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CODED-WIRE TAG LOSS STUDY

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INTRODUCTION

For each year from 1973 thru 1978, the Washington Department of Fisheries (WDF) has published a report documenting the estimated catch of WDF's coded-wire tagged (CWT) fish. These have been published as part of the WDF Progress Report series and provide estimated catch by fishery, area and time for each tag group with one or more tag recoveries during that year (WDF, 1976, 1976; Rasch 1977, 1978; Rasch and O'Connor, 1979; and O'Connor, 1980).

These reports have treated tag loss inconsistently (tag loss refers to the shedding of CWT's which had been implanted in the snout of fish). In the 1974 report, a 15% tag loss was used to adjust release figures. At the time of release, tag loss in juveniles had been estimated at about 5%, but adult returns to the hatchery rack showed 15% of the adipose marked fish were tagless. For the purpose of that report, it was assumed that the 15% tagless adult fish at the hatchery rack represented tag loss and that tag loss took place prior to recruitment to the fishery. In all other reports, release figures for specific groups were adjusted for tag loss on the basis of observations prior to release, whenever such checks were available. Often, however, a tag check was not performed at all or occurred only a very short time after tagging.

The studies in this report were conducted to gain insight into tag loss rates, factors affecting tag loss, length of time over which tag loss occurs, and the numerical significance of naturally occurring adipose fin marks. Studies were designed also to gain information on the effectiveness of the half length tag recently developed by Northwest Marine Technology (manufacturer of binary CWT's and equipment).

METHODS

Tag Loss

Eight test lots of approximately 10,000 fish were tagged and observed for tag loss at Minter Creek Hatchery (Figure 1). Four groups were coho salmon (Oncorhynchus kisutch) and four were chinook salmon (Oncorhynchus tshawytscha). The fish ranged in size from 60/lb to 523/lb. Some groups

were tagged with standard length CWT (Jefferts et al., 1963) and the remaining groups with half length CWT (Table 1). Coho lots were sampled for tag loss 3-4 times the first week, once a week for the next three weeks and once every other week thereafter until released. Two permanent staff members conducted all sampling for tag loss throughout the study.

Each time coho were sampled, the total group was crowded into the kettle area of a standard concrete raceway. Approximately 3,000 fish were randomly dipped from the kettle area and placed in a holding pen. From the holding pen, each of the two staff members dipped out sub-lots of approximately 50 fish and placed them in an anesthetic solution (1 gm/5 gal) of Tricaine Methanesulfonate (MS - 222) until each had checked 1,500 fish. Each time the individual found a fish that had shed its tag, it was designated as a "no tag" and it was put in a holding bucket of freshwater. After each individual had completed checking 1,500 fish, they exchanged buckets containing the "no tags" and verified the absence of tags. To assure magnetization, all "no tags" were placed in the magnetic field of a large horseshoe magnet three separate times and checked for detection each time to accommodate all possible planes in which the tag might be positioned.

Tag loss checks for chinook groups were performed in the same manner except tag checks were performed more frequently. Tag checks were performed four times the first week, three times the second week, twice the third and fourth weeks, once each week for the fifth through the eighth week, and then once every three weeks until release.

Standard WDF tagging procedures, with the exception of the tagging crew were used to tag all eight lots of salmon. Coho tagged with the half length CWT at 523/lb were done with completely experienced tagging personnel from WDF. A "typical" tagging crew is hired from local residents, who usually are experienced with the CWT or have limited experience from previous tagging done in the area. The other three lots of coho and four lots of chinook were tagged with this "typical" type of personnel. Each lot was tagged in one of the three mobile tagging units utilized by WDF.

With chinook groups, another variation was utilized. The crew that tagged chinook at 278/lb and 396/lb with the half length CWT spent the first day tagging fish that weren't part of the study groups. Personal observations by WDF tagging supervisors indicate that tag loss for a "typical" tagging crew generally tends to be higher the first day of tagging. They feel this is largely due to unfamiliarity with the tagging operation by the crew and to a lesser degree, initial adjustments in headmolds and related tagging hardware. For the first four hours on the second day of tagging, the crew tagged fish at 396/lb followed by fish at 278/lb for four hours in the afternoon. The third day the order was reversed (fish 278/lb were tagged in the morning and the group weighing 396/lb were tagged in the afternoon). The two groups of chinook at 216/lb tagged with the half length CWT and standard length CWT as variables were treated in the same manner.

This study design was intended to provide information on tag loss as a function of tag length, effects of fish size, and tagging crew effects. The tagging crew was not informed of the study's design as such knowledge might have influenced the outcome.

Naturally Missing Adipose Fins

Observations for frequency of naturally missing adipose fins among juvenile coho in the hatchery and native environments were made. In the process of hatchery tagging operations, tagging crews were asked to observe and record the occurrence of naturally missing adipose fins on juvenile coho of the 1977, 1978, and 1979 broods. The same request was made of crews trapping and tagging wild coho on several streams entering Puget Sound (Figure 1). Hatchery coho tagging crews made their observations during tagging from September through January preceeding releases of the coho in April through July. Wildstock tagging crews made their observations on the 1978 brood during April, May and June of 1980 during the natural coho outmigration to saltwater.

Four Puget Sound and Hood Canal hatcheries (Figure 1) were monitored in 1979 for naturally missing adipose fins among returning coho adults of the 1976 brood. The hatcheries (Minter Creek, Issaquah, Skykomish, and Hood Canal) were selected because they had not released fish from that

hatchery that were adipose marked and because samplers were located in the general vicinity. Simpson Hatchery on the Washington Coast (Figure 1) was also included because an abnormally high occurrence of naturally missing adipose fins among juveniles had been noted previously by a WDF CWT Supervisor.

Samplers were requested to take snouts from adult fish that appeared to have an adipose fin mark. Questionable marks (i.e., half adipose) were to be treated as marked fish as is the procedure with sport and commercial fishery sampling. All snouts taken from adipose marked fish were checked for CWT's at the WDF CWT recovery laboratory. Verification of absence of a CWT was made by having the snouts X-rayed. Similarly, observations for naturally missing adipose fins on adult fish from a natural environment occurred on the South Fork Skykomish River (Figure 1) on 1975 brood coho.

RESULTS

Tag Loss

The eight tag loss study groups (Table 1) were observed over periods of from 121 to 293 days with the average length of observation lasting 215 days. Tag loss ranged from 1.13% to 5.33%. The percentage of fish with no tag rose sharply (Tables 2-9 and Figures 2-9) for 2-4 weeks before leveling off. Chi-square trend tests with one degree of freedom (Armitage, 1973) did not indicate any significant increasing trend in total loss for any of the tag groups after 29 days (Table 10). Groups tagged with half length CWT showed no significant increasing trend after 17 days.

Mean tag loss for samples taken from day 29 until the end of testing for the chinook groups at 216/lb was 1.96% for the full length tag and 1.48% for the half length tag. A chi-square test with one degree of freedom showed no significant difference at the 5% level in tag loss between the half length CWT and standard length CWT when applied to chinook at 216/lb ($X_1^2 = 2.222$).

A significant difference at the 5% level, but not the 1% level, was found in tag loss for chinook groups tagged with the half length CWT at 278/lb and 396/lb ($X_1^2 = 5.03$). The mean tag loss for the 278/lb was 1.13% while the tag loss for the chinook at 396/lb was 1.84%.

