Distribution of the endangered grasshopper *Sigaus minutus* on the Earnscleugh Tailings Historic Reserve

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1. Introduction

Sigaus minutus Bigelow (Orthoptera: Acrididae) was rediscovered on the Earnscleugh tailings in September 1996. This area was briefly surveyed after a specimen labelled 'Earnscleugh' was found in Peter Child's insect collection. Peter Child sent Bigelow his first specimen of *Sigaus minutus* from Alexandra (Graveyard Gully), to which Bigelow refers in his book (Bigelow 1967). Graveyard Gully is now completely infested with the weed *Thymus vulgaris* and is unsuitable for *S. minutus* (Jamieson 1996).

I have been studying the ecology and distribution of *S. minutus* in the Alexandra area for the past three years and the discovery of the grasshopper on the Earnscleugh tailings is the most significant to date.

2. Objectives

1 Report on the total distribution of *Sigaus minutus* on the Earnscleugh Tailings Historic Reserve.

2 Identify what are the priority areas for conservation within this distribution.

3. Comment on the importance of these sites for the overall conservation of *Sigaus minutus.*

4. Identify any other priority insect species present on the Earnscleugh tailings.

3. Location

The Earnscleugh Tailings Historic Reserve (Appendix 1) is situated on the true right of the Clutha River, across the river from, and northwest of Alexandra. The area is bounded to the north and east by a crown-controlled strip of land (for water power development) beside the Clutha river, to the south by the Fraser River which flows into the Clutha, and to the west by privately owned tailings and unworked land. The riverine strip and the privately owned tailings were included in the survey.

4. Methods

A survey was made of the Earnscleugh Tailings for the grasshopper *S. minutus* during the week 17 to 24 March 1997. A number of sites were also checked on 13 April 1997. Grasshopper numbers are usually highest at this time of year with both adults and developing juveniles in the population. Usually from about March to May, grasshopper numbers decline as late stage juveniles and adults begin hibernation. However, the number of grasshoppers found at a regularly sampled site were similar when sampled on 17 March and 12 April 1997, which suggests that the survey was not affected by hibernation.

Grasshoppers were identified individually when they were disturbed. It was impossible to cover every square metre of ground, so the data were gathered from short excursions into the various habitat types within the study area. These habitat types included tailings from various gold mining episodes and unworked ground: at different elevations, with differing aspect, of differing gravel size, and with differing types and density of vegetation. Individuals were counted within each habitat type. This number was converted to the number seen per hour, which was then categorised as low, medium or high, so that comparisons could be made between areas. At two sites all individuals disturbed along transects 1.5 m apart were counted. The presence of adults within areas was noted.

5. Results and Discussion

Appendix 2 shows the results from twenty transects of approximately 30 m on unworked ground. More than twenty transects of approximately 40 m were made on the old tailings but grasshoppers were only found on four occasions on these transects. Positional records were not kept as accurately on the old tailings, as no grasshoppers were found on the majority of transects but instead a total count for all transects was made. These counts provided baseline data for establishing population numbers as low (≤5 per hour and a very patchy distribution), medium (6 to 20 per hour with larger more frequent patches), or high (>20 per hour and a more or less continuous distribution within the area).

5.1 TOTAL DISTRIBUTION OF *SIGAUS MINUTUS*

A map of the Earnscleugh tailings with grasshopper numbers marked as low, medium or high is shown (Appendix 3). Grasshoppers can be found over most of the area known as the tailings in varying amounts of patchiness in metapopulations of varying age structure. There were surprisingly few adults found in the survey which seems to have resulted from a generally poor season. Spring emergence was early in 1996, when there was a particularly hot September. However, this was followed by 3 months of cold wet weather, which

prolonged development. The very cold wet April may have resulted in very few overwintering individuals. Over 100 grasshoppers were seen during the survey, which is the greatest number of grasshoppers I have found at one site in the Alexandra area.

Three types of tailings as well as unworked ground have been identified in the Earnscleugh tailings complex (Coster 1995). These are the Clutha dredge tailings, a series of 'middle period' tailings dating from the early part of this century, and 'low tailings' next to the river from the last few years of last century. The distribution pattern of *S. minutus* roughly follows the tailing sequence; more grasshoppers are found on the more recent tailings than on the old tailings. No grasshoppers were seen on the low tailings next to the river which are well vegetated with moss and weeds. On the 'middle period' tailings, the population of grasshoppers is restricted to a few isolated patches, and numbers are generally low. On the Clutha dredge tailings, more grasshoppers were seen (medium, Appendix 3) and patches were larger and more frequent. Also, one area of the Clutha dredge tailings had the highest number of adults present in a metapopulation. On the unworked ground, numbers of grasshoppers were usually similar to the Clutha dredge tailings except on one area where a large extensive population of juvenile grasshoppers was found (high, Appendix 3). It is unlikely that these juveniles will overwinter, as they are all too young. To date, only stage VI and adult *S. minutus* have been found in the spring. However, this area is remarkable in that it contained the largest, most dense, and most extensive population of *S. minutus* I have found in three seasons' study.

