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Project Report

Using a Collection Health Index to prioritise access and activities in the New Zealand Arthropod Collection

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Abstract

A Collection Health Index (CHI) is a useful approach to help scope new activities, prioritise curation and accelerate digitisation within taxonomic collections. We use a Collection Health Index (CHI), based on McGinley (1993), to profile the curation levels in the New Zealand Arthropod Collection for major insect groups. There are several highly curated and well known groups (Hemiptera, Lepidoptera, 'Other Insects'). However, three major issues were identified: 1) curation becoming increasingly outdated in sections with large numbers of, particularly older, specimens (Coleoptera, Diptera); 2) historically poorer curation, with no resident expertise or resource (Diptera); and 3) high levels of family and genus-only material that needs further identification and a significant amount of alpha level taxonomy (parts of Coleoptera, parts of Diptera and Hymenoptera). Assessment using the CHI is simple and fast, allows future planning and is based on common issues for collection management, such as care, accessibility, organisation and data capture.

Keywords

access, curation, digitisation, Hymenoptera, insect, invertebrate, prioritisation, taxonomy

Introduction

Taxonomic collections are a critical resource to enable scientists and researchers to address global issues including climate change, biosecurity and conservation (Thiers et al. 2021). Several comprehensive reviews have recently provided frameworks and pathways for how taxonomic collections can play increasing roles in science, education and society, but also provide arguments for continued funding to support underlying infrastructure and the critical activities of collections (Lendemer et al. 2019, Thiers et al. 2021, Miller et al. 2022). However, the resources available within taxonomic collections seldom match wider expectations from the scientific community, end users and funding agencies. Particularly relevant is the increased demands on collections staff for access and the use of specimens and their data (digitisation) and concern that collections are often being inundated with specimens from environmental surveys (McGinley 1993, Schilthuizen et al. 2015, Ward et al. 2015).

To make the best use of their limited resources, taxonomic collections need to prioritise their activities, particularly planning for the ongoing care and maintenance of holdings and for greater access and use (McGinley 1993, Miller et al. 2022). McGinley (1993) introduced the concept of a Collection Health Index (CHI) for entomology collections. The Index provides an evaluation of collection health in terms of care, conservation of specimens, accessibility to specimens, physical organisation and data capture (McGinley 1993). It provides a quantitative measure that can be examined for different taxonomic hierarchies, sections within a collection and across time. The CHI is also adaptable, as demonstrated by its modification and use for other organisms (e.g. vertebrates, Williams et al. 1996; vertebrates, fungi, plants and (non-insect) invertebrates, Favret et al. 2007). The Index also enables prioritisation of further actions to improve quality and access. For example, reports can be generated listing the top priorities within a taxonomic group, a section or across the entire collection. Furthermore, new proposed activities can be better scoped before they start; and curatorial improvements can be used to accelerate digitisation. The CHI can be easily summarised and communicated to collection staff, managers and funders, providing a summary of the extent of holdings and its care.

The New Zealand Arthropod Collection (NZAC) is the world's largest taxonomic collection of terrestrial invertebrates from New Zealand (Ward and Tassell 2021). The NZAC is specifically funded by the New Zealand government as a 'Nationally Significant Collection and Database' focusing on taxonomy, systematics and natural sciences. The NZAC contains approximately 1.6 million 'objects' and, together, these objects contain an estimated 7 million individual specimens. There are approximately 1,250,000 dry mounted specimens (pinned); 250,000 fluid specimen lots (e.g. jars, vials, including bulk samples); 100,000 microscope slides; and 6,000 dried plant specimens. Over 216,000 objects have been digitised and these records are publicly available via the Global Biodiversity Information Facility (GBIF). Progress on digitisation can be visualised via a dynamic Shiny app (https://nzac.shinyapps.io/mass-digi/). The NZAC is important for its national holdings of invertebrate biodiversity; taxonomic research; and as a repository for voucher specimens from ecological surveys, importations of biocontrol agents and newly

established exotic species. Significant holdings include: > 4100 holotypes; the Maskell collection of scale insects (Hemiptera: Coccoidea) from the 1870s; a significant collection of weevils from South America and other parts of the world; and a substantial South Pacific collection held in trust for Pacific nations (~ 150,000 specimens).