The three coho groups tagged by three separate crews using standard length CWT showed mean tag losses of 1.62% for coho at 60/lb, 5.13% for coho at 110/lb and 1.45% for those coho tagged at 210/lb. Coho at 523/lb tagged with an experienced crew using the half length CWT experienced tag loss of 5.33%.

Naturally Missing Adipose Fins

Observations for natural missing adipose fins on juvenile coho in the hatchery showed an average loss of .045% for 1977, 1978 and 1979 broods (Table 11, 12 and 13). WDF tagging personnel noted that fins were only partially missing at times (Figure 10). It was noted that fins were in the process of being "lost" during the time of the observation period, so the percentage observed was a minimal value. Some missing fins were marked by fresh wounds or cuts. It may be that the fins were being bitten off by other fish during feeding periods. Fish were observed at the hatchery 3-12 months prior to release.

Observations on wildstock or naturally reared juvenile coho showed an average adipose fin loss of .06% for 1978 brood. These fish were observed upon their migration to saltwater and the marks observed showed no appearance of being fresh or new marks.

Observations of natural missing adipose fins on adult hatchery coho showed a .95% loss rate (Table 15). Simpson hatchery was included because of a known natural adipose mark problem. If Simpson is dropped from the sample, the natural adipose mark rate is .52%. Only three year old fish were used in the observations. Jacks were eliminated on a basis of scale analysis and CWT's.

Issaquah and Hoodsport hatcheries each had one coded-wire tagged three year old adult stray return that was adipose marked and contained a CWT, while Minter Creek had eleven such coho. The tagged adult (code 63-16/50) from Hoodsport hatchery was from a group that was an off-station plant in a nearby system from another hatchery. All fish were tagged so no adjustment was made to the Hoodsport observed figures. The eight CWT's (code 5-34/4) found at Minter Creek and Issaquah were released from a saltwater rearing pen. Twenty percent of the total group was released with a CWT, so the unmarked portions of the adult returns to Minter Creek and Issaquah hatcheries were thus adjusted downward by four for each CWT recovered, at those two facilities.

Native reared returning coho adults in 1978 at Sunset Falls on the Skykomish River were observed to have a .04% rate (8 of 20,388) of natural adipose marks (Seiler, 1979).

DISCUSSION

The half length tag proved to be a viable option for tagging salmon of small size. Past WDF practice has been to utilize CWT only with salmon that are 250/lb (1.82 gm/fish) and larger. This study showed low tag loss can be experienced while utilizing the half length CWT on salmon to at least 523/lb (.87 gm/fish). It should be noted, however, that tagging fish at 523/lb with the half length CWT required twice the amount of times as tagging fish at 225/lb. Even though tag loss can be expected to rise with a decrease in fish size, with experienced tagging crews it may not be unreasonable to expect to see successful coded-wire tagging with salmonids at 750/lb (.6 gm/fish) or smaller. With fish larger than 216/lb, I recommend that the standard length CWT be used rather than the half length CWT because of the limited number of available codes for half length CWT's, and that no significant difference in tag loss could be found between the two tags when applied to fish in this size range. A larger variable than fish size for fish larger than 500/lb in tag loss is the quality or experience of the tagging crew.

Tag Loss and Naturally Missing Adipose Fins

The increase between tag loss of the hatchery juvenile (.05%) and the hatchery adult (.52%) can be explained by the fact that the juvenile fish were sampled only half way through their hatchery rearing period. The observation was made that losses of adipose fins in hatchery juveniles were recent and seemed to be part of a dynamic process that probably continued after the observation. It is postulated that adipose fins might be "bitten" off during feeding periods at the hatchery. Adipose fins might be taken for or with OMP pellets during feeding. Crowded conditions might enhance natural adipose loss if they are being lost in this manner. This postulate is supported by the fact that natural adipose loss among stream reared wildstock coho is much lower than loss among hatchery fish (.05-.06%).

Although natural adipose fin marks were assessed only in coho is this study, they are known to occur in other salmon species as well. The presence of natural adipose fin marks among hatchery juveniles of other salmon species is less than among coho. This would be expected since other species are typically reared for less time and under less dense conditions than coho.

WDF tagging personnel (WDF, unpublished) observed .03% natural adipose marks among fall chinook fingerlings during tagging operations involving 1977, 1978, and 1979 broods. Net fishery sampling data for 1980 showed (WDF, unpublished) .12% (35/29,503) natural adipose marks in the Puget Sound chum fishery, with the highest incidences from the vicinity of the hatchery.

Regardless of how or when natural adipose marks occur, and they almost certainly do occur in all species of salmon to some degree, it becomes necessary to differentiate actual CWT loss from natural fin marks. It is easier to realize the necessity if one imagines a hatchery release group of 2 million fish with a natural adipose fin loss rate of .5%. If a tag group of 50,000 is released with an actual tag loss of 5%, upon return the tag loss would appear to be 25% instead of the actual 5%. If release figures weren't adjusted for tag loss and they were figured in the contribution an overestimation of 20% would occur.

The easiest way to account for tag loss is to adjust the release figures downward to reflect the actual number of retained tags. Results from these experimental groups showed that the final level of tag loss could be ascertained by waiting four weeks after tagging. Some minimal tag loss usually occurs after 4 weeks, but for practical working purposes, estimates made after four weeks provide a reasonable measure of final tag loss. Since this research work was confined to relatively few examples, further investigation might provide further refinement.

ACKNOWLEDGMENTS

I offer my special thanks to JoAnn Lincoln and Jeff McGowan for their dedication and perseverance in conducting the numerous tag retention checks. Thanks also to Duane Phinney, Michael Eames and Dick Geist for reviewing and providing editorial comments.

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A P P E N D I X I

(Tables)

Table 1. Tag loss study groups.

Species	Size	Tag	Tag loss 1/	Number tagged
Coho	523/lb	1/2 length CWT	5.33%	9,034
Coho	210/lb	Full length CWT	1.45%	10,168
Coho	110/lb	Full length CWT	5.13%	10,230
Coho	60/lb	Full length CWT	1.62%	10,855
Chinook	216/lb	Full length CWT	1.96%	9,847
Chinook	216/lb	1/2 length CWT	1.48%	10,272
Chinook	278/lb.	1/2 length CWT	1.13%	10,279
Chinook	396/lb	1/2 length CWT	1.84%	10,545

1/ The tag loss shown represents the mean computed from the samples taken on or subsequent to day 28.

Table 2. Tag loss for 1/2 length CWT, 523/lb coho.

Day of sample after tagging	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	90	3
3	96	3.2
5	94	3.13
7	121	4.03
17	129	4.3
24	154	5.13
31	164	5.47
45	162	5.4
60	166	5.53
75	157	5.2
89	179	6.0
101	161	5.37
115	164	5.47
143	164	5.47
159	154	5.13
171	157	5.2
185	165	5.5
196	169	5.63
213	163	5.43
227	161	5.37
241	155	5.17
256	156	5.2
269	150	5.0
283	151	5.03
293	135	4.5

Table 3. Tag loss for standard length CWT, 210/lb coho.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	5[1/]	.25
3	25	.83
5	22	.73
7	21	.7
14	31	1.03
21	34	1.13
28	37	1.23
42	37	1.23
58	39	1.3
63	43	1.43
77	44	1.47
92	37	1.23
104	38	1.27
118	38	1.27
132	38	1.27
146	50	1.67
160	52	1.73
175	47	1.57
188	50	1.67
203	40	1.33
213	49	1.63
227	59	1.97
241	48	1.6
256	47	1.57
269	35	1.17
283	43	1.43
293	42	1.4

[1/] Sample size of 2,000.

