

The following supplement accompanies the article

## Commercial trawling in seagrass beds: bycatch and long-term trends in effort of a major shrimp fishery

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Supplement. Catch comparison between rollerframe and otter trawls (Table S1), and photographs of potential predators on post-release by-catch from a commercial bait-shrimp trawler (Fig. S1)

Table S1. Catch composition from fishery-independent sampling with paired rollerframe (n = 52 tows) and otter trawls (n = 51 tows). Taxa are listed from the most to least abundant captured by rollerframe trawls. The mean ( $\pm$  SE) densities (number catch per 100 m<sup>2</sup>) of captured animals are provided for Size Classes 1 to 6

| Species                         | Common Name  | Gear        | No. caught | L <sub>1</sub><br>(1–25 mm) | L <sub>2</sub><br>(26–50 mm) | L <sub>3</sub><br>(51–75 mm) | L <sub>4</sub><br>(76–100 mm) | L <sub>5</sub><br>(101–150 mm) | L <sub>6</sub><br>(>150 mm) |
|---------------------------------|--------------|-------------|------------|-----------------------------|------------------------------|------------------------------|-------------------------------|--------------------------------|-----------------------------|
| <b>Arthropoda</b>               |              |             |            |                             |                              |                              |                               |                                |                             |
| <i>Tozeuma carolinense</i>      | Arrow Shrimp | rollerframe | 90,146     | 327.30 (73.22)              | 0.03 (0.03)                  | –                            | –                             | –                              | –                           |
|                                 |              | otter       | 38,510     | 137.29 (44.29)              | –                            | –                            | –                             | –                              | –                           |
| <i>Farfantepenaeus duorarum</i> | Pink Shrimp  | rollerframe | 27,124     | 96.10 (10.71)               | 2.38 (0.42)                  | 0.02 (0.02)                  | –                             | –                              | –                           |
|                                 |              | otter       | 3,474      | 11.76 (2.16)                | 0.62 (0.11)                  | –                            | –                             | –                              | –                           |

