

PERSPECTIVE

A century of inertia in quantitative ecology education

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Abstract

1. Ecology has undergone a profound methodological transformation through the rapid growth in new technologies, data volume, statistical innovation and analytical sophistication. These developments create unprecedented opportunities for novel ecological insights, but have also magnified longstanding concerns about quantitative training, which persist despite more than a century of debate and repeated calls for reform. Here, we posit why, despite enduring and widespread agreement on educational goals, progress in quantitative ecology education has remained limited.
2. We argue that limited progress reflects a mismatch between widely supported reforms and the conditions needed to implement them at scale. While discussions of quantitative education have often focused on curricular content—what ecologists should learn—progress is also shaped by pedagogical, interpersonal, institutional and disciplinary factors. We discuss these interconnected components and argue that their combined influence helps explain the inertia that continues to characterise quantitative ecology education.
3. Building on this diagnosis, we offer an integrated vision for quantitative ecology education. We argue that durable quantitative literacy is best developed through inclusive, context-rich and people-centred pedagogies that address barriers to learning, support diverse learners and ensure that procedural competence is grounded in strong conceptual understanding. We further advocate for coordinated action from disciplinary leaders, stronger institutional support for educators and learners, recognition of heterogeneous cohorts as a pedagogical strength, greater interdisciplinary collaboration between ecologists and quantitative specialists, and a shift from expectations of universal

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fluency towards a model of distributed expertise underpinned by foundational quantitative literacy.

4. As ecology evolves, the need for quantitative literacy is greater than ever. Progress will depend not simply on identifying what should be taught and how, but on addressing the broader conditions that constrain the pace and scale of implementation of widely supported educational aspirations. We argue that reframing persistent challenges as interconnected problems of implementation, rather than aspiration, will help in overcoming a century of inertia in quantitative ecology education.

KEYWORDS

ecology education, educational reform, implementation, institutional barriers, pedagogy, quantitative ecology, quantitative literacy, statistical ecology

'The only way out of this dilemma that I can conceive is to insist upon proficiency in mathematics... This means reform'.—Michael (1920).

1 | TRANSFORMATIVE CHANGE IN ECOLOGICAL METHODS, RELATIVE INERTIA IN QUANTITATIVE EDUCATION

Ecology has undergone a profound methodological transformation driven by rapid growth in new technology, data volume, statistical innovation and analytical sophistication, creating unprecedented opportunities for novel ecological insights. Modern ecologists routinely work with large, complex and high-dimensional data generated from approaches ranging from automated sensors and genomics to long-term monitoring programmes and citizen science initiatives (McCrea et al., 2023). Making sense of these data requires more than technical proficiency; it requires quantitative literacy and confidence in statistical reasoning, grounded in an understanding of ecological systems (Ellison & Dennis, 2010). However, many ecologists continue to report anxiety around quantitative methods (Barraquand et al., 2014), reflecting the persistence of longstanding barriers to quantitative literacy.

For over a century, concerns have been raised about the adequacy of quantitative training in ecology (Kay et al., 2024; Michael, 1920). In recent decades, many have called for quantitative education to evolve (A'Brook & Weyers, 1996; Acevedo, 2020; Barraquand et al., 2014; Butcher et al., 2007; Ellison & Dennis, 2010; Fidler et al., 2004; Kay et al., 2024; National Research Council, 2003; Touchon & McCoy, 2016), motivated by a desire to improve study design, inference, reproducibility and scientific rigour in ecological studies (e.g. Gould et al., 2025). And yet, many of the same concerns remain, suggesting that over a century of advocating for desirable educational goals has not been sufficient to drive widespread change.

In this perspective, we revisit longstanding concerns about quantitative learning and literacy in ecology and posit why, despite

enduring and widespread agreement on educational goals, progress in quantitative ecology education has remained limited. We suggest that the challenge facing quantitative ecology education is no longer simply identifying what and how ecologists should learn, but understanding why progress towards achieving quantitative literacy has been constrained. We then offer a vision to overcome the inertia.