Table 4. Tag loss for standard length CWT, 110/lb coho.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	6[1/]	.58
3	78	2.6
7	112	3.7
9	110	3.67
15	123	4.1
22	128	4.27
43	157	5.2
58	147	4.9
71	159	5.3
85	165	5.5
99	163	5.43
113	146	4.87
127	140	4.67
142	159	5.3
155	170	5.67
170	146	4.87
185	155	5.17

1/ Sample size of 2,000.

Table 5. Tag loss for standard length CWT, 60/lb coho.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	19[1/]	.95
2	44	1.47
4	38	1.27
7	51	1.7
14	43	1.43
21	44	1.47
28	45	1.5
42	50	1.67
56	51	1.7
72	47	1.57
84	44	1.47
98	43	1.43
109	59	1.97
121	49	1.63

1/ Sample size of 2,000.

Table 6. Tag loss for standard length CWT, 216/lb chinook.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	29	.97
2	34	1.13
7	48	1.6
9	45	1.5
12	48	1.6
14	46	1.53
16	42	1.4
19	46	1.53
23	42	1.4
26	53	1.77
29	57	1.9
37	54	1.8
44	58	1.93
49	58	1.93
63	60	2.0
84	61	2.03
104	54	1.8
139	63	2.1
201	63	2.1

Table 7. Tag loss for 1/2 length CWT, 216/lb chinook.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	40	1.33
2	32	1.07
5	42	1.4
7	32	1.07
9	43	1.43
12	42	1.4
14	43	1.43
16	48	1.6
19	36	1.2
23	43	1.43
26	42	1.4
29	50	1.67
37	50	1.67
44	46	1.53
49	52	1.73
63	46	1.53
84	41	1.37
104	43	1.43
139	32	1.07
198	40	1.33

Table 8. Tag loss for 1/2 length CWT, 278/1b chinook.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	13	.43
2	29	.97
3	25	.83
6	30	1.0
8	35	1.17
10	38	1.27
13	29	.97
16	40	1.33
21	35	1.17
24	31	1.03
27	32	1.07
31	25	.83
38	36	1.2
44	47	1.57
51	33	1.1
58	39	1.3
63	27	.9
77	34	1.13
98	28	.93
118	33	1.1
153	40	1.33
212	31	1.03

Table 9. Tag loss for 1/2 length CWT, 396/1b chinook.

Day of Sample	Number of no tags/3000 sample	Percentage of no tags/3000 sample
1	31	1.03
2	44	1.47
3	47	1.57
6	52	1.73
8	43	1.43
10	53	1.77
13	50	1.67
16	54	1.8
21	52	1.73
24	57	1.9
27	54	1.8
31	60	2.0
38	54	1.8
44	60	2.0
51	57	1.9
58	57	1.9
63	53	1.77
77	54	1.8
98	53	1.77
118	51	1.7
153	50	1.67
215	57	1.9

Table 10. Chi-square trend test significances.

Group	Day of significance	Significance for 1 degree of freedom
Coho, 523/lb, 1/2 CWT	17	.55
Coho, 210/lb	28	2.77
Coho, 110/lb	29	.18
Coho, 60/lb	28	.23
Chinook, 216/lb	29	.66
Chinook, 216/lb, 1/2 CWT	16	.07
Chinook, 278/lb, 1/2 CWT	16	.08
Chinook, 396/lb, 1/2 CWT	10	.02

Table 11. 1977 brood hatchery juvenile coho natural adipose observations.

Hatchery	Sample Size	Natural Adipose	%
Puyallup	171,000	59	.03
Issaquah	67,000	11	.02
George Adams	55,000	28	.05
Soleduck	160,000	7	.004
Grays River	103,000	31	.03
Skagit	49,000	4	.008
Skykomish	47,000	28	.06
Minter Creek	36,000	0	0
Green River	58,000	69	.12
Dungeness	102,000	8	.008
Washougal	500,000	12	.002
Total	1,348,000	257	.02

Table 12. 1978 brood hatchery juvenile coho natural adipose observations.

Hatchery	Sample Size	Natural Adipose	%
Green River	219,000	590	.27
Minter Creek	70,000	45	.06
Puyallup	100,000	25	.03
Deschutes	188,000	137	.07
George Adams	27,000	24	.09
Dungeness	102,000	12	.01
Toutle	246,000	59	.02
Washougal	632,000	154	.02
Total	1,584,000	1,046	.07

Table 13. 1979 brood hatchery juvenile coho natural adipose observations.

Hatchery	Sample Size	Natural Adipose	%
Skykomish	48,000	2	.004
Skagit	6,000	5	.08
Green River	56,000	78	.14
Minter Creek	56,000	17	.03
Puyallup	38,000	60	.16
Dungeness	171,000	9	.01
Total	375,000	171	.05

Table 14. 1978 brood wildstock juvenile coho natural adipose observations.

Region	Sample Size	Natural Adipose	%
Hood Canal	21,615	16	.07
North Puget Sound	53,677	33	.06
Central Puget Sound	2,938	1	.03
South Puget Sound	3,621	2	.06
Total	81,851	52	.06

Table 15. 1976 brood hatchery adult coho natural adipose observations.

Hatchery	Adults Sampled[1/]	Natural Adipose Marks Observation			Total %
		Good	Questionable	Total	
Minter Creek	7,248	35	22	57	.79
Issaquah	1,614	1	3	4	.25
Skykomish	5,598	1	9	10	.18
Simpson	5,477	96	20	116	2.12
Hoodsport	289	2	3	5	1.73
Total	20,226	135	57	192	.95%

[1/] Issaquah and Hoodsport each had one coded-wire tagged stray adult and Minter Creek had eleven. Expansion figures were applied to these recoveries and subtracted from the total adults sampled to correct for known strays.

A P P E N D I X II

(Figures)

