Speargrass weevil (*Lyperobius huttoni*) status on Mana Island

February 2021

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Cover image Adult speargrass weevil (*Lyperobius huttoni*) on taramea (*Aciphylla squarrosa*), Mana Island. Image: Colin Miskelly

Summary

Forty-one adult Wellington speargrass weevils (*Lyperobius huttoni*) were released on the west coast of Mana Island in 2006 & 2007. A survey for speargrass weevils during 6–8 February 2021 resulted in just three adult weevils being located, all within 200 metres of the release site. However, their distinctive feeding sign was found on 130 taramea (*Aciphylla squarrosa*) plants spread over a 1-kilometre distance south from the trig (and centred on the release site just south of Lance's gully), indicating that speargrass weevils are well-established on the island. Speargrass weevils have not reached the south-west corner of the island, which currently has the densest patches of their host-plant (taramea) on Mana Island.

It is possible that speargrass weevils will be affected by the same strain of *Beauveria pseudobassiana* (an entomopathogenic fungus) that infects, and is spread by, flax weevils (*Anagotus fairburni*) on Mana Island. We therefore measured the distance between taramea plants with weevil browse and the nearest flax plant (*Phormium* sp.), so that any change in speargrass weevil distribution over time can be related to their potential exposure to this fungus. The average distance between taramea plants with weevil browse sign and the nearest flax bush was 10.3 metres (median distance 4.2 metres, range 0 to 55 metres).

Recommendations are made for a follow-up survey within 5 years, to assess whether speargrass weevils have been affected by the 'flax weevil' strain of *Beauveria pseudobassiana*.

Background

Wellington speargrass weevils (*Lyperobius huttoni*) are large flightless beetles that are one of the few insect species that are protected under the Wildlife Act (1953). They are critically threatened in the North Island, where they are known from a small area of the Wellington south coast. The weevils are host-specific on the speargrass *Aciphylla squarrosa* (taramea), with the adults browsing on the needle-tipped leaves, leaf stalks and flowers-stalks, and the larvae feeding on the roots.

Speargrass weevils were identified as a suitable species to introduce to Mana Island Scientific Reserve in the *Mana Island Ecological Restoration Plan* (Miskelly 1999). Forty-one adult speargrass weevils sourced from Hawkins Hill (Te Kopahou Reserve) were released on Mana Island by Department of Conservation staff between March 2006 and December 2007 (Miskelly 2010). All were released on a terrace south of Lance's gully on the west coast, about 650 m south-southwest of the trig. Although their distinctive feeding sign was observed over subsequent years, the first post-release sighting of speargrass weevils was not until July 2012 (Table 1). Ten speargrass weevils were reported from Mana Island between 2012 and 2020 (Table 1). All observations were within 100 m of the release site, apart from one animal about 400 m north in November 2015 (C. Miskelly pers. obs.).

Speargrass has become much more common on Mana Island since the speargrass weevils were released (Grant Timlin pers. comm. to Colin Miskelly, June 2022).

Table 1 Speargrass weevil sightings on Mana Island between their release in 2006 & 2007 and the survey in February 2021. The winter to late spring date bias is largely due to the times of year when Colin Miskelly and assistants undertook petrel research on Mana Island, which provided opportunities for brief speargrass weevil surveys (usually less than an hour of search effort).

Date	Number seen	Observer(s)
10 Jul 2012	2	Colin & Kieran Miskelly
30 Sep 2013	1	Colin & Kieran Miskelly
24 Oct 2014	1	Colin Miskelly and Caroline Bost
18 Nov 2015	2	Colin Miskelly
25 Nov 2018	1	Colin Miskelly and Ruth Dunn
18 Aug 2019	2	Will Brockelsby, Annemieke Hendriks and Brittany Florence-Bennett
20 Oct 2020	1	Colin Miskelly and Cooper French

In contrast to the speargrass weevils, a second large weevil species released on Mana Island around the same time is now extremely abundant and has spread widely on the island. A total of 150 flax weevils (*Anagotus fairburni*) sourced from Maud Island were released near the south-west corner of Mana Island in 2004 & 2006 (Miskelly 2010). Flax weevils have become so abundant on Mana Island that they are having a major impact on their habitat, killing almost all mature flax plants on the southern section of the island's plateau as they spread north.

