ORIGINAL

Survey of the invasive New Zealand mudsnail, *Potamopyrgus antipodarum* in the Silver Creek drainage in and around The Nature Conservancy's Silver Creek Preserve, Idaho, USA

Prepared for:

The Nature Conservancy
Silver Creek Preserve, Idaho, USA

By:
David C. Richards and Gary T. Lester
EcoAnalysts, Inc.,
Moscow, Idaho

October 22, 2003

Introduction

The discovery of the New Zealand mudsnail, *Potamopyrgus antipodarum* (Gray), in Silver Creek, Idaho, USA has raised concern over its potential impacts to this world-renowned fishery and its native invertebrate fauna. *Potamopyrgus antipodarum* was first discovered in the western USA in the mid-Snake River, Idaho in the mid-1980's. It is now rapidly spreading throughout the western USA and has become established in many aquatic ecosystems in at least nine western states and three national parks (Richards and Gustafson 2003).

Potamopyrgus antipodarum is a parthenogenic livebearer with high reproductive potential and provides very little nutritional value to most native fishes. It often reaches densities greater than 100,000/m^2 in suitable habitat and has been reported to approach densities as high as 750,000/m^2 in sections of rivers in Yellowstone National Park (Hall and Dybdahl 2002). Frequently, these snails will comprise over 95% of the invertebrate biomass in a river. Due to limited funding, very little research has been published in the scientific literature concerning its impacts, although recent reports suggest that *P. antipodarum*'s negative ecological effects continue to be significant and include:

- Documented competition with native threatened invertebrates (Richards and Shinn 2002, 2003)
- Dramatic changes in primary production in rivers in Yellowstone National Park (Hall and Dybdahl 2001, Hall et al. 2003)
- Decreased growth in fishes at high densities of *P. antipodarum* (Cada and Kerans 2003)
- Potential secondary host and reservoir for vertebrate parasites (Staton et al 2003), and
- Degradation of whole ecosystem integrity.

Vectors responsible for its spread include; recreational use (primarily trout anglers), unsuspecting water resource managers/researchers and fish hatcheries. By thoroughly cleaning and drying equipment and gear, the spread of *P. antipodarum* into new areas can be easily reduced (Richards et al. 2003, Medhurst and Herbst 2003). Although public education addressing prevention of infection to new sites continues to be the most important management tool, control methods for infected sites are being investigated (Emblidge and Dybdahl 2003). Funding for research addressing *P. antipodarum's* ecology, impacts, and basic monitoring in the USA are almost non-existent compared to its current and future ecological and economic impacts.

Description of New Zealand mudsnail (Figures 1, 2, and 3)

Operculum: Like all prosobranchs, but unlike the more common pulmonate snails, the New Zealand mudsnail has an operculum to block the shell aperture when the animal is withdrawn into its shell. This is easily seen on live snails but the operculum is lost from dried shells and it is normally withdrawn beyond view in shells that are directly preserved in alcohol or formalin

Color: The shell is normally horn colored but ranges from light to dark brown or almost black. Encrusted shells can be any color.

Size: Almost all western populations reach a maximal size very near 5 mm. One population in Idaho (Cassia Creek of the Raft River) regularly pushes 6 mm. Reports of *Potamopyrgus antipodarum* reaching 12 mm do not apply to the western USA.

Shape: The shell is rather elongate compared to most western species. Like most snails, it is dextral (opening to the animals right). A full-grown shell normally has 5 or 6 whorls, which is more than most western species

Description of New Zealand mudsnail and other snail taxa that could be mistaken for *P. antipodarum* in Silver Creek, Idaho drainage

Most *P. antipodarum* found by EcoAnalysts Inc.,October, 2003 in the Silver Creek drainage were brown to dark brown, almost black in color and less than 5mm in length. All of the other attributes listed above also apply to Silver Creek *P. antipodarum*.

There are superficially several other taxa that could be mistaken for *P. antipodarum* in this area. The common pebble snail, *Fluminicola* sp. (Figure 1) was the most abundant snail taxon found in our sampling sites. It is about the same size as *P. antipodarum* but is much more round or oval (globose) and almost always black except when crusted over.

Physa sp. (Pulmonata; Family Physidae) (Figure 2) is common in this area particularly in the slower more nutrient rich sections. They grow to be much larger than *P. antipodarum*, but when small could be mistaken for *P. antipodarum*. *Physa* sp. shells open on the left (sinistral), do not have an operculum, and their shells are very fragile and easily broken. They are also mostly brown in color.

The most easily confused snail taxon with *P. antipodarum* is *Fossaria* sp. (Pulmonata; Family Lymnaeidae)(Figure 3). It is about the same size and shape as *P. antipodarum* but does not have an operculum, and has less whorls (usually 4). The aperature of *Fossaria* sp. is also more elongate than *P. antipodarum*. Several other snail taxa were found in our samples but do not resemble *P. antipodarum*.

Figure 1. New Zealand mudsnail, *Potamopyrgus antiporarum*, left and the common pebble snail, Fluminicola sp. right Photos courtesy of Dr. Daniel Gustafson, Montana State University, Bozeman, MT

Figure 2. Live *P. antipodarum*, left and *Physa* sp., right. Note: *P. antipodarum*'s aperature opens to the right, its aperature is smaller, and it has an operculum. *Physa* sp. aperature opens to the left and has a large aperature with no operculum. Photos courtesy of Dr. Daniel Gustafson, Montana State University, Bozeman, MT

Figure 3. New Zealand mudsnail, *Potamopyrgus antiporarum* left and *Fossaria* sp. right. Note *P. antipodarum* has and operculum, 6 whorls, darker color, and smaller, rounder, aperature. Fossaria has only 4 whorls. Photos courtesy of Dr. Daniel Gustafson, Montana State University, Bozeman, MT

Goals

The primary goal of this project was to qualitatively determine the distribution of the invasive New Zealand mudsnail, *Potamopyrgus antipodarum* in the Silver Creek drainage, Idaho. Two additional goals of this project were, 1) if *P. antipodarum* was present at any site, to subjectively estimate its density and 2) speculate on its origin in the system, vectors of spread, and future impacts.