The historic sequence of the tailings is also seen in the pattern of colonisation of the tailings by *Thymus vulgaris*. The middle period tailings are heavily infested with *T. vulgaris* and other weeds, and generally only the knolls of the herring-bone patterned heaps are clear. The Clutha dredge tailings have *T. vulgaris* in some but not all gullies between heaps, and plants are well spaced. It is interesting that the unworked ground is mostly only scattered with *T. vulgaris* plants or completely clear. Presumably the unworked ground does not provide the same opportunity for colonisation as the worked sites; it is mostly level, so moisture and plant debris do not collect, and it is elevated above and away from the river, so the larger gullies are not permeated by groundwater. Similarly, mosses and lichens are denser on the old tailings than on the 'middle period' tailings or Clutha dredge tailings and unworked ground. Although there are small pockets of native plant species on the old tailings, e.g. *Raoulia australis*, the middle tailings have mostly introduced species, e.g. *T. vulgaris*, *Sedem acre*, *Eschscholzia californica*, and *Populus nigra* at various levels of infestation. *S. minutus* is absent where the vegetation is densest and is only found on the clear knolls of the herring-bone heaps.

Elevation, aspect, and gravel size appear to affect grasshopper distribution and abundance where they contribute to changes in the density of the vegetation as described above. They may also affect grasshopper distribution and abundance where they contribute to microclimate effects which allow for successful overwintering. For example, in the spring, adults were found among the small piles of hand-stacked larger stones in the gullies which cut through the terraces but not on the flat, gravelly, unworked terraces.

Sigaus minutus inhabits rocky/stony ground and its behaviour is clearly adapted to this lifestyle. It will either leap away when disturbed or will back down into the crevices between stones, where it cannot be reached. Also, the female oviposits in the small crevices between stones without inserting her abdomen into the ground unlike the majority of grasshopper species. It is a clumsy grasshopper. Adult grasshoppers are unable to gain a footing among the branches or leaves of vegetation and fall to the ground in a confused way when they land in vegetated areas. However, some of the juvenile grasshoppers are more agile and can cling to small bushes. Elsewhere *S. minutus* has always been found in the presence of *Raoulia australis*, which also colonises rocky/stony ground (Jamieson & Manly 1997), so finding it without *R. australis* was surprising. This shows that the co-existence of *S. minutus* and *R. australis* is coincidental rather than necessary (Jamieson & Manly 1997).

S. minutus prefers bare ground and appears to move on to newly formed river terraces and exposed stony ground as they appear. Davis (1989) found it more prevalent on younger river terraces in the Mackenzie Country, and I found higher numbers on bulldozer tracks than on the surrounding hillsides with apparently good habitat, on Galloway Station, Alexandra. On the Earnscleugh gravel beds there are more grasshoppers on the barer ground. Even comparatively small plants (<300 mm) are obstacles to adult *S. minutus*, and populations become isolated on small patches of clear ground surrounded by vegetation. These isolated populations tend to die out.

5.2 AREAS FOR CONSERVATION

The selection and management of conservation sites within the Earnscleugh Historic Reserve must be made with the preference for bare ground and colonising nature of this species in mind. The selection of a small area of unworked ground with an adjoining area of Clutha dredge tailings and/or 'middle period' tailings could lead to the extinction of this population. An extensive area of tailings with invasive weed management is the only acceptable option. Numbers of grasshoppers are usually low, individuals are widely spaced, distribution is patchy and may vary from year to year, and the age structure of the population varies widely, both on the tailings and at other locations in the Alexandra area. They are very vulnerable to unpredictable weather conditions and numbers fluctuate wildly. A lot of juveniles one season may be followed by low numbers the next season. For example, 43 juveniles and adults recorded at a regularly surveyed site in February 1996 but only 10 were recorded in February 1997. At another site 20 grasshoppers were found in the autumn but none were found in the spring (Jamieson 1996). Thus, a wide variety of habitat possibilities with various microclimates is necessary to maintain a viable population. Unpredictable weather is regarded as one of the major factors affecting the persistence of insect species (Samways 1994).