During investigations into potential control mechanisms for flax weevils, a previously unrecognised strain of the entomopathogenic fungus *Beauveria pseudobassiana* was identified from flax weevil larvae on both Maud Island and Mana Island. It is likely that spores of the fungus were introduced along with the flax weevils, and that the fungus is being spread across Mana Island by flax weevils (and possibly other insects) and wind dispersal.

Beauveria fungi are dependent on live insects to complete their life cycle. The fungus is usually lethal to the host; after the insect dies, white spore-bearing strands grow out from the insect, creating a cotton-wool-like appearance (Figure 1). Although strains of *Beauveria pseudobassiana* are typically host-specific, other insect species can become infected if exposed to high spore densities (Travis Glare pers. comm.).

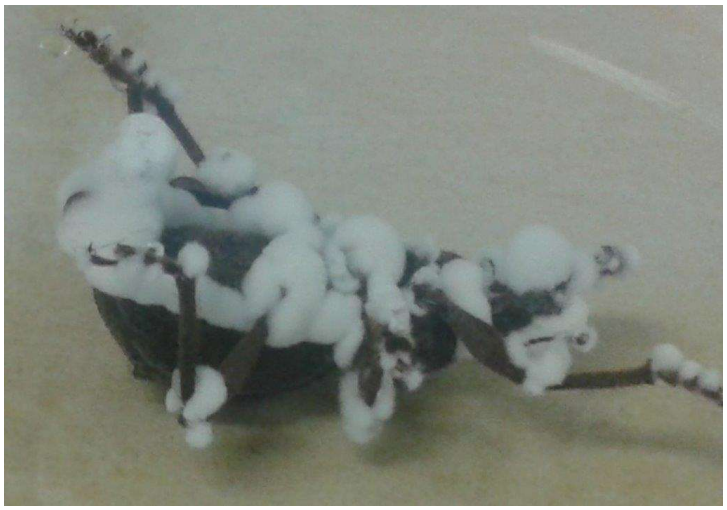

Figure 1 Adult flax weevil (*Anagotus fairburni*) infected with the fungus *Beauveria pseudobassiana*. Image: Jenny Brookes, Bio-Protection Research Centre.

The susceptibility of speargrass weevils to the strain of *Beauveria pseudobassiana* that infects flax weevils is unknown. The potential impact of the fungus on speargrass weevils was the primary motivator for this survey. In addition to providing information on the success (or otherwise) of the release of speargrass weevils 14–15 years earlier, the survey was designed to be repeatable, so that future surveys may be able to detect whether speargrass weevils have been affected by the spread of the 'flax weevil' strain of *Beauveria pseudobassiana*.

Objective: To determine the distribution and abundance of Hutton's speargrass weevil (*Lyperobius huttoni*) on Mana Island, in relation to the distribution of its host plant (taramea, speargrass *Aciphylla squarrosa*) and proximity to New Zealand flax (*Phormium* sp.).

Purpose: To determine whether speargrass weevils had successfully established on Mana Island since they were translocated there 14–15 years earlier, and to establish a baseline that could be used to assess any future impacts of the 'flax weevil fungus' (a strain of *Beauveria pseudobassiana*) on speargrass weevils on Mana Island.

Methods

A team of ten people visited Mana during 5–8 February 2021 to undertake a survey for speargrass weevils. All were familiar with the island and/or surveying methods for speargrass weevils. The coastal slopes of Mana Island were divided in advance into 34 blocks defined by topographic features and tracks (Fig. 2). Three blocks were identified as being too steep for direct survey (these are shaded red on the map), nine blocks were assessed as having low speargrass density (and are shaded yellow), and a further nine blocks are shaded half yellow to denote low speargrass density in their lower (seaward) portions. This left 22 blocks (or part blocks) that were considered to potentially have high speargrass density and that were accessible for survey.

The full team started at block 19 (the speargrass weevil release site) and worked together until all team members were familiar with speargrass weevil feeding sign. We then divided into teams of two or three people, with each team assigned a block to survey for speargrass weevils or their feeding sign. Each team member was issued with a can of spray-paint and a broom handle. A designated recorder within each team used a clipboard and datasheets to record data, and each team had at least one handheld, navigational Garmin GPS unit (and were familiar with how to mark and label waypoints). Each team worked systematically through their survey block, marking each speargrass plant found with a spot of paint, and keeping a tally of the number of plants found, whether they had flowerheads, whether they had weevil feeding sign, and whether any speargrass weevils were seen.

