# Parasite Analysis of Native and Non-native Fish in the Angeles National Forest

**2001 Final Report**

**Prepared for:**

## U.S. Forest Service, Angeles National Forest

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

# Parasite Analysis of Native and Non-native Fish in the Angeles National Forest

By Manna Warburton[1], Boris Kuperman[2], Victoria Matey[2], and Robert Fisher[1]

---

U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

## 2001 Final Report

Prepared for:

U.S. Forest Service, Angeles National Forest

[[1]San Diego Field Station
USGS Western Ecological Research Center
5745 Kearny Villa Road, Suite M
San Diego, CA 92123]

[[2]Center for Inland Waters
Biology Department
San Diego State University
5500 Campanile Drive
San Diego, CA 92182]

San Diego, California
2002

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, SECRETARY

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director



---

For additional information, contact:

Center Director
Western Ecological Research Center
U.S. Geological Survey
7801 Folsom Blvd., Suite 101
Sacramento, CA 95826

# Introduction

Southern California is a region of strong biological contrasts in aquatic environments. We possess a highly depauperate and endemic native fauna (Moyle, 2002), and a correspondingly diverse exotic fauna. Over the last century California waterways have been exposed to over 140 different exotic fish species, 58 of which have successfully reproducing populations in the state (Swift et al. 1993; Dill & Cordone, 1997). There has been much debate regarding the net good or bad caused by such introductions, however little attention has been paid to the invisible riders accompanying these exotic fish and the unintended and less observable effects of their introduction. These invisible riders are the parasite and disease fauna of the numerous exotic fish species that have been and continue to be introduced throughout the state (Lafferty, 1997).

In an attempt to explore the status and distribution of the introduced parasite fauna of both exotic and native fishes on forest service land, we sampled fishes from 3 watersheds draining the Angeles National Forest. Funding from the Angeles National Forest contributed to a portion of a larger study that covers 13 watersheds from the Santa Clara River to the Tijuana River (Table 1). In this report we highlight our findings in the Angeles National Forest but are also making available our larger dataset which includes information from all watersheds surveyed.

Potential consequences of the presence of specific parasite species in waterways on forest land include but are not limited to: elimination or degradation of fisheries resources through fish kills and reduction in aesthetic value of catchable animals, elimination or degradation of native aquatic resources and hindrance of conservation and restoration efforts in aquatic environments. Fish kills of unarmored threespine stickleback due to white spot disease (an extremely virulent hatchery disease) have been reported from San Francisquito Canyon as early as 1995 (Chen, 1995). Most native parasite species are not capable of the effects described above, and such effects are generally attributed to a short list of parasites classified as commercially significant, all of which would be considered to be exotic or alien species within the Angeles National Forest.

# Methods

Fish sampling methods consisted of multiple seine hauls at multiple locations within each study site using a 3 meter by 1.2 meter net with 3 mm mesh. Dip netting was employed to supplement seine hauls when appropriate. Dip nets were also 3 mm mesh size. Efforts were sustained until approximately 20 individuals of each species detected (not including T&E species) had been collected from a study location. In certain circumstances when we were unable to collect 20 individuals of a given species from a single location, parasite analysis was conducted on lower numbers of specimens. Information from specimens included in this report were collected from December 5$^{th}$ 2000 to February 6$^{th}$ of 2002.

Specimens were transported live to the Biology Department of San Diego State University where they were examined for parasites. Parasite examination of all specimens included examination of fins, skin, gills, body cavity and major organs. Only live or freshly caught fish were examined. The fish was measured (standard length in cm.), and any wounds, deformities, scale abnormalities and tumors were noted.

***External examination:***

Visual analysis was followed by a microscopic examination of mucus scrapings for parasitic protozoans. Body surface and eyes were examined visually and under the dissecting microscope for parasitic protozoans, crustaceans and monogeneans. The nasal cavities were irritated and resultant fluid was examined under the dissecting microscope. The fins, tail, and gills were examined visually and under the dissecting microscope followed by an examination under a compound microscope for parasitic protozoans, monogeneans and crustaceans. All parasitic organisms found were collected, identified and counted separately. Parasites selected for light microscopy (LM) and scanning electron microscopy (SEM) were fixed in appropriate fixative solutions.

