# **SUPPLEMENTARY FIGURE LEGEND**

**Supplementary Figure 1.** Example of one of the BRUV deployments at Tubbataha Reef National Park (TRNP). Photographed by Steve De Neef.

**Supplementary Figure 2.** Histograms of the estimated marginal means of the abundance distribution of the overall abundance and the abundance of different large carnivorous reef fish taxa per BRUV station at two depth categories in the two study locations. A) Overall abundance; B) Serranidae; 3) Lutjanidae; 4) Lethrinidae; 5) Carangidae; 5) *Cheilinus undulatus*.

**Supplementary Figure 3.** Histograms of the estimated marginal means of the species richness distribution of overall species richness and the observed species richness of different large carnivorous reef fish taxa per BRUV station at two depth categories in the two study locations. A) Overall species richness (Chao 1); B) Serranidae; C) Lutjanidae; D) Lethrinidae; E) Carangidae.

# **SUPPLEMENTARY TABLES**

**Supplementary Table 1.** Sample sizes (BRUV deployments analyzed) per location and depth category, and the depth ranges that were sampled.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Location** | **Depth Category** | **Depth Range (m)** | **Sample Size** | **Total** |
| TRNP | Shallow | 4-10 | 14 |  |
| TRNP | Mesophotic | 50-75 | 19 | 33 |
| Cagayancillo | Shallow | 4-12 | 20 |  |
| Cagayancillo | Mesophotic | 45-96 | 12 | 32 |
|  |  |  | Grand Total | 65 |

