EDGE AND DISTURBANCE EFFECTS ON FOREST FLOOR INVERTEBRATES IN TWO HOBART URBAN RESERVES

Samuel Davies[1], Michael Driessen[2] & Peter Davies[3]

[1,3]82 Waimea Avenue, Sandy Bay, Tasmania 7005; [2]Resource Management and Conservation Division, Department of Primary Industries and Water, GPO Box 44, Hobart, Tasmania 7000; email: michael.driessen@dpiw.tas.gov.au

INTRODUCTION

This paper describes a study being conducted on forest floor invertebrates in two adjacent bush reserves in Sandy Bay, Hobart. The Hobart City Council (HCC) manages approximately 3000 hectares of bushland and included in this area are Lambert Park (4.8 ha) and Bicentennial Park (51.7 ha), 3.5 km southeast of the centre of Hobart in the suburbs of Sandy Bay and Mt Nelson.

In 1948 the HCC reserved bush as the "Skyline Reserve" along the Mt Nelson skyline ridge and the upper and middle Lambert Rivulet catchment. In 2004 this was expanded by 45 ha and the entire 180 ha reserve, which sits above Churchill Avenue, became Bicentennial Park. On the lower side of Churchill Avenue, 10 acres was donated to the City over 100 years ago, forming the wet gully forest reserve of Lambert Park.

Both parks retain much original bush vegetation, ranging from wet closed forests to dry sclerophyll woodland surrounded by rocky outcrops, and wet streamside vegetation. Soils vary from shallow and sandy to clay soils – siltstone and mudstone derived soils in Lambert Park and dolerite derived soils on the upper Mt Nelson slopes.

Wet gully forests surround Lambert Creek and its two tributaries, with drier forests bordering the urban edges characterised by residential properties along the upper slope margins, typically with exotic to semi-exotic gardens and generally open fence lines. These are associated with a range of introduced grasses and weeds found along park margins, as well as woody weeds like *Cotoneaster*.

Both parks are a focus for recreational and commuter walking. Two publications (Hird 1995; AVK 1998) describe their general context, vegetation, and vertebrate fauna. There are no publications that describe the invertebrate fauna of either reserve.

In this article we describe a study being conducted on forest floor invertebrates, which forms a project under the new Student Directed Inquiry (SDI) syllabus

subject for the TCE students at Hutchins School, Hobart. The school is adjacent to Lambert Park.

The effectiveness of urban reserves for the conservation of invertebrate diversity is partially dependent on the degree to which exotic species are prevented from invading a range of habitats, which is in turn dependent on the size of the reserve and the level of disturbance from clearing, fire, vegetation/weed invasion and maintenance, track development and management, etc. (Gibb & Hochuli 2002).

A primary aim of the study is to assess the influence of reserve width and distance to urban edges on the presence of exotic invertebrate species. The two reserves are typified by having sharp boundaries between native bushland and the adjacent suburban blocks.

We are making a series of measurements to rate the level of disturbance at each study site and relate it to distance from the "urban edge" and the composition of pitfall trap catches. The size and cover of reserved forest fragments and soil moisture are also important factors that influence arthropod diversity in urban reserves (Watts & Larivière 2004), and these are also being measured.

Our study is being conducted during autumn-spring of 2008 in Lambert and Bicentennial Parks, with pitfall trapping of invertebrates and collecting data on habitat features. Pitfall trap data is being used to compare the diversity and abundance of forest floor invertebrates at ten sites selected along a gradient of reserve width and proximity to the urban edges of the reserves. In this article we present the study methodology and some preliminary results.

METHODS

Study sites

Ten sites were chosen within the adjacent Lambert Park-Bicentennial Park reserves (Figure 1). At each site, five pitfall trapping locations have been established, with a total of 50 traps set at any one time.

Site descriptions

The sites chosen for sampling were intended to capture a range of habitats within the reserve, along a gradient of increasing reserve width and distance from the urban boundary. The sites are as follows:

Sites 1, 2, 3 and 4: adjacent to creek along its length.

Sites 1a, 2a, 3a and 3b: adjacent to the urban edges of the reserves at a similar distance from the 'creek' sites.