Speargrass weevil browse is most evident on leaf bases and flower stalks (Fig. 3). However, they also browse the edges of the slender leaves, and evidence of this is easily overlooked (Fig. 4). Examples of weevil feeding sign within each survey block were photographed, to allow independent assessment of whether feeding sign has been correctly identified. This was the main purpose for the broom handles (to lever speargrass spines away to expose feeding sign or weevils for clearer photography – see Fig. 3C), as well as providing walking support on steep slopes.

Any plants with weevils or definite feeding sign were assigned a labelled GPS waypoint, and a matching waypoint was made or recorded for the nearest visible flax bush to each speargrass weevil or speargrass plant with weevil feeding sign. Examples of potential waypoint labels for survey block 20 were:

SW20.1 = weevil	FLAX20.1 = nearest flax to this weevil
FS20.2 = feeding sign	FLAX20.2 = nearest flax to this feeding sign

Figure 2 Speargrass weevil survey blocks identified before the February 2021 survey. Red shading identifies slopes that were too steep to survey. Yellow shading identifies areas assessed as having low speargrass density by Mana Island-based DOC staff and weeding contractors. This map was created for the field survey teams, based on an aerial image taken in 2018 (the maps that follow use February 2021 aerial images that were released in July 2021).

Figure 3 Speargrass weevil browse sign on speargrass leaf bases and flower stalks (and an adult speargrass weevil), Mana Island, February 2021. Image credits: A, B & F Annemieke Hendriks; C & D Zoe Quested; E Shaun Thompson.

Figure 4 Speargrass weevil browse sign on speargrass leaf edges, Mana Island, February 2021. Image credits: A & B Annemieke Hendriks; C Zoe Quested.

Note that a single flax bush may be the nearest flax plant to multiple weevils or their feeding sign; however, this would require only a single labelled GPS waypoint. The labelling system for weevils, feeding sign and the nearest flax bush was recorded on data sheets, taking care to ensure that every plant with a weevil or feeding sign had a labelled waypoint and also a nearest flax plant waypoint label recorded on the datasheet. Care was taken to ensure that all labels were unique.

When all team members considered the block to have been adequately covered, the team moved to their next assigned survey block.

On the third day of the survey, three blocks were re-surveyed by different teams (using a different colour spray-paint) to determine what proportion of speargrass plants had been missed during the initial survey, and whether the same proportion and distribution of weevil feeding sign was recorded. Each audit team aimed to sample 200 plants per block, and to gather GPS locations for any plants with apparent weevil browse sign. Rapid surveys (without individual speargrass plants being marked and counted) were undertaken in seven blocks (mainly near the southern end of the island), to determine whether there was evidence of speargrass weevils beyond the blocks that were surveyed in detail.

With the exception of the 'rapid survey' blocks, the focus of the survey was on care and precision, not speed. Within the blocks that were surveyed in detail, we aimed to estimate the number of speargrass plants present, and the proportion of these that had weevil feeding sign. We also aimed to accurately map every plant with feeding sign or a weevil (from its GPS waypoint), and to estimate the distance to the nearest flax plant (from its matching GPS waypoint).

Results

Detailed surveys

Ten blocks were surveyed in detail, with 2,791 speargrass plants counted (maximum plant density based on the area surveyed = 510 plants per ha in block 16; Table 2 & Fig. 5). Speargrass weevil browse sign was recorded on 130 plants in seven survey blocks during these initial surveys, with the highest number of browsed plants in blocks 18, 16 & 19 (Table 2 & Fig. 6). Weevil browse sign was detected more often on large plants, as evident from the proportion of plants with flowerheads that had weevil browse (larger plants were more likely to have flowerheads). Within the three blocks with high recorded rates of weevil browse, 30% of the plants had flowerheads, and 73% of the plants with weevil browse sign had flowerheads (i.e. plants with flowerheads were more than 6 times as likely to have weevil browse sign as plants without flowerheads).

Two adult weevils were found during initial surveys, with one each in blocks 18 & 21 (Table 2 and Figs 3F & 6).

