Report on New Zealand Flatworm study conducted at Garthdee Allotments in 2016

Summary of Findings

Brought into the UK in the 1960s, the New Zealand Flatworm exclusively eats earthworms. Earthworms are essential for good soil quality and the food chain. New Zealand Flatworms are between 5-15cm long, flat with a dark brown topside and a creamy pale underside and edge, and are often found curled up like a Swiss roll. They are pointed at both ends and covered in sticky mucus, trails of which are left wherever they have been.

In the spring of 2016, with the generous help of allotment holders at Garthdee, a study was made of the presence and abundance of New Zealand Flatworms and earthworms and the factors influencing these.

Key findings

- New Zealand Flatworms were widespread across Garthdee allotment– present in 70% of plots sampled.
- The greatest numbers of New Zealand Flatworms were found where plots were 'cluttered'. Plots with areas of soil covered in plastic, carpet and weed control fabric had the highest numbers of New Zealand Flatworms underneath them. These coverings act as refuge (daytime shelters for the flatworm as they are prone to drying out).
- Earthworm numbers sampled were low across Garthdee, with the exception of a few plots, in line with questionnaire responses. Furthermore, 60% of respondents said that earthworm numbers had decreased since they had taken on their plots.

Recommendations

- Awareness raising is extremely important. New plot holders should be provided with information on New Zealand Flatworm in their joining packs, including what they look like, so they can keep an eye out for them, something that is already happening at Garthdee. This will help control efforts and minimise numbers at the allotment, but most importantly reduce the risk of transfer of the New Zealand Flatworm (eggs or juveniles) from allotments to home gardens or elsewhere via plant material or soil.
- Removal of clutter from plots can help minimise areas of shelters for the New Zealand Flatworms to hide under.
- Temporary traps using weighted plastic can, however, be useful if one wishes to carry out control. In that case, systematic checking of the traps and control needs to be carried out regularly (otherwise the traps would help the flatworms rather than hinder) and over an extended period.
- Any conditions which make the soil more suitable for earthworms will help tip the balance in their favour, e.g. incorporating organic matter into soil will benefit earthworm populations.
- Further information about New Zealand Flatworm and advice for gardeners on minimising the impact of New Zealand Flatworms can be found on the OPAL website: www.opalexplorenature.org/nzflatworm. This website can also be used to leave observations such as observed changes in abundance of flatworms or earthworms in one's plot, or changes related to action taken.

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Full report on New Zealand Flatworm study conducted at Garthdee Allotments in 2016

Visits were made by members of Aberdeen University to Garthdee allotments in the spring of 2016 and questionnaires were distributed. Sampling took place in 38 full-sized plots and 15 half-sized plots, and 53 people responded to the questionnaire; unfortunately not every sampled plot had a corresponding questionnaire.

The following sections summarise the principal findings arising from the study.

Occurrence of New Zealand Flatworms

At Garthdee, 70% of all plots sampled had New Zealand Flatworm present (average 4.4 present per plot, maximum 17 in one plot). A total of 163 New Zealand Flatworms were found.

The questionnaires indicated 32% of Garthdee plot holders believed they had New Zealand Flatworm, while 43% thought they didn't and 25% did not know whether they did have New Zealand Flatworm or not (see table below for actual numbers). The discrepancy between our sampling and the questionnaire responses indicates that in many cases flatworms go unnoticed despite the fact that most allotment holders know their plot well.

Questionnaire response		**Sampling**	
		New Zealand Flatworm	
		Present	Absent
New Zealand Flatworm Present	(in 14 plots)	in 14 plots	in 0 plots
Don't know	(in 11 plots)	in 7 plots	in 4 plots
New Zealand Flatworm Absent	(in 21 plots)	in 11 plots	in 10 plots