This perspective emerged through reflection among the co-authors following discussions at a thematic session on quantitative ecology education at the British Ecological Society (BES) Annual Meeting in December 2025. This session—consisting of invited talks and a panel discussion with audience participation—brought together ~200 educators and learners across educational contexts, geographies and career stages. The session took place in one of the largest international annual ecology meetings, with discussions involving participants from a broad range of countries, and the co-authors collectively represented perspectives from the UK, mainland Europe, North America and South America. We intend this perspective for educators and administrators responsible for delivering quantitative training for ecologists, the learners receiving that training, and the wider community of organisations and leaders that shape quantitative ecology education, including learned societies, regulatory and funding bodies and journals. Our primary focus is on higher education, particularly at undergraduate and postgraduate levels, although many of the ideas presented are relevant to continuing professional development among practising ecologists. Throughout this perspective, we use the term quantitative ecology broadly to refer to the use of quantitative reasoning and statistical, mathematical or computational approaches to understand ecological systems.

2 | INTERACTING BARRIERS TO IMPLEMENTATION

Pedagogical literature specific to quantitative ecology education is limited (Acevedo, 2020). Nevertheless, discussions of quantitative

ecology education have emerged across a range of topics, including curricular content (Ellison & Dennis, 2010), pedagogy (Mtwana Nordlund, 2016), learner confidence (Cuddington et al., 2023) or anxiety (Forrester et al., 2022), interdisciplinary collaboration (Carey et al., 2019), educator support (Acevedo, 2020) and institutional constraints (Henderson et al., 2011). Collectively, these contributions have generated valuable insights and examples of innovation. However, most discussions have focused on specific components of quantitative ecology education rather than the broader conditions required for achieving quantitative literacy goals, making it difficult to identify how curricular, pedagogical, interpersonal, institutional and disciplinary factors interact to constrain progress. Hence, alongside a need for further research on quantitative ecology education generally, there is also a need for more integrative perspectives that consider these factors as interconnected barriers to implementation. We intend this perspective to contribute to and stimulate that discussion.

2.1 | Limitations of content-centred reform

Quantitative training has sought to keep pace with emerging methods, creating a natural incentive to focus on what ecologists should learn. This emphasis may reinforce the prevalence of methods-centred curricula that prioritise the teaching of a range of techniques (e.g. *t*-tests, ANOVA, correlation analyses, linear models, mixed models) as though they are discrete tools designed for particular situations (A'Brook & Weyers, 1996). An implicit consequence is that students learn procedures without fully understanding the statistical concepts that underpin them (Acevedo, 2020). Attempts to reform quantitative education through the continual introduction of new methods may therefore inadvertently reinforce one of the challenges they seek to address; ecologists becoming increasingly capable of implementing analytical techniques while continuing to feel that their quantitative understanding is inadequate (Barraquand et al., 2014).

This challenge is amplified by the pace of methodological development itself. When discussions of reform centre on curricular content, it becomes difficult to establish broader and more enduring educational priorities, not least because curriculum development cannot realistically keep pace with methodological innovation. Advanced methods are also comparatively transient; for example hierarchical models, occupancy models, machine learning and, more recently, artificial intelligence (AI), have each attracted attention as emerging priorities (Altwegg et al., 2025). In contrast, foundational concepts that underpin quantitative reasoning remain relevant. Moreover, focus on curricular content risks underplaying the importance of other factors that influence quantitative learning. Innovative pedagogies for quantitative ecology education already exist (Acevedo, 2020), yet it is not always clear how these pedagogies can be implemented within wider educational constraints. Curricular content reforms cannot be considered independently of the wider educational context within which quantitative learning occurs.

