

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

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 macrofouling 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

3

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

5

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

LoF 4

Macrofouling from 16% to 40% cover

4

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

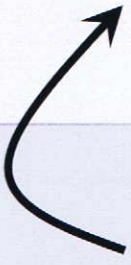
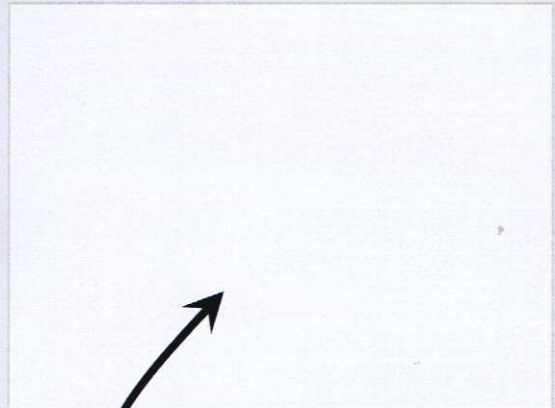
6

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



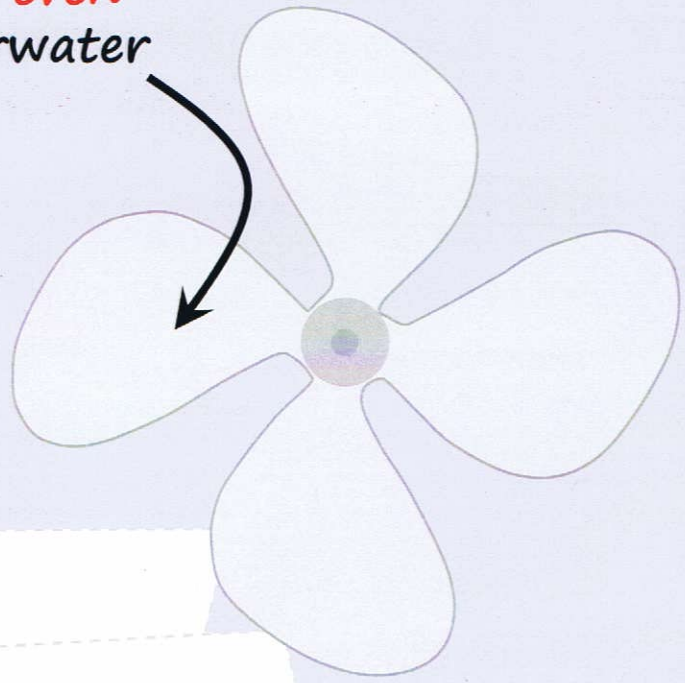
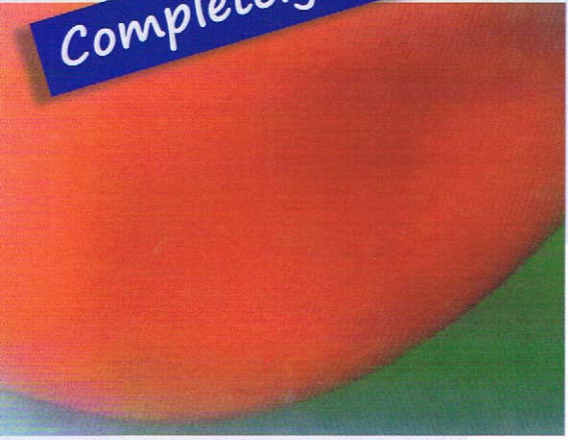
LoF 0