Given the size of the NZAC, using a CHI is useful to help scope new activities, prioritise curation and accelerate digitisation. In this paper, we aim to profile the NZAC and the major insect groups.

Data Gathering

The basic methods follow McGinley (1993), where each Cornell style insect drawer is given a single score which encompasses: care and conservation (level 1); specimen accessibility (levels 2-4); and physical organisation (levels 5-6) (Table 1). Assessments of taxonomic groups were undertaken in 2022, except for Hymenoptera which was done in 2019. The assessment is limited to pinned material.

Table 1.

Original names of the levels used to create a Collection Health Index from McGinley (1993); the shortened name used in the current assessment; and a summary of the basic actions required at each level.

Original name	Current name	Action(s) required to improve
1. Conservation problem	Damage	Conservation and care of specimens (e.g. gluing specimens that have fallen off pins); assessment of pest or mould damage
2. Unidentified, Inaccessible	Inaccessible	Unsorted material (order, family or subfamily level) is further identified to genus (or species)
3. Unidentified, Accessible	Genus-only	Identify genus level material to existing named species OR alpha taxonomy for undescribed species
4. Identified, but not integrated	Integrate	Integrate and arrange species into existing taxonomic hierarchy
5. Identified, but curation incomplete	Incomplete	Curation to update taxonomic names, labels, arrangement of species
6. Identified and curated	Complete	Maintain this species level of curation over time

We used a collection floor plan (cabinets, rows) and a numbered system for each drawer to briefly inspect and assign a score (level) to each drawer. If a drawer contained specimens at mixed levels of curation (e.g. well-curated specimens at level 6, but also unsorted material at levels 2-3), then the lowest score was used. This means the overall profile of groups and the NZAC have more conservative lower values. For the NZAC, level 2 was assigned if drawers contained specimens at order, family or subfamily; and level 3 was used for specimens identified to genus.

We did not use the scores at level 7-9 (data capture) or level 10 (scientific vouchers) because this information can now be obtained from other electronic databases or, as McGinley (1993) (p325) notes, “have more to do with research than collection management”. As the CHI assessment was undertaken, we also counted the number of empty drawers (to help plan for future space requirements) and counted whether the drawers contained specimens from ‘New Zealand’ or another country (‘International’).

Scores were entered into Microsoft Excel, summarised and basic data quality checks were completed using a formula (e.g. only one score per drawer; cannot have a score and be empty; cannot be both ‘New Zealand’ and ‘International’).

Assessment & Profile

Based on specimens from New Zealand, the NZAC has an overall CHI of 0.56, with the main taxonomic groups ranging from 0.38 - 0.79 (Table 2).

Table 2.

The Collection Health Index (CHI) for taxonomic groups within the NZAC. The CHI is split for New Zealand specimens and international specimens.

Taxonomic Group	Number of drawers	% Empty	CHI (NZ)	CHI (International)
Coleoptera	3784	16.31%	0.42	0.20
Diptera	864	21.30%	0.38	0.07
Hemiptera	792	42.30%	0.74	0.03
Hymenoptera	1152	22.40%	0.71	0.30
Lepidoptera	1548	6.01%	0.79	0.13
Other Insects	276	11.59%	0.62	0.10
Total NZAC	8416	18.05%	0.56	0.16

The profile of Lepidoptera (Fig. 1) is very close to the ‘ideal profile’ (see McGinley 1993, p321), where the majority is maintained at level 6, but also includes a small amount of new incoming material (levels 2 and 3). Both the Hemiptera and Other insects have high levels at level 6 (complete), although both are smaller in specimen numbers compared to the other insect orders (Hemiptera 90,000; Other insects 16,000) and have much less species diversity.

