Title: Blitz the Gap: a nation-wide effort to guide citizen science toward the needs of biodiversity science

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Data and code availability: The iNaturalist Canada dataset was downloaded on December 1, 2025 and provided by the Canadian Wildlife Federation. These data are available from the iNaturalist API or upon request for large batch (>300k observations) downloads. Code to reproduce analyses and figures is available at: github.com/PollockLab/BTG-analyse-the-gap.

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Abstract

To resolve persistent biases in conservation assessments and forecasting, we urgently need more systematic collection of biodiversity data. Citizen (or, community) science, despite its reputation for unstructured data, offers a particularly promising path forward, mobilizing participation at scales and speeds unmatched by traditional monitoring. Here, we introduce Blitz the Gap, a pan-Canadian initiative to guide citizen science with sampling ‘challenges’, bioblitzes and paid initiatives using iNaturalist. One year of semi-guided sampling helped to gain 540 species newly recorded on iNaturalist Canada, almost 50,000 km^2 of added spatial coverage, better representation of northern climates, and new evidence to help identify Key Biodiversity Areas. These results demonstrate the potential for guided citizen science, especially for taxonomic discovery, range-filling, and early alerts for species on the move. Our experience highlights the need for more tailored guidance and gamification, further development of adaptive sampling methods, and funding for bioblitzes and training of future taxonomists and naturalists. As countries work towards global conservation targets for 2030 and 2050, citizen science should be one of the core pillars of any large-scale monitoring network, contributing unparalleled taxonomic depth and engagement.

Introduction

We are in the midst of a global push to bend the curve of biodiversity loss by 2050 (Mace et al. 2018). This effort is formalized in the Kunming-Montreal Global Biodiversity Framework (KM-GBF) (CBD 2022), which calls for standardized national reporting on the state of biodiversity to motivate and track progress towards 2030 targets and 2050 long-term goals. Progress is being made through initiatives that explicitly integrate nature into business and financial decisions (TFND 2023), that assess and protect species (Reynolds & Mace 1999; Lacher et al. 2025) and their habitats (Eckert et al. 2023; Karimi et al. 2025), and that restore degraded ecosystems (Strassburg et al. 2020). Central to this effort is monitoring; to understand, manage, and protect biodiversity, we need to know where it is and how it is changing (Nichols & Williams 2006; Helmstedt et al. 2025).

Canada has a global responsibility to monitor and protect biodiversity (Coristine et al. 2019). It is home to 24% of remaining intact ecosystems in the world (Allan 2017), 20% of the world's fresh water (Desforges et al. 2022), and is a globally important carbon sink, holding 20% of the world's soil carbon stocks (Sothe et al. 2022). As the steward of these vast ecosystems, Canada's conservation policies and actions have consequences for global biodiversity well beyond its borders (Coristine et al. 2019). This is reflected in Canada's key role in global biodiversity policy, being the first industrialised nation to sign and ratify the Convention on Biological Diversity 1992 (Buxton et al. 2021) although national implementation of these policies remains challenging (Ray et al. 2021). Canada is also a leader in the development of the KM-GBF, and the first donor to the Global Biodiversity Framework Fund (Canada 2024). Today, the Government of Canada's Strategy to Protect Nature signals Canada's ambition to play a leading role in conservation, aiming to ‘set the pace’ of global efforts to stem biodiversity loss (Canada 2026).

As Canadian ecosystems face rising pressure from habitat deterioration, pollution, invasive species, exploitation, and climate change (IPBES 2019), monitoring biodiversity is more crucial than ever to inform conservation (Gonzalez et al. 2025). Habitat loss is currently the biggest threat to Canadian biodiversity, but climate change impacts are intensifying (Coristine & Kerr 2011). The climate across Canada is warming at twice the global average (Sothe et al. 2022), which is already driving species range shifts in temperate ecosystems (Talluto et al. 2017). Climate changes are most severe in the Canadian Arctic, which is facing a projected increase from 3 to 10°C by the end of the 21st century (Saulnier-Talbot et al. 2024). Therefore, northern ecosystems are disproportionately threatened: drastic compositional changes and losses of northern species are expected (Berteaux et al. 2018), leading to a pervasive erosion of the functional and interaction diversity that maintain ecosystem functioning (Eckert et al. 2026).

To deal with these pressures, we need coordinated conservation action (Eckert et al. 2023; Schiller et al. 2025) based on information about species’ distributions, community composition, and how and why these are changing. But biodiversity data are generally sparse, noisy, and biased, most often reflecting the distribution of humans who observe biodiversity rather than biodiversity itself (Geurts et al. 2023a, 2023b; Daru & Rodriguez 2023). Canada is no exception: most biodiversity data on the Global Biodiversity Information Facility (GBIF, excluding eBird records) is concentrated in ~10% of its landmass, typically in the densely populated south (Fig. 1). Because Canada is so vast, models are essential to predict biodiversity patterns and changes in the unsampled areas of the country. However, the extreme North-South sampling bias gradient coincides with the climatic gradients that shape biodiversity patterns, distorting our ability to model and forecast biodiversity through space and time (Wightman et al. 2025). To support critical conservation efforts like COSEWIC (Committee on the Status of Endangered Wildlife in Canada) assessments, protected area establishment, population management plans, and impact assessments, we need to find ways to build better species range maps and distribution models.

Even when standard bias correction methods are possible, to improve our models we still need to collect more data, and specifically in strategic locations. Resolving these data gaps requires coordinated effort, but 'coordination' is precisely one of the greatest challenges for monitoring and protecting biodiversity in Canada (Ray et al. 2021; Eckert et al. 2023; Gonzalez et al. 2025). Canada does not yet have a single, coordinated monitoring network. Instead, monitoring programs are typically designed and implemented in different jurisdictions, such as the Alberta Biodiversity Monitoring Institute (ABMI), the BC Biodiversity Program, and the Québec Biodiversity Monitoring Network. Resolving this lack of coordination is a key priority for conservation in Canada (Buxton et al. 2021) and emerging initiatives, such as CAN BON (the Canadian Biodiversity Observation Network), will be essential for this coordination and mobilization of biodiversity data for research, conservation, and policy (Gonzalez et al. 2025).

One of the major benefits of coordinated research is that we can be strategic about defining common goals and desired outcomes that can be revised and updated as needed. The field of adaptive sampling proposes a theoretical framework to do so (Henrys et al. 2024), typically with the goal of optimizing model performance (Guisan et al. 2006; Mondain-Monval et al. 2024). But despite over 30 years of literature illustrating its potential advantages, adaptive monitoring has rarely been applied on the ground (Chiffard et al. 2020), likely because of the high and unpredictable cost and logistical difficulties of iteratively changing standard survey designs, especially for long-term monitoring (Henrys et al. 2024).

Citizen science (also called community, or participatory science) is uniquely positioned to help with these two problems. First, citizen science platforms like iNaturalist, eBird, and eButterfly, coordinate widespread, crowdsourced sampling across jurisdictions, forming a kind of national monitoring network. Second, the rapid growth of these platforms demonstrate the capabilities of large communities of engaged users (Scher & Clark 2023; Callaghan et al. 2023). This inherent flexibility allows for rapid, low-cost adaptive sampling, something rarely achievable through standard structured monitoring programs including technology-supported sampling methods like camera traps or eDNA. The enthusiasm of citizen scientists, combined with the power of low-cost, widespread, and rapid sampling effort via existing platforms, means that some aspects of adaptive sampling can now be feasibly implemented at larger scales (e.g., Canada) than were previously possible.

Of course, implementation of adaptive sampling within citizen science requires careful and targeted measures, but these are feasible and worthwhile given the enormous potential to optimize large-scale participatory biodiversity monitoring (Dickinson et al. 2012; Callaghan et al. 2019). Many users already sample somewhat 'adaptively' thanks to gamified apps and platforms, like eBird's 'Rare Bird Alerts' (Scher & Clark 2023), and leaderboards that reward users for maximising the number of species they observe. Even low uptake of adaptive sampling priorities by citizen scientists can dramatically improve our ability to predict the distribution of biodiversity (Callaghan et al. 2019; Mondain-Monval et al. 2024).

We can encourage participation in adaptive sampling if we tailor incentives and engagement strategies to match observer motivations and behaviours (Sutherland et al. 2015;

Boakes et al. 2016). Though this is a relatively new field, early evidence shows that most people participate in citizen science because they want to contribute to science (Thompson et al. 2023), and they can be 'nudged' towards scientific priorities (Callaghan et al. 2023). To nudge sampling behaviours, users need actionable guidance (*i.e.*, maps and species lists) about when, where, and what to sample (Thompson et al. 2023). Ideally this guidance should update as data is collected (Callaghan et al. 2023). If we can motivate these 'nudges' at broad scales, citizen science is our best opportunity for implementing nation-wide adaptive monitoring to improve the biodiversity knowledge and thus the models that are integral to research and conservation.

Here, we present 'Blitz the Gap', a Canada-wide effort to guide citizen science towards scientific and conservation priorities for biodiversity monitoring. Specifically, we: 1) outline the Blitz the Gap project, including the design of sampling 'challenges' that guide observers towards data gaps which address multiple objectives in biodiversity science and conservation, 2) establish measures of success in engaging observers, 3) share outcomes and lessons learned, and 4) recommend next steps to leverage citizen science for biodiversity monitoring in Canada and beyond.

Blitz the Gap

Blitz the Gap (www.blitzthegap.org) is a nation-wide initiative to target gaps in Canadian biodiversity data. Blitz the Gap was hosted as an umbrella project on the citizen science platform iNaturalist, including collections projects for each of the sampling "Challenges" described below. The project began on April 1st, 2025, coinciding with the iNaturalist.org blog post (Loarie 2025) that started the Missing Canadian Species challenge. All other sampling challenges ran from June 1 to October 1, 2025 (inaturalist.ca/projects/blitz-the-gap).

Sampling “Challenges”

The Canadian Institute of Ecology and Evolution’s Living Data Project hosted a one-week workshop in April 2025 with the aim of defining sampling “Challenges” – that is, defining data gaps, including the context, rationale, and guidance (maps and/or species lists) to prioritise sampling. These were designed collaboratively by academic researchers throughout Canada, conservation practitioners (Wildlife Conservation Society Canada - WCS, Canadian Wildlife Federation - CWF), biodiversity monitoring experts (Biodiversité Québec), and iNaturalist users. The working group was hosted in two locations simultaneously to facilitate involvement from participants across Canada: at the University of British Columbia in Vancouver and at McGill University in Montreal, Canada.

The resulting challenges were designed to address scientific and conservation priorities in Canada, including (1) taxonomic, (2) spatial, and (3) temporal gaps (see Table 1). In many cases, these gaps were not exclusively addressed: some sampling challenges address two or more gaps at once, such as priority taxa in priority places (e.g., the “MayBA” challenge targets species of conservation interest in candidate sites for Key Biodiversity Areas). Each challenge was hosted as a collection project in the Blitz the Gap umbrella project on iNaturalist.

Engaging different user groups

Though participation was open to all users, Blitz the Gap’s primary objective was to leverage the expertise and effort of experienced observers, who represent only a fraction of iNaturalist users but contribute the most time and observations (Boakes et al. 2016), to fill gaps in Canadian biodiversity data.

To engage the iNaturalist community, Blitz the Gap was a Featured Project on iNaturalist Canada and advertised via a website (www.blitzthegap.org), press release (link), media articles (link), podcasts (link, link), social media (Instagram), and email campaigns to researchers, conservation practitioners, biodiversity data experts, and highly engaged iNaturalist users throughout Canada. The CWF also promoted the Great Canadian Bioblitz and the affiliated Campus Nature Challenge (September 21 to 28, 2025) and provided 1000$ CAD grants to six researchers to support this effort, which contributed to the Blitz the Gap project.

The Quebec Centre for Biodiversity Science supported sampling with the Champion Grant program, which awarded $1000 CAD grants to 24 teams of graduate students and postdoctoral researchers for sampling trips or local bioblitzes. To receive this grant, teams proposed data gaps to target with their sampling efforts, drawing on the Challenges described above or setting their own challenge according to their expertise.

The BC Biodiversity Program (www.bcinat.com), a program founded in 2019 to survey biodiversity in British Columbia's Parks (BC Parks) with iNaturalist, also participated in Blitz the Gap. The 16 members of the BC Biodiversity Program's 2025 field team contributed over 200,000 observations of 7,787 species, representing an average 12,500 observations in BC per person. In total, the 45 members of the program have made over 1,000,000 observations in BC since 2019 of over 12,000 species, covering ~15% of Canada's estimated biodiversity (80,000 species) (Canadian Endangered Species Conservation Council 2022).

Local bioblitz events

During Blitz the Gap, 49 local multi-observer bioblitzes were organised throughout Canada, including 14 local bioblitzes, 15 bioblitzes organized as part of the 8-day CWF Great Canadian

Bioblitz (nine were funded through CWF grants of $2000 CAD), and 20 bioblitzes during the Campus Nature Challenge (Table S1). These events include academic conference field trips (Canadian Society for Ecology and Evolution - CSEE, Canadian Botanical Association - CBA), one-day or multi-day bioblitzes in post-secondary campuses, provincial parks, nature reserves, Biosphere reserves (Cypress Hills Provincial Park, Gault Nature Reserve, Fundy and Irving Nature Park), research stations and field study sites throughout Canada (see Expedition Fiord Arctic Bioblitz, Box 1). Over 57,568 observations (excluding casual-grade records) were recorded by 1469 observers, resulting in 4571 species logged during these considered bioblitzes throughout Canada.

Methods

Data

All analyses are based on verifiable iNaturalist Canada records downloaded on December 1, 2025 and provided by the Canadian Wildlife Federation. To measure progress in filling spatial and conservation gaps during Blitz the Gap, we used a subset of this dataset for the period of June 1 to October 1, 2025. Progress in filling taxonomic gaps was evaluated between April 1 to October 1, 2025 to coincide with the iNaturalist.org blog post (Loarie 2025) that launched the Missing Canadian Species challenges. Data from the 49 local bioblitzes were downloaded from their iNaturalist project pages on May 15, 2026 (Table S1).

Observer categories

We categorised observers according to their total observations in iNaturalist Canada to determine how Blitz the Gap and local bioblitzes engaged iNaturalist users with varying experience. We defined three observer categories: casual (1-100 observations), enthusiast (100-4999 observations), and superuser (≥5000 observations). We also identified new observers who made their first observation in 2025. Following this classification, only 0.21% of observers are superusers (632 people), but they have contributed almost half (43.1%) of the observations in iNaturalist Canada. Almost 44% of the remaining observations were contributed by 6.8% of observers who are 'enthusiasts'.