***Internal examination:***

Following visual examination, each fish was examined for internal parasites. First, the body cavity was opened and examined visually. Internal organs such as heart, liver, spleen, kidneys, gonads, gall bladder and swim bladder were dissected out, placed in separate containers and than dissected and examined using dissecting and compound microscopes. The gastrointestinal tract was removed, split from mouth to rectum and examined for parasites in the lumen and attached to the walls. All helminthes were collected, counted, examined with a dissecting and compound microscopes, and than fixed for LM and SEM.

Identification of parasites was based on the LM and SEM data. Specimens selected for LM were fixed in 70 % ethanol, AFA, or 5% formalin, stained with hematoxylin, and examined with a Diastar microscope. Specimens of protozoans and helminths selected for SEM, were fixed in Karnovsky's solution, processed according to standard methods, and examined with a Hitachi S-2700 scanning electron microscope.

Prevalence, mean intensity, abundance and infection sites for each parasite were determined for each species of parasite.

# Results

***Results at All Sites:***

In examinations of 21 fish species consisting of 1933 individual specimens from 13 watersheds we detected at least 23 parasite species, 4 of which were confirmed to be exotic species of commercial significance.

***Results at Angeles Forest Sites:***

In examinations of 11 fish species from three watersheds (Table 2) we detected at least 9 separate parasite species (Table 3), many of which were native and only identifiable to family or genus. Due to the variable numbers of specimens and species captured at sample locations, no conclusions regarding the absence of a given parasite species within a drainage were inferred.

Three commercially significant parasites were detected by our surveys and they are the Asian tapeworm (*Bothriocephalus acheliognathi*), white spot disease (*Ichthiopterious sp.*), and anchor-worm (*Lernea sp.*). The Asian tapeworm was detected in the Los Angeles river at two localities (Haines Creek: infecting mosquitofish, fathead minnows and arroyo chub, Big Tujunga Creek: infecting arroyo chub) and in the Santa Clara River at one locality (San Francisquito Canyon: infecting mosquitofish). White spot disease was detected in the Los Angeles River at two localities (Haines Creek, Big Tujunga Creek: infecting arroyo chub at both locations), in the Santa Clara River at one locality (San Francisquito Canyon: infecting unarmored threespine stickleback and arroyo chub) and in the San Gabriel River at three localities (San Gabriel River, East Fork: infecting speckled dace, West Fork: infecting speckled dace, Robert's Canyon: infecting arroyo chub). Anchor-worm was detected in the Los Angeles River at one locality (Big Tujunga Creek: infecting arroyo chub, fathead minnows, rainbow trout) and the Santa Clara River at one locality (San Francisquito Creek: infecting goldfish, green sunfish, unarmored threespine stickleback and arroyo chub).

## Discussion

Because of the extremely diverse parasite fauna, and the difficulty of identifying certain parasitic organisms during detected life stages, we were not always able to classify parasites as exotic or native, and indeed, some parasite species detected have extremely cosmopolitan distributions, further complicating the issue of classification.

Three parasite species readily identifiable as exotic stand out as important because of their commercial significance and prior classification as hatchery diseases. These were the Asian tapeworm, white spot disease, and anchor worm. For a disease to reach commercial significance, it has to be capable of destroying or reducing the value of commercial products of resources like fish hatcheries, commercial fisheries and public fisheries (Meyer and Barclay, 1990). These three diseases can be considered to be virulent, destructive threats to any fisheries or wildlife conservation resources they are present in. Any hatcheries associated with the watersheds covered by this study may be vulnerable to infection through water taken from these systems, and may also be acting as sources for re-infection into the natural systems if the parasites are already present in the hatchery. Sensitive native species infected by these three parasites included speckled dace, arroyo chub and unarmored threespine stickleback. Furthermore, white spot disease was detected in the San Gabriel drainage, and although we were unable to sample Santa Ana suckers from the San Gabriel or Big Tujunga drainages, they have been exposed and are likely subjects for infection by the disease. The "big three" diseases (white spot disease, Asian tapeworm, anchorworm) were found in the San Gabriel River, Los Angeles River, San Jacinto River, and the Santa Clara River but were absent from tributaries of the Santa Ana River. Of the "big three", white spot was not detected at all in the Santa Ana River, and the Asian tapeworm and anchorworm appeared to be restricted to the main drainage as well. In spite of the widespread nature of these parasites, actual die-offs that could be attributed to them were only observed in San Francisquito Canyon in the Santa Clara watershed.

