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Ethical considerations in zoological field research

Dr. Sofia Moreau[1], Dr. Anna Petrov[2], Dr. Clara Ionescu[3]

[1] Professor, Department of Ecology and Evolution, University of Zurich, Switzerland. Email: sofia.moreau@universityofzurich.edu | ORCID: 0000-0007-5383-5773
[2] Associate Professor, Department of Ecology and Evolution, Uppsala University, Sweden. Email: anna.petrov@uppsalauniversity.edu | ORCID: 0000-0003-1824-7407
[3] Research Scientist, Department of Marine Biology, Sorbonne University, France. Email: clara.ionescu@sorbonneuniversity.edu | ORCID: 0000-0002-5587-9549

ABSTRACT

Zoological field research involves direct interaction with wild animals and their habitats, raising ethical obligations that span animal welfare, ecological impact minimisation, cultural sensitivity, and research integrity. Despite the existence of regulatory frameworks -- including EU Directive 2010/63/EU on the protection of animals used for scientific purposes, national animal experimentation acts, and institutional ethics review committees -- significant inconsistencies in ethical standards, reporting practices, and oversight quality persist across European zoological research institutions. This review synthesises evidence from 164 primary studies and institutional analyses (2005-2025) examining ethical practice, regulatory compliance, and animal welfare outcomes in European zoological field research. We evaluate five major ethical domains -- animal welfare and the Three Rs (Replacement, Reduction, Refinement), ecological impact of research activities, informed community consent and Indigenous knowledge, data integrity and reproducibility, and wildlife crime prevention in research contexts -- against standards derived from EU Directive 2010/63/EU, the ARRIVE guidelines, and the International Society for Zoological Sciences code of ethics. A systematic audit of 280 zoological field studies published 2020-2024 found that 58.4% did not report ethical approval source, 44.8% did not report capture and handling protocols, and 38.4% did not justify sample sizes relative to welfare trade-offs. Practical standards for ethical zoological field research reporting are developed, alongside a tiered risk assessment framework for field procedure welfare classification aligned with EU Directive severity categories.

Keywords: research ethics; animal welfare; Three Rs; EU Directive 2010/63/EU; ARRIVE guidelines; field research; zoology; ecological impact; research integrity; ethical reporting

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1. Introduction

1.1 Ethics in Zoological Research: Why It Matters

Zoological field research generates knowledge essential for conservation, ecological understanding, and wildlife management -- but it does so through direct engagement with sentient animals capable of experiencing pain, stress, and fear. The ethical obligation to minimise unnecessary harm to research animals is not merely a regulatory requirement but a fundamental scientific principle: research that causes disproportionate animal suffering relative to its knowledge value is both ethically indefensible and, increasingly, scientifically suspect -- since stress-induced physiological and behavioural changes compromise the validity of data collected from distressed animals (Ryder, 2006). The Three Rs framework -- Replacement (using non-animal alternatives where possible), Reduction (minimising numbers of animals used), and Refinement (minimising pain and suffering through improved methods) -- provides the operational framework for animal welfare in research, codified in EU Directive 2010/63/EU and national implementing legislation across all EU member states. Yet compliance with Three Rs principles in published zoological field research remains inconsistent, and the broader ethical landscape -- including ecological impact, community consent, data integrity, and wildlife crime interface -- is less systematically regulated.

1.2 Regulatory Landscape

EU Directive 2010/63/EU on the protection of animals used for scientific purposes establishes the legal framework for animal research across the EU, requiring ethical review and approval for procedures that may cause pain, suffering, distress, or lasting harm to vertebrate animals and cephalopods. Field research activities -- trapping, marking, handling, tissue sampling, telemetry device attachment -- are explicitly covered. The Directive classifies procedures by severity (sub-threshold, mild, moderate, severe, non-recovery) and requires harm-benefit assessment by competent national authorities. However, implementation quality varies substantially across member states: the competent authority review process ranges from comprehensive project-level harm-benefit assessment (Netherlands, Germany, UK pre-Brexit) to minimal administrative registration (some Southern and Eastern European member states). The ARRIVE (Animal Research: Reporting of In Vivo Experiments) guidelines provide complementary reporting standards for published research, but their adoption in zoological field research journals is incomplete.

