the R8. The R8 tube fits around the sleeve, supported by two L-brackets welded to the underside of the table surface. The sleeve is angled off the table surface to incline the R8 onto the grading table. A water gallery, attached at the opposite end of the table, supplies a flow of water onto the table surface for lubrication.

3.2.2 Performance Observations

Although the R8 tube opening is only 4" by 8", the system was able to handle coho weighing from 1.1kg to 7.2kg. Except for some late season catches, this is the weight range within which most coho are expected to fall.

The receiving table was capable of holding between 75 to 100 coho. This is the capacity of loading buckets used to remove fish from the vessels. The adjustable legs, water flow, and guides were intended to assist the movement of fish by gravity to the R8 tube, but in practice frequently caused fish to slip uncontrollably down to the opening so that fish either jammed in the sleeve (particularly when the table was full of fish), went through the R8 too slowly, or went through the R8 two or more at a time. The movement of fish into and through the R8 will need to be controlled to prevent these problems. The adjustable legs, intended to allow different degrees of slope, could only be adjusted in steps making it difficult to precisely align the sleeve and R8 tube. This resulted in some metal fatigue at the joint between the sleeve and table. Handling equipment should be designed to allow continuous height adjustments. Adequate stress tolerances should be specified for pressure points.

There were some health and safety concerns related to the design of the table. Some areas of the table's surface were not easily accessible for cleaning and sterilization. Sampling personnel feeding fish into the detector from the table experienced back pain after just 30 minutes at the job. Also, excessive amounts of water came through to the grading table causing some discomfort to graders working there. These deficiencies illustrated the importance of considering ergonomically efficient and simple table designs to minimize the risk of injury to sampling personnel and allow for effective maintenance.

Samplers using the electronic detection system at Neptune Fisheries were able to handle up to 800 coho per hour. This rate was fast enough to keep up with one grader. However, during high volume delivery cycles (every 6-8 days), the plant would assign two unloaders and three graders to a delivery. At these times, the samplers were not able to

keep up. Either the electronic detection equipment was moved off-line or only partial deliveries were passed through it.

3.2.3 Adaptability and Portability Observations

Given the large number of sites which might be required to implement electronic detection, it is cost-effective to seek solutions which are appropriate for as many of them as possible. Therefore, consideration should be given to both the adaptability and portability of proposed systems.

A preliminary survey of troll landing sites at Ucluelet and Tofino indicates that the front-oriented system used at Neptune Fisheries is not adaptable to most of these sites primarily because of space limitations. Size will determine the "footprint" needed for this equipment at landing sites where floor space for anything not directly related to landing operations is usually very limited. This space, and equipment placed on it including grading tables, fish totes or trolleys, weigh scales, ice chutes, awnings, hoses, and winches, has been designed specifically for the task of landing fish efficiently. Inserting equipment for electronic detection will undoubtedly impose some changes on how fish is landed, but these changes can be minimized by limiting the size of this equipment.

It was also discovered that the equipment is not easy to transport and set up. Four people were needed to move the table onto a site; then up to 45 minutes were needed to assemble it and attach the R8. It took two people to move or adjust it on site.

3.3 Hatchery Operations

Observations at Ucluelet pointed out some obvious deficiencies of the system used there. Testing at Chilliwack Hatchery provided an opportunity to evaluate a second system. This second system included a smaller receiving table at the front end of the R8 and a box at the back end containing a baffle to control the movement of coho exiting the diverter gate. As with the earlier prototype, the second table was designed to receive coho prior to being graded. Coho were thrown by hand from a brailing trough onto the receiving table, passed through the R8, and then shunted either to the hatchery grading table, or into a container for CWTed fish.

3.3.1 A Description of the Table and Exit Box Used to Support the Operation of the R8 at Chilliwack Hatchery

The second table was constructed from lighter weight aluminum than the first. Its working surface is about 1m x 1.5m, with 20cm edges on all four sides. One side is hinged to swing down. The surface area is only about half that of the first prototype and can be loaded with up to 50 coho at a time. The table is supported with step-wise adjustable legs which fold for transport and storage. A separate plastic sleeve is inserted through one of two openings on the side opposite the hinged edge permitting some flexibility in adjusting the R8 with respect to the table. A sliding baffle covers either opening or can be positioned so that both are opened when two R8 detector units are being used. No water gallery was attached to the table top; the surface was lubricated by periodically spraying it with water from a small hose.

The exit box attaches to a flange around the bottom end of the R8 tube detector. It is intended for use only with the diverter gate. The diverter gate opens to one side for coho which trigger a positive response (CWT detected) from the R8, and to another side for coho which trigger a negative response. A baffle in the exit box deflects the CWT coho to a holding area for later processing, and non-CWT coho back into grading operations. Four step-wise adjustable legs attached to either side of the exit box and to a flange around the front end of the R8 provide independent support.

3.3.2 Observations

The holding capacity of the receiving table was never reached during these trials because sampling personnel maintained a marginal lead in putting fish through the R8 over hatchery personnel loading the table from the brailer trough. This table is smaller and lighter than the first, hence is more portable and takes less time (15 minutes) to assemble. The openings where the R8 may be attached are closer to the sides of the table, so sampling personnel are closer to the fish and less likely to experience back strain. The problem with excessive amounts of water flowing through the system onto the grading table has also been eliminated.