Sites 4a and 4b: mid-slope and isolated from the urban edge, with a similar distance from the creek site as the urban edge sites adjacent to sites 2 and 3.

All sites were located away from public paths and tracks.

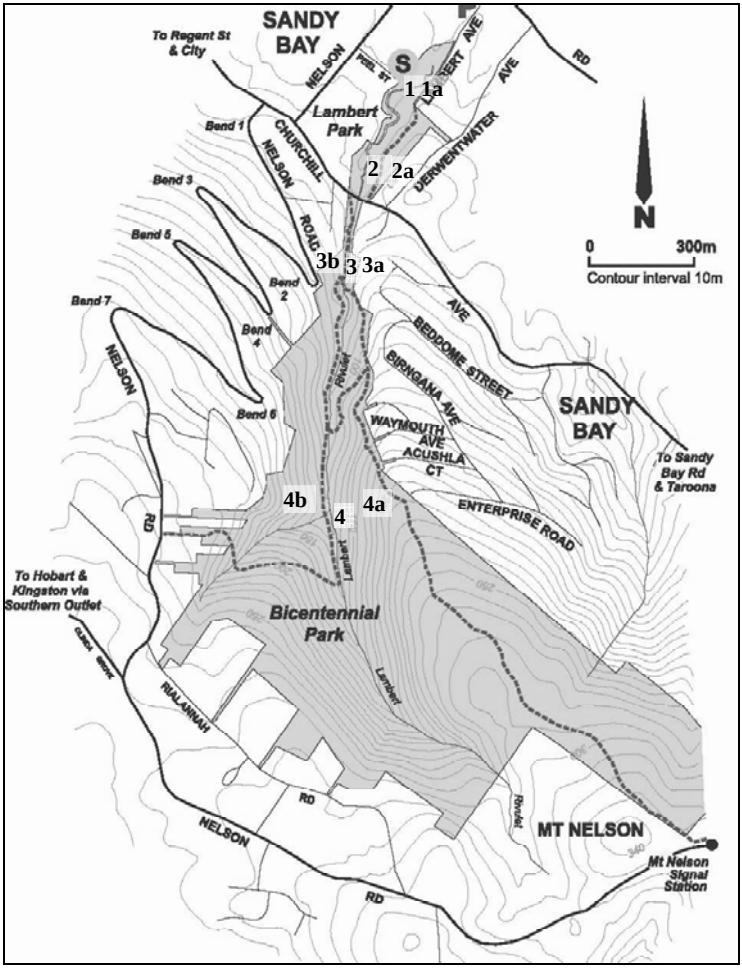

Figure 1. General setting of Lambert and Bicentennial Parks in Hobart (map courtesy of Hobart City Council). Numbers indicate study site locations.

Pitfall trapping

Pitfall traps consisted of an augured hole lined with a plastic pipe sleeve into which was placed a single plastic cup with its top level with the soil surface. Care was taken to minimise soil and local habitat disturbance around each trap location. Cups are one third-filled with 70% ethanol, and covered with a plastic lid to reduce

rain dilution and litter input (Plate 1). Lids are supported approx. 6 – 10 cm above the ground by wooden skewers.

Traps are placed within a radius of ca. 5 m, at each of five locations selected to represent the range of local habitat conditions. The full set of traps has been deployed for several separate sampling periods of ca. 10 – 14 days' duration.

Invertebrate collection and identification data

After each sampling period trap catches are collected and preserved with ethanol. All invertebrates are identified initially as morpho-taxon then, where possible, to family or genus/species, using low and high power microscopy.

Habitat data

Habitat variables were selected by identifying key factors that are believed to influence abundance and diversity of pitfall trap catches, as follows:

Abundance

1. food; 2. water/moisture; 3. cover/shelter; 4. disturbance;

Taxon Diversity

1. habitat complexity; 2. variety of food resources; 3. disturbance.

The habitat variables identified as being associated with these factors are listed in Table 1.

RESULTS

Pitfall trap catches for an initial 12-day trap set are summarised in Table 2. A total of 109 morpho-taxa have been identified to date, 85 of which were caught in the initial 12-day trapping period (listed in Table 3). The most diverse groups were, in order of decreasing diversity of morpho-taxa (Table 3): beetles (18 morpho-taxa), spiders (11), wasps (9), and ants (5).