- Zero slime/biofilm
- Zero macrofouling

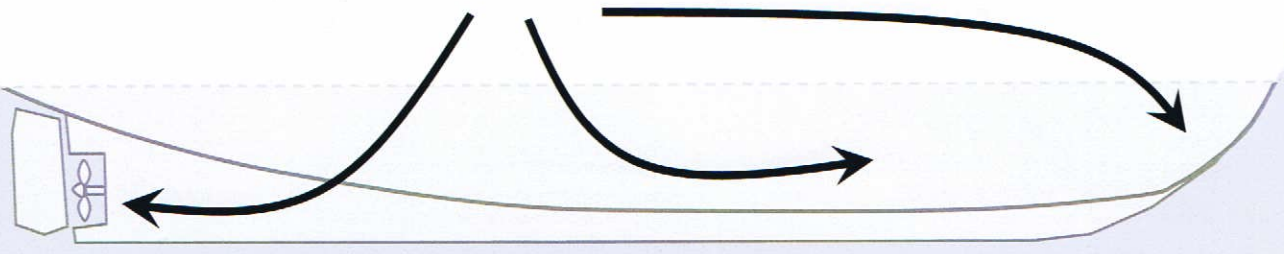


No fouling, **not even slime**, on underwater surfaces

Completely Clean

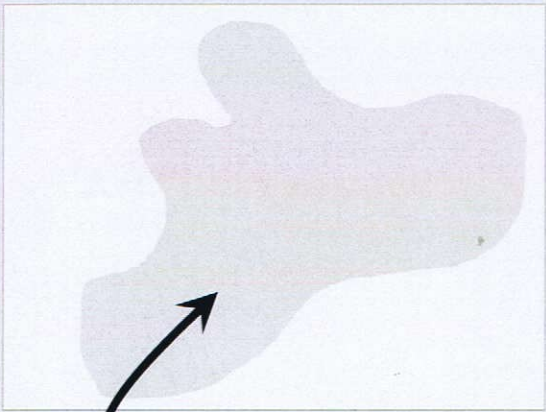


Submerged surfaces clear of any fouling accumulation



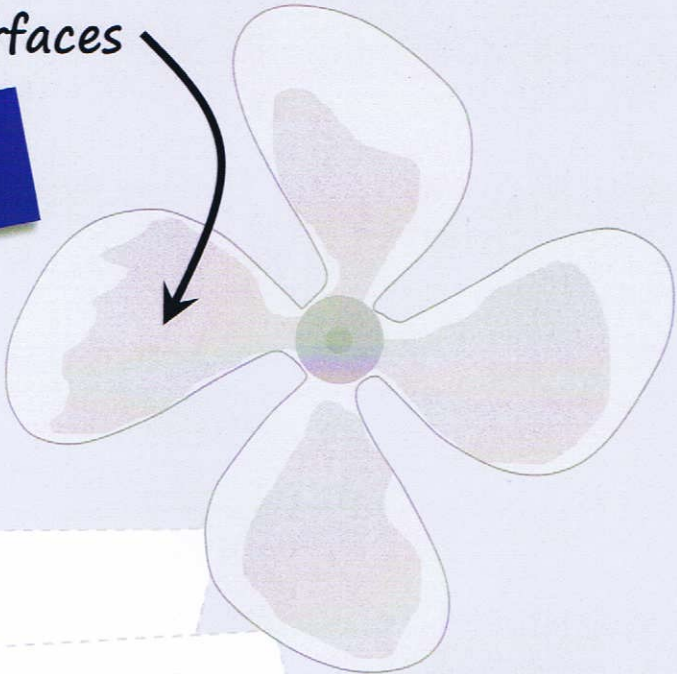
LoF 1

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



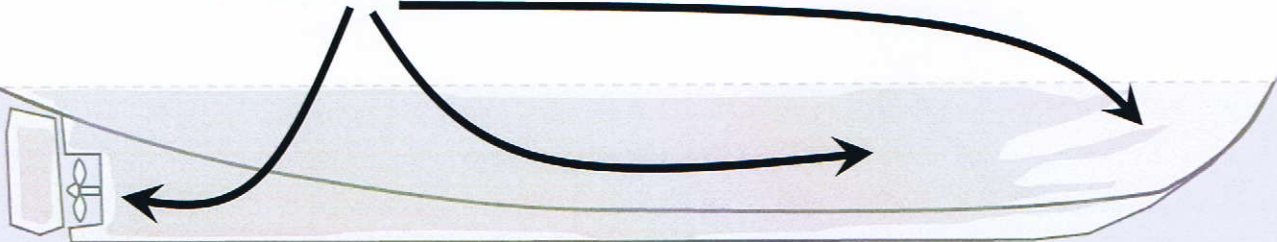