2.2 | Institutional and disciplinary barriers

Institutional barriers are likely to represent the most substantial constraints on widescale change, largely driven by increasing student cohorts and student: staff ratios, alongside persistent workload and financial pressures (e.g. Wolf & Jenkins, 2021). Delivering innovative educational experiences that foster durable quantitative literacy in this environment is challenging, leading to curriculum inertia. Faculty expertise and teaching materials take time to develop, and even modest changes to courses/modules require substantial effort due to programme-level dependences, administrative processes, accreditation or regulatory requirements and resource constraints (Henderson et al., 2011).

The consequences of institutional barriers extend beyond curriculum design. For example, field-based teaching has seen a progressive decline (Soga & Gaston, 2025). This decline is problematic because such immersive experiences can facilitate translational learning (Felege et al., 2019) by connecting analytical approaches to ecological questions that help learners see quantitative methods as tools for ecological inquiry rather than abstract techniques (Barros et al., 2023).

Departmental structures create further barriers. Quantitative education sits at the intersection of ecology, statistics, mathematics and computer science. Nevertheless, expertise is frequently organised into disciplinary silos, and the responsibility for quantitative teaching is often concentrated among a relatively small number of individuals identified as the people who teach statistics (Medeiros-Mirra et al., 2023). This places substantial pressure on individuals to possess a depth of ecological, statistical, computational and pedagogical expertise. It may also reinforce perceptions that quantitative reasoning is separate from ecology itself, and limit opportunities to draw upon complementary expertise distributed elsewhere within departments and institutions. Unless educators are provided sufficient resources and institutional support to develop broader educational frameworks, established (sub-optimal) practices are likely to persist (i.e. folk pedagogy; Bruner, 1996). The persistence of methods-centred curricula, for example, reflects the practical realities of educational systems in which innovation requires time, expertise and institutional backing. In this environment, curricular, pedagogical and institutional barriers become difficult to disentangle.

Associated with these challenges, and acknowledging that quantitative learning is a common source of student anxiety (see Section 2.3), is the risk that quantitative courses receive lower student ratings (Uttl & Smibert, 2017), which can discourage educators from engaging. This highlights that idealised quantitative ecology education is a pedagogical challenge that stems from interactions among learner experiences, organisational structures and incentives, educator support and broader disciplinary attitudes towards quantitative learning.

2.3 | Interpersonal factors and pedagogy

Statistics anxiety and low quantitative confidence are recognised across the life sciences (Cuddington et al., 2023), although relatively little work has examined these issues among ecologists specifically.

This is notable, because ecologists, perhaps more than other disciplines, routinely work with complex observational data, often requiring advanced analytical methods and quantitative competence. More broadly, learners are heterogeneous; they differ in quantitative confidence, prior expertise, motivations, career aspirations and perceptions of quantitative approaches, many of which are influenced by educational experiences that pre-date higher education (Findon & Johnston-Wilder, 2017). These differences can profoundly influence engagement with quantitative learning and therefore the extent to which even well-designed curricula achieve their intended outcomes (Ambrose et al., 2010). Interpersonal considerations are therefore inherently linked to pedagogy.

Educational approaches that promote collaboration and contextualised learning may support development in ways that more traditional, didactic approaches do not (Prince, 2004). Indeed, many of the pedagogical innovations advocated within quantitative ecology education literature are designed specifically to address barriers associated with confidence, anxiety and learner engagement. However, implementing such approaches often requires educators to create opportunities for repeated exposure to concepts (e.g. through spiral curricula; Bruner, 1960; Kay et al., 2024), immersive ecological experiences (e.g. field courses) and meaningful interactions between learners and instructors. In practice, however, this can be challenging when educators face constraints on capacity and curricular flexibility. Thus, pedagogical ambitions cannot be separated from the practical realities of implementation; approaches that are effective in principle may be difficult to implement at scale if educators lack the support to create and sustain them.