Seven exotic species have been identified consisting of several snail and slug species, European wasps and honey bees, and springtails (Collembola, especially *Hypogastrura purpurescens*), at several sites where they were by far the most numerous taxon. Extremely large numbers of *H. purpurescens* were observed in grassy sites adjacent to gardens, but this taxon was absent elsewhere.

Notable in this first trapping analysis was the absence of Argentine ants (*Linepithema humile*), which are recent invaders of adjacent urban blocks in both Sandy Bay and Mt Nelson and can reach very high densities (P. Davies pers. obs.). This species does not appear to have invaded the reserve, even along its margins. Interestingly, numbers of the native ant genus *Monomorium* appear to be higher in disturbed sites.

Table 1. Biotic features, determining factors and associated habitat measurements.

Feature and factors	What to measure	Lab/Field
ABUNDANCE		
1. Food		
Predators	Abundance of prey in trap (ratios)	L
Primary Consumers	Soil fertility, nitrogen and phosphorus	L
	Soil moisture – oven drying of soil cores	L
2. Water/moisture		
Soil	Soil moisture – oven drying of soil cores	L
Air near the ground	Evaporation rates – covered pans of water	F
3. Cover/shelter		
Near-ground vegetation cover	Shade, hemi-spherical mirror, on the ground	F
Mid/upper storey vegetation cover	Shade, hemi-spherical mirror, at standing height	F
Soil	Structure – dropped spike; and organic content - muffle furnace	L
4. Disturbance		
Human	Distance to tracks, urban (fences) and vegetation cleaning (cut stumps)	F
Fire	Charcoal on trunks and ground	F
Introduced Species	Abundance in trap – predators and prey (ratios)	L
TAXON DIVERSITY		
1. Habitat Complexity		
Near-trap patch	Intersection of stems, branches (debris within a vertical grid)	F
Forest complexity	Botanist's forest structure survey	F
Soil structure	Soil density – dropped spike	F
2. Variety of food resources		
Predators	Diversity of prey in traps (ratio)	L
Primary consumers	Diversity of food (e.g. plant species, wood debris	F
3. Disturbance	As above	

Table 2. Summary of pitfall trap catches for initial 12-day trapping period, 2008.

Site	1	1a	2	2a	3	3a	3b	4	4a	4b
No. taxa	27	30	25	39	20	34	31	22	33	22
Total abundance	197	295	292	1520	153	603	525	219	381	176
No. exotic taxa	0	1	0	5	0	1	1	0	0	0
% abundance exotics	0	0.3	0	72.8	0	49.8	41.9	0	0	0
% n taxa exotics	0	3.3	0	12.8	0	2.9	3.2	0	0	0
Distance from urban edge (m)	60	30	41	10	32	3	8	250	73	210

The proportion of total trap catches of exotic taxa ranged up to 73% (Table 2). However exotics were only observed at sites along reserve edges adjacent to suburban blocks (Figure 2), and their presence declines sharply with distance from the reserve edge (Figure 3).

A plot of the number of morpho-taxa against shading (Figure 4) reveals a significant positive correlation for sites where exotic species are absent ($r = 0.94$, $n = 6$, $p < 0.01$). A plot of the total abundance in trap catches against shading (Figure 5) also reveals a significant positive correlation for sites where exotic species are absent ($r = 0.78$, $n = 6$, $p < 0.05$). Sites with significant proportions of exotic species do not conform with either of these relationships (Figures 4 and 5).

More open drier sites appear to be characterised by the presence of greater abundances of scorpions, jassids and some spider taxa. Some morpho-taxa are ubiquitous across all sites and abundant – notably scorpions, some native ants, spider, spider mite, fly and springtails.

DISCUSSION

The results presented here are preliminary and only based on one series of pitfall trap data. They already indicate some interesting relationships between proximity to the urban edge of the reserve and the presence of exotic species – several of which are known pests associated with suburban exotic gardens (slugs, glass snails and the purple springtail).

