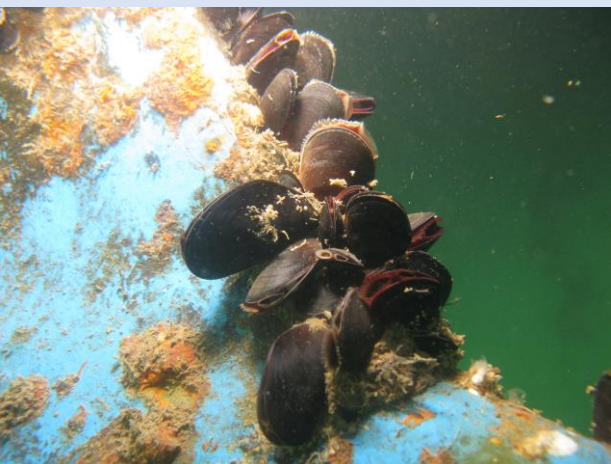


Level of Fouling

A method for **rapidly** characterising **biofouling** on the submerged surfaces of boats or ships

The LoF scale

- It is a ranking scale with **six categories**, ranging from zero to five
- Categories are based on the **amount of biofouling** you can see on a vessel's submerged surfaces
- It is a straightforward method for **consistent scoring** of vessel biofouling that can be related to **biosecurity risk**



It is an efficient method

- ✓ You don't need sampling tools in the field
- ✓ You don't have to spend time identifying or counting species underwater
- ✓ Does not require post-sampling time to process photographic data
- ✓ LoF ranks can be applied underwater and on land



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Glossary

Term	Description
<i>Slime layer</i>	A slime layer, or biofilm, is made up of microscopic organisms that are not individually visible to the naked eye. It is the first layer of biofouling accumulation. It can be a thin or thick film, or include little filaments.
<i>Macrofouling</i>	Macrofouling are larger visible organisms that can be seen with the naked eye. You can usually tell species and individuals apart from each other. They include common marine species, including barnacles, seaweed, bivalves, sponges, and sea squirts.
<i>Hull areas</i>	Hull areas are ‘simple’ submerged surfaces of vessels. These are usually flat or curved surfaces without sharp angles, corners or edges.
<i>Niche areas</i>	Niche areas are ‘complex’ submerged surfaces of vessels where nooks-and-crannies occur. They include rudders, propellers, struts, shafts, grates, thrusters, keels, and docking block areas that tend to accumulate biofouling.
<i>Visible surface</i>	The LoF system does not use quadrats or other sampling devices. Visible surfaces are hull and niche areas that users can access to apply LoF scores. Typically, it is more straightforward and accurate to apply LoF scores to distinct sections of vessels than to the entire vessel. This is especially the case in water, when the whole vessel is usually not visible in one view.
<i>Percent cover</i>	The LoF system relies on relatively quick estimations of percent cover. This is the proportion of a visible surface that is covered in biofouling. The categorical approach assists with accuracy.
<i>Biofouling species</i>	It is not necessary to know how to identify biofouling species to apply the LoF system. Some basic knowledge is needed to distinguish among very broad groups. While the range of organisms can vary predictably with biofouling accumulation, it is not a driver of LoF scoring. <u>Percent cover</u> is the key metric used to assign LoF scores.

The LoF scale

LoF rank	Estimate of <u>macrofouling</u> cover	Description
0	Zero	No slime layer. No macrofouling. <i>Only clean surfaces.</i>
1	Zero	<i>Slime layer</i> on some or all surfaces. <i>No macrofouling.</i>
2	1 - 5% of visible surface	<i>Macrofouling present</i> in small patches or a few isolated individuals or small colonies.
3	6 - 15% of visible surface	<i>Considerable macrofouling</i> on surfaces.
4	16 - 40% of visible surface	<i>Extensive macrofouling</i> present but more than half of surfaces without biofouling.
5	41 - 100% of visible surface	<i>Very heavy macrofouling</i> present covering substantial portions of visible surfaces.