3.4 Evaluation

It became clear during tests at Neptune Fisheries that the system was not able to sample fish fast enough to keep up with plant grading operations during high volume deliveries. In order to maintain the existing CWT sampling strategy of sampling 100% of each delivery, systems will have to be designed which can achieve throughput rates up to 1600 fish per hour.

Deliveries from mixed species troll fisheries to all sites, including Neptune Fisheries, will place demands on fish handling systems that will not be effectively satisfied by front-oriented handling. The proportion of coho in a multi-species troll fishery can vary substantially over time from as much as 98% during periods when trollers target on coho to as little as 10% during pink and sockeye openings. Large numbers of fish are usually landed for each delivery during the peak of these openings most of which are not required for sampling. Fish handling equipment should be designed so that it can be configured for optimal access to coho in any species mix without handling large numbers of other species.

Many of the deficiencies noted in the first prototype have been, at least partly, corrected in the second prototype. However, an important concern remains regarding the overall capability to conduct electronic sampling in more demanding conditions with little or no impact on existing plant or hatchery operations. In particular, the configuration of handling equipment to accommodate two R8s has not been effectively resolved. Although the second table design includes two openings to which R8 may be attached, fish going through each of two paired R8 detectors will exit only 0.5 meters apart onto a grading table that is 3 metres long. Coho without a CWT and CWT coho cannot be shunted horizontally into or out of the grading area without either crossing over each other or substantially restricting the useful area by hatchery graders.

4. Suggested Equipment Configurations

4.1 Sites Which Process Fewer Than 100 Coho per Delivery

Deliveries from commercial net catches with small bycatches of coho (<100 coho per delivery) may be most effectively accessed for electronic detection using wand-style CWT detectors. These do not require support equipment and can be integrated directly into current mark sampling operations without any significant effect.

4.2 Sites Which Process 30,000 to 60,000 Coho Annually

For medium volume troll landing sites (landings between 30,000 to 60,000 coho per season) with limited space, a free-standing, inclined R8 attached to a handcart may be the best solution. Coho would be sampled after being graded and weighed. The fish would be fed directly from totes or trolleys into the R8 and exit through a shunt system into one of two totes depending on the R8 test result. These operations will need to be in close proximity to the landing area so sample data can be easily associated with specific deliveries. This system may also be appropriate for sampling deliveries to Vancouver and Port Hardy from net fisheries in Juan de Fuca and Johnstone Straits with substantial bycatches of coho.

4.3 Sites Which Process More Than 60,000 Coho Annually

Currently, most commercial troll catch mark sampling is conducted at high volume landing sites (over 60,000 coho per season). Considering space limitations and anticipated fish handling requirements for multi-species fisheries at these sites, a side-oriented electronic detection system may be the configuration with least impact on landing operations. Detectors may be used on both sides of the grading table when large deliveries are being processed, to double the sampling rates achieved with just one detector (Figure 2). Space requirements could be minimized by using a modified existing grading table to load and hold fish for electronic sampling. The system could accommodate variable species mixes as well as different sampling rates.

The system would have two modes of operation:

- Deliveries comprised primarily of coho will be loaded onto an inclined step at the head of the grading table and held with a raised tailgate extending across the table. Coho would be selected first from each load and put through the R8 detector. Positive R8 results would be shunted off the grading table into a holding container and negative R8 results shunted back onto the grading table. Other species of fish remaining on the loading step are then released into the grading area by lowering the tailgate.
- Deliveries from sockeye and pink fisheries with low proportions of coho would be loaded below the tailgate permitting graders direct access to these fish. Negative R8 results would be returned to the loading step through a counter-inclined reversed R8 detector and positive R8 results will be shunted to a holding container. These fish will then be released from the loading step into the grading area once it is cleared again after which the procedure is repeated for the next loading.

It is anticipated that a side-oriented fish handling system would be effective not only at commercial troll landing sites but also at high volume troll catch processing plants in Vancouver (Pacific Salmon Industries and Lions Gate Fisheries).

5. Recommendations for Activities in 1997

5.1 Expand the Scope of the Testing

In general, the number of sites at which tests are conducted and the number of different technical personnel involved should be increased from 1996 to provide a wider range of test conditions.

5.2 Investigate the Reliability and Feasibility of Wand Detectors

DFO has not yet conducted thorough tests of wand detectors. It will be necessary to train samplers in effective wanding techniques and then to evaluate both the reliability of the wands in detecting CWTs and the additional sampling time required over traditional methods using visual identification of adipose clips.

5.3 Investigate the Use of Electronic Detection in Sampling Recreational Fisheries

If significant numbers of adipose-clipped, non-CWT fish are to be encountered in recreational fisheries, DFO will no longer be able to rely on the voluntary head recovery program to retrieve CWTs from these fisheries. Creel survey sampling procedures will have to be re-defined to incorporate electronic detection of CWTs. Protocols will have to be established for the removal of heads from CWT fish. Logistical issues have to be resolved regarding the storage and transport of the heads. Pilot projects should be conducted during 1997 as part of the Barkley Sound Creel Survey and the Georgia Strait Creel Survey.

5.4 Continue to Develop and Evaluate Equipment Which Supports the R8 Tube Detector at Medium and High Volume Commercial Sites

There should be further development and testing of side-oriented and free-standing R8 support systems. Knowledge gained in 1996 testing should be brought to bear on improved design specifications. Equipment manufactured in 1996 may be modified or new equipment fabricated according to these designs. The selection of sampling sites should be based on the expectation of high volume deliveries.