Flax (mainly whaririki *Phormium cookianum*) is a minor component of the coastal shrub community where speargrass occurs on Mana Island. However, at least one flax plant was present within 55 m of every browsed speargrass plant (Fig. 7). While the mean distance to the nearest flax plant was 10.3 m, the distribution was highly skewed, with 51% of browsed speargrass plants having at least one flax plant within 5 m, and 85% having a flax plant within 20 m (median distance 4.7 m).

The density of flax plants differed between blocks, as evident from the median and mean distance to the nearest flax plant in the three blocks with the highest recorded speargrass weevil browse sign (Table 3). Detailed maps showing the locations of speargrass plants with weevil browse sign, and the nearest flax plants to each, are presented in the Appendix.

Table 2 Speargrass data for the ten blocks that were surveyed in most detail in February 2021. Observers: Annemieke Hendriks, Andrew Simpson, Colin Miskelly, Cooper French, Dale Shirtliff, Jaz Hamilton, Julia Wilson-Davey, Leland Wineera Reuelu, Nick Fisentzidis, Shaun Thompson, Will Brockelsby, Zoe Quested. Total plants = total number of speargrass plants counted; With flowers[1] = the number of plants that had flowerheads; %[1] = the percentage of plants in the block that had flowerheads; Total browse = the number of speargrass plants that had weevil browse damage; With flowers[2] = the number of browsed plants that had flowerheads; %[2] = the percentage of browsed plants in the block that had flowerheads; Weevils = the number of adult speargrass weevils seen.

Block	Date	Observers	Area (ha)	Total plants	With flowers[1]	%[1]	Total browse	With flowers[2]	%[2]	Weevils
8	6 & 7 Feb	AS, CM, JWD, WB	2.3	331	141	42.6	0	0	-	
10	6 & 7 Feb	DS, ST, ZQ	2.8	731	152	20.8	6	2	33.3	
11	6 Feb	AS, CM, WB	1.6	8	1	12.5	0	0	-	
13	6 Feb	CM, JWD, LWR, NF, WB	0.6	95	34	35.8	8	6	75.0	
16	6 Feb	AS, CM, WB	0.6	306	80	26.1	35	22	62.9	
18	6 Feb	AH, CF, JH	1.3	412	164	39.8	43	36	83.7	1
19	6 & 7 Feb	AH, CF, JH	1.4	447	102	22.8	25	17	68.0	
20	7 Feb	AH, CF, JH	0.5	87	34	39.1	0	0	-	
21	7 Feb	AH, CF, JH	1.2	141	40	28.4	11	1	9.1	1
22	7 Feb	AH, CF, JH	1.7	233	92	39.5	2	2	100.0	
Total			14.0	2791	840	30.1	130	86	66.2	2

Figure 5 Summary of speargrass density on Mana Island in February 2021 survey. Yellow shading identifies areas where speargrass was recorded, with the intensity of shading proportional to plant density (adjusted maximum density recorded = 600 plants per ha). Red star = speargrass weevil release site, yellow stars = sites where adult speargrass weevils were found in February 2021. Red hatched areas (lower slopes) had low speargrass densities and were not surveyed.