Six steps to using this guide

The **LoF rank** appears here

1

One or two **key criteria** for assigning the correct LoF rank

2

LoF 4

Macrofouling from 16% to 40% cover

3

This area represents a **section of hull** showing the amount of fouling indicative of each LoF rank

More than half of the space has no macrofouling

A range of species within biofouling

4

A propeller also shows an indicative amount of fouling characteristic of each LoF rank on an example **niche area**

5

A photo provides an example of what each LoF looks like underwater

Extensive biofouling usually on both hull surfaces and niche areas

6

A boat hull provides an example of what a '**whole boat**' LoF would look like if you could see it all at once

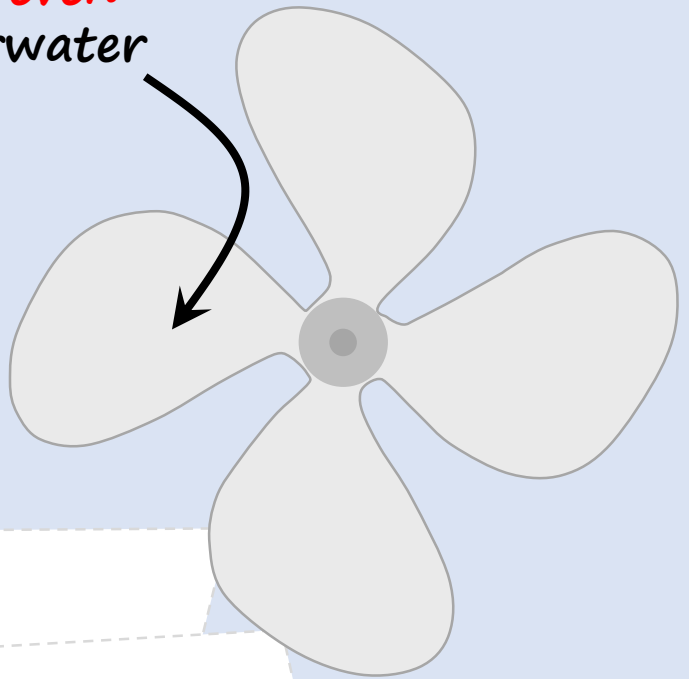
LoF 0

- Zero slime/biofilm
- Zero macrofouling

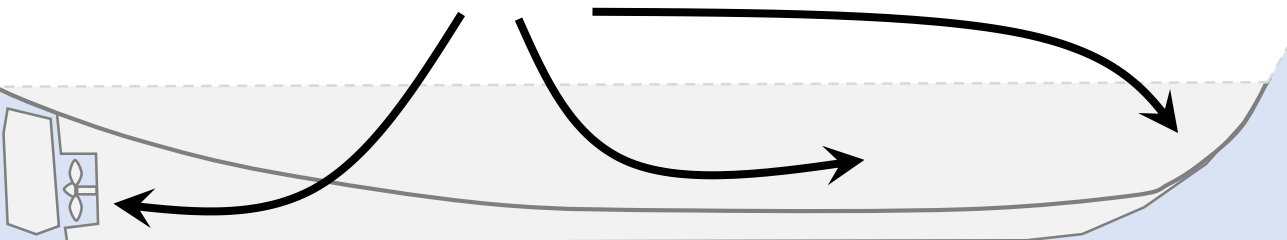


No fouling, **not even**
slime, on underwater
surfaces

Completely Clean

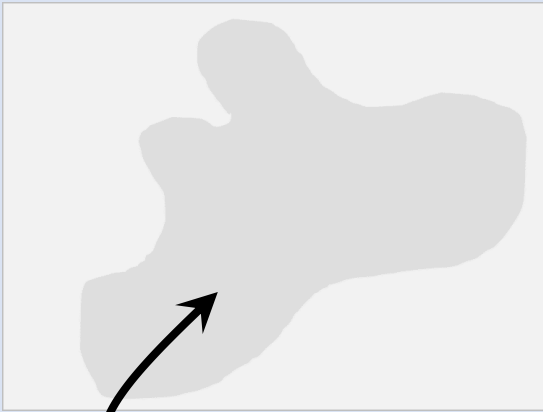


Submerged surfaces clear of
any fouling accumulation



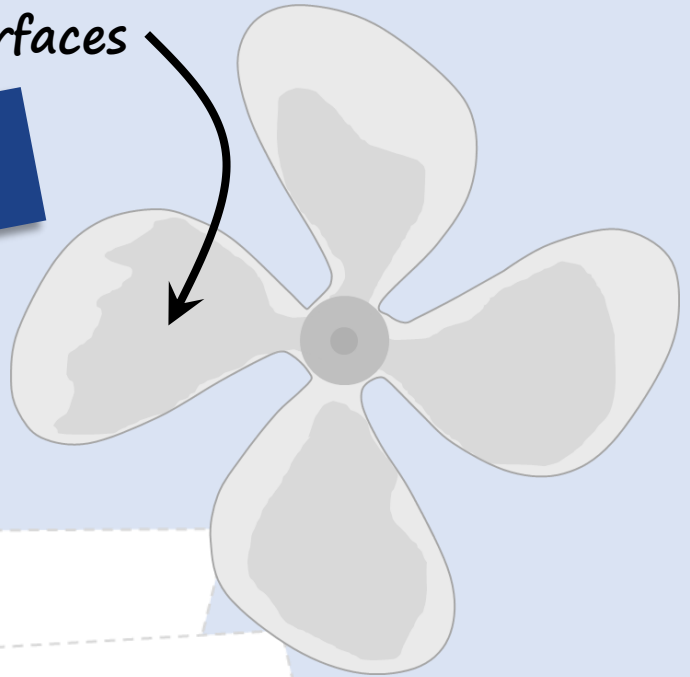
LoF 1

- Zero macrofouling
- **Slime layer / biofilm** present
- Amount of slime doesn't matter



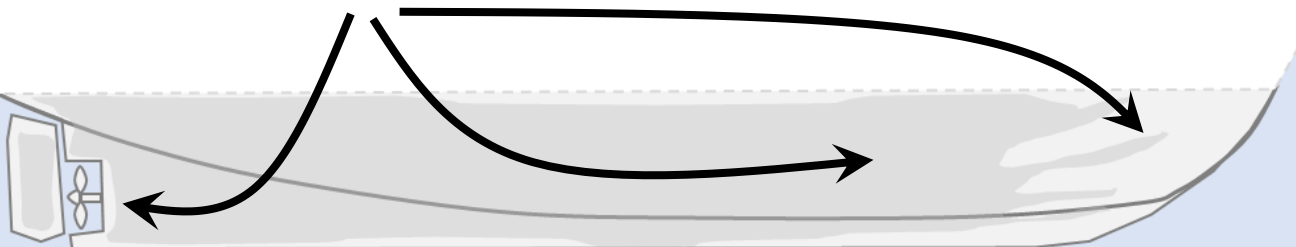
Slime on
underwater surfaces

You can 'write' with your
finger through the slime



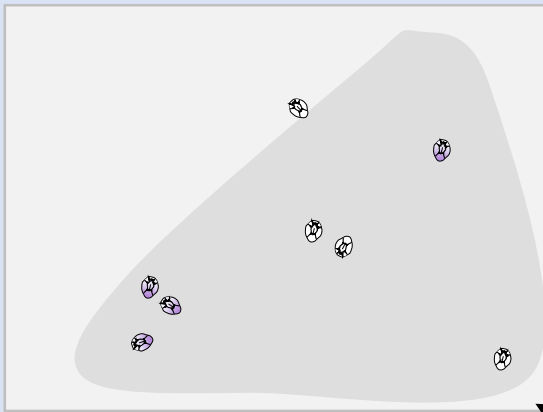
Hull with patches or
completely covered
in slime

