Academic ecosystems must evolve to support a sustainable postdoc workforce

Murielle Ålund, Nathan Emery, Benjamin J. M. Jarrett, Kirsty J. MacLeod, Helen F. McCreery, Nadya Mamoozadeh, John G. Phillips, Jory Schossau, Andrew W. Thompson, Alexa R. Warwick, Kelsey M. Yule, Erin R. Zylstra, Benjamin J. M. Jarrett, Nathan Emery.

The postdoctoral workforce comprises a growing proportion of the science, technology, engineering and mathematics (STEM) community, and plays a vital role in advancing science. Postdoc professional development, however, remains rooted in outdated realities. We propose enhancements to postdoc-centred policies and practices to better align this career stage with contemporary job markets and work life. By facilitating productivity, wellness and career advancement, the proposed changes will benefit all stakeholders in postdoc success—including research teams, institutions, professional societies and the scientific community as a whole. To catalyse reform, we outline recommendations for (1) skills-based training tailored to the current career landscape, and (2) supportive policies and tools outlined in postdoc handbooks. We also invite the ecology and evolution community to lead further progressive reform.

P

ostdoctoral researchers ('postdocs'; Fig. 1) contribute extensive research, teaching and service to their supervising faculty, home institutions and broader scientific communities1–4. In principle, these contributions are rewarded with opportunities to specialize and develop independence. In practice, however, postdocs' progress and well-being are constrained by social, mental and financial challenges5–8. Further, the skills and credentials that are prioritized in postdoc positions are misaligned with contemporary job markets (for example, refs. 9,11; Fig. 1b). These issues highlight an urgent need for policies and practices that better support a growing postdoctoral workforce. Ultimately, this will benefit all stakeholders in postdoc success—providing ethical and far-reaching returns on time and resource investments12–14.

Below, we describe five goals for enhancing postdoc professional development. We also feature innovative examples of policies and practices from around the globe. Our recommendations are applicable to many STEM disciplines, but especially relevant to ecology and evolution. Alternative careers in these fields commonly require additional training15–18, and non-academic paths are often unknown to both postdocs and their mentors. This causes anxiety and reticence for postdocs who, by choice or by necessity, are considering non-traditional careers14,16,17. Fortunately, the ecology and evolution community is also poised to lead adaptive reform. Our research targets complex interactions spanning many levels of biological organization. Consequently, our community possesses the tools and perspectives needed for strategic, evidence-based engineering of workplace ecosystems8.

Goal 1: Align career development with job markets

Research-focused postdoc positions were conceived as stepping-stones to faculty jobs, and postdoc professional development remains narrowly focused on the corresponding credentials and skills18–20. Job markets, in contrast, have changed. While most postdocs still desire faculty positions1, they increasingly disperse into a wide variety of careers in government, non-profit and private sectors (Fig. 1b). This changing landscape, seen in both the United States20 and Europe21–23, is especially evident within ecology, where 73% of US PhD recipients did not become research faculty over a ten-year period24.

How can STEM postdocs better prepare for diverse job markets? One approach involves provisioning skills-based training, such as workshops on teaching, project management or communication24,25. These can complement traditional academic training to prepare postdocs for diverse careers (Fig. 1b), but must be carefully integrated with other workplace aims and expectations1,15,16,26,27. While many universities now offer 'alternative' career development activities, these resources fall short if poorly advertised, infrequently offered or systematically deprioritized.

One innovative career development tool is the United Kingdom’s Researcher Development Concordat26,28, a dynamic agreement between funding agencies and research institutions—including many of the United Kingdom’s top-ranked universities. The concordat outlines projections for researcher career development that were developed by representatives from all levels of the hierarchy, including a minimum of 10 days annually for employees to pursue professional development.
Goal 2: Sustain wellness and work–life balance

Mental health is linked to physical health and is foundational to motivation and productivity. Among graduate students, low morale and depression are often attributed to financial insecurity, social isolation and lack of sufficient mentorship, and these factors can also impact postdocs. For example, postdocs face high risks of social isolation due to short-term contracts, staggered arrivals and frequent relocations. Importantly, social isolation can be amplified for underrepresented minorities, LGBTQ+ individuals, foreign researchers and other marginalized groups. Burnout, a related concern, is more likely when professional development and job searching are crammed into evenings and weekends. We recommend that individuals and institutions work to cultivate thriving peer communities, implement evidence-based initiatives supporting diversity, equity and inclusion, and provide strategic tools (for example, healthcare programs) that offset mental, logistical and financial strain. Supervisors can further promote wellness by clarifying expectations and values, modelling healthy work habits, discussing wellness in research planning and performance evaluation, and celebrating diverse axes of achievement.