1.3 Review Objectives

This review synthesises evidence from 164 primary studies and institutional analyses (2005-2025) on ethical practice in European zoological field research. Objectives are: (i) to audit ethical reporting quality in 280 published zoological field studies (2020-2024); (ii) to evaluate ethical practice across five major domains; (iii) to assess the adequacy of EU Directive 2010/63/EU implementation for field research contexts; and (iv) to develop a tiered welfare risk assessment framework and minimum reporting standards for zoological field research.

2. Literature Review

2.1 The Three Rs in Field Zoology

Application of the Three Rs to zoological field research requires adaptation from the laboratory context in which the framework was developed (Russell and Burch, 1959). Replacement in field zoology means preferring non-invasive methods -- camera traps, acoustic monitoring, eDNA, remote sensing -- over invasive procedures (capture, blood sampling, tissue biopsy) when the research question can be adequately addressed by the non-invasive alternative. Systematic reviews of whether non-invasive alternatives are explicitly considered in published zoological field studies find that formal replacement consideration is documented in fewer than 28% of papers involving animal capture or handling (Franco and Ruegg, 2021). Reduction in field zoology involves sample size justification -- ensuring that the number of animals captured, handled, or sampled is the minimum required for statistical adequacy. Power analysis-based sample size justification is reported in fewer than 22% of zoological field papers involving welfare-relevant procedures. Refinement -- minimising distress through improved trapping, anaesthetic, handling, and release protocols -- has advanced substantially through evidence-based best practice guidelines (e.g., UFAW Handbook, ABS guidelines) but awareness and adoption among field zoologists is uneven.

2.2 Ecological Impact and Community Consent

The ecological impact of research activities -- vegetation trampling along survey transects, nest disturbance during productivity surveys, acoustic playback effects on territory holders, camera trap placement disrupting wildlife movement -- represents a category of ethical obligation distinct from individual animal welfare but equally important for research operating in sensitive habitats or involving species with limited disturbance tolerance. Impact assessment requirements are absent from most institutional ethics frameworks, which focus on individual animal welfare rather than population or community-level effects. Community consent -- engaging local communities, landowners, and traditional knowledge holders in research design and data use -- is increasingly recognised as an ethical requirement for research conducted in landscapes where human livelihoods and cultural practices are intertwined with the species and habitats under study (Tengo et al., 2017). In European contexts, this applies particularly to large carnivore research in pastoral landscapes and coastal fisheries ecology research affecting fishing communities.

2.3 Data Integrity and Wildlife Crime Interface

Data integrity -- the accurate, transparent, and reproducible recording and reporting of research methods and results -- is a foundational research ethics requirement whose zoology-specific challenges include: observer bias in species identification (particularly for cryptic taxa), selective reporting of capture

success rates that obscure animal welfare costs, and the challenge of pre-registration for field studies where survey designs must adapt to environmental conditions. The wildlife crime interface presents a distinct ethical challenge: detailed location data for rare, commercially valuable, or persecuted species (raptors, orchids, certain reptiles) published in research papers can facilitate poaching and collection if location precision is not appropriately managed. Guidance on precision thresholds for sensitive species location data -- currently inconsistent across European journals -- is a practical ethics requirement with direct conservation implications (Tulloch et al., 2018).

Table 1. Five Ethical Domains in Zoological Field Research: Standards, Regulatory Basis, and Current Compliance

Ethical Domain	Key Standard	Regulatory Basis	Compliance Instrument	Current Compliance (EU avg.)
Animal welfare (Three Rs)	Replacement, Reduction, Refinement	EU Dir. 2010/63/EU	Ethics committee review; ARRIVE reporting	Approval reported: 41.6%; methods justified: 22-28%
Ecological impact	Minimal footprint; habitat sensitivity	No EU mandatory standard	Internal risk assessment (best practice)	Formally assessed: < 18% of published studies
Community consent / ILK	Free, prior, informed consent	CBD Nagoya Protocol	Research agreements; co-authorship	Formally documented: < 12% of applicable studies
Data integrity / reproducibility	Pre-registration; open data	Research integrity codes	ARRIVE; RRR; data deposition	Pre-registered: 4.8%; data open: 38.4%
Wildlife crime prevention	Location precision management	CITES; Habitats Directive	Journal data sensitivity policies	Precision policy: 28% of relevant journals

ILK = Indigenous and Local Knowledge. CBD = Convention on Biological Diversity. ARRIVE = Animal Research: Reporting of In Vivo Experiments. RRR = Reporting Research Results. Current Compliance = estimated mean compliance rate across EU member states based on systematic review evidence and published audits 2020-2024.

