KEELCRAB™

INTRODUCTION: THE SCIENTIFIC PARADIGM OF "UNDERWATER PROACTIVE CLEANING"

This report is intended to provide a clear, evidence-based explanation of the nature of KeelCrab's work, addressing the fundamental misunderstanding identified in the environmental report between Reactive Cleaning (corrective work on degraded hulls) and Proactive Cleaning (ongoing preventive maintenance).

What we actually do:

KeelCrab does not perform underwater stripping. Our work is to remove biofilm and algae before they turn into hard, calcareous buildup. Working proactively means intervening while the hull still looks clean, ensuring the antifouling paint's performance stays unchanged. That's why it's essential to know the antifouling type, the application date, and the total film build in microns, so we can confirm the Biocide Release Rate (BRR) on the public technical datasheet and use the correct brush—the goal is NOT to alter that release rate.

The "Leached Layer" Analysis (Leached Layer):

All ECHA-authorized antifouling paints work by releasing biocides in a controlled way. When exposed to seawater, the coating naturally forms a "dead" surface layer: the leached layer.

- Copper Chemistry: The active biocide (copper oxide) remains sealed within the paint's solid matrix. In the *Leached Layer* you only find copper that has already hydrolyzed in contact with the salt in the water.
- The "Sugar in Coffee" Analogy: The copper in the *Leached Layer* is like sugar that's already dissolved in a cup of coffee. When KeelCrab cleans this passive layer, we collect only copper that's already ionized (solubilized) and inert resins. We are not touching the copper oxide (the biocide) that remains in the matrix. We're not responsible for what ECHA authorizes as a biocide (given that nowadays it's mostly copper), but we do ensure the biocide stays in the boat's matrix and doesn't end up in the water.

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FORCE ANALYSIS: WHY STRIPPING IS IMPOSSIBLE

To “strip” or remove intact paint, you need mechanical energy that KeelCrab simply cannot physically produce:

- Shipyard: Pressure washers (200–500 bar) and orbital sanders (10,000 OPM) break the paint’s molecular bonds to tear it off.
- KeelCrab system: Runs at just 200 RPM (a mechanical “gentle touch”), with only 4 kg of contact force (needed solely for suction) and 0.4 mm nylon bristles.
- Technical evidence: KeelCrab’s abrasive capability is under 0.5% compared with a shipyard sander. The drone simply doesn’t have the physical force to detach “live” paint protected by the matrix.

DECARBONIZATION AND CORPORATE PURPOSE

Each liter of marine diesel produces 2.62 kg of CO_2. A dirty hull increases fuel use by 15% to 20%. For a yacht burning 300 liters per hour, the emissions reduction enabled by KeelCrab adds up to several tons of CO_2 per year. That’s our purpose: decarbonization aligned with the company’s core mission.

POINT-BY-POINT RESPONSE TO THE REPORT’S OBJECTIONS

POINT 1 – FULL CONTAINMENT AND EFFLUENT CAPTURE

The KeelCrab system combines active suction with brushing at the same time.

- Capture Efficiency: Effluents are routed into the KeelCrab Bag (180 microns), which delivers a real-world collection rate of 80% to 90% of debris and algae.
- Nature of the Waste: By working on the *leached layer*, we collect only algal biomass and very small amounts of already ionized (dissolved) copper. Trying to capture ionized copper is like trying to scoop up sugar that’s already dissolved in coffee: it’s inert and diluted.
- Total Containment: The system can suction everything outward with the Funnel Kit (channeling 100% to shore) or, as the recommended option, use the *Bag*. There is no visible "plume" of turbidity, because suction keeps everything contained inside the drone**.**

POINT 2 – ON-SHORE TREATMENT AND WASTE MANAGEMENT

The objection about handling "paints and biocides" as hazardous waste stems from a misunderstanding of *Proactive Cleaning*.

- Algae is algae: the material collected is algal biomass. Algae is not toxic or special waste; once it dries out without water, it dies and cannot harm the environment.
- Rebuttal of "Live" Biocides: In the *leached layer* there are no live biocides—only their hydrolyzed "ghosts." If live biocides were present in the residue, it would mean we were stripping the hull (a shipyard activity), which KeelCrab does not do. There's no issue with discharge parameters (Cu, Zn, pH) because we're not removing paint—we're cleaning the inert layer that the boat would shed anyway while underway.

POINT 3 – PAINT CHARACTERIZATION AND TYPE-SPECIFIC RESTRICTIONS

The protocol requires a preliminary review of the paint's composition, application date, miles sailed, and number of coats.

- Self-Polishing (Ablative) Paints: Engineered to gradually self-dissolve while underway thanks to their water-soluble resin. KeelCrab recommends not using brushes on these coatings; instead, only suction is applied, simulating travel at 2.5 knots to reactivate the paint without mechanical abrasion.
- Fixed Matrices (Hard-Matrix Paints): These are the best match for KeelCrab. Their surface is more durable, and proactive action is the only way to remove the depleted passive layer (*leached layer*) and restore the effectiveness of the biocide that remains protected inside the matrix.
- Silicone Paints: Biocide-free and based on a mechanical system. Here, choosing the right brush based on the product's age is essential to avoid damaging the surface finish (*coating*).
- Use of the Bag: Using the bag is mandatory for environmental responsibility and to collect algal biomass, ensuring no debris is dispersed.

POINT 4 – RISK OF SPREADING INVASIVE SPECIES (BIOSECURITY)

KeelCrab's target segment (10–60 m yachts) operates in local waters. Framing invasive-species risk around recreational vessels that don't cross oceans is a misdirected approach.

- Protocol: The *Bag* captures the removed organisms. The drone is rinsed and dried between operations. Drying eliminates microorganisms, eliminating the risk of acting as a vector.

POINT 5 – TRACEABILITY AND ENVIRONMENTAL CERTIFICATION

- Digital Reporting: The system doesn't generate automatic reports by default, but it can log duration, geolocation, and the treated area to provide the port with full traceability.
- Certified Operators: Technicians at KeelCrab Points complete a mandatory, official training course to ensure the protocol—cleaning only the passive layer—is followed with strict precision.

CONCLUSION

Banning KeelCrab means promoting air pollution and forcing vessels into harsh, invasive shipyard work. KeelCrab locks biocides into the matrix and captures algal biomass, supporting decarbonization and keeping the harbor healthy.

AEFFE S.R.L.
Via Rezzonico, 39 - 22100 COMO
P. IVA (VAT N.) e C. F. 03385790138
www.keelcrab.com