Slime can be made
of **tiny filaments**
and **flat film**



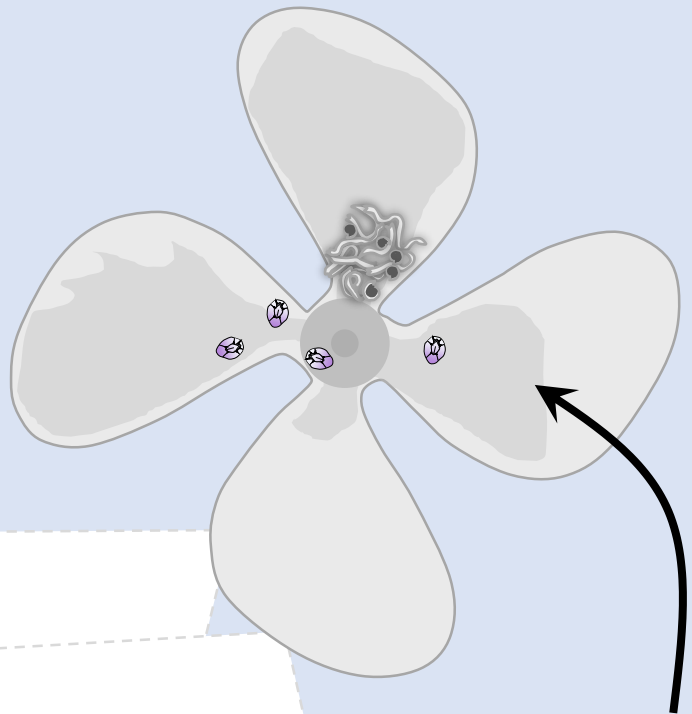
LoF 2

- **Macrofouling** present
- Macrofouling up **to 5% cover**



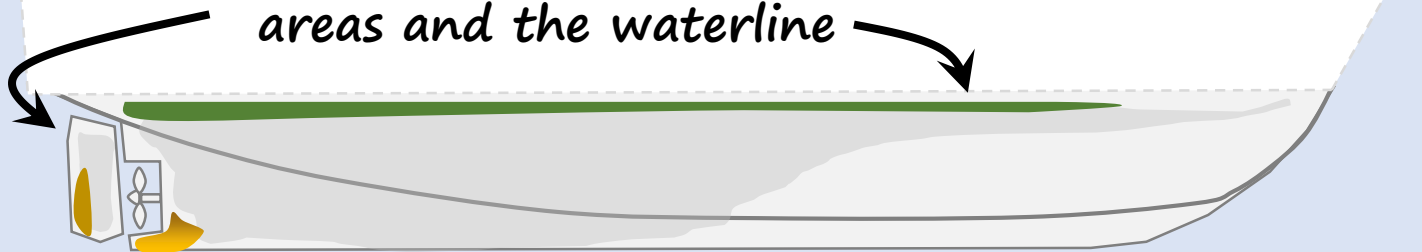
These barnacles occupy **1%** cover

Usually not many species in fouling



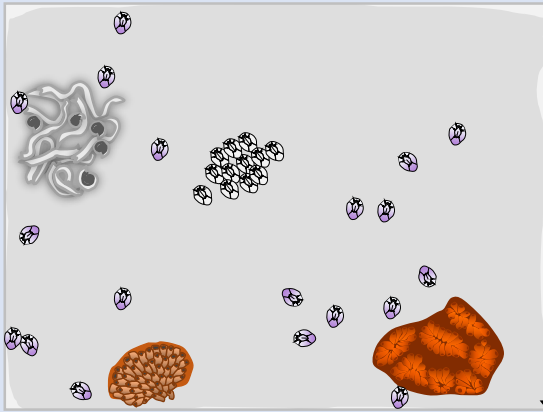
Amount of slime doesn't matter

Patchy cover of biofouling, often on niche areas and the waterline