5.5 Initiate a Pilot Project to Obtain Heads from Freezer Trollers

A pilot freezer-troll catch sampling schedule should be initiated to investigate the utility of a free-standing R8 system in west coast Vancouver Island fisheries. Currently, freezer troll catches are landed with adipose-clip marked coho as head-off. This precludes the recovery of CWTs from this stratum causing a potential bias in the CWT database and reducing overall sampling efficiency. Access to this stratum could be accomplished through onsite electronic detection as the means with which to field test large numbers of heads quickly for the presence of CWTs. If freezer-troller operators can be requested or required to

remove and keep all coho heads or snouts for delivery this stratum could be effectively sampled and associated with high resolution catch data if heads/snouts were seperated by date. Conservatively, a 15% gain in overall sampling efficiency could be realized given that up to 30% of west coast Vancouver Island regional troll catches are taken by freezer trollers.

5.6 Review Possible Legal Constraints on Changes Required for Electronic Sampling

Current legislation covering permissible sampling activities at landing sites should be reviewed to ensure that any procedural or physical modifications needed for electronic sampling activities are supported by law. If required, particularly for custom unloading operations, guidelines or landing requirements for coho should be developed to ensure that coho will be accessible for electronic detection wherever landings are made.

FIGURES

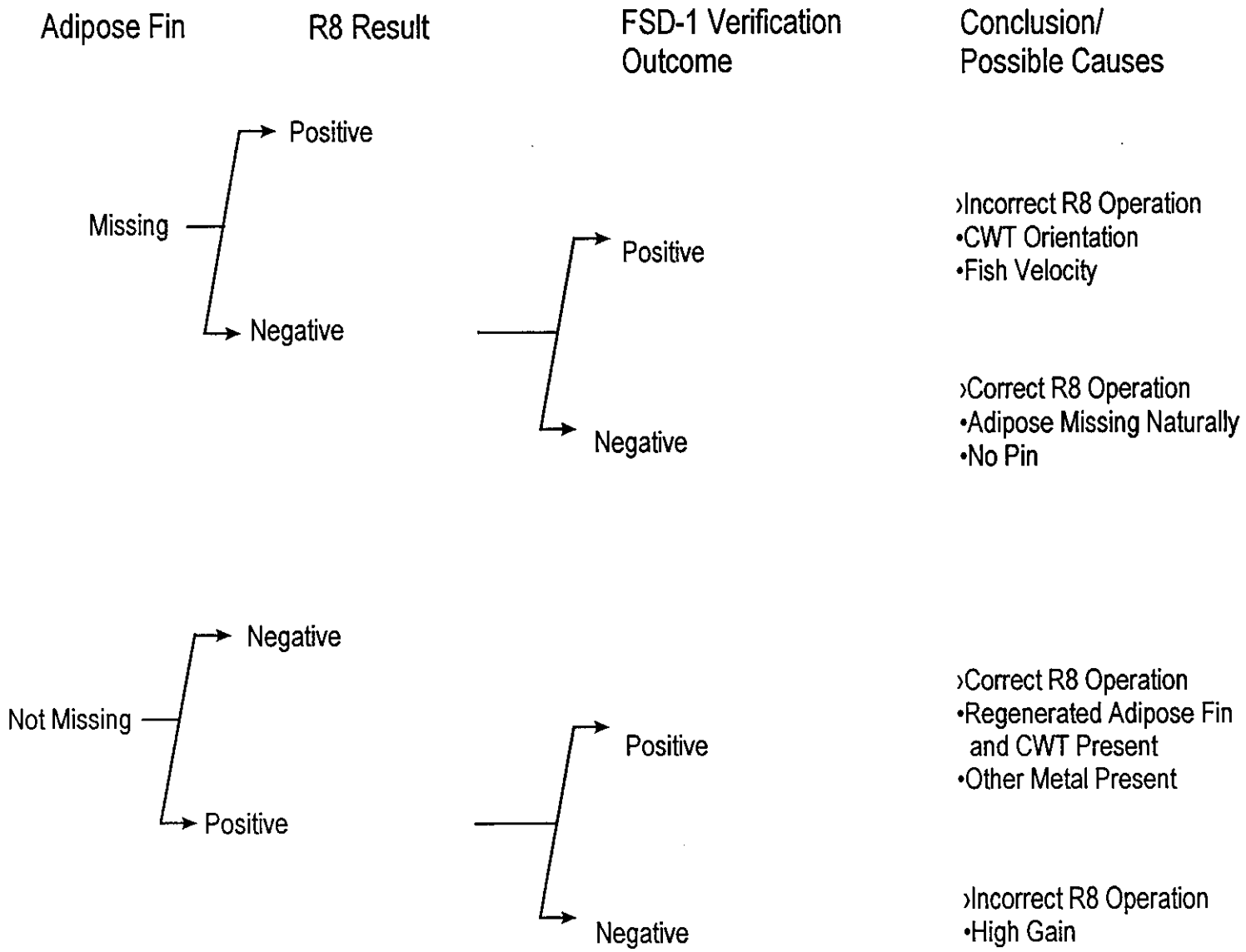


Figure 1._Flow for R8 detector testing procedure and results.