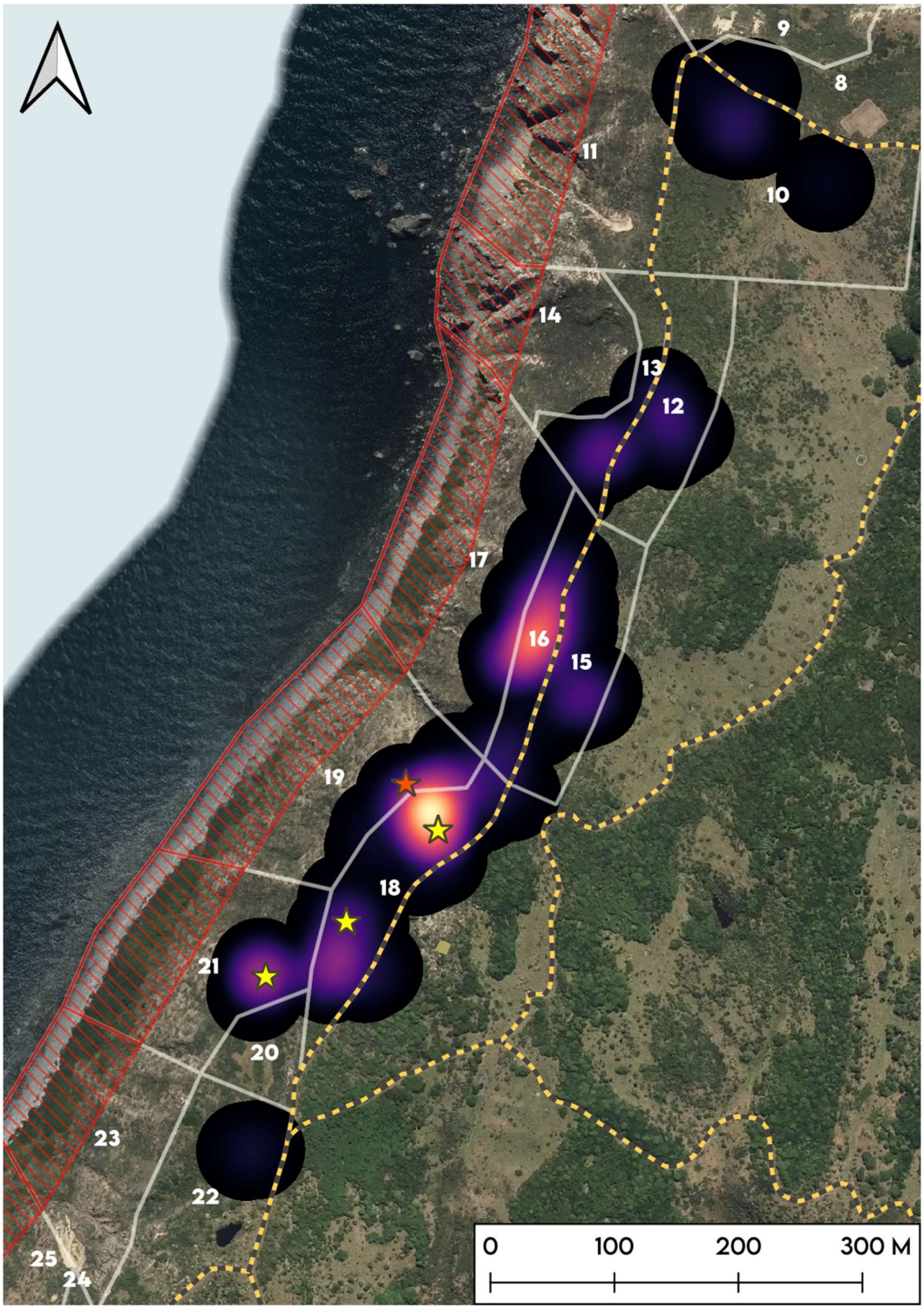

Figure 6 Heat map of speargrass weevil browse sign on Mana Island in February 2021. Brighter colours show areas with high densities of speargrass weevil browsing sign, with black showing low density of browse sign (areas outside the black areas had no browse sign detected). Red star = speargrass weevil release site, yellow stars = sites where adult speargrass weevils were found in February 2021 (one of the weevils in block 18 was found during the initial survey, and one during the audit survey). Red hatched areas (lower slopes) had low speargrass densities and were not surveyed.