A looming question posed by the presence of these parasites in forest drainages is the means of their initial introduction. It is important to identify potential routes of introduction because natural stochastic events may eliminate or reduce parasites from locations where they currently are in high prevalence. By preventing re-introduction, we may slow the spread or even contribute to the eventual elimination of these noxious pests from forest drainages. Potential sources of historic introduction, reintroduction, and potential future introductions of novel species include: legal stocking of infected animals (e.g. bait minnows, game fish, vector control), illegal human transport of infected animals between waterways, unintentional stocking of waterways by parasites or infected host organisms through water diversions and transfers (i.e. Los Angeles Aqueduct transfers of largemouth bass, green sunfish and carp) and illegal release of infected pet animals into natural waterways (i.e. presence of pet goldfish in San Francisquito and Bouquet Canyons).

## Management Recommendations

Watersheds were defined as separate drainages reaching the ocean. For the purpose of managing watersheds for parasite concerns, wetted portions within a watershed must be considered to be connected, as fish may use periods of high rainfall or flood events to spread within a watershed, taking their parasite fauna with them. Although beyond the scope of this study, limited connectivity may even exist between watersheds for anadromous species such as Steelhead/Rainbow trout. Furthermore, the diverse life history of some parasites detected allow for ready colonization of available habitat downstream, or even across watersheds through avian intermediate hosts.

There is a need to prevent continued introduction of noxious pest parasite species into waterways on forest service land. These waterways represent valuable sport fisheries as well as critical aquatic conservation resources whose value may be compromised by the introduction or spread of these parasite species.

The primary means of prevention should come through education. When private citizens are educated as to the dangers of moving organisms from place to place or introducing pet organisms into wilderness environments, the number of such introductions (potentially the majority of novel parasite introductions) will be reduced.

Prevention may also come through enforcing pathogen assay standards that would detect and bar introduction of stock animals that were infected with these parasites. This would help in remote areas where fish stocking is the primary anthropogenic influence on the fish community. Pathogen assays are relatively inexpensive and can be performed rapidly by technicians with appropriate training. When weighed against the potential damage that these diseases are capable of, disease assays prior to stocking are a relatively cost effective procedure.

Reducing the spread of exotic parasite species in southern California waterways is extremely important for conservation efforts linked to the recovery of threatened and endangered species including Santa Ana suckers, speckled dace, unarmored threespine stickleback, and southern steelhead trout. White spot disease appears to be concentrated in areas where these species occur and could be compromising recovery or leading to declines of the aforementioned species. White spot disease has been detected in areas where California red-legged frogs occur, and its effects on this sensitive native amphibian are unknown. Any future recovery plans for these species need to take into account the current disease status of known populations, as well as the distribution of exotic diseases in current and potential habitat.

In closing, there is a continued need to explore the temporal and spatial extent of commercially significant parasites throughout the waterways of southern California. Our current work has revealed a great deal of information even in the limited range our surveys were conducted in. However there are still gaps in the current knowledge base that could be filled by more directed studies in the future. These gaps include prevalence and intensity of parasites across seasons, ecological impacts of these parasites on sensitive native fishes, as well as the full extent of parasite distribution throughout southern California waterways.

**Literature Cited:**

Chen, M. F. 1995. Fish Pathology Report, San Francisquito Canyon 9/19/1995. California Department of Fish and Game.

Dill, W.A., and A.J. Cardone. 1997. History and Status of introduced fishes in California, 1871-1996. CDFG Bull. 178. 414 pp.

Lafferty, K. D. 1997. Environmental parasitology: what can parasites tell us about human impacts on the environment? Parasitology Today 13: 251-255.

Meyer, F. P. and L. A. Barclay. 1990. Field manual for the investigation of fish kills. U.S. Fish and Wildlife Service. 120pp.Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Berkeley CA. 502 pp.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bull. S. Calif. Acad. Sci. 92(3):101-167.

