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PARASITE TAG IDENTIFICATIONS OF U.S. PACIFIC NORTHWEST ORIGIN STEELHEAD TROUT CAUGHT IN THE NORTH PACIFIC OCEAN, 1984-1987

by

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ABSTRACT

Steelhead trout (*Oncorhynchus mykiss,* formerly *Salmo gairdneri*) caught in the North Pacific Ocean during June and July of 1984-1987 were examined for one or both of two freshwater origin parasites, *Plagioporus shawi* and *Nanophyetus salmincola.* The presence of either of these indicates origin of the fish from the U.S. Pacific Northwest (Washington to northern California, including Idaho). Prevalence (the frequency of the presence of infection) of *P. shawi* in the intestines was estimated to be 22 of 396 (5.6%) and 5 of 562 (0.9%) in steelhead caught during 1984 and 1985, respectively. Prevalence of *N. salmincola* in the kidney was estimated to be 22 of 83 (26.5%), 100 of 277 (36.1%), 140 of 311 (45.0%), and 114 of 211 (54.0%) in steelhead caught during 1984-1987, respectively. It is inadvisable to compare *N. salmincola* prevalences among years, except between 1986 and 1987, owing to the important differences in the examination protocols for the different years. An improved and standardized procedure was employed for 1986 and 1987 samples.

The *N. salmincola* data were analyzed in detail. An infected specimen was taken at a location (51°13'N, 170°36'E) outside of the known range of North American origin steelhead. For 1985-1987, prevalence frequencies in large 5°-longitude areas, most of which had previously been used for statistical analysis of the Japanese high seas salmon fishery, were compared for homogeneity (within years) by chi-square analysis (only one of these areas was sampled in 1984). In 1985, prevalence was significantly greater east of 180° longitude than west of this line (p=0.003). In 1986, prevalence also tended to be greater east of this line than west of it, but this was not significant at the 0.05 level. However, prevalence was significantly greater north of 46°N latitude than south of this line (p=0.026). In 1987, there were no apparent east-west or north-south trends. Correlation

analysis indicated no between-year correlation in the relative magnitude of prevalence in areas sampled in both 1986 and 1987 (r=0.017). Confidence intervals (90%) for overall annual prevalence in the central Pacific Ocean steelhead population were 29.9 % - 61.3% (point estimate = 45.4%) for 1986, and 43.3% - 63.0% (point estimate = 53.2%) for 1987. A *t*-test indicated no significant difference in these overall annual prevalences (p=0.429).

INTRODUCTION

Margolis (1984, 1985) used the presence of two freshwater trematode parasites, *Plagioporus shawi* and *Nanophyetus salmincola*, in ocean-caught steelhead trout (*Oncorhynchus mykiss*, formerly *Salmo gairdneri*) to indicate origin from the U.S. Pacific Northwest (Washington to northern California including Idaho; henceforth this shall be referred to as the U.S. Northwest). These parasites are acquired by juvenile steelhead only in freshwater, but they persist throughout all or most of the sea-life of their host. The freshwater range in which steelhead can become infected is determined by the range of the obligatory first intermediate host snails of these parasites (*Fluminicola virens* for *P. shawi* and snails of the genus *Juga* for *N. salmincola*). *P. shawi* has not been reported outside of the U.S. Northwest, and *N. salmincola*, although it occurs in Asia, is only sympatric with *O. mykiss* in the U.S. Northwest. Finally, *P. shawi* is site specific, occurring only in the intestine and pyloric caeca of its salmonid host, and *N. salmincola* exhibits site selectivity, concentrating most abundantly in the kidney (Margolis 1984).

Although *O. mykiss* originating from Asia are commonly known as Kamchatka trout, *O. mykiss* caught at sea are generally all referred to as steelhead. Steelhead caught in the North Pacific Ocean during June and July of 1984-1987 were examined for *P. shawi and N. salmincola* at the Fisheries Research Institute (FRI), University of Washington. Examinations for *P. shawi* were conducted only on fish caught in 1984 and 1985, but examinations for *N. salmincola* were made on fish from all sampling years. The results of these examinations are given in this report, and the *N. salmincola* infection information is examined in detail.

MATERIALS AND METHODS

The samples used in this study were provided by the Fisheries Agency of Japan (FAJ) as a part of the cooperative research program of the International North Pacific Fisheries Commission (INPFC). FAJ supplied FRI with the frozen carcasses of 396, 829, and 336 steelhead caught in the North Pacific Ocean in June and July of 1984-1986, respectively. In 1987, only the posterior one-third of the kidneys of 211 ocean-caught steelhead were supplied to FRI, as had been requested. The specimens examined for parasites were caught within the following ranges:

1984- 169°13'E to 174°57'E longitude and 51°47'N to 48°57'N latitude.

1985- Most were caught between 164°45'E to 177°43'W longitude and 51°20'N to 43°37'N latitude. Others were caught along approximately 155°W longitude between 55°N to 49°N latitude.

1986- 167°31'E to 177°30'W longitude and 50°40'N to 42°29'N latitude.

1987- 166°30'E to 173°28'W longitude and 49°23'N to 41°30'N latitude.

The steelhead were caught with gill nets and longlines by Japanese research vessels and mothership fishery catcherboats, which were requested to return all steelhead to motherships. Weight, length, sex, and gonad weight were recorded for each fish on board the vessel, and a scale sample was taken for age determination. The posterior one-third of the kidney was also removed from 1987 specimens. The carcasses and kidney samples were then immediately frozen. After temporary storage in Japan, they were shipped frozen to FRI where they were stored frozen until examination. Upon examination at FRI, carcasses were thawed and then checked for missing fins. Weight, length, gonad weight, and visceral fat weight were measured. Snouts were removed (from fish with missing fins), stomach contents were removed and preserved in formalin, and sagittal otoliths and scale samples were taken for age determination. The intestines and kidney samples were removed from some of the carcasses for parasitological examination.

Plagioporus shawi Examinations

Examinations for *P. shawi* were conducted at the time of carcass dissection for all 1984 specimens and 562 of the 1985 specimens. Many 1985 specimens were not examined for *P. shawi* because the carcasses arrived at FRI with the intestines in very poor condition or missing. Owing to time restrictions, *P. shawi* examinations were not conducted on 1986 and 1987 specimens because only relatively small percentages of the 1984 and 1985 specimens examined for *P. shawi* were found to be infected.

The intestine (from the posterior terminus of the pyloric caeca to the anus) was removed from a thawed carcass. This was split lengthwise with a small scissors, allowing the contents to fall into a plastic 500 ml beaker. The lining of the intestine was scraped off with a glass slide or a large knife onto a cutting board and the lining was added to the beaker. Warm tap water was run into the beaker to obtain a volume of 400-450 ml, and a tablespoon of sodium bicarbonate ($NaHCO_3$) was added. The contents of the beaker were vigorously stirred for about 20 seconds and then allowed to settle for 1-6 hours. The supernatant was then decanted through screening (approximately 2 mm mesh). Trapped material in the mesh was returned to the slurry of settleable material in the beaker, and the screen was visually inspected for the adult worms. The slurry was poured, in a number of aliquots depending on the volume, into a 50 ml petri dish. These aliquots were inspected for the worms under reflected light with a 7-60 X binocular dissecting microscope. Any worms that were found were shipped to the Pacific Biological Station (PBS) at Nanaimo, British Columbia for positive identification.

Nanophyetus salmincola Examinations

Examinations for *N. salmincola* were conducted on 83, 277, 311, and 211 specimens collected during 1984-1987, respectively. In 1984 and 1985, more specimens were caught in some INPFC areas than were necessary to examine for parasites to obtain a sufficiently large sample. Because laboratory time was limited, the catches from these areas were subsampled. The specimens chosen for examination were selected to represent all the INPFC ocean areas sampled. Usually, all specimens were examined from areas where relatively few steelhead were caught. A small number of 1986 specimens were not examined for parasites because of poor sample condition or because they could not be matched with data records. All 1987 samples were examined. On the basis of the kidney examination results, fish were designated as "infected" or "negative for infection." The term "negative for infection" was used rather than "uninfected" because, as is discussed below, it is virtually certain that some kidney infections were missed. In fact, the prevalence estimates for 1986 and 1987 samples differed from observed prevalence (the proportion of specimens in which *N. salmincola* was visually detected) based on this likelihood.

For 1984 specimens, examinations of whole kidneys were made as part of the carcass examination procedure. Kidney samples excised from the carcasses of steelhead caught in 1985 and 1986 were frozen for later examination as a separate, isolated task. Whole kidneys were removed from the 1985 steelhead and from about one-third of the 1986 steelhead. Only the posterior one-third of the kidney was removed from the remainder of the 1986 steelhead. The parasites concentrate very heavily in this portion (Donham 1928; Bennington and Pratt 1960; Millemann and Knapp 1970; Wood 1974), so only this portion was removed to save time in the examinations. Only the posterior one-third of the kidney was removed (at sea) from 1987 steelhead, and these were also examined as a solitary task.

Sections of thawed kidney samples from specimens caught in 1984 and 1985 were squash-mounted between two thick plexiglass plates (25.4 cm X 11.4 cm X 0.6 cm). The tissue was squashed by the torque from wing-nuts tightened on two bolts running through both plates, one on either side. Frozen kidney samples from 1986 and 1987 specimens were homogenized prior to examination by repeated and alternated mincing (with a heavy knife) and stirring (with a glass slide) of the samples on a plexiglass cutting board. Aliquots of this homogenate were squash-mounted between glass plates (20.3 cm X 10.2 cm X 0.3 cm). All specimens were examined under transmitted light with a 7-60 X binocular dissecting microscope.

A kidney examination ceased upon the positive identification of infection. To confirm the infection, the examiner normally would search until more than one parasite (metacercarial cyst) was located. The proportion of a kidney that was examined before designating a fish negative for infection was not the same for all years, however. The whole kidney was examined, in sections, for all 1984 specimens. There was no predetermined, consistent proportion of the kidney that was examined for specimens caught in 1985. All the tissue from small kidneys was examined, but larger kidneys were subsampled: first, a section of indeterminate size was cut off each end, and a section was cut from the middle; if parasites were not found in any of these three sections, a section was cut from the middle of each of the two remaining pieces. One of the five sections was entirely from the posterior one-third of the kidney, and another was wholly or in part from this portion. For most specimens, most or all of the posterior one-third was examined if parasites were not found earlier in the process. The 1985 examinations were perhaps more effective than the 1984 examinations because there were no other tasks "competing" for the time and attention of the worker, and because less of the examination was spent on kidney tissue apart from the posterior one-third. For 1986 and 1987 specimens, one-quarter sample aliquots of the homogenized kidney sample, measured by weight or volumetrically after transference of the homogenate to a volumetric syringe, were sequentially examined until infection was found or two quarters had been thoroughly examined. Thus, at the most, only one-half of a kidney sample was examined. Since the sample was homogenized, one-half of the posterior one-third of the kidney was examined regardless of whether all of the kidney had been removed or just the posterior one-third. Time was taken as needed for thorough examination, so whole kidneys required lengthier examinations.

Experience with the methods used for 1984 and 1985 specimens suggests that light infections (low numbers of cysts) may sometimes go undetected. These procedures have several shortcomings that I attempted to reduce by the following procedures, which were employed with the 1986 and 1987 specimens:

1. Tissue homogenization

Homogenized kidney tissue is easily squashed into a very thin layer that can be thoroughly examined without difficulty. Intact (unhomogenized) tissue, however, is very difficult to squash into a layer thin enough for adequate light transmittance; cysts can often remain hidden from view in thick tissue. Because of this problem, intact tissue is much more difficult and time-consuming to thoroughly examine than is homogenized tissue.

2. Use of glass plates instead of plexiglass plates

The problems associated with thick squash preparations are exacerbated by the use of plexiglass plates. Because plexiglass plates are somewhat flexible, the tissue tends to "bunch up" in a poorly squashed zone towards the middle of the plates. Pressure must be frequently exerted by hand during the examination. This results in the tissue alternately being less and more spread out, which makes thorough and consistent examination more difficult. Also, plexiglass plates attenuate light more than do clearer, thinner glass plates.

3. Increased illumination intensity

High light intensity is essential for locating the small parasite cysts. A high intensity halogen light source was used rather than the lower intensity tungsten source that had been used for previous examinations at FRI.

4. Sampling of two quarters of the posterior one-third of the kidney only

The thoroughness of an examination is directly related to the amount of time spent, and the amount of time required for a thorough examination is directly related to the amount of tissue examined. Probably the greatest problem with the examinations of 1984 and 1985 specimens is that examination of a whole kidney, or even a large proportion, is extremely time-consuming and difficult to perform in an efficient yet thorough manner, particularly if unhomogenized tissue is examined between plexiglass plates. Since the parasites concentrate heavily in the posterior one-third of the kidney, examination efficiency was increased by sampling only this portion for most 1986 and for all 1987 specimens. Also, only as much as one-half of any 1986 or 1987 kidney sample was ever examined; however, it was therefore possible that some light infections were missed. One-quarter sample aliquots were sequentially examined, rather than simply examining one-half of a sample, so that the number of overlooked infections in groups of specimens could be estimated by the method described below.

Calculation of *N. salmincola* Prevalence

For 1984 and 1985, the prevalence estimate for a sample was the observed prevalence. The method of estimating sample prevalence from 1986 and 1987 data, which was grouped as demonstrated below, was as follows:

Category	First Quarter	Second Quarter	No. of fish
1	Infection Found (+)	Not Examined	I
2	No Infection Found (-)	Infection Found (+)	i
3	No Infection Found (-)	No Infection Found (-)	U

The number of fish in which infection was found (n) equals I + i and the total number of fish examined (N) equals I + i + U. To estimate prevalence it was necessary to have an estimate of the number of fish in Category 3 that were actually infected. For any individual specimen in the sample, the best estimate of the probability of finding infection in a quarter given that infection had not been found in another quarter [P(+/-)] was

$$P(+/-) = i/(i + U)$$

By probability theory, this proportion was used to estimate the probability that infection would be found in either of the two quarters of the kidney sample that were not examined for fish in Category 3 [$P(U_i)$]

$$P(U_i) = P(+/-) + P(+/-) - P(+/-) \times P(+/-)$$

$P(U_i)$ was then multiplied by the number of fish in Category 3 (U) to estimate the number of fish in this category that were actually infected (U_i)

$$P(U_i) \times U = U_i$$

This equation yielded a non-whole number estimate of U_i. This was rounded to the nearest whole number before being added to the number of specimens in which infection was actually observed (n) to yield an estimate of the actual number of infected fish in the sample (n_a)

$$n + U_i \text{ (rounded off)} = n_a$$

The estimate of prevalence (Pr) for the sample was

$$Pr = n_a/N$$

This method was used to estimate overall prevalence in all specimens caught in 1986 and in 1987, and to estimate prevalence in the large 5°-longitude areas illustrated in Figure 1. These areas, except areas 16 and 17, have previously been used for analysis of data from the Japanese high seas salmon fisheries (Fredin and Worlund 1974; Myers et al. 1984; Harris 1988). Areas 16 and 17 were constructed to be of comparable size to the others and to include all other locations where steelhead were caught. Statistical analyses were conducted using these areas, or combinations of them when appropriate. The data was also stratified into much smaller 2°-latitude X 5°-longitude INPFC areas, but observed prevalence is presented for these rather than using the prevalence estimation model discussed above. It would not have been prudent to employ the prevalence estimation model for these because of the very small sample sizes in many of these areas.

RESULTS AND DISCUSSION

Plagioporus shawi

The numbers of steelhead examined for *P. shawi* and the numbers found to be infected are presented in Appendices 1 and 2 (specimens caught in 1984 and 1985 only), and detailed biological information for infected fish is given in Appendices 5 and 6. Prevalence of this parasite was very low in both 1984 and 1985. The parasite was found in 22 of 396 (5.6%) 1984 specimens and 5 of 562 (0.9%) 1985 specimens. The numbers of steelhead that were infected with *P. shawi* but not *N. salmincola* are shown in Figure 2 stratified by 2°-latitude X 5°-longitude INPFC area of capture. Margolis (1984, 1985) also reported very low prevalence of *P. shawi* in steelhead caught at sea. He found the parasite in 14 of 295 (4.7%) and 25 of 426 (5.9%) specimens collected in 1983 and 1984, respectively.

Nanophyetus salmincola

The numbers of steelhead examined for *N. salmincola* and the numbers found to be infected are presented in Appendices 1-4, and detailed biological information for infected fish is given in Appendices 5-8. Overall prevalence for 1984-1987 ranged from 26.5% to 54.0% (Table 1).

Margolis (1984, 1985) found *N. salmincola* infections in 30 of 295 (10.2%) and 79 of 426 (18.5%) ocean-caught steelhead captured in 1983 and 1984, respectively. For all of Margolis' specimens, the entire kidney was examined squash-mounted between plexiglass plates without prior homogenization. The examinations of kidneys from 1983 specimens took place as part of whole-fish parasite surveys aimed at selecting parasite tags. Examinations of kidneys from 1984 specimens were conducted as part of a carcass examination procedure similar to that performed at FRI.

Annual variations in the overall *N. salmincola* prevalences probably reflect annual differences in prevalence in steelhead at sea. Such differences are likely to occur owing to annual fluctuations in the parasite's freshwater abundance or fluctuations in the annual relative abundance at sea of the various steelhead populations and stocks. Kennedy (1977) reported that most fish parasite populations are basically unstable, and Light (1987) noted that very large annual fluctuations in the abundance of steelhead stocks are common. Sampling effort varied spatially among years (Figs. 4-7); annual variations in overall sample prevalence may be related to these spatial differences. However, the annual overall prevalence variations may in part be due to differences in the kidney examination protocols for the various years (Table 2). Direct comparisons of the laboratory techniques on the same kidney samples were not made, but I decided not to compare prevalences among all sampling years (1983-1987) because of the important differences in the examination protocols. There were no procedural differences for 1986 and 1987 specimens, except that the whole kidney was sampled from some 1986 specimens instead of just the posterior one-third. The probability of overlooking an infection may have been greater for 1986 specimens because of the larger amount of tissue examined; nevertheless, I do not feel that comparisons of prevalence between 1986 and 1987 are confounded.

