

# RESEARCH STRATEGY

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**Project Title:** Integrated Data-Intensive Methods for Complex Real-World Systems Research Programs

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### Significance

Many programs in bioluminescence, *Dagonichthys profundus*, and developmental transcriptomics still rely on fragmented data, partial context, and ad hoc analytic workflows.

The proposed work is grounded in phd student studying ring-shaped bioluminescent structures in *dagonichthys profundus*. primary curator of the mcnerdface lab's multi-terabyte deep-sea imaging and genomic dataset. and focuses on .

This matters because the field increasingly needs reproducible ways to connect bioluminescence and *Dagonichthys profundus* with high-value outcomes in research, translation, and operational use.

### Innovation

The application integrates data harmonization, predictive analytics, and practical decision support in one reusable package.

The project also treats as downstream design targets rather than afterthoughts.

By building around the seed data model already defined for this persona package, the resulting outputs can be reused across OpenERA and adjacent evaluation workflows.

### Approach

#### Preliminary Studies

Selected prior work includes Developmental transcriptomics of ring-shaped bioluminescent organs in *Dagonichthys profundus* and Pressure-dependent gene expression plasticity in *Dagonichthys profundus*: implications for depth-mediated behavioral variation.

The active collaborative environment includes , whose expertise spans .

Available facilities include , which reduce startup risk for the proposed workflow.

#### Key publications from the investigator's group:

Underhill FB, McNerdface ND. Developmental transcriptomics of ring-shaped bioluminescent organs in *Dagonichthys profundus*. *Deep Sea Genomics*. 2025;7(1):1-22. doi:10.55555/syn-dsg-2025-0211. PMID: 90000004.

McNerdface ND, Underhill FB, Whateley L. Pressure-dependent gene expression plasticity in *Dagonichthys profundus*: implications for depth-mediated behavioral variation. *J Abyssal Biol*. 2025;20(1):88-107. doi:10.55555/syn-jab-2025-0301. PMID: 90000006.

Underhill FB, Whateley L, McNerdface ND. A curated reference dataset for abyssal fish behavioral genomics. *Deep Sea Genomics*. 2024;6(4):301-315. doi:10.55555/syn-dsg-2024-0103. PMID: 90000005.

#### Aim 1

Build a harmonized data and metadata foundation for the focal research domain.

**Expected outcome:** A reusable output aligned with downstream reuse.

**Potential problems and alternatives:** If one data source, workflow stage, or analytic assumption proves brittle, the project will shift emphasis to harmonized intermediate representations and staged validation rather than forcing end-to-end dependence on a single pipeline.

#### Aim 2

Develop analytic models that identify interpretable and decision-relevant patterns.

**Expected outcome:** A reusable output aligned with downstream reuse.

**Potential problems and alternatives:** If one data source, workflow stage, or analytic assumption proves brittle, the project will shift emphasis to harmonized intermediate representations and staged validation rather than forcing end-to-end dependence on a single pipeline.

### **Aim 3**

Evaluate how outputs support downstream use cases in research, operations, and collaboration.

**Expected outcome:** A reusable output aligned with downstream reuse.

**Potential problems and alternatives:** If one data source, workflow stage, or analytic assumption proves brittle, the project will shift emphasis to harmonized intermediate representations and staged validation rather than forcing end-to-end dependence on a single pipeline.

### **Rigor, Reproducibility, and Evaluation**

All workflows will use explicit metadata, documented transformation steps, and clear separation between exploratory analysis and evaluation.

Evaluation will be tied to the persona's intended use cases, including Graduate student personnel on PI's sponsored project, NSF GRFP fellowship holder transitioning to institutional fellowship, and Student appearing as key personnel on faculty proposal.

Outputs will be suitable for downstream review and regeneration from the same seed package, supporting synthetic benchmarking across projects.