

# StormVision

GenAI-Based Person-in-Water Detection  
in Rough Seas

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# Project Review - StormVision - Interim

Goal: Detect a person in water from aerial drone images and evaluate robustness under calm-to-storm sea conditions using synthetic data

## Input & Output

- **Input:** Drone RGB image (real calm-sea + synthetic storm-sea)
- **Output:** Bounding Boxes (location) and Confidence Scores (probability).

## What changed from the proposal

- Added synthetic storm data generation using **Stable Diffusion + ControlNet** (inpainting with object-preserving masks)
- Introduced pair-aware dataset design (ORIG vs SYNTH image)
- Changed the problem formulation from image classification to object detection (bounding boxes + confidence)

## Novelty / contributions

- Built a paired real-synthetic storm dataset for person-in-water detection
- Introduced pair-aware evaluation to directly measure robustness degradation
- Demonstrated that fine-tuning with synthetic storm data improves detection robustness under severe sea conditions

# Related Work (Previous Work)

#	Paper / Year	Task	Method & Data	Key Findings & Limitations	Relevance to My Project
1	<b>SeaDronesSee (2022)</b> <a href="#">[reference]</a>	Human detection in open water	54K frames (YOLO / R-CNN)	<b>Finding:</b> Small humans are hard to detect.  <b>Limit:</b> No rough-sea conditions.	Serves as the main dataset we extend with GenAI rough-sea augmentation.
2	<b>Person-in-Water Detection (2024)</b> <a href="#">[reference]</a>	Detect people for SAR	72K frames, YOLOv4	<b>Finding:</b> Accuracy drops in unseen environments.  <b>Limit:</b> Lacks extreme sea states and extreme weather.	Shows that person-in-water detectors fail under unseen conditions, directly motivating our calm-to-storm robustness evaluation
3	<b>SafeSea (2024)</b> <a href="#">[reference]</a>	Generate synthetic harsh sea states	Latent Diffusion (Sea editing)	<b>Finding:</b> Rough-sea augmentation improves robustness.  <b>Limit:</b> Not focused on "person-in-water".	The conceptual foundation for our GenAI sea-state augmentation approach.

# Examples Synthetic generation :



# Dataset + EDA (300 samples)

## Data generation

- **Inpainting:** Uses automated masks to protect people and boats, changing only the weather around them.
- **Structure Preservation:** Uses **ControlNet** to lock the image outlines.