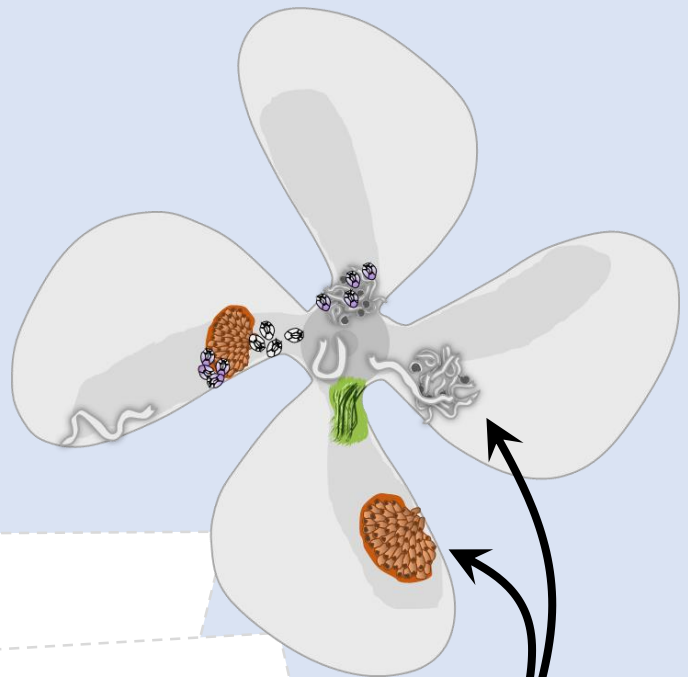
LoF 3

**Macrofouling from
6 to 15% cover**

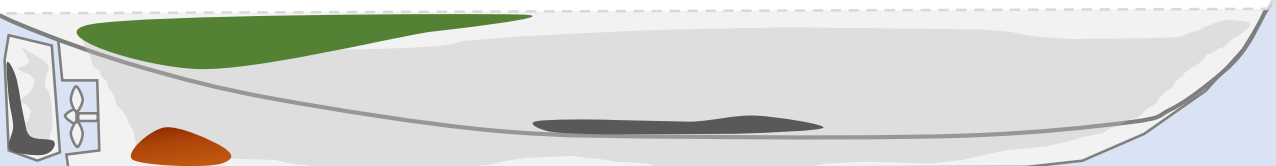


This biofouling occupies **12%** cover

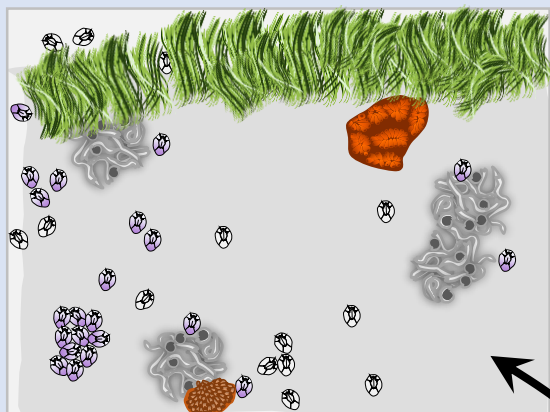
Considerable biofouling,
usually on niche areas



Biofouling often consists of several species, but the number of species doesn't matter to correctly apply LoF rank

