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Biofouling Organisms Observed

The scheduled grooming occurring only on the front, which by orientation from being suspended off the pier and restricted form rotating resulted in more direct and consistent sun exposure. Due to the shading effect, the back and edges of all plates experienced the biofouling pressure differently from that of the front. The combination of the shade and no grooming promoted a completely different array of organisms, to the point where the back and edges of all plates had to be scraped weekly once significant biofouling accumulated.

On the sun-side of Garolite plates that were subject to grooming, sampling, and imaging, the fouling community was soft for the first 5 weeks; consisting of green and brown algae, biofilm, and intermittent arborescent bryozoans. After 5 weeks, hard fouling appeared in the form of tubeworms and slipper snails. The sun-side of the Garolite control plates experienced the highest level of hard fouling in the form of bryozoans, slipper snails, tubeworms and mussels. Some of these organisms can be seen in Figure S1. Keeping the plates underwater allowed us to gently move the buoyant soft fouling aside to better investigate the community.

On the sun-side of all Intersleek plates, the fouling community was soft; consisting of green and brown algae, and noticeable biofilm where there was no algae attached. The biofouling on Intersleek also was visually less dense when compared to the Garolite counterparts of the same grooming frequency, demonstrating the effectiveness of the slime release coating. The Intersleek control did have the most biofoul coverage when compared visually to any of the groomed Intersleek but was still visually less fouled than the Garolite control.

To mitigate the possibility of a shading bias on the front of plates from the pilings and pier structure itself, the locations of every set of plates were shifted away from the coast during every grooming day (M, W, F) since the beginning of the field study. This was conveniently and quickly accomplished using threaded connecting links made from stainless steel installed on the ropes to detach and re-secure the individual submersible frames. All of these types of interactions with the plates were completed as much as possible in submerged conditions with the help of multiple ocean water filled totes. The grooming test tank was set up in a shack at the deployment dock that provided protection from the elements, such as sun and rain.

The observed organisms that established themselves on all the exposed surfaces of the plate (which comprises of the sun-side, edges, and back) is in agreement to what Menesees et al. (2017) observed on Garolite plates that were free of any coating. The plates in that study were 15.2 by 22.9 cm and suspended at a 22.5° angle from the vertical to both mimic the non-vertical portion of a hull and ensure continuously generated wall shear stress created by the bubbles as they rose along the Garolite surface. The single stream of bubbles created a distinctly clean region. Moving away from the bubble stream, the fouling growth gradually increases.

Since the back and edges of each plate in the presented study did not experience any contactless grooming, substantial biofouling did build up, warranting removal during every biological sampling day (Thursday) starting at week 3. The method of carefully scraping with a small putty knife was accomplished by holding the plate only by the permanently mounted tab to maintain no physical contact to the front surface. The scraping allowed the plates to fit into the chlorophyll a sampling device while maintaining no direct contact with the front surface other than the o-ring that created a seal for the sampling well as described in more detail in Figure S5. The scraping also prevented any biofouling that started on the edges or back of the plate from influencing or encroaching onto the front surface. Based on visual observations that occurred while handling plates, the same variety and rate of biofouling was observed on the back surface of all plates, which was expected since the Intersleek plates had the slime release coating only on the front surface, leaving the back surface in original
Garolite condition. Thus, the edges and back of all 40 plates in this study had the same surface type and same level of light exposure.