Over all four years, only one of the fish examined for *N. salmincola* was taken at a location (51°13'N, 170°36'E) clearly outside of the known ocean distribution of North American origin steelhead based on mark and tag data as described by Light et al. (1988; Fig. 3). This fish was taken on July 15, 1985, and it was infected with *N. salmincola*.

Infected fish were taken in a large majority of the 2°-latitude X 5°-longitude INPFC ocean areas sampled during 1984-1987 (Figs. 4-7). Sample size was three or less fish in all areas that yielded only fish in which infection was not found. In areas that yielded infected fish, observed prevalence ranged from 10.5% (6/57) to 75.0% (9/12) over all four years. Overall, the data indicated that infected steelhead were distributed throughout the areas sampled in all four years, but that the relative abundance of infected steelhead may vary considerably among these relatively small areas.

Table 3 gives prevalences in the large 5°-longitude areas demonstrated in Figure 1. Prevalences (as percentages) and sample sizes within these areas are illustrated geographically by year in Figures 8-11. Infection information for 1986 and 1987 specimens grouped by these areas is given in Table 4. Only area 5 was sampled in 1984, and prevalence was 26.5%. Prevalence ranged from 26.5% to 64.0% in 1985, not including area 12 from which only one fish was examined. Prevalence ranged from 22.9% to 78.6% in 1986 and from 25.0% to 75.0% in 1987. These prevalences clearly demonstrate that U.S. Northwest origin steelhead made up large or sometimes predominant proportions of the steelhead present in the sampled areas. Total proportions of U.S. Northwest origin steelhead in the samples cannot be estimated without freshwater prevalence information, but these proportions must be higher than the proportions of infected fish unless all U.S. Northwest origin steelhead present in the samples were infected.

To examine spatial trends in the relative abundance of infected fish, within-year homogeneity of prevalence frequencies among these areas was tested by chi-square analysis using a significance level of $p=0.05$, with Cochran's continuity correction method employed as needed. Larger scale spatial trends were examined by combining prevalence frequencies for selected areas and treating the combined frequency as a single prevalence frequency for the ocean region encompassed by the combined areas. Such a combined frequency could then be compared with other prevalence frequencies by chi-square analysis.

In 1985, prevalence increased substantially from west to east in the central Pacific (areas 5, 13, 14, and 15; area 12 was not included in this trend analysis because only one fish was examined).

A test of homogeneity among these areas indicated significant differences in the prevalence frequencies (p=0.003). However, there were no significant differences (p=0.421) among the prevalence frequencies in the areas west of 180° longitude (5, 13, and 14). The prevalence frequencies for areas 5, 13, and 14 were therefore combined, and the combined frequency (74/234 [31.6%]) was compared with the prevalence frequency in area 15 (16/25 [64.0%]), which is located east of 180° longitude. There was a significant difference (p=0.003) between these frequencies, indicating that infected fish had higher relative abundance east of 180° longitude than west of this line. Finally, there was no significant difference between the prevalence frequencies in areas 15 and 17 (p=0.748), which suggested similar relative abundance of infected steelhead in these widely separated areas.

There were significant differences among the prevalence frequencies in areas sampled in 1986 (p=0.006). Spatial prevalence trends were best analyzed by grouping the areas by position north or south of 46°N latitude. For both the northern and southern groups, prevalence was greatest in the most easterly area (areas 9 and 15, respectively, both located west of 180° longitude). However, the differences among the prevalence frequencies for the areas of each group were not significant at the 0.05 level (north: p=0.074; south: p=0.119). Prevalences in areas north of 46°N were mostly greater than prevalences in areas south of this line. The area prevalence frequencies within the groups were combined (north: 96/192 [50.0%]; south: 42/119 [35.3%]) and the combined frequencies were compared; there was a significant difference between the combined frequencies (p=0.026), indicating that infected steelhead had higher relative abundance north of 46°N than south of this line.

There were no apparent trends, either on a north-south or east-west basis, in the area prevalence frequencies for 1987, and a comparison of these frequencies did not indicate significant differences among them (p=0.608). The areas were grouped by position north or south of 46°N; within-group comparisons of the area prevalence frequencies indicated no significant within-group differences in the frequencies (north: p=0.441; south: p=0.578). A comparison of the combined frequencies for the north and the south group indicated no significant difference between these combined frequencies (p=0.446). Apparently, the relative abundance of infected steelhead did not differ significantly among the areas sampled in 1987.

Pair-wise chi-square comparisons (with Cochran's continuity correction) of 1986 and 1987 prevalence frequencies for the six areas sampled in both years (Table 3) indicated significant difference at the 0.05 level between only the annual frequencies in area 13 (p=0.006). However, for several of these areas sample sizes were rather small in at least one of the years. The paired annual percentage prevalences for these areas were analyzed for correlation after the prevalences were normalized by arc-sine transformation (Table 5). There was no between-year correlation in the relative magnitude of prevalence in these areas (r=0.017).

Infected steelhead showed no year-to-year consistency in their relative abundance among the central Pacific Ocean areas sampled during 1985-1987. Nevertheless, it is clear that they were very common over this broad ocean region. To make confidence intervals (90%) and point estimates of annual prevalence over the entire ocean regions sampled, the area prevalences (transformed) were treated as independent estimates of prevalence in the overall population. (This was done for 1986 and 1987, but not 1985 since in that year sampling took place over a much narrower region and prevalence may have been underestimated.) These point estimates were preferable to the overall prevalences in Table 1; because prevalence varied among areas, the overall prevalences were biased by large sample sizes in particular areas (e.g., 52.4% of all 1986 specimens were captured in area 5). I compared the point estimates of annual prevalence for equality using a *t*-test on the transformed area prevalences. Such a test considered area prevalence variations and made no assumption that the overall population was well represented by a total sample (all yearly specimens).

The 1986 and 1987 samples were collected over approximately the same large region of the central Pacific Ocean. For 1986, the 90% confidence interval for prevalence in this region was 29.9% - 61.3%, and the point estimate was 45.4%; for 1987, the 90% confidence interval was 43.3% - 63.0%, and the point estimate was 53.2%. The point estimates differed by only 7.8%, and the *t*-test did not indicate that prevalence in the steelhead of the central Pacific Ocean was significantly different between years.

When considering the above results one should keep in mind that prevalence in the sampled ocean areas may not be a consistent index of the relative abundance of U.S. Northwest origin steelhead. The consistency of ocean area prevalence as an index of the relative abundance of U.S. Northwest origin steelhead would be compromised by the occurrence of largely or wholly uninfected U.S. Northwest stocks with different distribution patterns than stocks that have high prevalence; the ratio of infected to uninfected U.S. Northwest origin steelhead in an ocean area would depend on which U.S. Northwest stocks contribute most steelhead to that area. To assess this, regional prevalence estimates are needed for the steelhead originating from the various regions of the U.S. Northwest. Prevalence in an ocean area may also be influenced by the sampling dates and precise locations of capture within the area because steelhead as a group migrate northward as the summer progresses (Sutherland 1973; Okazaki 1983). Finally, the year-class composition of an area sample may affect prevalence since prevalence may inherently vary between year-classes; for each year, all year-classes sampled in an area were considered together.

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Table 1. *N.salmincola* infection information and prevalence for steelhead caught in 1984-1987. Number of specimens examined (N), number of specimens in which infection was observed (n), number of specimens in which infection was observed in the first one-quarter aliquot (I), number of specimens in which infection was observed in the second one-quarter aliquot but not the first (i), number of specimens in which infection was not observed (U), estimated number of infected specimens (n_a), estimated percentage prevalence (%).

Year	N	n	I	i	U	n_a	%
1984	83	22	--	--	61	22	26.5
1985	277	100	--	--	177	100	36.1
1986	311	121	110	11	190	140	45.0
1987	211	95	84	11	116	114	54.0

Table 2. Comparison of kidney examination protocols for steelhead caught at sea during 1983-1987.

Year	Report	Prevalence (%)	Scope of examination	Examination of posterior one-third of kidney only
1983	Margolis 1984	10.2	parasite survey[a]	no specimens
1984	Margolis 1985	18.5	whole-fish[b]	no specimens
1984	Dalton 1989	26.5	whole-fish[b]	no specimens
1985	Dalton 1989	36.1	kidney alone[c]	no specimens
1986	Dalton 1989	45.0	kidney alone[c]	≈ 2/3 of specimens
1987	Dalton 1989	54.0	kidney alone[c]	all specimens

[a]Kidney examinations were conducted as part of whole-fish parasite surveys.

[b]In addition to the kidney examinations, various measurements and samples were taken from the carcasses. See text for description.

[c]Kidney examinations were conducted separately from carcass examinations.

Table 3. *N. salmincola* prevalence in steelhead captured in 1984-1987 stratified by 5°-longitude areas. Number of specimens in which infection was observed (n), estimated number of infected specimens (n_a), number of specimens examined (N).

	1984		1985		1986		1987	
Area	n/N	(%)	n/N	(%)	n_a/N	(%)	n_a/N	(%)
5	22/83	(26.5)	47/156	(30.1)	79/163	(48.5)	6/12	(50.0)
7	--	--	--	--	6/15	(40.0)	9/12	(75.0)
9	--	--	--	--	11/14	(78.6)	16/28	(57.1)
12	--	--	0/1	(0)	5/13	(38.5)	1/4	(25.0)
13	--	--	9/34	(26.5)	8/35	(22.9)	14/23	(60.9)
14	--	--	18/44	(40.9)	--	--	18/36	(50.0)
15	--	--	16/25	(64.0)	31/71	(43.7)	30/62	(48.4)
16	--	--	--	--	--	--	20/34	(58.9)
17	--	--	10/17	(58.8)	--	--	--	--

Table 4. *N. salmincola* infection information for steelhead collected in 1986-1987 stratified by 5°-longitude areas. Number of specimens examined (N), number of specimens in which infection was observed (n), number of specimens in which infection was observed in the first one-quarter aliquot (I), number of specimens in which infection was observed in the second one-quarter aliquot but not the first (i), number of specimens in which infection was not observed (U), estimated number of infected specimens (n_a).

	1986						1987					
Area	N	n	I	i	U	n_a	N	n	I	i	U	n_a
5	163	70	65	5	93	79	12	6	6	0	6	6
7	15	6	6	0	9	6	12	7	6	1	5	9
9	14	10	9	1	4	11	28	14	13	1	14	16
12	13	5	5	0	8	5	4	1	1	0	3	1
13	35	6	5	1	29	8	23	10	7	3	13	14
14	--	--	--	--	--	--	36	14	12	2	22	18
15	71	24	20	4	47	31	62	26	24	2	36	30
16	--	--	--	--	--	--	34	17	15	2	17	20

Table 5. *N. salmincola* prevalences (Pr) and arc-sine transformed prevalences (Pr_{a-s}) in steelhead collected in 1986-1987 stratified by 5°-longitude areas.

Area	1986 Pr (%)	1986 Pr_{a-s} (%)	1987 Pr (%)	1987 Pr_{a-s} (%)
5	48.5	44.140	50.0	45.0
7	40.0	39.232	75.0	60.0
9	78.6	62.445	57.1	49.082
12	38.5	38.351	25.0	30.0
13	22.9	28.590	60.9	51.296
14	--	--	50.0	45.0
15	43.7	41.381	48.4	44.083
16	--	--	58.9	50.127

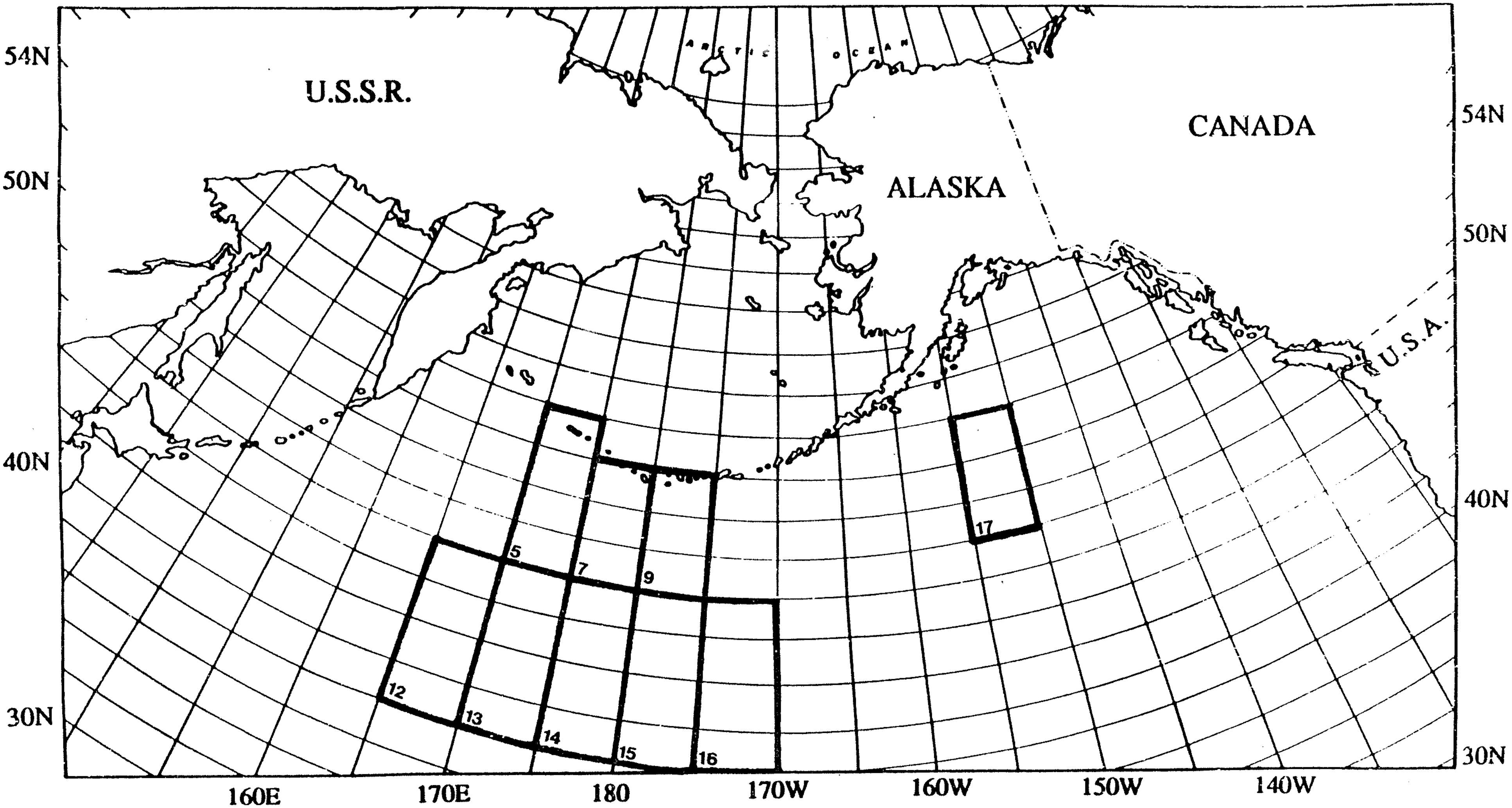

Figure 1. Large 5°-longitude areas used for spatial trend analysis of *N. salmincola* prevalence.

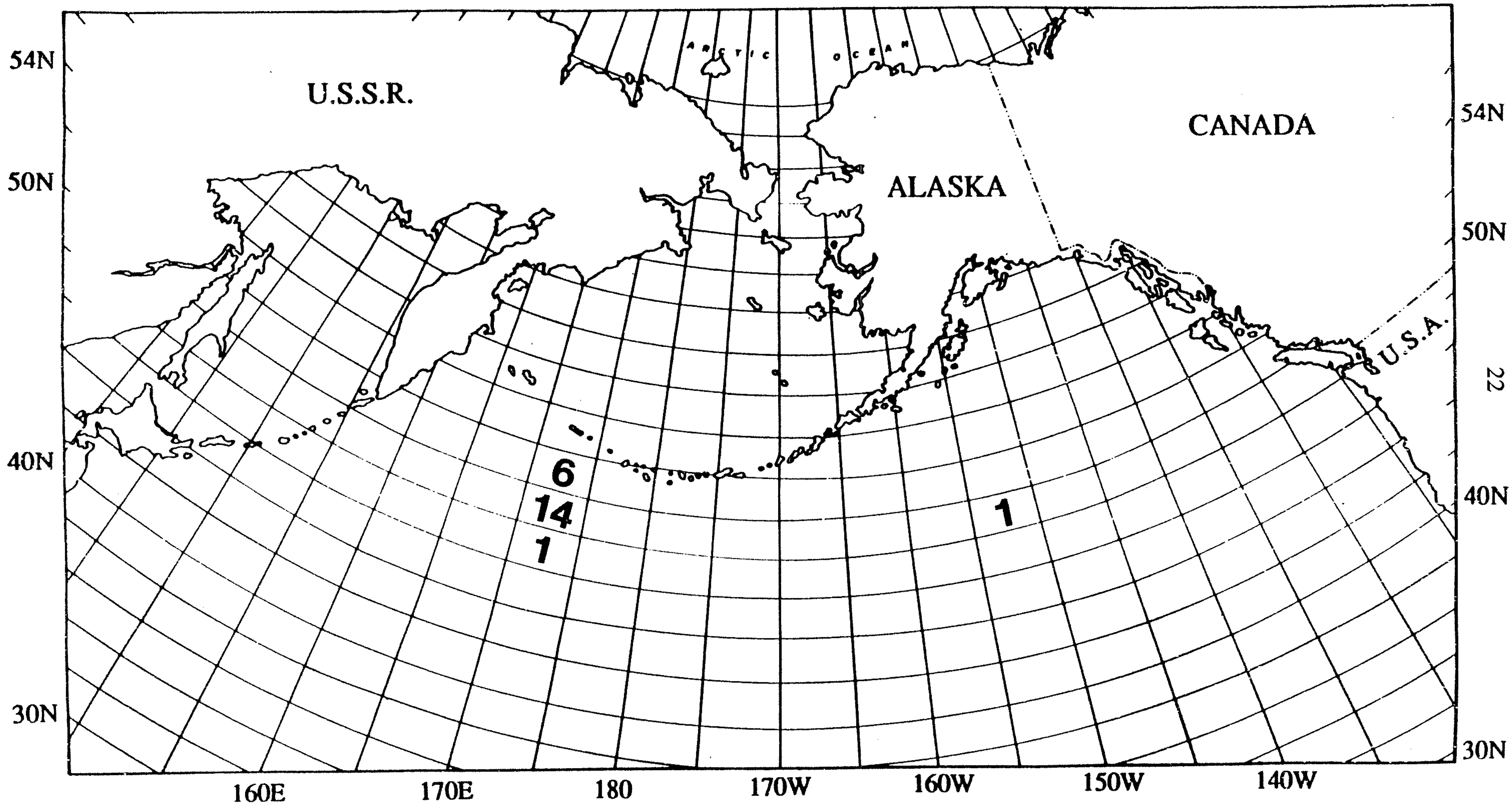

Figure 2. Numbers of steelhead captured in 1984 and 1985 that were infected with *P. shawi* but not *N. salmincola*, stratified by 2°-latitude X 5°-longitude INPFC areas.