The contribution of coordinated events

Blitz the Gap did not require iNaturalist users to join in order for their observations to contribute to the project. Given that not all participants signed up as members, this means we cannot fully isolate the effect of Blitz the Gap on iNaturalist records. However, we consider 1771 iNaturalist users to have contributed explicitly to Blitz the Gap, including 496 members of the Blitz the Gap project pages (including local BTG bioblitzes), 557 participants of CWF GCB local bioblitzes and the Campus Nature Challenge (CNC), and 12 CWF GCB grant awardees, 41 members of the BC Biodiversity Program (including 16 Team members in 2025), and 106 members of teams funded by the QCBS Champion Grant program. Some users participated in multiple initiatives.

We estimated the effect of Blitz the Gap on iNaturalist observations in three ways: 1) the extended sampling period of Blitz the Gap Challenges (June 1 - Oct 1), 2) the local bioblitz events associated with Blitz the Gap, the CWF Great Canadian Bioblitz, and the Campus Nature Challenge, and (3) funding programs, including the QCBS Champion Grants, the CWF's GCB grants, and the BC Biodiversity Program.

To do this, we established a baseline for each comparison, representing the expected observations for user groups (i.e., new, casual, enthusiast, superuser) given their past contribution (i.e., number of observations) to iNaturalist Canada. To assess Blitz the Gap's overall effect on its members (n = 1771), we compared each observer's actual contribution to their expected contribution given their past efficiency (observations/active day) from June 1 to October 1, 2024, multiplied by their active days during BTG (June 1 - Oct 1, 2025). To measure the effect of bioblitzes (including BTG, CWF GCB, and CNC; Table S1), we compared the actual contribution of bioblitz participants (n = 1465) during their active bioblitz days to their expected contribution given their efficiency outside of bioblitzes during Blitz the Gap. The effect of funding programs was calculated by comparing actual versus expected contributions by funded observers (n = 131) during Blitz the Gap given their efficiency prior to their funding program. For QCBS and CWF GCB grantees, this prior window is June 1 to October 1, 2024. Because the BC Biodiversity Program was launched in 2019, the prior window for the 2025 team is June 1 to October 1, 2018. We assessed gains in efficiency for each comparison as the fold increase between expected and contributed observations summed across observers in each group.

Results

Over 3 million (3,006,328) observations were collected in the Blitz the Gap project on iNaturalist between April 1 to October 1, 2025 from 64,880 observers (as of May 15, 2026). These data include 26,413 species that were identified by 18,079 identifiers, covering 33% of Canada's approximately 80,000 species (Canadian Endangered Species Conservation Council 2022). This represents almost 62% of all the data collected (4,858,265 total observations as of May 15, 2026) and 88% of the species (29,996 total species) recorded in iNaturalist Canada in 2025. For most of the Blitz the Gap Challenges, membership in the project was not required, so any observations that fit the criteria for a Blitz the Gap Challenge (place, time, and/or taxa) were included.

Therefore, these data reflect the efforts of Blitz the Gap alongside other important initiatives, especially the Canadian Wildlife Federation's Great Canadian Bioblitz (CWF GCB, an extended bioblitz period from Sept 21-28, 2025), and the widespread growth and uptake of iNaturalist more generally. See Supplementary File 2 for a summary of the sampling challenges.

Contributions of Blitz the Gap, local bioblitzes, and funding programs

Observers associated with the Blitz the Gap campaign (n = 1771) contributed 17.5% (939,437) of the observations on iNaturalist Canada between June 1st and October 1st, 2025, despite accounting for only 2.5% of the active users (n = 70,284) during this period. Compared to the same period in 2024, this represents an overall 1.5-fold increase in observations for these observers, representing >187,000 observations more than expected (Fig. 2). For comparison, other active observers (not associated with BTG) increased efficiency by 1.15x overall during this period. All observer groups increased in their efficiency during Blitz the Gap relative to the baseline expectation, with a doubling in the efficiency of casual observers (n = 210), a 1.7-fold increase for enthusiasts (n = 566), and a 1.3-fold increase for superusers (n = 117), who contributed >94,000 more observations than expected. New users (n = 740) contributed 20,301 observations.

Bioblitzes were particularly effective at accelerating sampling, more than tripling (3.2x) observer efficiency during bioblitzes compared to other periods of the Blitz the Gap campaign. New users and enthusiasts showed the greatest efficiency gains, with both groups contributing 3.8 times more data during bioblitzes than the baseline expectation from their contributions outside of bioblitzes. Even superusers, whose sampling rates are already high, showed a 2.6-fold increase in efficiency, collectively recording over 14,000 more observations during bioblitzes than typically expected outside of these events.

Funding programs brought the largest overall gains, with funded observers showing an overall 5-fold increase in efficiency or over 128,000 more observations than expected based on their records prior to the funding programs. The BC Biodiversity Program, which has paid team members to sample biodiversity with iNaturalist during each summer since 2019, showcases the potential for extensive gains from longer-term funding initiatives. The 2025 Team's 16 members contributed over 104,000 more observations during Blitz the Gap than expected given their observations prior to the funding program's launch, representing an 11.3-fold increase in efficiency. Sampling grant programs also approximately doubled efficiency: the QCBS Champion Grants led to a 1.85 fold increase and the CWF's GCB grants more than doubled (2.35x) efficiency, representing a total of over 11,000 more observations than expected for the same observers between June 1 and October 1, 2024.

Taxonomic gaps

During Blitz the Gap (Apr 1 - Oct 1), 540 species were logged as research-grade observations for the first time on iNaturalist in Canada (Supplementary File 1), with the largest gains in Insecta (236 spp.), Fungi (85 spp.), and Plantae (84 spp.) (Fig. 3b) – and importantly, gains in poorly-known groups (Fig. S1) like Chromista (31 spp.) and Protozoa (14 spp.). Of these species, 14 were recorded during local bioblitzes. Many of these species records were new to iNaturalist not just in Canada, but globally, including 92 species (Fig. S8).

Importantly, these numbers only reflect research-grade observations as of December 1st, 2025 (see Data section), so this is likely a temporary underestimation (see Fig. S2 for timeline of new species records since 2009). For example, 45% of observations in Blitz the Gap still need identification to become research-grade (as of April 28, 2026), and some of these could be new species records.

New species records were widely distributed across Canada, spanning both coasts and the southern border to the High Arctic (Fig. 3a). Many of these records were made in British Columbia, reflecting the contributions of the BC Biodiversity Program's large sampling effort and taxonomic expertise (Fig. 3). Of the 361 users who logged species that were missing in iNaturalist Canada prior to April 1, 2025, the BC Biodiversity Program were the most prolific: 15 of the 41 members (12 of whom were part of the 2025 field team) recorded an average of 3.7 (SD = 2.9) and up to 11 species, contributing a total of 40 species to iNaturalist Canada. Five QCBS members (recipients of small sampling grants) logged a total of six species for the first time on iNaturalist in Canada, contributing an average of 1.6 (and up to 2) new species per user. Five observers supported by CWF grants recorded 16 species, and 23 other members of the Blitz the Gap project added 64 species to iNaturalist Canada. In the broader iNaturalist community, 81 'superusers' logged an average of 2 newly recorded species (and up to 16) per user. Remaining contributions were from 183 'enthusiast' observers, and 49 'casual' users.

These 'new' species records are sparse but immensely valuable, contributing new information about undersampled, threatened, and newly-arriving species. For instance, the most observed 'new' species is Gurney's Pygmy Mole Grasshopper (*Ellipes gurneyi*), which is classified as "Possibly Extirpated" in Canada (NatureServe Canada) – but was recorded 53 times by one 'superuser' observer at Long Point National Wildlife Area in Ontario. The pace of data collection through iNaturalist is also convenient to detect new species arrivals, such as *Facelina auriculata*, a nudibranch that was only seen in European waters before being recorded four times on Canada's Atlantic coast during Blitz the Gap.

Spatial gaps

The spatial coverage of iNaturalist in Canada increased by 49,481 km^2 during Blitz the Gap (i.e., 49,481 cells at 1km^2 resolution were empty but gained at least 1 observation between June 1 and October 1, 2025), representing 0.5% of Canada's area (Fig. 4). Most (~60%) of these gains are due to a single observation: only 4% (2,089 km^2) of this added coverage is thanks to 10 or more observations, and 0.2% (106 km^2) is due to 100 or more observations. The most extreme gain was made in British Columbia, in Robson Bight Ecological Reserve (1,734 new observations in a 1 km^2 cell). However, gains were made for all 13 of iNaturalist's iconic taxon groups – meaning spatial coverage increased for typically hard-to-sample groups like Chromista (803 km^2) and Protozoa (2,104 km^2) to more highly sampled groups like Plantae (38,456 km^2) and Insecta (27,044 km^2), which saw the largest gains (Fig. S3).

At the species level, range coverage gains (that is, newly sampled cells within each species' range during Blitz the Gap) were widespread across Canada. Substantial gains were made even in highly sampled places like the St-Lawrence lowlands, where over 800 species (mostly plants) were recorded for the first time in specific cells on iNaturalist Canada (Fig. 5). Relative gains in species-level range coverage – i.e., the gained area as a proportion of each species' total range area – were most extreme in plants, with up to 12.5% gain for the introduced Fetid Marigold (*Dyssodia papposa*), and mammals, with up to 7.7% gain for the Vancouver Island Marmot (*Marmota vancouverensis*) which is Critically Endangered on the IUCN Red List. On average, relative coverage gains were highest for amphibian species (0.86% average gain per species, 0.55 SD) and reptiles (1.03% average, SD 0.62), which tend to have smaller and therefore easier-to-cover ranges.

Climate gaps

To map biodiversity, we do not need to completely cover Canada with data points: we need data about where species occur along the environmental gradients that shape their distributions. To face the accelerating pressure of climate change, we especially need to know how biodiversity varies along climatic gradients in Canada, but the strong data bias towards the southern border makes this particularly difficult (Wightman et al. 2025). Two of the Blitz the Gap sampling challenges (Table 1) aimed to address this urgent issue: (1) 'Closing the Climate Gap' targeted areas that represented undersampled climates, logging a total of >715,000 observations of over 15,600 species during Blitz the Gap (June 1 to October 1); and (2) 'Too Hot to Handle' targeted species whose distributions are expected to be exposed to severe climate changes in Canada, and collected >53,000 observations of 320 species during the same period.

Canada's biodiversity gaps can be reframed in climate space (Graham et al. 2025), defined here as the range of values of Annual Mean Temperature and Annual Precipitation that currently occur within Canada (Fig. S4). Biodiversity data are biased in this climate space (Fig. S5), overrepresenting warmer and drier climates (which are rarer) and underrepresenting Canada's more common cold and dry climates (typical of northern ecosystems) (Fig. 6). Some climates have yet to be sampled in iNaturalist Canada, including some of the driest and coldest zones (in the North), and unique climates in warmer and wetter zones (such as the West coast).

This climatic bias cannot be corrected in a single year – but progress is incremental, and importantly, possible. In 2025, iNaturalist users contributed to improving coverage of many of the drier and colder zones of northern Canada (Fig. 6) – more so than may be apparent from spatial coverage gains alone (Fig. 4). However, as in earlier years, concentrated sampling effort in southern climates built on iNaturalist's already high coverage of warm-dry zones in Canada (Fig. 6).

The benefits of framing spatial gaps in climate space can help to continue remedying this issue: all cells are not (climatically) equal in Canada (Fig. S5a,c). Zones with relatively common but undersampled climates (e.g., much of the North; Fig. S5a) are a strategic place to sample next to understand broad climate-biodiversity relationships. Unique but undersampled climates (e.g., mountainous regions in British Columbia) are critical to sample as well, both to refine the climatic limits of species' distributions and to document more unique and potentially endemic ecological communities.

Conservation gaps for Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are sites that contain concentrations of threatened and rare species and ecosystems, or large aggregations of species at a particular stage in their life cycle, contributing disproportionately to the persistence of biodiversity on lands and in waters (KBA Canada Coalition et al. 2021). KBAs are being used by governments, NGOs, and land trusts to directly inform conservation and planning decisions in Canada, focusing action on areas where it will have the greatest impact for biodiversity. Because KBA criteria are quantitative, demonstrating that a site qualifies requires recent data on the full distribution of a species and the size of its population at that site. Multiple sites in Canada could be KBAs according to experts or historical data (which we informally refer to as "MayBAs"), but more data is needed to confirm their status. To address this need for data, we partnered with Wildlife Conservation Society Canada to design a sampling challenge targeting priority species and locations for "MayBAs".

From June 1 to October 1, this challenge yielded 18,507 observations of 111 priority species for KBAs (as of May 29, 2026), helping to clarify their distributions. For example, the distribution of the Endangered Hickorynut mussel (*Obovaria olivaria*) is uncertain in Canada, making it challenging to assess for KBA criteria – but 23 new observations of this species were contributed during Blitz the Gap, including one of the northernmost records in the last 10 years. Just over 10% of the research-grade data available for the Jefferson Salamander (*Ambystoma jeffersonianum*), an Endangered (COSEWIC 2010) species in Canada, were contributed during 2025. Progress was made for the Desert Vagabond Lichen (*Circinaria hispida*) as well, which was recorded in 3 new sites, helping to refine the distribution of this nationally Vulnerable (N3N4, NatureServe (Gries 2026)) species.

About 2.8% of all research-grade observations during Blitz the Gap were submitted from MayBAs (38,951 observations from June 1 to Oct 1 2025, as of May 29, 2026), generating new and much-needed information about high-interest sites for conservation, and representing a 50% increase in the number of observations reported in the same geographic areas in 2024. Over the MayBA BTG challenge period, 3,659 unique observers reported 12,006 distinct taxa within these sites. The Beaverhills Biosphere MayBA in Alberta is one such case: iNaturalist users recorded 626 species, including 26 priority species (232 observations) for KBAs including the Endangered Little Brown Bat (*Myotis lucifugus*) (COSEWIC 2013). The Johnstone Strait - Southeast Queen Charlotte Strait MayBA gained almost 500 records of 188 species, including 21 species likely to meet KBA criteria in this priority site.