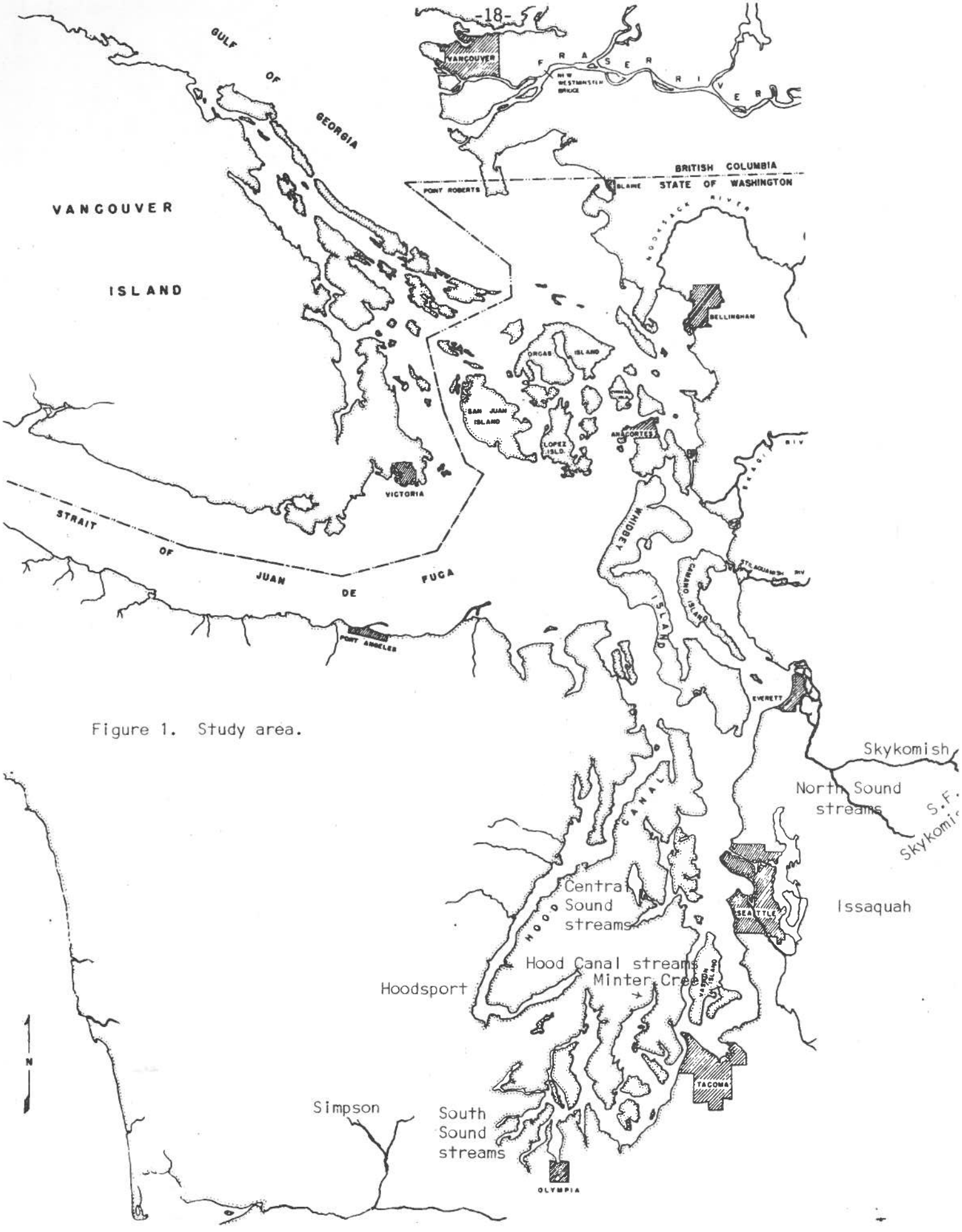


Figure 1. Study area.

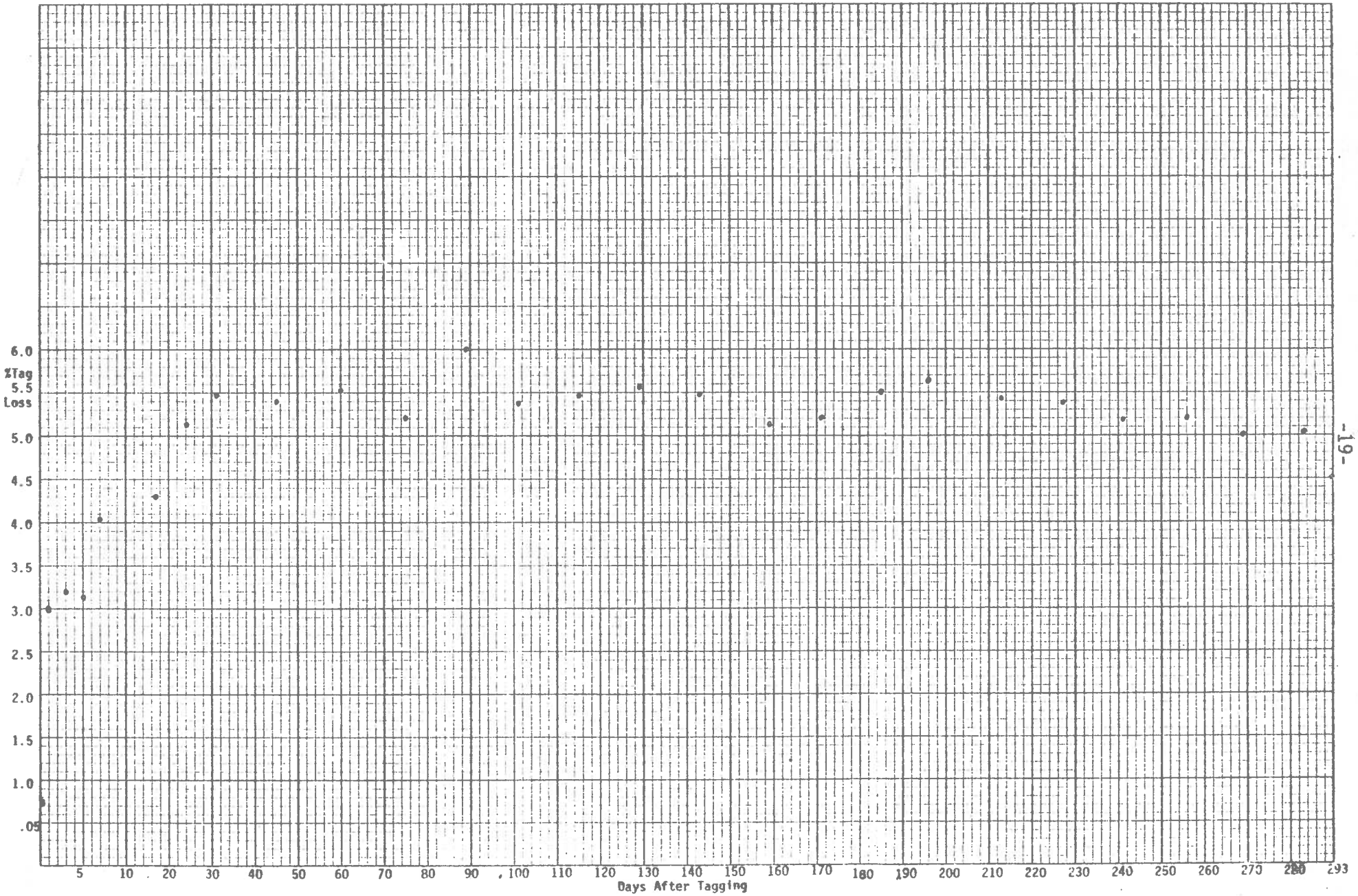


Figure 2. Tag loss for 1/2 length CWT, 523/lb. coho.