Methods

We qualitatively sampled thirty-one (31) sites in and near The Nature Conservancy's Silver Creek Preserve (Figures 4-8) for presence/absence of *P. antipodarum*, in October, 2003. We incorporated and modified methodology for sampling for rare freshwater lotic species (Strayer et al. 2003, Smith et al. 2001). Several sites were selected at access points in tributaries upstream of Silver Creek to determine *P. antipodarum* presence/absence. If *P. antipodarum* was absent, no further samples were taken in those tributaries. If *P. antipodarum* was present, such as was the case in Loving Creek, an additional sample was taken approximately half-way between the positive site and its confluence with Silver Creek. If no *P. antipodarum* were found, no further samples were taken in that tributary. Again, if *P. antipodarum* was found, an additional site was chosen half-way between sites, etc. Additional sites were located along Silver Creek proper, Sullivan Lake outlet, and other sites (Buhler Drain, Patton Creek, and Stalker Creek) on advice from TNC managers. Two sites were also sampled on Butte Creek near the Hayspur State Fish Hatchery. We also collected samples from two sites east of TNC preserve, at Silver Creek East Access (Idaho Fish and Game administered) and the eastern most bridge crossing of Highway 20 on Silver Creek.

At each site we collected five 2-minute timed kick net samples. The kick-net had a 0.5mm diameter mesh and was vigorously kicked through the bottom substrate (ie. rocks, gravel, silt, sand, vegetation) across the width of the stream segment. Contents of the net were then placed in 3-gallon white plastic buckets, stirred, vegetation shaken in the bucket, removed, and excess water drained off. Contents were then placed in small clear, shoe-box sized plastic containers and contents allowed to settle for 5 minutes. Each container was then visually inspected thoroughly for *P. antipodarum*. Often *P.*

antipodarum will become highly mobile after several minutes in a container and can rapidly be separated from other invertebrates, although at cooler temperatures it is less mobile. After thorough visual inspection, *P. antipodarum* was determined as present or absent. If present, *P. antipodarum* was estimated as, rare, low, moderate, or high density. After each sample collection, waders and equipment were thoroughly rinsed to limit contamination to other sites.

Because *P. antipodarum* is parthenogenic and it can take only one individual to start a population, there was no feasible method for us to statistically evaluate and conclude that *P. antipodarum* was truly absent from a site. For example, we could have sampled one small section of Silver Creek intensively for 1 month and not found any *P. antipodarum*, while 2 meters up or downstream it could have been present. Methods and sampling designs can be developed for estimating the probability of detecting a population of *P. antipodarum* of certain size or density, but these methods require intensive sampling of *P. antipodarum* populations of known density and are unavailable at this time. Therefore, sites identified as 'absent' could possibly contain *P. antipodarum* either upstream or downstream.

Results

Of the 31 sampled sites, only six had *P. antipodarum* present; sites 1, 2, and 3 on Silver Creek and the outlet of Sullivan Lake near TNC's Visitors Center (Figures 4 and 5), site 6 on Loving Creek at Highway 20 bridge crossing, and sites 26 and 27 on Butte Creek, near the Hayspur State Fish Hatchery (Figures 4 and 6). *Potamopyrgus antipodarum* was absent from samples from all other sites (N = 25).

Site 1 was at the outlet of Sullivan Lake and its confluence with Silver Creek. This site had the highest densities of *P. antipodarum* within TNC's Silver Creek Preserve. We estimated *P. antipodarum* densities at Site 1 to be low to moderate. This site also had the highest diversity of snail taxa of all sites. We estimated that there were at least seven snail taxa present between the outlet of Sullivan Lake and confluence with Silver Creek, including, *Stagnicola* sp, *Fluminicola* sp, *Physa* sp., *Fossaria* sp., *Gyrallus* sp., another large planorbid species (possibly *Planorbella* sp.) and the invasive *P. antipodarum*. Site 1 appears to provide ideal conditions for an increased *P. antipodarum* population.

Site 2 was where Dr. David Herbst originally identified *P. antipodarum* as present in Silver Creek in the summer of 2003. It was located approximately ¼ mile upstream of TNC's Visitors Center. We found *P. antipodarum* at rare to low abundance associated with an abundance of *Fluminicola* sp., and two caddisfly species, *Helicopsyche borealis* and *Brachycentrus americanus*. We suggest that the unidentified snail species from Dr. Herbst's samples was probably *Fossaria* sp.(Figure 1) , as it was common at Site 1 and also found at Site 2.

Site 3 was located approximately ¼ to ½ mile upstream of Site 2 at the bridge crossing. This site also had *P. antipodarum* at rare to low abundance in association with the snail *Fluminicola* sp., *Helicopsyche borealis* and *Brachycentrus americanus* .

Site 6, located at the Highway 20 bridge crossing on Loving Creek also had *P. antipodarum* present, although we only found 1 individual and this section of Loving Creek may not be ideal for mudsnails. We speculate that this single individual had migrated downstream from infested areas upstream on Loving Creek and Butte Creek near Hayspur fish hatchery, as we did not find any downstream on Loving Creek at Site 5.

Sites 26 and 27 on Butte Creek downstream of Hayspur fish hatchery had moderate to high densities of *P. antipodarum* and also appear to be ideal for mudsnail population growth. These sites appear to be the center of distribution for *P. antipodarum* spread in the Silver Creek drainage.