Financial solvency, another dimension of work–life balance, is an important consideration in seeking postdoctoral work. The economic impact of a postdoc is difficult to assess given the job’s uncertain duration and outcome, variation in costs of living, and a common requirement of self-financed serial relocation. Postdoc salaries vary greatly among nations, both relative to national medians and compared to those of non-postdoc residents with comparable credentials (Supplementary Table 1). For example, current postdoc stipends funded by the US National Institutes of Health (NIH) start at $44,600 (US$50,000) yr⁻¹, falling short of the National Academy of Sciences’ minimum recommendations from 2014 (an inflation-adjusted minimum of $48,600 yr⁻¹). Indeed, while typical postdoc salaries correspond to 1–1.5× the median salary in most countries surveyed, 36–60% of individuals with similar educational backgrounds out-earn postdocs in these countries (Supplementary Fig. 1, Supplementary Table 1). Many postdocs will also fail to recuperate delayed earnings. In France, for example, the salaries of postdocs transitioning into the private sector are not influenced by postdoctoral experience. These findings are particularly bleak given that most STEM postdocs have already deferred saving through several years of graduate training.

Disparities in other job benefits are also common among institutions, countries and funding sources. For example, less than 35% of US institutions offer (for example, parental) leave benefits for postdocs. Within institutions, individuals supported by external fellowships can also be denied benefits afforded to local colleagues, such as health insurance and retirement plans. In summary, to maintain the attractiveness of the postdoc career path to diverse and high-performing researchers, we must correct the insufficiency and inequity of current compensation standards.

Goal 3: Enhance mentoring

Postdoctoral work represents a challenging metamorphosis from apprenticeship to independence, providing advisors the opportunity to play positive, formative roles. Because postdoc roles vary greatly across institutions, here we define ‘advisors’ in a very broad sense—examples include professional training, career planning and awareness, ability to manage others, time management, ability to work on a team, ability to work with people outside the organization.

For example, current postdoc stipends funded by the US National Institutes of Health (NIH) start at $44,600 (US$50,000) yr⁻¹, falling short of the National Academy of Sciences’ minimum recommendations from 2014 (an inflation-adjusted minimum of $48,600 yr⁻¹). Indeed, while typical postdoc salaries correspond to 1–1.5× the median salary in most countries surveyed, 36–60% of individuals with similar educational backgrounds out-earn postdocs in these countries (Supplementary Fig. 1, Supplementary Table 1). Many postdocs will also fail to recuperate delayed earnings. In France, for example, the salaries of postdocs transitioning into the private sector are not influenced by postdoctoral experience. These findings are particularly bleak given that most STEM postdocs have already deferred saving through several years of graduate training.

Disparities in other job benefits are also common among institutions, countries and funding sources. For example, less than 35% of US institutions offer (for example, parental) leave benefits for postdocs. Within institutions, individuals supported by external fellowships can also be denied benefits afforded to local colleagues, such as health insurance and retirement plans. In summary, to maintain the attractiveness of the postdoc career path to diverse and high-performing researchers, we must correct the insufficiency and inequity of current compensation standards.
training\(^7\), and should be incentivized during hiring, evaluation and merit-based promotion\(^11\).

Great mentors provide postdocs with a running start followed by light-touch guidance, helping them identify misalignments between existing credentials, skill sets and career goals, while recommending corrective steps. For research or teaching faculty, some of this work can be informed by personal experience. However, since most postdocs ultimately settle into different careers from their mentors (Fig. 1b), advisors should also encourage connections with colleagues, resources or training that bridge gaps in experiential knowledge\(^3\).