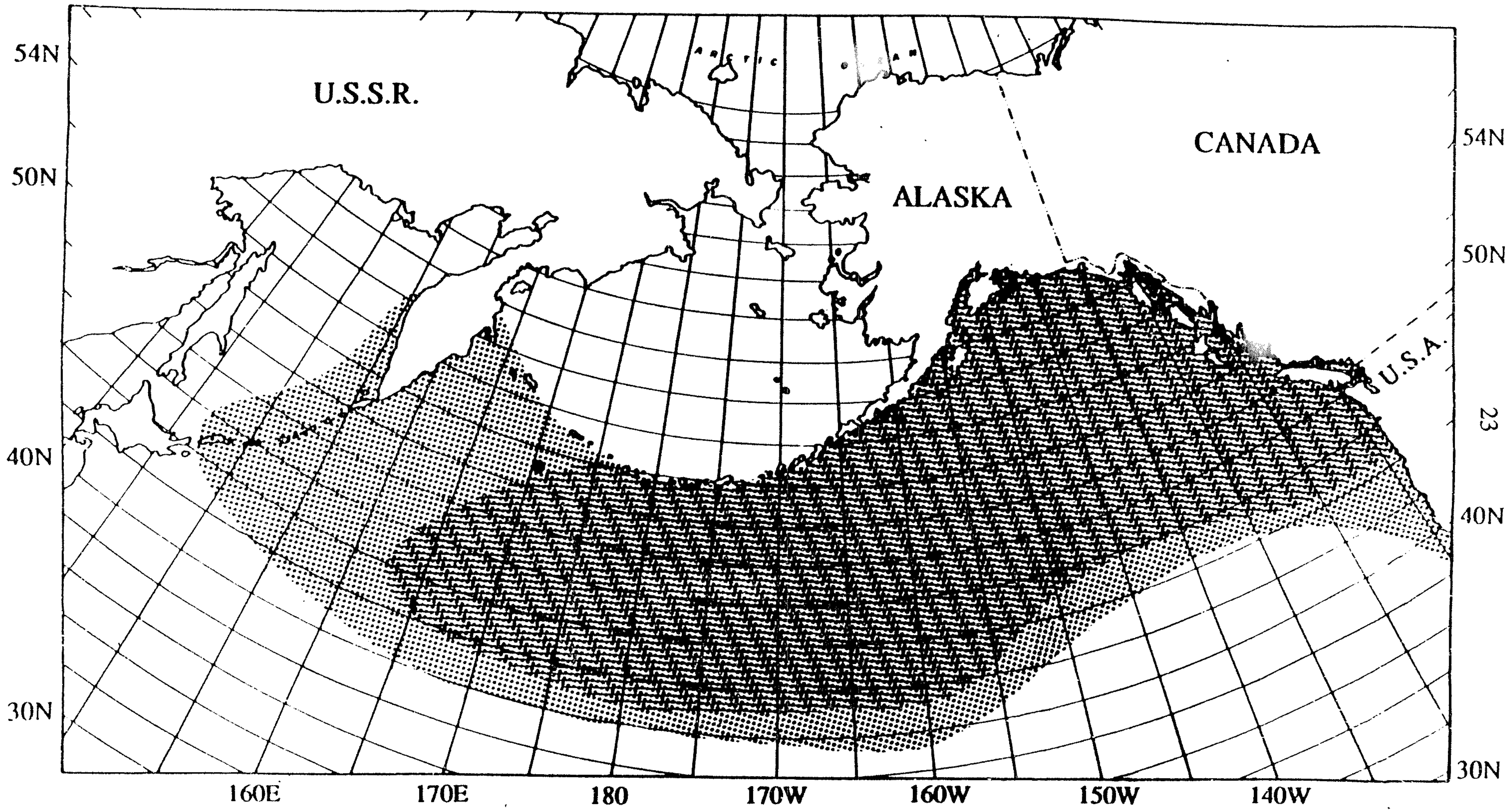

Figure 3. Known distribution of North American steelhead as evidenced by recoveries of marked or tagged fish within the larger distribution of steelhead determined from catch data. A steelhead infected with *N. salmincola* was taken on July 15, 1985 at 51°13'N, 170°36'E (●). (From Light 1988.)

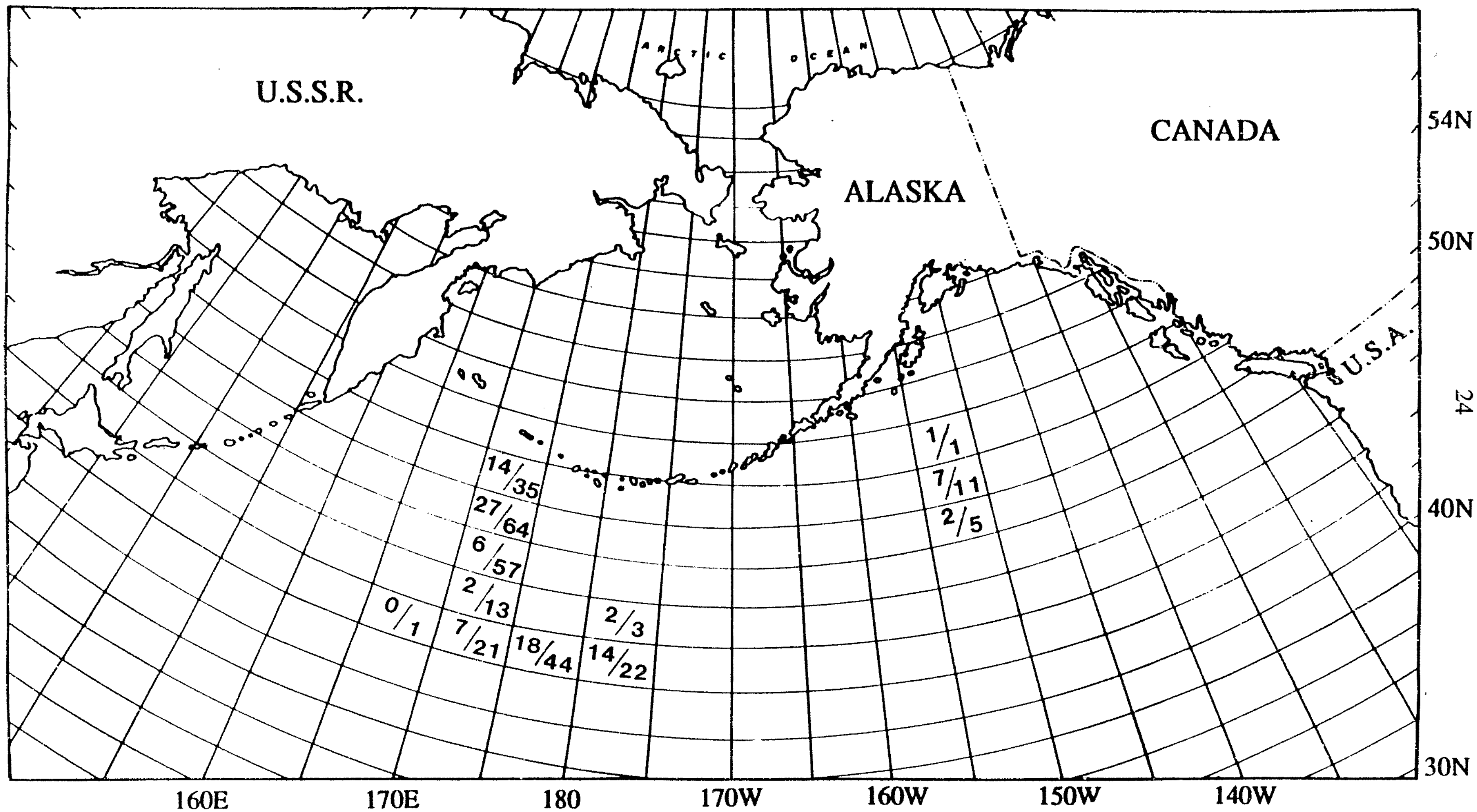

Figure 5. Observed prevalence (expressed as a fraction) of *N. salmincola* in 1985 specimens stratified by 2°-latitude X 5°-longitude INPFC areas.

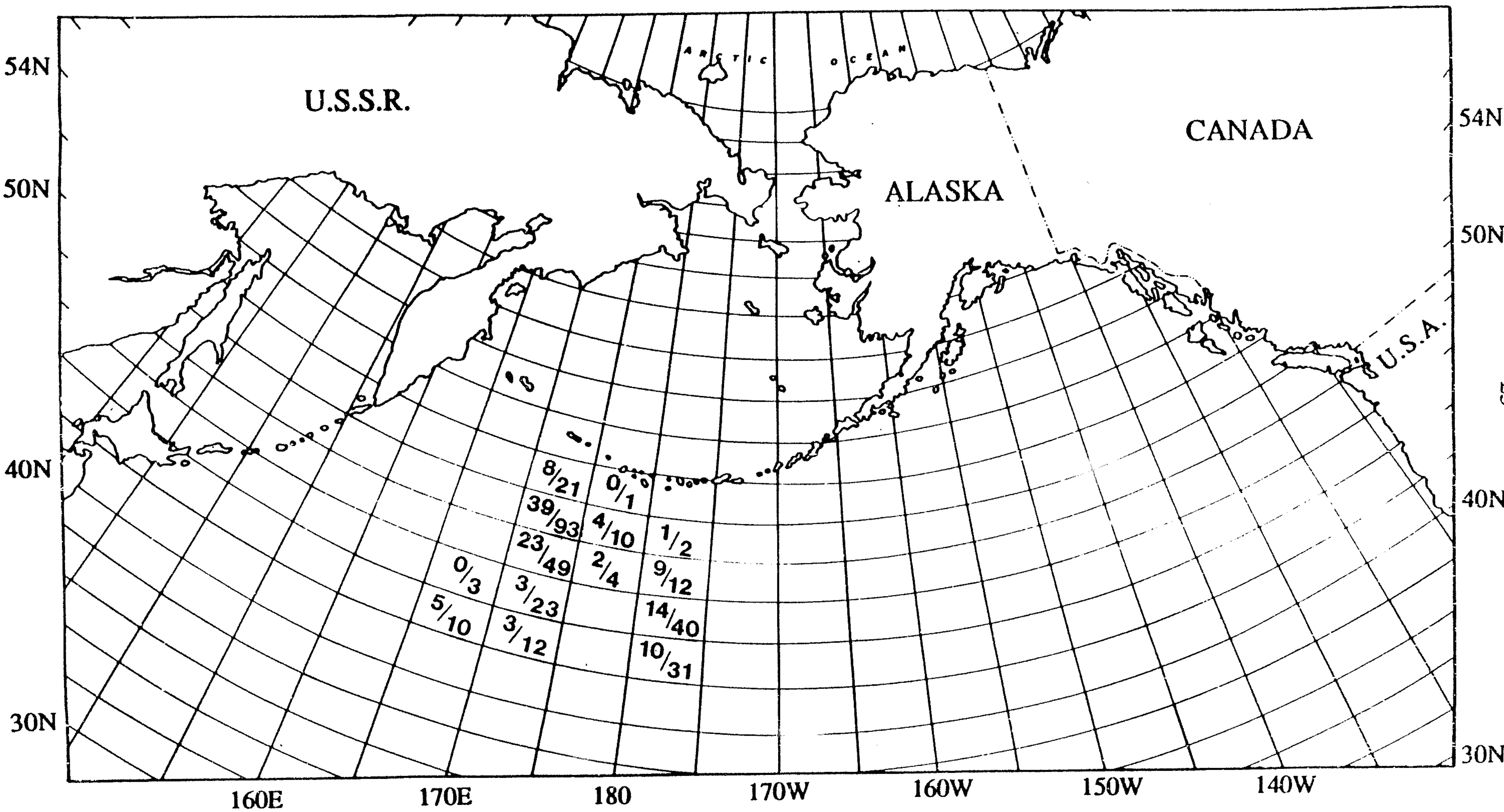

Figure 6. Observed prevalence (expressed as a fraction) of *N. salmincola* in 1986 specimens stratified by 2°-latitude X 5°-longitude INPFC areas.

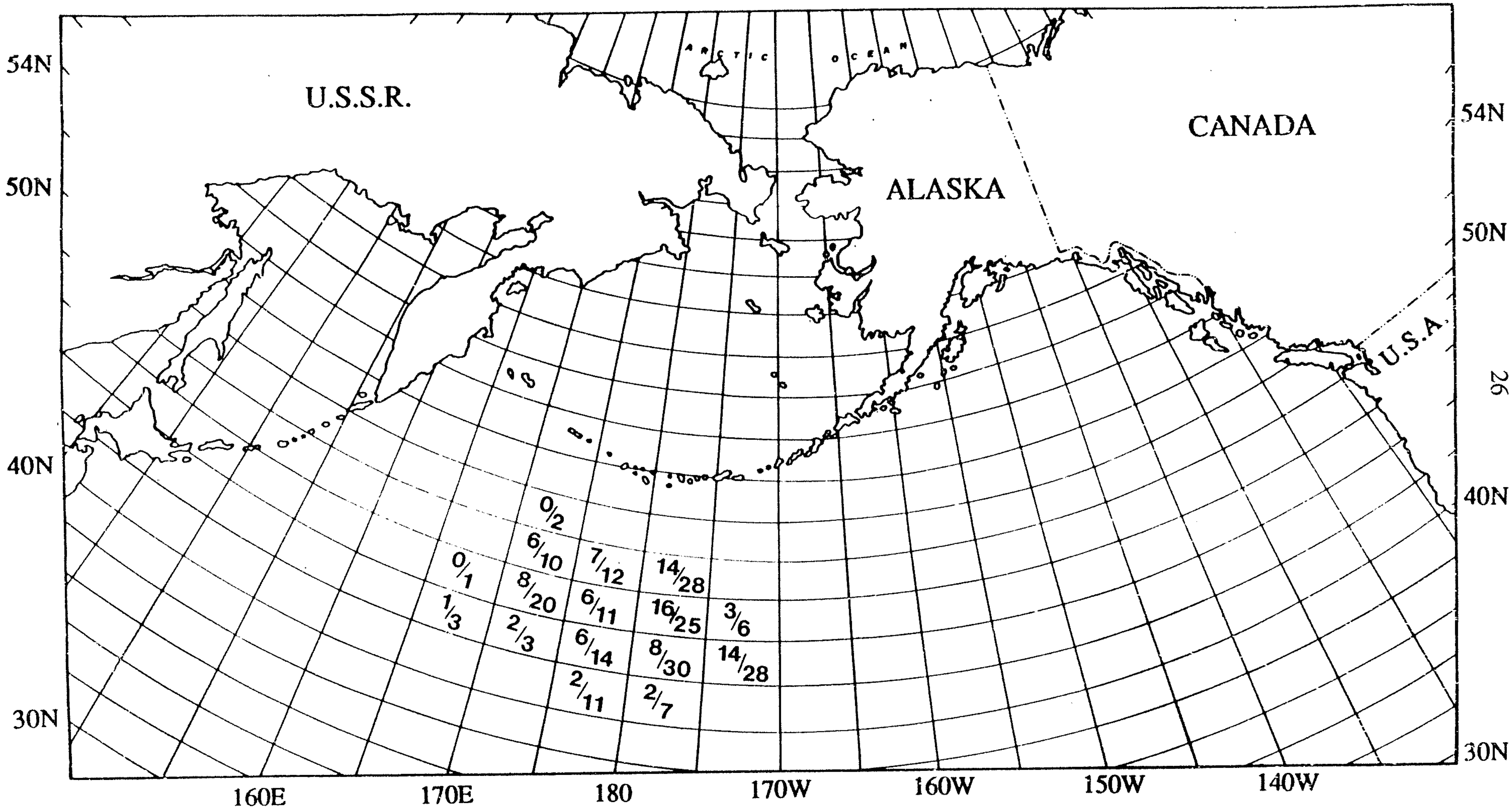

Figure 7. Observed prevalence (expressed as a fraction) of *N. salmincola* in 1987 specimens stratified by 2°-latitude X 5°-longitude INPFC areas.