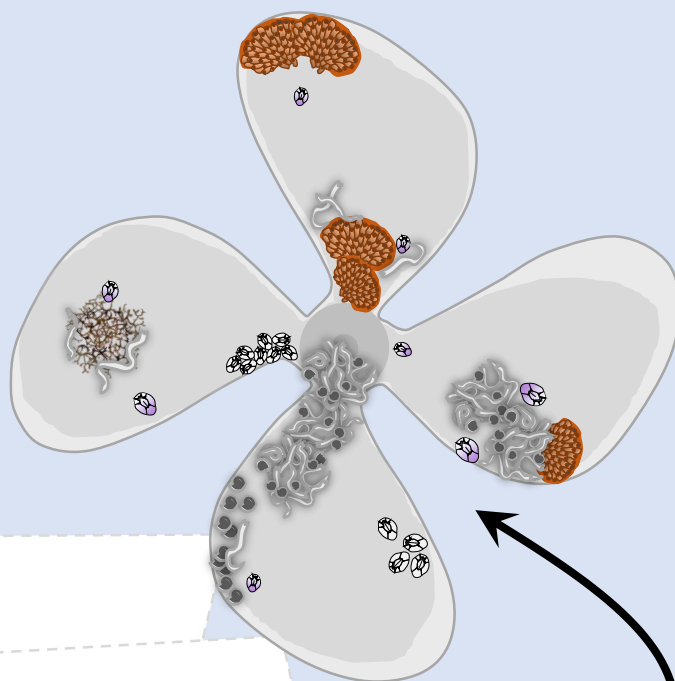


LoF 4

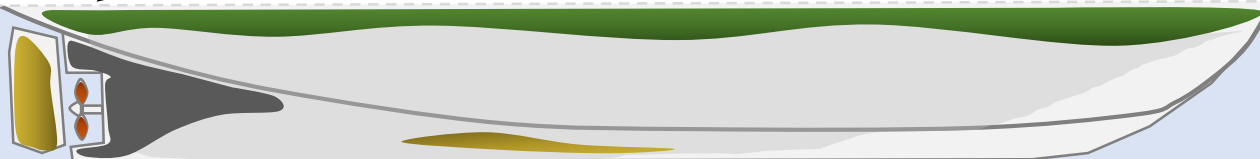


More than half of
the space has no
macrofouling

A range of species
within the biofouling

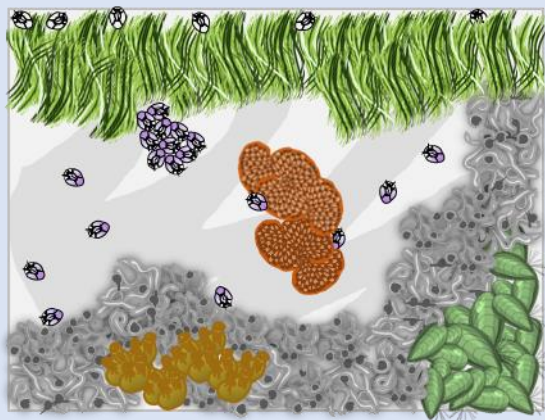


Extensive biofouling usually on both hull
surfaces and niche areas



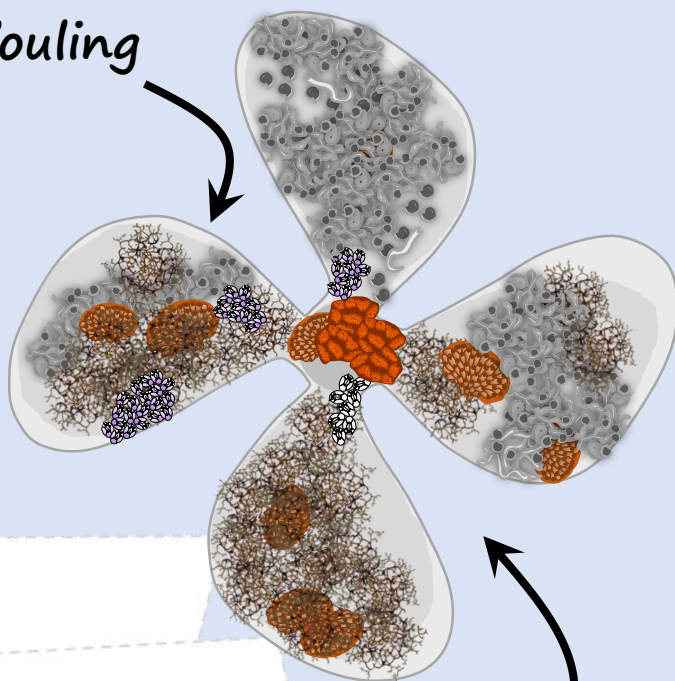
LoF 5

**Macrofouling from
41 to 100% cover**

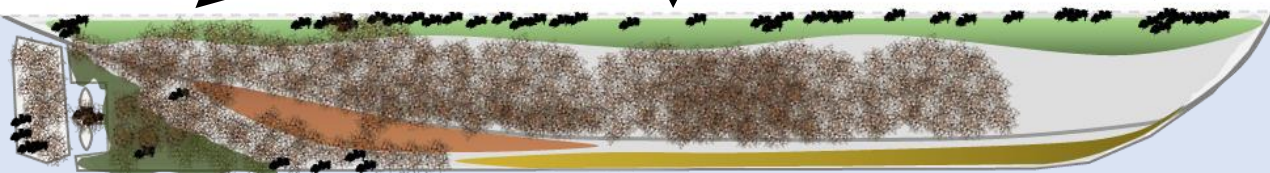


Very heavy biofouling

Usually many species

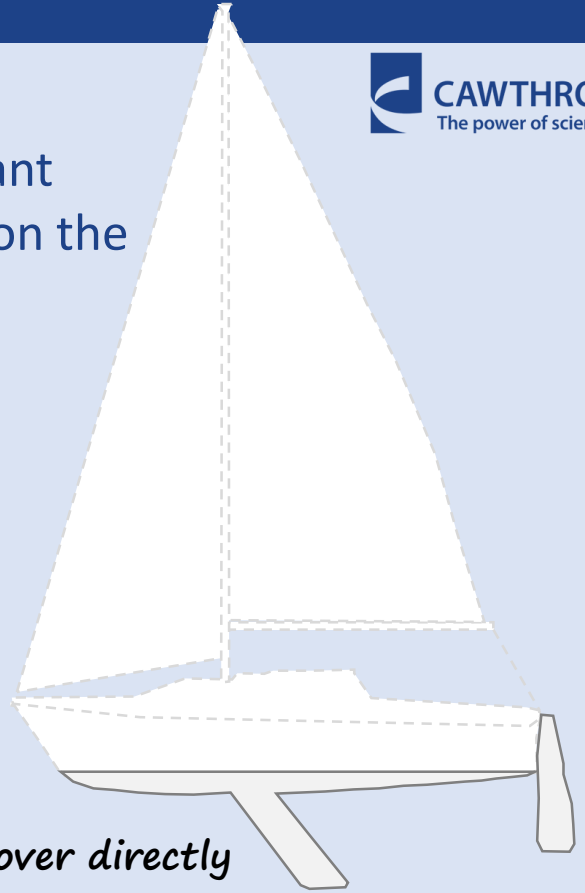


*Niche areas and hull surfaces have
substantial cover of macrofouling*

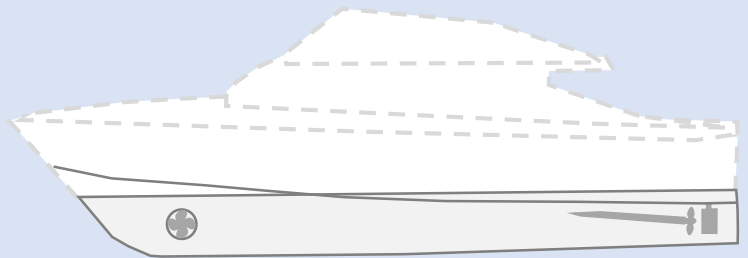
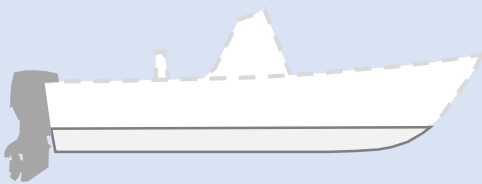


Hull configurations

Boats vary in size, hull shape, and complexity. This can be an important driver of biofouling accumulation on the submerged surfaces of vessels.



For LoF applications, it is important to relate your estimates of biofouling cover directly to your field of view (visible surface area). It is useful to record size estimates for each visible surface area evaluated. Niche areas have complex shapes and dimensions that should also be considered when assigning LoF scores.



Vessel niche areas

Biofouling is often distributed unevenly on vessel submerged surfaces. Niche areas – including rudders, propellers, thrusters, struts, and grates – typically accumulate biofouling before hull surfaces. But not always.

Species and patterns

The LoF system does not rely on knowledge of species identity and composition of biofouling. This is a major benefit of the system because it can be **broadly and consistently applied** while retaining **biological insight**.