Discussion

It appears that the New Zealand mudsnail, *Potamopyrgus antipodarum* has become established in the Silver Creek drainage in and near TNC's Silver Creek Preserve. Although, Dr. David Herbst suggested that *P. antipodarum* may have been established in Silver Creek in the preserve for up to five years, we feel it has recently invaded the preserve, perhaps in the last year or at most, two years prior. Dr. Dan Gustafson, Montana State University (personal communication) has sampled aquatic invertebrates in many of the tributaries of Silver Creek and also suggested a one or at most two-year establishment. Dr. Gustafson has recently found *P. antipodarum* in Loving Creek near its junction with Butte Creek and the Hayspur fish hatchery. We did not sample this section but found them to be abundant just upstream in Butte Creek.

Terry Maret, USGS, Boise, Idaho did not find any *P. antipodarum* in their June 2001 samples in Silver Creek near the USGS gage, which suggests a recent invasion. The low densities of *P. antipodarum* in Silver Creek near TNC Visitors Center also implies a recent invasion, as this appears to us to be very good habitat for this invasive species. It also suggests that anglers may be the primary transport mechanism. The abundant densities of *P. antipodarum* near Hayspur fish hatchery could indicate that this is where the snail first became established, possibly a few years earlier than the invasion into TNC' preserve. It has been suggested that some fish in the Hayspur hatchery originated from a known *P. antipodarum* infested hatchery in Nampa, Idaho although we have not verified this. Because we did not find *P. antipodarum* in any downstream sites from TNC's Visitors Center and upstream of the bridge on Silver Creek near the Visitors Center, we hope that it hasn't spread any farther, although Dr. Herbst apparently did report them from a location on Stalker Creek (www2.montana.edu/nzms).

Most tributaries of Silver Creek and Silver Creek itself appear to us to be very good potential *P. antipodarum* habitat. There are fairly stable flows and temperatures, high nutrients and abundant vegetation. From our experience this indicates that *P. antipodarum* could become well established and reach high densities. We have also noticed that many streams in the western USA where *P. antipodarum* have invaded also have an abundance of *Flumincola* sp., *Helicopsyche borealis*, and *Brachycentrus americanus* and *Gammarus* sp. (scuds). Reasons for this association are unknown but are probably related to environmental conditions. This species assemblage may be a useful indicator of potential *P. antipodarum* invasibility.

Some tributaries of Silver Creek, such as Grove Creek, seem to have a high calcium carbonate load as evidenced by calcium precipitates on the substrate and vegetation, which was dominated by highly calcified *Chara* sp. In the stretch of Grove Creek that we sampled (Site 4), there were no *Fluminicola* sp. nor any other snail species found, although there were many *H. borealis and Gammarus* sp (scuds). We speculate that the calcium precipitate load is so high as to exclude many longer lived invertebrate species including, possibly *P. antipodarum.*

Conclusion

Although the New Zealand mudsnail is established in Silver Creek Preserve, it appears that it has not reached densities high enough to have noticeably impacted the ecosystem. We are fortunate to have detected it early in its invasion and are now able to monitor its future affects, however benign or severe they may be. We are also now prepared to implement any, as of yet unforeseen, controls that may become available. Finally, even though *Potamopyrgus antipodarum* is a relatively fast moving snail, it does not seem to spread upstream rapidly on its own. With proper regulation, management, and education, its spread upstream from its invasion front can be curtailed.

Literature cited

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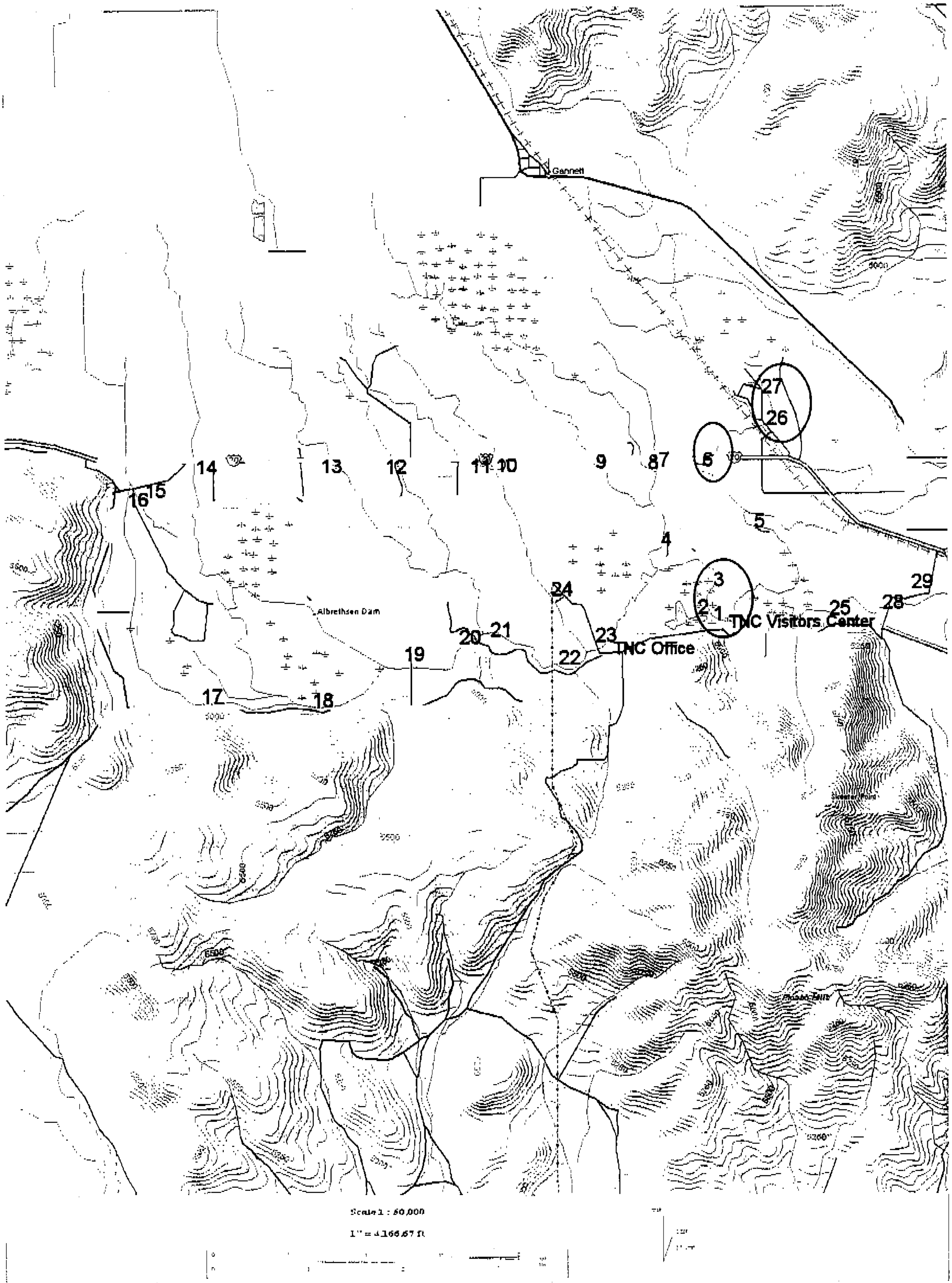