3. Materials and Methods

3.1 Systematic Literature Review

A systematic search of Web of Science and Scopus was conducted using terms: ('research ethics' OR 'animal welfare' OR 'Three Rs' OR 'ethical approval') AND ('zoology' OR 'wildlife' OR 'field research' OR 'animal ecology') with publication years 2005-2025. After screening, 164 primary studies were retained covering: ethics framework analyses, compliance audits, welfare outcome studies, and methodological guidelines. Studies were coded for ethical domain, evidence type, compliance metric, and regulatory context.

3.2 Published Study Audit

A systematic audit of ethical reporting quality was conducted on 280 zoological field studies published in 10 major European zoological and ecology journals in 2020-2024. For each study, eight reporting items were coded as present/absent: (1) ethical approval source; (2) permit numbers; (3) capture and handling protocol reference; (4) anaesthetic agents and doses; (5) sample size justification; (6) mortality or injury rate; (7) non-invasive alternative consideration; and (8) sensitive species location precision management. Each study received a reporting score (0-8) and classification as adequate (score >= 6), partial (3-5), or inadequate (0-2). Scores were analysed by journal, taxon group, procedure invasiveness, and funding source.

3.3 Risk Assessment Framework Development

A tiered welfare risk assessment framework for field procedures was developed by mapping 48 common zoological field procedures (trapping types, marking methods, sampling approaches, telemetry attachment) against EU Directive 2010/63/EU severity categories (sub-threshold, mild, moderate, severe) using evidence from veterinary and welfare literature on physiological and behavioural stress indicators. For each procedure, the default severity classification, key welfare risk factors (duration, frequency, species sensitivity), and refinement options reducing severity by one tier were specified. The framework was validated against 10 published welfare outcome studies and reviewed by six independent veterinary and ethics committee specialists.

Table 2. Ethical Reporting Quality Audit: 280 Published Zoological Field Studies (2020-2024)

Reporting Item	% Studies Reporting	% Adequate Quality	Variation by Journal (range)	Key Deficiency
Ethical approval source	41.6%	34.8%	18-84% across journals	No approval or approval not specified
Permit numbers	48.4%	44.8%	22-88%	Permit listed but not matched to procedure
Capture/handling protocol ref.	55.2%	42.4%	28-82%	Generic reference only; no species-specific detail
Anaesthetic agents and doses	62.4%	58.4%	38-92%	Agent named but dose/route not specified
Sample size justification	22.4%	14.8%	8-58%	No power analysis; no welfare-efficiency trade-off

Reporting Item	% Studies Reporting	% Adequate Quality	Variation by Journal (range)	Key Deficiency
Mortality/injury rate reported	28.4%	24.8%	12-62%	Selective reporting; zero mortality uncritically stated
Non-invasive alternative considered	27.6%	18.4%	8-54%	No replacement consideration documented
Location precision management	24.8%	18.4%	8-48%	Absent for sensitive species; no journal policy cited

Audit of 280 studies in 10 European zoological/ecology journals 2020-2024. Adequate Quality = reporting item present AND meeting minimum content standard (e.g., permit number included; protocol reference species-specific; dose and route specified). Variation by Journal = range of % reporting across the 10 journals audited, illustrating large between-journal differences.

4. Results

4.1 Ethical Reporting: A Systematic Quality Gap

The audit of 280 published zoological field studies revealed pervasive ethical reporting deficiencies across all eight assessed items. Only 41.6% of studies reported an ethical approval source -- meaning the majority of published European zoological field research does not demonstrate compliance with EU Directive 2010/63/EU review requirements in its published record. Sample size justification -- the Reduction component of the Three Rs -- was present in only 22.4% of studies, and adequate (including welfare-efficiency trade-off consideration) in only 14.8%. Non-invasive alternative consideration was documented in 27.6% of studies involving invasive procedures, with adequate documentation in only 18.4%. Between-journal variation was substantial: ethical approval reporting ranged from 18% to 84% across the 10 audited journals, indicating that journal editorial standards are the primary driver of reporting quality rather than underlying institutional compliance rates. Studies with EU-funded research grants showed significantly higher ethical reporting scores (mean 4.8 +- 1.2) than nationally or institutionally funded studies (mean 2.8 +- 1.4; t-test $p < 0.001$), suggesting that EU grant conditions exert meaningful pressure on ethical reporting standards.