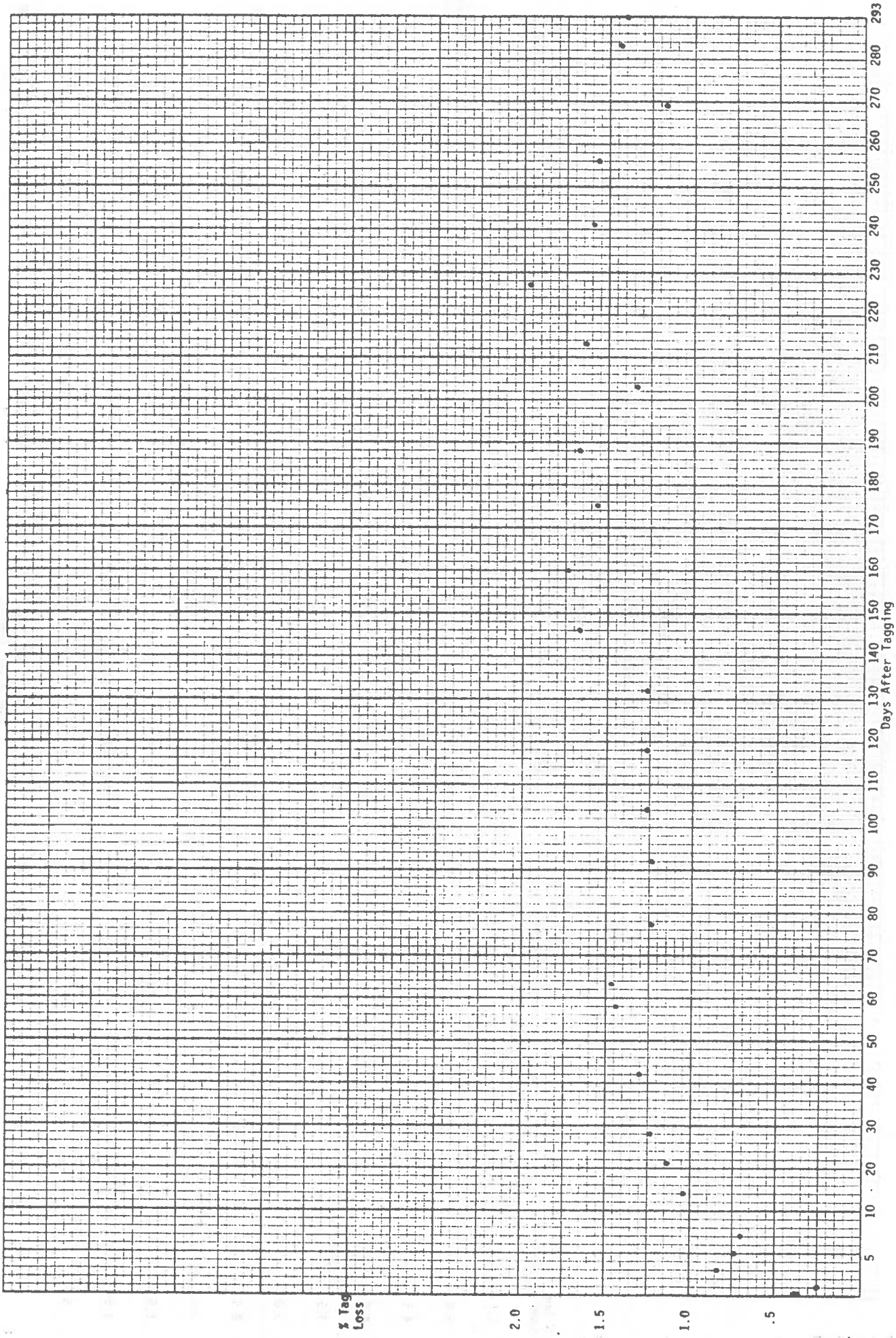


Figure 3. Tag loss for standard length CWT, 210/lb coho.

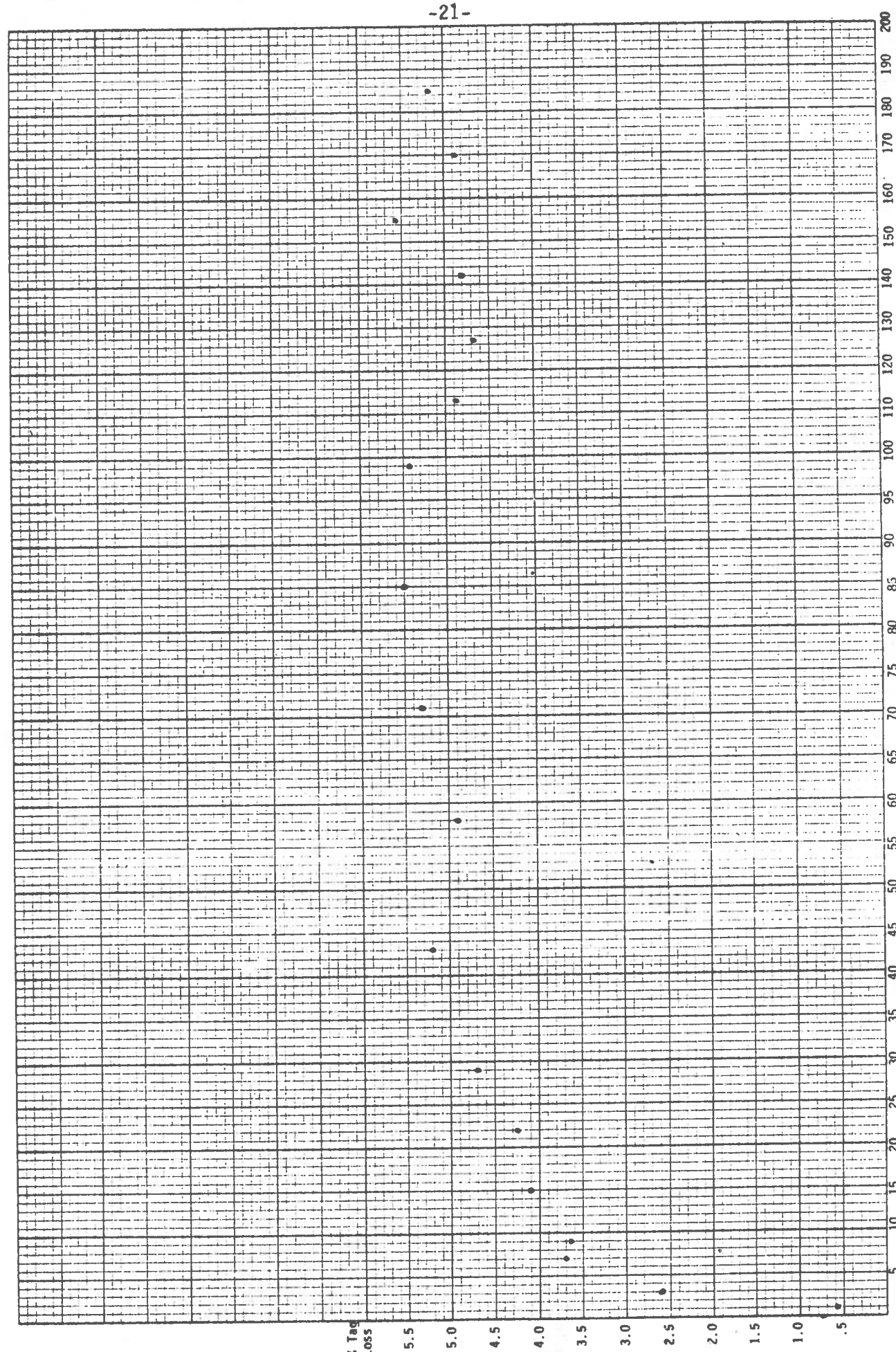


Figure 4. Tag loss for standard length CWT, 110/lb coho.