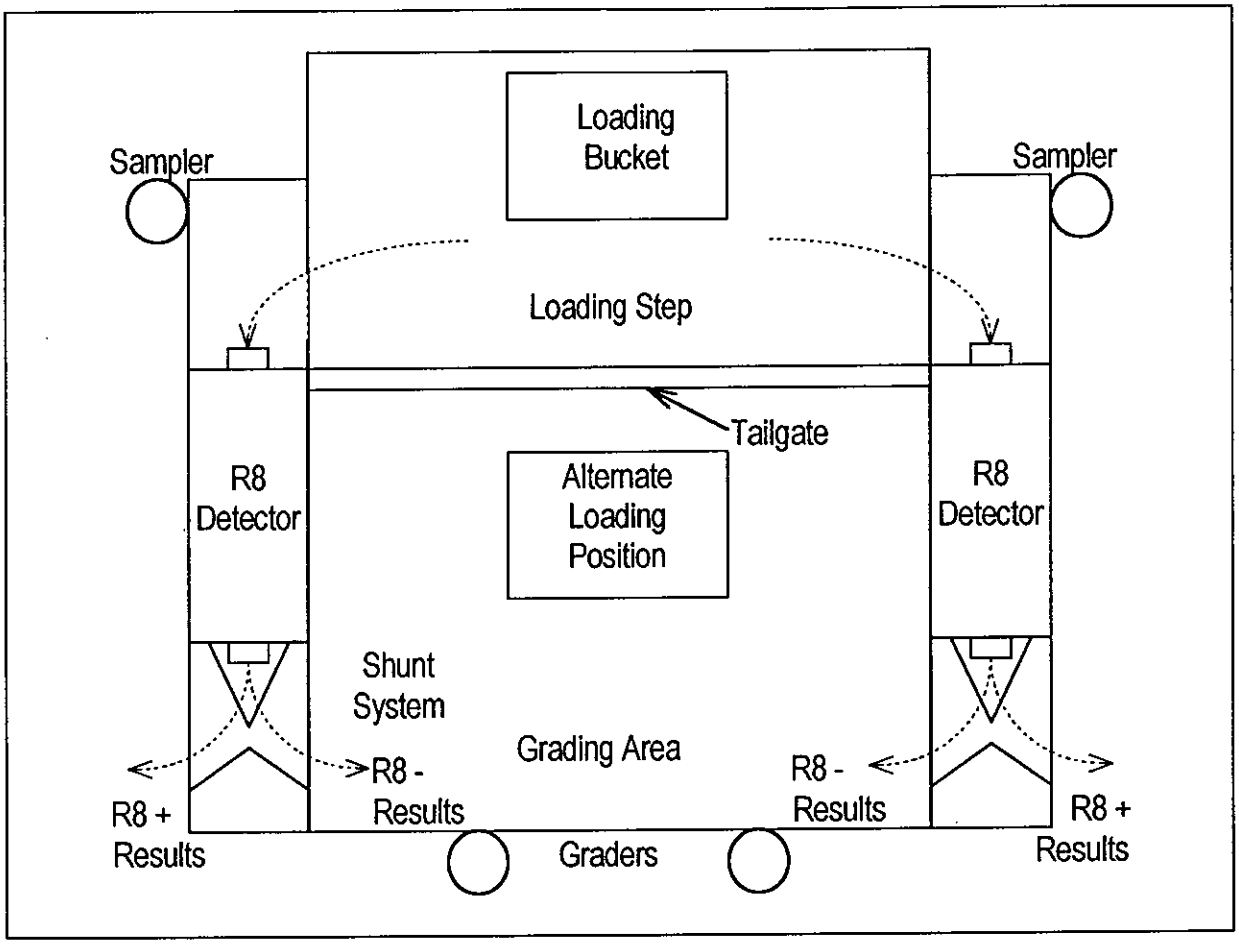


Figure 2. Proposed side-oriented electronic detection system. Scale is approximately 1:30.

TABLES

Table 1. R8 testing records for Neptune Fisheries, Ucluelet

Date	Sample Size	Adipose Clipped Fish				Unclipped Fish	
		Total Clips	R8 Result		Restest	R8 Result	
			+	-	-	+	-
22-Jul	274	15	11	4	4	0	259
26-Jul	1199	43	34	9	9	1	1155
27-Jul	742	27	25	2	2	3	712
31-Jul	2754	151	129	22	22	2	2601
1-Aug	395	18	16	2	2	3	374
2-Aug	908	45	36	9	9	0	863
4-Aug	1149	51	40	11	11	0	1098
5-Aug	659	27	23	4	4	2	630
8-Aug	1718	69	55	14	14	0	1649
23-Aug	2352	104	88	16	16	0	2248
Total	**12150**	**550**	**457**	**93**	**93**	**11**	**11589**

Table 2. R8 testing records for Chilliwack Hatchery.

Date	Sample Size	Adipose Clipped Fish					Unclipped Fish			
		Total Clips	R8 Result		Retest of neg's		R8 Result		Retest of pos's	
			+	-	-	+	+	-	+	-
4-Nov	225	17	14	3	2	1	16	192	3	13
29-Nov	1248	30	29	1	1	0	18	1200	7	11
4-Dec	1237	23	19	4	3	0	4	1210	0	3
11-Dec	473	15	14	1	1	0	1	457	0	1
Total	**3183**	**85**	**76**	**9**	**7**	**1**	**39**	**3059**	**10**	**28**

Table 3. Comparisons of visual counts with automatic counts registered by the gate system.