The whole of the Alexandra end of the reserve from the quarry down to the Clutha River, southwards to the Fraser River, which includes all three areas of tailings and unworked ground, is necessary for the maintenance of the population (Appendix 3). If sections 141, 182, and 181 were also included in the reserve their future should be ensured. The Clyde end of the tailings does not

provide the same opportunity, as there is no unworked ground and very little variation in elevation, so there are not the same microclimate possibilities. I did not find any grasshoppers on the site where gravel has been quarried for the Clyde dam project. Presumably this type of large-scale disturbance has been too rapid and extensive to allow the grasshopper to shift with the changing conditions. This type of operation should not be allowed in the conservation area.

The management of the area should include clearance of thyme. A *T. vulgaris* management programme on a small experimental site would be relatively easy to carry out as the plants are easy to pull out of the loose gravel. To assess the impact of these measures on *S. minutus* the population should be monitored over a number of summers.

Care should be taken to maintain the historic aspects of the reserve when managing the habitat for conservation of *S. minutus*. Also, it should be noted that the grasshopper population is particularly vulnerable in spring, with egg-laying occurring from September to December, and any rock or stone movement could easily destroy egg clutches. Movement on the reserve should be restricted to tracks during this period.

5.3 IMPORTANCE OF THE EARNSCLEUGH SITE

This site is most important for the conservation of *S. minutus* in the Alexandra area. The majority of other populations of *S. minutus* are on small isolated patches of privately owned farmland where land management practices will ensure their extinction. In a survey of 20 sites on Crawford Hills Rd, Alexandra (Jamieson & Manly 1997), no *S. minutus* were found on land which is in pasture, used for orcharding, and/or irrigated. Grasshoppers were only found at 2 sites on Crawford Hills Rd where there were remnant patches of *R. australis*. The buildup of soil on farmland and in association with *R. australis*, *S. acre*, and *T. vulgaris* is unsuitable for *S. minutus*. Also, experiments have shown that acridids cannot tolerate insecticides or herbicides and are very sensitive to heavy metals and fertilisers in the soil (Heliovaara & Vaisanen, 1993).

This site is also most important for conservation of *S. minutus* in New Zealand. *S. minutus* is only found in the Alexandra area, the Lindis Pass and the Mackenzie Country. In Alexandra and the Lindis Pass area, populations are small, infrequent and scattered. Numbers of *S. minutus* in the Mackenzie Country were reasonable (over 481 specimens were seen in 13 days sampling, Davis 1989), but since then, there has been severe flooding, e.g. December 1994 and December 1995, and most of the populations found were located on river terraces. Davis also expressed concern about the encroachment of invasive plants on to *S. minutus* territory. When I visited some of these sites beside Edwards Stream in February 1996, I found very few *S. minutus* (< 10 in 4 km) at sites where numbers had been high (252 grasshoppers in 7 km). Thus, the survival of populations in these areas cannot be counted on in the long term.

5.4 OTHER INSECT SPECIES FOUND

Orthoptera
Phaulacridium otagoense Ritchie and Westerman
Phaulacridium marginale Walker
Pteronembrius nigrovus Swan