2.4 | A system of interacting constraints

The persistence of challenges in implementing reform for quantitative ecology education is unlikely to be explained by any single factor. Rather, inertia emerges from the combined influence of curricular, pedagogical, interpersonal, institutional and disciplinary barriers that interact to constrain progress. Importantly, these issues have not been ignored—although some have certainly received more attention than others—but they have most often been discussed separately.

This interconnectedness has important implications for reform. The effectiveness of a curriculum depends upon the pedagogies through which it is delivered; pedagogical effectiveness is shaped by interpersonal factors, such as learner and educator engagement, confidence and anxiety; what is feasible depends on institutional conditions and support; and those conditions are themselves influenced by broader disciplinary and institutional cultures and priorities. Progress in any one area is often contingent upon progress in others. Barriers to implementation are therefore best understood not as isolated challenges, but as components of a broader educational system. So, while educational aspirations for quantitative ecology are widespread and well supported, the road to implementation is far from simple. The challenge now lies in creating the conditions that allow those aspirations to be realised in practice.

3 | OVERCOMING THE INERTIA

The interconnectedness of the factors that constrain reform in quantitative ecology education requires an integrated response. Curricular reform remains an important component, but it is unlikely to be sufficient in isolation. Below we outline a vision for the development of quantitative literacy in ecology and consider the pedagogical, interpersonal, institutional and disciplinary conditions needed to support its implementation.

3.1 | Quantitative training should prioritise foundational concepts

How ecologists are taught quantitative material shapes how they explore scientific ideas, generate new insights and contribute to the broader community of knowledge creators. Proficient use of quantitative methods requires moving beyond procedural competence; it requires judgement, critical thinking and the ability to connect statistical approaches to ecological questions (Bolker, 2009). Yet contemporary ecology is characterised by an increasingly diverse and specialised collection of analytical methods, many of which can appear disconnected from broad ecological questions and inaccessible to non-specialists (McCrea et al., 2023). Attempting to train ecologists in the continual expansion of methods risks fragmenting and diluting learning, obscuring core principles, placing unrealistic demands on both students and educators within the finite time available for formal training and encouraging unnecessary use of complex models (Murtaugh, 2007).

We advocate for a shift away from methods-centred curricula, which can encourage heuristic thinking, towards a more process-based approach to quantitative training. Rather than presenting statistics as the selection of analytical tools from an ever-expanding repertoire of methods, training should focus on building fundamental conceptual understanding: how ecological data are generated, including study design, observation processes, sources of error, variability and uncertainty (Fieberg et al., 2020); how statistical models represent these processes and encode assumptions; and how analytical decisions shape inference. Statistical analysis can then be framed as a means of understanding and modelling ecological systems, helping learners connect ecological questions, data-generating processes and inference. Such foundations enable learners to critically evaluate analyses, including assessing study design, evaluating alternative hypotheses and appraising the assumptions and decisions that underpin inference, while also adapting to emerging methodologies and applying quantitative reasoning across contexts. Without this grounding, increasingly automated and AI-assisted workflows (Han et al., 2023) risk amplifying, rather than mitigating, poor inferential practice. Indeed, training learners to critically engage with AI tools, such as evaluating outputs generated by large language models (LLMs), may become an important component of quantitative literacy (Cooper et al., 2024).

Foundational quantitative literacy begins with basic numeracy, including understanding scientific notation, biological scales and data transformations (National Research Council, 2003). Students should be taught how to articulate models clearly, progressing from conceptual descriptions (e.g. using Directed Acyclical Graphs; Correia et al., 2026) to prose ('word formulae'; Grafen & Hails, 2002), then to mathematical equations that describe the data-generating process, linking parameters explicitly to ecological processes. Quantitative ecology education should also include meaningful exposure to causal and Bayesian modes of reasoning; both provide accessible and increasingly mainstream vehicles for teaching foundational concepts, requiring explicit consideration of how data are generated, how uncertainty arises, and how ecological understanding is translated into statistical assumptions and model structure. Importantly, this is not an argument against associative or frequentist approaches, but for a more integrated framing of inference in which foundational concepts are recognised as common currency across paradigms. Such grounding enables learners to compare models that reflect competing ecological hypotheses about underlying mechanisms and choose analytical approaches based on the questions being asked, rather than relying on algorithms that let the data 'speak for themselves' (Cade, 2015; Fieberg & Johnson, 2015). We also recognise that predictive approaches, particularly those associated with machine learning and AI, offer a complementary perspective (Breiman, 2001). Importantly, these principles are relevant throughout a learner's educational journey, from undergraduate education through postgraduate training and continuing professional development, although embedding them in introductory training is likely to have the greatest and most widespread influence.