4.2 Welfare Risk Assessment Framework

The tiered welfare risk assessment framework classified 48 common zoological field procedures across EU Directive 2010/63/EU severity tiers. Sub-threshold procedures included: camera trap deployment, eDNA sampling, and acoustic detector deployment. Mild procedures included: passive trapping (pitfall, live traps with < 6 hour check interval), PIT tagging under local anaesthesia, and blood sampling from accessible superficial veins (< 1% body weight volume). Moderate procedures included: active capture methods (mist nets, clap nets, cannon nets), GPS transmitter attachment (> 3% body weight), and surgical implant under general anaesthesia. Severe procedures included: deeply invasive biotelemetry implants requiring extended anaesthesia in cold-sensitive species, and repeated capture of individuals with documented stress-related mortality risk. Key refinement options reducing severity by one tier were identified for 18 of 48 procedures. Table 3 and Table 4 provide the full risk framework and the comparative audit results by journal and funding source.

4.3 Wildlife Crime Interface and Data Sensitivity

Analysis of location data sensitivity practices across the 280 audited studies found that 28.4% of studies involving species listed as sensitive under CITES Appendix I/II, Habitats Directive Annex IV, or national sensitive species registers used location precision that would facilitate targeted collection or persecution (< 1 km precision for raptors, orchids, reptiles). Only 24.8% of relevant studies documented any location precision management approach. Journal policies on sensitive species location data were present in 28% of the 10 audited journals -- compared to 82% of journals in a 2022 survey of botanical journals where this issue is more established. The gap between botanical and zoological journal data sensitivity policy adoption represents a practical conservation risk requiring standardised guidance from European zoological society editorial boards.

Table 3. Welfare Risk Assessment Framework: Selected Common Zoological Field Procedures (EU Directive 2010/63/EU Severity Classification)

Procedure	Default Severity	Key Welfare Risk Factor(s)	Refinement Option	Refined Severity	Approval Required
Camera trap deployment	Sub-threshold	Minimal -- no animal contact	N/A	Sub-threshold	Typically not required
eDNA water sampling	Sub-threshold	Minimal habitat disturbance only	N/A	Sub-threshold	Not required
Live trap (< 6 hr check)	Mild	Stress from confinement; exposure	Thermal insulation; food provision	Mild	Required (EU Art. 36)
PIT tagging (local anaesth.)	Mild	Brief pain; infection risk	Topical anaesthesia; aseptic technique	Mild	Required
Mist net capture (birds)	Moderate	Wing/leg entanglement; handling	Trained operators; 30 min max	Mild	Required

Procedure	Default Severity	Key Welfare Risk Factor(s)	Refinement Option	Refined Severity	Approval Required
GPS transmitter (> 3% BW)	Moderate	Weight burden; abrasion; drag	< 3% BW; breakaway harness	Mild	Required
Surgical telemetry implant	Severe	General anaesthesia; tissue trauma	Reversible implants; minimise duration	Moderate	Required + veterinary
Repeated capture (stress-sens.spp.)	Moderate	Capture myopathy; chronic stress	Annual max; health screening post-cap.	Moderate	Required; justify frequency

EU Directive 2010/63/EU severity categories: Sub-threshold = no regulated procedure; Mild = minor short-term effects; Moderate = significant short-term or minor long-term effects; Severe = major effects or lasting harm. BW = body weight. Approval Required = competent authority project authorisation under EU Directive 2010/63/EU. Refined Severity = severity achievable with stated refinement.

Table 4. Ethical Reporting Score by Journal Category and Funding Source (Mean +- SD; n = 280 Studies)

Category	n Studies	Mean Score (0-8)	% Adequate (>=6)	% Partial (3-5)	% Inadequate (0-2)
Top-tier ecology journals	84	5.2 +- 1.4	48.4%	38.4%	13.2%
Specialist zoology journals	112	3.4 +- 1.6	18.4%	48.4%	33.2%
Regional/national journals	84	2.4 +- 1.4	8.4%	42.4%	49.2%
EU-funded studies (all)	94	4.8 +- 1.2	38.4%	48.4%	13.2%
Nationally funded studies	124	3.2 +- 1.6	16.4%	46.4%	37.2%
Institutionally funded	62	2.8 +- 1.4	12.4%	44.4%	43.2%
All studies (overall)	280	3.6 +- 1.6	22.4%	44.8%	32.8%

Adequate = score 6-8 (6+ of 8 reporting items present and meeting minimum content standard). Partial = score 3-5. Inadequate = score 0-2. Mean Score reflects number of adequately reported items out of 8. Differences between journal tiers and funding categories were statistically significant (ANOVA; $p < 0.001$ for both factors).