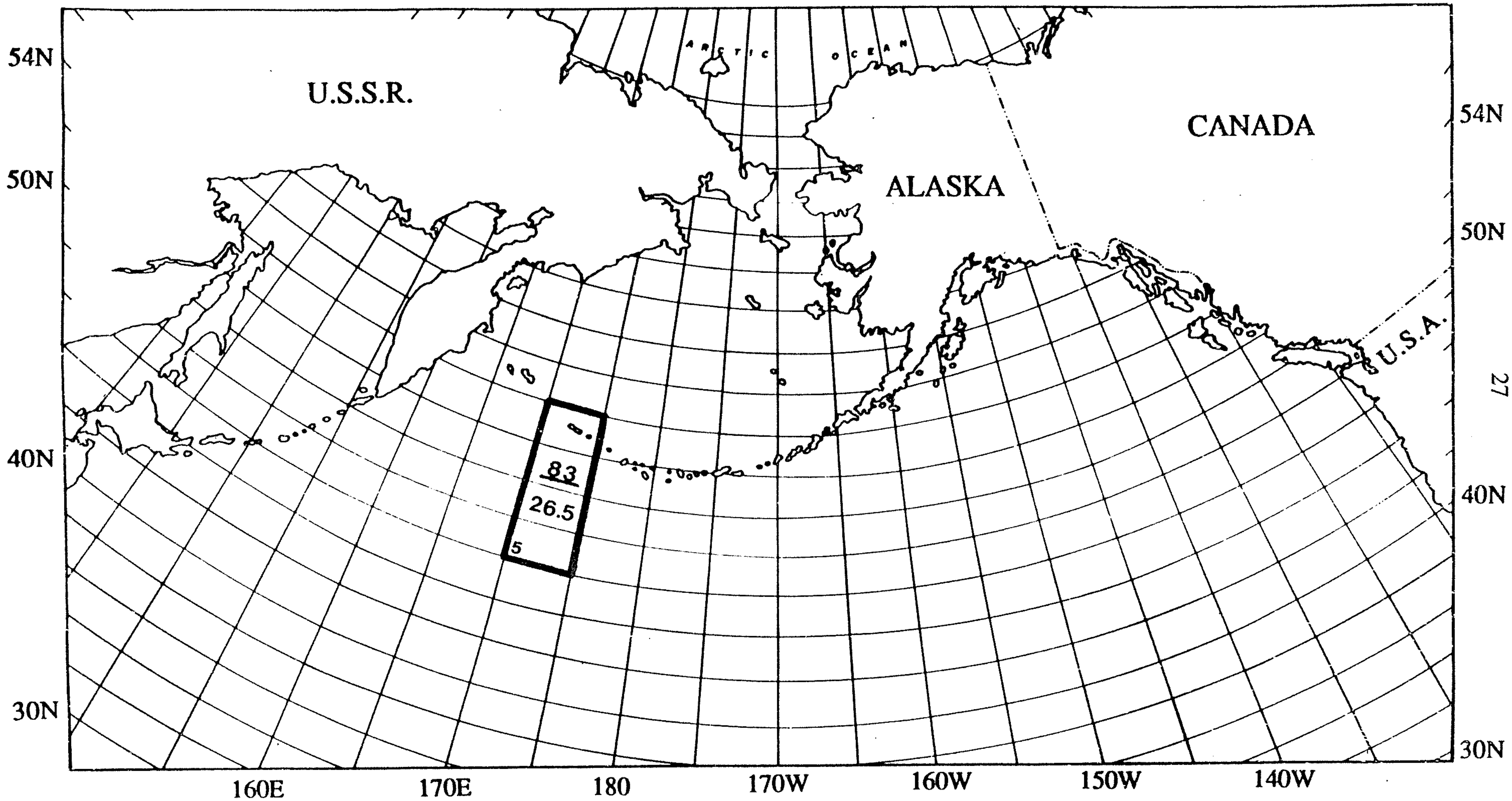

Figure 8. Percentage prevalence of *N. salmincola* in 1984 specimens stratified by large 5°-longitude areas. Sample size is also shown (underlined).

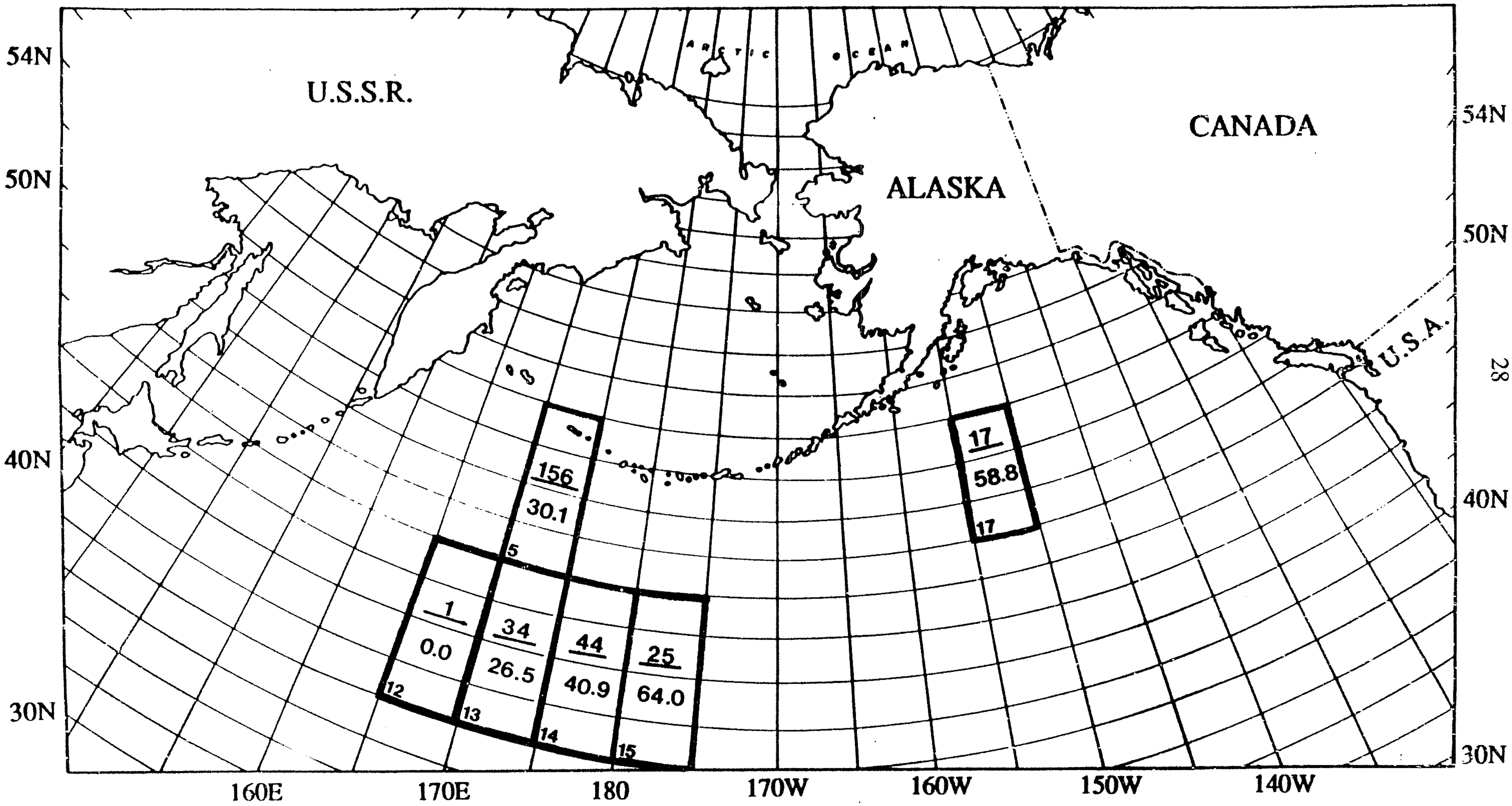

Figure 9. Percentage prevalence of *N. salmincola* in 1985 specimens stratified by large 5°-longitude areas. Sample size is also shown (underlined).

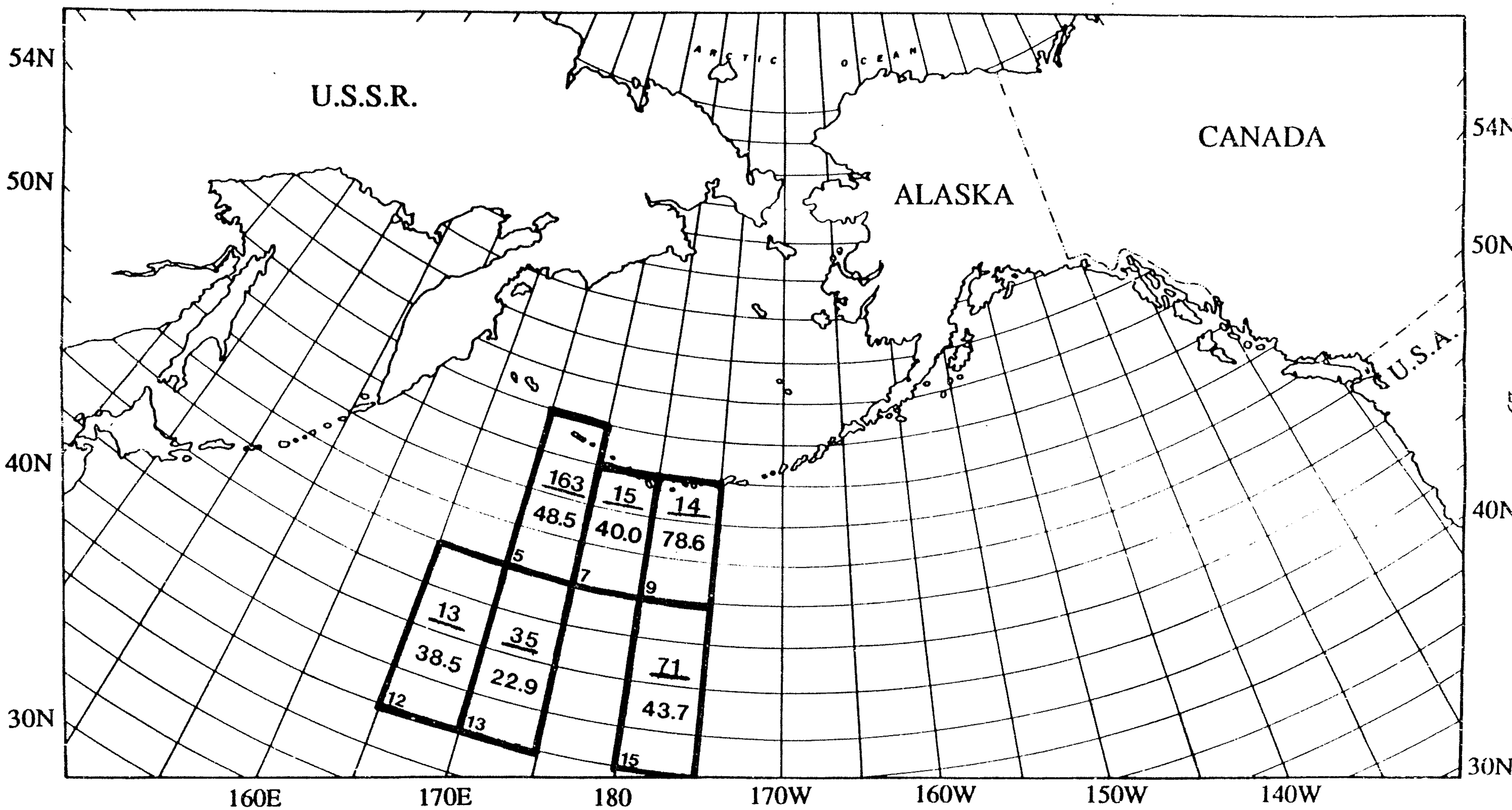

Figure 10. Percentage prevalence of *N. salmincola* in 1986 specimens stratified by large 5°-longitude areas. Sample size is also shown (underlined).

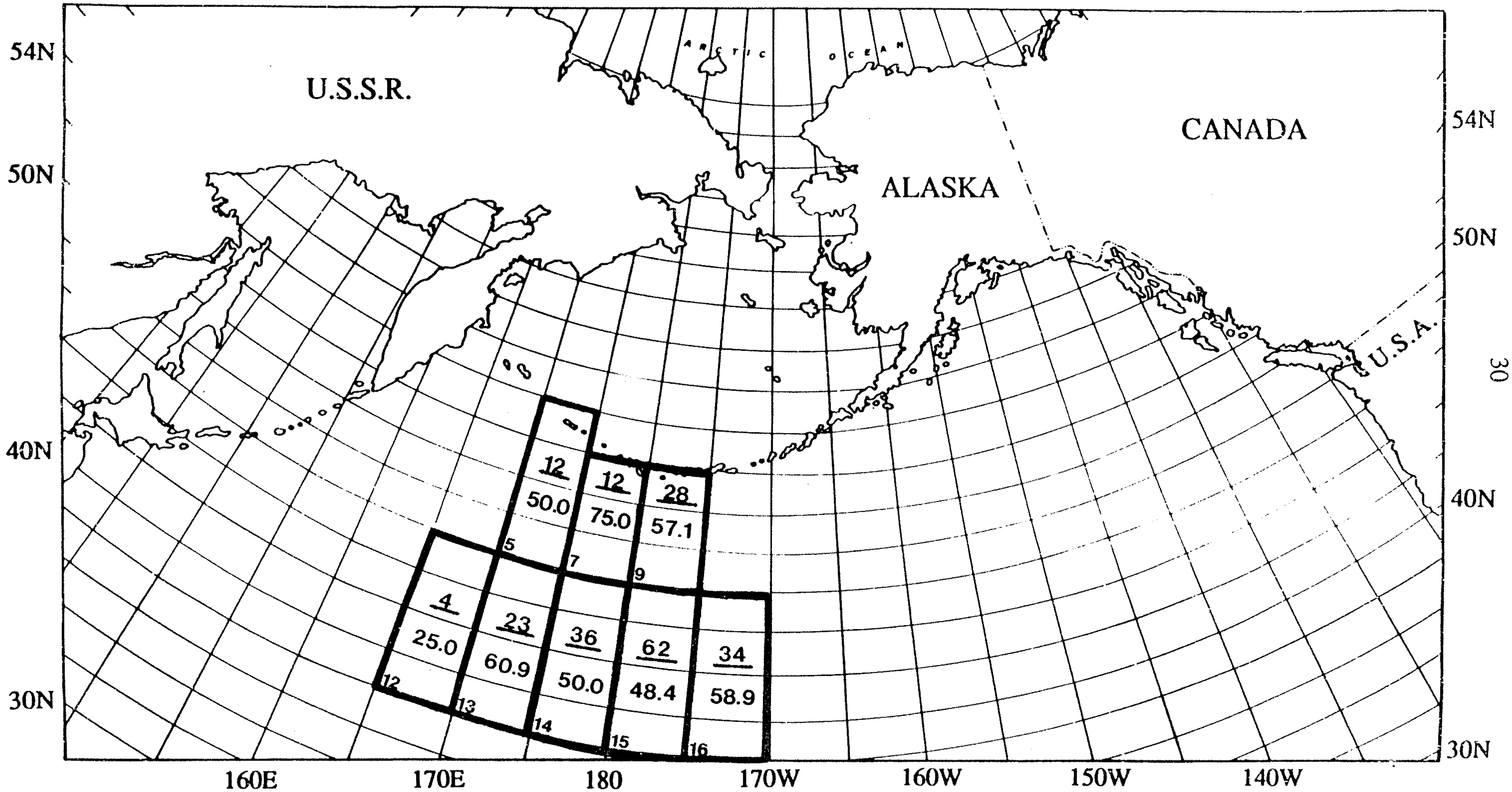

Figure 11. Percentage prevalence of *N. salmincola* in 1987 specimens stratified by large 5°-longitude areas. Sample size is also shown (underlined).

Appendix 1. List of steelhead caught in 1984 that were examined for parasites. Number of fish examined (N), number of fish in which infection was found (n).