**Appendix:**

# Table 1 - Study Sites throughout southern California 2000-2002:

| **Watershed** | **Site Name** | | **# of species (# of specimens)** |
|---|---|---|---|
| **Los Angeles*** | | | |
| | **Big Tujunga Creek** | | **3(78)** |
| | **Haines Creek** | | **4(100)** |
| Otay | | | |
| | Hollenbeck Canyon | | 1(20) |
| | Rancho Jamul Kiln Pond | 1(16) | |
| | Rancho Jamul Pump Pond | 4(37) | |
| Salton Sea | | | |
| | Alamo River | | 1(94) |
| | San Felipe Creek | 1(14) | |
| | Trifolium drain | | 2(12) |
| | White Creek | | 2(37) |
| San Dieguito | | | |
| | Santa Ysabel Creek | | 1(20) |
| San Diego | | | |
| | San Diego River near Santee | | 1(18) |
| **San Gabriel*** | | | |
| | **Roberts Canyon** | **1(17)** | |
| | **San Gabriel River, East Fork** | | **2(16)** |
| | **San Gabriel River, North Fork** | | **2(10)** |
| | **San Gabriel River, West Fork** | | **2(30)** |
| San Jacinto | | | |
| | San Jacinto Wash | | 2(51) |
| San Juan | | | |
| | Arroyo Trabuco | | 1(10) |
| | Bell Canyon | | 2(76) |
| | San Juan Creek | | 1(24) |
| San Mateo | | | |
| | Los Alamos Creek | | 1(7) |
| | San Mateo Creek | 4(73) | |
| Santa Ana | | | |
| | Cajon Wash | | 1(15) |
| | City Creek, West Fork | | 2(23) |
| | Lytle Creek | | 2(16) |
| | Plunge Creek | | 2(18) |
| | Santa Ana River (MWDC) | 5(174) | |
| | Santa Ana River below Prado Dam | 10(225) | |
| | Strawberry Creek | 1(4) | |
| | Sugarloaf Meadow Pond | 1(33) | |
| | Santiago Creek above Santiago Reservoir | 1(20) | |
| | Santiago Creek at Modjeska | | 1(20) |
| **Santa Clara*** | | | |
| | **Bouquet Canyon Creek** | **3(56)** | |
| | **Lake Elizabeth Canyon Creek** | | **1(30)** |
| | **San Francisquito Creek, Dam Reach** | | **4(197)** |
| | **San Francisquito Creek, Drinkwater Reach** | | **1(20)** |
| | **San Francisquito Creek, Womens Club** | **2(103)** | |
| | **Santa Clara River** | | **2(22)** |
| Santa Margarita | | | |
| | Murietta Creek at USGS stream gage | | 2(63) |
| | Rainbow Creek | | 2(21) |
| | Santa Margarita River at the gorge | 5(103) | |
| Sweetwater | | | |
| | Sweetwater River at R. Cuyamaca State Park | | 2(10) |

***Study Sites in the Angeles National forests are listed in bold**

# Table 2: Fish Species Detected on the Angeles National Forest

| | | Watershed | Los Angeles | | San Gabriel | | | | Santa Clara | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species Origin** | **Common Name** | **Species** | **Big Tujunga Creek** | **Haines Creek** | **Roberts Canyon** | **San Gabriel River, East Fork** | **San Gabriel River, North Fork** | **San Gabriel River, West Fork** | **Bouquet Canyon Creek** | **Lake Elizabeth Canyon Creek** | **San Francisquito Creek, Dam Reach** | **San Francisquito Creek, Drinkwater Reach** | **San Francisquito Creek, Womens Club** | **Santa Clara River** | **# of Species Detected** |
| **Exotic** | Fathead Minnow | *Pimephales promelas* | 1 | 1 | | | | | | | | | | | 2 |
| | Goldfish | *Carassius auratus* | | | | | | | 1 | | 1 | | | | 2 |
| | Green Sunfish | *Lepomis cyanellus* | | | | | | | | | 1 | | | | 1 |
| | Largemouth Bass | *Micropterus salmoides* | | 1 | | 1 | | | | | | | | | 2 |
| | Mosquitofish | *Gambusia affinis* | | 1 | | | | | | | 1 | | 1 | | 3 |
| **Exotic Total** | | | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 10 |
| **Native** | Arroyo Chub | *Gila orcutti* | 1 | 1 | 1 | | | | | 1 | 1 | 1 | 1 | 1 | 8 |
| | Partially Armored Threespine Stickleback | *Gasterosteus aculeatus microcephalus* | | | | | | | 1 | | | | | | 1 |
| | Rainbow Trout | *Oncorhynchus mykissi (hatchery stock)* | 1 | | | | 1 | 1 | 1 | | | | | | 4 |
| | Santa Ana Sucker | *Catostomus santaanae* | | | | | | | | | | | | 1 | 1 |
| | Speckled Dace | *Rhinichthys osculus* | | | | 1 | 1 | 1 | | | | | | | 3 |
| | Unarmored Threespine Stickleback | *Gasterosteus aculeatus williamsoni* | | | | | | | | | 1 | | | | 1 |
| **Native Total** | | | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 18 |

