# Apex-Sense

## Integrated Platform for Real-Time Predator Ecology

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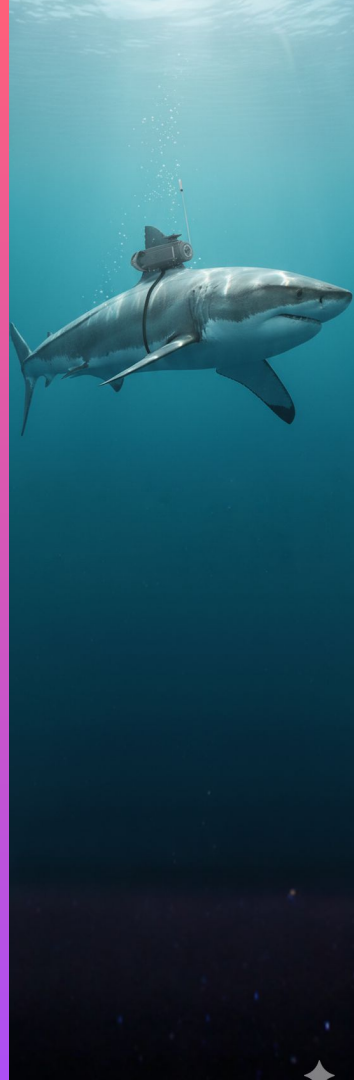
# Problem Statement

Existing shark tags only track location, omitting critical real-time feeding data. This prevents building effective predictive models necessary for dynamic marine conservation and fisheries management.



# Addressing the Critical Constraint: The Behavioral and Temporal Data Gap

## Challenge 1

Insufficient Behavioral Context

→ Traditional tags only provide low-resolution geo-location upon surfacing, failing to capture high-frequency kinetic data needed to discern crucial behaviors like hunting, mating, or foraging.

## Challenge 2

Ecological Ambiguity (The Trophic Gap)

→ We track movement, but cannot confirm trophic interactions (feeding) in real-time. This inability to identify prey type and consumption frequency results in speculative ecological models.

## Challenge 3

Data Latency

→ Data is often retrieved months to years after collection, rendering it historical and unusable for real-time dynamic management of conservation efforts or fisheries.

# The Solution: The Apex-Sense

## Core Function

A robust platform that measures Location, High-Resolution Kinematics, and Bio-Acoustics to algorithmically confirm and transmit feeding events

## System Architecture

On-board Micro-Processor runs a Feeding Trigger Algorithm to filter raw sensor data, packaging only confirmed behavioral events for immediate satellite transmission.

## Key Differentiator

We shift telemetry from purely descriptive tracking to predictive behavioral intelligence by providing validated data points for trophic ecology.


APEX-SENSE: REAL-TIME DATA FLOW ARCHITECTURE

# Technical Breakdown: Feeding Event Confirmation

## High-Resolution Kinematics (The Strike)

3-Axis Accelerometer and Gyroscope: Detects specific, high-frequency kinetic signatures, primarily sudden increases in VeDBA (Vectorial Dynamic Body Acceleration), lunges, and lateral head-shakes indicative of a predatory strike. (The Primary Trigger

## Bio-Acoustic Verification (The Prey)

Miniature Hydrophone Array: Records and analyzes ambient sound. Specific acoustic patterns—such as the distinctive sounds of prey schools or noise anomalies associated with consumption—are used to corroborate the kinetic strike and classify prey.

## Environmental Context (The Confirmation)

Temperature, Salinity, and Pressure Probes: Localized, rapid environmental changes (e.g., a drop in temperature from ingesting colder prey) provide a third confirmation point, which is essential for reducing false-positive event alerts.

# Low-Latency Data Architecture & Power Management

STPrimary Satellite Uplink (Iridium/Argos)RENGTHS

→ Function: Activated upon surfacing. Transmits small, high-value JSON packets containing confirmed event metadata (Time, Location, Confirmation Score). Achieves low-latency, global real-time alerts.

Secondary Acoustic Modem

→ Function: Activated when in range (approx. 5 km) of a receiving coastal buoy. Performs high-bandwidth offload of full raw sensor logs (acceleration and acoustic traces) for ML model validation.

Power Management: Harvesting

→ Integration of a Piezoelectric Generator to convert low-frequency kinetic energy from continuous tail-beats into supplemental power, substantially extending operational lifespan.

# Ecological Impact and Predictive Modeling

## Output 1: Predictive Modeling of Hot Zones

The validated data is used to train a Convolutional Neural Network (CNN), which forecasts areas of High Predator-Prey Interaction Probability based on environmental correlation.

## Application 1: Dynamic Conservation Policy

Enables marine protected area (MPA) boundaries to become dynamic, shifting in real-time based on predicted feeding activity, thereby increasing the efficiency of conservation resource deployment.

## Application 2: Responsible Fisheries Governance

Real-time alerts and predictive maps can be used by governance bodies to issue dynamic, spatially-explicit advisories to commercial fishing vessels, minimizing unwanted bycatch.

# prototype


Apex-Sense
Satellite Uplink
Hydrophone
eDNA Sampler
Bio-Acustic Hydrophone

# Conclusion

The Apex-Sense system fundamentally redefines marine telemetry by delivering real-time, confirmed feeding event data, moving beyond traditional location-only tracking. This multi-sensor, intelligent platform empowers unprecedented predictive ecological modeling, offering the actionable intelligence crucial for dynamic marine conservation and sustainable resource management.

# THANK YOU

Any questions?