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
51°06'N	169°13'E	Meiyo maru	18-VII	1	0	0	--
51°06'N	169°20'E	Meiyo maru	18-VII	1	0	0	--
50°22'N	170°43'E	Meiyo maru	19-VII	1	0	0	--
50°02'N	171°14'E	Kizan maru	15-VII	1	0	0	--
50°40'N	171°58'E	Kizan maru	21-VII	2	0	0	--
50°41'N	171°59'E	Kizan maru	21-VII	1	0	0	--
50°35'N	172°02'E	Kizan maru	21-VII	2	0	0	--
49°45'N	172°12'E	Meiyo maru	20-VII	5	0	0	--
51°00'N	172°14'E	Kizan maru	21-VII	1	0	0	--
50°37'N	172°14'E	Kizan maru	21-VII	1	0	0	--
49°48'N	172°20'E	Kizan maru	15-VII	1	0	0	--
50°51'N	172°26'E	Kizan maru	21-VII	1	0	0	--
49°45'N	172°26'E	Meiyo maru	20-VII	1	0	0	--
50°05'N	172°28'E	Kizan maru	15-VII	1	0	0	--
49°51'N	172°30'E	Kizan maru	15-VII	1	0	0	--
50°03'N	172°36'E	Jinyo maru	10-VII	1	0	0	--
49°17'N	172°48'E	Meiyo maru	20-VII	2	0	0	--
50°42'N	172°49'E	Kizan maru	21-VII	2	1	0	--
50°57'N	172°50'E	Meiyo maru	24-VII	4	0	0	--
50°00'N	172°50'E	Jinyo maru	17-VII	2	0	1	1
50°06'N	172°52'E	Kizan maru	21-VII	1	0	0	--
50°21'N	173°00'E	Kizan maru	21-VII	1	0	0	--
50°03'N	173°00'E	Jinyo maru	10-VII	1	0	1	1
50°25'N	173°02'E	Kizan maru	21-VII	1	0	0	--
50°10'N	173°02'E	Kizan maru	21-VII	3	0	0	--
49°17'N	173°02'E	Meiyo maru	20-VII	1	0	0	--
51°16'N	173°03'E	Kizan maru	20-VII	1	0	0	--
50°05'N	173°03'E	Jinyo maru	23-VII	2	0	0	--
49°45'N	173°05'E	Jinyo maru	17-VII	4	0	3	0
49°52'N	173°06'E	Kizan maru	19-VI	1	0	0	--
50°06'N	173°07'E	Kizan maru	21-VII	1	0	0	--
49°31'N	173°09'E	Meiyo maru	20-VII	2	0	0	--
50°10'N	173°10'E	Kizan maru	21-VII	1	0	0	--
49°45'N	173°13'E	Jinyo maru	17-VII	5	0	4	1
49°17'N	173°16'E	Meiyo maru	20-VII	3	0	1	1
49°50'N	173°17'E	Jinyo maru	23-VII	3	0	1	0
49°45'N	173°20'E	Jinyo maru	17-VII	3	0	2	1
50°57'N	173°21'E	Meiyo maru	24-VII	1	0	0	--
50°42'N	173°21'E	Meiyo maru	24-VII	2	0	0	--
50°27'N	173°21'E	Meiyo maru	24-VII	1	0	0	--
51°10'N	173°24'E	Kizan maru	20-VII	1	0	0	--
50°05'N	173°24'E	Jinyo maru	23-VII	6	1	2	0
49°35'N	173°24'E	Jinyo maru	23-VII	3	0	1	1
50°12'N	173°26'E	Jinyo maru	20-VII	3	0	2	1
49°22'N	173°26'E	Nojima maru	24-VI	1	0	0	--
49°45'N	173°28'E	Jinyo maru	17-VII	8	0	6	1
49°45'N	173°28'E	Meiyo maru	22-VII	4	1	0	--
50°05'N	173°31'E	Jinyo maru	23-VII	3	0	1	0
49°08'N	173°32'E	Jinyo maru	21-VII	1	0	0	--
50°15'N	173°33'E	Jinyo maru	16-VII	1	0	0	--
50°31'N	173°34'E	Jinyo maru	20-VII	1	0	0	--
50°28'N	173°35'E	Nojima maru	21-VII	1	0	0	--
50°00'N	173°35'E	Jinyo maru	17-VII	1	0	0	--
49°45'N	173°35'E	Jinyo maru	17-VII	12	0	11	2

Appendix 1. (cont.)

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
49°45'N	173°35'E	Meiyo maru	22-VII	12	1	0	--
49°30'N	173°35'E	Meiyo maru	22-VII	2	0	0	--
49°23'N	173°35'E	Jinyo maru	18-VII	1	0	1	1
51°47'N	173°37'E	Jinyo maru	21-VII	1	0	0	--
49°00'N	173°37'E	Meiyo maru	21-VII	1	0	0	--
51°31'N	173°41'E	Kizan maru	20-VII	1	0	0	--
50°09'N	173°42'E	Nojima maru	21-VII	1	0	0	--
50°50'N	173°43'E	Jinyo maru	14-VII	1	0	0	--
49°45'N	173°43'E	Jinyo maru	17-VII	7	1	4	0
49°45'N	173°43'E	Meiyo maru	21-VII	3	0	0	--
49°00'N	173°44'E	Meiyo maru	21-VII	3	0	0	--
50°03'N	173°45'E	Meiyo maru	23-VII	1	0	0	--
49°57'N	173°45'E	Jinyo maru	12-VII	1	0	0	--
49°47'N	173°45'E	Jinyo maru	19-VII	5	1	5	2
49°45'N	173°46'E	Meiyo maru	22-VII	3	0	0	--
49°30'N	173°46'E	Meiyo maru	22-VII	2	0	0	--
50°28'N	173°47'E	Nojima maru	22-VII	3	0	0	--
50°19'N	173°47'E	Meiyo maru	23-VII	1	0	0	--
49°22'N	173°47'E	Meiyo maru	22-VII	6	1	0	--
50°15'N	173°49'E	Jinyo maru	16-VII	1	0	0	--
50°12'N	173°49'E	Jinyo maru	20-VII	2	0	0	--
49°45'N	173°50'E	Jinyo maru	17-VII	4	0	1	0
49°23'N	173°51'E	Jinyo maru	18-VII	2	0	2	1
49°00'N	173°51'E	Meiyo maru	21-VII	2	0	0	--
50°32'N	173°53'E	Jinyo maru	12-VII	1	0	0	--
50°00'N	173°53'E	Jinyo maru	19-VII	5	0	3	0
49°47'N	173°53'E	Jinyo maru	19-VII	6	0	2	2
50°19'N	173°54'E	Meiyo maru	23-VII	1	0	0	--
50°50'N	173°56'E	Jinyo maru	20-VII	1	0	0	--
50°28'N	173°56'E	Nojima maru	21-VII	3	0	0	--
50°14'N	173°56'E	Jinyo maru	11-VII	1	0	0	--
51°21'N	173°58'E	Jinyo maru	21-VII	1	0	0	--
49°45'N	173°58'E	Meiyo maru	21-VII	7	0	0	--
50°57'N	174°00'E	Meiyo maru	24-VII	1	0	0	--
50°27'N	174°00'E	Meiyo maru	24-VII	1	0	0	--
50°12'N	174°00'E	Jinyo maru	12-VII	1	0	0	--
49°57'N	174°00'E	Jinyo maru	12-VII	1	0	0	--
49°47'N	174°00'E	Jinyo maru	19-VII	13	1	4	0
50°31'N	174°03'E	Jinyo maru	20-VII	3	0	0	--
49°45'N	174°05'E	Jinyo maru	17-VII	3	0	2	0
49°37'N	174°06'E	Jinyo maru	18-VII	3	0	0	--
49°10'N	174°06'E	Jinyo maru	18-VII	2	0	0	--
50°53'N	174°07'E	Kizan maru	19-VII	1	0	0	--
50°19'N	174°07'E	Meiyo maru	23-VII	2	0	0	--
50°56'N	174°08'E	Nojima maru	22-VII	2	0	0	--
50°50'N	174°08'E	Jinyo maru	14-VII	1	0	1	0
50°00'N	174°08'E	Jinyo maru	19-VII	2	0	2	0
49°47'N	174°08'E	Jinyo maru	19-VII	6	1	3	1
50°12'N	174°11'E	Jinyo maru	20-VII	2	0	1	0
49°45'N	174°12'E	Meiyo maru	21-VII	1	0	0	--
49°06'N	174°12'E	Meiyo maru	22-VII	5	0	0	--
50°32'N	174°14'E	Kizan maru	18-VII	1	1	0	--
49°30'N	174°15'E	Meiyo maru	21-VII	1	1	0	--
51°38'N	174°16'E	Kizan maru	20-VII	1	0	0	--
50°42'N	174°16'E	Meiyo maru	24-VII	2	0	0	--
50°31'N	174°18'E	Jinyo maru	20-VII	3	0	2	0

Appendix 1. (cont.)

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
50°12'N	174°18'E	Jinyo maru	20-VII	4	1	0	--
50°08'N	174°19'E	Jinyo maru	11-VII	1	0	1	1
49°47'N	174°19'E	Meiyo maru	23-VII	4	0	0	--
49°15'N	174°19'E	Meiyo maru	21-VII	6	2	0	--
49°23'N	174°21'E	Jinyo maru	18-VII	2	0	0	--
48°57'N	174°21'E	Jinyo maru	18-VII	1	0	0	--
50°31'N	174°22'E	Kizan maru	18-VII	1	0	0	--
49°45'N	174°22'E	Meiyo maru	21-VII	2	0	0	--
50°31'N	174°25'E	Jinyo maru	20-VII	6	1	0	--
49°15'N	174°26'E	Meiyo maru	21-VII	8	1	0	--
49°00'N	174°27'E	Meiyo maru	21-VII	2	0	0	--
49°50'N	174°28'E	Jinyo maru	18-VII	5	0	2	0
49°37'N	174°28'E	Jinyo maru	18-VII	1	0	0	--
50°15'N	174°29'E	Jinyo maru	16-VII	1	0	0	--
50°14'N	174°29'E	Nojima maru	22-VII	5	0	0	--
50°00'N	174°29'E	Nojima maru	20-VII	4	0	0	--
50°30'N	174°30'E	Kizan maru	18-VII	1	0	0	--
49°57'N	174°30'E	Jinyo maru	12-VII	1	0	0	--
49°47'N	174°30'E	Jinyo maru	19-VII	2	0	0	--
50°31'N	174°33'E	Jinyo maru	20-VII	7	2	2	1
50°12'N	174°33'E	Jinyo maru	20-VII	3	0	0	--
49°47'N	174°33'E	Meiyo maru	23-VII	3	1	0	--
49°30'N	174°33'E	Meiyo maru	21-VII	5	0	0	--
49°30'N	174°34'E	Meiyo maru	21-VII	3	0	0	--
49°00'N	174°34'E	Meiyo maru	21-VII	1	0	0	--
50°30'N	174°35'E	Meiyo maru	3-VII	1	0	0	--
49°50'N	174°36'E	Jinyo maru	18-VII	7	0	1	0
49°22'N	174°40'E	Meiyo maru	22-VII	2	0	0	--
50°56'N	174°41'E	Nojima maru	22-VII	2	0	0	--
50°50'N	174°41'E	Kizan maru	18-VII	1	0	0	--
49°20'N	174°41'E	Kizan maru	19-VI	1	0	0	--
50°34'N	174°43'E	Jinyo maru	16-VII	1	0	0	--
50°00'N	174°43'E	Nojima maru	20-VII	3	1	0	--
49°50'N	174°43'E	Jinyo maru	18-VII	7	1	3	1
49°37'N	174°43'E	Jinyo maru	18-VII	2	0	0	--
49°23'N	174°43'E	Jinyo maru	18-VII	2	0	2	1
49°10'N	174°43'E	Jinyo maru	18-VII	1	0	0	--
50°27'N	174°45'E	Jinyo maru	12-VII	1	0	1	0
50°45'N	174°46'E	Kizan maru	18-VII	1	0	0	--
50°28'N	174°47'E	Kizan maru	18-VII	1	0	0	--
49°47'N	174°47'E	Nojima maru	1-VII	1	0	0	--
50°35'N	174°48'E	Meiyo maru	23-VII	2	0	0	--
50°31'N	174°48'E	Jinyo maru	20-VII	3	0	1	0
49°08'N	174°48'E	Jinyo maru	24-VII	1	1	0	--
50°19'N	174°49'E	Meiyo maru	23-VII	1	0	0	--
49°08'N	174°49'E	Jinyo maru	21-VII	1	0	1	1
50°03'N	174°55'E	Meiyo maru	23-VII	4	0	0	--
50°00'N	174°57'E	Nojima maru	20-VII	5	0	0	--

Appendix 2. List of steelhead caught in 1985 that were examined for parasites. Number of fish examined (N), number of fish in which infection was found (n).

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
43°51'N	164°45'E	Kaiun maru	14-VI	1	0	0	--
43°53'N	166°39'E	Kaiun maru	15-VI	1	0	1	0
50°59'N	169°56'E	Jinyo maru	15-VII	1	0	0	--
50°20'N	170°07'E	Jinyo maru	17-VII	1	0	0	--
43°41'N	170°35'E	Kaiun maru	18-VI	3	0	3	2
51°13'N	170°36'E	Jinyo maru	15-VII	1	0	1	1
50°50'N	170°39'E	Jinyo maru	17-VII	1	0	1	0
50°05'N	170°47'E	Jinyo maru	17-VII	1	0	1	1
49°49'N	170°47'E	Nojima maru	28-VII	2	0	0	--
50°07'N	170°54'E	Nojima maru	28-VII	3	0	0	--
50°50'N	170°55'E	Jinyo maru	17-VII	1	0	1	0
50°05'N	171°01'E	Nojima maru	28-VII	1	0	0	--
50°20'N	171°08'E	Nojima maru	28-VII	5	0	0	--
50°05'N	171°11'E	Jinyo maru	17-VII	2	0	1	1
50°18'N	171°15'E	Nojima maru	28-VII	2	0	0	--
50°16'N	171°22'E	Nojima maru	28-VII	2	0	0	--
50°39'N	171°24'E	Meiyo maru	23-VII	2	0	0	--
51°20'N	171°28'E	Meiyo maru	20-VII	1	0	0	--
51°20'N	171°36'E	Meiyo maru	20-VII	1	0	0	--
50°39'N	171°39'E	Meiyo maru	23-VII	1	0	0	--
50°03'N	171°47'E	Jinyo maru	22-VII	1	0	0	--
49°45'N	171°53'E	Jinyo maru	20-VII	5	0	1	0
49°38'N	171°55'E	Nojima maru	25-VII	2	0	0	--
49°38'N	171°55'E	Nojima maru	26-VII	1	0	0	--
49°27'N	171°55'E	Nojima maru	27-VII	1	0	0	--
50°05'N	171°57'E	Nojima maru	28-VII	1	0	0	--
49°54'N	171°59'E	Jinyo maru	21-VII	1	0	1	0
49°45'N	172°00'E	Jinyo maru	20-VII	6	1	6	3
50°03'N	172°01'E	Jinyo maru	22-VII	1	0	1	0
50°03'N	172°03'E	Nojima maru	27-VII	3	0	0	--
49°45'N	172°03'E	Nojima maru	27-VII	1	0	0	--
49°54'N	172°06'E	Jinyo maru	21-VII	2	0	0	--
49°39'N	172°06'E	Jinyo maru	21-VII	2	0	1	1
50°03'N	172°08'E	Jinyo maru	22-VII	1	0	1	0
49°48'N	172°08'E	Jinyo maru	22-VII	1	0	1	0
49°22'N	172°10'E	Nojima maru	26-VII	1	0	0	--
50°30'N	172°11'E	Jinyo maru	18-VII	1	0	1	0
50°15'N	172°11'E	Jinyo maru	18-VII	3	0	3	1
49°42'N	172°13'E	Meiyo maru	24-VII	2	0	0	--
49°48'N	172°15'E	Jinyo maru	22-VII	2	0	2	2
50°39'N	172°18'E	Meiyo maru	23-VII	1	0	0	--
50°03'N	172°18'E	Nojima maru	26-VII	2	0	0	--
49°22'N	172°18'E	Nojima maru	25-VII	3	0	0	--
50°00'N	172°19'E	Jinyo maru	18-VII	5	0	4	2
49°45'N	172°19'E	Jinyo maru	30-VI	1	0	1	0
49°54'N	172°20'E	Jinyo maru	21-VII	1	0	0	--
49°39'N	172°20'E	Jinyo maru	21-VII	1	0	1	0
50°00'N	172°21'E	Meiyo maru	24-VII	2	0	0	--
50°00'N	172°21'E	Jinyo maru	29-VI	1	0	1	0
49°45'N	172°21'E	Jinyo maru	20-VII	2	0	2	1
49°42'N	172°21'E	Meiyo maru	24-VII	2	0	0	--
45°56'N	172°24'E	Iwaki maru	8-VII	13	0	13	2
48°52'N	172°25'E	Iwaki maru	5-VII	2	0	2	2
50°45'N	172°27'E	Jinyo maru	18-VII	2	0	1	0
50°15'N	172°27'E	Jinyo maru	18-VII	4	0	3	2

Appendix 2. (cont.)