The highest proportion of Hymenoptera is at level 3 (genus-only), reflecting that a high number of specimens either need identification to an existing described species and significant alpha level taxonomy to describe new species. Of all the groups, Hymenoptera has the highest proportion of level 4 (integrate). This is due to several large surveys from university student projects (Frost et al. 2015, Kendall and Ward 2016, Saunders and Ward 2018); and also a growing voucher collection associated with specimens for DNA barcoding and machine-learning imaging projects.

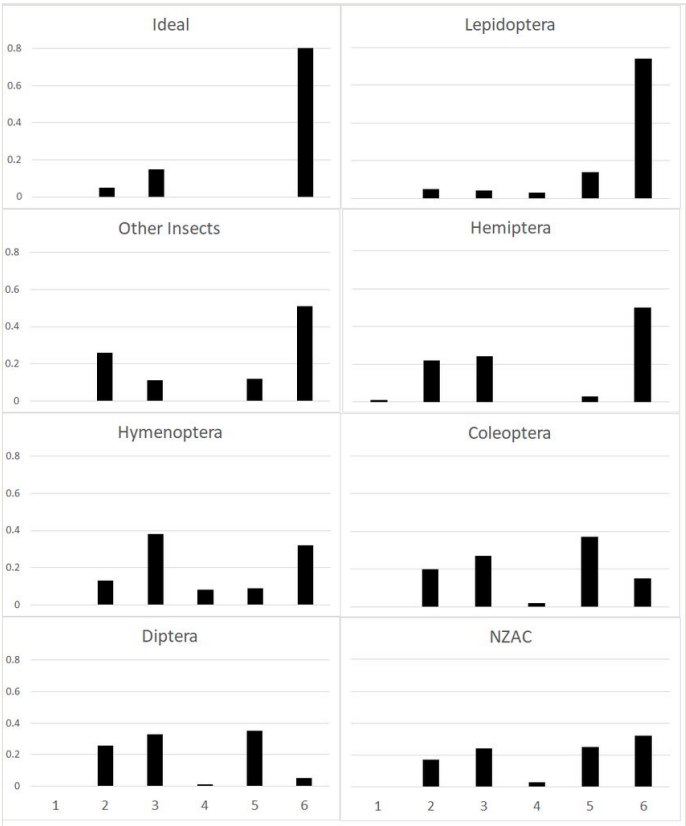

Figure 1. doi

Collection Health Index profiles for proportions of New Zealand specimens at levels 1-6 (1. Damage, 2. Inaccessible, 3. Genus-only, 4. Integrate, 5. Incomplete, 6. Complete) with the 'ideal profile' (from McGinley 1993); taxonomic groups sorted by the most 'complete'; and the profile for the whole NZAC.

The profiles of both Coleoptera and Diptera represent a mix of issues. Coleoptera is the largest section within the NZAC (~ 635,000 specimens), but has large numbers of specimens collected prior to the 1980s that are now in need of refreshed curation and updates to taxonomic names. However, there is also a substantial number of new incoming specimens. The Diptera collection, while smaller (~ 135,000 specimens), contains a high proportion of old material which has been historically poorly curated.

International specimens in the NZAC account for ~ 270,000 specimens, some 20% of the NZAC. For 'International' specimens, the overall CHI is 0.16, with the main taxonomic groups ranging from 0.03 - 0.30 (Table 2; Fig. 2). These CHI values are much lower than specimens from New Zealand. All groups have very high levels of inaccessible specimens (47%-97%), although significant numbers of Coleoptera (33%) and Diptera (26%) are at level 5, where specimens have been identified, often reflecting input from international visitors and experts, but curation is incomplete.