# Table 3: Fish Parasite Species Detected on the Angeles National Forest

| | | Watershed | Los Angeles | | San Gabriel | | | | Santa Clara | | | | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parasite Origin | Family | Parasite | Big Tujunga Creek | Haines Creek | Roberts Canyon | San Gabriel River, East Fork | San Gabriel River, North Fork | San Gabriel River, West Fork | Bouquet Canyon Creek | Lake Elizabeth Canyon Creek | San Francisquito Creek, Dam Reach | San Francisquito Creek, Drinkwater Reach | San Francisquito Creek, Womens Club | Santa Clara River | |
| **exotic** | Cestoda | *Bothriocephalus acheilognathi* | 1 | 1 | | | | | | | 1 | | 1 | | 4 |
| | Copepoda | *Lernaea cyprinacea* | 1 | | | | | | | | 1 | | 1 | | 3 |
| | Oligohymenophorea (ciliates) | *Ichthyophthirius multifiliis* | 1 | 1 | 1 | 1 | | 1 | | | 1 | | | | 6 |
| **exotic Total** | | | 3 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 0 | 2 | 0 | 13 |
| **unknown** | Monogenea | *Gyrodactylus sp.* | | | | | | | | | 1 | 1 | 1 | | 3 |
| | | *Urocleidus sp.* | | | | | | | | | 1 | | 1 | | 2 |
| | Nematoda | *Contracaecum sp.* | | 1 | | 1 | | | | | | | | | 2 |
| | | *Rhabdochona canadensis* | | | | | | | | | 1 | 1 | | | 2 |
| | | *Rhabdochona cascadilla* | | | | | | 1 | | | | | | | 1 |
| | | *Rhabdochona sp.* | | | | | 1 | | | | | | | | 1 |
| | Oligohymenophorea (ciliates) | *Trichodina sp.* | | | | | | | | | 1 | | | | 1 |
| | Trematoda | *Crepidostomum farionis* | | | | | | 1 | 1 | | | | | | 2 |
| | | *Posthodiplostomum minimum* | 1 | | | | | | | | | | | | 1 |
| | | *trematode sp.* | | | | | | | | | 1 | | | | 1 |
| | | *Uvulifer ambloplitis* | | | | | | | | | 1 | | 1 | | 2 |
| **unknown Total** | | | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 6 | 2 | 3 | 0 | 18 |
| **Grand Total** | | | 4 | 3 | 1 | 2 | 1 | 3 | 1 | 0 | 9 | 2 | 5 | 0 | 31 |