**Figure S1.** The front (top) and back (bottom) of the Garolite control plates at day 43 of the field test study. The box shows a close up picture of the area when submerged to better show the mussel that is attached. The top also shows circular areas that were used for sampling for chl $a$. Since the front of the plates had a significant amount of biomass by day 35, the sampling device could not maintain a seal for the circular well even if there were no hard fouling in the way. The samples for that day was taken with a sterilized cell lifter, the most noticeable resulting patch being on the front of the second plate from the left.
Figure S2. The back of the control set of Garolite plates installed in its submersible frame is shown, revealing a variety of macrofouling at day 51 which is after the end of the 7 week study. The last extensive scraping of the back happened 2 weeks prior.
Image Setup and Collection
Four 10.2 × 10.2 cm plates were lined up in order and secured flush to a grooming frame. To begin assembly, the grooming frame was positioned upside down on spacers in the corners to prevent the sample plates from coming into contact with anything on the front surface (sun-side). Touching was strictly on the tabs and the back surface (shade-side) if needed to ensure flushness. A set of four duplicate plates was labeled on the back with frequency and duplicate number. They were consistently placed in decreasing order (Figure S3a) so that when the grooming frame was flipped over, they were in increasing order. Figure S3b shows the flush side that was exposed to contactless grooming via shear stress. The pink foam visible in Figure S3a was attached to achieve neutral buoyancy of the assembled grooming frame when submerged in the grooming tank. The fasteners were permanently mounted to the frame. On the other side of the grooming frame, the screws acted like a fixture to mount the plates consistently.

Figure S3. Photos taken of the back after installation (a) and front (b) of the grooming frame after a group of 4 duplicate plates were installed. A paper note was used to document the details and time of what was photographed.
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In the tables S2 through S11; the images are arranged in pairs where the top picture is the ‘before’, while the bottom is the ‘after’ as seen in Figure S4. In the subsequent pages, note that position [4] was left untouched for image processing, while positions [1,2,3] are the plates reserved for biological sampling where little circles free from biofouling were the result of sample collection as described in the main paper. Table S1 provides a more detailed explanation of the format and organization of the image collection.

![Table S1](attachment:TableS1.png)

**Figure S4.** Illustration of the location of each of the 4 replicate plates and how the group looked before and after scheduled grooming on that day in the proceeding table. The only exceptions are the control plate photos, where there was no contactless grooming preformed.

**Table S1.** Detailed legend for the following tables displaying all photos used in image analysis. The field study was initiated on a Wednesday in order to consistently distribute the labor throughout the week.
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**Table S2.** Contactless grooming on Garolite at a frequency of 3×/week.

| Week | Day     | 3× Garolite |
|------|---------|-------------|
| W,   | 6-12    | submerged   |
| F,   | 6-14    |             |
| 1    |         |             |
| M,   | 6-17    |             |
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| Week | Day | 3x Garolite (Continued) |
|------|-----|-------------------------|
| W, 6-19 | | |
| 2 | F, 6-21 | |
| M, 6-24 | | |
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| Week | Day     | 3× Garolite (Continued) |
|------|---------|-------------------------|
| W,   | 6-26    |                         |
| 3    | F, 6-28 |                         |
| M,   | 7-1     |                         |
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| Week | Day | 3x Garolite (Continued) |
|------|-----|-------------------------|
| W, 7-3 |     | ![Image](image1.png) |
| F, 7-5 |     | ![Image](image2.png) |
| M, 7-8 |     | ![Image](image3.png) |
| Week | Day  | 3× Garolite (Continued) |
|------|------|-------------------------|
|      |      | W, 7-10                 |
|      |      | F, 7-12                 |
|      |      | M, 7-15                 |
| Week | Day  | 3× Garolite (Continued) |
|------|------|-------------------------|
| W,   | 7-17 | ![Image](image1.png)    |
| 6    | F,   | ![Image](image2.png)    |
|      | 7-19 | ![Image](image3.png)    |
|      | M,   | ![Image](image4.png)    |
|      | 7-22 | ![Image](image5.png)    |
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| Week | Day | 3× Garolite (Continued) |
|------|-----|-------------------------|
| W, 7-24 | | ![Image](image1.png) |
| 7 | F, 7-26 | ![Image](image2.png) |
| | M, 7-29 | ![Image](image3.png) |
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Table S3. Contactless grooming on Garolite at a frequency of 2×/week.