The exotic species do not appear to penetrate further than some 25 m into the reserve, and appear to be absent at the majority of trap sites (though European wasps have in-ground nests well within the reserve, an observation made with some pain by S. Davies!).

Table 3. Main taxonomic groups caught in traps in the initial 12-day period, 2008.

Class/Order	General name	Total Abundance	Total N Taxa
Acarina	Mite	132	3
Amphipoda	Amphipod	53	1
Arachnida	Spider	151	11
Coccoidea	Scale insect	17	1
Coleoptera	Beetle	302	18
Collembola	Springtail	1999	4
Dermaptera	Earwig	1	1
Diplopoda	Millipede	43	2
Diptera	Flies	546	4
Embioptera	Embiopteran	5	1
Hemiptera	Bug	5	4
Heteroptera	Bug	116	1
Hymenoptera	Ant	356	5
	Bee	2	2
	Wasp	18	9
Isopoda	Isopod	50	1
Lepidoptera	Moth	28	4
Orthoptera	Cricket	23	1
	Grasshopper	1	1
	Insect pupa	18	1
Platyhelminthes	Flatworm	1	1
Pseudoscorpionida	Pseudoscorpion	3	1
Psocoptera	Louse	1	1
Pulmonata	Slug	1	1
	Snail	29	4
Scorpiones	Scorpion	175	1
Siphonaptera	Flea	2	1
	Sum	**4078**	**85**

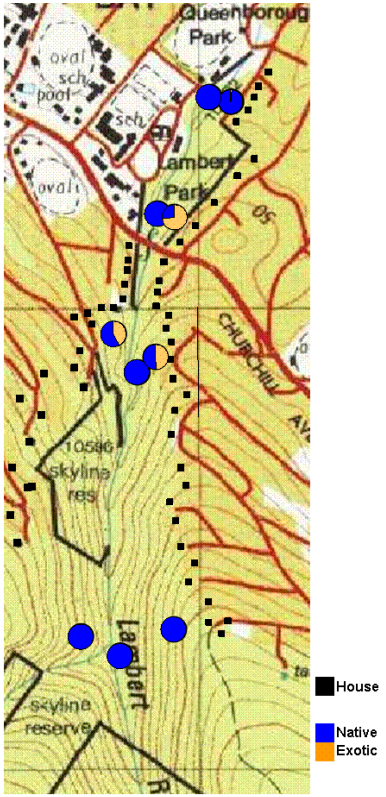

Figure 2. Site locations showing proportions of invertebrate abundance in pitfall traps that were exotic and native species. The locations of houses adjacent to reserve boundaries are also shown.

Plate 1. Setting pitfall traps (site 3), Bicentennial Park.

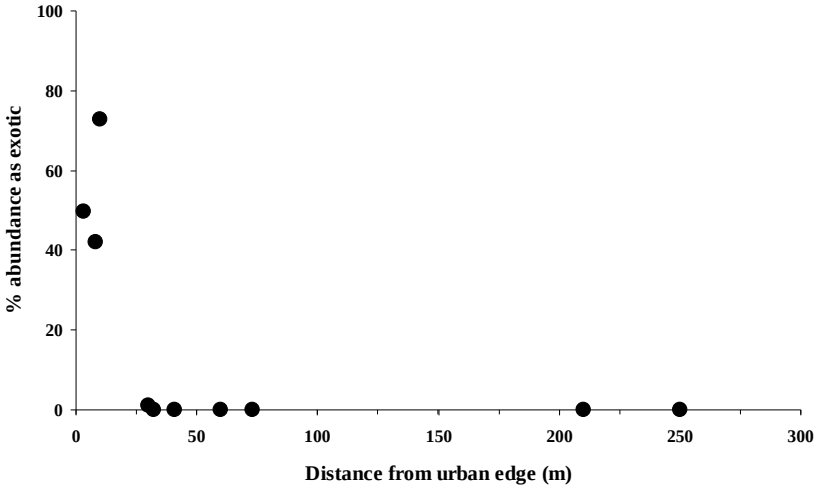

Figure 3. Relationship between overall percentage number of trap individuals as exotic species and site distance from urban edge.