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
49°54'N	172°27'E	Jinyo maru	21-VII	1	0	1	1
47°56'N	172°27'E	Iwaki maru	6-VII	4	0	4	1
47°56'N	172°27'E	Iwaki maru	7-VII	1	0	1	0
46°58'N	172°28'E	Iwaki maru	7-VII	51	1	52	5
49°33'N	172°29'E	Jinyo maru	22-VII	2	0	2	1
49°45'N	172°33'E	Nojima maru	26-VII	1	0	0	--
49°45'N	172°33'E	Nojima maru	27-VII	2	0	0	--
49°22'N	172°33'E	Nojima maru	26-VII	1	0	0	--
50°30'N	172°35'E	Jinyo maru	18-VII	2	0	2	2
49°45'N	172°35'E	Jinyo maru	20-VII	3	0	1	0
50°03'N	172°36'E	Jinyo maru	22-VII	1	0	1	1
50°03'N	172°40'E	Nojima maru	27-VII	1	0	0	--
49°38'N	172°40'E	Jinyo maru	20-VII	2	0	2	1
50°00'N	172°41'E	Meiyo maru	24-VII	2	0	0	--
49°24'N	172°41'E	Jinyo maru	21-VII	2	0	0	--
50°00'N	172°43'E	Jinyo maru	18-VII	3	0	2	1
49°48'N	172°43'E	Jinyo maru	22-VII	1	0	1	0
51°09'N	172°45'E	Meiyo maru	28-VII	3	0	0	--
50°52'N	172°45'E	Meiyo maru	28-VII	1	0	0	--
49°42'N	172°45'E	Meiyo maru	24-VII	1	0	0	--
43°38'N	172°45'E	Kaiun maru	19-VI	4	0	4	1
49°54'N	172°48'E	Nojima maru	25-VII	3	0	0	--
49°45'N	172°49'E	Jinyo maru	20-VII	4	0	2	0
49°38'N	172°54'E	Jinyo maru	20-VII	6	0	4	1
49°54'N	172°55'E	Nojima maru	25-VII	3	0	0	--
49°33'N	172°57'E	Jinyo maru	22-VII	3	0	3	1
50°57'N	172°58'E	Meiyo maru	22-VII	1	0	0	--
50°15'N	172°59'E	Jinyo maru	18-VII	3	0	1	0
50°18'N	173°00'E	Meiyo maru	28-VII	2	0	0	--
49°54'N	173°01'E	Jinyo maru	21-VII	3	0	2	1
49°24'N	173°01'E	Jinyo maru	21-VII	1	0	1	1
49°27'N	173°03'E	Nojima maru	27-VII	1	0	0	--
49°54'N	173°10'E	Nojima maru	25-VII	2	0	0	--
50°52'N	173°06'E	Meiyo maru	28-VII	1	0	0	--
50°45'N	173°07'E	Jinyo maru	18-VII	2	0	2	2
50°18'N	173°07'E	Meiyo maru	28-VII	2	0	0	--
49°38'N	173°08'E	Jinyo maru	20-VII	1	0	0	--
50°03'N	173°10'E	Jinyo maru	22-VII	1	0	1	0
49°54'N	173°10'E	Nojima maru	25-VII	1	0	0	--
49°54'N	173°10'E	Nojima maru	26-VII	2	0	0	--
49°48'N	173°10'E	Jinyo maru	22-VII	2	0	2	1
49°45'N	173°10'E	Nojima maru	27-VII	1	0	0	--
49°38'N	173°10'E	Nojima maru	25-VII	1	0	0	--
49°38'N	173°10'E	Nojima maru	26-VII	1	0	0	--
50°12'N	173°11'E	Nojima maru	20-VII	1	0	0	--
50°18'N	173°14'E	Meiyo maru	28-VII	1	0	0	--
50°00'N	173°15'E	Jinyo maru	18-VII	3	0	3	0
49°24'N	173°15'E	Jinyo maru	21-VII	2	1	1	1
49°23'N	173°15'E	Jinyo maru	20-VII	3	0	2	1
49°38'N	173°18'E	Nojima maru	25-VII	1	0	0	--
49°38'N	173°18'E	Nojima maru	26-VII	2	0	0	--
50°35'N	173°21'E	Meiyo maru	28-VII	3	0	0	--
49°58'N	173°21'E	Jinyo maru	19-VII	1	0	0	--
50°39'N	173°22'E	Meiyo maru	22-VII	1	0	0	--
49°54'N	173°22'E	Jinyo maru	21-VII	3	0	1	0
49°48'N	173°24'E	Jinyo maru	22-VII	1	0	1	0

Appendix 2. (cont.)

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
49°54'N	173°25'E	Nojima maru	26-VII	3	0	0	--
49°24'N	173°25'E	Meiyo maru	24-VII	1	0	0	--
49°58'N	173°29'E	Jinyo maru	19-VII	2	1	1	1
49°54'N	173°29'E	Jinyo maru	21-VII	2	0	1	0
49°28'N	173°29'E	Jinyo maru	19-VII	4	0	3	1
49°24'N	173°29'E	Jinyo maru	21-VII	3	0	2	2
50°03'N	173°31'E	Jinyo maru	22-VII	1	0	1	0
49°33'N	173°31'E	Jinyo maru	22-VII	1	0	1	1
49°38'N	173°36'E	Jinyo maru	20-VII	1	0	1	1
49°58'N	173°37'E	Jinyo maru	19-VII	1	0	0	--
49°28'N	173°37'E	Jinyo maru	19-VII	4	0	0	--
50°57'N	173°38'E	Meiyo maru	22-VII	1	0	0	--
49°38'N	173°43'E	Jinyo maru	20-VII	3	0	1	0
49°28'N	173°44'E	Jinyo maru	19-VII	3	0	2	0
49°06'N	173°49'E	Nojima maru	24-VII	2	0	0	--
49°38'N	173°50'E	Jinyo maru	20-VII	3	0	3	0
49°28'N	173°52'E	Jinyo maru	19-VII	4	0	0	--
49°13'N	173°52'E	Jinyo maru	19-VII	1	0	0	--
49°06'N	173°56'E	Nojima maru	24-VII	2	0	0	--
49°53'N	173°57'E	Jinyo maru	20-VII	2	0	1	1
49°19'N	173°57'E	Meiyo maru	25-VII	1	0	0	--
49°43'N	173°59'E	Jinyo maru	19-VII	2	0	0	--
49°34'N	174°03'E	Nojima maru	23-VII	1	0	0	--
49°46'N	174°07'E	Nojima maru	21-VII	2	0	0	--
49°28'N	174°07'E	Jinyo maru	19-VII	1	0	1	1
49°13'N	174°07'E	Jinyo maru	19-VII	7	0	0	--
50°13'N	174°09'E	Meiyo maru	26-VII	3	0	0	--
49°34'N	174°10'E	Nojima maru	23-VII	2	0	0	--
49°18'N	174°10'E	Nojima maru	23-VII	1	0	0	--
49°06'N	174°11'E	Nojima maru	24-VII	1	0	0	--
50°04'N	174°14'E	Nojima maru	21-VII	1	0	0	--
49°54'N	174°14'E	Nojima maru	22-VII	2	0	0	--
[illegible]°37'N	174°17'E	Meiyo maru	26-VII	2	0	0	--
49°55'N	174°18'E	Meiyo maru	25-VII	1	0	0	--
49°50'N	174°18'E	Nojima maru	23-VII	1	0	0	--
49°19'N	174°18'E	Meiyo maru	25-VII	1	0	0	--
50°31'N	174°20'E	Jinyo maru	23-VII	1	0	0	--
49°46'N	174°22'E	Nojima maru	21-VII	2	0	0	--
49°36'N	174°22'E	Nojima maru	22-VII	1	0	0	--
49°28'N	174°22'E	Jinyo maru	19-VII	5	0	0	--
49°01'N	174°25'E	Meiyo maru	25-VII	2	0	0	--
50°00'N	174°26'E	Nojima maru	24-VII	1	0	0	--
50°13'N	174°28'E	Jinyo maru	23-VII	1	0	1	0
50°22'N	174°29'E	Nojima maru	21-VII	1	0	0	--
49°36'N	174°29'E	Nojima maru	22-VII	1	0	0	--
49°53'N	174°32'E	Jinyo maru	20-VII	3	0	0	--
49°37'N	174°32'E	Meiyo maru	25-VII	1	0	0	--
49°06'N	174°34'E	Nojima maru	24-VII	2	0	0	--
49°37'N	174°38'E	Meiyo maru	26-VII	2	0	0	--
49°19'N	174°38'E	Meiyo maru	26-VII	2	0	0	--
49°24'N	174°41'E	Nojima maru	24-VII	1	0	0	--
49°46'N	174°44'E	Nojima maru	21-VII	1	0	0	--
49°43'N	174°44'E	Jinyo maru	19-VII	6	0	0	--
49°28'N	174°44'E	Jinyo maru	19-VII	3	0	2	0
49°13'N	174°44'E	Jinyo maru	19-VII	1	0	1	0
49°19'N	174°45'E	Meiyo maru	26-VII	3	0	0	--

Appendix 2. (cont.)

Locality of Capture		Vessel	Date of Capture	*P. shawi*		*N. salmincola*	
Latitude	Longitude			N	n	N	n
49°18'N	174°48'E	Nojima maru	23-VII	1	0	0	--
50°31'N	174°49'E	Jinyo maru	23-VII	1	0	1	0
49°42'N	174°49'E	Nojima maru	24-VII	2	0	0	--
49°37'N	174°52'E	Meiyo maru	26-VII	1	0	0	--
49°36'N	174°52'E	Nojima maru	23-VII	1	0	0	--
49°50'N	174°55'E	Nojima maru	23-VII	1	0	0	--
43°37'N	174°55'E	Kaiun maru	20-VI	10	0	14	4
43°59'N	176°45'E	Kaiun maru	21-VI	12	0	12	4
43°55'N	178°42'E	Kaiun maru	22-VI	31	0	32	14
43°41'N	179°17'W	Kaiun maru	24-VI	2	0	2	2
44°50'N	177°46'W	Kaiun maru	26-VI	3	0	3	2
43°53'N	177°43'W	Kaiun maru	25-VI	19	0	20	12
49°55.5'N	155°02.7'W	Oshoro maru	10-VII	1	0	0	--
55°00'N	155°00'W	Oshoro maru	4-VII	11	0	0	--
53°00'N	155°00'W	Oshoro maru	7-VII	0	--	1	1
51°00'N	155°00'W	Oshoro maru	9-VII	0	--	1	0
51°00'N	155°00'W	Oshoro maru	10-VII	2	0	10	7
49°00'N	155°00'W	Oshoro maru	11-VII	79	1	5	2
49°00'N	154°59'W	Oshoro maru	11-VII	1	0	0	--

Appendix 3. List of steelhead caught in 1986 that were examined for parasites. Number of fish examined (N), number of fish in which infection was found (n).

Locality of Capture		Vessel	Date of Capture	*N. salmincola*	
Latitude	Longitude			N	n
42°51'N	167°31'E	Hokushin maru	17-VI	8	5
43°54'N	167°47'E	Hokushin maru	19-VI	2	0
45°29'N	168°31'E	Shin Riasu maru	21-VI	2	0
44°27'N	168°32'E	Shin Riasu maru	20-VI	1	0
50°08'N	170°14'E	Jinyo maru	13-VII	1	1
50°24'N	170°21'E	Jinyo maru	14-VII	1	1
50°40'N	170°28'E	Jinyo maru	14-VII	1	0
50°24'N	170°28'E	Jinyo maru	14-VII	1	1
50°35'N	170°38'E	Jinyo maru	12-VII	1	1
49°53'N	170°42'E	Jinyo maru	13-VII	1	1
50°05'N	170°45'E	Jinyo maru	12-VII	1	1
50°22'N	170°49'E	Jinyo maru	13-VII	1	0
49°46'N	170°56'E	Jinyo maru	13-VII	1	1
50°35'N	170°59'E	Jinyo maru	12-VII	1	0
50°08'N	171°03'E	Jinyo maru	13-VII	1	0
50°35'N	171°06'E	Jinyo maru	12-VII	1	0
50°20'N	171°06'E	Jinyo maru	12-VII	1	0
50°22'N	171°10'E	Jinyo maru	13-VII	1	0
49°46'N	171°10'E	Jinyo maru	13-VII	1	1
49°55'N	171°19'E	Jinyo maru	10-VII	1	0
49°50'N	171°20'E	Jinyo maru	12-VII	1	1
49°43'N	171°20'E	Jinyo maru	12-VII	1	1
49°50'N	171°27'E	Jinyo maru	12-VII	1	1
42°29'N	171°30'E	Shin Riasu maru	27-VI	3	1
45°30'N	171°31'E	Shin Riasu maru	24-VI	13	1
46°32'N	171°32'E	Shin Riasu maru	23-VI	26	10
49°40'N	171°33'E	Jinyo maru	10-VII	2	1
49°46'N	171°50'E	Jinyo maru	11-VII	1	1
49°37'N	171°50'E	Jinyo maru	11-VII	1	1
49°33'N	171°54'E	Jinyo maru	10-VII	2	0
49°46'N	171°57'E	Nojima maru	23-VI	2	1
49°50'N	172°02'E	Jinyo maru	12-VII	1	0
49°29'N	172°09'E	Jinyo maru	9-VII	1	1
49°29'N	172°13'E	Jinyo maru	9-VII	1	0
50°10'N	177°22'E	Jinyo maru	10-VII	1	0
49°55'N	177°22'E	Jinyo maru	10-VII	1	0
49°36'N	172°24'E	Jinyo maru	9-VII	1	1
49°46'N	172°25'E	Jinyo maru	11-VII	1	0
47°35'N	172°25'E	Hokushin maru	5-VII	18	12
49°40'N	172°29'E	Jinyo maru	10-VII	1	0
49°29'N	172°31'E	Jinyo maru	9-VII	1	0
49°36'N	172°38'E	Jinyo maru	9-VII	1	0
48°53'N	172°43'E	Hokushin maru	4-VII	11	3
49°29'N	172°45'E	Jinyo maru	9-VII	1	0
49°46'N	172°46'E	Jinyo maru	11-VII	1	0
49°30'N	173°02'E	Kizan maru	14-VII	1	1
49°44'N	173°18'E	Kizan maru	14-VII	1	1
49°29'N	173°23'E	Jinyo maru	8-VII	1	1
49°44'N	173°26'E	Kizan maru	14-VII	1	1
49°52'N	173°32'E	Jinyo maru	7-VII	1	0
49°29'N	173°37'E	Jinyo maru	8-VII	1	0
49°43'N	173°50'E	Kizan maru	11-VII	1	0
49°45'N	173°51'E	Jinyo maru	8-VII	1	0
49°34'N	173°51'E	Kizan maru	13-VII	1	0
49°20'N	173°51'E	Nojima maru	30-VI	2	1

Appendix 3. (cont.)

Locality of Capture		Vessel	Date of Capture	*N. salmincola*	
Latitude	Longitude			N	n
49°20'N	173°51'E	Kizan maru	13-VII	1	1
49°20'N	173°54'E	Kizan maru	12-VII	2	1
49°45'N	173°58'E	Jinyo maru	8-VII	1	1
49°30'N	173°58'E	Kizan maru	14-VII	2	1
49°20'N	173°58'E	Nojima maru	30-VI	1	0
49°34'N	173°59'E	Kizan maru	13-VII	1	0
49°33'N	174°02'E	Kizan maru	12-VII	1	0
49°20'N	174°02'E	Kizan maru	12-VII	3	2
49°20'N	174°04'E	Nojima maru	23-VI	1	0
50°11'N	174°05'E	Kizan maru	11-VII	1	0
49°20'N	174°05'E	Nojima maru	30.VI	2	1
49°52'N	174°07'E	Jinyo maru	7-VII	1	0
49°48'N	174°08'E	Nojima maru	2-VII	1	0
49°33'N	174°10'E	Kizan maru	12-VII	2	2
49°20'N	174°10'E	Kizan maru	12-VII	1	0
49°20'N	174°11'E	Nojima maru	23-VI	1	1
50°12'N	174°12'E	Kizan maru	9-VII	1	0
49°29'N	174°12'E	Jinyo maru	8-VII	1	1
50°08'N	174°15'E	Kizan maru	13-VII	1	1
49°52'N	174°15'E	Kizan maru	10-VII	1	1
49°20'N	174°15'E	Kizan maru	13-VII	2	1
49°20'N	174°19'E	Nojima maru	30-VI	1	0
49°30'N	174°22'E	Nojima maru	1-VII	1	0
49°29'N	174°22'E	Kizan maru	11-VII	2	1
50°32'N	174°23'E	Kizan maru	10-VII	1	0
50°08'N	174°23'E	Kizan maru	10-VII	1	1
49°33'N	174°26'E	Kizan maru	12-VII	1	0
49°29'N	174°26'E	Jinyo maru	8-VII	1	0
49°11'N	174°29'E	Kizan maru	11-VII	1	0
46°29'N	174°29'E	Shin Riasu maru	2-VII	4	1
49°29'N	174°30'E	Kizan maru	11-VII	2	1
45°31'N	174°30'E	Shin Riasu maru	2-VII	9	2
44°30'N	174°30'E	Shin Riasu maru	30-VI	1	0
50°08'N	174°31'E	Kizan maru	10-VII	1	1
49°20'N	174°31'E	Kizan maru	13-VII	2	2
43°33'N	174°32'E	Shin Riasu maru	29-VI	8	2
50°33'N	174°34'E	Kizan maru	13-VII	1	0
50°12'N	174°36'E	Kizan maru	9-VII	1	0
49°43'N	174°38'E	Kizan maru	11-VII	1	0
49°20'N	174°40'E	Nojima maru	30-VI	2	0
49°52'N	174°42'E	Jinyo maru	7-VII	1	1
49°33'N	174°42'E	Kizan maru	12-VII	1	0
49°20'N	174°42'E	Kizan maru	12-VII	1	1
50°27'N	174°43'E	Kizan maru	9-VII	1	0
50°17'N	174°45'E	Kizan maru	11-VII	1	0
50°08'N	174°47'E	Kizan maru	10-VII	1	0
49°57'N	174°52'E	Kizan maru	9-VII	3	0
50°30'N	177°30'E	Shin Riasu maru	12-VII	1	0
49°57'N	177°30'E	Iwaki maru	30-VI	1	0
49°57'N	177°30'E	Iwaki maru	1-VII	9	4
47°52'N	177°32'E	aki maru	2-VII	4	2
44°50'N	177°32'W	Iwaki maru	12-VI	23	7
43°49'N	177°31'W	Iwaki maru	11-VI	8	1
43°18'N	177°31'W	Iwaki maru	10-VI	11	4
48°55'N	177°30'W	Iwaki maru	18-VI	2	1

Appendix 3. (cont.)

Locality of Capture		Vessel	Date of Capture	*N. salmincola*	
Latitude	Longitude			N	n
47°57'N	177°30'W	Iwaki maru	17-VI	4	3
46°55'N	177°30'W	Iwaki maru	15-VI	8	6
45°52'N	177°30'W	Iwaki maru	13-VI	17	7
42°30'N	177°30'W	Iwaki maru	9-VI	11	5

Appendix 4. List of steelhead caught in 1987 that were examined for parasites. Number of fish examined (N), number of fish in which infection was found (n).