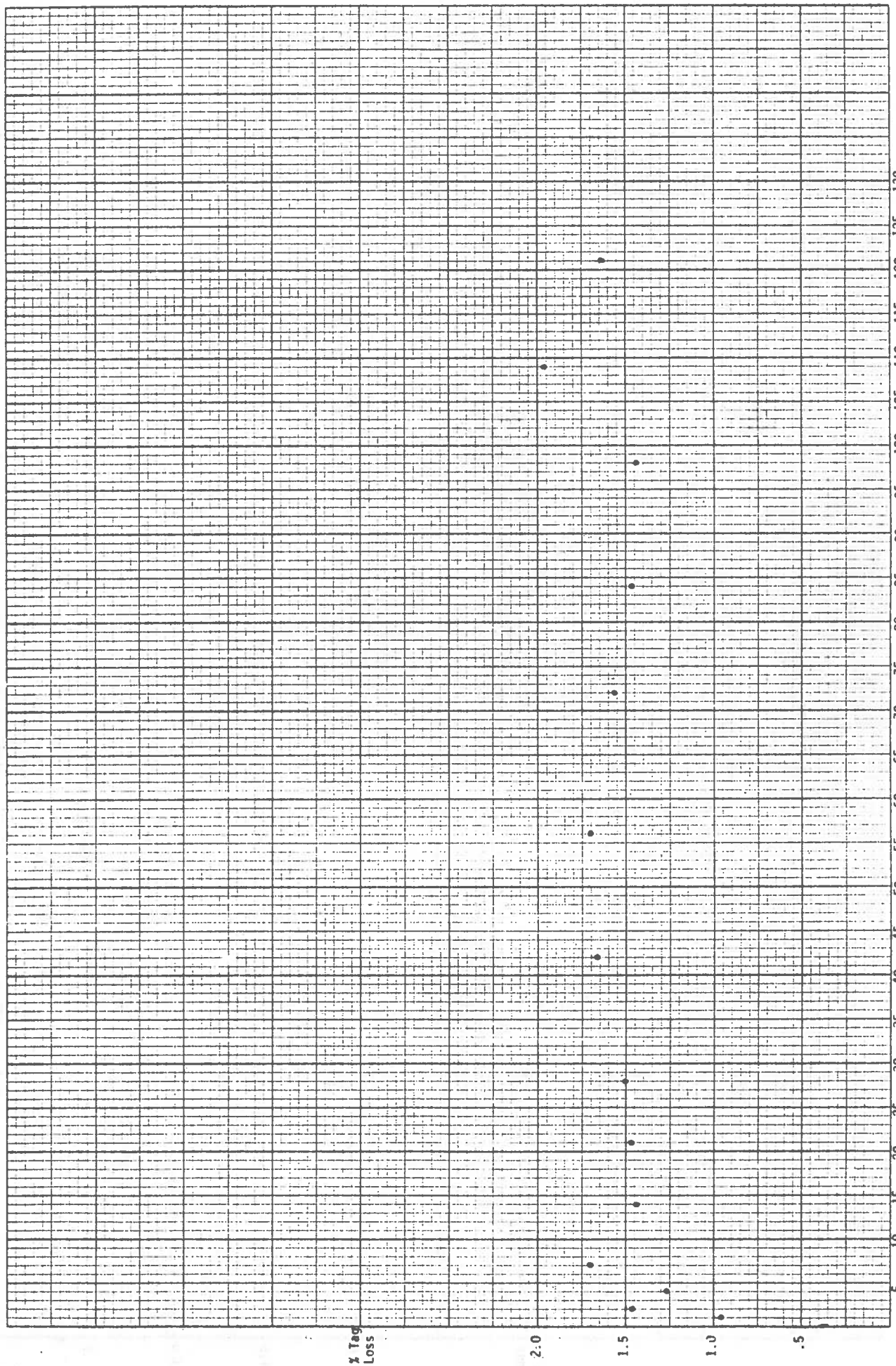
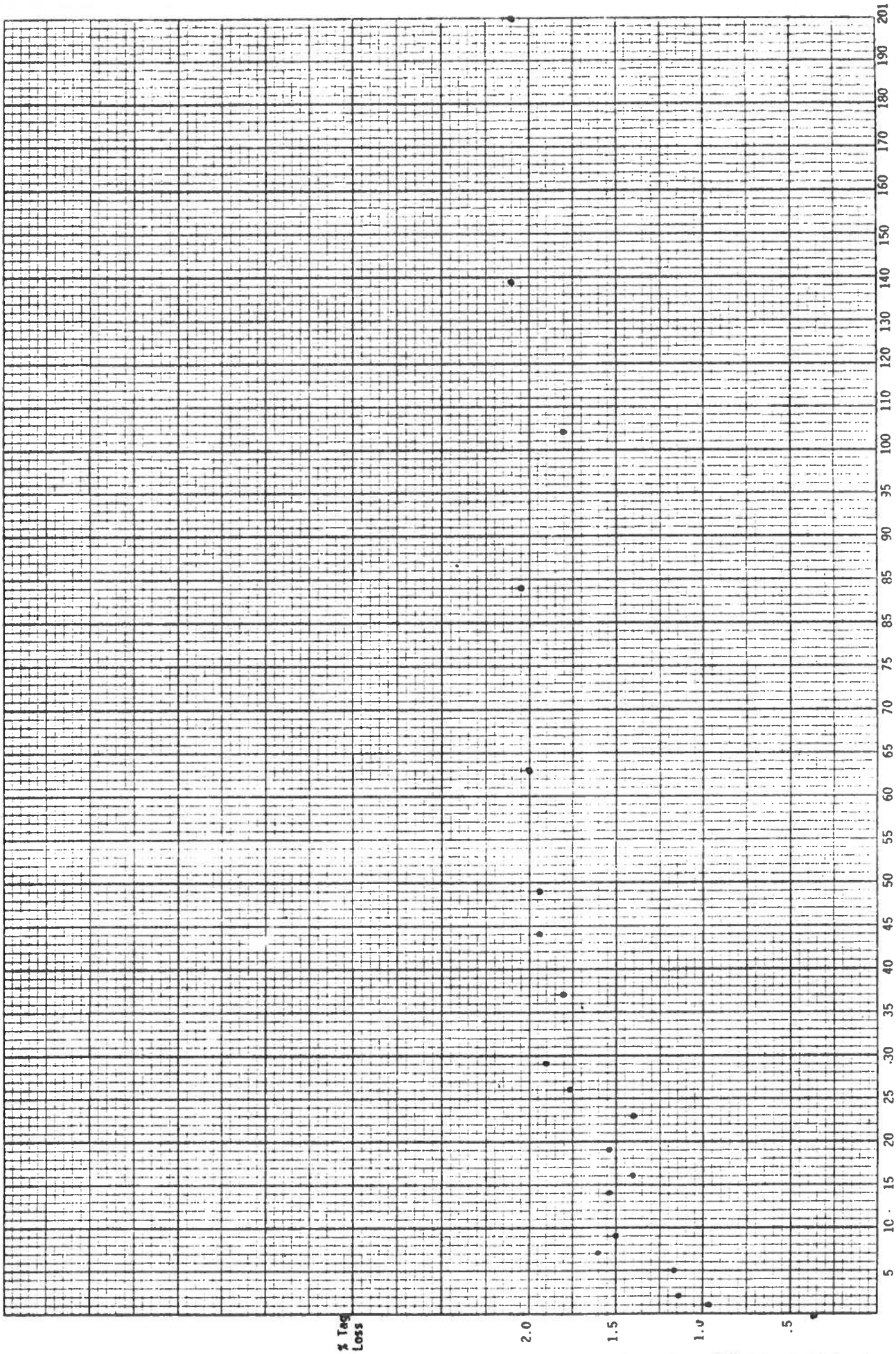


Figure 5. Tag loss for standard length CWT, 60/lb coho.