|                                   |                       |             |        |             |              |               |              |             |             |
|-----------------------------------|-----------------------|-------------|--------|-------------|--------------|---------------|--------------|-------------|-------------|
| <i>Periclimenes longicaudatus</i> | Longtail Grass Shrimp | rollerframe | 394    | 1.43 (0.60) | –            | –             | –            | –           | –           |
|                                   |                       | otter       | 768    | 2.75 (1.27) | –            | –             | –            | –           | –           |
| <i>Libinia dubia</i>              | Longnose Spider Crab  | rollerframe | 258    | 0.04 (0.02) | 0.80 (0.21)  | 0.09 (0.03)   | –            | –           | –           |
|                                   |                       | otter       | 386    | 0.04 (0.02) | 1.08 (0.24)  | 0.25 (0.08)   | –            | –           | –           |
| <i>Metoporphaphis calcarata</i>   | Arrow Crab            | rollerframe | 110    | 0.40 (0.09) | –            | –             | –            | –           | –           |
|                                   |                       | otter       | 27     | 0.09 (0.03) | –            | –             | –            | –           | –           |
| <i>Callinectes sapidus</i>        | Blue Crab             | rollerframe | 76     | –           | 0.06 (0.03)  | 0.05 (0.03)   | 0.07 (0.02)  | 0.07 (0.03) | 0.02 (0.01) |
|                                   |                       | otter       | 66     | 0.01 (0.01) | 0.11 (0.05)  | 0.02 (0.01)   | 0.03 (0.01)  | 0.06 (0.02) | 0.01 (0.01) |
| <i>Hippolyte zostericola</i>      | Zostera Shrimp        | rollerframe | 4      | 0.01 (0.01) | –            | –             | –            | –           | –           |
|                                   |                       | otter       | 0      | –           | –            | –             | –            | –           | –           |
| <b>Chordata</b>                   |                       |             |        |             |              |               |              |             |             |
| <i>Lagodon rhomboides</i>         | Pinfish               | rollerframe | 36,554 | 0.20 (0.10) | 26.64 (4.39) | 82.24 (12.09) | 20.52 (3.53) | 2.93 (0.36) | 0.20 (0.04) |
|                                   |                       | otter       | 11,511 | 0.02 (0.01) | 4.20 (0.81)  | 17.15 (2.17)  | 14.00 (2.32) | 4.98 (0.77) | 0.69 (0.09) |
| <i>Orthopristis chrysoptera</i>   | Pigfish               | rollerframe | 8,868  | 0.10 (0.05) | 7.71 (1.69)  | 17.15 (2.467) | 6.21 (1.03)  | 0.86 (0.25) | 0.17 (0.06) |
|                                   |                       | otter       | 2,886  | 0.06 (0.03) | 2.02 (0.48)  | 3.43 (0.61)   | 3.39 (0.549) | 1.27 (0.40) | 0.13 (0.02) |
| <i>Bairdiella chrysoura</i>       | Silver Perch          | rollerframe | 854    | 0.76 (0.38) | 0.94 (0.27)  | 0.62 (0.14)   | 0.57 (0.12)  | 0.17 (0.05) | 0.05 (0.02) |
|                                   |                       | otter       | 743    | 0.36 (0.13) | 0.87 (0.21)  | 0.63 (0.17)   | 0.46 (0.10)  | 0.27 (0.06) | 0.06 (0.02) |
| <i>Opsanus beta</i>               | Gulf Toadfish         | rollerframe | 634    | 0.01 (0.01) | 0.12 (0.07)  | 0.16 (0.06)   | 0.49 (0.08)  | 1.17 (0.13) | 0.34 (0.04) |
|                                   |                       | otter       | 196    | 0.01 (0.01) | 0.01 (0.01)  | 0.01 (0.01)   | 0.05 (0.03)  | 0.37 (0.06) | 0.25 (0.04) |
| <i>Monacanthus hispidus</i>       | Planehead Filefish    | rollerframe | 422    | 0.17 (0.06) | 0.49 (0.09)  | 0.51 (0.12)   | 0.28 (0.07)  | 0.05 (0.02) | 0.03 (0.02) |
|                                   |                       | otter       | 360    | 0.19 (0.15) | 0.22 (0.06)  | 0.43 (0.15)   | 0.32 (0.08)  | 0.11 (0.03) | 0.02 (0.01) |