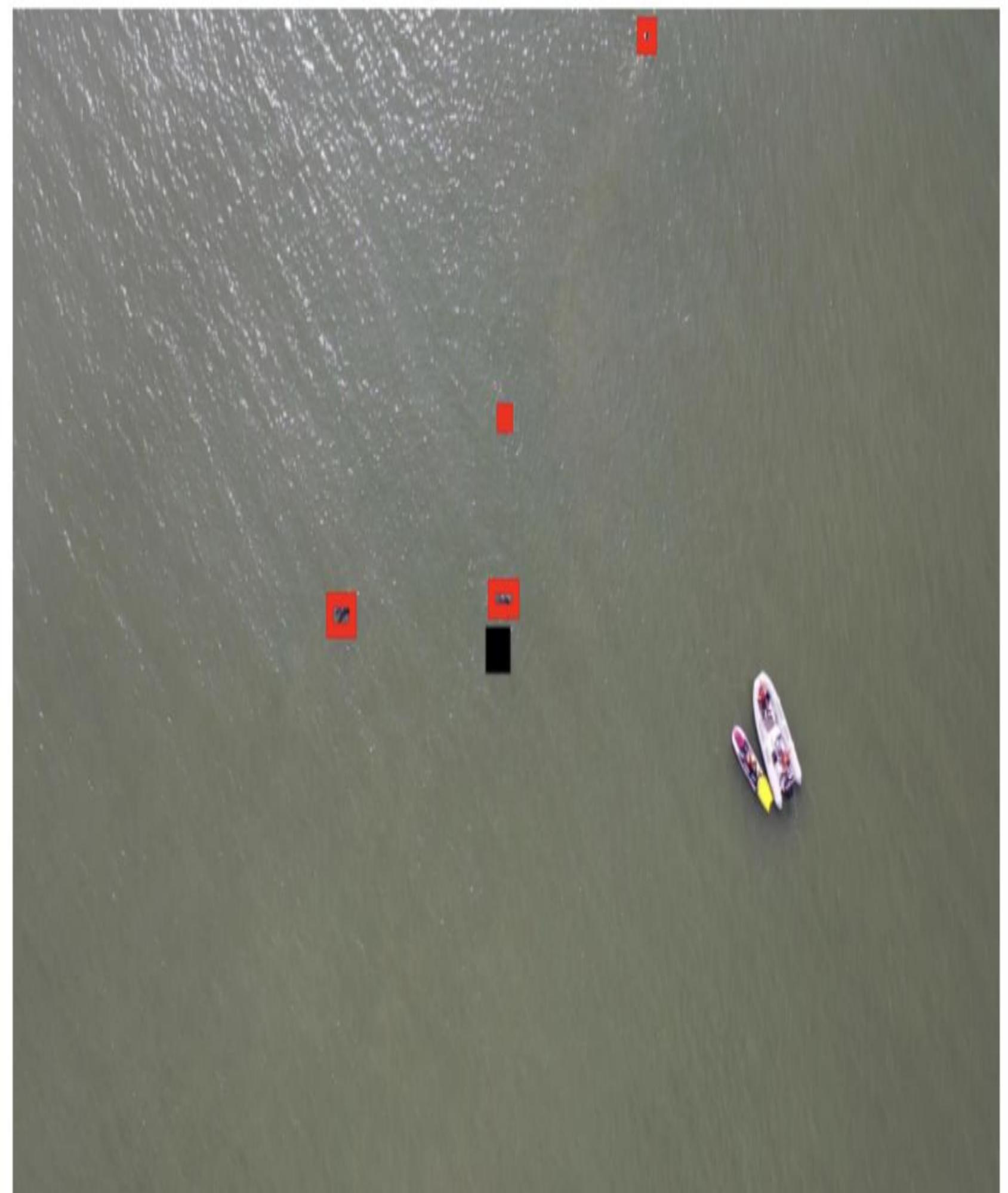
## Dataset

- **Total Volume:** ~600 Images (300 Original + 300 Synthetic).
- **Positive Samples:** 450 Images
  - Contain labeled objects (People / Boats).
- **Negative Samples (Background):** 150 Images
  - "Empty" stormy sea (No objects).
  - Crucial for reducing False Positives.