Locality of Capture		Vessel	Date of Capture	*N. salmincola*	
Latitude	Longitude			N	n
44°30'N	166°30'E	Hokuho maru	9-VII	1	0
43°21'N	167°29'E	Kaiun maru	12-VI	1	0
43°21'N	167°29'E	Kaiun maru	12-VI	2	1
45°30'N	171°30'E	Hokuho maru	21-VI	2	1
45°30'N	171°30'E	Hokuho maru	22-VI	1	0
42°30'N	171°30'E	Hokuho maru	24-VI	1	1
45°31'N	172°14'E	Kaiun maru	5-VII	10	4
44°42'N	172°25'E	Kaiun maru	6-VII	7	3
47°25'N	172°30'E	Kaiun maru	2-VII	2	1
48°38'N	172°34'E	Kaiun maru	1-VII	2	0
46°23'N	172°41'E	Kaiun maru	4-VII	8	5
43°31'N	173°30'E	Hokuho maru	15-VI	1	1
42°30'N	173°30'E	Hokuho maru	13-VI	1	0
41°32'N	176°31'E	Shin Riasu maru	8-VI	1	1
41°32'N	176°31'E	Shin Riasu maru	9-VI	3	0
43°49'N	177°16'E	Hokushin maru	23-VI	9	3
42°46'N	177°29'E	Hokushin maru	24-VI	5	3
44°47'N	177°30'E	Hokushin maru	22-VI	4	2
46°29'N	177°36'E	Hokushin maru	20-VI	12	7
45°12'N	177°36'E	Hokushin maru	21-VI	7	4
41°32'N	178°33'E	Shin Riasu maru	9-VI	3	0
41°32'N	178°32'E	Shin Riasu maru	10-VI	4	1
41°30'N	178°30'W	Shin Riasu maru	11-VI	3	1
43°50'N	177°41'W	Hokushin maru	28-VI	19	4
45°49'N	177°39'W	Hokushin maru	30-VI	9	6
47°47'N	177°37'W	Hokushin maru	4-VII	19	10
44°43'N	177°37'W	Hokushin maru	29-VI	16	10
46°50'N	177°30'W	Hokushin maru	2-VII	9	4
42°54'N	177°21'W	Hokushin maru	27-VI	11	4
41°32'N	176°15'W	Shin Riasu maru	11-VI	1	0
41°32'N	176°15'W	Shin Riasu maru	12-VI	1	1
42°30'N	173°31'W	Shin Riasu maru	12-VI	6	2
42°30'N	173°31'W	Shin Riasu maru	13-VI	8	6
44°36'N	173°28'W	Shin Riasu maru	14-VI	1	1
44°36'N	173°28'W	Shin Riasu maru	15-VI	5	2
43°36'N	173°28'W	Shin Riasu maru	13-VI	9	3
43°36'N	173°28'W	Shin Riasu maru	14-VI	5	3

Appendix 5. Distribution, biological data, and identifying parasites for steelhead caught in 1984 that were identified by parasitic infection as being of U.S. Pacific Northwest origin.

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
Latitude	Longitude								
50°42'N	172°49'E	Kizan maru	21-VII	M	2	832	6200	12.59	P
50°00'N	172°50'E	Jinyo maru	17-VII	F	2	748	4800	27.36	N
50°03'N	173°00'E	Jinyo maru	10-VII	M	2	740	4375	3.72	N
49°45'N	173°13'E	Jinyo maru	17-VII	F	2	732	4800	26.87	N
49°17'N	173°16'E	Meiyo maru	20-VII	F	2	739	4050	34.24	N
49°45'N	173°20'E	Jinyo maru	17-VII	F	2	739	4100	31.88	N
50°05'N	173°24'E	Jinyo maru	23-VII	F	1	673	3100	3.07	P
49°35'N	173°24'E	Jinyo maru	23-VII	M	2	773	4600	1.73	N
50°12'N	173°26'E	Jinyo maru	20-VII	F	2	828	5850	67.53	N
49°45'N	173°28'E	Jinyo maru	17-VII	M	2	707	3800	2.52	N
49°45'N	173°28'E	Meiyo maru	22-VII	M	3	817	5500	28.62	P
49°45'N	173°35'E	Jinyo maru	17-VII	M	2	722	4150	31.10	N
49°45'N	173°35'E	Jinyo maru	17-VII	F	1	589	2340	3.67	N
49°45'N	173°35'E	Meiyo maru	22-VII	--	2	626	3800	--	P
49°23'N	173°35'E	Jinyo maru	18-VII	F	1	644	2780	2.77	N
49°45'N	173°43'E	Jinyo maru	17-VII	F	1	660	3075	2.05	P
49°47'N	173°45'E	Jinyo maru	19-VII	F	2	746	4300	37.56	N
49°47'N	173°45'E	Jinyo maru	19-VII	F	2	722	4200	26.21	N+P
49°22'N	173°47'E	Meiyo maru	22-VII	F	2	714	4150	1.25	P
49°23'N	173°51'E	Jinyo maru	18-VII	M	1	660	2920	0.76	N
49°47'N	173°53'E	Jinyo maru	19-VII	F	2	756	4250	33.76	N
49°47'N	173°53'E	Jinyo maru	19-VII	F	2	710	3300	6.61	N
49°47'N	174°00'E	Jinyo maru	19-VII	F	2	681	3350	30.34	P
49°47'N	174°08'E	Jinyo maru	19-VII	M	1	623	2800	9.02	N
49°47'N	174°08'E	Jinyo maru	19-VII	M	1	605	2420	1.37	P
50°32'N	174°14'E	Kizan maru	18-VII	F	2	727	4600	63.17	P
49°30'N	174°15'E	Meiyo maru	21-VII	F	2	738	4610	34.49	P
50°12'N	174°18'E	Jinyo maru	20-VII	F	2	775	4850	53.78	P
50°08'N	174°19'E	Jinyo maru	11-VII	M	2	829	6200	22.65	N
49°15'N	174°19'E	Meiyo maru	21-VII	F	2	722	4400	53.94	P
49°15'N	174°19'E	Meiyo maru	21-VII	F	2	722	4400	34.18	P
50°31'N	174°25'E	Jinyo maru	20-VII	F	2	765	4800	44.93	P
49°15'N	174°26'E	Meiyo maru	21-VII	M	1	586	2120	1.07	P
50°31'N	174°33'E	Jinyo maru	20-VII	F	2	593	2210	13.93	N+P
50°31'N	174°33'E	Jinyo maru	20-VII	M	2	804	5600	19.21	P
49°47'N	174°33'E	Meiyo maru	23-VII	M	1	552	2080	0.87	P
50°00'N	174°43'E	Nojima maru	20-VII	M	1	695	3825	1.80	P
49°50'N	174°43'E	Jinyo maru	18-VII	M	2	776	5050	38.75	N+P

Appendix 5. (cont.)

Locality of capture: Latitude	Locality of capture: Longitude	Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
49°23'N	174°43'E	Jinyo maru	18-VII	F	2	735	4050	36.87	N
49°08'N	174°48'E	Jinyo maru	24-VII	F	2	719	3375	19.74	P
49°08'N	174°49'E	Jinyo maru	21-VII	F	2	787	5700	25.93	N

[a] Fork length and body weight determined at time of capture.

[b] Gonad weight determined from post-thawed fish at the Fisheries Research Institute.

[c] N= *Nanophyetus salmincola* ; P= *Plagioporus shawi*.

Appendix 6. Distribution, biological data, and identifying parasites for steelhead caught in 1985 that were identified by parasitic infection as being of U.S. Pacific Northwest origin.

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
Latitude	Longitude								
43°41'N	170°35'E	Kaiun maru	18-VI	M	3	741	4100	--	N
43°41'N	170°35'E	Kaiun maru	18-VI	F	2	660	2850	3.25	N
51°13'N	170°36'E	Jinyo maru	15-VII	F	2	735	4450	45.27	N
50°05'N	170°47'E	Jinyo maru	17-VII	M	2	820	5250	33.00	N
50°05'N	171°11'E	Jinyo maru	17-VII	F	1	592	2280	5.31	N
49°45'N	172°00'E	Jinyo maru	20-VII	F	2	625	2560	17.80	N+P
49°45'N	172°00'E	Jinyo maru	20-VII	M	2	825	5650	78.39	N
49°45'N	172°00'E	Jinyo maru	20-VII	M	2	705	3750	55.72	N
49°39'N	172°06'E	Jinyo maru	21-VII	M	1	633	2900	6.08	N
50°15'N	172°11'E	Jinyo maru	18-VII	M	2	746	4000	24.14	N
49°48'N	172°15'E	Jinyo maru	22-VII	F	2	715	4000	47.47	N
49°48'N	172°15'E	Jinyo maru	22-VII	F	2	737	4150	50.04	N
50°00'N	172°19'E	Jinyo maru	18-VII	F	2	681	3350	47.52	N
50°00'N	172°19'E	Jinyo maru	18-VII	M	2	705	3600	25.58	N
49°45'N	172°21'E	Jinyo maru	20-VII	M	3	866	6450	14.77	N
45°56'N	172°24'E	Iwaki maru	8-VII	F	1	538	1680	5.31	N
45°56'N	172°24'E	Iwaki maru	8-VII	M	1	612	2370	0.78	N
48°52'N	172°25'E	Iwaki maru	5-VII	M	2	730	4230	14.87	N
48°52'N	172°25'E	Iwaki maru	5-VII	M	2	800	5410	4.39	N
50°15'N	172°27'E	Jinyo maru	18-VII	M	1	641	2820	44.23	N
50°15'N	172°27'E	Jinyo maru	18-VII	F	2	772	4900	6.15	N
49°54'N	172°27'E	Jinyo maru	21-VII	F	2	711	3750	26.50	N
47°56'N	172°27'E	Iwaki maru	6-VII	M	2	752	4300	6.83	N
46°58'N	172°28'E	Iwaki maru	7-VII	F	2	775	4600	34.95	N
46°58'N	172°28'E	Iwaki maru	7-VII	F	1	512	1410	2.84	N
46°58'N	172°28'E	Iwaki maru	7-VII	F	1	613	2400	1.68	N
46°58'N	172°28'E	Iwaki maru	7-VII	M	2	696	3200	11.98	N
46°58'N	172°28'E	Iwaki maru	7-VII	M	1	604	2320	1.0	N
46°58'N	172°28'E	Iwaki maru	7-VII	M	1	672	3100	1.11	P
49°33'N	172°29'E	Jinyo maru	22-VII	M	3	790	4450	1.19	N
50°30'N	172°35'E	Jinyo maru	18-VII	F	2	810	5600	55.80	N
50°30'N	172°35'E	Jinyo maru	18-VII	M	2	785	5350	18.10	N
50°03'N	172°36'E	Jinyo maru	22-VII	F	2	758	4600	65.46	N
49°38'N	172°40'E	Jinyo maru	20-VII	F	2	743	4450	49.94	N
50°00'N	172°43'E	Jinyo maru	18-VII	M	2	710	3500	3.99	N
43°38'N	172°45'E	Kaiun maru	19-VI	M	3	752	4000	--	N
49°38'N	172°54'E	Jinyo maru	20-VII	F	2	759	4300	61.67	N
49°33'N	172°57'E	Jinyo maru	22-VII	M	2	799	4700	11.09	N
49°54'N	173°01'E	Jinyo maru	21-VII	F	2	718	3750	60.61	N

Appendix 6. (cont.)

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
Latitude	Longitude								
49°24'N	173°01'E	Jinyo maru	21-VII	M	2	792	5250	34.34	N
50°45'N	173°07'E	Jinyo maru	18-VII	M	2	815	5250	13.46	N
50°45'N	173°07'E	Jinyo maru	18-VII	F	2	760	4700	44.97	N
49°48'N	173°10'E	Jinyo maru	22-VII	M	2	860	6950	24.27	N
49°24'N	173°15'E	Jinyo maru	21-VII	M	3	820	5950	27.50	N
49°24'N	173°15'E	Jinyo maru	21-VII	M	2	807	4850	10.77	P
49°23'N	173°15'E	Jinyo maru	20-VII	F	2	705	3500	1.47	N
49°58'N	173°29'E	Jinyo maru	19-VII	F	2	765	4300	25.70	N+P
49°28'N	173°29'E	Jinyo maru	19-VII	F	2	743	4150	6.32	N
49°24'N	173°29'E	Jinyo maru	21-VII	F	2	692	3300	27.53	N
49°24'N	173°29'E	Jinyo maru	21-VII	F	2	724	4250	74.66	N
49°33'N	173°31'E	Jinyo maru	22-VII	F	2	714	3600	51.18	N
49°38'N	173°36'E	Jinyo maru	20-VII	M	1	635	2460	0.87	N
49°53'N	173°57'E	Jinyo maru	20-VII	F	2	735	4200	72.34	N
49°28'N	174°07'E	Jinyo maru	19-VII	M	1	636	2360	0.71	N
43°37'N	174°55'E	Kaiun maru	20-VI	M	2	618	2540	1.24	N
43°37'N	174°55'E	Kaiun maru	20-VI	M	1	580	2020	0.87	N
43°37'N	174°55'E	Kaiun maru	20-VI	M	1	522	1580	0.70	N
43°37'N	174°55'E	Kaiun maru	20-VI	F	2	777	4700	29.32	N
43°59'N	176°45'E	Kaiun maru	21-VI	M	2	810	5150	8.65	N
43°59'N	176°45'E	Kaiun maru	21-VI	F	2	721	3600	31.69	N
43°59'N	176°45'E	Kaiun maru	21-VI	M	1	600	1930	0.82	N
43°59'N	176°45'E	Kaiun maru	21-VI	M	2	645	2500	5.59	N
43°55'N	178°42'E	Kaiun maru	22-VI	F	1	615	2130	1.99	N
43°55'N	178°42'E	Kaiun maru	22-VI	F	1	615	2480	18.79	N
43°55'N	178°42'E	Kaiun maru	22-VI	F	1	602	1920	1.58	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	2	625	2200	0.88	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	520	2420	2.18	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	619	2280	14.66	N
43°55'N	178°42'E	Kaiun maru	22-VI	F	2	752	3720	--	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	593	2150	1.77	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	599	2020	2.77	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	630	2640	3.51	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	625	2660	1.75	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	625	2620	4.34	N
43°55'N	178°42'E	Kaiun maru	22-VI	M	1	596	1980	0.54	N
43°55'N	178°42'E	Kaiun maru	22-VI	F	1	594	2200	6.6	N
43°41'N	179°17'W	Kaiun maru	24-VI	M	1	578	2160	1.0	N
43°41'N	179°17'W	Kaiun maru	24-VI	M	1	565	2040	0.75	N
44°50'N	177°46'W	Kaiun maru	26-VI	M	1	578	1780	1.88	N

Appendix 7. Distribution, biological data, and identifying parasites for steelhead caught in 1986 that were identified by parasitic infection as being of U.S. Pacific Northwest origin.

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
Latitude	Longitude								
42°51'N	167°31'E	Hokushin maru	17-VI	F	2	701	4025	54.58	N
42°51'N	167°31'E	Hokushin maru	17-VI	--	3	760	4680	--	N
42°51'N	167°31'E	Hokushin maru	17-VI	M	2	762	4430	3.9	N
42°51'N	167°31'E	Hokushin maru	17-VI	F	2	752	4300	23.5	N
42°51'N	167°31'E	Hokushin maru	17-VI	M	2	801	5120	4.3	N
50°08'N	170°14'E	Jinyo maru	13-VII	M	2	739	4200	9.3	N
50°24'N	170°21'E	Jinyo maru	14-VII	F	2	700	4100	77.7	N
50°24'N	170°28'E	Jinyo maru	14-VII	M	2	791	4500	3.9	N
50°35'N	170°38'E	Jinyo maru	12-VII	M	2	769	4550	3.6	N
49°53'N	170°42'E	Jinyo maru	13-VII	F	2	781	4750	54.9	N
50°05'N	170°45'E	Jinyo maru	12-VII	F	2	750	4100	28.1	N
49°46'N	170°56'E	Jinyo maru	13-VII	F	2	730	4050	60.8	N
49°46'N	171°10'E	Jinyo maru	13-VII	F	2	785	4900	45.5	N
49°50'N	171°20'E	Jinyo maru	12-VII	F	2	740	3900	26.0	N
49°43'N	171°20'E	Jinyo maru	12-VII	M	2	819	5400	8.5	N
49°50'N	171°27'E	Jinyo maru	12-VII	M	2	745	4300	15.4	N
42°29'N	171°30'E	Shin Riasu	27-VI	M	--	569	2140	--	N
45°30'N	171°31'E	Shin Riasu	24-VI	M	2	736	3200	--	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	770	4730	28.8	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	693	3770	47.2	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	752	4260	60.3	N
46°32'N	171°32'E	Shin Riasu	23-VI	M	2	812	5470	6.75	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	728	4210	50.2	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	754	4270	37.75	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	722	3750	4.55	N
46°32'N	171°32'E	Shin Riasu	23-VI	M	3	820	5600	6.25	N
46°32'N	171°32'E	Shin Riasu	23-VI	F	2	704	3640	16.25	N
46°32'N	171°32'E	Shin Riasu	23-VI	M	2	770	4980	3.15	N
49°40'N	171°33'E	Jinyo maru	10-VII	F	2	776	5000	42.35	N
49°46'N	171°50'E	Jinyo maru	11-VII	M	2	733	4650	26.7	N
49°37'N	171°50'E	Jinyo maru	11-VII	M	2	752	4400	4.0	N
49°46'N	171°57'E	Nojima maru	23-VI	F	2	713	4300	23.0	N
49°29'N	172°09'E	Jinyo maru	9-VII	F	3	760	3900	34.05	N
49°36'N	172°24'E	Jinyo maru	9-VII	F	2	800	6000	39.25	N
47°35'N	172°25'E	Hokushin maru	5-VII	F	1	690	2780	14.83	N
47°35'N	172°25'E	Hokushin maru	5-VII	--	2	730	3360	--	N
47°35'N	172°25'E	Hokushin maru	5-VII	F	1	540	1740	6.6	N
47°35'N	172°25'E	Hokushin maru	5-VII	F	2	682	3530	35.0	N
47°35'N	172°25'E	Hokushin maru	5-VII	M	2	652	2830	50.85	N

Appendix 7. (cont.)