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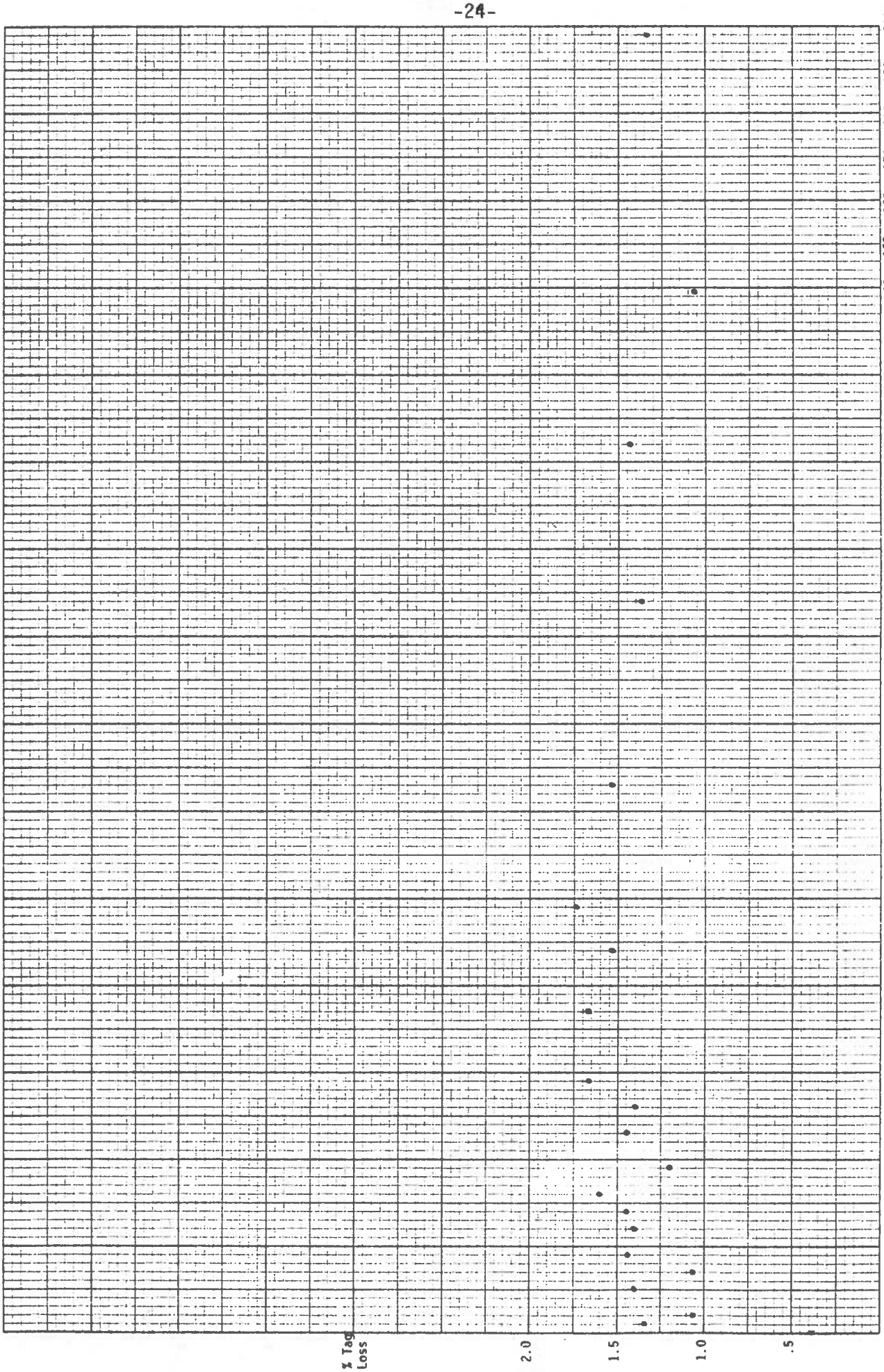

Figure 7. Tag loss for 1/2 length CWT, 216/lb chinook.

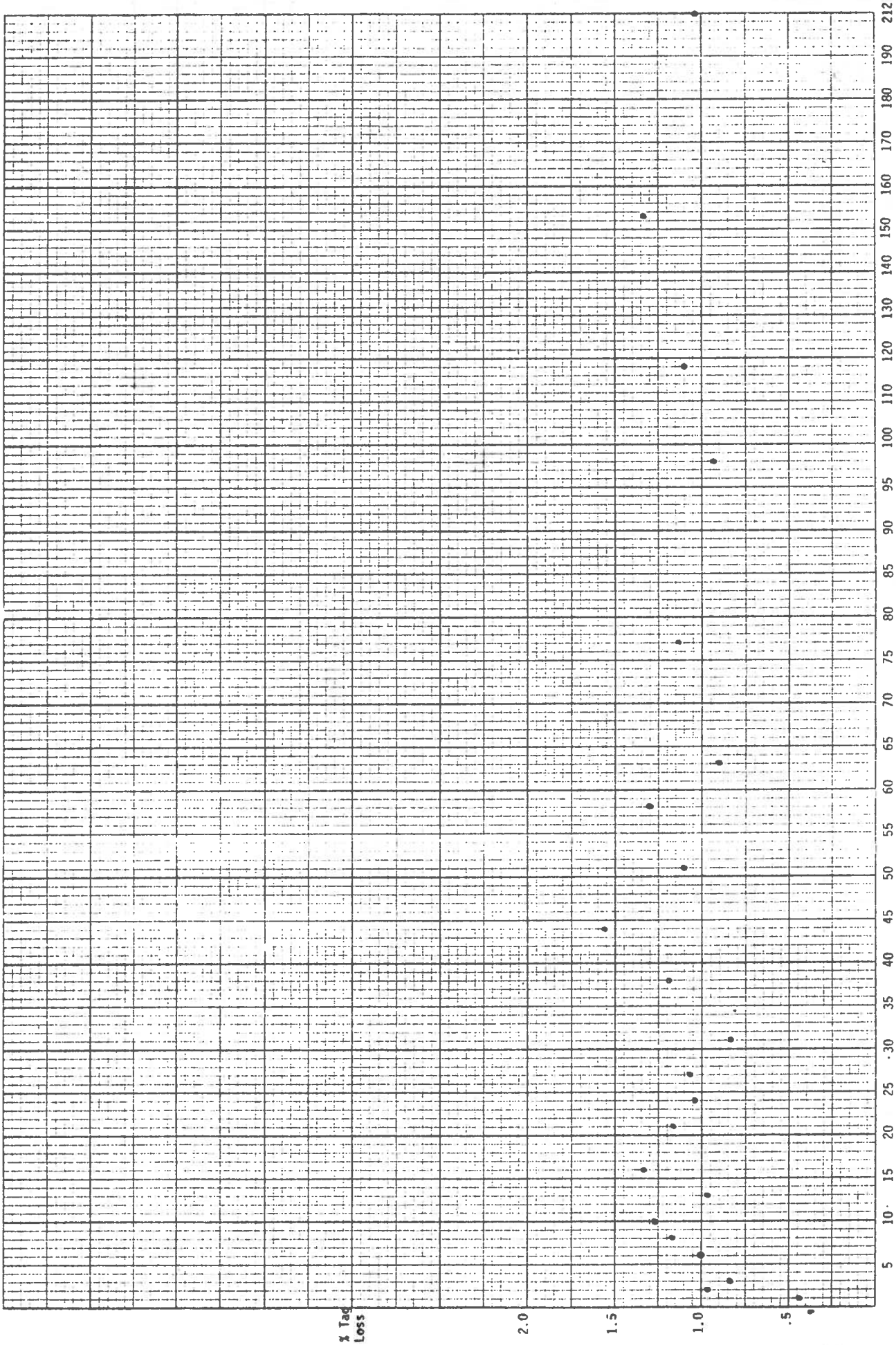

Figure 8. Tag loss for 1/2 length CWT, 278/lb chinook.