Figure 4. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites, Silver Creek, Idaho, October 2003. Sites 1,2,3,6,26,and 27 (circled in red) were positive; all other sites were negative.

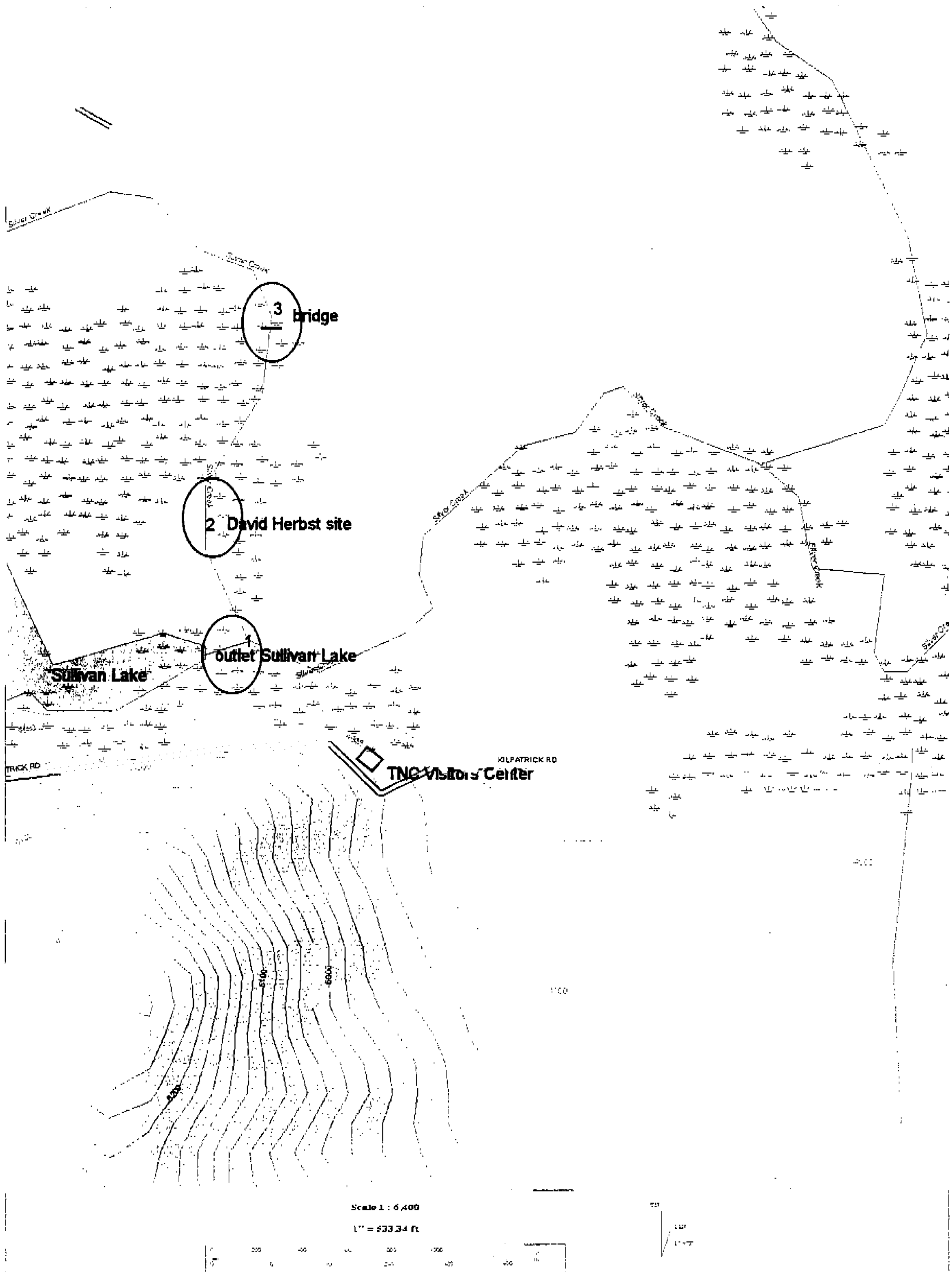

Figure 5. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites 1,2, and 3, Silver Creek, Idaho, October 2003. All three sites positive.