Box 1. The power of bioblitzes

The term ‘bioblitz’ (short for ‘biodiversity blitz’) was coined in 1996 by Susan Rudy at the US National Park Service to describe an event where multiple people (including volunteers, expert scientists, naturalists, etc.) assess biodiversity in a specified area during a limited time – essentially providing a ‘snapshot’ survey (Meeus et al. 2023). Bioblitzes are often organised via citizen science platforms as an outreach strategy to engage people with nature (e.g., City Nature Challenge, Campus Biodiversity Network, the CWF’s Great Canadian Bioblitz, and many others). But bioblitzes offer benefits beyond outreach: they are a relatively low-cost way to collect a lot of biodiversity data, quickly (Hoskins et al. 2026). Being more structured than purely opportunistic citizen science, bioblitzes are particularly useful to rapidly survey sites and species of interest (e.g., candidate sites for conservation or restoration, invasive species, threatened species) and lesser-known habitats, or even to revisit sites through time to detect changes. Here, we use them as a way to further leverage citizen science platforms to target data gaps. ‘Expert bioblitzes’, which specifically engage professional scientists and conservation practitioners, are emerging as a way to rapidly address data needs that require more expertise and that lie outside the scope of long-term monitoring programs (Parker et al. 2018).

The Expedition Fiord Arctic Bioblitz, organized during Blitz the Gap 2025, exemplifies the potential of an expert bioblitz. From June 2nd to July 29th 2025, 11 professional scientists from McGill, Queen’s, and McMaster Universities made over 10,000 observations of ~180 species (including 100 plants) in the remote Expedition Fiord region of Axel Heiberg Island (Inuktitut name: *Umingmat Nunaat*), Nunavut, an uninhabited island in the Canadian High Arctic. Notable observations include a new northern range record for American Pipit (*Anthus rubescens*)— which was suspected to be breeding at Expedition Fiord in 2025—and the first iNaturalist submissions in Canada for three species of vascular plant: Arctic fescue (*Festuca edlundiae* S. Aiken, Consaul, and Lefkovitch), Hartz's bluegrass (*Poa hartzii* Gand.), and Sorensen's catchfly (*Silene sorensenis* (B. Boivin) Bocquet). The bioblitz complimented collection-based biodiversity surveys that were running concurrently, and contributed valuable insight into species distributions at the extreme (and lesser sampled) end of Canada's climate gradient (Fig. 6), providing a baseline that will become increasingly valuable in understanding future change as the Arctic warms nearly four times faster than the global average (Rantanen et al. 2022).

Lessons Learned

Blitz the Gap is an attempt at guiding citizen science towards scientific and conservation priorities in Canada. One year of biodiversity records cannot solve all data limitations in Canada, but it is enough to make progress – and this progress can be expected to continue if we succeed in maintaining and leveraging the engagement and enthusiasm of citizen science communities. Below, we outline some lessons learned and recommendations from Blitz the Gap to recognize the full potential of citizen science for biodiversity monitoring in Canada and beyond.

1. Citizen science excels at taxonomic 'discovery' and filling species ranges

While the use of citizen science data for biodiversity analyses has been criticized for several reasons, including a lack of 'absence' data (Brotons et al. 2004; Lobo et al. 2010; Anderson et al. 2011), observer biases (Isaac et al. 2014; Scher & Clark 2023), and strong spatial, temporal, and taxonomic biases (Bowler et al. 2022; Geurts et al. 2023a; Daru & Rodriguez 2023), we have shown the potential for addressing some (though, not all) of these limitations with 'nudges'.

Even without strong nudging, citizen science is particularly effective at two things: accumulating 'new' species records and improving knowledge of species' geographic ranges.

The role of citizen science in publicly recording biodiversity is especially important given declines in sampling by natural history collections and the feared 'death of taxonomy' (Wheeler 2014; Forbes et al. 2025) – although credible citizen science data often relies on knowledgeable taxonomists to confirm identification. Because of the enormous scale of crowdsourced sampling by citizen scientists, species are added to iNaturalist every year even without 'nudging' – though nudging could speed up progress in filling taxonomic gaps. As of April 2026, iNaturalist contains at least one observation in Canada for almost half (42.5%, or 34,053 species) of Canada's estimated 80,000 species, and we can expect iNaturalist to continue yielding gains in the coverage of Canada's species richness (Fig. S2), with higher potential for gains in some groups. For seven of iNaturalist's 13 "iconic taxon groups" (Chromista, Protozoa, Fungi, Insecta, Arachnida, Actinopterygii, and other Animalia not included in the other 12 groups), at least one new species is added to iNaturalist in Canada per 1000 observations of the given group, based on the last five years (2020-2025) (Fig. S1). At least one new Fungi, Protozoa, and Chromista species is logged per 500 observations (on average) in these groups (based on 2020-2025), and this rate has not yet decelerated for Protozoa and Chromista (Fig. S1). Beyond new species records, iNaturalist helps to make progress in documenting some rare and data-deficient taxa: 766 species reached 10 observations in 2025 (Fig. S6), providing much-needed information to begin understanding their distribution. Almost 565 species reached 100 observations (Fig. S7), including 187 plants and 228 insects – and these may now be eligible for iNaturalist's Computer Vision model which is trained on users' photos and identifications in order to provide suggestions for automated taxon identifications.

Gains in new species records are regularly made possible by experts' identifications. For an iNaturalist record to be included in GBIF, it must have consensus in the identifications made by the iNaturalist community. This key data quality benchmark is often met because of the efforts of a small proportion of iNaturalist users who contribute the majority of identifications (Callaghan et al. 2022; Campbell et al. 2023). Identifiers may be regionally focused with broad taxonomic interests or be taxonomically focused with widespread geographic coverage (Campbell et al. 2023). Engaging taxonomic or regional experts in identification efforts can have substantial impacts on the data available on the platform, especially when 'nudged' towards specific taxonomic or regional targets (Mesaglio et al. 2025). About 4x more users contributed observations to Blitz the Gap than contributed identifications, and the top 100 identifiers contributed >1 million identifications. Without community identifications, iNaturalist data would be substantially less reliable and many of the taxonomic and geographic gains would be impossible (Callaghan et al. 2022; Campbell et al. 2023).

As for range coverage, citizen science provides the widespread effort required to document species' geographic ranges and their occupancy within their ranges. As citizen scientists continue recording the nature around them, and especially if they are 'nudged', geographic gaps will continue to shrink (Fig. 4) – particularly at the species level. Even in highly-sampled areas, many species saw improvements in range coverage during 2025 (Fig. 5b), with some hotspots showing range coverage gains for over 800 species. For species with small ranges in areas that are relatively easy to access, we can expect citizen science to cover most of their range. But for large-ranged species, citizen science is likely only capable of filling part of the range. In such cases, coverage in environmental space may be a more feasible goal to achieve through citizen science, particularly when sites with relatively undersampled environments are accessible (as in the Climate Gap challenges, Fig. 5).

Going forward, taxonomic discoveries, documenting rare species, and filling species' ranges in geographic and environmental space are prime candidates for soft-guided citizen science.

2. There is vast untapped potential for adaptive sampling with citizen science

Adaptive sampling is not a new concept, but it is newly possible (and scalable) thanks to the rapid and widespread rise of citizen science (Callaghan et al. 2019). Existing off-the-shelf computational approaches for adaptive sampling are typically designed to improve species distribution models – that is, to ensure that each new data point improves how well we can predict a species' distribution (Guisan et al. 2006; Chiffard et al. 2020; Henrys et al. 2024; Mondain-Monval et al. 2024). Though this is a useful exercise, recommending priority areas that are feasible to sample is complicated: the priorities are rarely realistic or cost-effective to achieve with citizen science. Sampling priorities also depend on the objective – meaning a new data point may be highly valuable for some purposes (e.g., documenting a rare species in a candidate Key Biodiversity Area, as in the MayBA challenge) despite not improving model performance. Typical adaptive sampling approaches may therefore not be immediately useful to identify or fill the gaps we can realistically target with citizen science. Instead, we need to bridge adaptive sampling techniques with the realistic potential and constraints of citizen science to prioritise places and species that are important, but also *possible* to sample – including accessibility, security, and proximity to densely populated areas (Sutherland et al. 2015; Scher & Clark 2023; Daru & Rodriguez 2023).

3. We need to mobilize expertise to fill data gaps

Biodiversity data gaps are usually ‘gaps’ for a reason – and some gaps require more targeted, consistent, and often more expensive sampling than citizen science can currently offer. If we rely solely on citizen science, spatial gaps in inaccessible places will likely persist in places that are only accessible with expensive transportation (e.g., helicopters) or that are inaccessible to the public (e.g., private lands, conservation and restoration zones) (Daru & Rodriguez 2023). Many taxonomic gaps will still require funded, organised, and expert effort to resolve, particularly for species that are harder to find and identify (Laforest et al. 2013; Rondeau et al. 2023; Bennett et al. 2024). To detect change, we need consistent and frequent monitoring across sites, which is rarely aligned with the opportunistic effort from most citizen science programs – though there are some notable exceptions (e.g., the North American Breeding Bird Survey and Christmas Bird Count). For conservation applications, citizen science may also not be suitable to monitor sensitive species and habitats, particularly when these require specialized training or permissions.

The data gaps in Canada are still big – but so are the pressures faced by biodiversity. We cannot afford to wait for sampling to fill all remaining gaps before we assess change and act to prevent losses (Eckert et al. 2023). Covering the entire map of Canada with data points is not necessary: biodiversity models can ‘fill the map’ by predicting the distribution of species through space and time, if we have enough (good) data to fit them (Pollock et al. 2020). To achieve this, we need strategic data collection. This will rely on advances in biodiversity modeling to best leverage the citizen science data that is quickly becoming our primary source of information about biodiversity (Dorazio 2014; Isaac et al. 2014). As a first step, it is helpful to describe and track gaps in biodiversity data to understand how they impact biodiversity predictions through space and time (Beck et al. 2014; Hortal et al. 2015; Mentges et al. 2021; Bowler et al. 2022; Daru & Rodriguez 2023). But, to move forward, we also need to leverage advances in statistical modeling to account for existing biases and imperfect detection (Dorazio 2014; Fithian et al. 2015; Wightman et al. 2025) alongside initiatives to fix the problem at its source, as we did with Blitz the Gap – that is, to sample adaptively with the goal of building better biodiversity models (Henrys et al. 2024; Mondain-Monval et al. 2024).

Even with successful nudging, citizen science cannot completely replace standardized, repeated monitoring. Though citizen science can contribute to 51% of the indicators of progress in the Kunming-Montreal Global Biodiversity Framework, the remaining 49% depend on more structured data collection from governmental agencies, conservation organisations, and other scientific monitoring programs (Danielsen et al. 2024). To effectively monitor biodiversity, investing also in structured, long-term monitoring programs (Magurran et al. 2010; Hughes et al. 2017), digitization of natural history collections (Eckert et al. 2024), and technology-assisted monitoring (*e.g.*, acoustic recorders, camera traps, movement trackers, eDNA) (Schneider et al. 2019; Sugai & Llusia 2019; Tuia et al. 2022; Sheard et al. 2024; Sutherland et al. 2026) will be critical to document biodiversity patterns and capture fast-paced changes across the Canadian landscape. As data streams accelerate and diversify, coordination is essential to improve data curation, management, and access, and therefore to build a responsive and informative monitoring network in Canada (Gonzalez et al. 2025).

4. Detecting change requires repeated sampling

Filling spatial data gaps helps to improve models and maps, but to track biodiversity change, we need repeated measurements through time (Magurran et al. 2010). Detecting biodiversity change is a notoriously challenging but crucial task to manage biodiversity, to evaluate outcomes of conservation actions, and to monitor progress towards international targets, among other applications (Dornelas et al. 2013; Hughes et al. 2017; Helmstedt et al. 2025). Distinguishing trends from the substantial natural variability of biological populations and ecological communities requires intensive and repeated data collection (Valdez et al. 2023; Leung & Gonzalez 2024), but this is rarely available through citizen science (except coordinated initiatives like the Christmas Bird Count and the Breeding Bird Survey). At the species level, detecting occupancy changes is only possible with widespread annual monitoring, and more sites are needed to detect declines compared to increases (Southwell et al. 2023). At the community level, species richness changes are often undetectable if sampling is spatially biased and imperfectly accurate, even with a long-term monitoring network including thousands of sites (Valdez et al. 2023).

Change detection is therefore particularly challenging when relying on unstructured and opportunistic citizen science data (Isaac et al. 2014; Dambly et al. 2021), where sampling effort and detection are inconsistent, and species and site selections are biased (Fournier et al. 2019; Mentges et al. 2021; Scher & Clark 2023). Optimising monitoring for change detection is crucial (Field et al. 2005), alongside development and validation of statistical methods for trend detection to harness more ecological insights from citizen science data (Isaac et al. 2014; Acevedo-Charry et al. 2025; Goury et al. 2026) – but these methods need further testing and refining (Rapacciuolo et al. 2021; Soberón & Christén 2026).

More promising solutions are to (1) ensure long-term financial support and (2) leverage technological advances to monitor consistently in strategically selected sites, alongside predictive modeling to track and respond to changes in near-real time (Zurell et al. 2025).

Biodiversity monitoring technologies (remote sensing, camera traps, audio recorders, and movement tracking) alongside advancements in AI for data processing (e.g., individual and species identifications, Edge AI) are accelerating the collection of high-quality data to enable biodiversity change assessments (Schneider et al. 2019; Sugai & Llusia 2019; Bauer et al. 2024; Davidson et al. 2025; Pollock et al. 2025). Leveraging these large quantities of spatially-explicit and frequently-updated biodiversity data through time is a promising way forward to detect and eventually attribute change (Gonzalez et al. 2023).

5. Data gaps are not necessarily knowledge gaps

Many of the apparent ‘gaps’ in the Canadian biodiversity data map do not necessarily reflect a lack of knowledge about biodiversity. These ‘gaps’ are simply a lack of species occurrence points in the Global Biodiversity Information Facility (GBIF), but this is only one way to define ‘biodiversity data’ – which does not necessarily align with Indigenous, community, and traditional ways of observing biodiversity.

