

1 **Conceptualising ecology to support more theory-driven research**

2 A manuscript in consideration as an *Editorial* for *Journal of Animal Ecology*

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13 **1. What are ecological concepts, and why are they important?**

14 Concepts are abstract ideas that describe processes of interest. As such, concepts are the
15 backbone to theories in any science. Concepts and theories are related in that novel theories
16 cannot emerge without the existence of the solid concepts that underpin them. Indeed,
17 Einstein and Darwin would not have been able to put forward their respective theories of
18 relativity (Einstein 1918) and evolution (Darwin 1859) without the concepts of ‘gravity’ and
19 ‘natural selection’. Concepts are not necessarily empirically testable, while theories must be.

20 Concepts are particularly useful to investigate and understand ecological systems
21 because nature is complex. The development of concepts has historically enabled ecologists
22 to better understand the interactions between organisms and their environments, as well as
23 their underlying mechanisms. Indeed, ecological concepts encapsulate key processes such as
24 energy transfer (*e.g.*, ‘energy flows’, Lindeman 1942), self-regulation (*e.g.*, ‘density
25 dependence’, Nicholson and Bailey 1935), species interactions (*e.g.*, ‘competition’, Volterra
26 1927; ‘facilitation’, Clements 1916), or evolutionary dynamics (*e.g.*, ‘fast evolution’,
27 Reznick, Bryga, and Endler 1990; ‘eco-evolutionary dynamics’, Pelletier, Garant, and
28 Hendry 2009). By providing a consistent structure to study ecological systems, ecological
29 concepts allow researchers to classify life history strategies (Stearns 1983; Stott et al. 2024),
30 predict behaviours (Hamilton 1964), quantify the stability and resilience of systems (Van
31 Meerbeek, Jucker, and Svenning 2021), or identify key drivers of biodiversity (McArthur and
32 Wilson 1970). These foundational concepts integrate biology, evolution, environmental
33 sciences, and conservation, enabling us to address global challenges such as resource
34 depletion, climate change, and biodiversity loss.

35 To further fuel the development and implementation of concepts in ecology, in 2020
36 *Journal of Animal Ecology* added a seventh Article Type to its publishing portfolio:

37 'Concepts'. The goal of Concept articles is to challenge existing paradigms or to introduce
38 novel ideas that may guide the field of animal ecology in fresh directions and ultimately
39 support more theory-driven research. Here, we provide some key examples of concepts that
40 have helped advance ecology. In doing so, we also highlight contributions published in
41 *Journal of Animal Ecology*, and provide suggestions to authors interested in submitting
42 Concept articles to the Journal.

43

44 **2. Conceptual landmark contributions**

45 *Journal of Animal Ecology* has published a myriad of foundational studies that continue to
46 shape our ecological thinking. Concepts published in our Journal come from authors at all
47 career stages, from students to retirees, thus demonstrating the importance of a fresh
48 perspective as well as experienced insights. Indeed, ecology is a global science made of many
49 perspectives, and we are keen to receive concepts that represent and celebrate this diversity.
50 Authors considering submitting a Concept article might find some additional inspiration from
51 both the content and the format of some of the research areas we highlight below. We note
52 these are not comprehensive, with many others not covered here. Concept articles can also be
53 found in the following live link of our Journal's website:
54 [https://besjournals.onlinelibrary.wiley.com/hub/journal/13652656/features/
55 concepts_in_animal_ecology](https://besjournals.onlinelibrary.wiley.com/hub/journal/13652656/features/concepts_in_animal_ecology).

56 - Population Ecology: Understanding and predicting population dynamics has been
57 central to the field of Ecology since its inception. Nicholson's (1933) publication in
58 our Journal on the regulatory mechanisms of animal population dynamics was
59 fundamental for population ecology. Similarly, Elton and Nicholson's (1942) work
60 also in *Journal of Animal Ecology* on the long-term population cycles of the Canada

61 lynx (*Lynx canadensis*) and its prey significantly contributed to our understanding of
62 predator-prey dynamics. Further conceptual developments published by *Journal of*
63 *Animal Ecology* in this area include the application of prediction intervals for more
64 accurate population forecasts (Asbjørnsen et al. 2005), or the formalisation of
65 population responses to disturbances (Benton, Cameron, and Grant 2004).