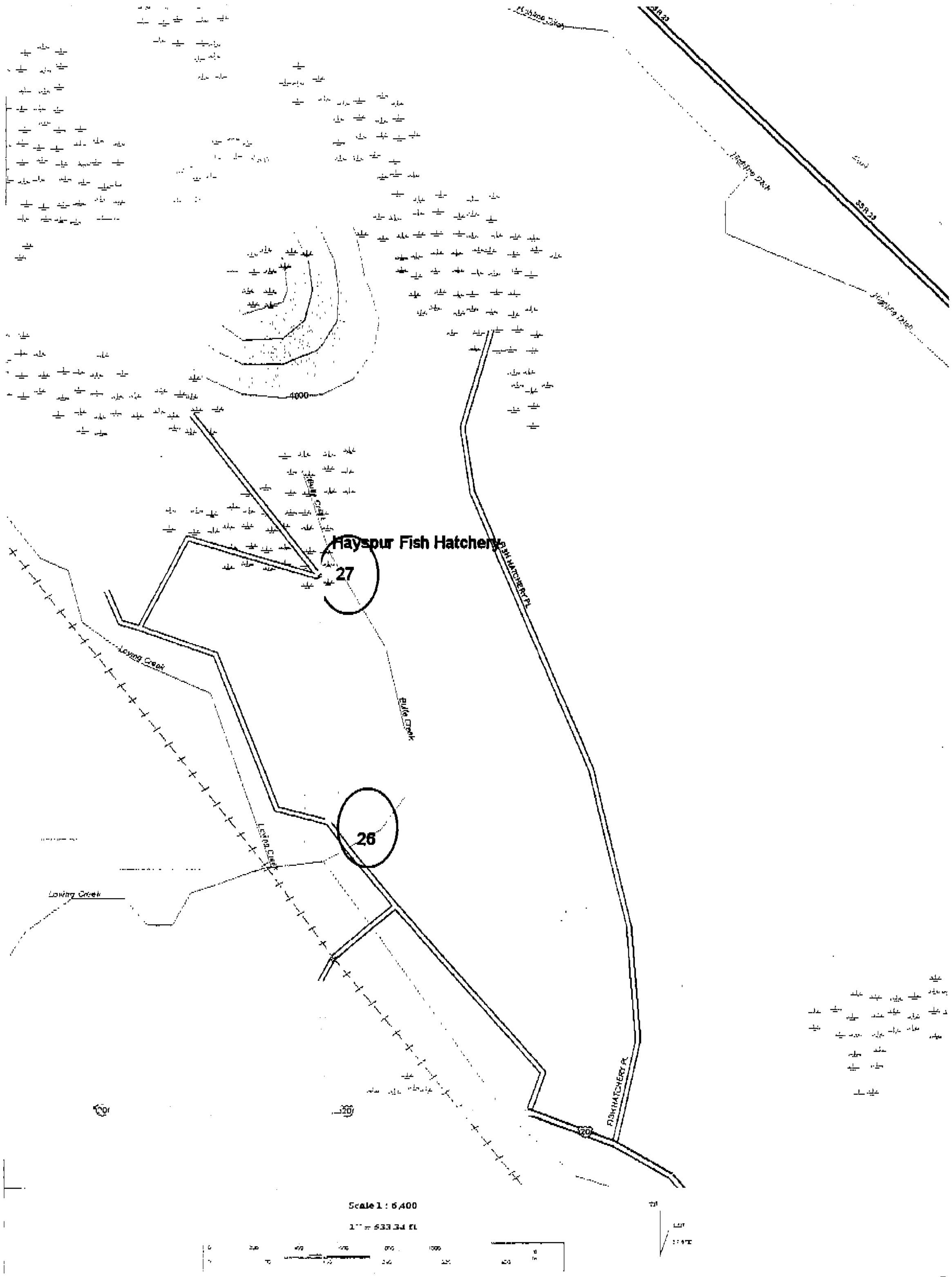

Figure 6. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites 26 and 27 near Hayspur State Fish Hatchery, Butte Creek, tributary to Silver Creek, Idaho, October 2003. Both sites positive.