**Supplementary Table 2.** List of large carnivorous reef fish species recorded in BRUV deployments (n = 65). This excludes fishes (25 individuals in 7 genera) that could not be identified to the species level (Supplementary Table 3). Threat category based on IUCN Red List of Threatened Species: EN – Endangered; VU – Vulnerable. Trophic group classification was based on dietary information summarized in FishBase (Froese and Pauly 2022): P – Piscivore; I – Invertivore; GC – Generalist carnivore; GC\* - Unknown, but probably a generalist carnivore. Species occurrences are indicated by “1” in the two locations (T – TRNP; C – Cagayancillo) and two depth categories (S – shallow; M – mesophotic) per location.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Family** | **Species** | **Threat Category** | **Trophic Group** | **T-S** | **T-M** | **C-S** | **C-M** |
| Carangidae | *Carangoides coeruleopinnatus* |  | GC |  | 1 |  |  |
| Carangidae | *Carangoides ferdau* |  | GC | 1 | 1 |  |  |
| Carangidae | *Carangoides oblongus* |  | GC | 1 | 1 |  | 1 |
| Carangidae | *Carangoides orthogrammus* |  | GC | 1 |  |  | 1 |
| Carangidae | *Carangoides plagiotaenia* |  | GC | 1 | 1 | 1 |  |
| Carangidae | *Caranx ignobilis* |  | P | 1 | 1 | 1 | 1 |
| Carangidae | *Caranx lugubris* |  | P |  | 1 |  | 1 |
| Carangidae | *Caranx melampygus* |  | GC | 1 | 1 | 1 | 1 |
| Carangidae | *Caranx papuensis* |  | GC |  |  | 1 |  |
| Carangidae | *Caranx sexfasciatus* |  | GC | 1 |  |  | 1 |
| Carangidae | *Elagatis bipinnulata* |  | GC |  |  | 1 | 1 |
| Carangidae | *Scomberoides lysan* |  | GC |  |  | 1 |  |
| Carangidae | *Seriola dumerili* |  | GC |  |  | 1 |  |
| Carangidae | *Seriola rivoliana* |  | GC |  | 1 |  |  |
| Labridae | *Cheilinus undulatus* | EN | GC | 1 | 1 | 1 | 1 |
| Lethrinidae | *Gymnocranius griseus* |  | I |  | 1 |  | 1 |
| Lethrinidae | *Gymnocranius microdon* |  | I |  | 1 |  |  |
| Lethrinidae | *Lethrinus atkinsoni* |  | GC |  |  | 1 |  |
| Lethrinidae | *Lethrinus erythracanthus* |  | GC | 1 | 1 | 1 | 1 |
| Lethrinidae | *Lethrinus erythropterus* |  | GC |  |  | 1 |  |
| Lethrinidae | *Lethrinus nebulosus* |  | GC |  | 1 | 1 |  |
| Lethrinidae | *Lethrinus olivaceus* |  | GC | 1 | 1 |  | 1 |
| Lethrinidae | *Lethrinus rubrioperculatus* |  | GC |  |  | 1 |  |
| Lethrinidae | *Lethrinus semicinctus* |  | GC |  |  |  | 1 |
| Lethrinidae | *Lethrinus xanthochilus* |  | GC |  | 1 | 1 |  |
| Lethrinidae | *Monotaxis grandoculis* |  | I | 1 | 1 | 1 | 1 |
| Lethrinidae | *Monotaxis heterodon* |  | I | 1 | 1 | 1 | 1 |
| Lutjanidae | *Aphareus furca* |  | GC | 1 | 1 | 1 | 1 |
| Lutjanidae | *Aprion virescens* |  | P | 1 | 1 |  | 1 |
| Lutjanidae | *Lutjanus bohar* |  | P | 1 | 1 | 1 | 1 |
| Lutjanidae | *Lutjanus carponotatus* |  | GC |  | 1 |  |  |
| Lutjanidae | *Lutjanus decussatus* |  | GC |  | 1 | 1 | 1 |
| Lutjanidae | *Lutjanus ehrenbergii* |  | GC |  |  | 1 |  |
| Lutjanidae | *Lutjanus fulviflamma* |  | GC |  |  | 1 |  |
| Lutjanidae | *Lutjanus gibbus* |  | GC |  | 1 | 1 |  |
| Lutjanidae | *Lutjanus rivulatus* |  | GC | 1 | 1 | 1 | 1 |
| Lutjanidae | *Symphorichthys spilurus* |  | GC | 1 | 1 |  |  |
| Serranidae | *Aethaloperca rogaa* |  | GC | 1 |  | 1 |  |
| Serranidae | *Cephalopholis argus* |  | P | 1 | 1 | 1 | 1 |
| Serranidae | *Cephalopholis miniata* |  | P |  |  | 1 |  |
| Serranidae | *Cephalopholis polleni* |  | GC\* |  | 1 |  | 1 |
| Serranidae | *Cephalopholis sexmaculata* |  | GC |  | 1 | 1 | 1 |
| Serranidae | *Epinephelus fasciatus* |  | GC |  |  | 1 |  |
| Serranidae | *Epinephelus fuscoguttatus* | VU | GC | 1 | 1 |  | 1 |
| Serranidae | *Epinephelus lanceolatus* |  | GC |  | 1 |  |  |
| Serranidae | *Epinephelus maculatus* |  | GC |  | 1 |  | 1 |
| Serranidae | *Epinephelus malabaricus* |  | GC |  | 1 |  |  |
| Serranidae | *Gracila albomarginata* |  | P | 1 | 1 | 1 | 1 |
| Serranidae | *Plectropomus areolatus* | VU | P | 1 | 1 |  |  |
| Serranidae | *Plectropomus laevis* |  | GC | 1 | 1 |  |  |
| Serranidae | *Plectropomus leopardus* |  | GC | 1 | 1 |  | 1 |
| Serranidae | *Plectropomus oligacanthus* |  | GC | 1 | 1 | 1 | 1 |
| Serranidae | *Pogonoperca punctata* |  | GC |  |  |  | 1 |
| Serranidae | *Variola albimarginata* |  | P |  | 1 |  | 1 |
| Serranidae | *Variola louti* |  | P |  | 1 | 1 | 1 |