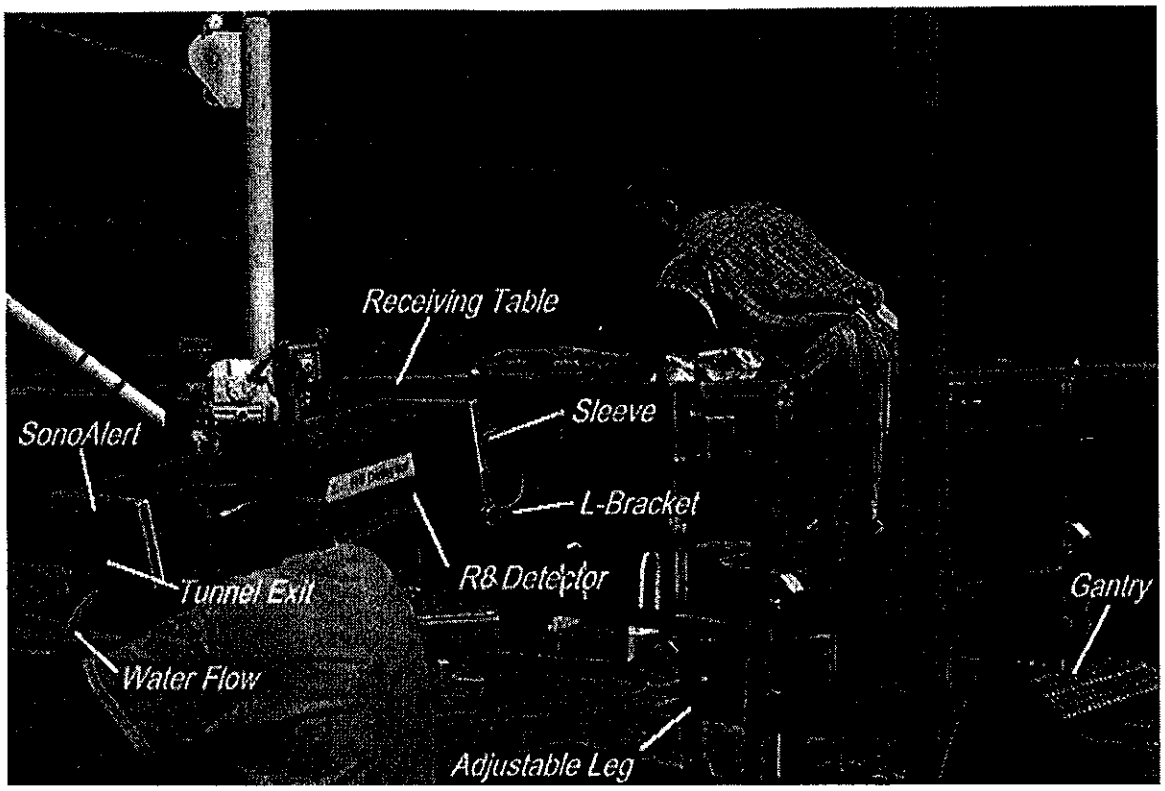
December 4, 1996: Chilliwack Hatchery:

	Trial 1		Trial 2	
	Visual count	Automatic count	Visual count	Automatic count
Not Adipose-Clip Marked	156	164	252	262
Adipose-Clip Marked	1	5	7	9
Total Count per Trial	157	169	259	271

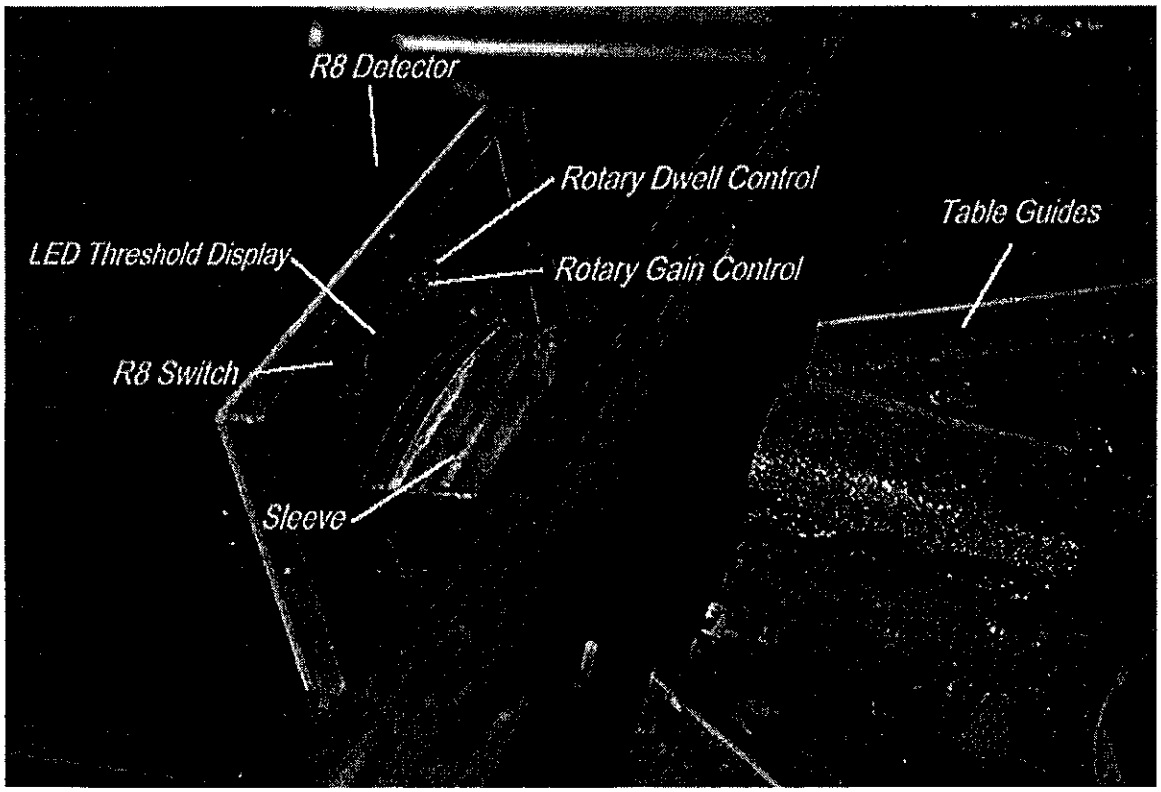
December 11, 1996: Chilliwack Hatchery:

	Trial 1		Trial 2	
	Visual count	Automatic count	Visual count	Automatic count
Not Adipose-Clip Marked	124	129	259	265
Adipose-Clip Marked	7	9	4	6
Total Count per Trial	131	138	263	271

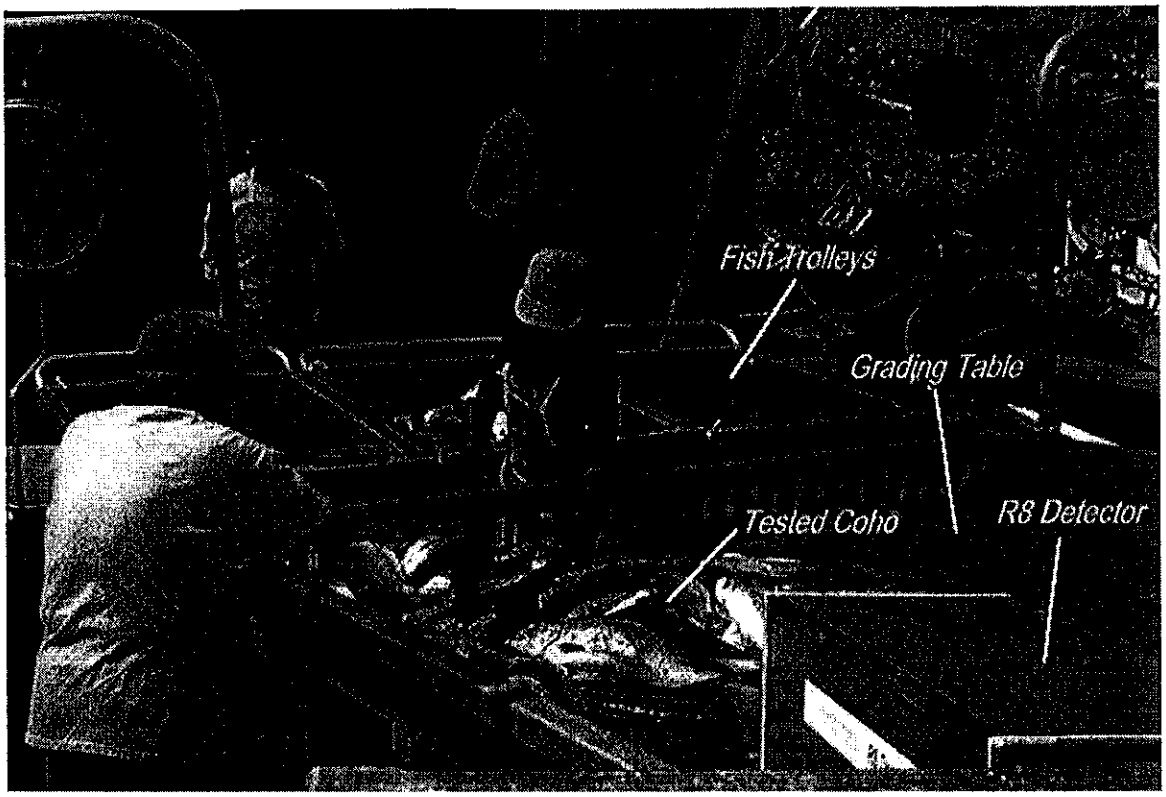
PHOTOGRAPHS



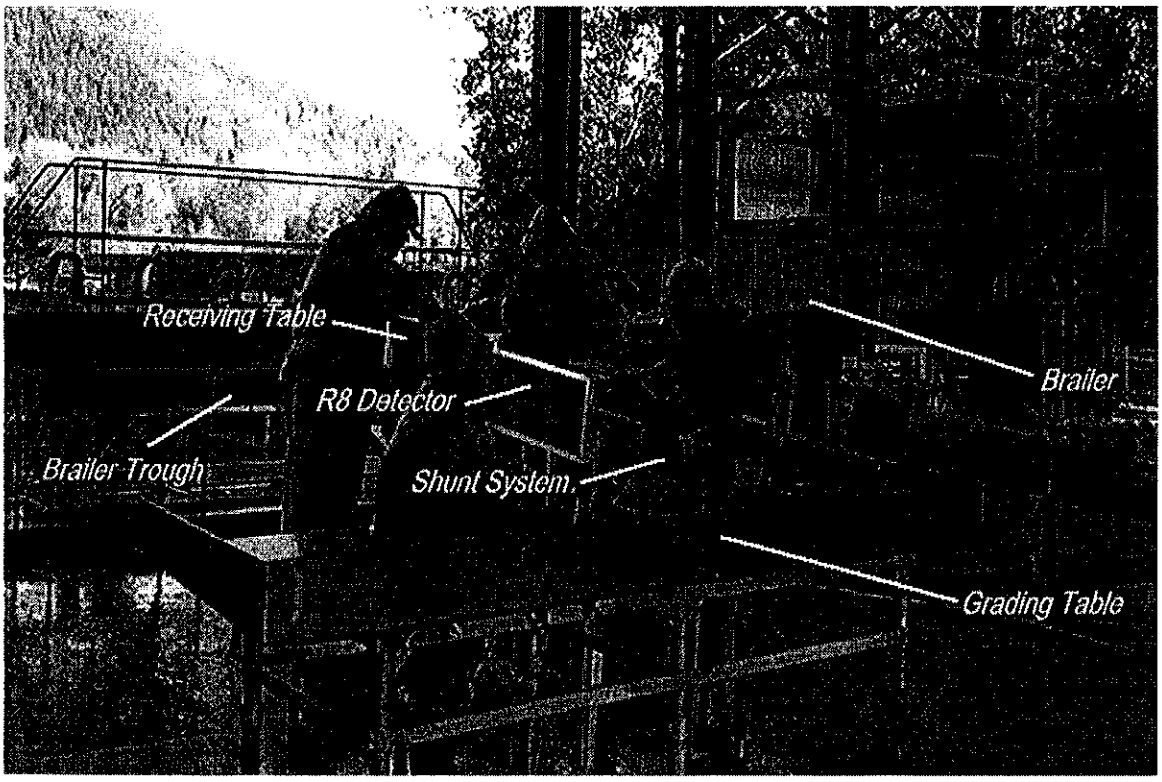
