Grant Proposal Draft

Coastal Research Robotics

Smart Robotics for Coastal Ecosystem Protection

Project Title

AI-Assisted Underwater Detection and Mapping of Invasive Green Crab in Bellingham Bay

Applicant

Coastal Research Robotics

Project Period

12 months

Project Type

Pilot research and field validation

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1. Project Summary

Coastal Research Robotics proposes a 12-month pilot to validate an AI-assisted underwater survey workflow for detecting and mapping invasive European green crab observations in shallow coastal habitats near Bellingham Bay.

The pilot addresses a practical management gap: current monitoring programs are highly labor-intensive and often provide limited spatial and temporal resolution. This project will test whether a structured robotics plus computer vision method can produce operationally useful invasive species intelligence for fisheries managers, tribal resource teams, and marine researchers.

Primary outputs include:

- field-tested species detection workflow,
- curated local training and validation dataset,
- geospatial observation maps,
- pilot performance report with scale-up recommendations.

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2. Statement of Need

European green crab pressure creates ecological and management risk in nearshore systems due to predation, competition, and habitat disturbance. Resource managers need earlier and denser observations to prioritize interventions. Existing trap-heavy methods are critical but can be difficult to scale across broad habitat areas at high frequency.

There is a clear need for tools that improve:

1. early detection potential,
2. habitat-level visibility,
3. intervention targeting confidence.

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3. Project Goals and Objectives

Goal

Validate whether AI-assisted underwater surveys can improve invasive species detection and mapping utility in shallow coastal environments.

Objectives

1. Build and tune a field-capable crab detection workflow.
2. Distinguish invasive and native crab detections with measurable confidence.
3. Generate mapped outputs suitable for management interpretation.
4. Document operational constraints and readiness for scale-up.

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4. Methods and Work Plan

4.1 Technical Approach

The pilot uses a tethered ROV survey system with HD video and controlled lighting. Video is processed through species detection/classification models, then logged with mission metadata for mapping and analysis.

Detection records include:

- timestamp,
- confidence score,
- depth,
- location proxy,
- frame reference.

4.2 Field Survey Design

- Select representative shallow habitat segments.
- Execute repeatable transect-style missions.
- Record continuous video and mission notes.
- Perform post-survey quality review and detection validation.

4.3 Validation

Pilot validation combines:

1. manual review subsets,
2. confidence-threshold analysis,
3. condition-based error tracking.

Where feasible, detections are compared to baseline reference methods to evaluate relative utility.

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5. Timeline and Milestones

Months 1-2

- protocol finalization,
- baseline data collection and labeling,

- model and logging pipeline setup.

Months 3-4

- baseline model training,
- error analysis and threshold tuning.

Months 5-6

- robotics and inference integration,
- bench and controlled water tests.

Months 7-9

- field survey execution,
- iterative model refinement with local conditions.

Months 10-12

- full analysis,
- map package generation,
- final report and scale-up plan.

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6. Deliverables

1. Pilot protocol and survey SOP package
2. Curated field imagery dataset (pilot scope)
3. Detection performance report
4. Geospatial observation maps and summaries
5. Final pilot report with recommendations

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7. Expected Outcomes

By project end, Coastal Research Robotics expects to demonstrate:

- practical detection workflow viability in real coastal conditions,
- useful species observation mapping outputs,
- a credible evidence base for expanded monitoring pilots and partnership programs.

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8. Broader Impact

This project supports coastal ecosystem protection by improving how invasive species observations are produced, interpreted, and operationalized. The approach is designed to complement existing monitoring programs, not replace them, by adding higher-resolution underwater observation intelligence.

The same platform can later support additional ecosystem monitoring priorities, including species pattern analysis and habitat stress indicators.

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9. Organizational Capability

Coastal Research Robotics is a focused marine technology venture with a defined mission: build practical, scientifically useful robotics workflows for coastal ecosystem monitoring. The company strategy prioritizes operational realism, transparent validation, and close alignment with stakeholder decision needs.

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10. Budget Framework (High-Level)

Major cost categories:

1. robotics platform and field equipment,
2. AI/data processing infrastructure,
3. field operations and logistics,
4. analysis and reporting.

Detailed budget can be adapted to specific grant format and cost rules.

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11. Sustainability and Next Phase

Post-pilot, the program advances through:

1. repeated seasonal monitoring cycles,
2. expanded habitat coverage,
3. targeted smart-trap integration research,
4. broader regional partnership deployment.

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12. Contact

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