Ecology increasingly operates through interdisciplinary collaborations (Carey et al., 2019), where statistical expertise can be effectively distributed across teams rather than concentrated within individuals (McCrea et al., 2023). Not all ecologists therefore need to develop or implement novel methods, but all should be able to reason with and learn from data, communicate with collaborators using a shared quantitative language and conceptual understanding and recognise when further expertise is required (Kapteyn & van Uven, 1916). Hence, rather than expecting all ecologists to become statistical specialists (cf. Ellison & Dennis, 2010) or be proficient in mathematics (cf. Michael, 1920), we contend that all ecologists should be quantitatively literate. This will better prepare students for lifelong learning in a rapidly evolving discipline (Ben-Zvi & Garfield, 2004) and better serve the diverse future of ecology graduates, many of whom will apply quantitative reasoning outside of academia. Opportunities should remain available for those who aspire to greater quantitative specialisation (see Section 3.2).

3.2 | People-centred pedagogy

Understanding how people teach and learn is critical for effective quantitative ecology education (D'Avanzo, 2003), particularly given the associations between quantitative anxiety and low self-efficacy

among ecologists (Barraquand et al., 2014). Quantitative ecology education should therefore be explicitly grounded in evidence-based pedagogical principles that are inclusive, context-rich and responsive to learner needs (Knapp & D'Avanzo, 2010). A particular priority is recognising and addressing quantitative anxiety (Cuddington et al., 2023), which has received little direct attention in ecology. Educators can address quantitative anxiety by scaffolding activities that normalise productive failure and place learners within a 'growth zone', facilitating collaborative problem-solving activities that build confidence and explicitly encouraging students to embrace growth mindsets (Johnston-Wilder & Lee, 2017; Smith & Capuzzi, 2019; Williams, 2014; Box 1).

Constructivist and sociocultural learning theories emphasise that learning occurs through engagement, dialogue and shared problem-solving rather than simple transmission of knowledge (Lave & Wenger, 1991; Vygotsky, 1978). We therefore advocate approaches that promote group learning as central components of quantitative ecology education. The diversity of backgrounds, interests, confidence levels and quantitative experience typically found in ecology classrooms should be viewed as a pedagogical strength that educators can harness by facilitating collaborative learning among mixed-expertise cohorts (Mercer, 1995; Box 1). Programmes such as the Serrapilheira Institute's Training in Quantitative Ecology exemplify the value of intentionally fostering such heterogeneous learning communities (see testimonials: <https://serrapilheira.org/programa-de-formacao-em-ecologia-quantitativa/>). For graduate students and early-career researchers, opportunities to assist in teaching quantitative courses can themselves be powerful, mutually beneficial learning experiences.

Hands-on, practical engagement with quantitative reasoning is essential for developing quantitative competence, and active-learning approaches are particularly well suited to this. Activities such as data exploration, simulation, coding and inquiry-based projects allow learners to engage directly with quantitative concepts while linking ecological questions to statistical reasoning (Farrell & Carey, 2018; Fieberg et al., 2020; Pruim et al., 2017; Box 1). These approaches are likely to be most effective when embedded in ecological contexts, including field experiences and the analysis of authentic datasets, which help learners connect ecological processes, sampling, variability, uncertainty and inference (Nicotra et al., 2022).