In many of the apparent data ‘gaps’ in Northern Canada, there is a profound wealth of Traditional Knowledge held by Indigenous peoples and local communities about biodiversity, how it is changing, and how to conserve and manage it (Parlee et al. 2014; da Silva et al. 2025). This information is some of the richest data available for biodiversity change assessments globally (e.g., IPBES) and nationally (e.g., COSEWIC Aboriginal Traditional Knowledge Subcommittee), and for researching, monitoring, and managing biodiversity (Parlee et al. 2014; Henri et al. 2021; Reid et al. 2021). For example, the Collective for Parks, Conservation, Innovation and Leadership (CPCIL) is a network built on interdisciplinary collaboration between researchers, students, professionals, practitioners, and knowledge holders to identify knowledge gaps and to bring evidence for conservation decision-making in Canada. The importance of the knowledge and leadership of Indigenous peoples and local communities is a pillar of Canada's Strategy to Protect Nature (Canada 2026), and in the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (Parks & Tsioumani 2023). This knowledge is irreplaceably valuable for the development of a Canadian Biodiversity Observation Network (CAN BON) to guide conservation actions and decision-making with the most complete information possible (Gonzalez et al. 2025).

Recommended next steps

Though citizen science is not a one-size-fits-all solution, it is a cost-effective and increasingly informative approach to biodiversity monitoring – one that complements both new technology-based data streams and large, continuously-funded monitoring networks. While soft-guiding citizen science has much potential, large-scale initiatives like Blitz the Gap remain challenging, particularly with regards to identification and communication of achievable sampling priorities, tracking and rewarding information gains from newly collected data for specific purposes (or 'gaps'), and integration of sampling priorities and reward schemes with existing platforms and databases. To address these challenges, we recommend :

1. **Measure, track and reward targets based on needed information gains.** Most reward systems in existing platforms reward quantity over quality of data points – incentivizing high observation and species counts rather than 'informative' data (with the notable exception of Rare Bird Alerts on eBird; (Scher & Clark 2023)). The value of a data point can be attributed based on the objective (e.g., first species sightings, improving SDM performance, extending a time series) and summarised in leaderboard form to engage

users through competition – a strategy that has already contributed to engaging citizen scientists across platforms.

2. **Develop customized, updatable platforms to guide sampling.** It should be easy for citizen scientists to choose locations and/or taxa to sample (or to identify) without being overwhelmed by overly detailed (e.g., long species lists without common names) or overly general guidance (e.g., broad-scale and coarse-resolution maps). For example, people typically want to zoom to their home or a particular location to see local sampling priorities, and may be less interested in seeing all sampling priorities at the scale of Canada. This includes selecting useful base maps for navigation in the field, such as activity maps (e.g. Strava), and trail maps. It also includes enabling users to select a species group of interest to facilitate engagement. Identifiers could also benefit from more informative prioritisation (in iNaturalist, 'needs ID' observations are by default filtered by recency) to highlight points with high potential value for recording rare species, improving species distribution models, tracking change, and more. In all cases, sampling priorities should be updated as new data is collected. Dynamic prioritisation (e.g., the FrogID project; (Callaghan et al. 2023)) motivates engaged users to sample adaptively according to up-to-date guidance about where to go and what to look for.
3. **Enable more flexibility for projects on existing citizen science platforms.** Most platforms optimize user experience to engage people in observing biodiversity at large scales with as little friction as possible. Incentivizing adaptive sampling requires extending most platforms' original goal to instead engage people in collecting data for scientific purposes. For now, many 'advanced' users are engaged enough to consult external resources to inform their sampling – but this is only a small portion of users.

Citizen science platforms could integrate more options to customize project pages to more easily engage users in adaptive sampling schemes. On iNaturalist, implementing custom priority maps and custom species lists is a major challenge, due to size limits on custom 'Place' polygons, and restrictions on batch uploading species lists and on the number of taxa that can be selected. Integrating boolean operators ('and', 'or') would offer a substantial improvement for granular customization, for example to target multiple distinct place 'AND' taxon combinations that are of conservation interest (as in the MayBA challenge). Other tools could include hosting customizable interactive map viewers for dynamic sampling priorities and custom point systems and leaderboards (where users accumulate points based on a 'value' scheme, such as new species logged in a priority location, improved predictive performance of SDMs, etc.). We also recommend more tailoring of identification functions to the needs of identifiers, who are typically highly active and taxonomically specialized (Campbell et al. 2023), as identification is a rate-limiting step in getting already observed data to research grade status and hence to GBIF.

4. **Coordinate expert identification 'blitzes'.** Similar to drawers of museum specimens waiting for someone to look at them, many iNaturalist observations are waiting for identification. Coordinated efforts similar to Blitz the Gap could guide strategic identification 'blitzes', which have the potential to process much of the existing observations on iNaturalist into accessible data via GBIF. For example, a version of iNaturalist's recent 'ID-a-thon' could specifically engage experts to identify records with high potential value for research and conservation as a relatively fast and low-cost way to fill data gaps.

5. **Identify a top 50 (or so) list of monitoring sites across Canada.** We must take steps toward a semi-structured national monitoring program through identifying a list of places that we can monitor through time with repeat sampling at regular intervals. Given that almost 50 bioblitz events were organised during Blitz the Gap, we propose to begin with a list of top 50 priorities for repeated sampling throughout Canada. This should include a full citizen science survey with taxonomic expertise paired with other monitoring technologies (acoustic recording units, camera traps, eDNA collection). The scientific samples should be all linked with records on platforms like iNaturalist and eBird as in emerging initiatives, such as MycoMap (https://mycomap.org). Ideally, this would also be implemented in places with existing long-term and intensive monitoring, as with movement data from WildTrax, while balancing research needs with already existing infrastructure.
6. **Build a 'science' of citizen science.** Each person's motivations, behaviours, and expertise influence how they collect and contribute biodiversity data (Boakes et al. 2016; Thompson et al. 2023). We are only beginning to understand how to leverage citizen science to fill outstanding biodiversity data gaps and engage people in biodiversity monitoring and conservation (Dickinson et al. 2012; Callaghan et al. 2019) – but, so far, early evidence suggests that citizen scientists are more than willing to 'go the extra mile' to contribute data that helps us better understand and protect biodiversity (Callaghan et al. 2023). Citizen science is poised to play a major role in global biodiversity monitoring and conservation going forward, with the potential to feed over half of the biodiversity metrics used to track progress in the Kunming-Montreal Biodiversity Framework (Danielsen et al. 2024). Finding creative ways to connect people with nature while

engaging them in repeated and structured monitoring for research and conservation is sure to be crucial to our ability to make and monitor progress towards global biodiversity targets. We recommend starting with simple, clear goals with sampling events structured for that purpose, such as ‘exploration’ challenges for spatial coverage and repeat bioblitzes in the same area at a pre-defined time period for detecting change (ideally coupled with other types of sampling and held at places with existing needs and user communities like KBAs). For Canada, we urgently need to identify these sampling priority places and ensure that they are surveyed repeatedly in the next decade.

7. **Fund and embed guided citizen science into government agencies, research programs, and monitoring programs.** Citizen science brings a major windfall of low-cost data, but it is not necessarily sustainable nor ethical to rely solely on volunteer effort for monitoring (Resnik et al. 2015). First, funding is urgently needed for training programs for taxonomists and naturalists – especially those without a professional position – who are core to the success of citizen science platforms like iNaturalist. Funding citizen scientists is particularly important when trying to ‘nudge’ sampling, to incentivize and reward participants for their efforts to address scientific needs. The BC Biodiversity Program, QCBS Champion Grants, and CWF’s Great Canadian Bioblitz Grants demonstrate that this can be done with a relatively small budget compared to standard monitoring programs: citizen science platforms ‘outsource’ the resources, time, and effort needed to organise, identify, store, and share collected data in an accessible way – with the added bonus of transparency. For example, the QCBS Champion Grant program cost $24,000 and led to over 33,000 observations (under 1$/observation) of more than 4,700 species between May and December 2025, of which over 17,100

observations are now research-grade (via a public identification process) and accessible through GBIF. There is enormous potential for these platforms to be used by government agencies, research programs, and monitoring programs to streamline data collection, processing, and sharing – allowing more of the budget to be allocated towards sampling, which is ultimately what is most needed.

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Table 1. Sampling challenges designed for Blitz the Gap 2025. More detailed description of the challenges, including maps and species lists, is available at pollocklab.github.io/blitz-the-gap. Summary of observations, species, and identification for each challenge is available in Supplementary File 2.

Challenge	**Gap(s)**	**Target**
Missing Canadian Species	Taxonomic	Species (animals, plants, insects, fungi and lichen) that are expected to be in Canada (*e.g.*, from historical records, unconfirmed sightings) but that have not yet been observed in iNaturalist in Canada.
Hey birders, don't look up!	Taxonomic	Non-bird taxa, ideally recorded while birding to contribute a more taxonomically complete survey.
Make a splash!	Taxonomic, Spatial	Freshwater species in Canadian freshwater systems, with spatial priorities set for endemic but poorly sampled sites.
Trailblazers	Spatial	Improving the spatial evenness of observations in parks (e.g., going beyond the parking lot and trailheads), where parks with highly clustered observations were prioritised.
Canada's Most Wanted	Taxonomic	Species of conservation interest, including invasive species and >2,200 species threatened nationally or subnationally.
Made in Canada	Taxonomic	Species that are endemic to Canada or whose distributions are mostly in Canada.
We are the 99.9%	Spatial	Anywhere outside of the 60 most highly sampled counties of Canada, which contain over 75% of all iNaturalist observations in Canada while only representing only 3.5% of Canada's area.
Closing the Climate Gap	Spatial	Areas that represent unique Canadian climates that have yet to be surveyed thoroughly.
Too hot to handle	Taxonomic, Conservation	Species that models suggest will be most negatively impacted by climate change, in some cases losing substantial parts of their range. These species don't have enough data for us to know if they are indeed shrinking from climate change.
Getting Even	Taxonomic, Spatial	Areas where sampling is uneven, targeting the major taxonomic group that is most disproportionately under-sampled.

Challenge	**Gap(s)**	**Target**
More than a monarch	Taxonomic	Any butterfly or moth species in Canada.
MayBAs	Conservation	Species that are likely to meet criteria for Key Biodiversity Areas, especially in candidate KBAs (MayBAs).
Seaweeds of Canada	Taxonomic	Seaweed species in Canada.
Revisit the Past	Temporal	Species not observed in Canada since before 2000.

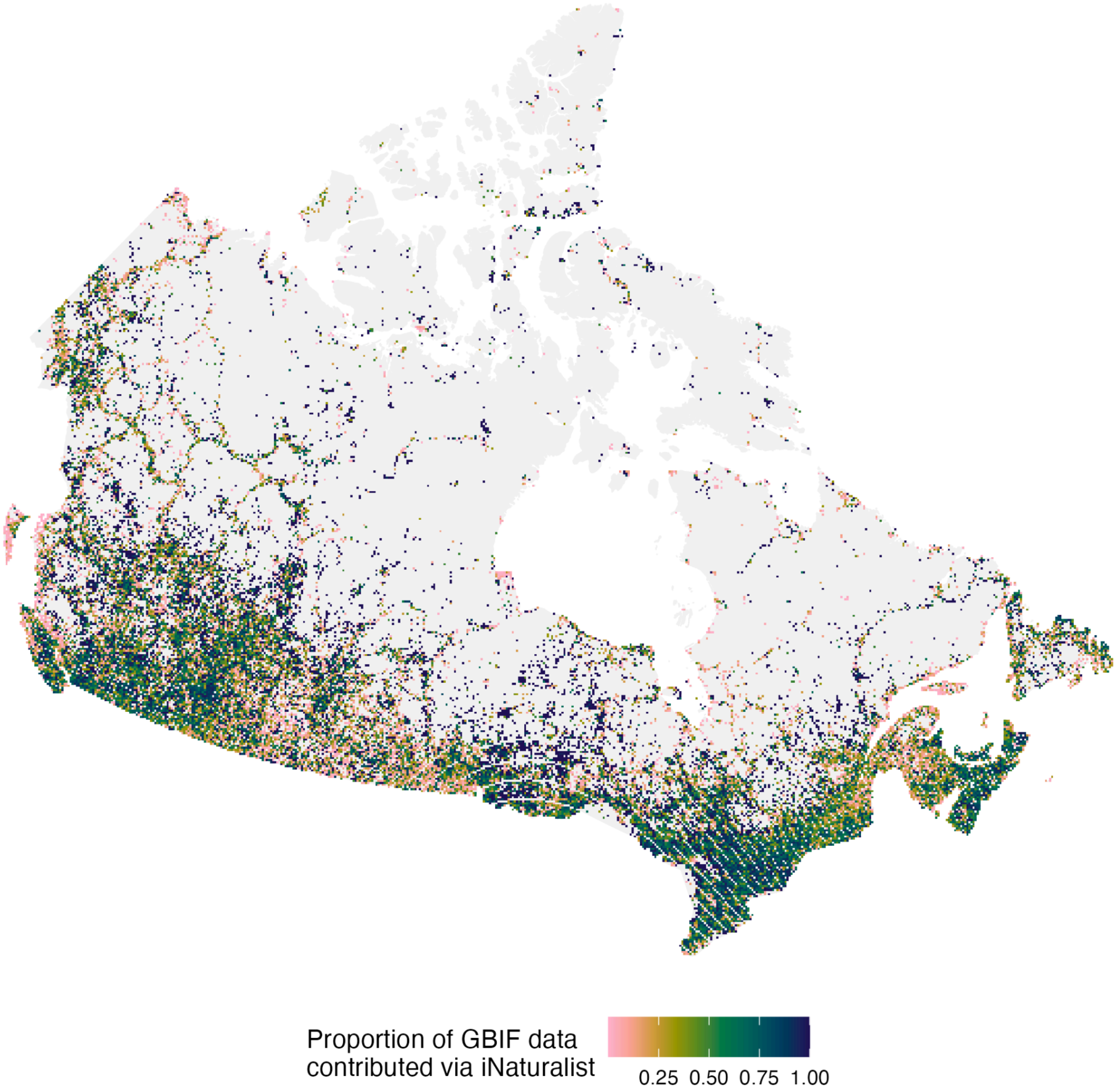


Figure 1. Proportion of occurrence data for non-bird species on the Global Biodiversity Information Facility (GBIF) contributed via iNaturalist.

This map (100km resolution) excludes Aves, as eBird is the largest source of citizen science bird data (rather than iNaturalist). All biodiversity data on GBIF is concentrated in 9.5% of Canada's area. iNaturalist data accounts for over half of the biodiversity data in 5% of Canada's area, and is the sole source of data in over a third of this area (representing about 1.8% of Canada's area).

