**Supplementary material**

**Description of the particle-settling experiment**

Since breakdown of feces can influence their settling velocity (Perez *et al.*, 2014), we adapted the experiment performed in previous studies (Magill *et al.*, 2006; Cromey *et al.*, 2009; Perez *et al.*, 2014) to obtain freshly emitted fecal material in the same undamaged form in which it enters the environment. The experimental layout was composed of a cylindrical-conical tank 0.68 m3 in volume (Fig. 3) supplied with seawater filtered at 50 µm (27.1–27.8°C; 37.0 PSU). The conical section of the tank ended in a cylindrical drain (d = 0.16 m) connected directly to a square-section Plexiglas column (H = 1.10 m, internal width = 0.15 m). A funnel was placed between the tank and the top of the column to direct particles to the center of the column. Between experiments, the tank and column were thoroughly cleaned, and the volume of seawater replaced entirely to keep water clarity constant.

Fish were obtained from a captive broodstock (Ifremer, Experimental Aquaculture facilities, Le Robert, Martinique), acclimated in 10 m3 circular tanks for 1 month and fed commercial Nutrima® pellets (NUTRImarine 6.0 and 9.0 mm, 51% protein and 14% lipids). Fish in four size categories (mean weight, small: 648 g, medium: 1152 g, large: 1913 g, very large: 3155 g) were used in the experiment (n = 5, 3, 2 and 2 for small, medium, large and very large, respectively). Fish in each category were successively transferred into the tank 5 hours before the experiment.

Particles were filmed for 4 hours after the first emission of fecal particles using a GoPro® HERO4 Silver camera (1080 p, narrow angle, frame rate = 30 frames s-1) mounted on a tripod 30 cm from the column (pixel resolution = 200 µm) and illuminated by Bowens Esprit Gemini studio lighting. Settling was recorded over a 10 cm section whose center lay 30 cm from the top of the column and 50 cm from the bottom of the column to allow particles to reach terminal velocity and avoid velocity interference with the bottom. After filming, digital settling videos were cut into 15-min segments and selected randomly for analysis to ensure representative subsampling.

The same experimental setup (tank and column device) was used to measure settling velocities of a range of red drum commercial feed. NUTRImarine 1.2, 2.2, 3.2, 4.5, 6.0 and 9.0 mm pellets were individually dropped in the center of the tank and allowed to sink 20 cm in the column before being recorded over a descent of 40 cm. The same camera used in the feces-settling experiment was mounted on a tripod 80 cm from the column (pixel resolution = 900 µm).

Particle-tracking software based on the OPENCV library was used to determine the total number of particles observed, excluding those that touched the column. For each particle, individual positions were tracked, and settling velocity in the filmed section calculated from the time between the first and last detection.

All data were screened using R software (R Core Team, 2018) to remove analytical noise and outliers and to select only particles that were constantly tracked over a minimum distance of 5 cm for fecal particles or 20 cm for feed pellets. Particles were then randomly selected for analysis in each fish size category (n = 712) and feed-pellet category (n = 31). Since residuals of fecal and pellet particle-settling velocities of all samples did not follow a normal distribution, even after arithmetic transformation (Shapiro test, p < 0.01), non-parametric tests were used. The R package “fitdistrplus” (Delignette-Muller and Dutang, 2015) was used to calculate the skewness and kurtosis of the empirical distributions observed and determine the theoretical distributions that fit the datasets the best.