66 - Niche Theory: Hutchinson's (1957) "n-dimensional niche" concept helped re-define
67 how ecologists think about species' roles in ecosystems. *Journal of Animal*
68 *Ecology* has published subsequent works examining how species partition resources
69 and space to coexist. This theory continues to shape research, with further conceptual
70 advances in this area including the integration of individual sociality (Webber and
71 Vander Wal 2018) and individual heterogeneity across space (Costa-Pereira et al.
72 2018).

73 - Trophic Interactions and Food Webs: Elton, the founding editor of *Journal of Animal*
74 *Ecology*, pioneered the concept of food-chains and food-webs (Elton 1927),
75 organising species into functional groups. In recent years, the development and
76 application of network science to ecological systems is helping to resolve previously
77 intractable questions in ecology and evolution, allowing the study of multiple
78 interaction types (Pocock, Evans, and Memmott 2012), 'multilayer' networks (Pilosof
79 et al. 2017) and the resilience of entire communities of interacting species to
80 environmental change (Maia et al. 2021). Two recent Concept articles published in
81 *Journal of Animal Ecology* on this topic expand network ecology in freshwater
82 ecosystems (Windsor 2023), and show how nutrients could be integrated into network
83 analyses (Cuff et al. 2024).

84 - Life History Strategies: Life history theory examines the optimal strategies of
85 organisms given their trade-offs between survival, development, and reproduction

86 under different environmental conditions (Stearns 1999, 1977). This body of theory
87 has been vastly expanded in recent decades, with key contributions in *Journal of*
88 *Animal Ecology* shaping our understanding of senescence and fitness (Žák and
89 Reichard 2021), the evolutionary underpinnings of life-history variation in birds
90 (Culina et al., n.d.), mammals (Coulson, Tuljapurkar, and Childs 2010), and other taxa
91 (Žák and Reichard 2021), and delivering direct applications to genetics (Coulson,
92 Tuljapurkar, and Childs 2010) and conservation (Morrison and Hero 2003).

93 - Metapopulation Dynamics: The metapopulation framework, developed by Levins
94 (1969) and advanced by Hanski (1991), describes populations as networks of smaller
95 populations connected by dispersal. This framework has informed conservation
96 efforts by helping ecologists understand how species persist in fragmented habitats
97 (Nonaka et al. 2019). *Journal of Animal Ecology* has published key contributions on,
98 for instance, butterfly metapopulations, showing how species survive despite frequent
99 local extinctions (Hanski, Saastamoinen, and Ovaskainen 2006).

100 - Ecosystem Services: The concept of ecosystem services (*sensu* LaBastille 1985),
101 while initially developed outside of *Journal of Animal Ecology*, has been expanded
102 through studies on the role of animals in ecosystems. Research published in this
103 Journal on pollinators (Minachilis et al. 2023), seed dispersers (Naniwadekar et al.
104 2019), and vertebrates (Luck et al. 2012) has emphasised their role in providing
105 essential ecosystem services, from crop pollination (Minachilis et al. 2023) to nutrient
106 cycling (Del Toro, Ribbons, and Ellison 2015). Such work has crucial implications for
107 biodiversity conservation and sustainability.

108 - Molecular Ecology: Increasingly available molecular genetic data are helping to
109 unravel fundamental ecological questions related to biogeography, genomics,
110 conservation genetics, and behavioural ecology. Recent research published in this

111 Journal has used environmental DNA to examine the temporal dynamics and
112 functional stability of arthropod communities (Thomassen et al. 2024), and DNA
113 metabarcoding to study species-interaction networks (Lucas et al. 2018) through to
114 test the niche variation hypothesis (Jesmer et al. 2020). Still, there is considerable
115 scope to use advances in this field to either tackle previously intractable questions in
116 ecology, or define new eco-evolutionary Concepts afforded by the technology,
117 particularly in the context of climate change (Layton and Bradbury 2022).