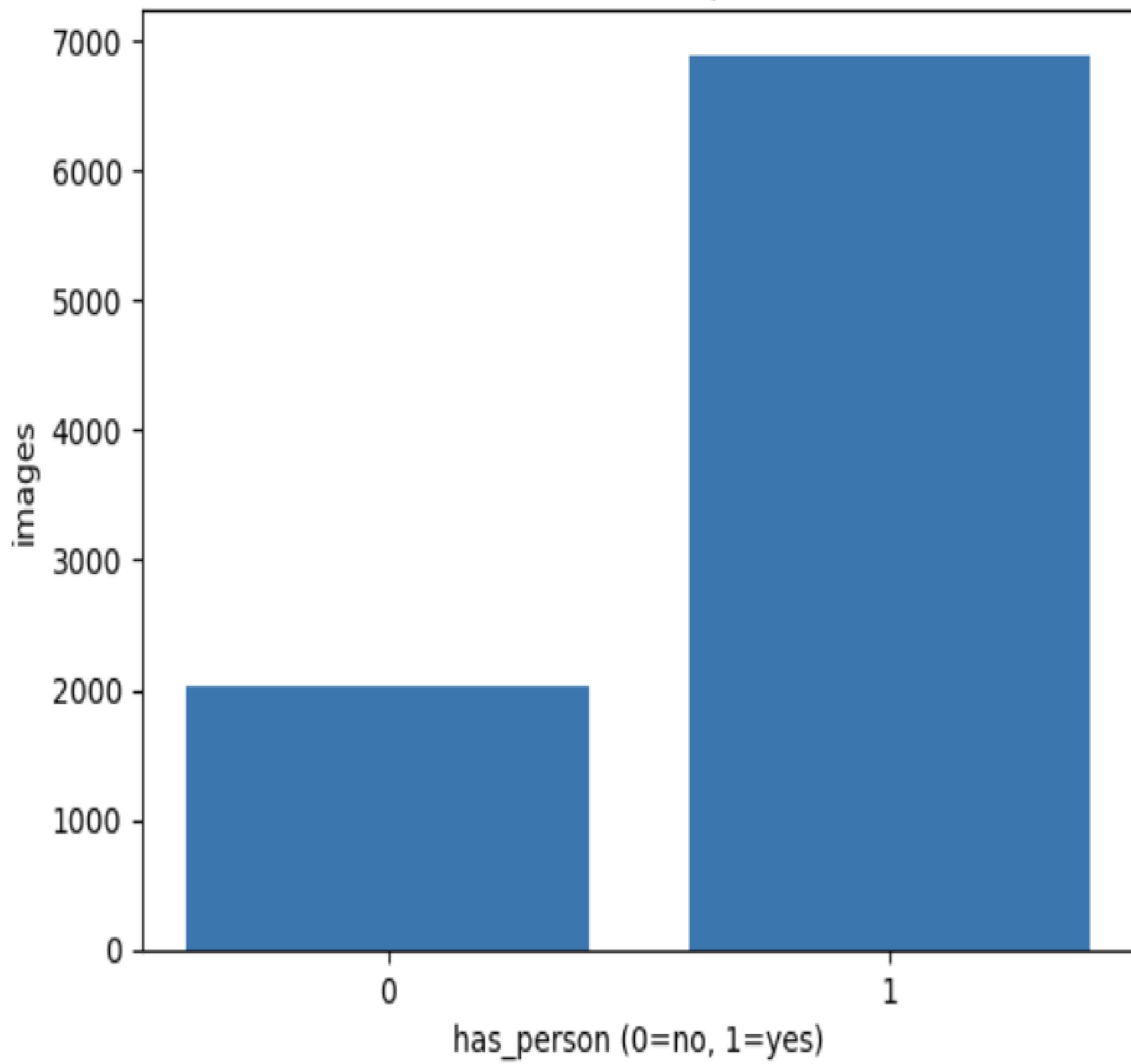
## EDA highlights Original Dataset (SeaDronesSee)

- **Tiny Objects:** Targets (Persons) occupy <1% of the image pixels, making detection difficult.
- **Background Dominance:** Images are 95%+ water, creating a high signal-to-noise ratio.