Well-structured communication is an essential component of mentoring dynamics. To facilitate this, postdocs and advisors should meet within the first three months of an appointment to discuss goals and expectations, produce a formal mentoring agreement, and generate individual development plans\(^3\). Other meeting outcomes might include written research plans, which can increase grant proposals and manuscript submissions by 25%\(^1\). Advisors should continue regular one-on-one meetings to revisit established goals and expectations, examining progress and setbacks through constructive bidirectional performance review. These procedures are standard practice in the private sector but remain rare within STEM institutions.

Lastly, postdocs can benefit profoundly from becoming mentors themselves\(^7\). Fulfilling in its own right, mentoring others helps individuals better manage relationships with advisors, ultimately

---

**Table 1 | Recommended content for postdoc handbooks**

| Area                        | Minimum essentials                                                                 | Better-case scenario                                                                 | Best-case scenario                                                                 |
|-----------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Advocacy                    | External resources (National Postdoc Association and so on)                       | University postdoc association (run by postdocs)                                      | Campus postdoctoral office (with permanent employees)                                |
| Policy                      | Official institutional mission                                                     | Postdocs explicitly integrated into campus and department missions                   | Participatory representation (department meetings, faculty council and so on)        |
| Equity and inclusivity      | Official protective policies                                                       | Diversity and inclusivity initiatives                                                | Active campus support resources                                                     |
| Mentoring and oversight     | Grievance protocol. Job description and review protocols                           | Personalized work plan encompassing research activity and career development           | Oversight of, and incentives for, faculty excellence in mentoring. Work plan encompassing wellness |
| Healthcare and benefits     | Human resources information                                                        | Medical and mental health coverage details. Vested retirement plan                    | Workplace wellness programs                                                         |
| Networking tools            | Overview of home department                                                        | Dedicated e-resources for postdocs (listserv, website and directories)                | Physical space for professional activities. Program-specific postdoc communities    |
| Career development          | Work hours permitting career search activities                                      | Active support in job searching from mentor and institution                            | Skills training and professional development built into work plans and evaluations    |
| Leave policy                | Statement regarding leave policies                                                 | Progressive leave policies for parents and others in need. Information about external support while on leave (for example, National Science Foundation supplemental funding) | Temp replacements for individuals on leave                                           |
| Research funding            | Office of sponsored projects information                                            | Overview of external funding opportunities (European Research Council, National Science Foundation and so on) | Seed funding opportunities. Administrative support for postdoc-led proposals         |
| Travel policy               | Travel policy and travel office information                                        | Institutional protocols for work-related travel                                       | Opportunities for travel support. Interest-free loans for work-related travel         |
| Family policy               | Legally mandated protections and policies                                          | Elective childcare. Family resources and inclusive work culture                       | Subsidized childcare. Backup dependent care                                         |
| Alumni and colleagues       | Visible directories of current postdocs                                            | Data on postdoc alumni (for example, years at institution, home lab(s) and job placement) | Active network of alumni employed in diverse sectors                                  |
| Housing resources           | Housing office information                                                        | Off-campus housing resources                                                         | Affordable housing options that accommodate families and indefinite employment       |
| Relocation resources        | General information about area                                                      | Current information (Motor vehicles office, state and city tax policies and so on)    | Relocation assistance                                                                |
| International postdocs      | International student/staff policy                                                 | International office information                                                     | Legal and tax resources for postdocs                                                |
| Home lab resources          | Contact for the department of Environment, Health and Safety and training information | Collegial and supportive lab culture                                                | Written policies for home lab and/or research project(s)                             |
| IT resources                | E-mail access and tech support information                                         | Cloud access                                                                         | Software licenses. Dedicated computer for work                                        |

The ‘Minimum essentials’ version consolidates relevant information that typically exists at home institutions. The ‘Better-case scenario’ appends resources that many institutions or programs do not yet provide. The ‘Best-case scenario’ outlines active and comprehensive efforts to support postdoctoral productivity.
benefiting all members of a research team\textsuperscript{1,2}. Because authentic mentoring requires considerable time and reflection, it should also be explicitly factored into a postdoc's career development plan and performance assessments.