Slime on underwater surfaces

You can 'write' with your finger through the slime

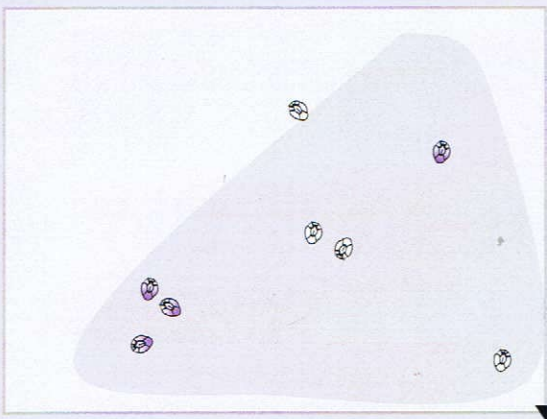


Hull with patches or completely covered in slime

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



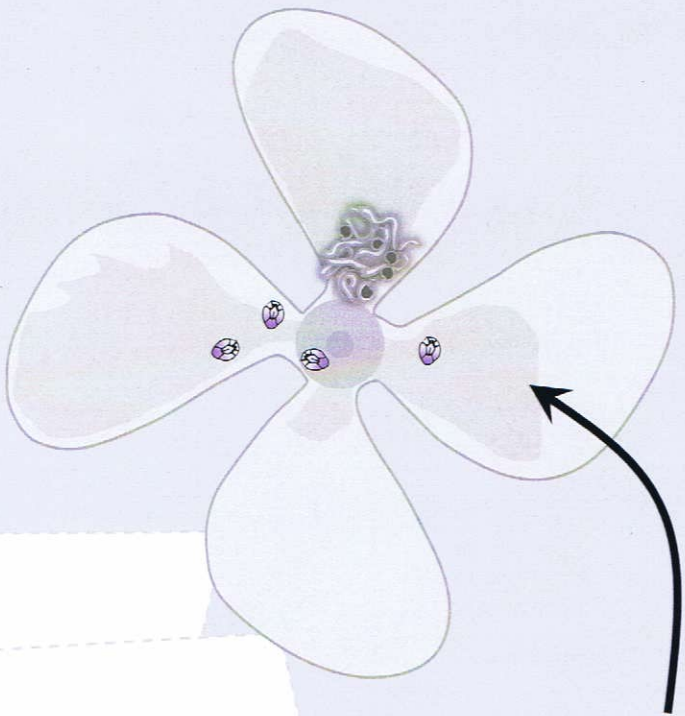
LoF 2



These barnacles occupy **1%** cover

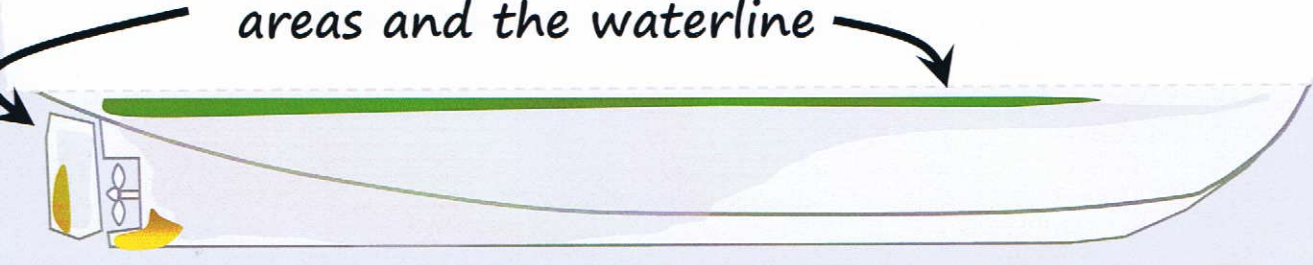
- **Macrofouling present**
- **Macrofouling up to 5% cover**