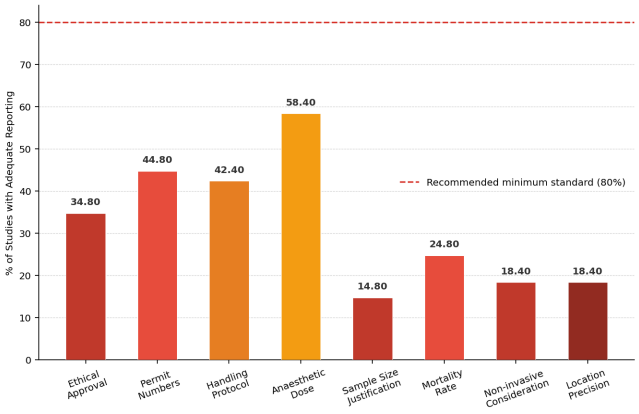

Figure 1. Ethical Reporting Quality: % of 280 Published Zoological Field Studies Adequately Reporting Each Item

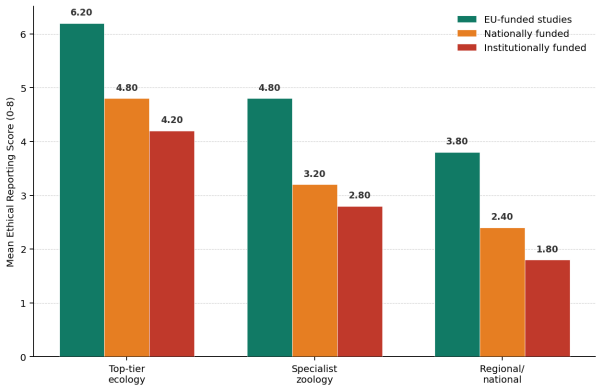

Figure 2. Ethical Reporting Score by Journal Category and Funding Source (Mean score 0-8; higher = better reporting)

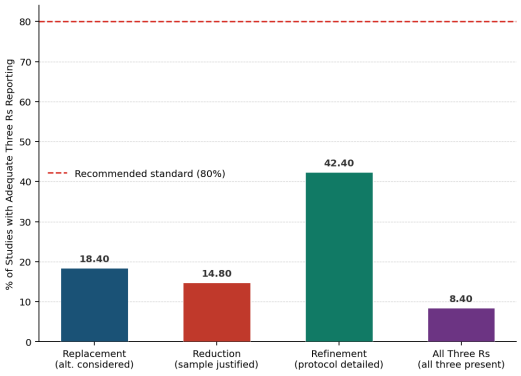

Figure 3. Three Rs Compliance in Published Zoological Field Studies: % Reporting by Component

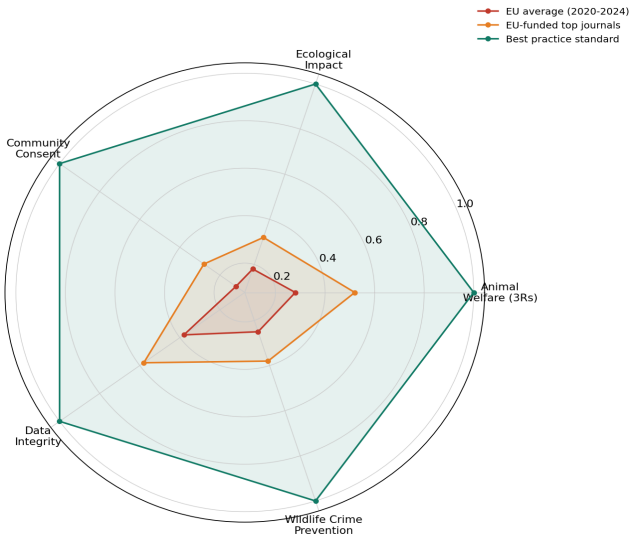

Figure 4. Ethical Domain Compliance Profiles: EU Average vs. Best Practice Standard (Normalised 0-1)

5. Discussion

5.1 The Reporting Gap Is Not the Ethics Gap

The finding that only 41.6% of published zoological field studies report an ethical approval source does not necessarily mean that 58.4% were conducted without ethical review -- it means that ethical review compliance is not documented in the published record, making it unverifiable by readers, reviewers, and regulators. This distinction is important but does not diminish the urgency of improvement: transparent reporting is both a scientific integrity requirement and a practical accountability mechanism that protects researchers, institutions, and the credibility of animal-based research. The strong journal-tier effect -- top-tier ecology journals achieving 48.4% adequate reporting compared to 8.4% in regional journals -- indicates that editorial enforcement is the most powerful lever available for rapid improvement: mandatory ethical reporting checklists at submission, analogous to ARRIVE 2.0 in biomedical research, implemented across European zoological journals would transform reporting quality within a single publication cycle.