|                                  |                                |             |     |             |             |              |             |             |             |
|----------------------------------|--------------------------------|-------------|-----|-------------|-------------|--------------|-------------|-------------|-------------|
| <i>Syngnathus floridae</i>       | Florida Pipefish               | rollerframe | 528 | –           | –           | 0.04 (0.04)  | 0.14 (0.06) | 0.53 (0.10) | 1.21 (0.24) |
|                                  |                                | otter       | 186 | –           | –           | –            | 0.01 (0.01) | 0.19 (0.06) | 0.47 (0.14) |
| <i>Syngnathus scovelli</i>       | Gulf Pipefish                  | rollerframe | 346 | –           | –           | 0.04 (0.02)  | 0.33 (0.10) | 0.88 (0.19) | 0.01 (0.01) |
|                                  |                                | otter       | 36  | –           | –           | 0.01 (0.01)  | 0.01 (0.01) | 0.11 (0.03) | –           |
| <i>Hyporhamphus unifasciatus</i> | Atlantic Silverstripe Halfbeak | rollerframe | 280 | –           | 0.01 (0.01) | 0.01 (0.01)  | 0.01 (0.01) | 0.11 (0.04) | 0.87 (0.12) |
|                                  |                                | otter       | 0   | –           | –           | –            | –           | –           | –           |
| <i>Hippocampus erectus</i>       | Lined Seahorse                 | rollerframe | 270 | 0.36 (0.33) | 0.01 (0.01) | 0.20 (0.06)  | 0.34 (0.12) | 0.07 (0.03) | 0.01 (0.01) |
|                                  |                                | otter       | 170 | 0.01 (0.01) | 0.03 (0.02) | 0.20 (0.07)  | 0.29 (0.13) | 0.07 (0.05) | 0.01 (0.01) |
| <i>Cynoscion nebulosus</i>       | Spotted Seatrout               | rollerframe | 240 | 0.01 (0.01) | 0.46 (0.12) | 0.12 (0.05)  | 0.18 (0.07) | 0.07 (0.02) | 0.04 (0.02) |
|                                  |                                | otter       | 67  | –           | 0.14 (0.06) | 0.02 (0.01)  | 0.01 (0.01) | 0.02 (0.01) | 0.05 (0.02) |
| <i>Chilomycterus schoepfi</i>    | Striped Burfish                | rollerframe | 232 | 0.04 (0.03) | 0.05 (0.02) | 0.17 (0.05)  | 0.15 (0.04) | 0.17 (0.04) | 0.27 (0.05) |
|                                  |                                | otter       | 148 | 0.04 (0.02) | 0.01 (0.01) | 0.06 (0.02)  | 0.05 (0.01) | 0.13 (0.03) | 0.23 (0.05) |
| <i>Paralichthys albigutta</i>    | Gulf Flounder                  | rollerframe | 140 | –           | 0.01 (0.01) | 0.12 (0.03)  | 0.12 (0.04) | 0.16 (0.04) | 0.11 (0.03) |
|                                  |                                | otter       | 24  | –           | –           | 0.01 (0.01)  | –           | 0.03 (0.02) | 0.05 (0.01) |
| <i>Lactophrys quadricornis</i>   | Scrawled Cowfish               | rollerframe | 92  | 0.07 (0.03) | 0.17 (0.09) | 0.01 (0.01)  | –           | 0.04 (0.02) | 0.04 (0.02) |
|                                  |                                | otter       | 44  | 0.03 (0.02) | 0.10 (0.05) | –            | 0.01 (0.01) | 0.01 (0.01) | 0.02 (0.01) |
| <i>Lutjanus synagris</i>         | Lane Snapper                   | rollerframe | 90  | 0.03 (0.02) | 0.12 (0.05) | 0.12 (0.05)  | 0.04 (0.02) | 0.02 (0.02) | –           |
|                                  |                                | otter       | 23  | –           | 0.01 (0.01) | 0.04 (0.02)  | 0.01 (0.01) | 0.02 (0.01) | –           |
| <i>Anchoa mitchilli</i>          | Bay Anchovy                    | rollerframe | 86  | –           | 0.19 (0.08) | 0.09 (0.05)  | 0.03 (0.03) | –           | –           |
|                                  |                                | otter       | 97  | 0.01 (0.01) | 0.32 (0.10) | 0.018 (0.01) | –           | –           | –           |