Usually not many species in fouling

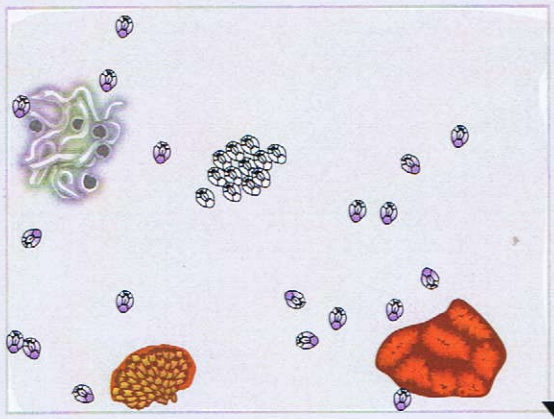


Amount of slime doesn't matter

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



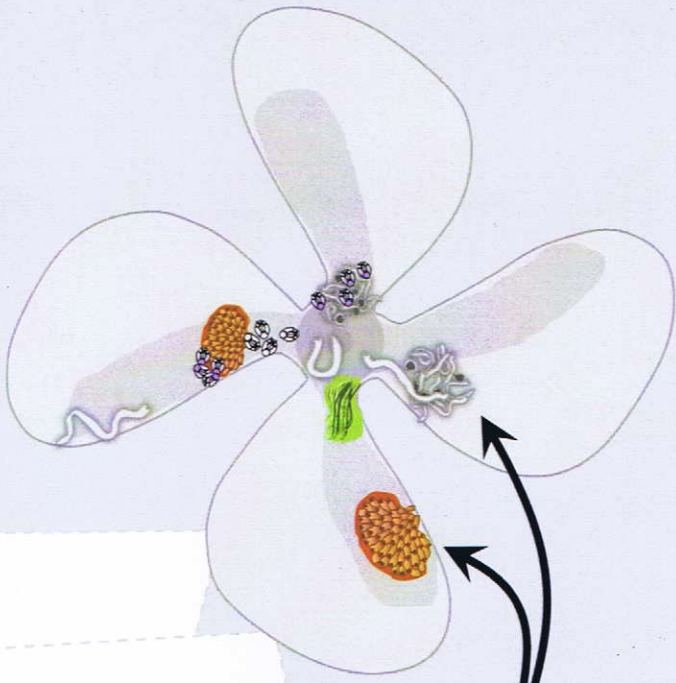
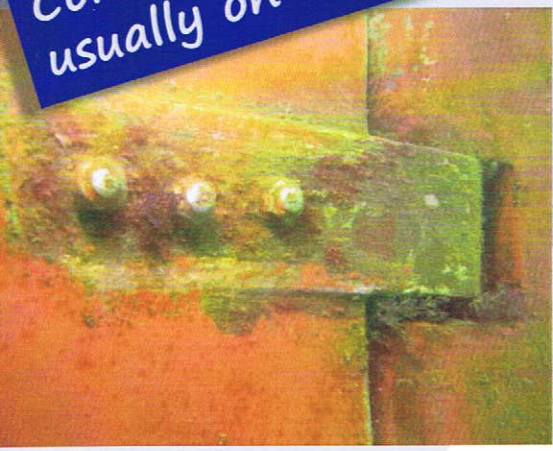
LoF 3