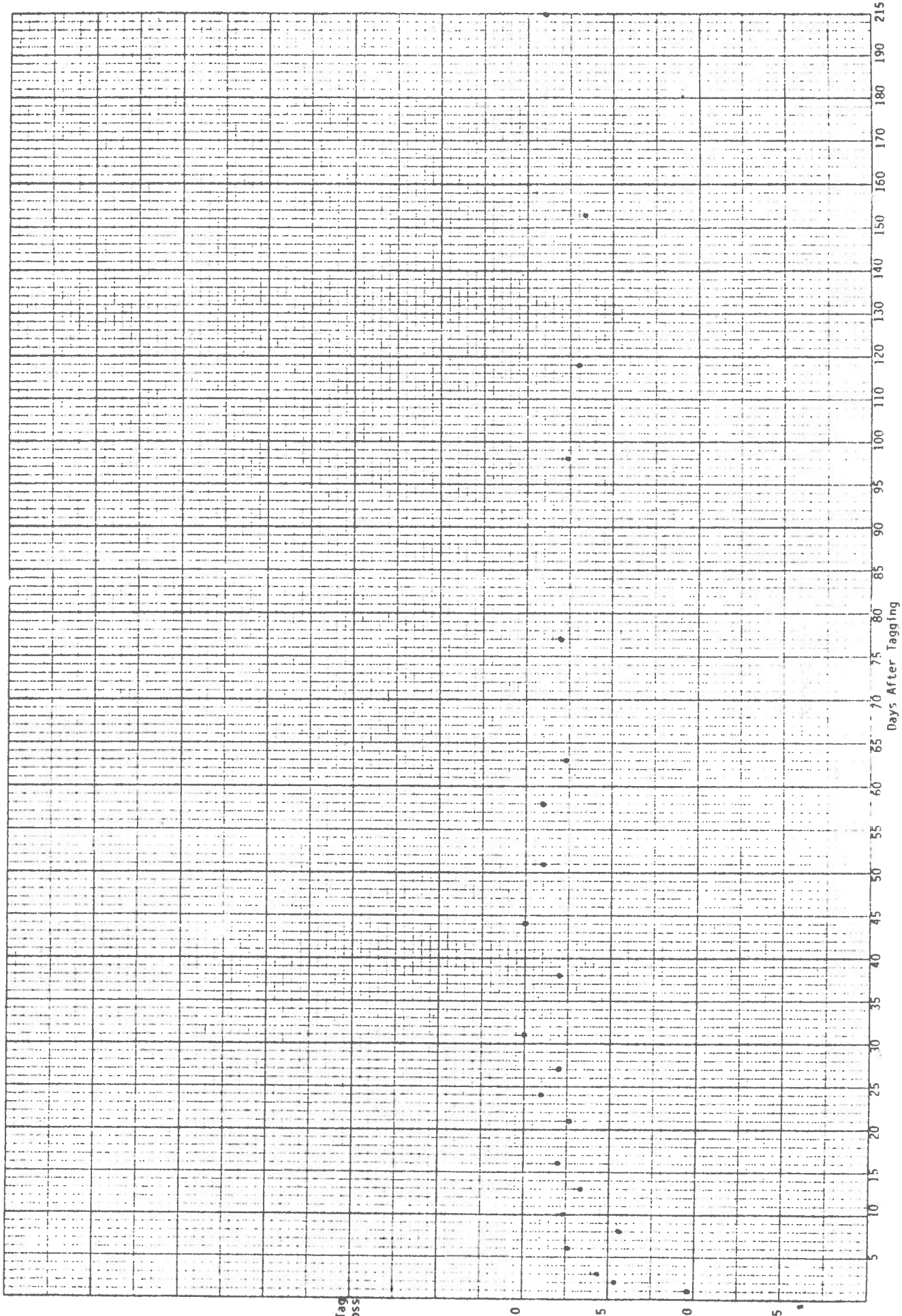

Figure 9. Tag loss for 1/2 length CWT, 396/lb chinook.

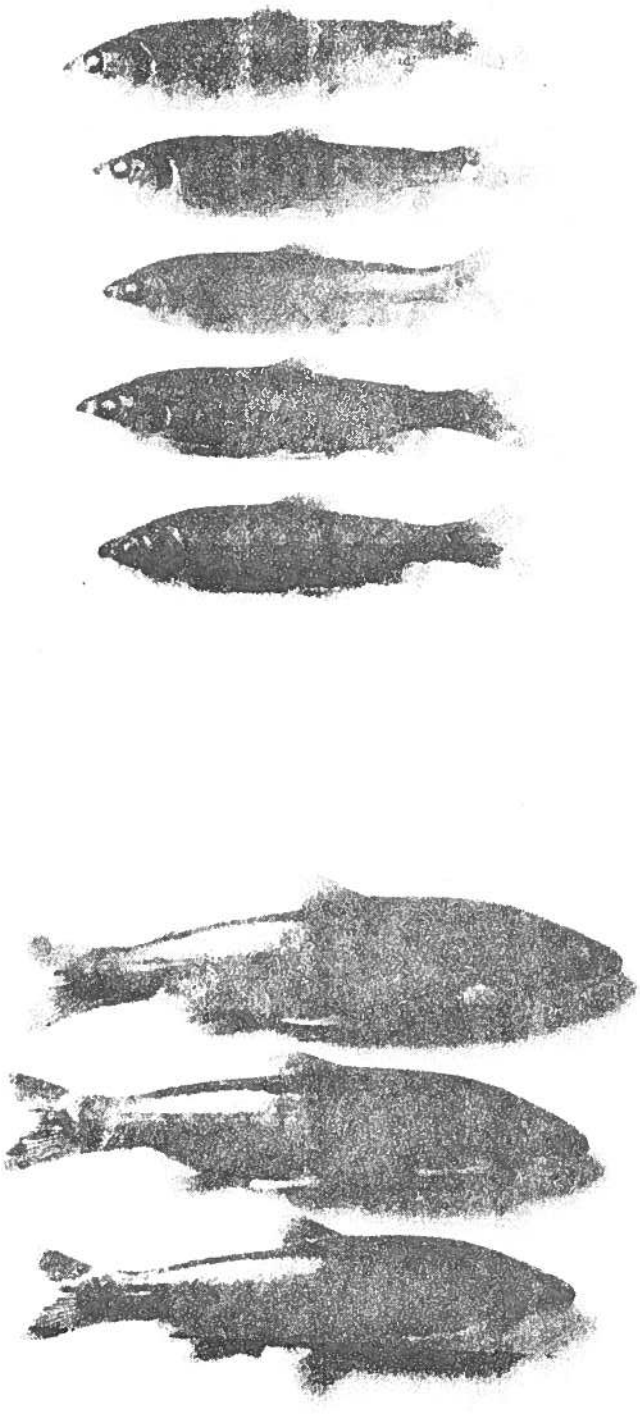

Figure 10. Degrees of natural adipose loss.