**Table S1.** Predicted deposition footprint over a 1-year period for theoretical red drum Small, Medium and Large farms in Mayotte’s North-East Lagoon. F, solid deposition rate or range; AUIF, area under influence for a given solid deposition rate; DCF, distance of influence from cages for a given solid deposition rate. Deposition metrics are given for different F, indicating detectable (D), moderate (M) and severe (S) impacts and the peak deposition rate in the domain (Fmax). Total area under influence, AUIF>0.5 = AUID + AUIM + AUIS.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Zone | Farm type | Scenario ID | Site ID | Mean current intensity | Depth | Fmax | AUID | DCD | AUIM | DCM | AUIS | DCS |
| cm s-1 | m | kg solids m-² yr-1 | m² | m | m² | m | m² | m |
| Coastal | Small | Co-S1 | 1 | 0.6 | 33 | 5.1 | 4500 | 60 | - | - | - | - |
| Co-S2 | 2 | 0.8 | 9 | 10.7 | 2100 | 20 | - | - | - | - |
| Co-S3 | 3 | 1.0 | 25 | 4.6 | 3500 | 40 | - | - | - | - |
| Co-S4 | 4 | 1.4 | 9 | 8.3 | 2800 | 30 | - | - | - | - |
| Co-S5 | 5 | 1.4 | 9 | 8.4 | 2700 | 30 | - | - | - | - |
| Co-S6 | 6 | 2.4 | 17 | 3.7 | 3000 | 40 | - | - | - | - |
| Co-S7 | 7 | 5.1 | 31 | 1.9 | 1500 | 20 | - | - | - | - |
| Co-S8 | 8 | 5.2 | 9 | 4.2 | 4400 | 90 | - | - | - | - |
| Co-S9 | 9 | 5.9 | 30 | 1.7 | 1700 | 20 | - | - | - | - |
| Co-S10 | 10 | 6.1 | 10 | 3.8 | 4700 | 90 | - | - | - | - |
| Co-S11 | 11 | 13.4 | 20 | 1.2 | 1800 | 30 | - | - | - | - |
| Co-S12 | 12 | 17.2 | 8 | 2.3 | 1600 | 20 | - | - | - | - |
| Medium | Co-M1 | 1 | 0.6 | 33 | 44.0 | 12,500 | 100 | 2200 | 20 | 1500 | 10 |
| Co-M7 | 7 | 5.1 | 31 | 17.5 | 42,600 | 350 | 1100 | 10 | - | - |
| Co-M9 | 9 | 5.9 | 30 | 15.2 | 56,500 | 470 | 800 | 10 | - | - |
| Large | Co-L1 | 1 | 0.6 | 33 | 26.0 | 82,700 | 110 | 29,500 | 20 | - | - |
| Co-L7 | 7 | 5.1 | 31 | 10.5 | 308,400 | 410 | - | - | - | - |
| Co-L9 | 9 | 5.9 | 30 | 10.2 | 303,300 | 460 | - | - | - | - |
| Off-coast | Medium | Oco-M13 | 13 | 1.4 | 26 | 31.6 | 23,900 | 140 | 2600 | 20 | 400 | 10 |
| Oco-M14 | 14 | 1.8 | 41 | 24.1 | 27,900 | 220 | 1800 | 10 | - | - |
| Oco-M15 | 15 | 1.8 | 30 | 27.0 | 33,500 | 220 | 2200 | 10 | - | - |
| Oco-M16 | 16 | 3.5 | 49 | 14.8 | 65,800 | 480 | 700 | 10 | - | - |
| Oco-M17 | 17 | 3.8 | 41 | 16.1 | 51,800 | 350 | 800 | 10 | - | - |
| Oco-M18 | 18 | 4.2 | 32 | 16.3 | 54,000 | 320 | 800 | 10 | - | - |
| Oco-M19 | 19 | 6.4 | 34 | 12.3 | 68,500 | 560 | 200 | 10 | - | - |
| Oco-M20 | 20 | 6.7 | 46 | 11.6 | 49,700 | 510 | - | - | - | - |
| Oco-M21 | 21 | 9.2 | 28 | 11.1 | 72,600 | 570 | - | - | - | - |
| Oco-M22 | 22 | 9.8 | 37 | 11.4 | 69,600 | 730 | - | - | - | - |
| Oco-M23 | 23 | 16.8 | 36 | 5.8 | 21,400 | 490 | - | - | - | - |
| Oco-M24 | 24 | 19.2 | 26 | 8.1 | 42,000 | 680 | - | - | - | - |
| Large | Oco-L13 | 13 | 1.4 | 26 | 27.0 | 95,200 | 140 | 24,800 | 20 | - | - |
| Oco-L14 | 14 | 1.8 | 41 | 16.0 | 210,900 | 240 | 7,400 | 10 | - | - |
| Oco-L15 | 15 | 1.8 | 30 | 19.1 | 154,200 | 180 | 10,500 | 20 | - | - |
| Oco-L16 | 16 | 3.5 | 49 | 9.5 | 362,100 | 500 | - | - | - | - |
| Oco-L17 | 17 | 3.8 | 41 | 9.5 | 354,200 | 430 | - | - | - | - |
| Oco-L18 | 18 | 4.2 | 32 | 13.1 | 256,100 | 420 | 3,200 | 10 | - | - |
| Oco-L19 | 19 | 6.4 | 34 | 10.4 | 304,300 | 660 | - | - | - | - |
| Oco-L20 | 20 | 6.7 | 46 | 6.5 | 395,200 | 610 | - | - | - | - |
| Oco-L21 | 21 | 9.2 | 28 | 8.9 | 353,700 | 650 | - | - | - | - |
| Oco-L22 | 22 | 9.8 | 37 | 6.5 | 430,800 | 800 | - | - | - | - |
| Oco-L23 | 23 | 16.8 | 36 | 4.8 | 394,400 | 700 | - | - | - | - |
| Oco-L24 | 24 | 19.2 | 26 | 5.6 | 475,800 | 850 | - | - | - | - |
|  |  | Dl-L25 | 25 | 3.7 | 48 | 9.0 | 378,900 | 510 | - | - | - | - |
| Deep Lagoon | Large | Dl-L26 | 26 | 4.3 | 38 | 9.1 | 345,100 | 510 | - | - | - | - |
| Dl-L27 | 27 | 4.5 | 32 | 11.7 | 276,600 | 380 | - | - | - | - |
| Dl-L28 | 28 | 4.8 | 30 | 11.9 | 266,200 | 380 | - | - | - | - |
| Dl-L29 | 29 | 5.4 | 41 | 7.9 | 414,600 | 580 | - | - | - | - |
| Dl-L30 | 30 | 5.9 | 30 | 10.6 | 281,900 | 490 | - | - | - | - |
| Dl-L31 | 31 | 6.3 | 31 | 9.0 | 383,000 | 510 | - | - | - | - |
| Dl-L32 | 32 | 6.9 | 27 | 9.8 | 328,600 | 460 | - | - | - | - |
| Dl-L33 | 33 | 8.6 | 28 | 7.8 | 355,200 | 500 | - | - | - | - |
| Dl-L34 | 34 | 8.8 | 33 | 6.6 | 447,200 | 630 | - | - | - | - |
| Dl-L35 | 35 | 9.7 | 27 | 7.4 | 420,400 | 590 | - | - | - | - |
| Dl-L36 | 36 | 11.8 | 32 | 6.6 | 436,300 | 640 | - | - | - | - |