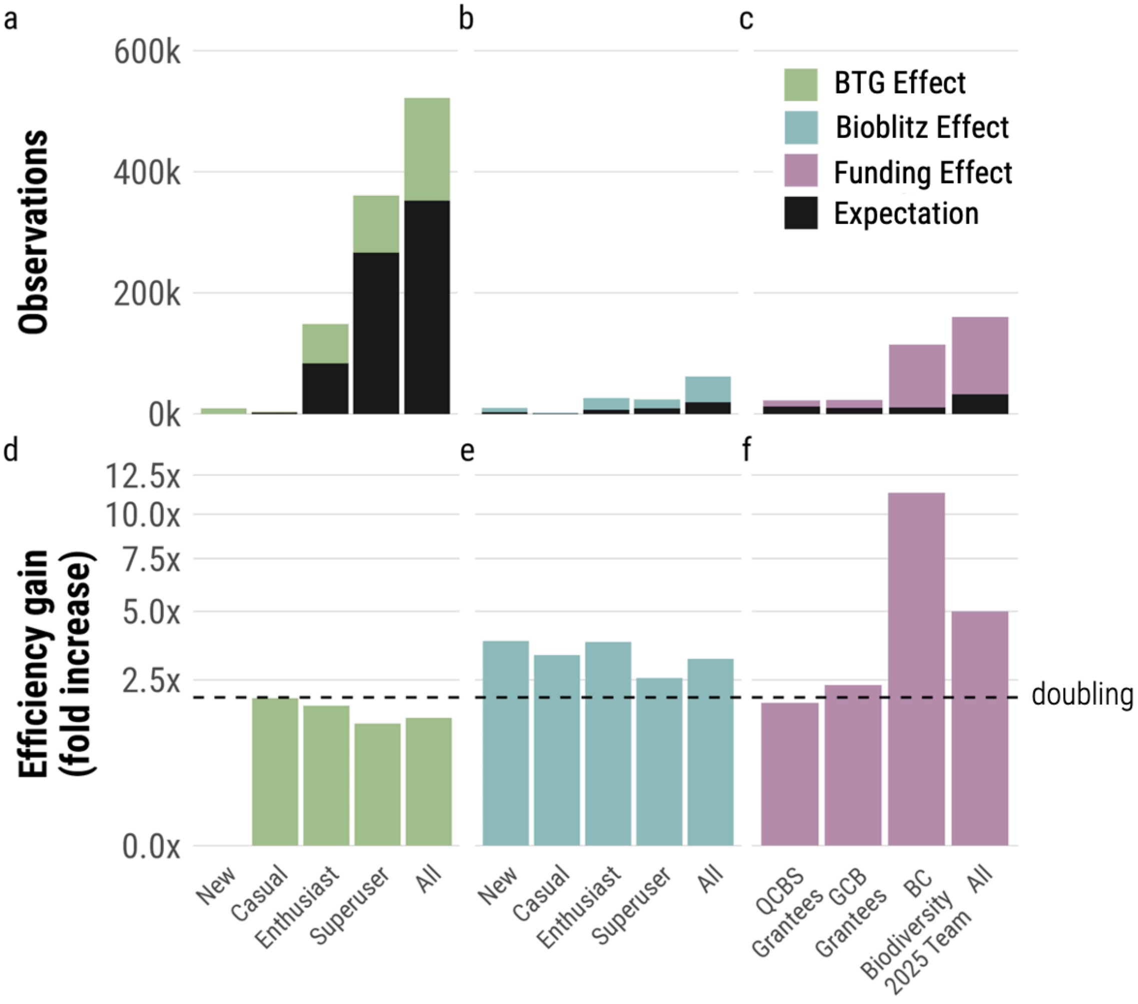


Figure 2. The contributions of (a,d) Blitz the Gap (BTG), (b,e) local bioblitzes, and (c,f) funding programs to iNaturalist observations and efficiency gains during Blitz the Gap. Observers are grouped according to their total observations in iNaturalist Canada: new (first observation is in 2025), casual (1-100 observations), enthusiast (100-4999 observations), and superuser (≥5000 observations). Panels a-c: Total observations contributed between June 1st and October 1st by **(a)** all members of Blitz the Gap projects and affiliated bioblitzes and funded initiatives, **(b)** local bioblitz participants, **(c)** observers funded by the Quebec Centre for Biodiversity Science (QCBS), the CWF's Great Canadian Bioblitz (GCB), and the BC

Biodiversity Program’s 2025 team. Expectation (in black) shows the observations expected from the same observers based on their past efficiency (observations/active day): **(a,d)** active days during BTG x past efficiency (June 1 - Oct 1, 2024); **(b,e)** active days during bioblitz events x efficiency during the rest of BTG; **(c,f)** active days during BTG x efficiency rate prior to funding (2024 for QCBS and GCB grantees, and 2018 for BC Biodiversity Program). Colour block shows the additional contributed observations beyond the expectation. **Panels d-f:** Efficiency gain per group, measured as the fold increase between the expected and contributed observations during Blitz the Gap. The dashed line shows a doubling effect.

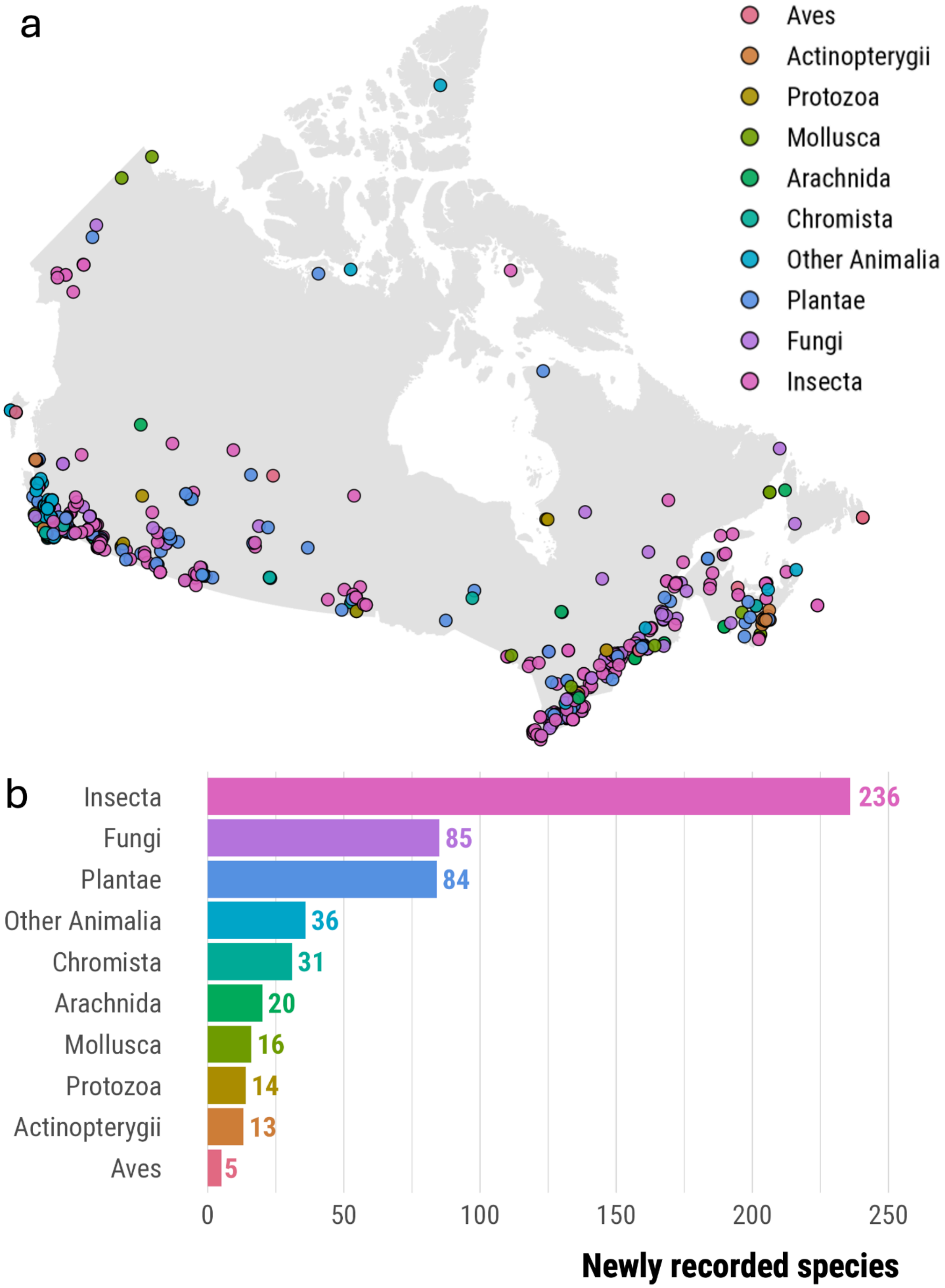

a
Aves
Actinopterygii
Protozoa
Mollusca
Arachnida
Chromista
Other Animalia
Plantae
Fungi
Insecta
b
Insecta
Fungi
Plantae
Other Animalia
Chromista
Arachnida
Mollusca
Protozoa
Actinopterygii
Aves
236
85
84
36
31
20
16
14
13
5
0
50
100
150
200
250
Newly recorded species

Figure 3. Species recorded for the first time on iNaturalist in Canada during Blitz the Gap. Newly recorded species are defined as species that were not recorded in iNaturalist in Canada prior to April 1st, 2025, but have at least one research-grade observation during the “Missing Canadian Species” challenges in Blitz the Gap (until October 1st, 2025). (a) Map of the locations where the newly recorded species were observed for each iNaturalist “iconic taxon group”. (b) The number of newly recorded species per taxonomic group.

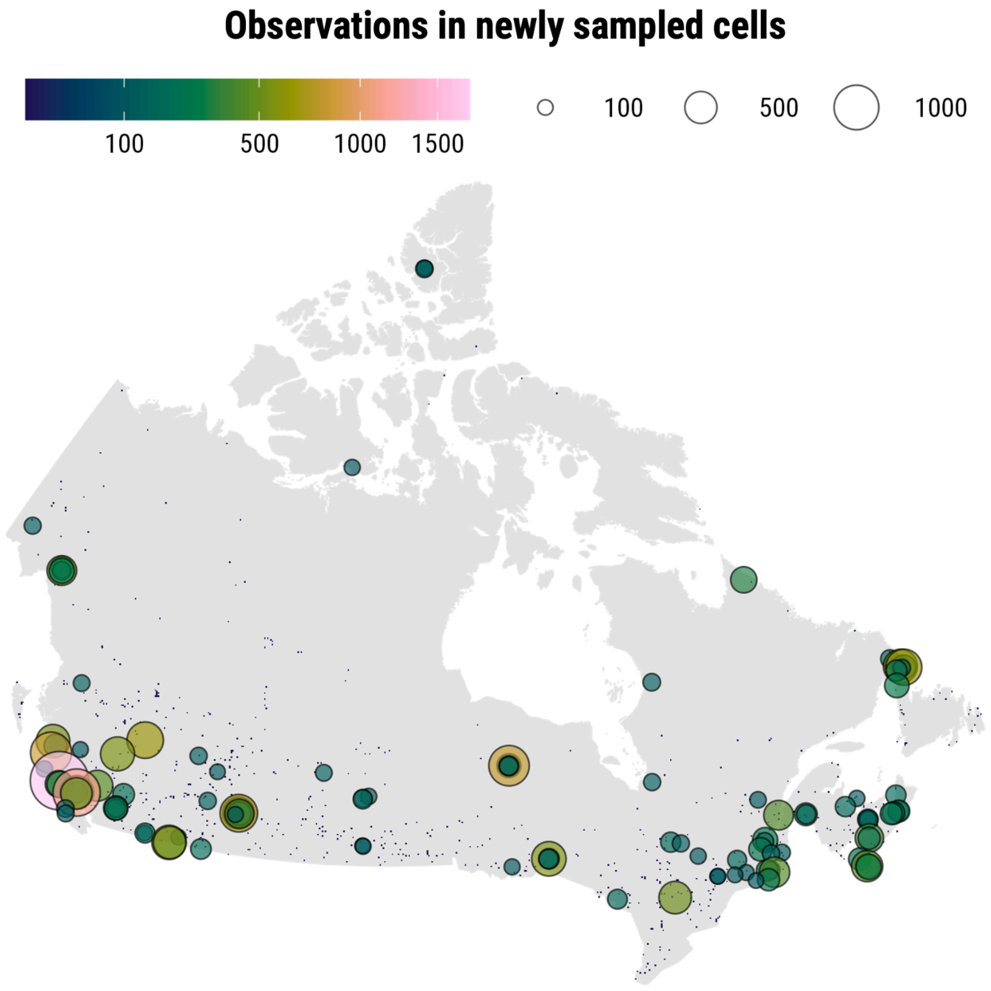
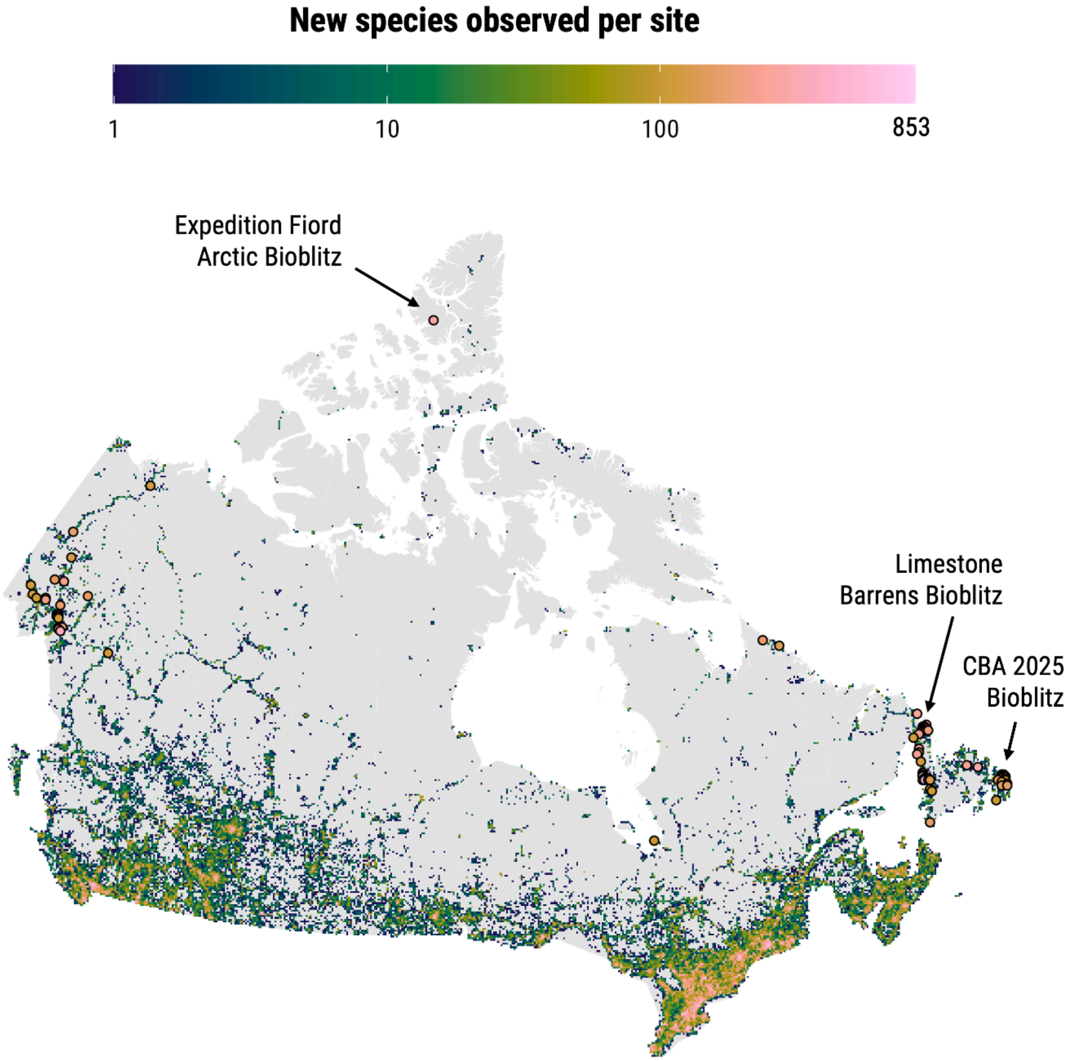


Figure 4. Gains in spatial coverage (newly sampled cells) during Blitz the Gap.