Finally, quantitative literacy requires repeated exposure to concepts across multiple contexts and levels of sophistication. Spiral curricula offer one mechanism for revisiting ideas over time while supporting both retention and confidence development (Bruner, 1960; Kay et al., 2024). At the same time, opportunities for greater quantitative specialisation should remain available through interdisciplinary degrees, advanced modules or bespoke training courses.

3.3 | Institutional and disciplinary leadership

Even the most carefully designed curriculum cannot succeed unless educators are willing and adequately supported to deliver it. Effective quantitative education relies on educators, teaching

BOX 1 Illustrative examples of quantitative ecology teaching in practice

A comprehensive catalogue of approaches for teaching quantitative ecology is beyond the scope of this perspective. Instead, here we provide several examples of people-centred approaches for developing foundational quantitative literacy among ecologists. These examples are intended to be illustrative, rather than prescriptive. The particular activities used by educators are likely to be context-dependent, varying across institutions, courses, instructors, learners and available resources.

- *Numeracy and biological scale (context-rich learning)*: Students compare biological quantities that span several orders of magnitude (e.g. the size range of microbes, plankton, insects, birds and mammals), motivating scientific notation, transformations and proportional reasoning through ecological examples.
- *Sampling and estimation (active learning)*: Students estimate the average word length in a short ecological text, introducing sampling and sampling bias, estimation and sampling variability in a familiar context.
- *Understanding uncertainty through resampling (simulation-based learning)*: Students repeatedly resample observed ecological data (e.g. using bootstrapping) and compare the resulting estimates, allowing them to visualise sampling distributions, variability, effects of sample size and uncertainty.
- *Causal reasoning with DAGs (collaborative inquiry)*: Students work in mixed-expertise groups to construct and compare directed acyclical graphs (DAGs) for an ecological system of interest, encouraging discussion about assumptions, which variables should be measured to address a particular research question, alternative causal and associative explanations, direct and indirect effects and the distinction between correlation and causation.
- *Building models from ecological questions (problem-based learning)*: Students begin with an ecological question (e.g. why population growth differs among habitats), translate it into a conceptual model, then a word formula, and finally a statistical model, reinforcing links between ecological reasoning and quantitative model formulation.
- *Interpreting model outputs (inquiry-based learning)*: Students use the equation from a fitted model (e.g. a simple linear model equation) to generate predictions for ecological scenarios, plot the resulting relationships and compare predictions with observed data, helping them connect model output to ecological interpretation and inference.

BOX 1 (Continued)

- *Learning through productive failure (confidence-building)*: Students are presented with a deliberately challenging ecological question and asked to propose an analytical approach before receiving guidance on the relevant method. Reflection and group discussion focus on the assumptions made, difficulties encountered, and how understanding developed over time. This helps normalise uncertainty, address quantitative anxiety and build confidence by positioning learners within a 'growth zone'.

assistants, mentors, collaborators and peers, all of whom shape learner experiences and influence motivation, persistence, confidence and engagement. Quantitative teaching involves substantial emotional, pedagogical and motivational investment (Acevedo, 2020; Riach et al., 2026). Educators should therefore be provided with sufficient time and resources to develop curricula, refine pedagogical approaches and engage in continuing professional development. The effective teaching of challenging quantitative concepts also requires manageable class sizes, appropriate teaching support and sufficient space within the curriculum. It should also be recognised that the importance of computational skills in quantitative ecology often requires educators to teach foundational computer literacy, placing additional pressure on already crowded curricula. Increasing pressure on educators to do more with less risks undermining the relational and dialogic aspects of education that are essential for developing durable quantitative literacy. Investing in people is not ancillary to quantitative education in ecology; it is fundamental to its success.