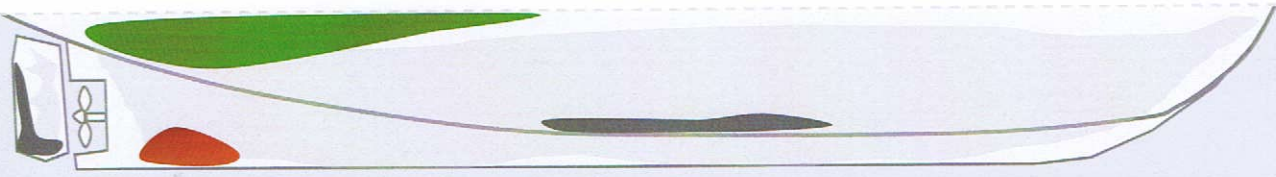
**Macrofouling from
6 to 15% cover**

This biofouling occupies **12%** cover

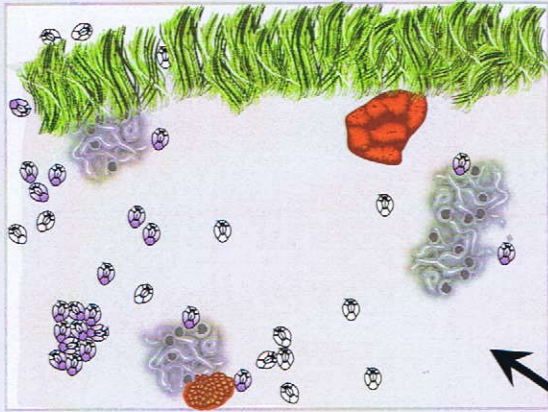
**Considerable biofouling,
usually on niche areas**