8953.jpg



Class balance | Train



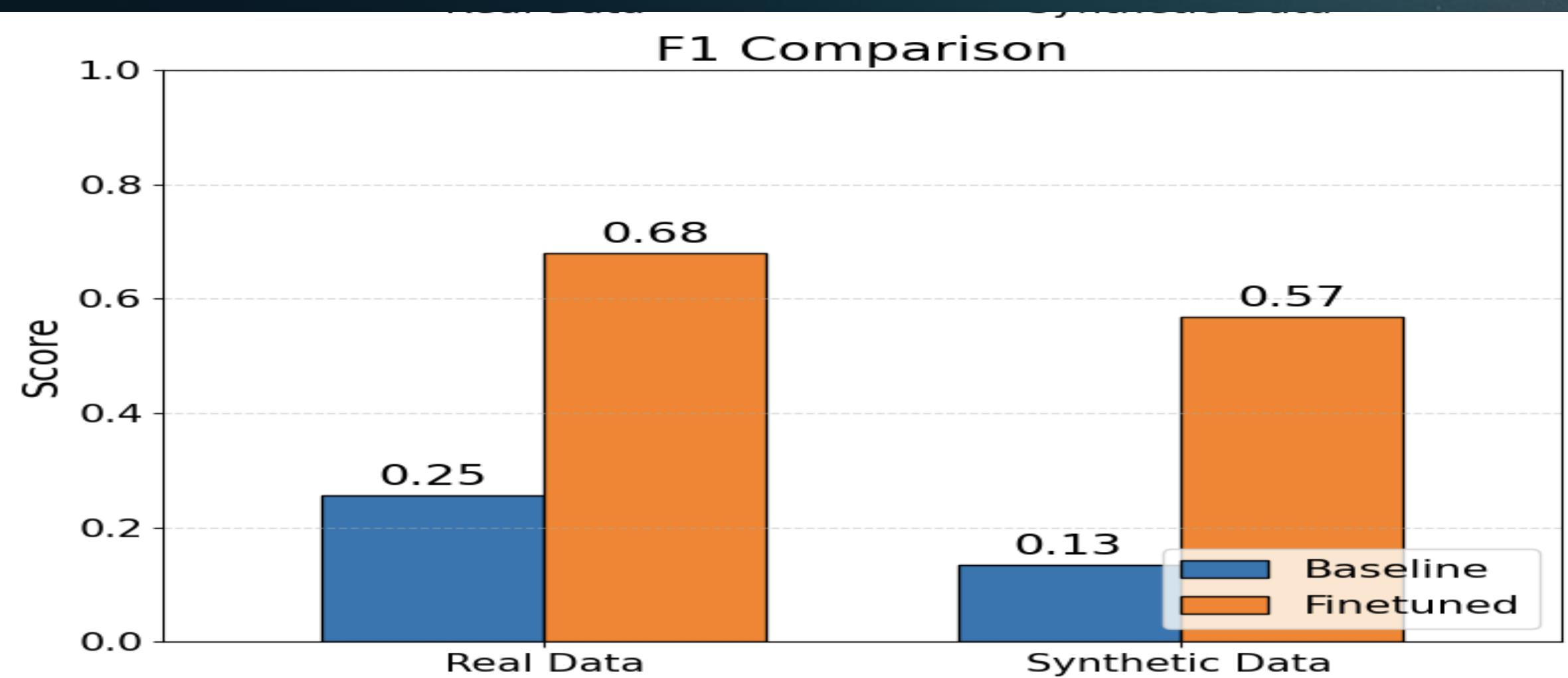
# Baseline Solution and Results

## Baselines

- **Model A (Baseline):** Standard YOLOv8s pre-trained
- **Model B (Finetuned):** Fine-tuned on our hybrid dataset (Real + Synthetic) to master detection in storm conditions.

