PATENT SPECIFICATION

TITLE: SEAVAX2 (RIVERVAX2) AI-DRIVEN AUTONOMOUS SELECTIVE AQUATIC FILTRATION VESSEL SYSTEM, RECONFIGURABLE SEPARATION METHOD, AND SEANET AI-DRIVEN FLEET MANAGEMENT ARCHITECTURE

INVENTOR / APPLICANT: Jameson Hunter / Cleaner Ocean Foundation

1. ABSTRACT

An autonomous, zero-emission waterborne surface vessel system, reconfigurable fluid filtration assembly, and global artificial intelligence fleet architecture for the selective detection, separation, and extraction of floating, submerged, and micro-particulate waste, ghost fishing gear, and targeted biomass from marine, littoral, and riverine environments.

The vessel features a floating structural platform housing an adaptable fluid intake head, variable-geometry collector booms, and an internal reconfigurable multi-stage filtration matrix. The intake and processing assemblies may be positioned forward, midship, or aft relative to the vessel hull to accommodate variable operational depths, shallow-water littoral maneuvers, or high-flow riverine currents. Upstream sensor arrays—comprising optical recognition, multi-frequency sonar, and spectral analysis—discriminate between anthropogenic debris and non-target marine organisms or flora. Ingested fluid is selectively routed through modular separation units, including mechanical cutters/shredders, hydrocyclonic chambers, density separation channels, or fine mesh conveyances based on real-time material classification.

The system is driven by a zero-emission renewable energy power plant (utilizing photovoltaic, wind, green hydrogen, or e-methanol systems) and governed by an artificial intelligence network that integrates orbital satellite remote sensing to map pollution hotspots, optimize basin-scale fleet passage, track illegal discharge points for regulatory enforcement, and coordinate multi-vessel operations across global aquatic environments.

2. BACKGROUND & FIELD OF THE INVENTION

Field of the Invention

This invention relates generally to autonomous waterborne surface vehicles (USVs), selective fluid separation assemblies, and robotic environmental remediation systems. More particularly, the invention relates to floating platforms equipped with reconfigurable multi-stage filtration systems, real-time debris and flora/fauna discrimination, zero-emission

renewable power plants, and AI-driven satellite-integrated fleet control networks for large-scale marine (seas/oceans), littoral, and riverine pollution recovery.

Background and Economic Context of the Invention

According to estimates by the United Nations Environment Programme (UNEP), between 8 million and 12 million metric tons of plastic waste enter the world's oceans annually, originating predominantly from uncontrolled dumping into river networks, coastal runoff, and maritime activities.

To address a global pollution flux of this magnitude, any technological solution must balance hydrodynamic sweep capacity against the practical fleet economics of manufacturing and deployment:

1. **Fleet Scalability & Production Constraints:** Exceedingly large marine structures require specialized naval shipyards for construction, severely limiting global build capacity, increasing unit capital costs, and restricting maintenance accessibility. Conversely, undersized craft lack the volumetric intake sweep necessary to cover vast oceanic gyres within meaningful timeframes. The present system optimizes platform dimensioning to maximize sweep area relative to hull displacement, enabling mass production across standard commercial shipyards once international legislative frameworks establish a viable market mechanism.

2. **Operational Hardware Robustness & Simplicity**: To maintain cost efficiency across multi-vessel fleet deployments, physical components must prioritize mechanical simplicity, modularity, and structural robustness over overly complex mechanical geometries, reducing capital expenditure and field maintenance requirements.

3. **Versatility Across Deep Water, Littoral, and Riverine Operating Environments:** Ocean-going blue-water operations typically focus on surface and near-surface debris (0 to 3 meters depth). However, riverine, estuary, and close-to-shore littoral operations (RiverVax configurations) often encounter localized currents, shallow drafts, or submerged waste layers requiring deeper or dynamically adjusted collector head placements. Fixed forward-only intake positions restrict vessel maneuverability in shallow or confined waterways.

4. **Lack of Material Discrimination & Fleet Coordination:** Prior recovery craft lack upstream optical/sonar systems capable of distinguishing synthetic polymers from marine life, and operate as isolated units without basin-scale predictive modeling of debris drift, leading to inefficient transit and inability to target primary riverine dumping nodes.

There exists an urgent need for a flexible, energy-autonomous filtration system capable of selective material processing across adaptable hull configurations while operating as part of an artificially intelligent, satellite-directed global fleet.

3. SUMMARY OF THE INVENTION

The present invention provides a scalable, reconfigurable aquatic waste harvesting platform and AI fleet management system that addresses the aforementioned prior art limitations.