| Week | Day   | 2× Garolite |
|------|-------|-------------|
|      | W, 6-12 submerged |             |
| 1    | F, 6-14 |             |
|      | M, 6-17 |             |
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| Week | Day | 2× Garolite (Continued) |
|------|-----|-------------------------|
| 2    | F, 6-21 | ![Image of Garolite panel after 2× treatment on a female day, 6-21] |
|      | M, 6-24 | ![Image of Garolite panel after 2× treatment on a male day, 6-24] |
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| Week | Day | 2× Garolite (Continued) |
|------|-----|-------------------------|
| 3    | F, 6-28 | ![Image](image1.png) |
|      | M, 7-1  | ![Image](image2.png) |
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| Week | Day  |
|------|------|
|      | F, 7-5 |
| 4    |      |
|      | M, 7-8 |

2× Garolite (Continued)
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| Week | Day   | 2x Garolite (Continued) |
|------|-------|-------------------------|
|      | F, 7-12 |                         |
| 5    |       |                         |
|      | M, 7-15 |                         |
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| Week | Day   | 2× Garolite (Continued) |
|------|-------|-------------------------|
|      | M, 7-22 |                          |
| 6    | F, 7-19 |                          |
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| Week | Day    | 2x Garolite (Continued) |
|------|--------|-------------------------|
| F    | 7-26   |                         |
| 7    |        |                         |
| M    | 7-29   |                         |
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**Table S4.** Contactless grooming on Garolite at a frequency of 1×/week.

| Week | Day    | 1× Garolite               |
|------|--------|---------------------------|
| 1    | W, 6-12| submerged                 |
| 2    | W, 6-19|                           |
| 3    | W, 6-26|                           |
| 4    | W, 7-3 |                           |
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| Week | Day | 1× Garolite (Continued) |
|------|-----|-------------------------|
| 5    | W, 7-10 | ![Image](image1.png) |
| 6    | W, 7-17 | ![Image](image2.png) |
| 7    | W, 7-24 | ![Image](image3.png) |
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Table S5. Contactless grooming on Garolite at a frequency of 0.5x/week.

| Week | Day     | 0.5x Garolite               |
|------|---------|-----------------------------|
| 1    | W, 6-12 | submerged                   |
| 3    | W, 6-26 |                             |
| 5    | W, 7-10 |                             |
| 7    | W, 7-24 |                             |
Table S6. The Control Garolite plates did not experience contactless grooming.

| Week | Day     | Control Garolite |
|------|---------|------------------|
| 1    | W, 6-12 | submerged        |
| 4    | Th, 7-4 |                  |
| 5    | Th, 7-11|                  |
| 6    | Th, 7-18|                  |
| 7    | Th, 7-25|                  |
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Table S7. Contactless grooming on Intersleek at a frequency of 3x/week.

| Week | Day | 3x Intersleek |
|------|-----|---------------|
| W, 6-12 | | submerged |
| F, 6-14 | | |
| M, 6-17 | | |
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| Week | Day | 3× Intersleek (Continued) |
|------|-----|---------------------------|
| W, 6-19 | | |
| F, 6-21 | | |
| M, 6-24 | | |
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| Week | Day  | 3× Intersleek (Continued) |
|------|------|---------------------------|
| W,  | 6-26 |                           |
| 3   | F,  | 6-28                      |
| M,  | 7-1  |                           |
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| Week | Day | 3× Intersleek (Continued) |
|------|-----|---------------------------|
| W,   | 7-3 |                           |
| 4    | F,  |                           |
|      | 7-5 |                           |
| M,   | 7-8 |                           |
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| Week | Day | 3× Intersleek (Continued) |
|------|-----|---------------------------|
| W, 7-10 |     |                           |
| F, 7-12 |     |                           |
| M, 7-15 |     |                           |
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| Week | Day | 3x Intersleek (Continued) |
|------|-----|---------------------------|
| W, 7-17 | 6 | F, 7-19 |
| 7-17 | 7-19 | M, 7-22 |
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| Week | Day | 3x Intersleek (Continued) |
|------|-----|---------------------------|
| W, 7-24 | | |
| 7 | F, 7-26 | |
| M, 7-29 | | |
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Table S8. Contactless grooming on Intersleek at a frequency of 2×/week.