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

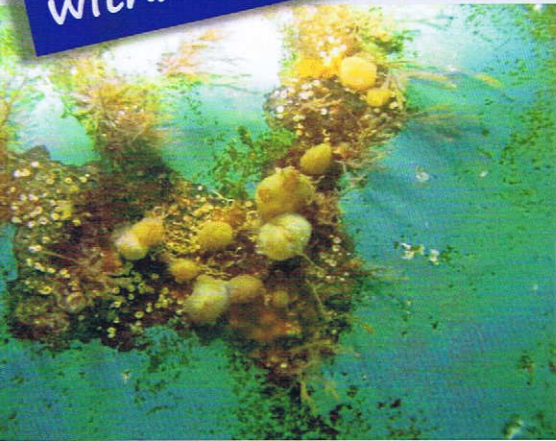


LoF 4

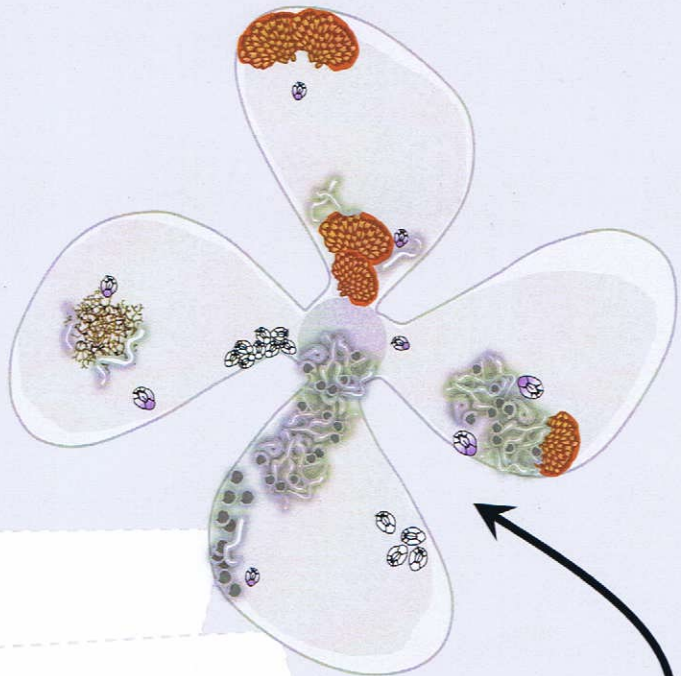


More than half of the space has no macrofouling

A range of species within the biofouling



Macrofouling from 16 to 40% cover

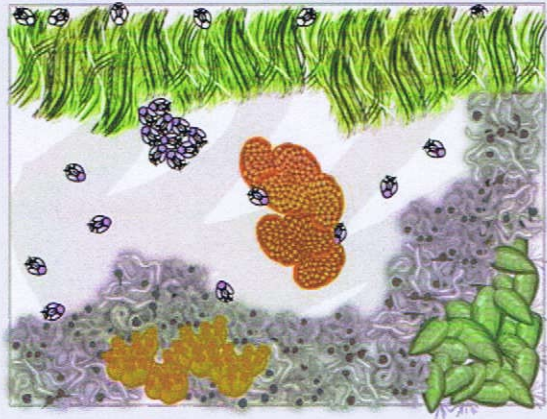


Extensive biofouling usually on both hull surfaces and niche areas



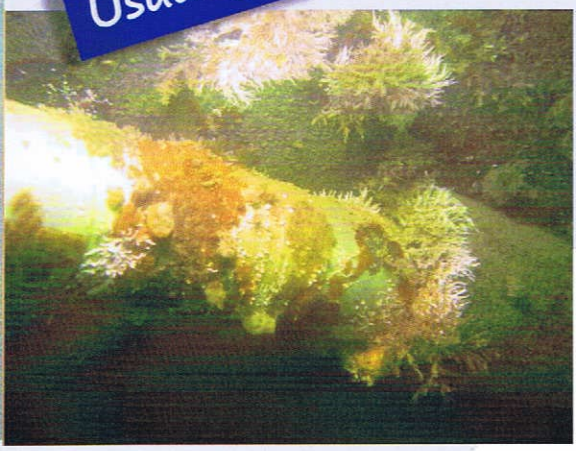
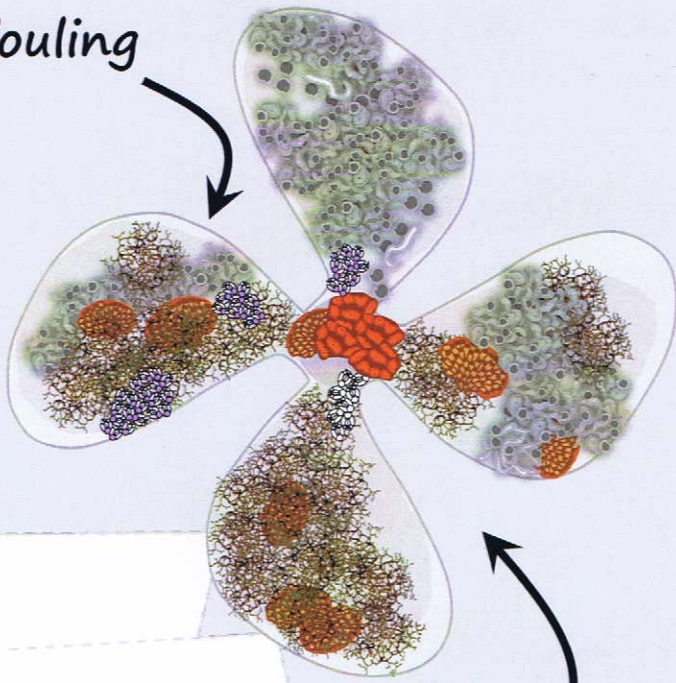
LoF 5

