

# Coastal Research Robotics

## Founder Whitepaper (Submission-Ready)

### Smart Robotics for Coastal Ecosystem Protection

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#### Document Control

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#### Cover Abstract

Coastal Research Robotics is building AI-assisted underwater monitoring systems to improve invasive species detection and coastal ecosystem intelligence. The first use case focuses on invasive green crab observations in shallow coastal environments relevant to Dungeness crab and nearshore habitat management.

This whitepaper outlines the company thesis, technical architecture, pilot design, commercialization pathway, and validation framework.

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#### 1. Strategic Context

Invasive marine species management is a persistent coastal challenge. Teams responsible for response often need better spatial and temporal visibility than manual workflows can provide at scale. Coastal Research Robotics is designed around this operational gap.

The company does not assume full automation on day one. It prioritizes field-valid, decision-relevant intelligence that can integrate into existing management workflows.

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#### 2. Problem Definition

European green crab pressure creates ecological risk through predation, competition, and habitat disturbance dynamics. Monitoring programs are active, but many are constrained by:

1. labor intensity,
2. delayed detection cycles,
3. limited spatial resolution.

These constraints reduce early warning quality and make intervention targeting harder.

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### **3. Company Thesis and Positioning**

#### **Thesis**

A practical underwater robotics workflow, coupled with species-aware AI and disciplined ecological logging, can materially improve invasive species intelligence quality.

#### **Positioning**

Coastal Research Robotics is positioned as a marine ecosystem intelligence company enabled by robotics, not only a hardware provider.

#### **Canonical Brand**

- Name: Coastal Research Robotics
  - Tagline: Smart Robotics for Coastal Ecosystem Protection
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### **4. Technical Architecture**

The platform has three layers:

1. Field Robotics Layer
2. Detection and Classification Layer
3. Ecological Intelligence Layer

#### **4.1 Field Robotics Layer**

Use a tethered ROV survey model for reliability, low latency, and repeatable mission control in shallow habitats.

#### **4.2 Detection and Classification Layer**

Apply computer vision to classify target species from underwater video with confidence scoring and conservative thresholds for operational use.

#### **4.3 Ecological Intelligence Layer**

Transform detections into map-based summaries and trend-ready data products, including contextual metadata for interpretation.

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### **5. Data and AI Strategy**

#### **5.1 Data Principle**

Model quality depends on field-condition diversity more than model novelty.

Priority data characteristics:

- variable visibility,
- variable lighting,
- benthic clutter,
- occlusions,
- negative examples.

## 5.2 Data Flywheel

1. missions produce new footage,
2. curated frames are labeled,
3. models are retrained,
4. field performance improves.

## 5.3 Validation Discipline

1. track class confusion patterns,
  2. evaluate confidence behavior by condition,
  3. maintain human-in-the-loop QA for critical outputs.
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## 6. Pilot Program Design

### Pilot Region

Bellingham Bay shallow coastal habitat zones.

### Pilot Objective

Validate operationally useful invasive species detection and mapping outputs in real field conditions.

### Pilot Method Summary

- structured transect-style survey missions,
- continuous video capture,
- metadata-linked detection logging,
- post-mission validation and map generation.

### Pilot Deliverables

1. field-tested workflow,
  2. curated pilot dataset,
  3. detection performance report,
  4. map output package,
  5. scale-up recommendations.
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## 7. Market and Customer Model

Early customer segments:

1. government fish and wildlife agencies,
2. tribal fisheries/resource teams,
3. marine research institutions,
4. restoration and monitoring organizations.

The near-term route is pilot and contract led, aligned with institutional adoption patterns.

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## **8. Business Model and Scale Path**

### **Stage A**

Pilot projects and scoped survey engagements.

### **Stage B**

Recurring monitoring services and standardized reporting packages.

### **Stage C**

Platform-level analytics and broader deployment support.

Primary revenue modes:

1. pilot contracts,
  2. monitoring services,
  3. deployment/support packages,
  4. analytics subscriptions at maturity.
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## **9. 12-Month Execution Plan**

### **Months 1-4**

- data and model baseline,
- protocol and pipeline setup.

### **Months 5-6**

- integrated prototype,
- controlled test validation.

### **Months 7-10**

- field pilot missions,
- iterative model refinement.

### **Months 11-12**

- final performance analysis,
  - partner-ready evidence package,
  - year-two roadmap.
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## 10. Risk and Validation Framework

### Technical Risks

1. visibility variability,
2. misclassification under clutter.

### Operational Risks

1. inconsistent mission execution,
2. incomplete metadata capture.

### Commercial Risks

1. long institutional sales cycles.

### Controls

- SOP-driven operations,
  - conservative confidence governance,
  - transparent reporting tied to measured outcomes.
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## 11. Expansion Strategy

Once the core invasive crab workflow is validated, expansion can include:

1. broader species pattern monitoring,
2. habitat pressure indicators,
3. additional management use cases such as sea urchin-related ecosystem stress monitoring.

Expansion should remain evidence-first and use-case anchored.

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## 12. Funding and Partnership Approach

Near-term growth is best supported by:

1. pilot-aligned grants,
2. research collaborations,
3. contracted monitoring programs.

Priority partnership profile:

- field access and ecological interpretation support,
  - data QA and validation collaboration,
  - practical pathway to repeat deployment.
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## 13. Conclusion and Immediate Priorities

Coastal Research Robotics has a practical entry path:

1. prove field-valid detection and mapping,
2. convert evidence into repeat engagements,

3. scale toward durable ecosystem intelligence products.

Immediate priorities:

- finalize pilot protocol and SOPs,
  - execute local data collection cycles,
  - complete first validation report,
  - package results for funding and partnership conversion.
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## **Appendix A: Standard Company Description**

Coastal Research Robotics develops AI-assisted underwater systems for invasive species monitoring and coastal ecosystem intelligence. The company combines practical field robotics, species-aware computer vision, and geospatial ecological reporting to help managers improve monitoring coverage and intervention targeting.

## **Appendix B: Standard Mission Line**

Protect coastal ecosystems with smart robotics and actionable ecological intelligence.