|                               |                       |             |    |             |             |             |             |             |             |
|-------------------------------|-----------------------|-------------|----|-------------|-------------|-------------|-------------|-------------|-------------|
| <i>Diplodus holbrooki</i>     | Spottail Pinfish      | rollerframe | 72 | –           | 0.06 (0.03) | 0.06 (0.04) | 0.03 (0.02) | 0.12 (0.04) | –           |
|                               |                       | otter       | 39 | –           | 0.02 (0.01) | 0.01 (0.01) | 0.02 (0.02) | 0.08 (0.03) | 0.01 (0.01) |
| <i>Eucinostomus argenteus</i> | Spotfin Mojarra       | rollerframe | 68 | 0.06 (0.05) | 0.17 (0.10) | 0.01 (0.01) | –           | –           | –           |
|                               |                       | otter       | 3  | –           | –           | 0.01 (0.01) | –           | –           | –           |
| <i>Trinectes maculatus</i>    | Hogchoker             | rollerframe | 62 | –           | 0.10 (0.05) | 0.12 (0.05) | –           | –           | –           |
|                               |                       | otter       | 0  | –           | –           | –           | –           | –           | –           |
| <i>Eucinostomus gula</i>      | Silver Jenny          | rollerframe | 48 | 0.04 (0.04) | 0.14 (0.08) | –           | –           | –           | –           |
|                               |                       | otter       | 2  | –           | 0.01 (0.01) | –           | –           | –           | –           |
| <i>Sphoeroides nephelus</i>   | Southern Puffer       | rollerframe | 44 | 0.03 (0.03) | –           | 0.02 (0.02) | 0.03 (0.02) | 0.05 (0.02) | 0.03 (0.02) |
|                               |                       | otter       | 51 | –           | 0.01 (0.01) | 0.01 (0.01) | 0.04 (0.01) | 0.10 (0.03) | 0.03 (0.01) |
| <i>Aluterus scriptus</i>      | Scrawed Filefish      | rollerframe | 42 | 0.01 (0.01) | 0.04 (0.03) | 0.09 (0.04) | 0.01 (0.01) | –           | 0.01 (0.01) |
|                               |                       | otter       | 24 | –           | 0.01 (0.01) | 0.02 (0.01) | 0.05 (0.02) | 0.01 (0.01) | 0.01 (0.01) |
| <i>Gobiosoma robustum</i>     | Code Goby             | rollerframe | 24 | –           | 0.06 (0.05) | 0.03 (0.03) | –           | –           | –           |
|                               |                       | otter       | 4  | 0.01 (0.01) | 0.01 (0.01) | –           | –           | –           | –           |
| <i>Synodus foetens</i>        | Inshore Lizardfish    | rollerframe | 22 | –           | –           | –           | 0.04 (0.04) | 0.02 (0.01) | 0.02 (0.01) |
|                               |                       | otter       | 3  | –           | –           | –           | –           | –           | 0.01 (0.01) |
| <i>Hippocampus reidi</i>      | Slender Seahorse      | rollerframe | 20 | –           | –           | –           | 0.07 (0.06) | 0.01 (0.01) | –           |
|                               |                       | otter       | 12 | –           | –           | 0.02 (0.02) | 0.02 (0.02) | –           | –           |
| <i>Symphurus plagiusa</i>     | Blackcheek Tonguefish | rollerframe | 18 | –           | –           | 0.03 (0.02) | 0.04 (0.03) | –           | –           |
|                               |                       | otter       | 1  | –           | –           | –           | 0.01 (0.01) | –           | –           |
| <i>Diplectrum bivittatum</i>  | Dwarf Seabass         | rollerframe | 18 | –           | –           | 0.07 (0.05) | –           | –           | –           |
|                               |                       | otter       | 0  | –           | –           | –           | –           | –           | –           |

|                                 |                     |             |    |   |             |             |             |             |              |
|---------------------------------|---------------------|-------------|----|---|-------------|-------------|-------------|-------------|--------------|
| <i>Ariopsis felis</i>           | Hardhead Catfish    | rollerframe | 14 | - | -           | 0.02 (0.02) | -           | -           | 0.03 (0.01)  |
|                                 |                     | otter       | 6  | - | -           | -           | -           | -           | 0.02 (0.01)  |
| <i>Mycteroperca microlepis</i>  | Gag                 | rollerframe | 14 | - | -           | -           | 0.01 (0.01) | 0.01 (0.01) | 0.04 (0.02)  |
|                                 |                     | otter       | 29 | - | -           | -           | -           | -           | 0.10 (0.03)  |
| <i>Diplectrum formosum</i>      | Sand Perch          | rollerframe | 12 | - | -           | 0.02 (0.02) | 0.01 (0.01) | 0.01 (0.01) | -            |
|                                 |                     | otter       | 2  | - | -           | -           | -           | 0.01 (0.01) | 0.01 (0.01)  |
| <i>Strongylura marina</i>       | Atlantic Needlefish | rollerframe | 12 | - | -           | -           | -           | 0.02 (0.01) | 0.02 (0.019) |
|                                 |                     | otter       | 0  | - | -           | -           | -           | -           | -            |
| <i>Chloroscombrus chrysurus</i> | Atlantic Bumper     | rollerframe | 8  | - | 0.03 (0.03) | -           | -           | -           | -            |
|                                 |                     | otter       | 6  | - | 0.04 (0.04) | -           | -           | -           | -            |
| <i>Centropristis striata</i>    | Black Seabass       | rollerframe | 6  | - | -           | -           | -           | 0.01 (0.01) | 0.01 (0.01)  |
|                                 |                     | otter       | 30 | - | 0.01 (0.01) | -           | -           | 0.02 (0.01) | 0.07 (0.02)  |
| <i>Brevoortia patronus</i>      | Gulf Menhaden       | rollerframe | 6  | - | -           | -           | -           | 0.02 (0.02) | -            |
|                                 |                     | otter       | 0  | - | -           | -           | -           | -           | -            |
| <i>Achirus lineatus</i>         | Lined Sole          | rollerframe | 4  | - | -           | 0.01 (0.01) | -           | -           | -            |
|                                 |                     | otter       | 0  | - | -           | -           | -           | -           | -            |
| <i>Microgobius gulosus</i>      | Clown Goby          | rollerframe | 4  | - | -           | 0.01 (0.01) | -           | -           | -            |
|                                 |                     | otter       | 0  | - | -           | -           | -           | -           | -            |
| <i>Monacanthus ciliatus</i>     | Fringed Filefish    | rollerframe | 4  | - | -           | 0.01 (0.01) | -           | -           | -            |
|                                 |                     | otter       | 0  | - | -           | -           | -           | -           | -            |