**Supplementary Table 3.** List of the 25 individual fish that could only be identified to the genus level. Trophic group classification was based on dietary information summarized in FishBase (Froese and Pauly 2022). P – Piscivore; I – Invertivore; GC – Generalist carnivore; GC\* - Unknown, but probably a generalist carnivore. Species occurrences are indicated by “1” in the two locations (T – TRNP; C – Cagayancillo) and two depth categories (S – shallow; M – mesophotic) per location.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Family** | **Genus** | **Trophic Groups** | **T-S** | **T-M** | **C-S** | **C-M** | |
| Serranidae | *Cephalopholis* | GC |  |  | 1 |  |
| Serranidae | *Epinephelus* | GC |  | 1 |  |  |
| Serranidae | *Plectropomus* | P | 1 |  |  |  |
| Serranidae | *Plectropomus* | P | 1 |  |  |  |
| Serranidae | *Variola* | P |  |  |  | 1 |
| Serranidae | *Variola* | P |  |  |  | 1 |
| Serranidae | *Variola* | P |  |  |  | 1 |
| Serranidae | *Variola* | P |  |  |  | 1 |
| Serranidae | *Variola* | P | 1 |  |  |  |
| Serranidae | *Variola* | P |  | 1 |  |  |
| Serranidae | *Variola* | P |  | 1 |  |  |
| Serranidae | *Variola* | P |  | 1 |  |  |
| Lethrinidae | *Lethrinus* | GC |  |  | 1 |  |
| Lethrinidae | *Lethrinus* | GC |  |  | 1 |  |
| Carangidae | *Carangoides* | GC | 1 |  |  |  |
| Carangidae | *Caranx* | GC |  |  |  | 1 |
| Carangidae | *Caranx* | GC |  |  |  | 1 |
| Carangidae | *Caranx* | GC |  | 1 |  |  |
| Carangidae | *Caranx* | GC |  | 1 |  |  |

**Supplementary Table 4.** Summary of p values in testing for differences in large carnivorous reef fish abundance across treatment combinations (depth category\*study location). Cag – Cagayancillo. Significant results are highlighted in bold.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Grouping** | **shallow\*TRNP vs. mesophotic\*TRNP** | **shallow\*Cag vs. mesophotic\*Cag** | **shallow\*TRNP vs. shallow\*Cag** | **mesophotic\*TRNP vs. mesophotic\*Cag** |
| Overall | 0.056 | **<0.001** | 0.709 | **0.047** |
| Serranidae | 0.238 | **0.004** | 0.145 | 0.644 |
| Lutjanidae | 0.102 | **0.005** | 0.804 | 0.148 |
| Lethrinidae | 0.995 | 0.233 | 0.404 | 0.735 |
| Carangidae | 0.108 | **0.030** | 0.071 | 0.146 |
| *Cheilinus undulatus* | **0.018** | 0.458 | 0.344 | 0.373 |

**Supplementary Table 5.** Summary of p values in testing the effect of different bait types used in TRNP (barracuda, frigate tuna, and sardines) and in Cagayancillo (black jack, bluefin trevally, and skipjack tuna) and the interaction with depth category on overall abundance. The bait type in TRNP is tested relative to barracuda and mesophotic reefs, and the bait type in Cagayancillo is tested relative to black jack and mesophotic reefs. A bait type mix of bluefin trevally and black jack was removed because it was only used in 1 station. Significant results are highlighted in bold.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Standard Error** | **z Value** | **p Value** |
| **TRNP** |  |  |  |  |
| Frigate Tuna | 0.166 | 0.196 | 0.849 | 0.396 |
| Sardine | 0.254 | 0.199 | 1.28 | 0.201 |
| Frigate Tuna\*  Shallow Reef | 0.815 | 0.298 | 2.73 | **0.006** |
| Sardine\*  Shallow Reef | 0.076 | 0.456 | 0.168 | 0.867 |
| **Cagayancillo** |  |  |  |  |
| Bluefin Trevally | 1.42 | .252 | 5.63 | **<0.001** |
| Skipjack Tuna | 0.182 | .335 | 0.544 | 0.587 |
| Bluefin Trevally\*  Shallow Reef | -1.01 | .347 | -2.92 | **0.004** |