Lepidoptera
Dichromodes n. sp. Patrick

Coleoptera
Chrysomela hyperici Forster

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8. Addendum

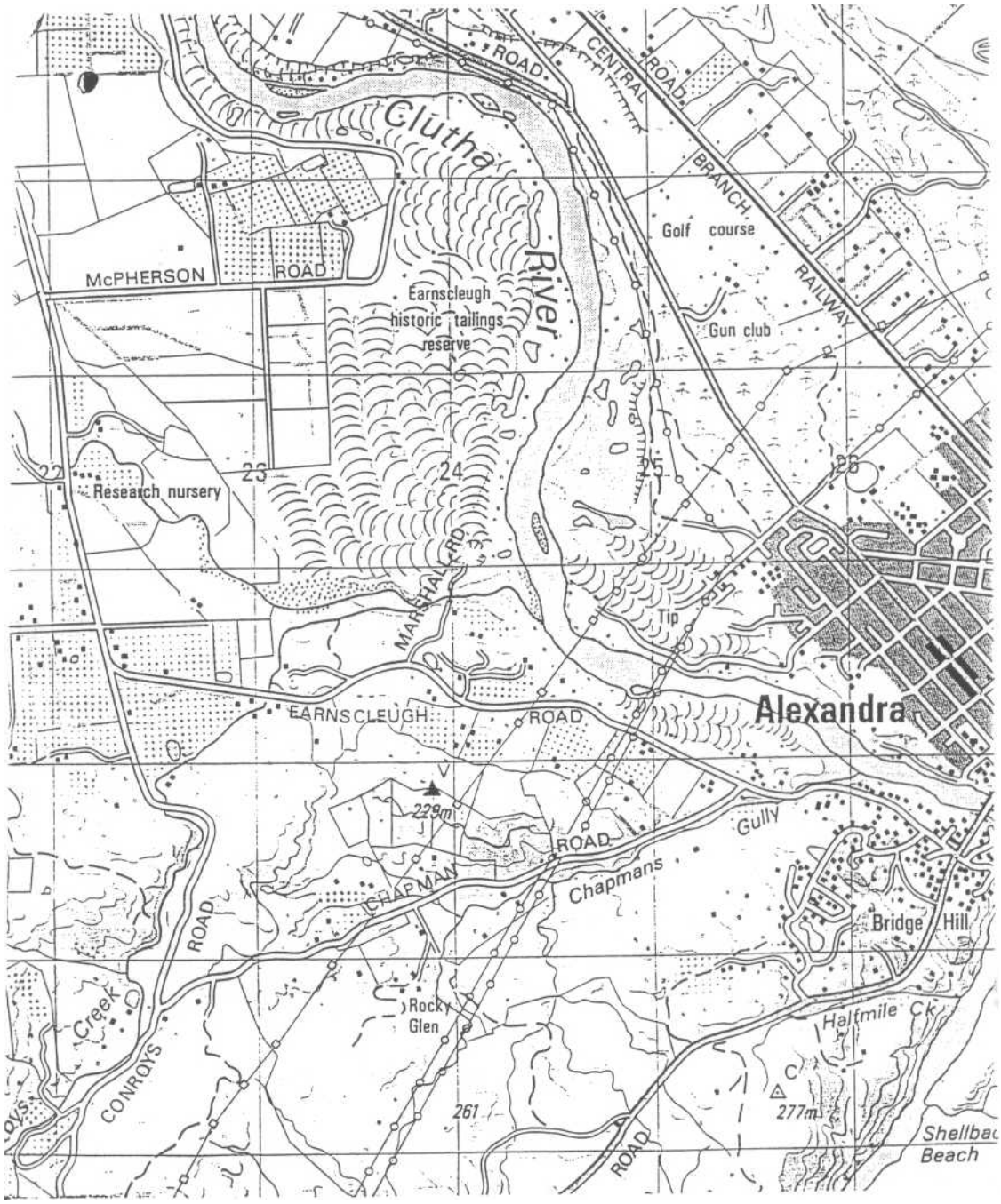
Since going to press, taxonomic work has shown that what was known as *Sigaus minutus* (Alexandra) is a new species which is morphologically distinct from *Sigaus minutus* (Tekapo). A taxonomic description of this species (proposed name *Sigaus childi)* has been prepared for the *New Zealand journal of zoology* (Jamieson, in press). Bigelow (1967) confused these two species when he was sent specimens by Peter Child.

Also, further taxonomic work has shown that distribution records in this report actually include two separate species which are morphologically similar and have similar habitat preferences. The second species is also of the *Sigaus* type and has not been recorded in New Zealand before. Since this discovery, it has also been found on the gold dredge tailings on the opposite side of the Clutha River (the true left). It has not been found elsewhere in the Alexandra district despite targeting of this type of habitat (Jamieson 1996 and unpublished).

A recent survey carried out on 16 and 17 March 1998 showed the proportions of these two species on the Earnscleugh tailings varies: on the middle tailings the two species appear to be in equal numbers, but on the unworked ground only the second species was found. As a consequence, numbers of *Sigaus childi* on the Earnscleugh tailings are much lower than was originally thought.

As two rare grasshopper species are present on the Earnscleugh tailings the continued conservation of this area is of the highest priority.

Appendix 1 Location map of the Earnscleugh tailings Historic Reserve.



Scale 1:25000, from NZMS 260 Sheet G42

Appendix 2 Numbers of grasshoppers found on 20 transects made on unworked ground.

Transect no.	No. grasshoppers
1	3
2	4
3	2
4	2
5	3
6	0
7	2
8	1
9	1
10	0
11	3
12	1
13	2
14	1
15	1
16	2
17	4
18	3
19	1
20	2
total	38

Appendix 3 Density (low (L), medium (M), or high(H), see text for details) and distribution of *Sigaus minutus* on the area known collectively as the Earnscleugh tailings. (Map drawn from N.Z. Aerial Mapping, Survey No. 5361, Photo No. D/2, Flown 18/2/79.)