118 Other key concepts in ecology published by the Journals of the British Ecological
119 Society can be found in this link: [https://www.britishecologicalsociety.org/learning-and-
120 resources/career-development/key-concepts-in-ecology/](https://www.britishecologicalsociety.org/learning-and-resources/career-development/key-concepts-in-ecology/).

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122 3. Ten tips for writing a strong Concept article in *Journal of Animal Ecology*

123 Here, we provide some tips to help interested authors properly showcase the concept at the
124 heart of their manuscript submissions:

125 1. **Focus on novelty:** Introduce a new or significantly revised concept that advances
126 ecological theory or addresses a current gap in the literature. Concepts articles should
127 clearly state how they differ from established concepts in the area of interest. We
128 welcome submissions of classical concepts that may be in need of a good ‘dust off’,
129 but we caution authors against re-branding well-established concepts that are still
130 relevant nowadays in their original definitions.

131 2. **Theoretical foundation:** Situate your concept within the broader literature, making
132 connections to existing theories while highlighting your key contribution and how it

133 could help develop extensions and new theories. Authors are encouraged to do so by
134 contextualising the broader ecological literature.

135 3. **Testable predictions:** If pertinent, ensure your concept offers a theoretical framework
136 that can be empirically tested or used to predict ecological patterns. In doing so, we
137 encourage authors to provide specific ways of applying the concept and testing
138 predictions that will emerge from its usage.

139 4. **Relevance to animal ecology:** Focus on the ecology of animals, emphasising how the
140 concept relates to animal-animal or animal-other kingdom interactions, population
141 dynamics, or physiological, evolutionary, biogeographical, or ecosystem processes.
142 Naturally, though, we encourage authors to detail whether and how their concept may
143 apply to other kingdoms.

144 5. **Provide empirical examples:** Consider supporting your concept with empirical
145 evidence when possible. Case studies or data-driven examples from diverse taxa can
146 strengthen the argument.

147 6. **Incorporate interdisciplinary perspectives:** Consider integrating concepts from
148 related fields such as anthropology, economics, mathematics, sociology, geology,
149 computer science, climatology, *etc.* to offer a broader perspective.

150 7. **Not just one's own views:** Do not constrain the concept to your own work. Instead,
151 Concept articles should provide thought-provoking, novel, or controversial
152 perspectives on a concept related to animal ecology, which consider multiple views.

153 8. **A picture is worth a thousand words:** Include well-designed, clear, and informative
154 figures, diagrams, infographics, *etc.* that support your concept. Infographics can be
155 particularly effective, as they can convey abstract ideas to our broad readership.

156 9. **Format:** Use a format that works for you and your ideas. The standard "Introduction -
157 Methods - Results - Discussion" format of Research Articles does not typically result
158 in effective Concept papers. For once, Concept papers do not need to be supported by

159 data and analyses. We invite authors to provide an early section on ‘history’ of the
160 concept. Likewise, authors should consider a final section where they highlight
161 opportunities for future studies, suggesting testable hypotheses, new applications for
162 their concept, and synergies with emerging areas of research.

163 **10. Follow journal guidelines:** Ensure your manuscript adheres to the specific formatting
164 and stylistic guidelines of *Journal of Animal Ecology*, including citation styles, figure
165 presentation, and structure, as well as word count. Concepts are limited to 3,000
166 words (including title page, abstract, and references list) and up to four tables or
167 figures. The word limit is deliberate and *not* flexible. We want to provide our authors
168 with the platform to communicate said concepts in a concise and streamlined manner.
169 Concepts are *not* reviews of a topic in ecology. Indeed, for reviews, authors should
170 consider our *Review* article type, which offers a substantially greater word count limit
171 (<https://besjournals.onlinelibrary.wiley.com/hub/journal/13652656/author-guidelines>).

172 Authors wishing to submit a *Concepts in Animal Ecology* article are encouraged to
173 contact the commissioning editor of *Journal of Animal Ecology*
174 (rob.salguero@biology.ox.ac.uk) to discuss the idea prior to submission.