**Goal 4: Develop administrative support**

Postdocs with administrative support are better positioned to stay motivated and productive, boosting the prestige of their group and institution\textsuperscript{1,3,16,40}. This support can also remove long-standing barriers to faculty positions for underrepresented groups in STEM\textsuperscript{1,5,6,12}. Administrative support can take several forms including international offices supporting foreign postdocs, and Offices for Postdoctoral Affairs (OPAs) that provide advocacy and coordinate resources across entities\textsuperscript{12,14}. Self-organized Postdoctoral Associations (PDAs) are another valuable resource that promotes interdisciplinarity, peer networking and postdoc-centred advocacy\textsuperscript{1,12} (Table 1, Supplementary Table 2).

Currently, administrative support for postdocs varies widely among institutions. To demonstrate this, we surveyed 50 top-ranked universities' websites for any mention of an OPA, PDA or other (for example, department-specific) postdoc resource (for methods and full results, see Supplementary Table 2). A majority of the websites outlined at least one resource—either at the departmental level (typically within a STEM discipline), or else within the graduate school. However, only 35\% indicated a dedicated OPA or PDA at the university level; this included 58\% of surveyed US institutions, whereas only 16\% of surveyed European institutions mentioned an OPA and 32\% mentioned a university-wide PDA. Transnational dialogues, ideally including policymakers, institutional administrators and postdocs, could illuminate how this structural variation impacts various indices of success.

Local (for example, departmental) initiatives can play key roles in recruiting and empowering postdocs. For example, institutional support was found to enhance job seeking strategies and efficacy among biomedical postdocs\textsuperscript{3}. One mechanism for increasing local support involves granting postdocs representation in organizational decisions (for example, faculty meetings). Small resource investments (such as access to a physical meeting space for video conferencing/interviews and interaction with students and colleagues) can further promote dynamic local peer communities, collaboration and career development.

Data on postdoc career trajectories are valuable to many groups including jobseekers, funding agencies and policymakers, yet are rarely gathered and shared by research institutions\textsuperscript{44}. Public disclosure of this readily obtained information (for example, alumni research activities, service outputs and job placements at the lab, department and/or college levels) could considerably aid the development of best practices for postdoc training (Table 1).

Recent syntheses offer further recommendations for administrative change (for example, refs.\textsuperscript{12,13,14,16}). At best, however, these carefully prepared guidelines are implemented sporadically among institutions. Our chief recommendation is therefore to explicitly include postdoc-related concerns in administrative mission statements, strategic plans and other official policies at departmental and institutional levels (Table 1). This will ensure postdocs have a protected place and voice within local workplaces.

**Goal 5: Increase broader support**

Scientific societies and funding agencies already play vital roles in postdoc career development. For example, conferences help disseminate research and build networks that can lead to permanent jobs. Although many societies work to cultivate student participation, postdoc inclusion initiatives are much less common. To illustrate this, we surveyed costs and supporting resources for 34 conferences in ecology and evolutionary biology that occurred between 2018 and 2020 (Supplementary Table 3). All events offered student rates (an average 44\% reduction from full rate), but only 17 provided discounts for postdocs (at a smaller 13\% reduction). For context, full professor salaries are often nearly double those of postdocs\textsuperscript{12,45}, making postdocs' income-adjusted conference costs disproportionately high. Conference costs are also amplified for individuals with special needs and/or more limited resources (for example, scientists in developing countries and parents needing childcare); this can restrict career progression\textsuperscript{1,15,34,46}. Although some conferences offer support to broaden participation, only 40\% of those we surveyed advertised such opportunities for postdocs. At a minimum, reduced postdoc registration fees would increase equity and invigorate scientific discourse at conferences. An even better approach might use sliding scales (for example, based on self-reported income brackets) to determine registration costs.

Throughout this Perspective, we have discussed several important postdoc support mechanisms. Many of these require resource investment and will consequently encounter inertia or resistance during planning and implementation. We end by appealing to funding agencies and reviewers to encourage change by carefully assessing postdoc development plans and budgeting during proposal reviews. By co-prioritizing training plans and resources, funding agencies can prevent unsustainable over-exploitation of one of science's most important assets: the postdoctoral workforce.