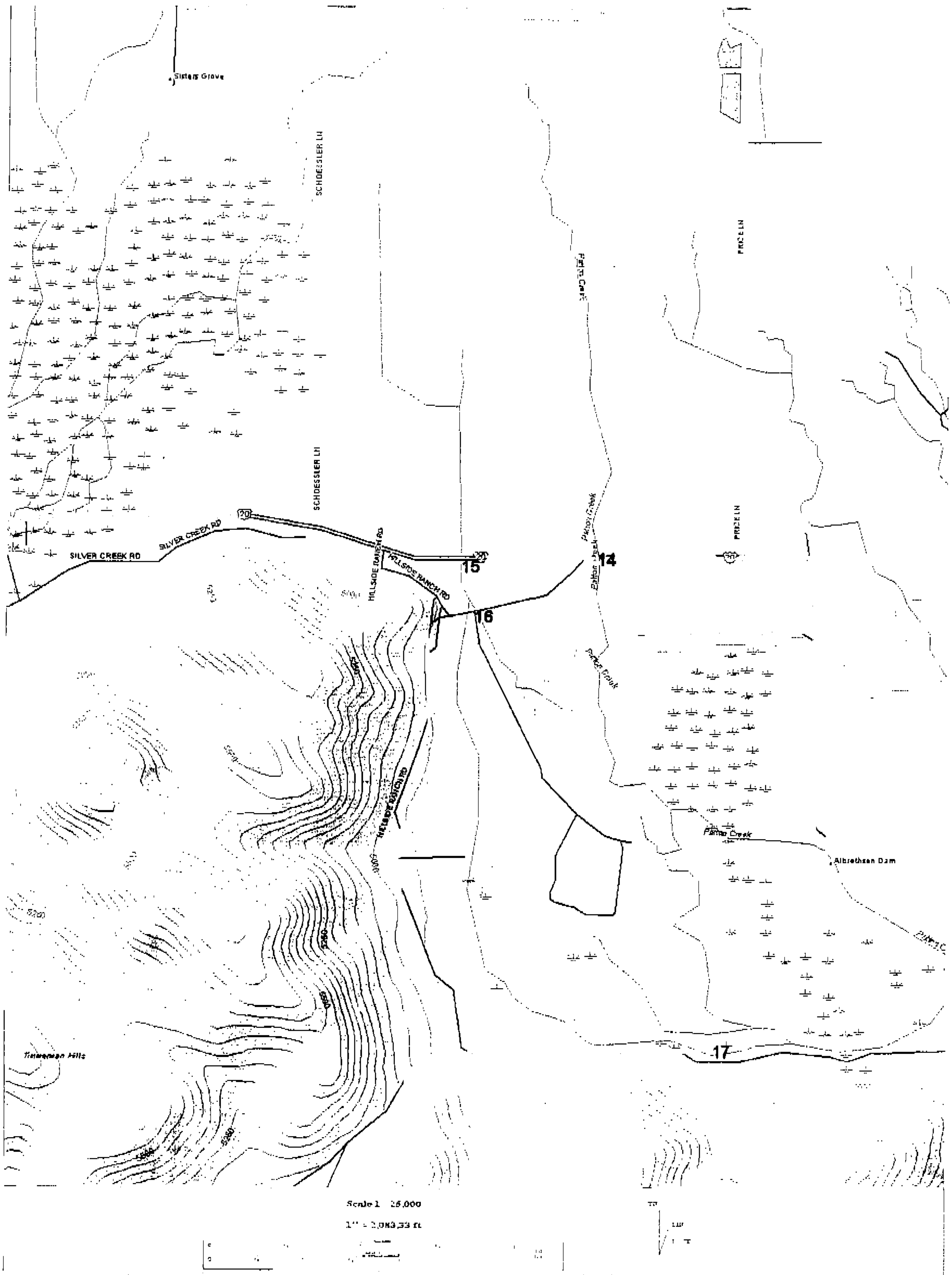

Figure 7. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites 14, 15, 16,and 17, Patton Creek and Buhler drain, Idaho, October 2003. All sites negative.

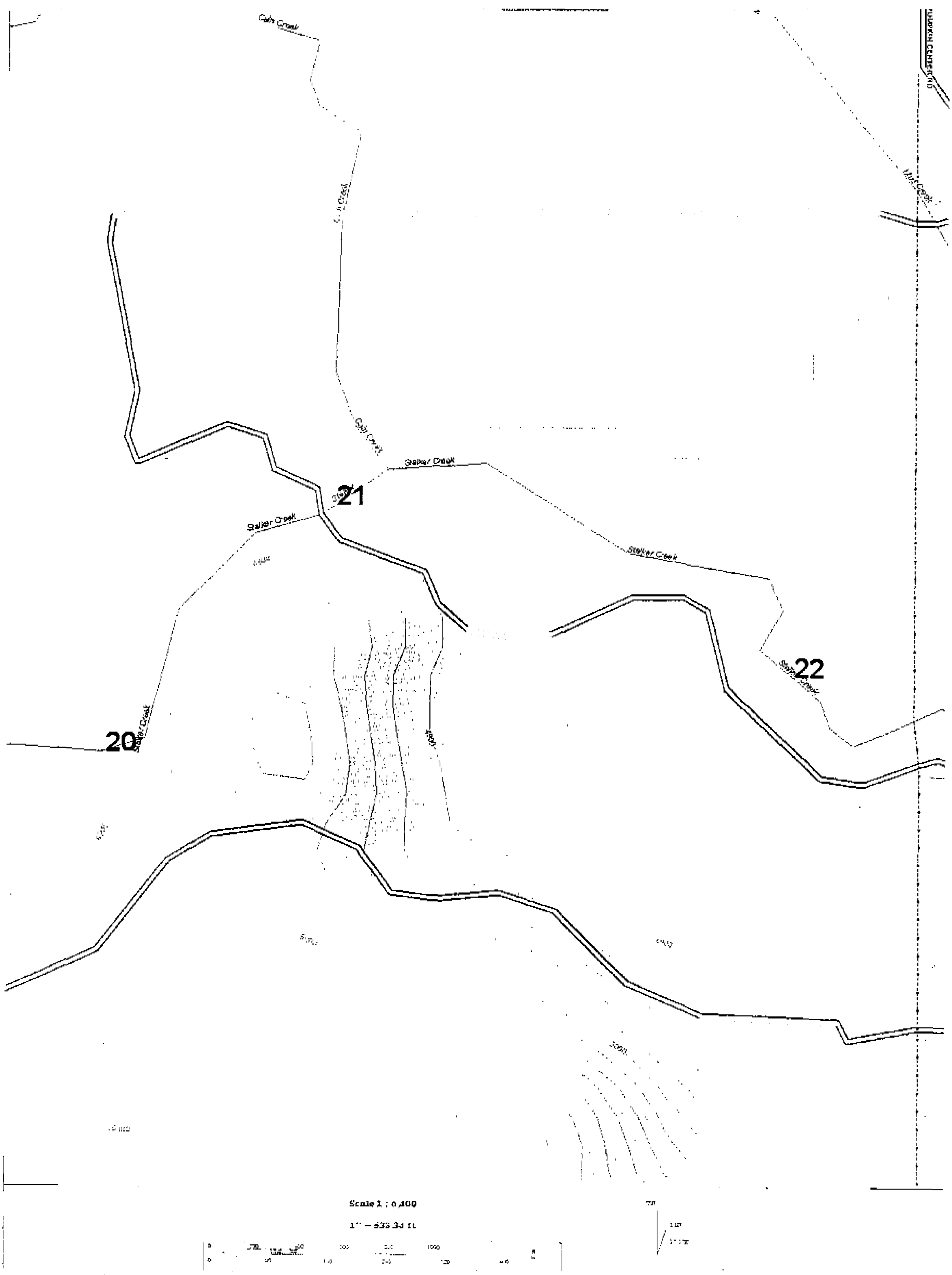

Figure 8. New Zealand mudsnail. *Potamopyrgus antipodarum* sample sites 20,21,22 collected October 2003. All three sites negative.