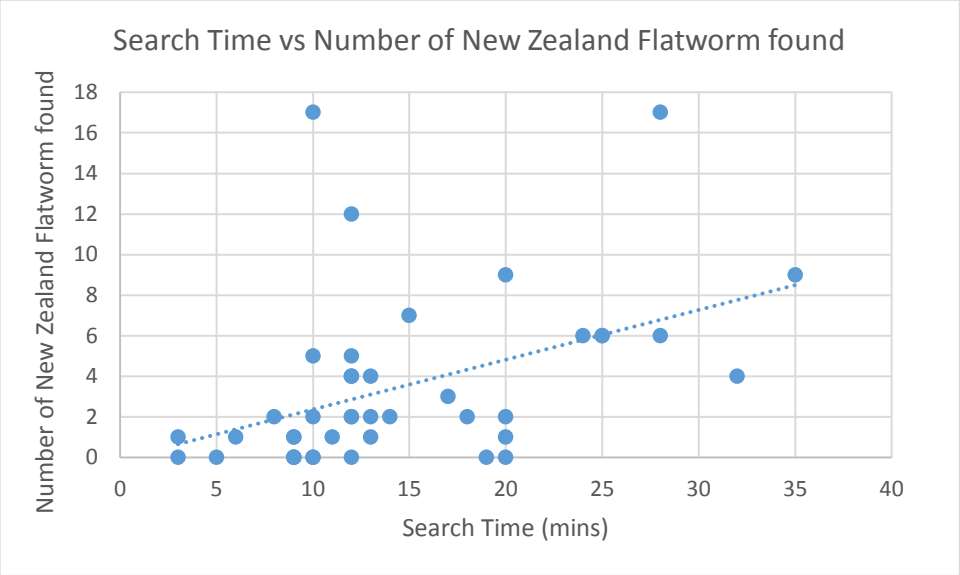
Very few plots holders (6%) reported ever having seen an egg capsule in their allotment plot. Likewise, during our sampling very few eggs were observed: one on each of two plots, both of which had already hatched.

Egg capsules resemble shiny blackcurrants and are commonly found in early summer and later autumn. They vary in size between 4-11 mm long and 3-8 mm wide. Juvenile flatworms, as seen in picture on the right, emerge from the egg and are initially cream or yellow in colour. The characteristic shiny slime of New Zealand Flatworms can also be seen in the picture on the left.

Refuges of New Zealand Flatworm (daytime shelters)

The presence of refuges, i.e. places that New Zealand Flatworms shelter under, has in previous studies been highlighted as an important issue, so we studied this in detail. Refuges could be formed by stones, wood, plastic, weed control fabric or anything the New Zealand Flatworm could hide under during the day.

The abundance of refuges on a plot was categorised as either none, small, medium or lots. Only one plot had no refuge of any sort, 18 plots had small amounts, 14 plots had a medium amount and 14 plots had lots. There was a reasonably clear relationship between the time it took to search possible hide-outs and the numbers of New Zealand Flatworm found. Therefore, the more cluttered a plot was, the longer it took us to inspect them all and more New Zealand Flatworms were present.



Refuge Results

- The proportion of New Zealand Flatworms found under each type of refuge was: plastic (46%), carpet (23%), weed control fabric (18%), wood (7%), large stones (5%), metal (1%), ceramic (1%), and asphalt paper (1%). These percentages partially reflect where the flatworms like to hide under (sheet material, tarpaulin, carpet and weed control fabric). The refuges keep the ground nicely smooth and damp, and flatworms prefer these areas because they are prone to dehydration. The different percentages against the various refuge types also reflect how common certain materials are in the allotment. The highest number of New Zealand Flatworms found was 17, in two different plots; on one plot they were all found under plastic and in the other plot all 17 were found under one piece of carpet.

- Most New Zealand Flatworms were found under carpet and plastic (average numbers of 4.1 and 3.9 respectively per plot), with fewer numbers per plot found under weed control fabric (2.4), wood (2.4) and large stones (1.1).

History of invasion at Garthdee

The point at which allotment holders became aware that New Zealand Flatworm was present at Garthdee allotments varied markedly. Just less than half of respondents (43%) were aware of New Zealand Flatworm presence at Garthdee when they took on the plot or shortly thereafter, but 53% of respondents only became aware several years after taking on their plot. It appears that New Zealand Flatworms have been present at Garthdee since at least 2001, although one respondent said they knew it was there as far back as 1998. Information on New Zealand Flatworms has recently been included in joining packs at Garthdee, which is

extremely useful to help raise awareness. An understanding of the issue can help prevent the spread and transfer of New Zealand Flatworms. Most (83%) respondents reported that they did not have New Zealand Flatworm in their home gardens, and many reported they were now very careful with bringing plant material and soil from the allotment into their home garden.