## Results

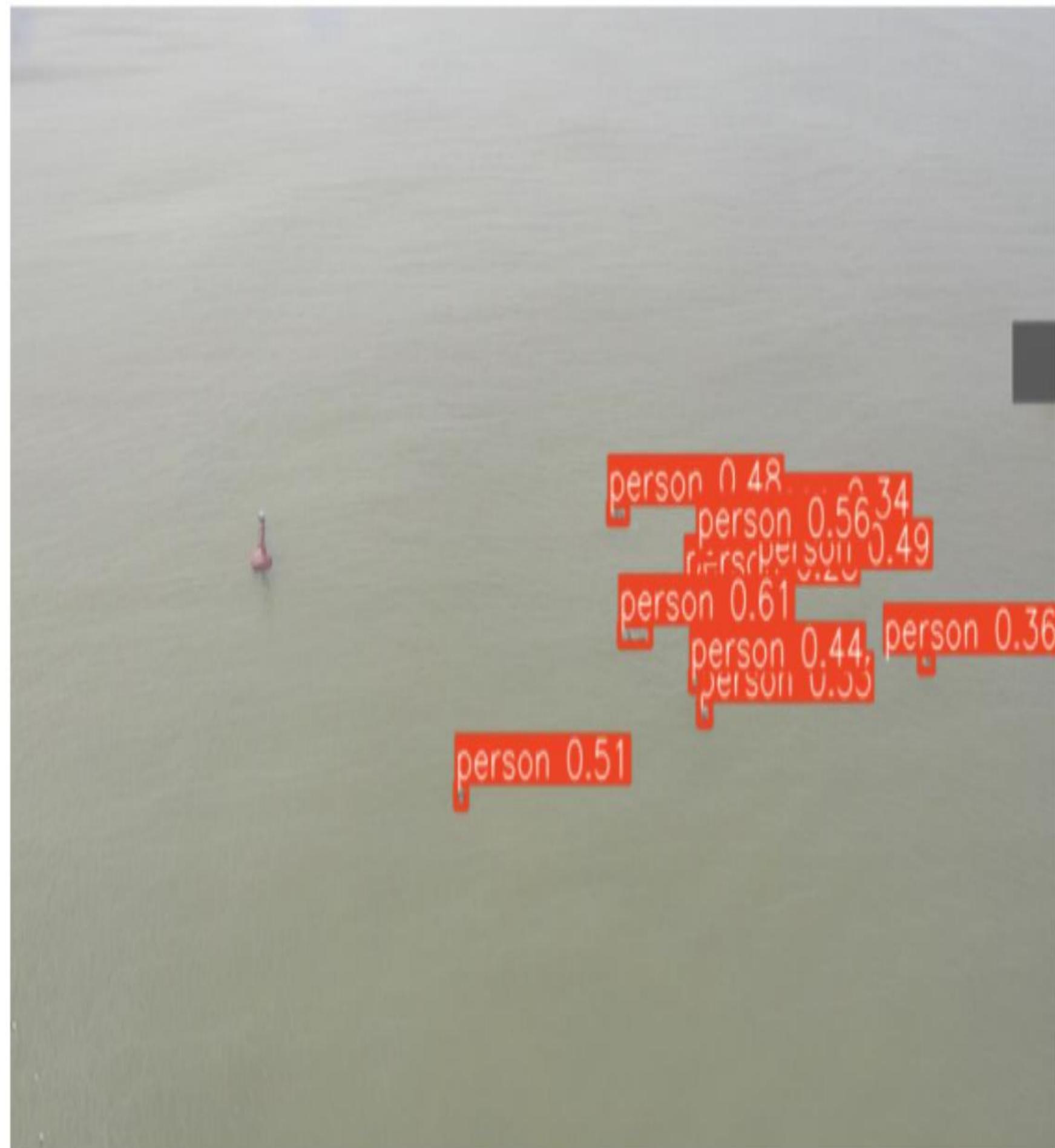
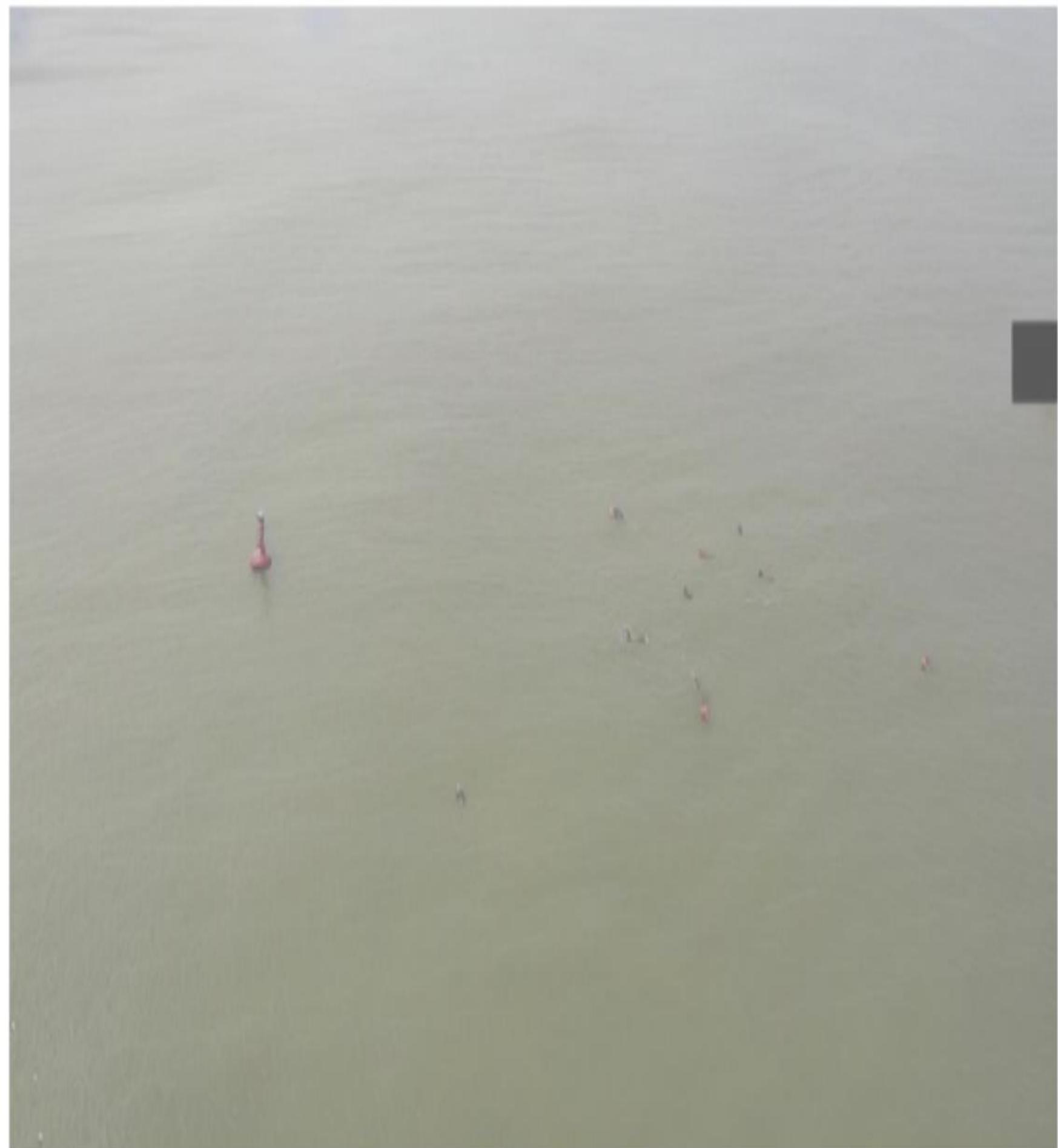
- **Higher Recall:** Significantly improved detection of small targets in storm conditions.
- **Weather Resilience:** Successfully detects objects through rain and fog, outperforming the baseline.