| Week | Day    | 2× Intersleek          |
|------|--------|------------------------|
|      |        | submerged              |
| 1    | W, 6-12|                        |
|      | F, 6-14|                        |
|      | M, 6-17|                        |
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| Week | Day       | 2× Intersleek (Continued) |
|------|-----------|---------------------------|
|      |           |                           |
| 2    | F, 6-21   |                           |
|      |           |                           |
| 2    | M, 6-24   |                           |
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| Week | Day | 2× Intersleek (Continued) |
|------|-----|--------------------------|
| 3    | F, 6-28 | ![Image](image1.png) |
|      | M, 7-1 | ![Image](image2.png) |
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| Week | Day  | 2× Intersleek (Continued) |
|------|------|---------------------------|
|      |      |                           |
| 4    | F, 7-5 |                           |
|      | M, 7-8 |                           |
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| Week | Day   | 2× Intersleek (Continued) |
|------|-------|---------------------------|
| 5    | F, 7-12 |                           |
|      | M, 7-15 |                           |
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| Week | Day     | 2× Intersleek (Continued) |
|------|---------|---------------------------|
| F, 7-19 | 6     |                            |
| M, 7-22 |       |                            |
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| Week | Day   | 2× Intersleek (Continued) |
|------|-------|---------------------------|
|      | F, 7-26 |                           |
| 7    | M, 7-29 |                           |
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Table S9. Contactless grooming on Intersleek at a frequency of 1×/week.

| Week | Day       | 1× Intersleek                     |
|------|-----------|-----------------------------------|
| 1    | W, 6-12   | submerged                         |
| 2    | W, 6-19   |                                   |
| 3    | W, 6-26   |                                   |
| 4    | W, 7-3    |                                   |
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| Week | Day  | 1x Intersleek (Continued) |
|------|------|---------------------------|
| 5    | W, 7-10 | ![Image](image1.png) |
| 6    | W, 7-17 | ![Image](image2.png) |
| 7    | W, 7-24 | ![Image](image3.png) |
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Table S10. Contactless grooming on Intersleek at a frequency of 0.5×/week.

| Week | Day     | 0.5× Intersleek |
|------|---------|-----------------|
| 1    | W, 6-12 | submerged       |
| 3    | W, 6-26 |                 |
| 5    | W, 7-10 |                 |
| 7    | W, 7-24 |                 |
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Table S11. The Control Intersleek plates did not experience contactless.

| Week | Day   | Control Intersleek |
|------|-------|---------------------|
| 1    | W, 6-12 | submerged           |
| 4    | Th, 7-4 |                     |
| 5    | Th, 7-11|                     |
| 6    | Th, 7-18|                     |
| 7*   | M, 7-29|                     |

*Only the Intersleek control was groomed at the end of the study because the fouling appeared to be all soft. Foul release coatings such as Intersleek SR1100 are designed to keep the adhesion strength weak in order for biofouling to be pulled off from the shear stress that results in a vessel resuming underway operations after being idle. Contactless grooming in a way simulates this change in vessel operation. After applying the image-processing algorithm, this pair of photos are now a data point that could be considered a frequency of 0.14x/week.
Additional Chlorophyll a Collection Detail and Data

The sampling device was 3D printed out of PLA filament into two separate parts; the top piece printed in black and the bottom piece printed in grey as shown in Figure S4(a). The complete assembly included two adjustable steel “Hold-Down Toggle Clamps” installed on the bottom piece and a single “Oil-Resistant Buna-N O-Rings” press fitted into one of the eight shallow cylindrical cavities. No additional o-rings were installed to prevent contact on any area that is not scheduled to be sampled. Only the edges and back experienced contact during the handling and sampling procedure.