Locality of capture Latitude	Longitude	Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
47°35'N	172°25'E	Hokushin maru	5-VII	M	2	732	4670	1.6	N
47°35'N	172°25'E	Hokushin maru	5-VII	F	2	757	4265	23.69	N
47°35'N	172°25'E	Hokushin maru	5-VII	M	3	725	3840	2.1	N
47°35'N	172°25'E	Hokushin maru	5-VII	M	2	742	4420	--	N
47°35'N	172°25'E	Hokushin maru	5-VII	F	2	677	3200	32.3	N
47°35'N	172°25'E	Hokushin maru	5-VII	M	2	705	3360	1.3	N
47°35'N	172°25'E	Hokushin maru	5-VII	M	1	609	2080	0.65	N
48°53'N	172°43'E	Hokushin maru	4-VII	M	2	855	6930	7.o	N
48°53'N	172°43'E	Hokushin maru	4-VII	M	2	738	3870	11.2	N
48°53'N	172°43'E	Hokushin maru	4-VII	F	2	643	3160	24.2	N
49°30'N	173°02'E	Kizan maru	14-VII	F	2	743	4275	36.3	N
49°44'N	173°18'E	Kizan maru	14-VII	F	2	764	4225	30.35	N
49°29'N	173°23'E	Jinyo maru	8-VII	M	2	796	5200	21.1	N
49°44'N	173°26'E	Kizan maru	14-VII	F	2	749	4400	46.5	N
49°20'N	173°51'E	Nojima maru	30-VI	F	2	730	4380	36.75	N
49°20'N	173°51'E	Kizan maru	13-VII	M	2	7.78	42.75	2.5	N
49°20'N	173°54'E	Kizan maru	12-VII	F	2	732	4100	48.75	N
49°45'N	173°58'E	Jinyo maru	8-VII	M	2	782	5000	7.4	N
49°30'N	173°58'E	Kizan maru	14-VII	F	2	738	4125	38.8	N
49°20'N	174°02'E	Kizan maru	12-VII	F	2	716	4375	44.5	N
49°20'N	174°02'E	Kizan maru	12-VII	F	3	769	4275	32.1	N
49°20'N	174°05'E	Nojima maru	30-VI	M	2	795	5505	13.7	N
49°33'N	174°10'E	Kizan maru	12-VII	F	2	729	4475	37.8	N
49°33'N	174°10'E	Kizan maru	12-VII	F	2	741	4075	41.7	N
49°20'N	174°11'E	Nojima maru	23-VI	M	2	771	4435	7.9	N
49°29'N	174°12'E	Jinyo maru	8-VII	F	2	763	5250	36.25	N
50°08'N	174°15'E	Kizan maru	13-VII	M	2	694	4225	30.9	N
49°52'N	174°15'E	Kizan maru	10-VII	M	2	806	5925	9.0	N
49°20'N	174°15'E	Kizan maru	13-VII	M	2	711	5450	5.0	N
49°29'N	174°22'E	Kizan maru	11-VII	M	2	822	5850	5.85	N
50°08'N	174°23'E	Kizan maru	10-VII	M	2	810	6000	34.2	N
46°29'N	174°29'E	Shin Riasu	2-VII	M	2	708	3300	1.4	N
49°29'N	174°30'E	Kizan maru	11-VII	M	2	790	4750	22.4	N
45°31'N	174°30'E	Shin Riasu	2-VII	F	--	780	5300	--	N
45°31'N	174°30'E	Shin Riasu	2-VII	F	2	733	4030	39.5	N
50°08'N	174°31'E	Kizan maru	10-VII	M	2	795	5275	6.1	N
49°20'N	174°31'E	Kizan maru	13-VII	F	2	747	3700	35.6	N
49°20'N	174°31'E	Kizan maru	13-VII	M	2	787	4800	40.25	N
43°33'N	174°32'E	Shin Riasu	29-VI	F	2	659	2810	16.6	N
43°33'N	174°32'E	Shin Riasu	29-VI	F	2	650	2840	4.2	N

Appendix 7. (cont.)

Locality of capture: Latitude	Longitude	Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
49°52'N	174°42'E	Jinyo maru	7-VII	M	--	818	5850	14.65	N
49°20'N	174°42'E	Kizan maru	12-VII	M	3	794	4950	3.75	N
49°57'N	177°30'E	Iwaki maru	1-VII	M	2	812	5320	--	N
49°57'N	177°30'E	Iwaki maru	1-VII	--	2	702	4125	--	N
49°57'N	177°30'E	Iwaki maru	1-VII	M	2	736	4190	1.39	N
49°57'N	177°30'E	Iwaki maru	1-VII	M	2	776	5120	4.29	N
47°52'N	177°32'E	Iwaki maru	2-VII	M	2	762	4000	1.49	N
47°52'N	177°32'E	Iwaki maru	2-VII	M	2	722	4205	2.15	N
44°50'N	177°32'W	Iwaki maru	12-VI	M	2	678	2895	--	N
44°50'N	177°32'W	Iwaki maru	12-VI	M	2	687	2945	2.41	N
44°50'N	177°32'W	Iwaki maru	12-VI	F	2	700	3085	13.77	N
44°50'N	177°32'W	Iwaki maru	12-VI	F	2	670	2580	14.72	N
44°50'N	177°32'W	Iwaki maru	12-VI	F	2	682	2410	--	N
44°50'N	177°32'W	Iwaki maru	12-VI	F	2	613	2000	14.5	N
44°50'N	177°32'W	Iwaki maru	12-VI	F	2	682	2845	14.15	N
43°49'N	177°31'W	Iwaki maru	11-VI	F	2	680	3370	--	N
43°18'N	177°31'W	Iwaki maru	10-VI	F	2	644	2520	2.15	N
43°18'N	177°31'W	Iwaki maru	10-VI	M	2	722	3475	0.47	N
43°18'N	177°31'W	Iwaki maru	10-VI	--	1	477	1300	--	N
43°18'N	177°31'W	Iwaki maru	10-VI	F	2	743	3880	18.11	N
48°55'N	177°30'W	Iwaki maru	18-VI	F	2	668	2750	32.1	N
47°57'N	177°30'W	Iwaki maru	17-VI	F	2	660	3070	18.0	N
47°57'N	177°30'W	Iwaki maru	17-VI	M	3	748	4150	9.37	N
47°57'N	177°30'W	Iwaki maru	17-VI	M	2	751	4640	5.5	N
46°55'N	177°30'W	Iwaki maru	15-VI	--	2	727	3535	--	N
46°55'N	177°30'W	Iwaki maru	15-VI	F	4	750	4500	5.98	N
46°55'N	177°30'W	Iwaki maru	15-VI	F	2	653	2170	3.68	N
46°55'N	177°30'W	Iwaki maru	15-VI	M	3	--	--	6.93	N
46°55'N	177°30'W	Iwaki maru	15-VI	F	2	681	2900	17.42	N
46°55'N	177°30'W	Iwaki maru	15-VI	--	2	702	3180	--	N
45°52'N	177°30'W	Iwaki maru	13-VI	M	2	747	3420	1.31	N
45°52'N	177°30'W	Iwaki maru	13-VI	F	2	698	3500	3.58	N
45°52'N	177°30'W	Iwaki maru	13-VI	--	2	683	3315	3.15	N
45°52'N	177°30'W	Iwaki maru	13-VI	F	2	600	1850	0.69	N
45°52'N	177°30'W	Iwaki maru	13-VI	F	2	747	4175	25.64	N
45°52'N	177°30'W	Iwaki maru	13-VI	F	2	693	2755	11.36	N
45°52'N	177°30'W	Iwaki maru	13-VI	F	2	644	2360	6.64	N
42°30'N	177°30'W	Iwaki maru	9-VI	M	2	722	3510	7.61	N
42°30'N	177°30'W	Iwaki maru	9-VI	--	1	538	1510	--	N
42°30'N	177°30'W	Iwaki maru	9-VI	M	1	557	1370	0.97	N
42°30'N	177°30'W	Iwaki maru	9-VI	--	2	661	2370	--	N

Appendix 7. (cont.)

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[b]	Identifying Parasites[c]
Latitude	Longitude								
42°30'N	177°30'W	Iwaki maru	9-VI	--	1	570	1665	--	N

[a] Fork length and body weight determined at time of capture.

[b] Gonad weight determined from post-thawed fish at the Fisheries Research Institute.

[c] N= *Nanophyetus salmincola.*

Appendix 8. Distribution, biological data, and identifying parasites for steelhead caught in 1987 that were identified by parasitic infection as being of U.S. Pacific Northwest origin.

Locality of capture		Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[a]	Identifying Parasites[b]
Latitude	Longitude								
43°21'N	167°29'E	Kaiun maru	12-VI	F	2	752	4800	15	N
45°30'N	171°30'E	Hokuho maru	21-VI	F	1	564	1640	4	N
42°30'N	171°30'E	Hokuho maru	24-VI	M	1	594	2180	3	N
45°31'N	172°14'E	Kaiun maru	5-VII	M	X	640	2950	1	N
45°31'N	172°14'E	Kaiun maru	5-VII	M	1	578	2200	2	N
45°31'N	172°14'E	Kaiun maru	5-VII	M	2	766	3650	1	N
45°31'N	172°14'E	Kaiun maru	5-VII	M	2	796	4800	1	N
44°42'N	172°25'E	Kaiun maru	6-VII	F	X	626	2950	40	N
44°42'N	172°25'E	Kaiun maru	6-VII	F	1	548	2000	47	N
44°42'N	172°25'E	Kaiun maru	6-VII	M	2	796	4500	3	N
47°25'N	172°30'E	Kaiun maru	2-VII	F	2	744	4100	36	N
46°23'N	172°41'E	Kaiun maru	4-VII	M	2	718	3700	1	N
46°23'N	172°41'E	Kaiun maru	4-VII	F	2	730	3750	43	N
46°23'N	172°41'E	Kaiun maru	4-VII	F	X	800	5000	46	N
46°23'N	172°41'E	Kaiun maru	4-VII	M	X	720	3700	2	N
46°23'N	172°41'E	Kaiun maru	4-VII	F	2	735	4100	25	N
43°31'N	173°30'E	Hokuho maru	15-VI	F	2	732	4400	60	N
41°32'N	176°31'E	Shin Riasu maru	8-VI	F	2	634	2870	10	N
43°49'N	177°16'E	Hokushin maru	23-VI	F	1	588	2050	3	N
43°49'N	177°16'E	Hokushin maru	23-VI	M	1	583	2000	1	N
43°49'N	177°16'E	Hokushin maru	23-VI	F	2	698	3500	65	N
42°46'N	177°29'E	Hokushin maru	24-VI	F	1	603	2400	10	N
42°46'N	177°29'E	Hokushin maru	24-VI	F	1	562	1980	6	N
42°46'N	177°29'E	Hokushin maru	24-VI	F	2	710	3350	26	N
44°47'N	177°30'E	Hokushin maru	22-VI	F	X	554	1540	3	N
44°47'N	177°30'E	Hokushin maru	22-VI	F	2	724	3000	5	N
46°29'N	177°36'E	Hokushin maru	20-VI	F	2	716	3650	40	N
46°29'N	177°36'E	Hokushin maru	20-VI	F	2	668	3000	22	N
46°29'N	177°36'E	Hokushin maru	20-VI	F	2	678	2900	23	N
46°29'N	177°36'E	Hokushin maru	20-VI	F	X	741	3850	33	N
46°29'N	177°36'E	Hokushin maru	20-VI	M	2	750	4100	56	N
46°29'N	177°36'E	Hokushin maru	20-VI	F	2	692	3500	20	N
46°29'N	177°36'E	Hokushin maru	20-VI	M	3	746	4000	1	N
45°12'N	177°36'E	Hokushin maru	21-VI	M	2	765	4100	6	N
45°12'N	177°36'E	Hokushin maru	21-VI	M	2	736	4600	5	N
45°12'N	177°36'E	Hokushin maru	21-VI	M	2	718	3850	15	N
45°12'N	177°36'E	Hokushin maru	21-VI	M	2	736	3400	3	N
41°32'N	178°32'E	Shin Riasu maru	10-VI	M	2	820	5150	3	N
41°30'N	178°30'W	Shin Riasu maru	11-VI	M	2	586	1420	8	N

Appendix 8. (cont.)

Locality of capture Latitude	 Longitude	Vessel	Date of capture	Sex	Ocean Age	Length[a]	Weight[a]	Gonad Weight[a]	Idenifying Parasites[b]
43°50'N	177°41'W	Hokushin maru	28-VI	M	1	547	1650	4	N
43°50'N	177°41'W	Hokushin maru	28-VI	M	2	742	3500	4	N
43°50'N	177°41'W	Hokushin maru	28-VI	F	2	704	3000	17	N
43°50'N	177°41'W	Hokushin maru	28-VI	M	X	606	2100	12	N
45°49'N	177°39'W	Hokushin maru	30-VI	F	X	690	3100	33	N
45°49'N	177°39'W	Hokushin maru	30-VI	F	2	665	2800	19	N
45°49'N	177°39'W	Hokushin maru	30-VI	M	3	758	4100	8	N
45°49'N	177°39'W	Hokushin maru	30-VI	F	2	638	2350	14	N
45°49'N	177°39'W	Hokushin maru	30-VI	F	2	688	2800	30	N
45°49'N	177°39'W	Hokushin maru	30-VI	F	3	712	3300	29	N
47°47'N	177°37'W	Hokushin maru	4-VII	F	2	708	3700	43	N
47°47'N	177°37'W	Hokushin maru	4-VII	M	X	710	2900	7	N
47°47'N	177°37'W	Hokushin maru	4-VII	F	2	714	3200	26	N
47°47'N	177°37'W	Hokushin maru	4-VII	M	2	700	3350	22	N
47°47'N	177°37'W	Hokushin maru	4-VII	F	2	668	3050	23	N
47°47'N	177°37'W	Hokushin maru	4-VII	M	2	671	2700	2	N
47°47'N	177°37'W	Hokushin maru	4-VII	F	2	730	3750	54	N
47°47'N	177°37'W	Hokushin maru	4-VII	M	1	596	2200	2	N
47°47'N	177°37'W	Hokushin maru	4-VII	M	3	740	3550	3	N
47°47'N	177°37'W	Hokushin maru	4-VII	F	2	695	3350	45	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	738	3950	6	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	728	3600	39	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	647	2450	7	N
44°43'N	177°37'W	Hokushin maru	29-VI	M	X	584	2000	2	N
44°43'N	177°37'W	Hokushin maru	29-VI	M	1	624	2460	3	N
44°43'N	177°37'W	Hokushin maru	29-VI	M	2	678	2800	18	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	700	2900	29	N
44°43'N	177°37'W	Hokushin maru	29-VI	M	1	588	2100	3	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	680	2650	41	N
44°43'N	177°37'W	Hokushin maru	29-VI	F	2	688	2900	31	N
46°50'N	177°30'W	Hokushin maru	2-VII	F	2	697	3100	31	N
46°50'N	177°30'W	Hokushin maru	2-VII	M	2	675	2900	5	N
46°50'N	177°30'W	Hokushin maru	2-VII	M	3	802	5200	7	N
46°50'N	177°30'W	Hokushin maru	2-VII	F	3	803	6100	47	N
42°54'N	177°21'W	Hokushin maru	27-VI	M	3	764	3900	7	N
42°54'N	177°21'W	Hokushin maru	27-VI	M	1	575	1900	2	N
42°54'N	177°21'W	Hokushin maru	27-VI	F	2	662	2500	36	N
42°54'N	177°21'W	Hokushin maru	27-VI	M	1	580	1900	6	N
41°32'N	176°15'W	Shin Riasu maru	12-VI	M	1	606	2320	1	N
42°30'N	173°31'W	Shin Riasu maru	12-VI	F	1	580	2000	7	N

Appendix 8. (cont.)

Locality of capture		Vessel	Date of capture	Sex	Ocean age	Length[a]	Weight[a]	Gonad Weight[a]	Identifying Parasites[b]
Latitude	Longitude								
42°30'N	173°31'W	Shin Riasu maru	12-VI	M	1	572	1820	1	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	M	1	558	1800	3	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	M	2	564	1880	1	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	M	1	5900	1800	1	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	F	2	684	2850	46	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	M	1	562	1960	1	N
42°30'N	173°31'W	Shin Riasu maru	13-VI	M	2	714	3020	1	N
44°36'N	173°28'W	Shin Riasu maru	14-VI	F	2	743	3800	20	N
44°36'N	173°28'W	Shin Riasu maru	15-VI	F	1	544	1700	3	N
44°36'N	173°28'W	Shin Riasu maru	15-VI	M	1	556	--	1	N
43°36'N	173°28'W	Shin Riasu maru	13-VI	F	2	614	2200	7	N
43°36'N	173°28'W	Shin Riasu maru	13-VI	M	2	536	2200	--	N
43°36'N	173°28'W	Shin Riasu maru	13-VI	M	1	569	1920	1	N
43°36'N	173°28'W	Shin Riasu maru	14-VI	F	1	555	1700	10	N
43°36'N	173°28'W	Shin Riasu maru	14-VI	F	1	594	1820	15	N
43°36'N	173°28'W	Shin Riasu maru	14-VI	F	2	657	2750	23	N

[a] Fork length, body weight, and gonad weight determined at time of capture.

[b] N= *Nanophyetus salmincola*.