Cells (1km^2 resolution) with 100 observations or more are highlighted as points, scaled and colored by the number of observations in iNaturalist during Blitz the Gap (June 1 to October 1, 2025) within each 1km^2 cell. The largest contributions (in terms of number of observations per cell) to closing the spatial gap were made in British Columbia. Cells with fewer than 100 points are shown in dark blue.


New species observed per site
1
10
100
853
Expedition Fiord
Arctic Bioblitz
Limestone
Barrens Bioblitz
CBA 2025
Bioblitz

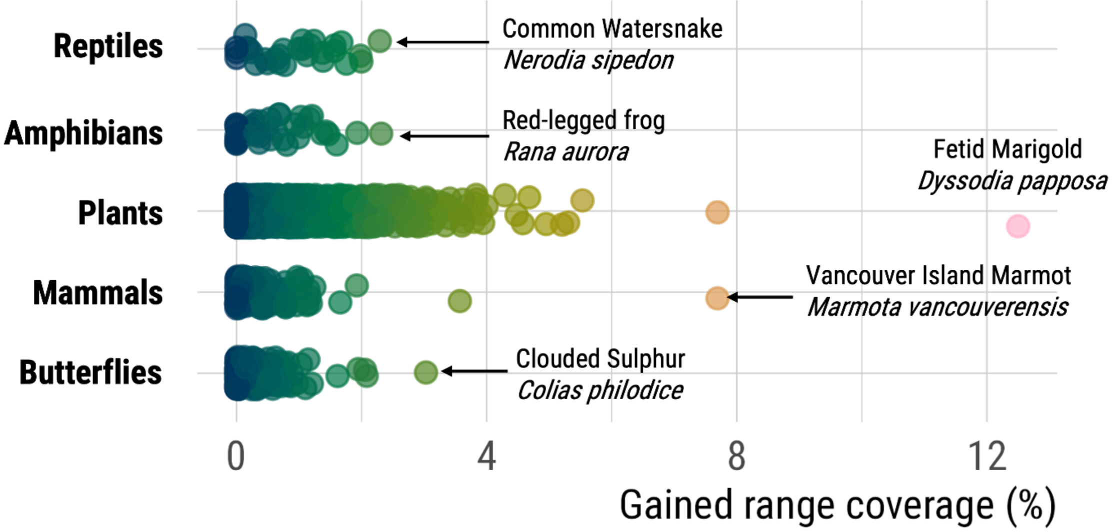

Reptiles
Amphibians
Plants
Mammals
Butterflies
Common Watersnake
Nerodia sipedon
Red-legged frog
Rana aurora
Fetid Marigold
Dyssodia papposa
Vancouver Island Marmot
Marmota vancouverensis
Clouded Sulphur
Colias philodice
0
4
8
12
Gained range coverage (%)

Figure 5. Gains in geographic range coverage during Blitz the Gap.

(a) Map of species' range coverage gains at the Canadian scale, showing the number of species sampled for the first time in each cell during Blitz the Gap (June 1st to October 1st, 2025). Empty cells (in grey) did not gain species observed or were not sampled. Cells in the north with >100 new species records are highlighted as points, including the Expedition Fiord Arctic Bioblitz, the Limestone Barrens Bioblitz, and the Canadian Botanical Association (CBA) 2025 Bioblitz. **(b)** Species-level range coverage gains as a percentage of the species' total range area for reptiles, amphibians, plants, mammals, and butterflies. Species with the largest gains in range coverage in each taxonomic group are labelled: Common watersnake (*Nerodia sipedon*) (2.3%); Red-legged frog (*Rana aurora*) (2.3%) is of Special Concern in Canada (COSEWIC 2002); Fetid Marigold (*Dyssodia papposa*) (12.5%) is introduced (NatureServe Canada); the Vancouver Island Marmot (*Marmota vancouverensis*) (7.7%) is an Endemic species and is Endangered in Canada (COSEWIC 2000); Clouded Sulphur (*Colias philodice*) is native to Canada (3.0%).

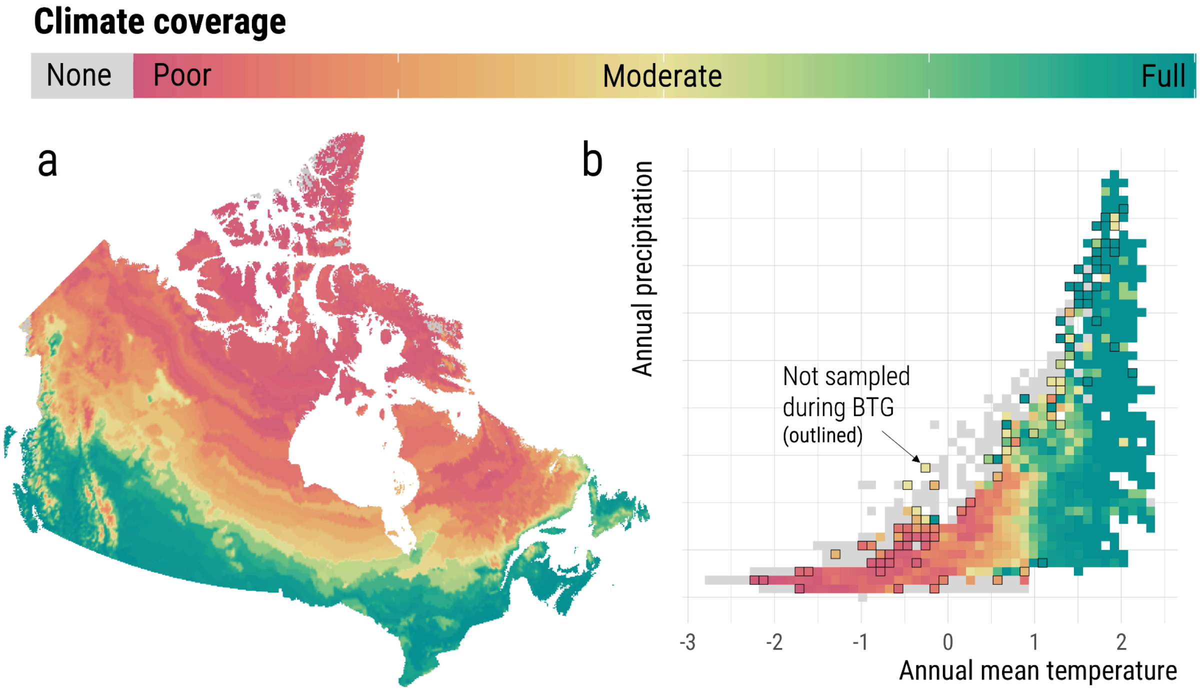


Figure 6. Climate coverage in iNaturalist data in Canada in geographic and climate space. **(a)** Map of climate coverage in Canada, where yellow to green zones are well covered relative to their climate frequency in the Canadian landscape and yellow to red zones are poorly covered. Grey zones are climates that have not yet been sampled in iNaturalist Canada. (b) Coverage in climate space, defined by annual mean temperature and annual precipitation. Each grid cell is coloured by how completely the climate zone has been sampled, and can include multiple cells on the geographic map in panel a. Outlined cells were not sampled in iNaturalist during Blitz the Gap (June 1 - October 1, 2025). See [Fig. S4](#) and [S5](#) for details.

Supplementary material

S1. Measuring species-level range coverage

We used range polygons from IUCN for the reptiles, amphibians, mammals, and butterflies present in the iNaturalist dataset in Canada. For plants, we used range polygons from the Botanical Information and Ecology Network (BIEN) accessed via the R package *BIEN* and rasterized to 10 km^2. We clipped all range polygons to Canada. To produce a conservative estimate of range area for the reptiles, amphibians, mammals, and butterflies, we generated area of habitat maps by clipping range polygons with species-associated elevation and habitat classes from the IUCN Habitat Classification Scheme (Version 3.1), which were translated into corresponding landcover classes from the International Geosphere-Biosphere Programme (IGBP) to map habitat types. Each species' total range area is then measured as the area of suitable landcover and elevation within its range as defined from the IUCN range polygon, rasterized to 12.5 km^2 resolution. Geographic range coverage was then measured as the proportion of cells within the species' total range that contained at least one occurrence in iNaturalist.

Table S1. Bioblitz events during Blitz the Gap 2025 as part of the Campus Nature Challenge (CNC), Blitz the Gap local bioblitzes (BTG), and the Great Canadian Bioblitz (GCB). These bioblitzes were recorded as iNaturalist projects with the listed Title and ID. Start and end dates are listed as DD/MM. Blitz the Gap local bioblitzes are assembled in a project on iNaturalist (inaturalist.ca/projects/blitz-the-gap-local-bioblitzes), except the Limestone Barrens bioblitz (inaturalist.ca/projects/limestone-barrens-of-newfoundland). All GCB bioblitzes listed here as were supported by CWF grants.

Event	Title	ID	Start	End
CNC	Mount Allison University-Campus Nature Challenge 2025	260199	21/09	28/09
	Collaboration Heritage College & Cégep de l'Outaouais-Campus Nature Challenge 2025	260206	21/09	28/09
	Bioblitz du Cégep de l'Outaouais - Septembre 2025	259932	21/09	8/10
	Fanshawe College - Campus Nature Challenge 2025	259894	21/09	28/09
	Vanier College - Campus Nature Challenge 2025	248279	21/09	28/09
	McGill University - Campus Nature Challenge 2025	248245	21/09	28/09
	Université Laval - Défi nature campus 2025	248299	21/09	28/09
	2025 Campus Nature Challenge - Niagara College	259057	21/09	28/09
	INRS - Défi nature campus 2025	248296	21/09	28/09
	UQAM - Défi nature campus 2025	259903	21/09	28/09
	Bioblitz Armand-Frappier | INRS+CANOPÉE pour le Défi nature campus et Grand bioblitz canadien 2025	256243	26/09	26/09
	UQO - Défi nature campus 2025	260204	19/09	28/09
	Bioblitz avec le Cégep Garneau 2025	259582	25/09	2/10
	Université de Sherbrooke-Défi nature campus 2025	259649	21/09	28/09
	UQAR- Défi nature campus 2025	260205	21/09	28/09

	Bioblitz INRS+TÉLUQ+UQ | Défi nature campus et Grand bioblitz canadien 2025	258239	23/09	23/09
	ETS-École de technologie supérieure Défi nature campus 2025	260202	21/09	28/09
	Cégep du Vieux Montréal - Défi nature campus 2025	259893	21/09	28/09
	RRC Polytech - Campus Nature Challenge 2025	260067	21/09	28/09
	St. Thomas University, NB- Campus Nature Challenge 2025	260200	21/09	28/09
BTG	Expedition Fiord Arctic Bioblitz	248464	01/06	01/10
	Cypress Hills Bioblitz 2025	227409	06/06	08/06
	BioBlitz the Gap: Gault Nature Reserve	240788	06/06	07/06
	BioBlitz the Gap: Station de biologie des Laurentides	241287	28/05	01/08
	Irving Nature Park, Ocean Week, Blitz The Gap	243158	01/06	01/06
	Fundy Trail, Ocean Week Fundy - Blitz The Gap	243161	06/06	06/06
	Forêt Ouareau BioBlitz 2025	244779	13/06	16/06
	BioBlitz the Gap: CSEE Île du marais	241300	06/07	09/07
	Blitz the Gap: Quebec soil fauna	248412	n.d.	n.d.
	BioBlitz the Gap: CSEE Johnville Bog & Forest Park	241298	06/07	06/07
	BioBlitz the Gap: CSEE Parc national du Mont-Mégantic	241296	06/07	06/07
	Ram Mountain biodiversity blitz 2025	241314	30/05	20/09
	UBC Farm Bioblitz - Blitz the Gap!	249523	28/06	28/06
	Limestone Barrens of Newfoundland	155651	07/07	14/07
GCB	Bamfield Spider-Blitz 2025	261033	25/09	28/09
	CWF/FCF - WCS Great Canadian BatBlitz 2025	261767	21/09	28/09
	Cortes Island 2025 Northern Wilds Bioblitz	260432	25/09	29/09
	Marais de la Rivière-aux-Cerises	237498	21/09	28/09
	City of Edmonton - Great Canadian Bioblitz	255676	21/09	28/09
	Foray NL Mushroom & Lichen Diversity	111092	22/09	26/09
	Swan Lake Christmas Hill Nature Sanctuary	67238	21/09	28/09