175 **4. Conclusion: Areas of focus for future concepts**

176 As the field of animal ecology continues to evolve, several emerging areas offer exciting
177 opportunities for conceptual development. We are particularly keen to continue to receive
178 concepts that help our discipline overcome said challenges.

179 One of the most promising areas is Artificial Intelligence (AI) in ecology. AI has
180 already drastically transformed how ecologists collect and analyse data, from enhanced field
181 monitoring (Shermeister, Mor, and Levy 2024), to automating species identification (Blair et
182 al. 2024), to bridging lab and field pipelines (Harrison, Mohr, and van de Waal 2023), and

183 expediting predictive analytics (Windsor 2023). AI applications allow ecologists to handle
184 vast datasets more efficiently (Smith and Pinter-Wollman 2021), offering unprecedented
185 opportunities to monitor ecosystems in real time. However, with the potential to access and
186 analyse more data, new challenges too are starting to emerge, including the choice of
187 approach and the reproducibility of the research.

188 Another promising area in ecological research is the refinement of methodological
189 pipelines. New tools, such as remote sensing (Davison et al. 2023), genetic techniques (Li et
190 al. 2021), and integrative modelling (Zhao et al. 2019), provide ecologists with more accurate
191 and scalable approaches for studying ecosystems. We are also keen to receive submissions in
192 these areas, as the further development of pipelines requires the formalisation of concepts
193 therein.

194 Ecological concepts are also key in applied contexts such as wildlife management,
195 environmental policy, and sustainability efforts. The frameworks that ecological concepts
196 sustain inform ecological restoration projects (Elliot Noe et al. 2022), guide rewilding
197 strategies (Burgos et al. 2022), and help assess the effectiveness of protected areas (Wood et
198 al. 2013). Ultimately, the ability to accurately model ecosystems and predict responses to
199 environmental pressures underpins conservation efforts globally. We welcome more concepts
200 and theoretical frameworks in this area.

201 We are excited to receive submissions that revisit ecological concepts that
202 have evolved over time. Ideas such as niche theory (Grinnell 1917; Dussault
203 2022), metapopulation dynamics (Levins 1969; Hanski, Saastamoinen, and Ovaskainen
204 2006), and trophic cascades (Hairston, Smith, and Slobodkin 1960; Katano, Nakamura, and
205 Yamamoto 2006) have transformed as new technologies and data sources have expanded our
206 understanding of ecosystems (Koger et al. 2023; Leach et al. 2023). Revisiting these concepts
207 can provide fresh perspectives, especially in the context of climate change, habitat

208 fragmentation, and rapid species loss (Lustenhouwer et al. 2023; Sánchez-Hernández 2023;
209 Reed, Visser, and Waples 2023; Layton and Bradbury 2022).

210 As the future of ecology is shaped by these and other emerging areas, the *Journal of*
211 *Animal Ecology* will continue to welcome contributions that push the boundaries of our
212 knowledge. By embracing technological advances, refining methodologies, rethinking
213 established concepts, testing old theories, and proposing new ones, we will deepen our
214 understanding of the natural world and address the pressing environmental challenges of our
215 time.

216 In this piece, we have highlighted some key concepts published in *Journal of Animal*
217 *Ecology* and other journals that, with time, have become staples of our ecological thinking.
218 While some of the on-going Concept submissions will no doubt reach those heights, we
219 encourage our authors to not let that thought be their ultimate goal. Rather than receiving
220 only Concepts that have the potential to become heavily cited, we are more interested in
221 receiving a wide diversity of concepts, with a special emphasis on ECRs and under-
222 represented groups and sub-disciplines of ecology. Researchers are welcome to approach us
223 to obtain initial feedback on their ideas for concepts and to receive suggestions on further
224 development. We look forward to your Concepts!

225

226 **Acknowledgements**

227 We stand on the shoulders of giants. We acknowledge the myriad of seminal conceptual
228 works published in *Journal of Animal Ecology* and other Journals, which have shaped our
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