|  |                   |             |     |             |             |             |   |   |             |
|--|-------------------|-------------|-----|-------------|-------------|-------------|---|---|-------------|
| <i>Lactophrys trigonus</i>                     | Trunkfish         | rollerframe | 4   | 0.01 (0.01) | 0.01 (0.01) | –           | – | – | –           |
|  |                   | otter       | 1   | 0.01 (0.01) | –           | –           | – | – | –           |
| <i>Selene vomer</i>                            | Lookdown          | rollerframe | 4   | –           | –           | 0.01 (0.01) | – | – | –           |
|  |                   | otter       | 5   | –           | 0.02 (0.02) | –           | – | – | –           |
| <i>Halichoeres bivittatus</i>                  | Slippery Dick     | rollerframe | 2   | –           | 0.01 (0.01) | –           | – | – | –           |
|  |                   | otter       | 0   | –           | –           | –           | – | – | –           |
| <i>Ophidion holbrookii</i>                     | Bank Cusk-eel     | rollerframe | 2   | –           | –           | –           | – | – | 0.01 (0.01) |
|  |                   | otter       | 0   | –           | –           | –           | – | – | –           |
| <i>Epinephelus morio</i>                       | Red Grouper       | rollerframe | 2   | –           | –           | –           | – | – | 0.01 (0.01) |
|  |                   | otter       | 2   | –           | –           | –           | – | – | 0.01 (0.01) |
| <i>Lophogobius cyprinoides</i>                 | Crested Goby      | rollerframe | 0   | –           | –           | –           | – | – | –           |
|  |                   | otter       | 1   | –           | –           | 0.01 (0.01) | – | – | –           |
| <i>Myrophis punctatus</i>                      | Speckled Worm Eel | rollerframe | 0   | –           | –           | –           | – | – | –           |
|  |                   | otter       | 1   | –           | –           | –           | – | – | 0.01 (0.01) |
| <i>Scorpaena brasiliensis</i>                  | Barbfish          | rollerframe | 0   | –           | –           | –           | – | – | –           |
|  |                   | otter       | 1   | –           | –           | –           | – | – | 0.01 (0.01) |
| <i>Engraulis eurystole</i>                     | Silver Anchovy    | rollerframe | 0   | –           | –           | –           | – | – | –           |
|  |                   | otter       | 22  | –           | 0.07 (0.04) | 0.01 (0.01) | – | – | –           |
| <b>Mollusca</b><br><i>Argopecten irradians</i> | Bay Scallop       | rollerframe | 276 | 0.11 (0.05) | 0.49 (0.11) | 0.41 (0.07) | – | – | –           |
|  |                   | otter       | 151 | 0.01 (0.01) | 0.23 (0.06) | 0.30 (0.06) | – | – | –           |

Fig. S1. Post-release mortality of fishes and invertebrates may occur via predation by (A) large flocks of birds (e.g. gulls) and (B) predatory fishes (e.g. Ladyfish and Gafftopsail Catfish—note the reflection of eyes in photo) that follow commercial bait-shrimp trawlers. Photos taken at night aboard a commercial bait-shrimp trawler in the Big Bend, FL, courtesy of C. C. Koenig

(A)

(B)