Bug Battle - 2025 - Kings County Count Week	257310	19/09	26/09
Bug Battle - 2025 - Annapolis County Count Week	257307	19/09	26/09
DUC Acadia University Campus Club: Great Canadian BioBlitz	256903	21/09	28/09
UNB Wetlands Conservation Society: Great Canadian BioBlitz	256906	21/09	28/09
Univert Laval: Le Grand Bioblitz canadien	256909	21/09	28/09
Wetlanders DUC Campus Club: Great Canadian Bioblitz 2025	256899	21/09	28/09
University of Guelph: Great Canadian BioBlitz	257184	21/09	28/09
MST 2025 Fall Walks and Forays	259157	21/09	28/09

Supplementary Figures

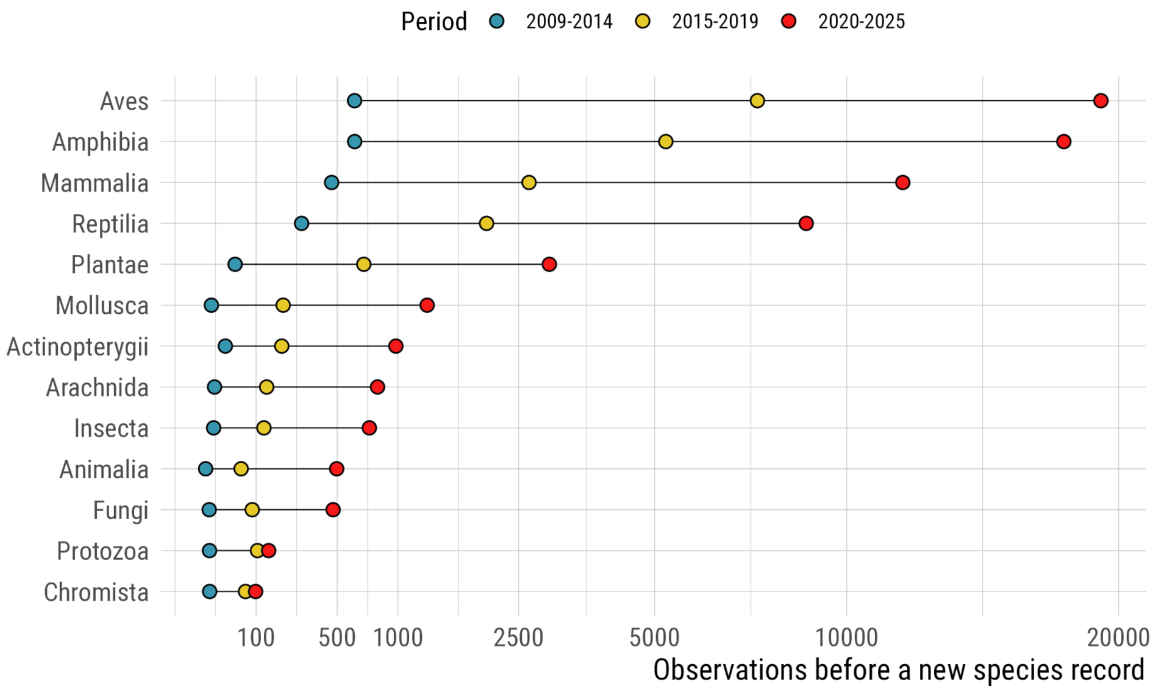


Figure S1. Number of observations per new species record in each iconic taxon group over three periods of sampling, from 2009 to 2025.

Groups for which we have already recorded most species require more observations per new species record (such as Aves, Amphibia, and Mammalia in 2025), compared to groups for which coverage is less complete (such as Chromista and Protozoa). Spacing between periods reflects the information gained during each time period, where larger spaces indicate that taxonomic coverage has increased. For groups like Protozoa and Chromista, this means that the rate of adding new species to iNaturalist is essentially the same since 2015-2019, while groups like Aves and Amphibia have seen large progress in the same period.

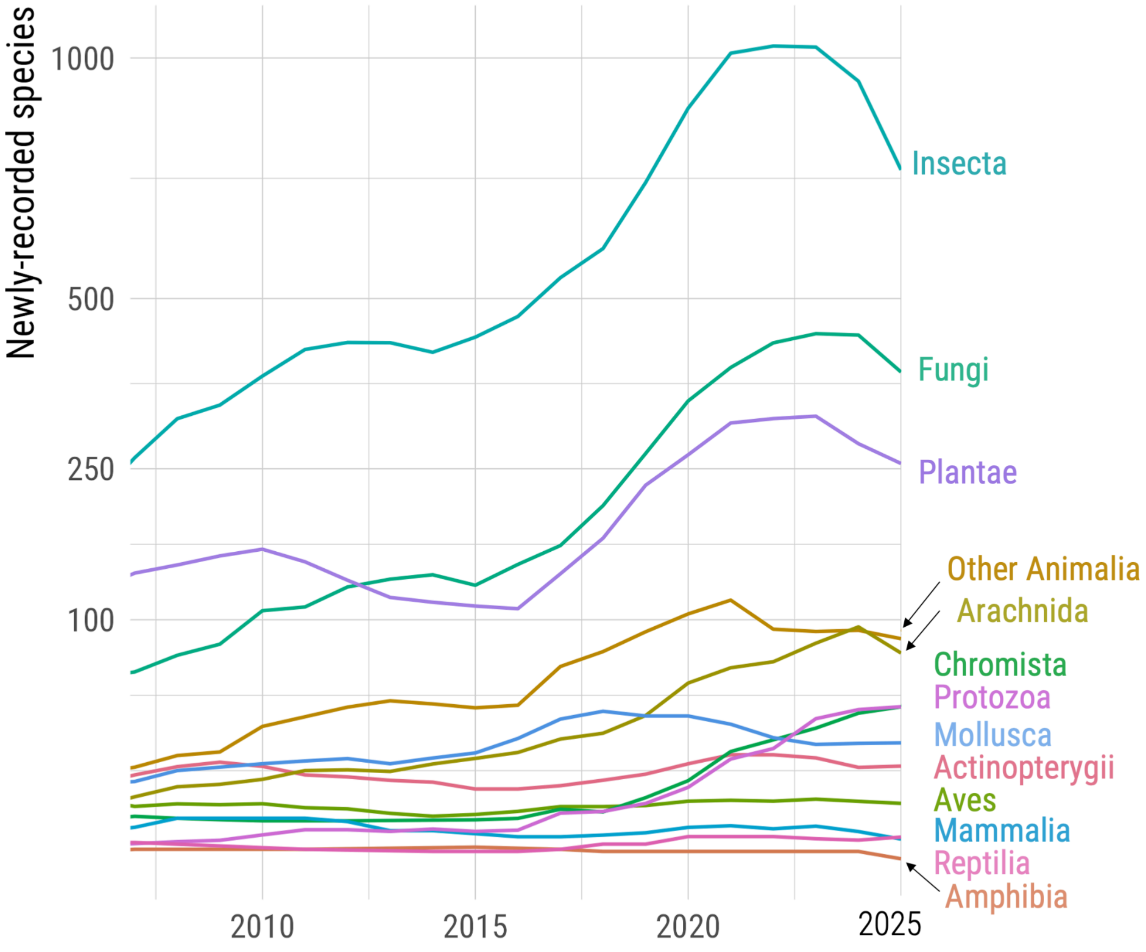


Figure S2. New species records each year from 2008 to 2025 for iNaturalist's iconic taxa. This plot shows a five-year moving window average of the number of newly recorded species per year on iNaturalist in Canada, based on research-grade observations as of December 2025. New species records in 2025 are likely under-estimated for some groups due to the lag time required to resolve observations to research-grade, which depends on identifiers from the iNaturalist community reaching a consensus. As of April 2026, 45% of observations in Blitz the Gap still require identification before becoming research-grade.

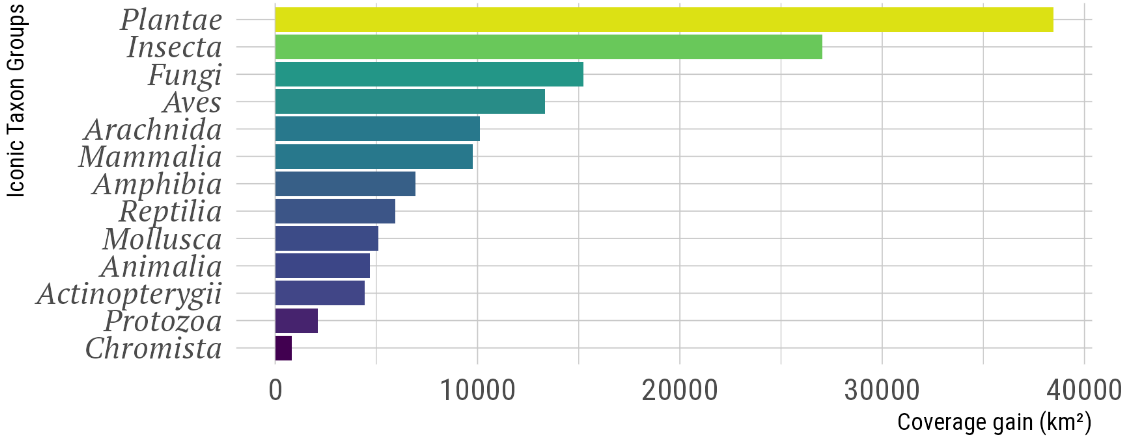


Figure S3. Spatial coverage gains (in km^2) in iNaturalist per taxa during Blitz the Gap. Spatial coverage gain is calculated as the previously unsampled area (1 km^2 cells) in iNaturalist Canada prior to June 1st, 2025 and gained at least one observation during Blitz the Gap. Taxa are the “iconic taxon” groups defined by iNaturalist.

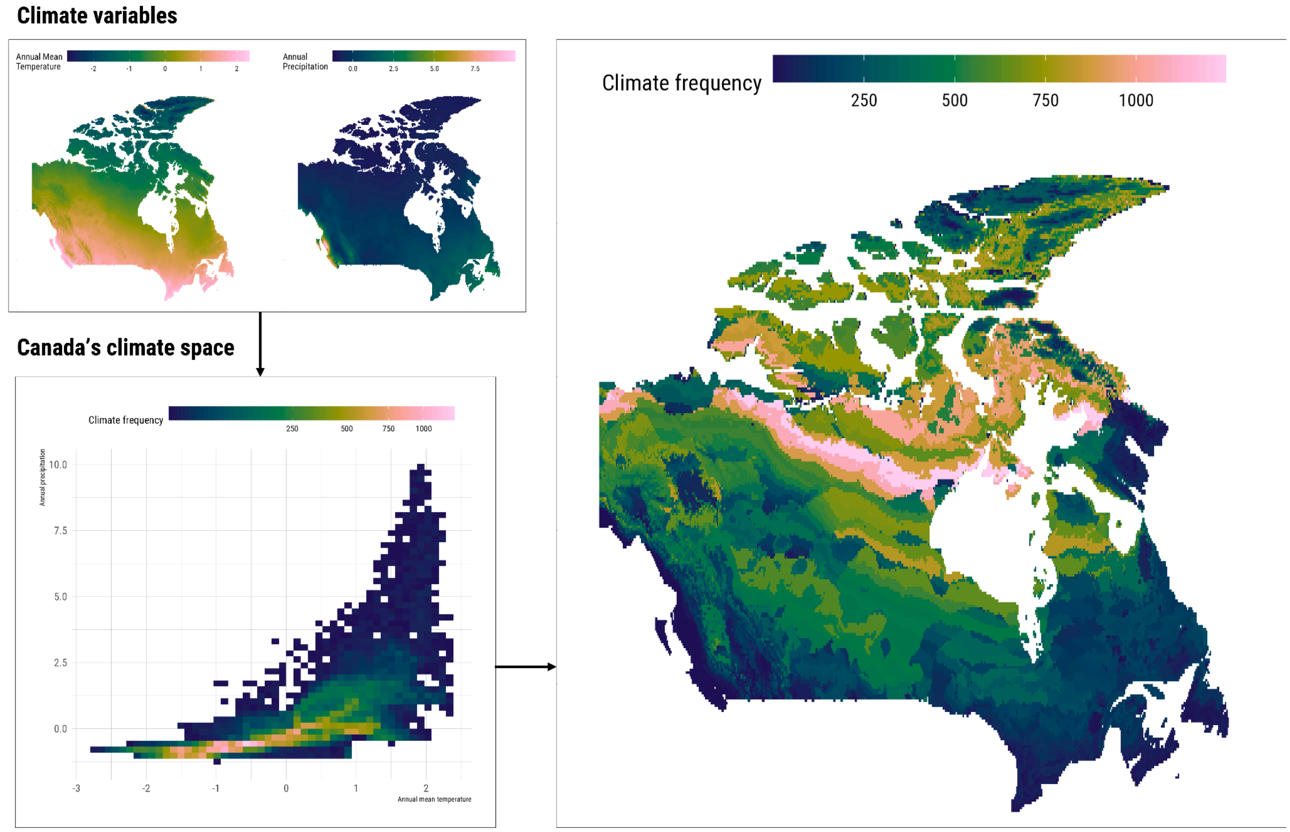


Figure S4. A portrait of Canada's climate space.

Canada's climate space was defined here with two key variables for the distribution of Canadian biodiversity: annual mean temperature and annual precipitation. The Canadian map of these two variables were combined in a two-dimensional space, showing the climate space available in Canada. This space is binned with a 50x50 grid to group map cells that represent the same 'climate zone', representing similar climate conditions, which resulted in 750 bins (or 'climate zones'). In each bin, climate frequency was measured as the number of map cells included in the bin, i.e., within the zone's climate conditions. These climate frequencies are then mapped in geographic space (right panel) to highlight climates that are relatively common (pink) or relatively rare (dark) throughout Canada. Data is from WorldClim (Fick & Hijmans 2017).