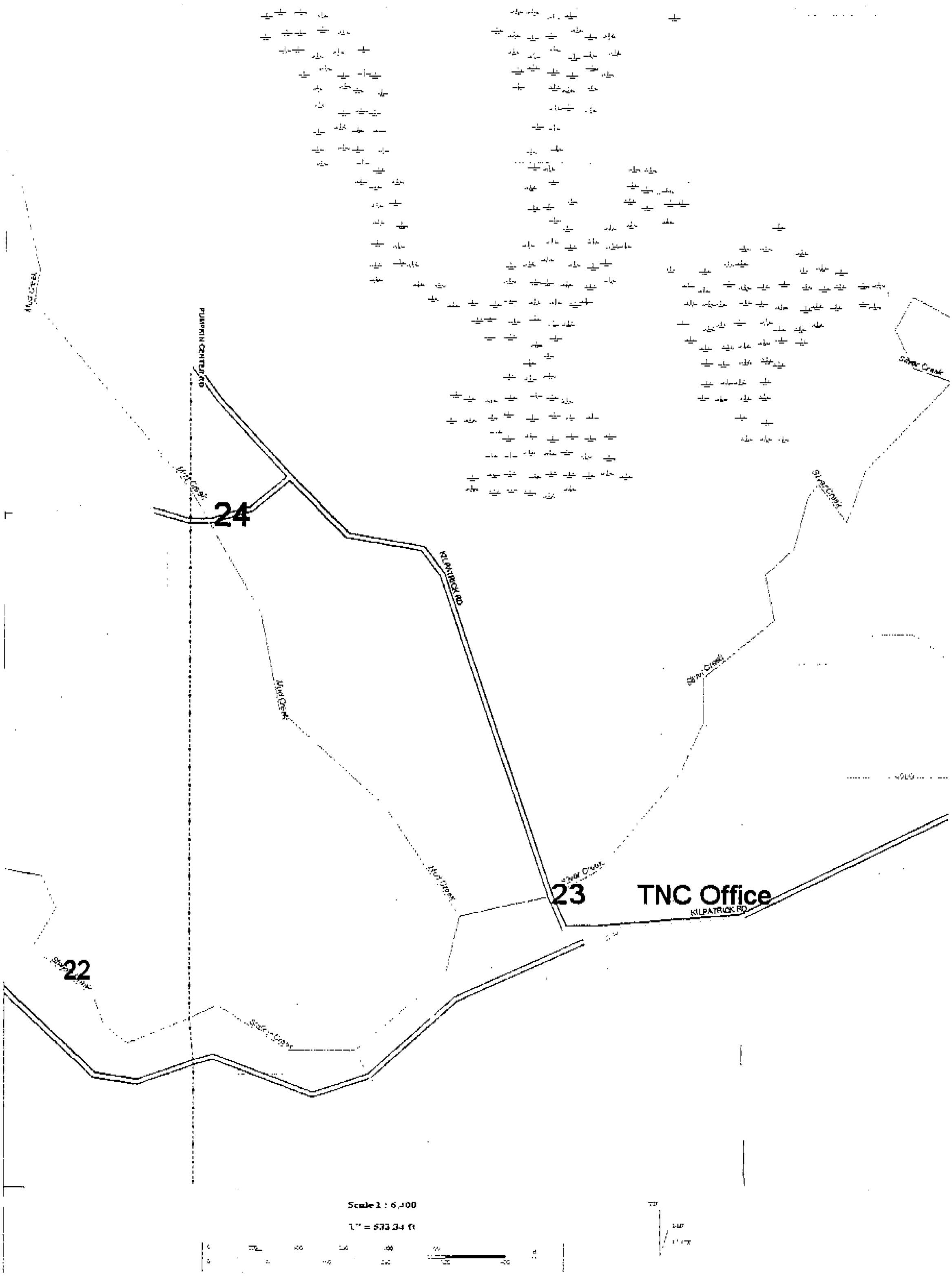

Figure 9. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites 22, 23, and 24, sampled October 2003. All three sites negative.