Photograph 1._R8 detector operating with prototype receiving table at Neptune Fisheries, Ucluelet: July 1996.



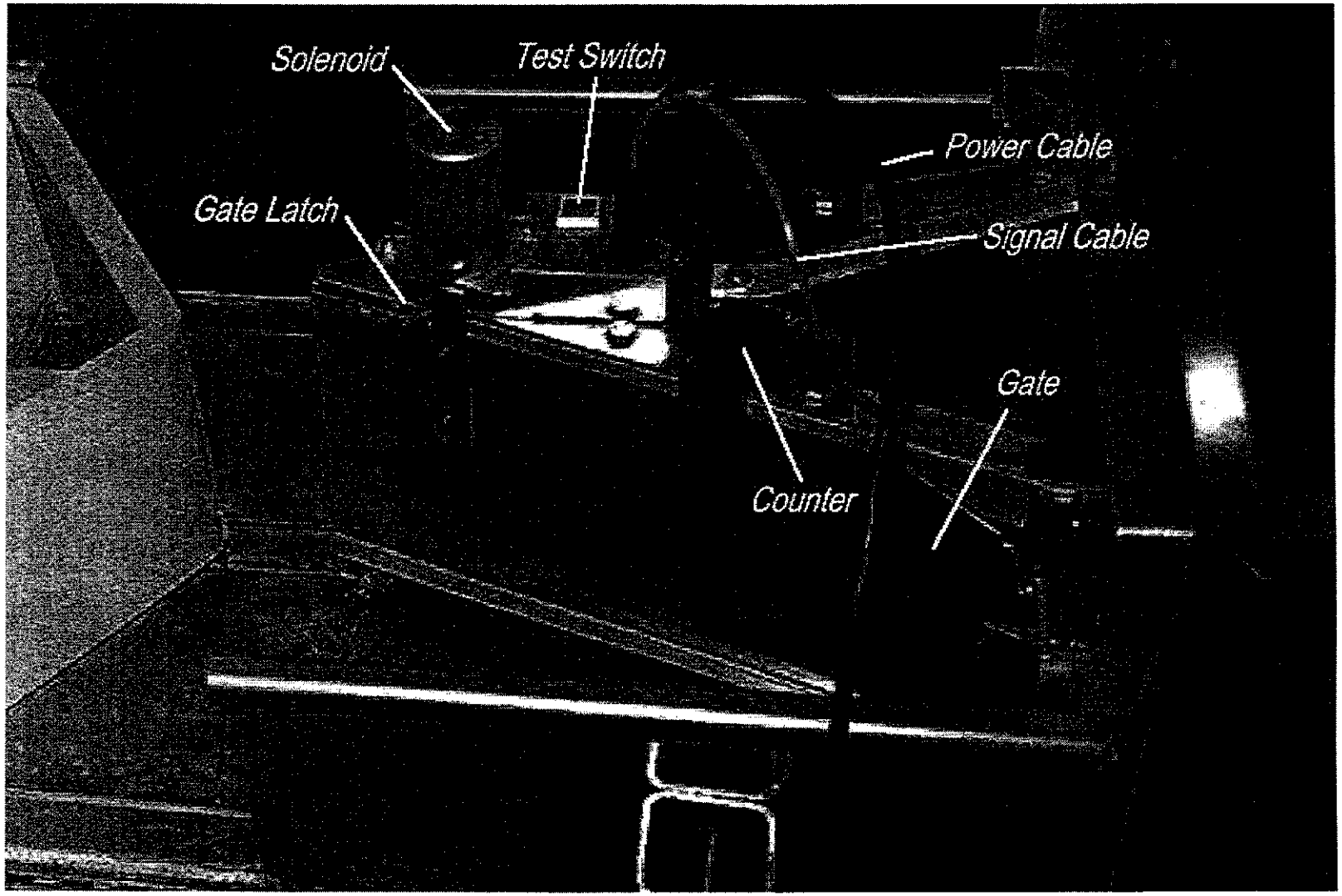
Photograph 2._ Detail of R8 detector control panel and prototype receiving table: July 1996.