The majority of questionnaire respondents (63%) said that they did not know how New Zealand Flatworms first arrived in their plot at Garthdee. A further 19% said that New Zealand Flatworm was present when they took over the plot, and 13% thought it arrived with plant material from garden centres. No-one suggested that New Zealand Flatworm may have arrived with top soil or peat-based compost, from neighbouring plots or from plant material from friends. It was surprising that no-one reported that the New Zealand Flatworms may have come from neighbouring plots, as 30% of plot holders knew that neighbouring plots had New Zealand Flatworms (7% said they didn't and 63% didn't know if neighbouring plots had New Zealand Flatworms or not).

There was no clear picture of how numbers of New Zealand Flatworms have changed at Garthdee. A third of plot holders who completed a questionnaire responded to the question, and of those, 21% thought New Zealand Flatworm numbers had increased, 32% decreased, 5% fluctuated, 5% stayed the same, and 37% of people did not know. It is likely that the answer given is in part determined by how long people have had their plots for. In fact people who had their plots for. The majority of plot holders who had their plot more than 15 years, thought that the number of New Zealand Flatworms was lower than in previous years, indicating that New Zealand Flatworms may be on the decline in the predator-prey cycle. This may lead to earthworm numbers potentially recovering, but this could also be followed by New Zealand Flatworm numbers increasing again.

Impact of New Zealand Flatworms on earthworms

Of the 52 people that responded, 39 people said they had earthworms, although these were often Compost worms and Brandling worms usually found in compost bins but both can also occur in wet, decaying leaf litter, organic-rich soils and manure heaps or in the soil after compost has been dug in. During sampling the vast majority of worms found were immature worms that could not be identified to species, however, there were also Grey worms, Blue-grey worms and a few individual Brandling worms and Lob worms.

Compost worm - The whole body is stripy on its upper surface when moving. Saddle usually paler than the rest of the body.

Brandling worm - stripy on its upper surface with dark red bands and a pale pink or yellowish band in between

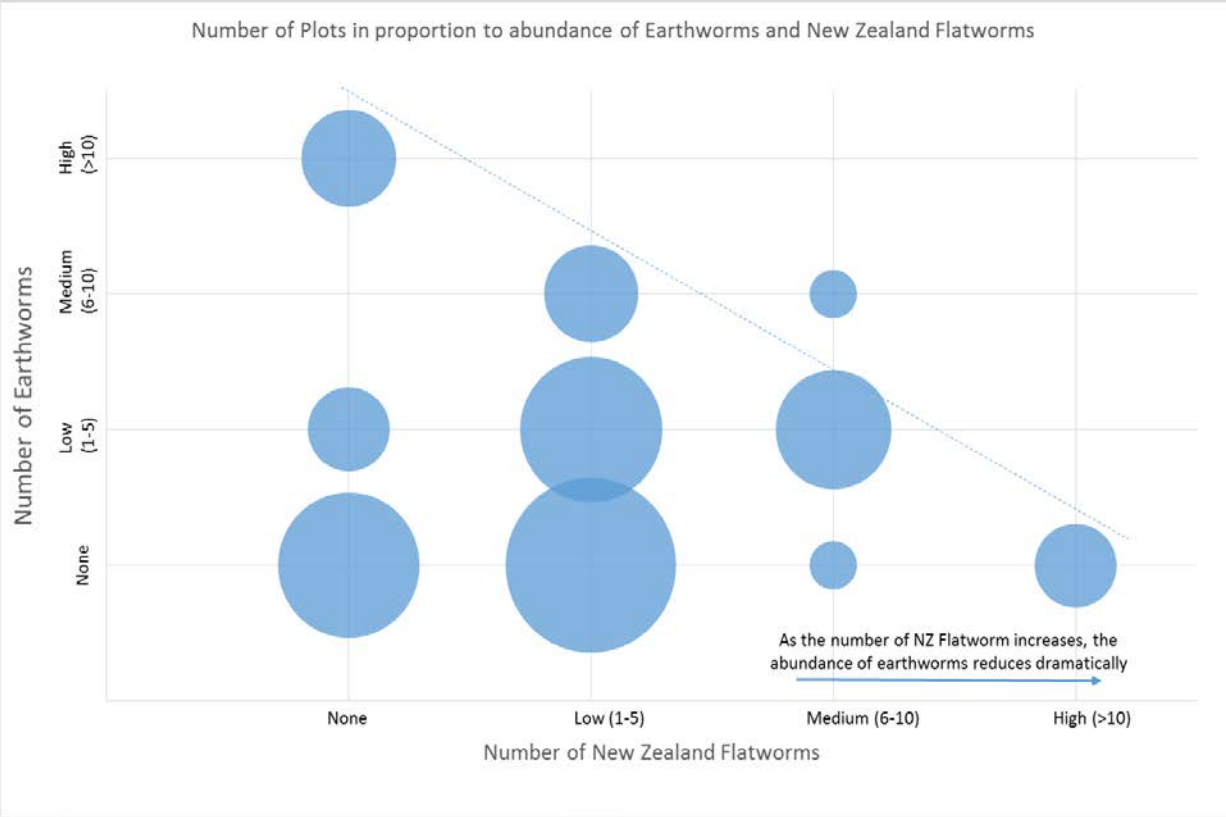
Since the arrival of New Zealand Flatworms, 59% of plot-holders reported that the number of earthworms had decreased, 24% stayed the same, 14% of people did not know and only 1 plot-holder (3%) thought that the number of earthworms had increased. Several very useful insights were given:

- "Very few earthworms <20, only under grass not open soil when digging it up".
- "Earthworms were plentiful when I first had allotment but now a rarity".
- "Amazed there are no earthworms – it's wrong! Have worms in the compost which hope by forking it onto land would get worms in plot. If I see an earthworm its "hey, look at this, an earthworm"

- "Not many earthworms. We check every week for NZ Flatworms and kill about 20 average"
- "No earthworms seen this year"
- "Earthworms are v rare. At home I usually see an earthworm on every spadeful when I dig over garden. At the plot I can dig over 20m2 and not see an earthworm."

When plots were searched, earthworms were found in half of the plots, but numbers were low: in 33% of plots between 1 and 5 earthworms were found, in 9% of plots between 6 and 10, and in 7% of plots more than 10. The earthworms were often found in grassy patches, suggesting that grassy paths and grassy patches may be important for the survival of earthworms where New Zealand Flatworm is present.

Number of plots in proportion to abundance of earthworms and New Zealand Flatworms. The size of the circle indicates the number of plots. The bigger the circle the more plots.



Plot characteristics

The type of boundary (hard e.g. corrugated metal, wall etc. or soft e.g. wire mesh fence) did not seem to affect New Zealand Flatworm numbers, although in most cases there was a mix of boundaries in a plot. One might imagine that hard boundaries would minimise movement of New Zealand flatworms between plots, however as with raised beds, we could not find evidence for such 'obstacle' effects.

Other plot characteristics were also investigated, and revealed that:

- The presence of compost bin(s) did not affect the number of New Zealand Flatworms.
- The amount of grass found in a plot did not significantly determine the number of New Zealand Flatworms.
- The amount of grass present however, *did* influence the number of *earthworms* found. The more grass present, generally the higher the numbers of earthworms.

Gardening practice

Of plot holders, 91% added compost to plots, usually on an annual basis; 78% added manure either annually or biannually, and 24% added lime. There was no apparent relationship between the various additions and the number of New Zealand Flatworms or earthworms. Some plot holders did, however, report that they felt that the addition of lime helped keep numbers of New Zealand Flatworm down.

There was roughly an equal number of plots with and without wood chips. There did not seem to be any relationship between the presence of New Zealand Flatworms and the presence of wood chips. A potential issue with wood chip, however, may be the introduction of New Zealand Flatworm from these products.

A third of plot holders exchanged plant material, but very few exchanged soil (7%).

Various methods are employed by people to control New Zealand Flatworms, including salt, lemon juice and squashing them (note: squashing is not a recommended method due to potential for accidently transporting them, or their eggs). Some people opted not to control New Zealand Flatworms on their plots.

A quarter of respondents said they had changed gardening practices as a result of having New Zealand Flatworms, including being more vigilant about transferring New Zealand Flatworms from the allotment to gardens at home. Eight people mentioned that they had removed carpet, plastic and wood in an attempt to reduced New Zealand Flatworm numbers.

Relationship with other fauna

At Garthdee 78% of plot holders reported seeing beetles. Large predatory beetles such as Drove and Ground beetles are known to be New Zealand Flatworm predators, so any measures to promote their numbers may be helpful. Whilst the presence of beetles was recorded during plot sampling, there were however no obvious relationship with the numbers of New Zealand Flatworms found.

The majority of plot holders thought that bird populations had not changed since they first noticed New Zealand Flatworms, and no-one reported changes to mammal populations.

So, although an impact to earthworms from New Zealand Flatworm has been confirmed at the allotment plot level, this has not led to observable effects on local birds and mammal populations.