Primary



Secondary



Tertiary

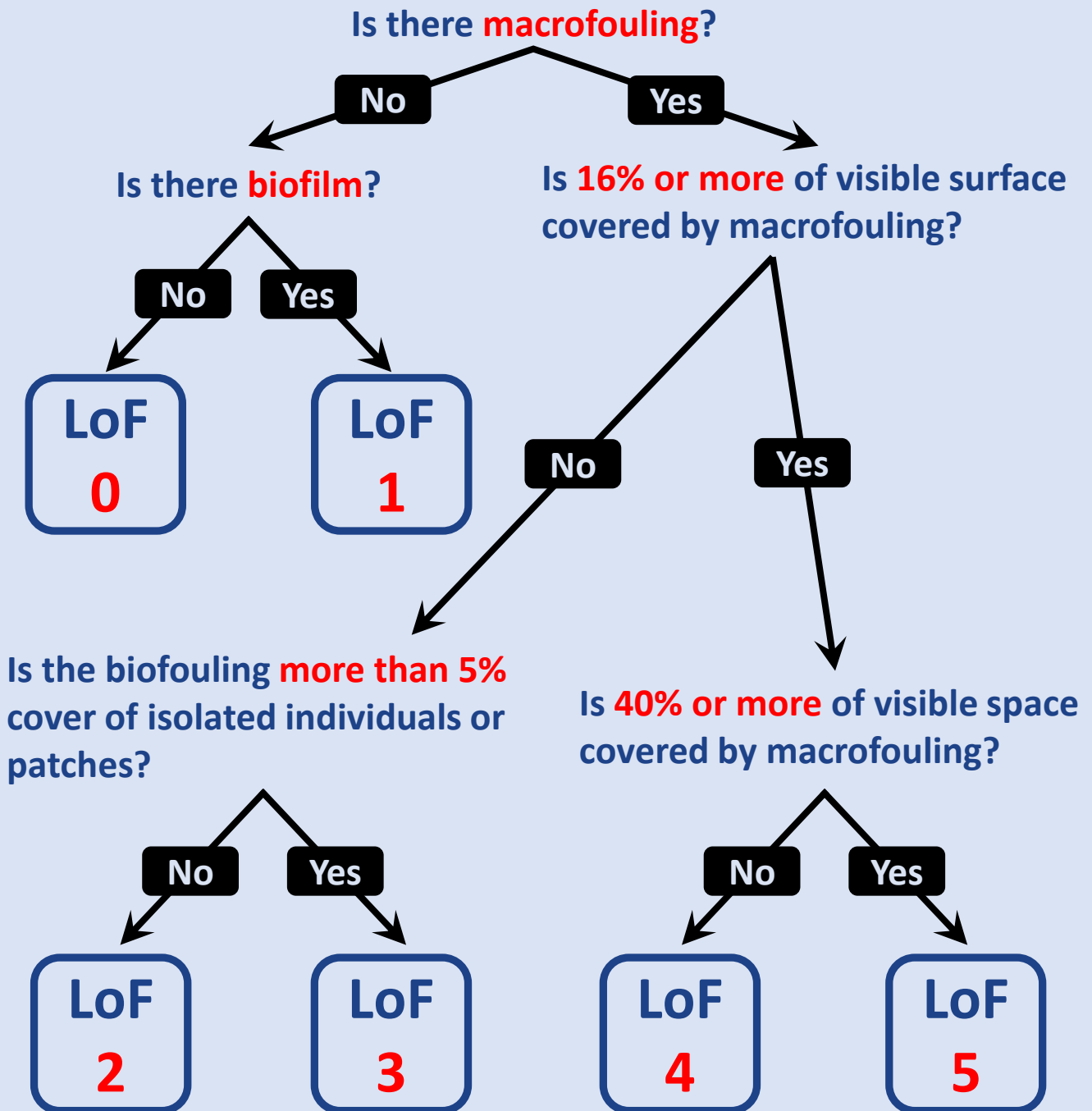
Biofouling accumulates to surfaces in broadly predictable ways: beginning with a biofilm (slime) and filamentous green algae (primary); followed by barnacles, tubeworms, and bryozoans (secondary); and subsequently a well-developed community of many species including sea squirts, sponges, and mobile species (tertiary). These can often align with LoF ranks, from low to high.

However

Species richness or composition does not always correlate with percent cover. **In the LoF system, percent cover is the key criterion.** A single species can produce a ranking of LoF 5, suggesting some problems with the biosecurity of the vessel maintenance regime.



LoF Cheat Sheet





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Citation

Davidson I, Floerl O, Fletcher L, Cahill P (2019). Level of Fouling rank scale - an updated guideline. Prepared for Auckland Council, Auckland, New Zealand. 14pp.

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