Macrofouling from 41 to 100% cover

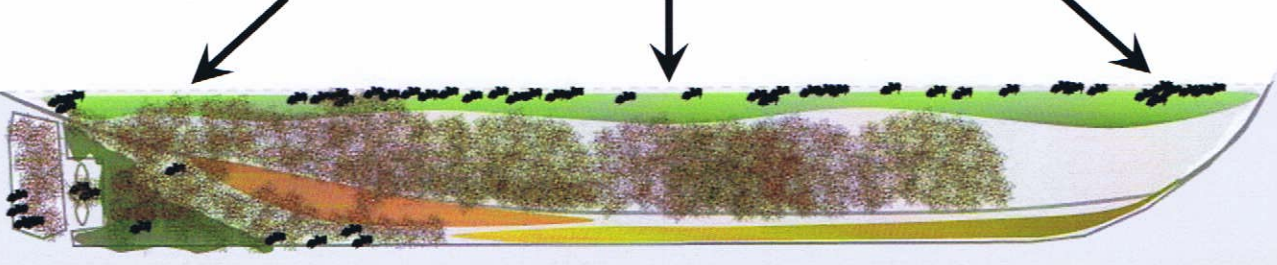


Very heavy biofouling

Usually many species



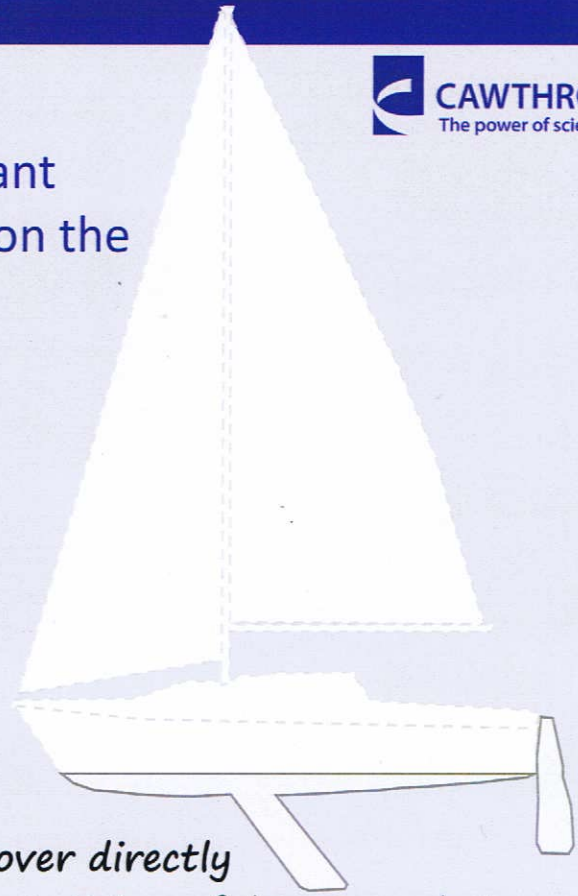
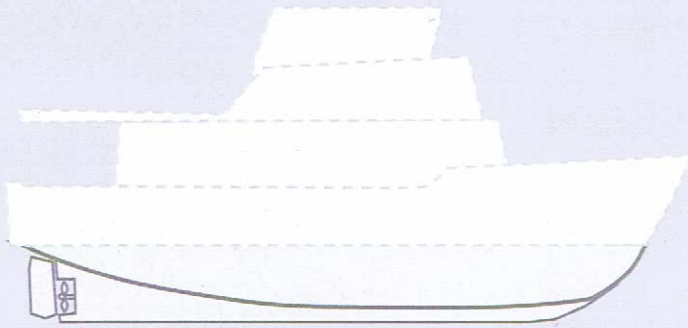
Niche areas and hull surfaces have substantial cover of macrofouling



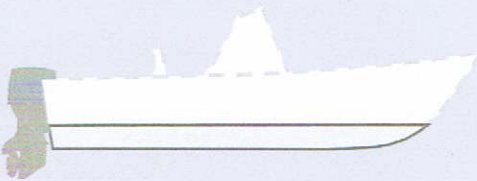
Hull configurations



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

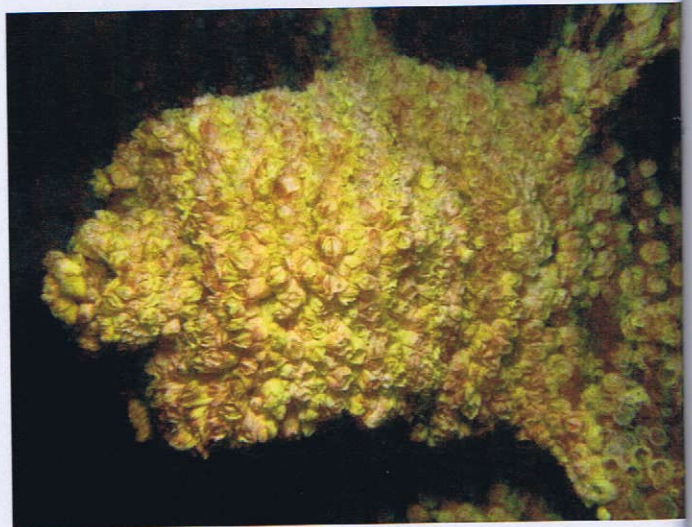


Tertiary

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

Is there **macrofouling**?

No

Yes

Is there **biofilm**?

No

Yes

LoF

0

LoF

1

Is **16% or more** of visible surface covered by macrofouling?

No

Yes

Is the biofouling **more than 5%** cover of isolated individuals or patches?

No

Yes

LoF

2

LoF

3

Is **40% or more** of visible space covered by macrofouling?

No

Yes

LoF

4

LoF

5

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. 15pp.





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Level of Fouling rank scale - an updated guideline

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