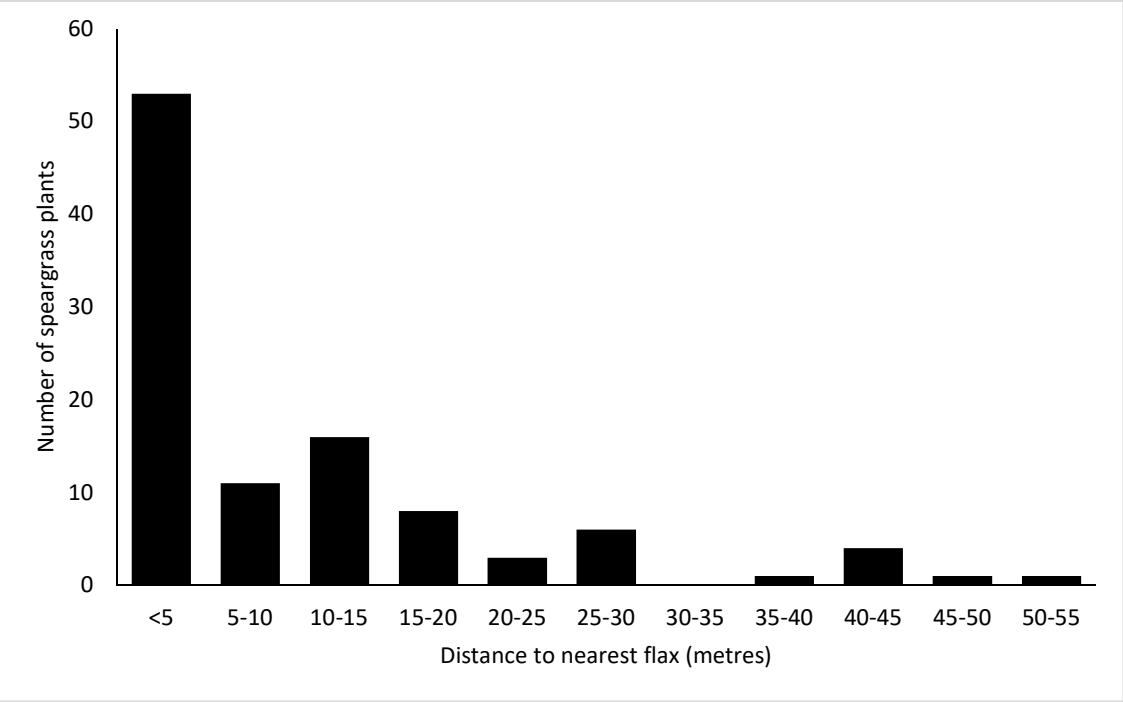

Figure 7 The distance between speargrass plants with weevil browse sign and the nearest flax bush (*Phormium* sp.) on Mana Island in February 2021.

Table 3 Median, mean and maximum distances (metres) between speargrass plants with weevil browse sign and the nearest flax bush, in the three survey blocks with the highest recorded evidence of speargrass weevil browsing. Some GPS points were recorded incorrectly or gave false locations (outside the survey block) and so the sample size for each block is smaller than the total number of speagrass plants with weevil browse sign recorded in the block.

Survey block	n	Median	Mean	Maximum
16	34	6.1	9.7	45.0
18	24	11.9	14.2	42.6
19	15	11.2	17.2	55.3

Rapid surveys

Speargrass plants are abundant at the south end of Mana Island (Fig. 5). However, we did not attempt to count plants and estimate their density during rapid surveys to determine whether speargrass weevils had reached the area. (Note that the speargrass density shading used for blocks 28 to 33 in Fig. 5 is indicative rather than being based on quantitative data.) We did not find clear evidence of speargrass weevils being present, despite searching an estimated 1000+ speargrass plants at the south end of the island.

There is more than 0.5 km of habitat with low or no speargrass that may be preventing speargrass weevils from colonising the south end of Mana Island (i.e. blocks 24 & 26 in Fig. 8).

Figure 8 Heat map of speargrass weevil browse sign on Mana Island in February 2021 overlain on the speargrass density map (see Figs 3 & 4). Brighter colours show areas with high densities of speargrass weevil browsing sign, with black showing low density of browse sign (areas outside the black areas had no browse sign detected). Red star = speargrass weevil release site, yellow stars = sites where adult speargrass weevils were found in February 2021. Red hatched areas (lower slopes) had low speargrass densities and were not surveyed.

Audit surveys

The audit surveys revealed that about 18% of speargrass plants had been missed in the initial surveys (i.e. they did not have paint spots), but that only 11% of the plants that were missed had flowerheads (Table 4). This suggests that most of the plants that were missed in the initial surveys were small and immature. This correction factor of 18% of plants being missed in the initial survey suggests that block 16 had about 600 speargrass plants per hectare.

Unfortunately we were unable to determine the accuracy of browse scoring for individual plants, as the GPS co-ordinates were not accurate enough to be confident that the same plant was being compared between days. A significant 'geometric dilution of precision' (GDOP) was apparent between the initial survey day, and the following audit day. This reduced the sub-5 metre accuracy of the GPS units, relative to previously captured waypoints. However, the teams noted that very few unmarked plants found during the audit surveys had weevil browse sign. Unfortunately this was not recorded on the datasheets, as we were relying on GPS data to determine whether browse sign was found at any new locations.

An additional adult weevil was found in survey Block 18 during the audit survey (Table 4). This was the third and final weevil found during the survey.