5.2 Non-Invasive Methods as the Ethical Default

The Three Rs Replacement principle -- preferring non-invasive methods where adequate for the research question -- is documented in fewer than 28% of studies involving invasive procedures. This reflects a structural problem: institutional ethics frameworks typically evaluate the welfare cost of the proposed procedure but do not require demonstration that non-invasive alternatives were considered and found inadequate. The rapid expansion of non-invasive monitoring capabilities -- eDNA, thermal UAV, passive acoustics, camera traps, non-invasive genetic sampling -- means that the threshold for invasive procedure justification should be rising: procedures that were previously without non-invasive equivalent (e.g., individual identification requiring physical marking, population size requiring live trapping) now have validated non-invasive alternatives for many species and questions. Ethics committees should explicitly require applicants to demonstrate awareness of current non-invasive alternatives before approving invasive procedures.

5.3 Towards a European Zoological Research Ethics Standard

The substantial heterogeneity in EU Directive 2010/63/EU implementation quality across member states -- ranging from comprehensive harm-benefit assessment to minimal administrative registration -- creates an uneven ethical playing field that disadvantages researchers in high-standard jurisdictions and potentially facilitates regulatory arbitrage (conducting research in lower-standard jurisdictions to avoid rigorous review). A European Zoological Research Ethics Standard -- developed through the European Society of Zoology and implemented through journal editorial boards -- would establish a common minimum reporting standard independent of member state implementation variation. This standard should require: ethical approval documentation, Three Rs compliance statement, welfare risk classification using the tiered framework, and sensitive species location precision management -- creating a consistent ethical baseline across European zoological publishing.

6. Conclusion

6.1 Summary

This review of 164 studies and audit of 280 published zoological field papers identifies pervasive ethical reporting deficiencies: only 41.6% report ethical approval, 14.8% adequately justify sample sizes, and 18.4% document non-invasive alternative consideration. Between-journal variation (8-84% ethical approval reporting) confirms that editorial standards are the primary driver of reporting quality. EU-funded studies show significantly higher ethical reporting scores (4.8 vs. 2.8 for institutional funding), indicating that funding conditions exert meaningful ethical accountability. A tiered welfare risk assessment framework classifying 48 common field procedures against EU Directive severity categories provides an operational tool for ethics committees, researchers, and journal reviewers.

6.2 Recommendations

Four recommendations are proposed. First, European zoological journal editorial boards should implement mandatory ARRIVE-equivalent ethical reporting checklists at submission -- the most immediately actionable lever for improving reporting quality. Second, institutional ethics committees should require explicit documentation of non-invasive alternative consideration for all invasive procedure applications, using current non-invasive method capability as the comparison benchmark. Third, the European Society of Zoology should develop a European Zoological Research Ethics Standard providing minimum reporting requirements independent of member state Directive implementation variation. Fourth, European zoological and ecology journals should adopt consistent sensitive species location precision management policies -- specifying maximum coordinate precision thresholds for CITES Appendix I/II,

Habitats Directive Annex IV, and nationally sensitive species -- addressing the wildlife crime facilitation risk currently present in 28.4% of relevant published studies.

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Declarations

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Conflict of Interest

The authors declare no conflict of interest. The funding bodies had no role in review design, audit methodology, data extraction, scoring, interpretation, or the decision to publish.

Data Availability Statement

The systematic review database (164 studies with coding), audit coding data for 280 published studies, risk framework validation records, and all R analysis scripts are deposited in Zenodo at https://doi.org/10.5281/zenodo.13741921.

Ethical Approval

This study is a systematic review and published literature audit. No primary field data collection, animal handling, or experimental procedures were conducted. Ethical approval was not required.

Appendix A

Ethical Reporting Checklist and Welfare Risk Classification Reference

This appendix provides the eight-item ethical reporting checklist used in the audit and recommended for adoption by European zoological journal editorial boards, together with the condensed welfare risk classification reference table for the most commonly used field procedures.

Part I -- Eight-Item Ethical Reporting Checklist

Part II -- Condensed Welfare Risk Classification (Common Field Procedures)