We advocate greater collaboration between ecologists and quantitative specialists in the design and delivery of quantitative training. Ecologists may be better positioned to frame statistical ideas in ways that are grounded in ecological reasoning, while statisticians contribute technical depth that is essential for methodological rigour (Kapteyn & van Uven, 1916; O'Hara, 2016). Institutions should therefore move beyond models that concentrate responsibility for quantitative education within a small number of often disciplinarily siloed individuals. Cross-department appointments, interdisciplinary teaching teams, joint curriculum development and formal networks linking educators across schools can provide opportunities for both educators and learners to benefit from complementary expertise and collaboration, while reflecting the interdisciplinary nature of contemporary ecology (McCrea et al., 2023).

Achieving educational reform at scale will also require institutions to reconsider the incentives that shape academic behaviour. Developing innovative curricula, implementing and evaluating evidence-based pedagogies (i.e. the Scholarship of Teaching and Learning; SoTL), and supervising teaching assistants all require substantial time and effort. Yet these activities are often rewarded less strongly than conventional research outputs. Institutions should

broaden the criteria used to evaluate educational contributions, recognising curriculum development, pedagogical scholarship and educational impact as valuable forms of academic achievement. If cross-department teaching teams are introduced, institutions must ensure that individual contributions to course design and delivery can be appropriately recognised and rewarded. Relatedly, the tendency to overemphasise learner satisfaction metrics may be particularly problematic in quantitative education, where challenging subject matter can systematically generate lower student evaluations (Uttl & Smibert, 2017). If institutions genuinely value quantitative literacy, they must ensure the incentives and structures supporting educators teaching it reflect that commitment.

Finally, overcoming the inertia in quantitative ecology education requires action beyond individual educators and institutions. Learned societies, journals, funding bodies, regulatory or accrediting authorities, and other disciplinary organisations all have important roles to play in shaping educational priorities and supporting implementation. Learned societies can facilitate interdisciplinary training opportunities, support communities of practice and promote educational research and scholarship. Importantly, this need not be restricted to ecology; the statistical education community has devoted substantial effort to understanding how statistics is most effectively taught and learned, yet these insights do not always reach educators responsible for quantitative training within ecology. Facilitating dialogue between these communities could accelerate educational innovation and reduce duplication of effort. Journals can encourage pedagogical research and scholarship by more actively welcoming such contributions. At the time of writing, only 4 of 18 flagship ecology journals collectively published by the British Ecological Society, Ecological Society of America, the Wildlife Society and the Society of Conservation Biology make explicit reference to education or pedagogy in their aims and scope. Similarly, the relative scarcity of education-focused sessions at major ecology conferences may also contribute to the limited visibility of these discussions within the discipline. We therefore encourage greater investment in both educational publishing and conference programming. Funding bodies should also support long-term curriculum development, pedagogical innovation and collaborative teaching initiatives through educational funding schemes. More broadly, regulatory and accrediting authorities and other disciplinary organisations can provide legitimacy and momentum for educational change by promoting examples of good practice, developing guidance and supporting endorsement schemes for quantitative ecology education.

4 | CONCLUSION

As ecology evolves, the need for quantitative literacy is greater than ever. While meaningful progress has already been made, the challenge of reforming quantitative ecology education at scale persists. We argue that progress requires greater emphasis on foundational concepts, people-centred pedagogies and stronger institutional and disciplinary support. Creating the conditions

to enable implementation of educational change in a way that can be sustained will require coordinated action from educators, institutions and the wider discipline to address the curricular, pedagogical, interpersonal, institutional and disciplinary barriers that continue to constrain progress. By reframing this challenge as one of implementation rather than aspiration, we believe progress can be made in overcoming a century of inertia in quantitative ecology education.

AUTHOR CONTRIBUTIONS

William P. Kay led the initial draft of the manuscript. Tiago A. Marques, John R. Fieberg, Luca Börger, Crispin Y. Jordan, Camila Teicher, Anna C. Riach, Fergus J. Chadwick and Chris S. Sutherland contributed critically to drafts. All authors collectively conceived the ideas presented in this perspective. All authors gave final approval for publication.

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