# Baseline Model

vs

# Finetune Model



# Plan (Roadmap to Final Project)

Week	Phase Focus	Key Tasks (StormVision Specifics)	Weekly Deliverable
1	Data-Centric Optimization <i>(Refining the input)</i>	<ul style="list-style-type: none"><li><b>Hard Negative Mining:</b> Generate additional "empty sea" images (specifically with heavy foam/whitecaps)</li><li><b>Extreme Scenarios:</b> Create a small batch of edge cases (e.g., night/low-light, heavy fog mix) to test robustness.</li></ul>	v2_synth_dataset (Enhanced & Cleaned)
2	Model-Centric Optimization <i>(Tuning &amp; Training)</i>	<b>Architecture Comparison (Optional):</b> Train YOLOv8m (Medium) alongside the current Small version	Final best.pt Model
3	Evaluation & Analysis <i>(Visualizing Results)</i>	Evaluation & Analysis	Final Results & Graphs
4	Delivery & Presentation <i>(Packaging)</i>	<ul style="list-style-type: none"><li><b>Repository Cleanup:</b> Organize code, upload datasets, and write a detailed README.md (Motivation, Pipeline, Results).</li><li><b>Visual Abstract:</b> Create one high-level diagram summarizing the Input → Hybrid Pipeline → Output.</li><li><b>Final Presentation:</b> Prepare the 5-slide deck: Motivation, Novelty, Methodology, Results, and Conclusions.</li></ul>	Final Submission (GitHub Repo + PPT/PDF)