Table 4 Audit data (shaded grey) for the three blocks that were surveyed twice. Observers: Annemieke Hendriks, Andrew Simpson, Colin Miskelly, Cooper French, Dale Shirtliff, Jaz Hamilton, Julia Wilson-Davey, Shaun Thompson, Will Brockelsby, Zoe Quested. Under 'Plant status', New = unmarked plants , and Marked = plants with paint spots from the initial survey. With flowers = the number of plants in each category that had flowerheads, % = the percentage of plants in each category that had flowerheads, Weevils = the number of adult speargrass weevils seen.

Block	Date	Observers	Plant status	Total plants	With flowers	%	Weevils
16	6 Feb	AS, CM, WB	New	306	80	26.1	
16	8 Feb	AH, CF, JH	Marked	152	48	31.6	
16	8 Feb	AH, CF, JH	New	51	14	27.5	
18	6 Feb	AH, CF, JH	New	412	164	39.8	1
18	8 Feb	DS, ST, ZQ	Marked	194	75	38.7	1
18	8 Feb	DS, ST, ZQ	New	20	1	5.0	
19	6 & 7 Feb	AH, CF, JH	New	447	102	22.8	
19	8 Feb	AS, CM, JWD	Marked	175	44	25.1	
19	8 Feb	AS, CM, JWD	New	40	5	12.5	

Discussion

The February 2021 survey revealed that speargrass weevils were well-established on Mana Island. While only three adult weevils were found, their feeding sign was found on 130 speargrass plants spread along 1 kilometre of the shoulder of the coastal slopes, extending from near the trig to halfway down the west coast of the Island. Speargrass weevils were apparently absent from a dense population of speargrass plants at the southern end of the Island.

Although speargrass plants do not grow among dense flax swards, all the speargrass plants that we found with speargrass weevil browse sign were within 55 metres of a flax plant, and more than half of them were within 5 metres of a flax plant. It is likely that some speargrass weevils will be exposed to spores of the strain of *Beauveria pseudobassiana* that infects flax weevils; however, we do not know how susceptible they are to this strain. Variation in flax density between survey blocks 16, 18 & 19 (where 79% of speargrass weevil browse sign was found) should allow future assessment of the impacts of the 'flax weevil' strain of the fungus on speargrass weevils, as speargrass weevils in block 16 are more likely to be exposed to the fungus than speargrass weevils in the two other blocks.

In order to assess observer accuracy in identifying speargrass weevil browse sign, it would be beneficial to develop a marker system that distinguishes plants assessed as having weevil browse from those that do not have any browse. This would allow a follow-up 'audit' team to assess the level of false positive and false negative scores in the initial survey.

Recommendations

We recommend that a follow-up survey of blocks 16, 18 & 19 (using similar methodology) be made in the next 3–5 years, with the survey timed to closely follow the peak in flax mortality in these three adjacent blocks. This should reveal whether speargrass weevils in block 16 have been impacted by the 'flax weevil' strain of *Beauveria pseudobassiana*, compared to nearby blocks with lower flax density.

Survey of blocks 8 & 22 should be made around the same time, to assess the rate of spread of speargrass weevils at the northern and southern limits of their Mana Island distribution.

Any dead speargrass weevils found during the survey (or incidentally before then) should be incubated at 100% humidity to determine if they are infected with *Beauveria*.

If further salvage translocations of speargrass weevils are made from the Wellington south coast, it is recommended that they be released in the very dense population of speargrasses at the southern end of Mana Island. If speargrass weevils become more conspicuous (and therefore more catchable) within their current range on Mana Island, consideration should be given to moving 20 or more to the south end of the island. This would increase the resilience of the total Mana Island population, and a safeguard against loss of the current (northern) population.

Acknowledgements

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References

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Miskelly, C. 2010. Mana Island *ecological restoration plan* review. Wellington, Department of Conservation. 45 pp.

Appendix

Maps showing where speargrass weevil browse sign was detected. A circle with a blue ‘S’ shows the location of a speargrass plant with weevil browse sign. Pink lines connect each of these to the nearest flax plant (white diamond with a green ‘F’).

1 Blocks 8 & 10

2 Blocks 12 & 13

3 Block 16

4 Blocks 16, 18 & 19

5 Blocks 18 & 21

6 Block 22