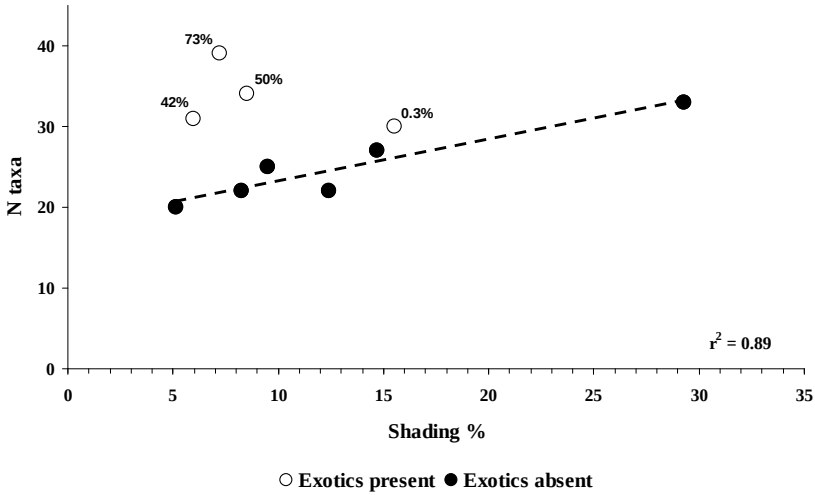

Figure 4. Relationship between number of morpho-taxa found in pitfall traps with shading, for sites with and without exotic taxa present (with percentage of abundance as exotics shown). Least squares regression for those sites with no exotics is shown, along with its r^2 value ($p < 0.01$).

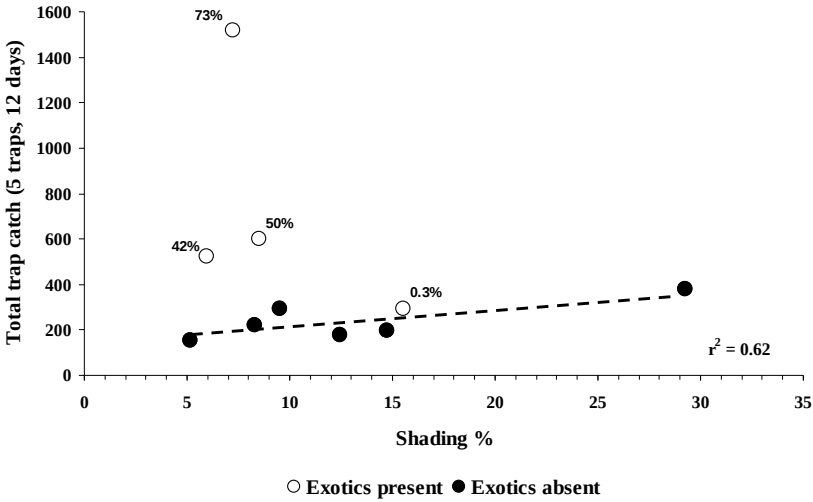

Figure 5. Relationship between total abundance in pitfall traps with shading, for sites with and without exotic taxa present (with percentage of abundance as exotics shown). Least squares regression for those sites with no exotics is shown, along with its r^2 value ($p < 0.05$).

DISCUSSION (continued…)

This absence of exotic taxa is probably linked to the low level of disturbance in the reserve adjacent to the trap sites, combined with the maintenance of low levels of exotic weeds in the core of the reserve (thanks to active management by a local community group and the HCC). The presence of exotic plants is a known facilitator of exotic invertebrate presence in urban reserves (Clark & Samways 1997).

These initial results suggest that the reserve is maintaining a wide variety and abundance of native forest floor invertebrate taxa, which appear to be responding to natural habitat gradients.

Further analysis of trap catches and habitat relationships is underway, with an additional focus on local 'micro-habitat' characteristics around individual pitfall trap locations within sites.

This study illustrates the success of the SDI syllabus in providing opportunities for secondary school students to conduct studies of invertebrates, under the guidance of experienced mentors.

ACKNOWLEDGEMENTS

We would like to thank Dr Abell (Hutchins School) for guidance of the SDI project. We would also like to thank Tom Sloane, Cathy Young (DPIW) and Kevin Bonham for assistance with identification of several taxa.

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