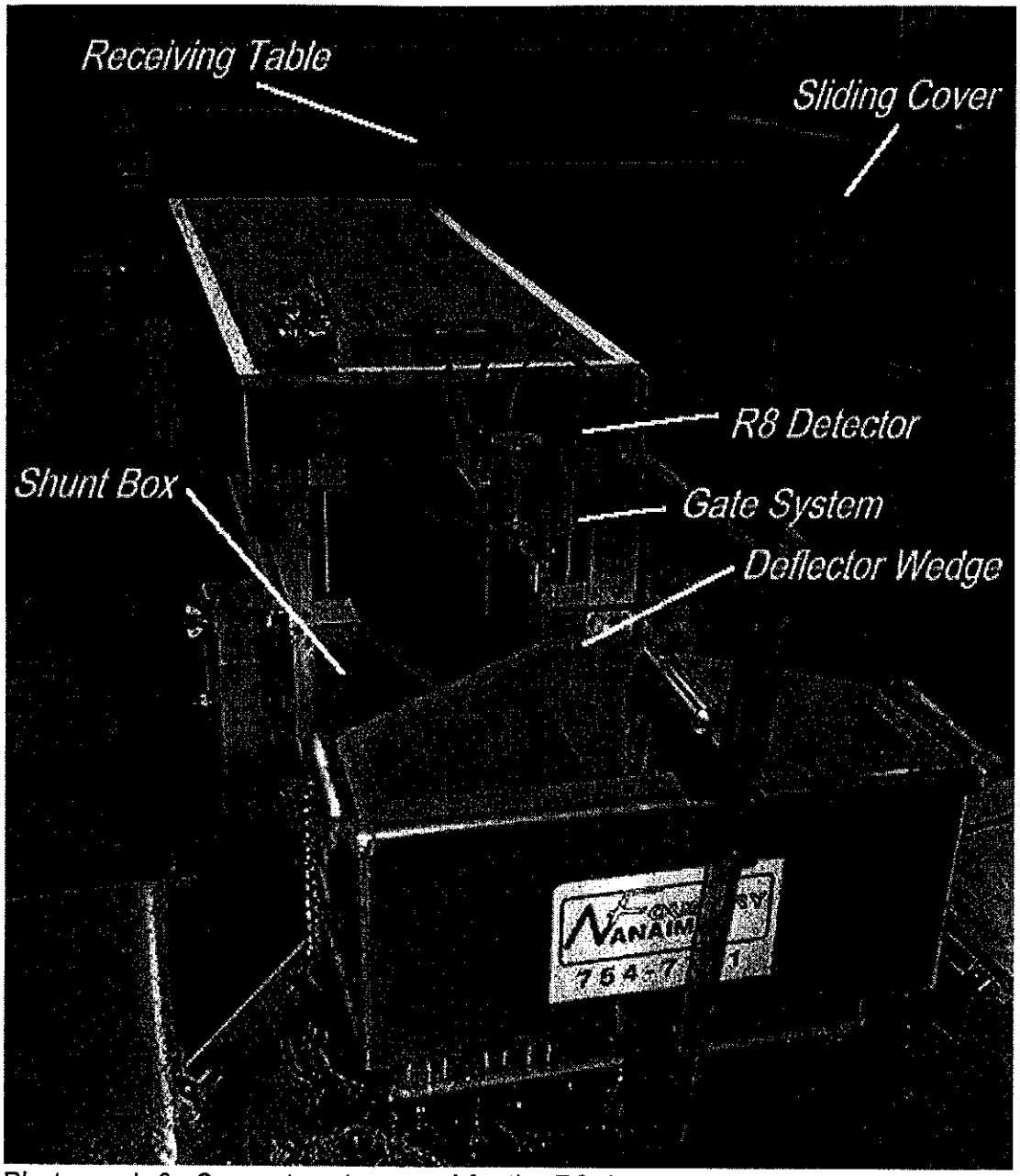
Photograph 3._R8 detector and grading operations at Neptune Fisheries, Ucluelet: July 1996.



Photograph 4._R8 detector system operation and evaluation at Chilliwack Hatchery: December 1996.



Photograph 5._Detail of gate system with R8 detector and shunt box.



Photograph 6._Support system used for the R8 detector at Chilliwack Hatchery: December 1996.