Primary aspects of the invention include:

1. **Flexible Platform Architecture:** A waterborne platform (e.g., multi-hull, catamaran, trimaran, or specialized monohull) fabricated from structural materials, housing an internal reconfigurable fluid processing matrix. The intake and processing assemblies may be arranged at forward, midship, or aft positions of the vessel structure to suit specific operational depths (ranging from surface layer to depths exceeding 3 meters) and shallow-draft riverine or littoral environments.

2. **Variable-Geometry Intake Assemblies:** Dynamic collector structures incorporating articulating booms that deploy laterally to establish an expanded intake sweep width relative to vessel length.

3. **Optical & Sonar Discrimination Suite:** An upstream sensor suite combining optical recognition, artificial neural network (ANN) image classification, multi-frequency sonar, and spectral analysis to discriminate between synthetic debris (plastics, nylon netting, industrial waste) and living marine organisms or natural floating biomass (fish, mammals, sargassum, kelp).

4. **Reconfigurable Multi-Stage Filtration Matrix:** An internal processing system comprising a plurality of selectively engaged filtration pathways. Dependent on detected waste characteristics, fluid and entrained matter are dynamically routed through one or more processing modules:

- mechanical cutting and shredding assemblies (for ghost nets, ropes, and entangling lines);
- hydrocyclonic separation chambers (for density-based particle fractioning);
- variable mesh filtration belts or escalators (for macro- and micro-plastic extraction); and
- organic bypass channels (for safe discharge of non-target marine fauna and flora).

5. **Zero-Emission Renewable Power Architecture:** A hybrid renewable power plant configured to supply continuous propulsion and operational power, utilizing solar, wind,

green hydrogen, e-methanol fuel cells, or combinations thereof, providing long-range energy autonomy and supporting high-energy biomass or heavy waste processing.

6. **Artificial Intelligence Fleet Architecture (SeaNet):** An AI network integrating real-time satellite remote sensing, ocean current modelling, and river discharge data to target major pollution nodes, plot energy-optimized fleet routing across major oceans, track illegal dumping points for regulatory enforcement, and coordinate multi-vessel operations to systematically tackle global plastic flux targets.

4. DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the functional operation and system architecture:

Structural Configuration & Intake Positioning

The vessel platform comprises a waterborne hull structure engineered for structural simplicity and standardized manufacturing. The intake collector head, fluid pumps, and internal separation matrices are modularly configured and may be integrated into:

- **Forward Intake Configurations:** Suited for ocean-going surface and near-surface sweeping (0 to 3 meters depth) where forward motion assists fluid ingestion into the collection channel.

- **Aft or Midship Intake Configurations:** Suited for shallow-draft riverine, estuary, or close-to-shore littoral operations (RiverVax configurations), allowing the collector head, conveyances, and shredding stages to operate at variable or deeper submerged angles behind or within the main hull, protecting intake structures during river navigation and improving maneuverability in confined waters.

Upstream Discrimination & Dynamic Routing

Upstream of the active filtration zone, a sensor array continuously scans the water column. When the sensor suite detects synthetic polymers or entangling ghost nets, the autonomous control system engages corresponding internal pathways:

1. **Entangling Net Mode:** Fluid is directed through heavy-duty mechanical cutters/shredders to sever ropes and netting into manageable fragments prior to de-watering.
2. **Micro-Particle Mode:** Fluid is directed through hydrocyclonic separation chambers and fine mesh matrices to fractionate sub-millimeter synthetic particles.

3. **Organic Biomass / Non-Target Mode:** Upon detecting marine fauna or natural floating flora (such as sargassum or kelp), fluid flow is dynamically routed through an organic bypass channel or low-velocity diversion flow to safely return non-target material to the water column without mechanical harm.

Renewable Power & Auxiliary Hydrogen Support

The propulsion and processing systems draw power from an onboard zero-emission renewable energy management system. For routine ocean cruising and surface skimming, energy harvested from photovoltaic arrays (and optional) wind turbines satisfies operational demand. For high-drag or energy-intensive processing operations—such as heavy net shredding, deep-water pumping, or harvesting dense biomass—the power management system automatically engages auxiliary green hydrogen or e-methanol fuel cells.

AI Fleet Operations & UNEP Regulatory Integration

A distributed artificial intelligence control system fuses local vessel sensor telemetry with orbital satellite imagery and hydrodynamic drift models. The AI calculates energy-efficient passage routes for individual vessels across major oceanic basins and primary river estuaries. By mapping localized concentrations of waste discharge over time, the system identifies illegal riverine dumping sources and logs timestamped, geospatially verified pollution tracking data for submission to national authorities and international environmental bodies (such as UNEP) to support enforcement and prosecution under applicable legislation.