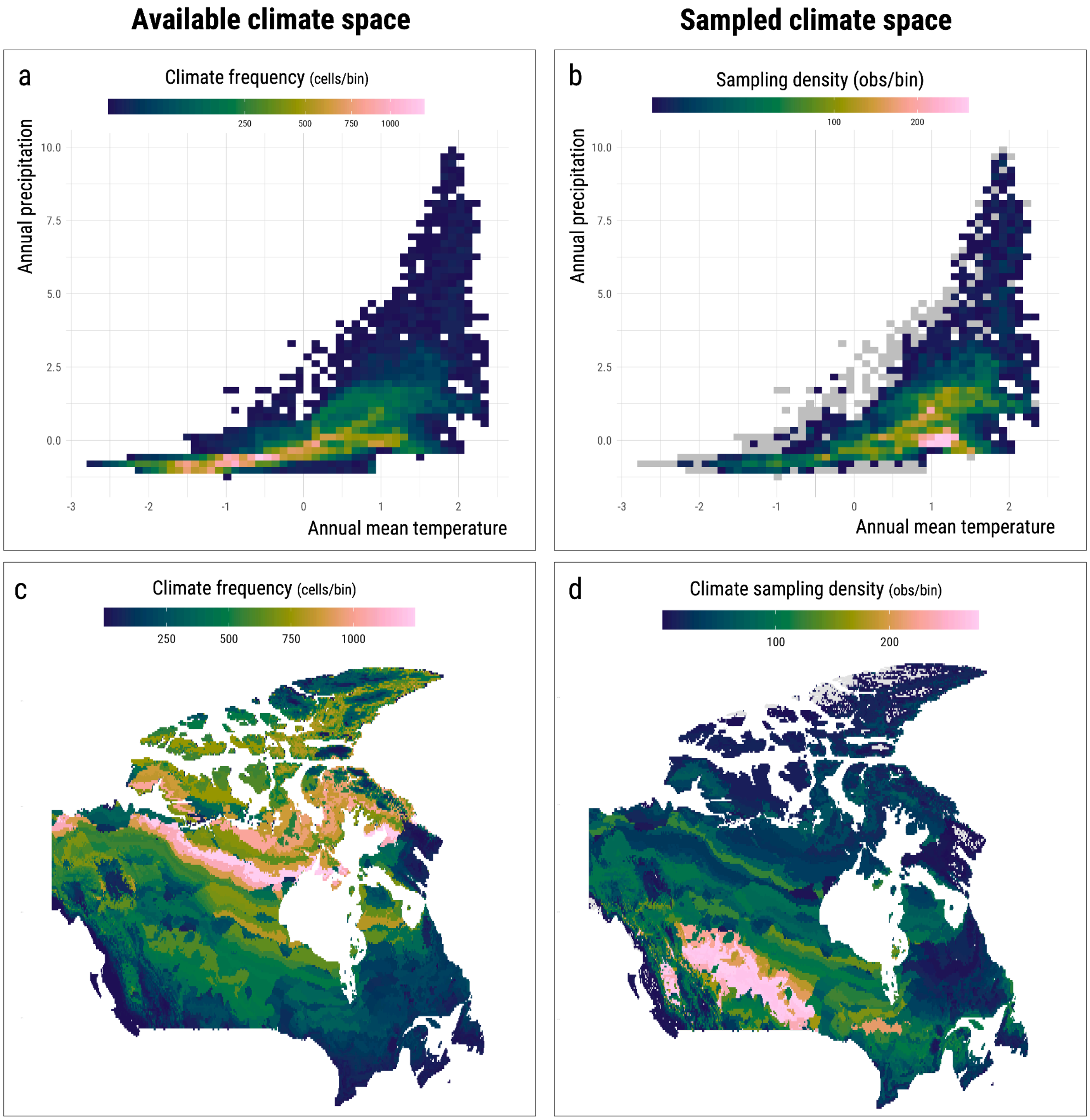

Available climate space
Sampled climate space
a
Climate frequency (cells/bin)
250
500
750
1000
Annual precipitation
10.0
7.5
5.0
2.5
0.0
-3
-2
-1
0
1
2
Annual mean temperature
b
Sampling density (obs/bin)
100
200
Annual precipitation
10.0
7.5
5.0
2.5
0.0
-3
-2
-1
0
1
2
Annual mean temperature
c
Climate frequency (cells/bin)
250
500
750
1000
d
Climate sampling density (obs/bin)
100
200

Figure S5. The climate sampling gap in Canada. Left panels: Available climate space in Canada (defined following Fig. S4) mapped **(a)** in climate space, and **(c)** in geographic space. Climate frequency is a measure of climate commonness throughout Canada, to highlight climates that are relatively common (pink) or relatively rare (dark) throughout Canada. **Right panels:** Sampling density in the climate bins, illustrated **(b)** in climate space and **(d)** geographic space. Densely-sampled climates are shown in pink, and poorly-sampled climates are shown in darker colors. Overall, Canadian biodiversity data are biased towards warmer and drier climates, primarily representing moderately common climates in the South, and missing Canada's most common climates which are cold and dry (as in the North).

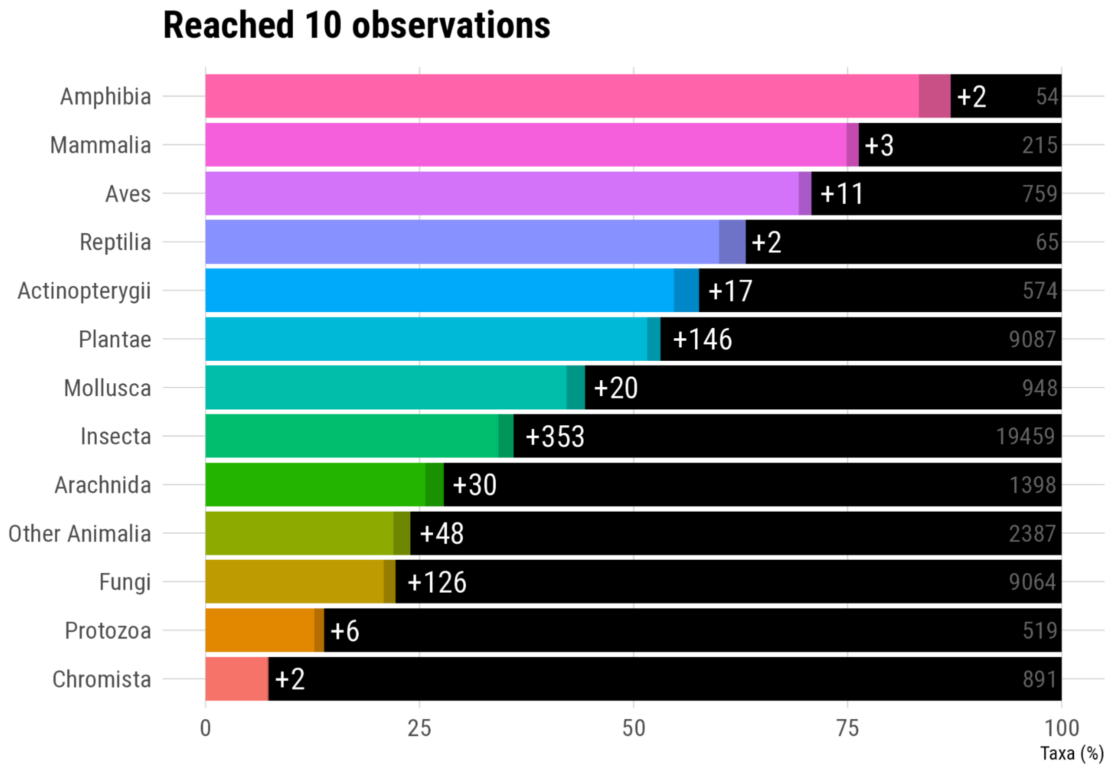


Figure S6. Number of species in iNaturalist's iconic taxon groups that reached at least 10 observations in 2025.

Each bar is scaled according to the number of basal taxa (a.k.a. iNaturalist "taxon leaf"; i.e. taxa at species level or higher that are taxonomically unique and not represented by another more basal taxon; (iNaturalist 2024)) in each group on iNaturalist in Canada as of June 2026, labelled on the black line. Each coloured bar shows the total number of taxa with over 10 observations as of December 2024 (solid) and those added in 2025 (transparent). The number of taxa that reached 10 observations in 2025 are labeled in white.

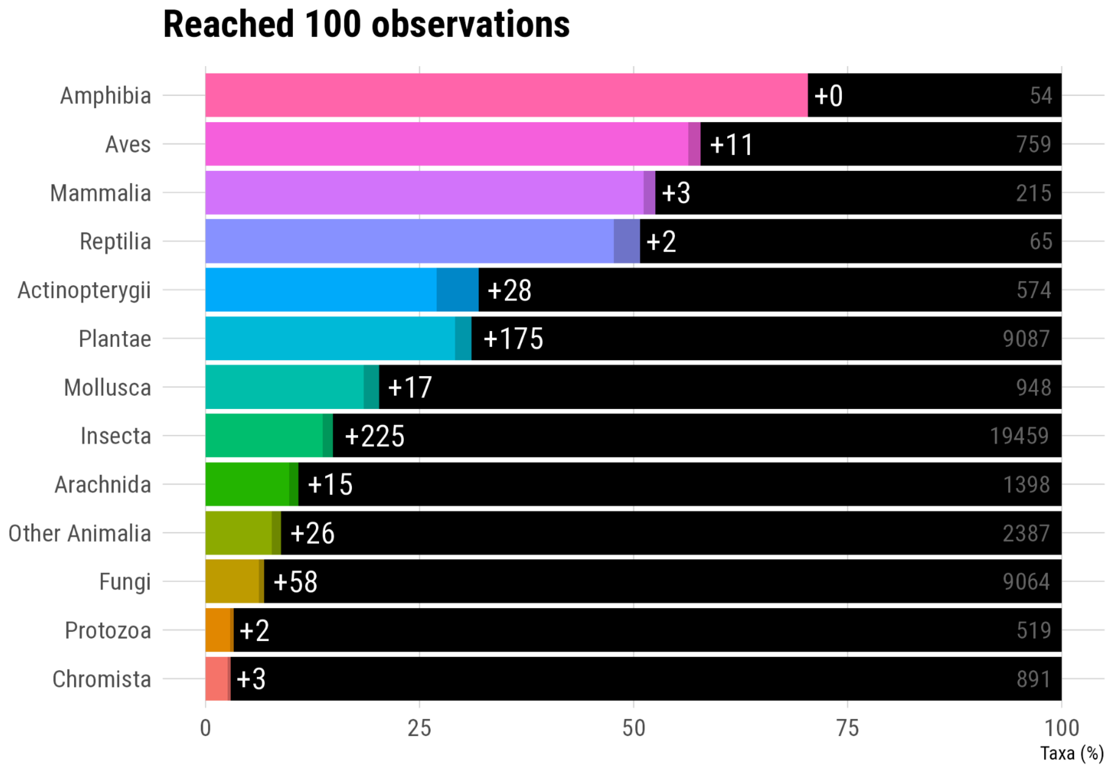


Figure S7. Number of species in iNaturalist's iconic taxon groups that reached at least 100 observations in 2025.

Each bar is scaled according to the number of basal taxa (a.k.a. iNaturalist "taxon leaf"; i.e. taxa at species level or higher that are taxonomically unique and not represented by another more basal taxon; (iNaturalist 2024)) in each group on iNaturalist in Canada as of June 2026, labelled on the black line. Each coloured bar shows the total number of taxa with over 100 observations as of December 2024 (solid) and those added in 2025 (transparent). The number of taxa that reached 100 observations in 2025 are labeled in white.

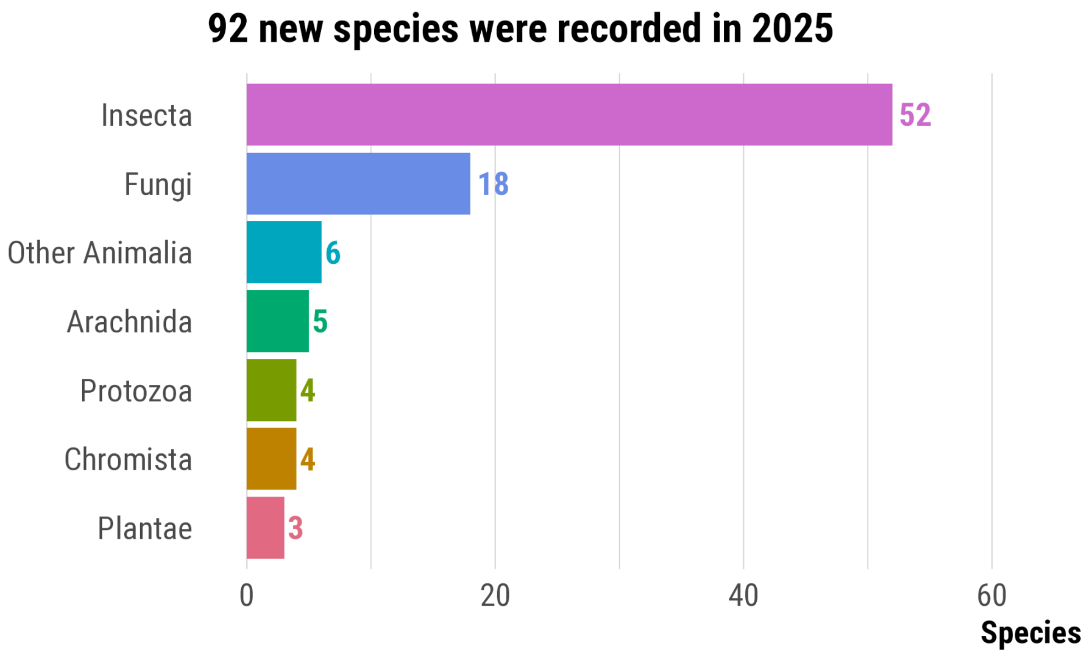


Figure S8. Species recorded for the first time on iNaturalist globally during 2025. Newly recorded species are defined here as species that were not recorded in iNaturalist (globally) before 2025 but have at least one research-grade observation in 2025. Barplot shows the number of newly recorded species in 2025 per taxonomic group. These globally new species records on iNaturalist are determined according to the 1 Global Observation in Canada project (data accessed on May 12, 2026), which is hosted by the Canadian Wildlife Federation (inaturalist.ca/projects/1-global-observation-in-canada-1-observation-globale-au-canada).

Supplementary data files

Supplementary File 1. New species records in iNaturalist Canada in 2025.

This table lists the new species recorded with at least one research-grade observation during Blitz the Gap (Apr 1 - Oct 1, 2025) in iNaturalist Canada, and the number of observations per species. This file is available at PollockLab/BTG-analyse-the-gap on GitHub at the following url: https://github.com/PollockLab/BTG-analyse-the-gap/blob/main/outputs/missing-species/newsp_nobs_2025.csv

Supplementary File 2. Summary of the Blitz the Gap sampling challenge projects.

This figure shows the total counts of observations, species and identifications for each of the Blitz the Gap 2025 sampling challenges on iNaturalist Canada (screenshots from May 31st, 2026). This file is available at PollockLab/BTG-analyse-the-gap on GitHub at the following url: https://github.com/PollockLab/BTG-analyse-the-gap/blob/main/figures/manual-edits/btg_project_mashup.pdf

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