**Conclusions**

In summary, better support for postdocs will generate far-reaching returns. Postdocs are a vital part of the international research community and are integral to teaching and service activities at institutions around the world. Because career prospects for postdocs have changed over time, so too must the nature of their preparation for the next career stage.

We have shown here that many factors impact the quality of postdocs' personal and professional lives. Coordinated discussion and reform surrounding these factors is increasingly possible, in part due to the growing size and connectivity of the postdoc population. To leverage this emerging opportunity, we strongly encourage discourse among postdocs, home institutions, organizations and initiatives such as the National Postdoc Association and the NIH-funded Postdoc Academy. These initiatives offer free resources for postdocs' professional development and are stimulating important dialogues.

We have proposed structuring postdoc-centred policies and practices around five core goals: (1) aligning career development with job prospects; (2) sustaining wellness and work–life balance; (3) enhancing mentoring; (4) developing administrative support; and (5) increasing broader support. Achieving these goals requires coordinated effort from individuals, departments, institutions and scientific societies, and will ultimately benefit everyone involved. To facilitate and document progress, we encourage future studies of how progressive changes impact the well-being and productivity of both individual postdocs and academia at large.

We believe evolutionary biologists and ecologists should lead essential reforms to postdoc professional development, implementing data-driven practices that appropriately value and capacitate postdocs' extensive contributions to STEM. Our disciplines are collaborative and diverse, and our rigorous investigation of complex interactions among genes, individuals, species and whole ecosystems has surely prepared us well to develop optimal, postdoc-centred policies and practices within our own workplace communities.

**Reporting Summary.** Further information on research design is available in the Nature Research Reporting Summary linked to this article.

**Data availability**

All data generated or analysed during this study are included in the published Perspective (and its Supplementary Information files).
**Reporting Summary**

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see Authors & Referees and the Editorial Policy Checklist.

### Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

- **n/a**
  - The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
  - A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
  - The statistical test(s) used AND whether they are one- or two-sided
  - Only common tests should be described solely by name; describe more complex techniques in the Methods section.
  - A description of all covariates tested
  - A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
  - A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
  - For null hypothesis testing, the test statistic (e.g. F, t, r) with confidence intervals, effect sizes, degrees of freedom and P value noted
  - Give P values as exact values whenever suitable.
  - For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
  - For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
  - Estimates of effect sizes (e.g. Cohen's d, Pearson's r), indicating how they were calculated

*Our web collection on statistics for biologists contains articles on many of the points above.*

### Software and code

Policy information about availability of computer code

| Data collection | All data collected is presented in our Supplementary Materials, including links to sites from which publicly-accessible data were collected and the date of download |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|
| Data analysis   | No software was used for analyses presented in this manuscript                                                                   |

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

### Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

*Our manuscript contains a data availability statement: All data used in the paper are presented in our Supplementary Materials, including links to sites from which publicly-accessible data were collected, and the date of download.*
Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences  ☐ Behavioural & social sciences  ☑ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description
Our comment outlines recommendations for enhancing postdoc training and professional development

Research sample
We sampled data from online sources as described in the supplementary materials section

Sampling strategy
We sampled data from online sources as described in the supplementary materials section

Data collection
We collected data from the internet to characterize the current salaries, career paths, and resources available to postdocs in a variety of countries. The methods and data are clarified in the manuscript and supplementary materials.

Timing and spatial scale
We sampled data from online sources as described in the supplementary materials section and provide information about the scope and timing of available data within the manuscript.

Data exclusions
no data were excluded

Reproducibility
The data we present in our figures and text are included in the supplementary tables, along with links to their original sources.

Randomization
The manuscript does not call for randomization.

Blinding
The manuscript does not call for blinding

Did the study involve field work?  ☐ Yes  ☑ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

| n/a | Involved in the study |
|-----|-----------------------|
| ☒   | Antibodies           |
| ☐   | Eukaryotic cell lines|
| ☒   | Palaeontology        |
| ☒   | Animals and other organisms |
| ☒   | Human research participants |
| ☒   | Clinical data        |

Methods

| n/a | Involved in the study |
|-----|-----------------------|
| ☒   | ChIP-seq              |
| ☒   | Flow cytometry        |
| ☒   | MRI-based neuroimaging|