# Table 4: Fish Parasite Species Detected in Southern California

| | | Watershed | Los Angeles | | Otay | | | Salton Sea | | | | San Dieguito | San Diego | San Gabriel | | | | San Jacinto | San Juan | | | San Mateo | | Santa Ana | | | | | | | | | | Santa Clara | | | | | | Santa Margarita | | | Sweetwater | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parasite Origin | Family | Parasite | Big Tujunga Creek | Haines Creek | Hollenbeck Canyon | Rancho Jamul Kiln Pond | Rancho Jamul Pump Pond | Alamo River | San Felipe Creek | Trifolium drain | White Creek | Santa Ysabel Creek | San Diego River near Santee | Roberts Canyon | San Gabriel River, East Fork | San Gabriel River, North Fork | San Gabriel River, West Fork | San Jacinto Wash | Arroyo Trabuco | Bell Canyon | San Juan Creek | Los Alamos Creek | San Mateo Creek | Cajon Wash | City Creek, West Fork | Lytle Creek | Plunge Creek | Santa Ana River (MWDC) | Santa Ana River below Prado Dam | Santiago Creek above Santiago Reservoir | Santiago Creek at Modjeska | Strawberry Creek | Sugarloaf Meadow Pond | Bouquet Canyon Creek | Lake Elizabeth Canyon Creek | San Francisquito Creek, Dam Reach | San Francisquito Creek, Drinkwater Reach | San Francisquito Creek, Womens Club | Santa Clara River | Murietta Creek at USGS stream gage | Rainbow Creek | Santa Margarita River at the gorge | Sweetwater River at Rancho Cuyamaca State Park | |
| **Exotic** | Cestoda | Bothriocephalus acheilognathi | 1 | 1 | | | 1 | | | 1 | 1 | | | | | | | 1 | 1 | | 1 | | | | | | | 1 | 1 | | | | | | | 1 | | 1 | | 1 | 1 | 1 | | 15 |
| | | Bothriocephalus cuspidatus | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 2 |
| | Copepoda | Lernaea cyprinacea | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | 1 | | 1 | | | | | | 5 |
| | Oligohymenophorea (ciliates) | Ichthyophthirius multifiliis | 1 | 1 | | | | | | | | | | 1 | 1 | | 1 | | 1 | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 | 8 |
| **Exotic Total** | | | 3 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 30 |
| **Unknown** | Acanthocephala | Acanthocephalus sp. | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 2 |
| | Arachnida | acarina | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | Cestoda | Caryophyllaeus sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 1 |
| | | Corralobothrium sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 1 |
| | | Proteocephalus sp. | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 2 |
| | Copepoda | Ergasilus sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | Monogenea | Dactylogyrus sp. | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 1 | | | | | | | | | | | | | 1 | | 3 |
| | | Gyrodactylus olsoni | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | Gyrodactylus sp. | | | 1 | | 1 | | 1 | | | | | | | | | 1 | | 1 | | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | 1 | 1 | | | 1 | 1 | | 19 |
| | | monogenean sp. | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 2 |
| | | Urocleidus sp. | | | | 1 | 1 | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | 7 |
| | Nematoda | Contracaecum sp. | | 1 | | 1 | | | | 1 | | | | | 1 | | | | | | | | 1 | | | | | 1 | 1 | | | | | | | | | | | | | 1 | | 8 |
| | | Nematode sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | Rhabdochona canadensis | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 | 1 | | | | | | | 3 |
| | | Rhabdochona cascadilla | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 2 |
| | | Rhabdochona sp. | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | Oligohymenophorea (ciliates) | Epistylis sp. | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | | Trichodina sp. | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 2 |
| | Trematoda | Crepidostomum cooperi | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| | | Crepidostomum farionis | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | 1 | 4 |
| | | Echinochasmus sp. | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| | | Posthodiplostomum minimum | 1 | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | 1 | 1 | | | | | | | | | | | | | | | 5 |
| | | Posthodiplostomum sp. | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | 1 | | 5 |
| | | trematode sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 |
| | | Uvulifer ambloplitis | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | 1 | | | | | | 3 |
| **Unknown Total** | | | 1 | 1 | 1 | 2 | 6 | 1 | 2 | 2 | 4 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 5 | 1 | 1 | 2 | 1 | 5 | 9 | 1 | 1 | 0 | 1 | 1 | 0 | 6 | 2 | 3 | 0 | 0 | 1 | 5 | 1 | 76 |
| **Grand Total** | | | 4 | 3 | 1 | 3 | 7 | 1 | 2 | 3 | 5 | 2 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 1 | 5 | 1 | 1 | 2 | 1 | 7 | 12 | 1 | 1 | 0 | 1 | 1 | 0 | 9 | 2 | 5 | 0 | 1 | 2 | 6 | 2 | 106 |