Figure S5. The sampling device was sanitized in between plate sampling with isopropyl alcohol. (a) A plate slides into a slot designed into the bottom piece. Contact on the front plate was avoided by holding only the permanently installed tab. The top piece was carefully set down on the plate with the well containing the single o-ring targeted on the area not yet sampled. Engaging the clamp compresses the o-ring to create a leak-proof seal. The plastic top piece was constrained from ever coming into contact with the plate by resting completely on the flat face of the bottom piece of the sampling device. (b) 1 mL of 0.2 µm-filtered seawater was added to the well. (c) An overhead view in to show the water sitting in the sealed well. (d) The biofouling in the well was scraped off with a sterile plastic pestle before collected with a pipette.
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For additional detail on Cohen’s $d$, the following two tables have been provided.

**Table S12.** Results of repeated measures ANOVA testing the effects of grooming on the concentration of chlorophyll $a$ in fouling material growing on Garolite and Intersleek plates.

| Plate type | Grooming Frequency | Time points considered | Time $F$ | Grooming $F$ (compared to Control) | Time × Grooming $F$ |
|------------|--------------------|------------------------|----------|-----------------------------------|---------------------|
| Garolite   | 3×                 | 37                     | 37.775***| 0.706                             | 4.079               |
|           |                    | 30                     | 42.559***| 26.255**                          | 6.377               |
|           | 2×                 | 37                     | 11.716*  | 2.702                             | 2.165               |
|           |                    | 30                     | 37.938** | 1.076                             | 0.254               |
|           | 1×                 | 37                     | 26.548** | 1.12                              | 3.838               |
|           |                    | 30                     | 35.906** | 4.109                             | 0.86                |
|           | 0.5×               | 30                     | 59.282** | 15.341*                           | 1.536               |
| Intersleek| 3×                 | 37                     | 28.512***| 19.787*                           | 16.927**            |
|           |                    | 30                     | 36.648***| 30.479**                          | 20.622**            |
|           | 2×                 | 37                     | 29.783***| 16.405*                           | 16.133***           |
|           |                    | 30                     | 38.292***| 28.019**                          | 18.706**            |
|           | 1×                 | 37                     | 27.955***| 21.128*                           | 15.36**             |
|           |                    | 30                     | 37.247   | 30.252**                          | 19.758**            |
|           | 0.5×               | 37                     | 11.789** | 6.17                              | 8.43**              |
|           |                    | 30                     | 35.23    | 26.289**                          | 20.758***           |

Values represent $F$ ratios.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$
Table S13. Effects of grooming on chlorophyll a on fouled plates. Values represent Cohen's $d$ estimates of effect size, a standardized mean difference between chl a on control and groomed plates across 3 replicate plates each. Cohen’s d values < 0 imply decreased chl a on groomed plates. Cohen’s d > 0 implies increased chl a on groomed plates.

| Plate Type | Grooming frequency | Days post-deployment |
|------------|--------------------|----------------------|
|            |                    | 9        | 16      | 23      | 30      | 37      |
| Garolite   | 0.5x/week          | 2.23     | -0.54   | -1.89   | -1.14   | a       |
|           | 1x/week            | 0.54     | -0.99   | -1.96   | -0.80   | 1.60    |
|           | 2x/week            | -2.63    | -4.00   | 1.22    | 0.23    | 1.28    |
|           | 3x/week            | -3.80    | -5.37   | -1.74   | -2.77   | 0.99    |
| Intersleek | 0.5x/week          | b        | -2.50   | -1.46   | -5.18   | 0.45    |
|           | 1x/week            | b        | -2.42   | -2.19   | -5.18   | -1.26   |
|           | 2x/week            | b        | -2.46   | -2.02   | -5.01   | -0.38   |
|           | 3x/week            | b        | -2.47   | -2.06   | -5.29   | -1.00   |

aBiofilm could not be sampled due to hard fouling
bCohen’s $d$ could not be calculated due to negligible chl a concentration and zero standard deviations.

References

Menesses M, Belden J, Dickenson N, Bird J. 2017. Measuring a critical stress for continuous prevention of marine biofouling accumulation with aeration. Biofouling, 33(9):703–711