

sDiv working group meeting report

“sEXCRETE I”

Working group meeting report

Overview and Aims

The first meeting of the sEXCRETE Working Group brought together researchers from ecology, physiology, and biogeochemistry, with expertise in marine, terrestrial and aquatic taxa, to advance a synthesis of how animals mediate the movement of energy and elements through ecosystems. The group’s overarching goal is to integrate Metabolic Theory of Ecology (MTE) and Ecological Stoichiometry (ES) into a unified framework that can predict animal-driven fluxes of carbon (C), nitrogen (N), and phosphorus (P) across taxa and environments. A central motivation of the meeting was to strengthen the recognition of animals as active components of Earth system functioning, often described during discussions as “*the circulatory system of the biosphere*,” by explicitly linking individual-level physiology to ecosystem-scale nutrient cycling.

I. Focal Areas of Discussion

1. Foundations and Assumptions

Participants critically examined the theoretical foundations of MTE and ES, identifying areas of convergence (e.g., body size and temperature effects) and divergence (e.g., assumptions about homeostasis and tissue turnover). Discussions highlighted how ontogeny, tissue composition, and differential elemental turnover challenge simplified assumptions commonly used in models. A key open question was which assumptions hold across scales and taxa, and where flexibility or breakdown is most likely.

2. Mechanisms

A major focus was on identifying which biological processes should be considered “mechanistic” and at what level (organismal vs. tissue-level). Participants discussed digestion, assimilation, excretion, and egestion as core processes, while recognizing that additional mechanisms (e.g., microbial mediation, secondary metabolites, parasite effects) may be critical in specific systems. The group emphasized starting from measurable processes and progressively refining model complexity.

3. Drivers and Environmental Context

Temperature and nutrient supply were discussed as key drivers shaping the coupling between energy and elemental fluxes. Topics included temperature effects on assimilation efficiency, gut retention time, and feeding strategies, as well as differences between ectotherms and endotherms. Participants identified several promising meta-analyses and datasets to inform this work, while noting gaps for certain taxa and environments.

4. Scaling from Individuals to Ecosystems

Discussions explored how individual-level fluxes scale to populations and ecosystems, including thought experiments such as ecosystems without animals, the role of megafauna, and animal-mediated nutrient storage and transport. The group highlighted that animals may either accelerate or slow nutrient cycling depending on nutrient availability and ecosystem context. A recurring challenge was defining the “ecosystem” boundary in a way that is both conceptually clear and analytically useful.

II. Content of Presentations

We began the week with a presentation that provided an overview of the working group proposal and included synthesis of participant responses to a pre-meeting questionnaire on MTE and ES. We also had a presentation by Benoit Gauzens, who introduced FluxWeb as a tool for quantifying energy and matter fluxes in food webs, highlighting its potential relevance for scaling individual-level processes to ecosystems. As our dynamic was to work in small groups and then reconvene with the whole group, we had regular presentations from the small groups reporting on their discussions and progress in 1) synthesizing modeling approaches to merging MTE and ES, and 2) developing a general model for animal nutrient flux.

III. General Research Directions

Across sessions, participants converged on several shared research directions:

- Developing a generic, individual-based mass-balance model describing ingestion, assimilation, excretion, and egestion.
- Identifying a minimal set of traits (e.g., body size, temperature sensitivity, elemental content) required to predict nutrient fluxes across taxa.
- Exploring how ontogeny, behavior, and physiological flexibility modify model predictions.
- Evaluating how different modeling approaches (statistical, process-based, first-principles) complement one another.
- Linking individual-level models to ecosystem-scale fluxes while remaining transparent about assumptions and uncertainties.

Potential data sources discussed included published excretion and body composition datasets, trait databases, and targeted case studies across aquatic and terrestrial systems.

IV. Structure of the Meeting

The week combined multiple working formats typical of sDiv synthesis groups:

- Plenary discussions structured around pre-circulated survey questions
- Breakout groups focusing on conceptual frameworks, mechanisms, and traits
- Hybrid sessions with remote participation by external experts
- Walk-and-talk discussions to encourage informal exchange and synthesis
- Daily summaries to integrate perspectives across subgroups

This varied structure facilitated both deep disciplinary discussion and cross-cutting synthesis.

V. Next Steps and Upcoming Deliverables

The group identified several concrete next steps:

1. Model review paper: A systematic synthesis of existing MTE-, ES-, and hybrid models, focusing on assumptions, parameters, and predictive scope.
2. Conceptual model paper: Development of an idealized, flexible individual-based model for animal-mediated nutrient fluxes.
3. Software and data products: Initial development of an R package and exploration of a shared, open-access database to support modeling efforts.
4. Regular coordination: Planned whole-group check-ins approximately every two months.

These products are intended to be mutually reinforcing and accessible to a broad ecological audience.

VI. Working Atmosphere and sDiv Support

The meeting atmosphere was highly collaborative, open, and constructive, with active engagement from both senior and early-career researchers. Participants consistently emphasized that sDiv support was essential in enabling an effective meeting, particularly through strong logistical coordination and meeting infrastructure, support for hybrid participation, dedicated time and space for in-depth discussion, and guidance on authorship, data sharing, and open science practices.

Overall, sDiv support was viewed as highly effective in fostering interdisciplinary exchange and accelerating progress toward shared synthesis goals. The general working atmosphere was inclusive, respectful, and forward-looking, creating an intellectually stimulating environment that strongly facilitated collaboration among participants.