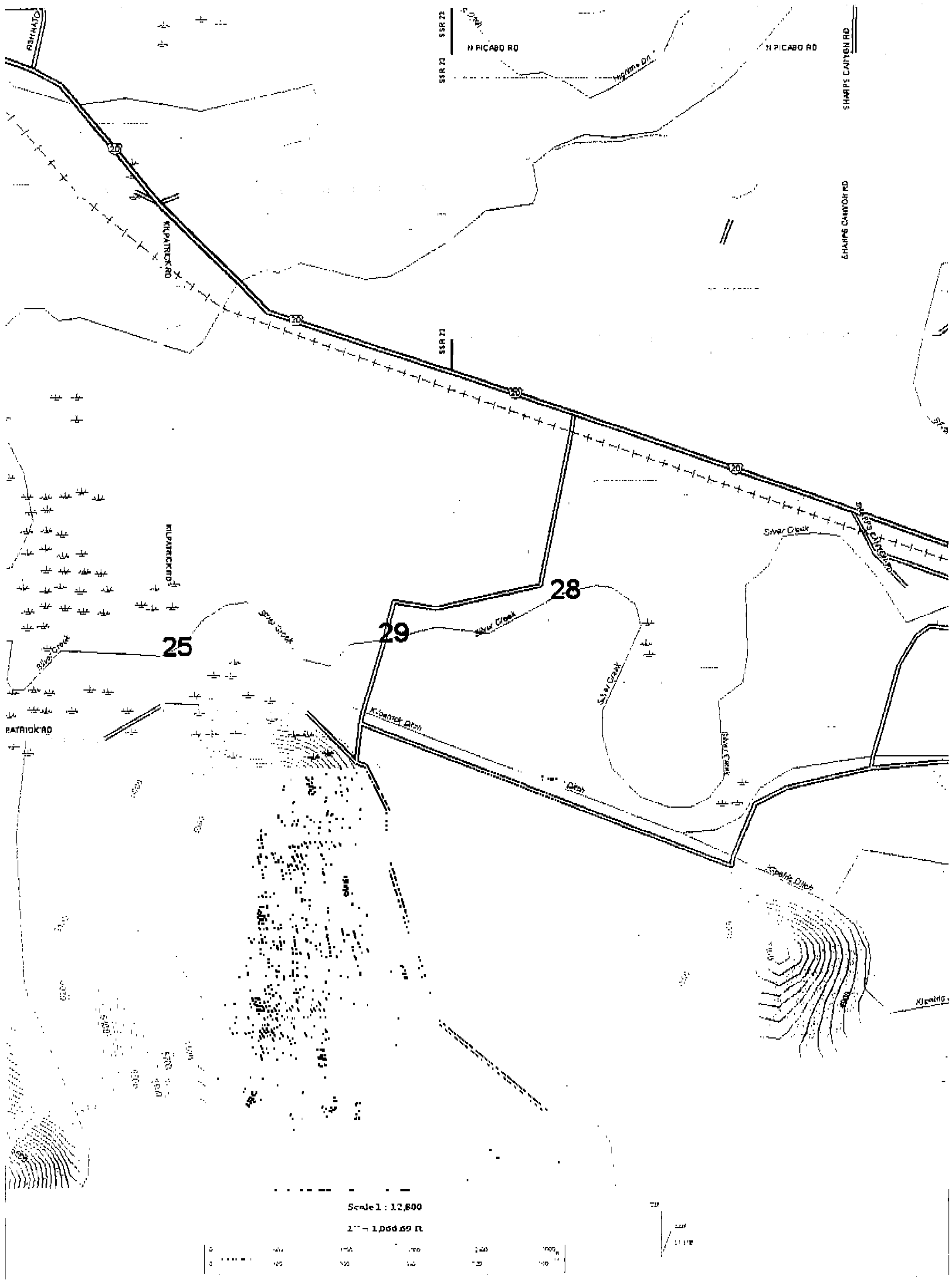

Figure 10. New Zealand mudsnail, *Potamopyrgus antipodarum* sample sites 25, 28, and 29 collected October 2003. All three sites negative.

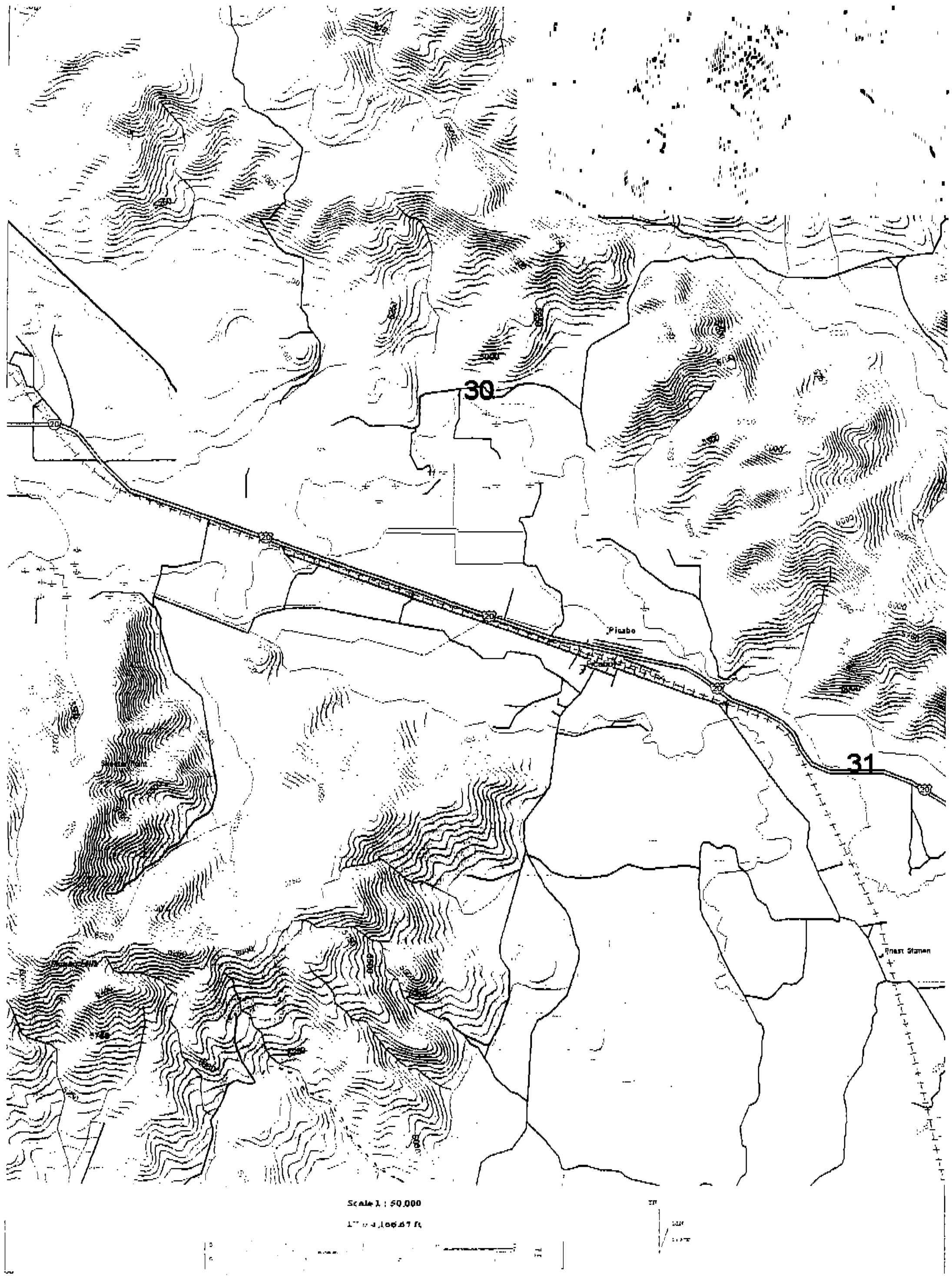

Figure 11. New Zealand mudsnail. *Potamopyrgus antipodarum* sample sites 30 and 31, collected October 2003. Both sites negative.