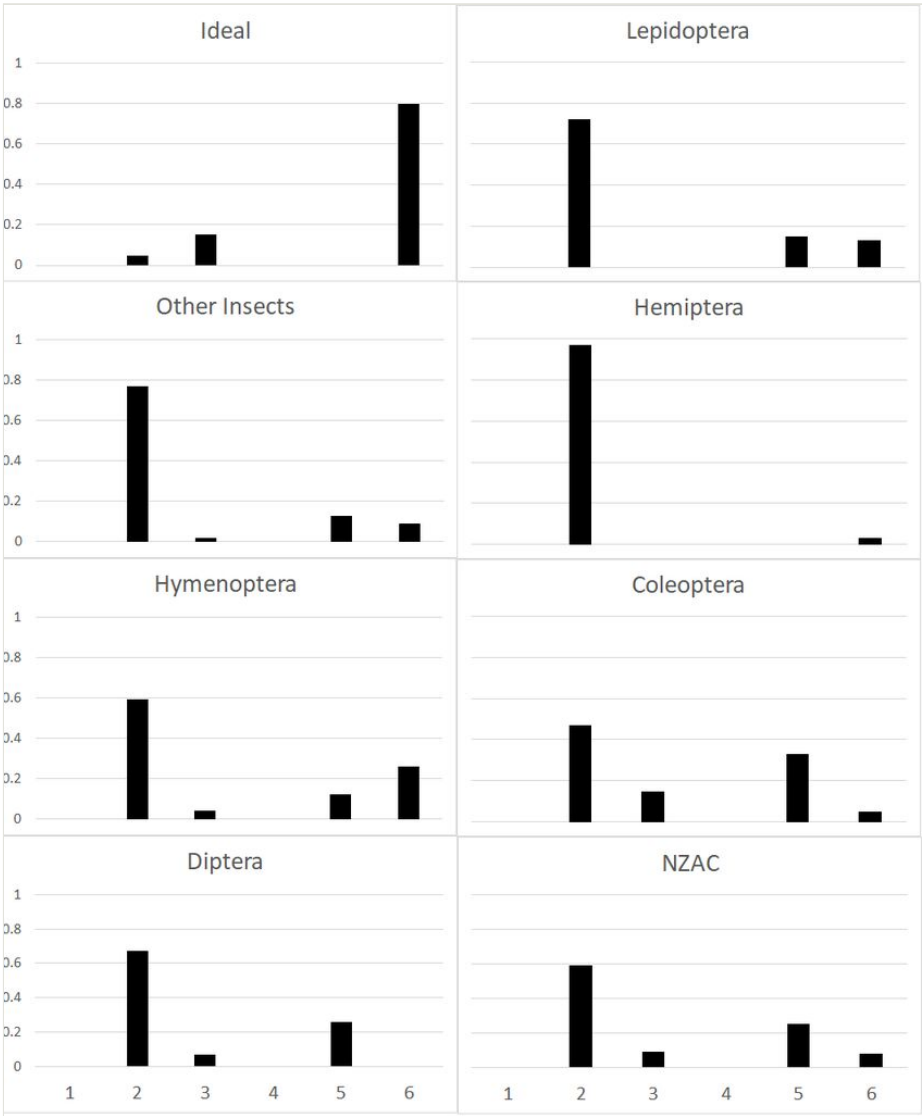

Figure 2. doi

Collection Health Index profiles for proportions of 'International' specimens within the NZAC at levels 1-6 (1. Damage, 2. Inaccessible, 3. Genus-only, 4. Integrate, 5. Incomplete, 6. Complete) with the 'ideal profile' (from McGinley 1993); taxonomic groups in the same order as Figure 1; and the profile for the whole NZAC.

In 1999, the CHI was used to assess holdings of Hymenoptera in the NZAC. This work was not published, but the data are available and the CHI was 0.52. Three assessments have subsequently been completed in 2009 (CHI 0.58), 2014 (CHI 0.77) and 2019 (CHI 0.73) (Fig. 3). Major activities include:

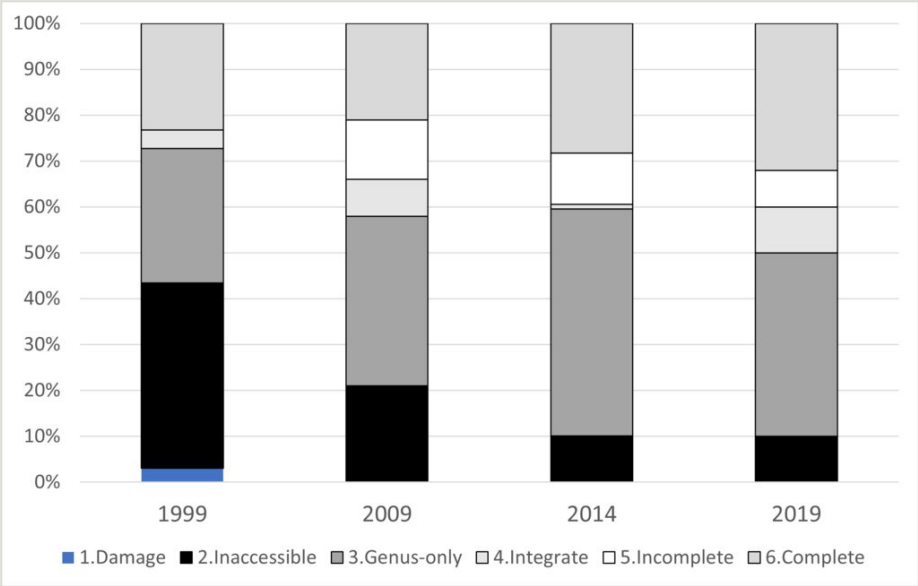

Figure 3. doi

Proportions of curation levels 1-6 (1. Damage, 2. Inaccessible, 3. Genus-only, 4. Integrate, 5. Incomplete, 6. Complete) for Hymenoptera within the NZAC over four time periods (1999, 2009, 2014, 2019).

1. specimens identified as being damaged in 1999 have been fixed;
2. there has been a large increase in the number of specimens now accessible (level 2 'inaccessible' is greatly reduced);
3. more specimens at 'genus-only' where alpha taxonomy is now needed; and a steady increase in 'complete' specimens.

The slightly lower over CHI in 2019 than 2014 is related to the increased material that needs to be integrated.

Conclusions

The overall CHI profile of the NZAC is a mix of the major taxonomic groups within and largely reflects the expertise and resources made available for curation of each taxonomic group. On the positive side, there are substantial sections that are highly curated and well known (Hemiptera, 'Other Insects') and close to the 'ideal profile' (Lepidoptera). On the negative side, there are problems with:

1. curation becoming increasingly outdated in sections with large numbers of, particularly older, specimens (Coleoptera, Diptera);
2. historically poor curation, with no resident expertise or resource to identify, describe species and curate the specimens (Diptera); and

3. high levels of family and genus-only material that needs further identification and alpha level taxonomy to progress to higher levels (parts of Coleoptera, parts of Diptera and Hymenoptera).

Very high proportions of the international specimens within the NZAC are inaccessible for other users. This essentially reflects priorities to work on the New Zealand biota since the formation of the Crown Research Institutes in 1992 and when work on the Pacific biota was largely abandoned.

Collection profiling is a useful tool for evaluating the health of any natural history collection (Williams et al. 1996, Favret et al. 2007, Miller et al. 2022), especially for setting priorities. For example, the 1999 assessment of Hymenoptera revealed that a large proportion of specimens were inaccessible (40%). This was reduced to 20% in 2009 and now, with continued efforts, is at 10%. Furthermore, the family Braconidae was identified as the most poorly curated group, with a CHI of 0.34 (in 1999). With ongoing curation and visits by overseas experts, the Braconidae is now one of the most well-curated sections, with a CHI of 0.79.

Future activities can now be based on the 2022 assessment. For example, increases in the CHI will be most achieved by:

1. reducing the numbers of inaccessible specimens (Hemiptera, Hymenoptera and Other Insects); and
2. curating specimens from level 5 into level 6 (Lepidoptera, Coleoptera and Diptera).

Recommendations

The CHI is a valuable tool to provide a snapshot of an entire collection(s) or sections within a collection and to help direct subsequent actions and activities. It is a very simple and fast system to implement and summarise and is based on common issues for collection management: care, accessibility, organisation and data capture.

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Author contributions

DW developed the project and completed the data summary and analysis; DW undertook assessments for Hymenoptera in 2009, 2014 and 2019; DW and SM completed the scoring for the CHI in 2022 and wrote the paper.

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