**Table S2**. Results of the principal component analysis performed in three zone’s (Coastal, Off-coast, Deep lagoon) current field dataset based on different hydrodynamic variables. H, bathymetry; % EC, percentage of time the current is established, ILT, mean current intensity at low tide; IHT, mean current intensity at high tide; DHT, Duration at high tide.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **N** | **H**  **(m)** | **% EC**  **(%)** | **ILT**  **(cm s-1)** | **IHT**  **(cm s-1)** | **DHT**  **(hh:mm)** |
| Coastal | Cluster 1 | 11 | 12.2 ± 4.9 | 75.3 ± 12.6 | 1.2 ± 0.5 | 1.4 ± 0.7 | 05:12 ± 00:52 |
| Cluster 2 | 149 | 17.4 ± 7.1 | 93.5 ± 4.5 | 2.9 ± 1.6 | 3.1 ± 1.7 | 06:04 ± 01:01 |
| Cluster 3 | 53 | 14.5 ± 4.9 | 95.9 ± 2.7 | 8.1 ± 2.8 | 8.0 ± 3.0 | 06:01 ± 00:26 |
| Off-coast | Cluster 1 | 74 | 36.1 ± 5.8 | 84.0 ± 4.1 | 3.3 ± 1.4 | 3.4 ± 1.4 | 05:19 ± 00:33 |
| Cluster 2 | 577 | 39.3 ± 6.6 | 95.8 ± 2.2 | 5.0 ± 1.6 | 5.0 ± 1.6 | 05:56 ± 00:20 |
| Cluster 3 | 84 | 32.1 ± 3.2 | 97.4 ± 1.2 | 14.6 ± 3.2 | 14.9 ± 1.7 | 06:09 ± 00:14 |
| Deep lagoon | Cluster 1 | 66 | 29.0 ± 2.2 | 87.9 ± 3.4 | 5.4 ± 0.9 | 5.7 ± 0.8 | 05:30 ± 00:10 |
| Cluster 2 | 284 | 35.6 ± 6.1 | 94.2 ± 1.4 | 5.2 ± 0.8 | 5.2 ± 0..8 | 05:50 ± 00:07 |
| Cluster 3 | 28 | 29.4 ± 2.5 | 97.0 ± 1.0 | 11.4 ± 2.8 | 11.7 ± 2.1 | 06:12 ± 00:07 |

**Table S3.** Simple linear regression results between site hydrodynamic characteristics (mean barotropic current intensity and depth) and dispersion metrics (Fmax, maximum solid deposition rate; AUIF>0.5, total area under farm influence; DCD, farthest distance at which a detectable impact was predicted).Slope and intercept values with standard errors (SE) in brackets were given for regression with significant R-squared value only.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Regression variables | | Dataset | Regression results | | |
| y | x | Farm type | R² | Slope (SE) | Intercept (SE) |
| Mean barotropic  current intensity  (ln cm s-1) | Fmax | Small | 0.578\*\* | -0.290\*\* (0.078)) | 2.466\*\*\* (0.431) |
| Medium | 0.906\*\*\* | -0.090\*\*\* (0.008) | 3.095\*\*\* (0.163) |
| Large | 0.805\*\*\* | -0.124\*\*\* (0.012) | 2.987\*\*\* (0.147) |
| AUIF>0.5 | Small | 0.131 |  |  |
| Medium | 0.210 |  |  |
| Large | 0.738\*\*\* | 6.815E-6\*\*\* (8.12E-7) | -5.923E-1\* (2.779E-1) |
| DCD | Small | 0.001 |  |  |
| Medium | 0.800\*\*\* | 4.481E-3\*\*\* (6.22E-4) | -0.361 (0.282) |
| Large | 0.824\*\*\* | 3.765E-3\*\*\* (3.48E-4) | -0.211 (0.182) |
| Depth  (m) | Fmax | Small | 0.203 |  |  |
| Medium | 0.030 |  |  |
| Large | 0.039 |  |  |
| AUIF>0.5 | Small | 0.009 |  |  |
| Medium | 0.035 |  |  |
| Large | 0.040 |  |  |
| DCD | Small | 0.052 |  |  |
| Medium | 0.010 |  |  |
| Large | 0.006 |  |  |

*p > 0.05, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001.*

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