5. CLAIMS

1. **An AI driven autonomous aquatic filtration vessel system for selective debris recovery, comprising:**
   a waterborne floating platform; a fluid intake head mounted to said platform and comprising articulating collector booms deployable laterally to establish a variable intake sweep width; an upstream sensor array configured to generate real-time sensor data identifying target debris materials and discriminating said target debris from non-target marine flora and fauna; a reconfigurable multi-stage filtration matrix housed within said platform, comprising a plurality of distinct filtration and separation modules and a fluid control system configured to dynamically route ingested fluid and debris through selected filtration modules based on input from said sensor array; a zero-emission renewable energy power plant configured to supply electrical power for vessel propulsion, fluid pumping, and filtration operation; and an onboard autonomous controller operational to govern vessel navigation, intake boom geometry, and filtration routing.

2. **An artificially intelligent fleet management network for global aquatic waste remediation, comprising:**
a plurality of autonomous surface filtration vessels, each vessel comprising a reconfigurable multi-stage waste filtration matrix, an upstream material discrimination sensor, and an autonomous navigation unit; a central artificial intelligence processing engine communicatively coupled to said plurality of vessels and to an orbital satellite data feed; wherein said central processing engine is configured to analyze satellite imagery, hydrodynamic ocean current data, and river discharge models to identify waste accumulation hotspots and illegal discharge nodes; wherein said central processing engine calculates energy-optimized transit pathways for individual vessels within said plurality of vessels to target said identified waste accumulation hotspots; and wherein said central processing engine logs geospatial pollution tracking data associated with identified discharge nodes for regulatory reporting and legal enforcement.

3. **An AI driven method for reconfigurable, selective filtration of waterborne debris from an aquatic environment, the method comprising:**
navigating an autonomous vessel through an aquatic environment using power generated by an onboard zero-emission renewable energy power plant; dynamically adjusting the lateral position of articulating collector booms to vary an intake sweep area; scanning fluid and debris upstream of an intake head using an optical and sonar discrimination sensor array; identifying whether ingested material comprises macro-plastics, micro-plastics, entangling net material, or organic biomass using an onboard artificial intelligence model; dynamically configuring an internal fluid path to route ingested material through at least one corresponding separation module selected from a mechanical shredder, a hydrocyclonic separator, a density separation chamber, or a mesh filter; and compacting de-watered target waste into an internal storage bay while discharging non-target fluid and biomass back into the aquatic environment.

4. The vessel system of claim 1, wherein said fluid intake head and multi-stage filtration matrix are mounted at a forward, midship, or aft position of said floating platform to optimize filtration at variable water depths or within shallow-draft riverine and littoral environments.

5. The vessel system of claim 1, wherein said upstream sensor array comprises at least one optical camera, a multi-frequency sonar transducer, and a hyperspectral sensor coupled to an artificial neural network trained to differentiate synthetic polymers from living marine organisms, kelp, and sargassum.

6. The vessel system of claim 1, wherein said reconfigurable multi-stage filtration matrix includes a ghost net processing module comprising electromechanical or hydraulic cutters configured to sever and shred entangled synthetic lines prior to compaction.

7. The vessel system of claim 1, wherein said reconfigurable multi-stage filtration matrix includes a hydrocyclonic separation module configured to fractionate micro-plastic particles from water based on fluid rotational velocity and particle specific gravity.

8. The vessel system of claim 1, wherein said zero-emission renewable energy power plant comprises a hybrid energy architecture incorporating at least one of photovoltaic panels, wind turbine generators, green hydrogen storage with fuel cell stacks, or e-methanol fuel cells.

9. The vessel system of claim 1, wherein said onboard autonomous controller is communicatively linked to a satellite data network, and wherein said controller adjusts vessel navigation tracks in response to satellite-detected waste drift vectors.

10. The fleet management network of claim 2, wherein said central processing engine is configured to map major riverine input sources and compile timestamped, geospatially referenced evidence of illegal plastic dumping for submission to national or international regulatory bodies.

11. The method of claim 3, wherein identifying entangling net material automatically triggers the engagement of a mechanical shredding unit positioned along said internal fluid path.

12. The method of claim 3, wherein said zero-emission renewable energy power plant utilizes green hydrogen or methanol fuel cells to supply auxiliary energy during high-drag biomass or heavy waste processing operations.