**Supplementary Table 6.** Summary of p values in testing for differences in Chao1 overall species richness and observed species richness per taxonomic group of large carnivorous reef fishes across treatment combinations (depth category\*location). Cag – Cagayancillo. Significant results are highlighted in bold.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Grouping** | **shallow\*TRNP vs. mesophotic\*TRNP** | **shallow\*Cag vs. mesophotic\*Cag** | **shallow\*TRNP vs. shallow\*Cag** | **mesophotic\*TRNP vs. mesophotic\*Cag** |
| Overall | 0.316 | 0.335 | 0.243 | 0.262 |
| Serranidae | 0.251 | 0.056 | 0.407 | 0.919 |
| Lutjanidae | 0.823 | 0.608 | 0.371 | 0.897 |
| Lethrinidae | 1.00 | 0.876 | 0.549 | 0.461 |
| Carangidae | 0.363 | 0.218 | **0.033** | 0.967 |

**Supplementary Table 7.** Summary of p values in testing the effect of different bait types used in TRNP (barracuda, frigate tuna, and sardines) and in Cagayancillo (black jack, bluefin trevally, and skipjack tuna) and the interaction with depth category on the Chao1 estimate of overall species richness. The bait type in TRNP is tested relative to barracuda and mesophotic reefs, and the bait type in Cagayancillo is tested relative to black jack and mesophotic reefs. A bait type mix of bluefin trevally and black jack was removed because it was only used in 1 station. Significant results are highlighted in bold.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Standard Error** | **t Value** | **p Value** |
| **TRNP** |  |  |  |  |
| Frigate Tuna | 0.044 | 0.034 | 1.26 | 0.217 |
| Sardine | 0.012 | 0.029 | 0.403 | 0.690 |
| Frigate Tuna\*  Shallow Reef | -0.056 | 0.058 | -0.969 | 0.341 |
| Sardine\*  Shallow Reef | -0.030 | 0.082 | -0.368 | 0.716 |
| **Cagayancillo** |  |  |  |  |
| Bluefin Trevally | -0.110 | 0.084 | -1.32 | 0.199 |
| Skipjack Tuna | 0.086 | 0.116 | 0.736 | 0.468 |
| Bluefin Trevally\*  Shallow Reef | 0.113 | 0.101 | 1.12 | 0.272 |

**Supplementary Table 8**. Summary of significant p values from post-hoc tests following the PERMANOVA in Table 2 that tested the effect of different bait types used in TRNP (barracuda, frigate tuna, and sardines) and in Cagayancillo (black jack, bluefin trevally, and skipjack tuna) and the interaction with depth category on large carnivorous reef fish assemblage structure. P values adjusted are calculated by the package pairwiseAdonis (Martinez Arbizu, 2020) to control for Type I errors by using the Holm method.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Depth Category and Bait Type Comparisons** | **Df** | **Sum of Squares** | **F Model** | **R2** | **P Value** | **P Value Adjusted** |
| Bluefin Trevally Shallow Reef vs. Bluefin Trevally Mesophotic Reef | 1 | 0.970 | 2.672 | 0.113 | 0.0005 | 0.005 |
| Bluefin Trevally Shallow Reef vs. Sardine Mesophotic Reef | 1 | 1.023 | 2.992 | 0.143 | <0.001 | 0.002 |
| Bluefin Trevally Shallow Reef vs. Frigate Tuna Mesophotic Reef | 1 | 1.093 | 3.139 | 0.142 | <0.001 | 0.002 |
| Bluefin Trevally Mesophotic Reef vs. Sardine Mesophotic Reef | 1 | 0.915 | 2.733 | 0.174 | <0.001 | 0.005 |
| Bluefin Trevally Mesophotic Reef vs. Frigate Tuna Shallow Reef | 1 | 1.128 | 3.694 | 0.188 | <0.001 | 0.002 |
| Sardine Mesophotic Reef vs. Frigate Tuna Shallow Reef | 1 | 1.299 | 4.946 | 0.276 | <0.001 | 0.003 |
| Bluefin Trevally Shallow Reef vs. Black Jack Mesophotic Reef | 1 | 0.813 | 2.193 | 0.128 | 0.006 | 0.027 |
| Bluefin Trevally Shallow Reef vs. Barracuda Mesophotic Reef | 1 | 0.789 | 2.264 | 0.112 | 0.002 | 0.016 |
| Bluefin Trevally Shallow Reef vs. Frigate Tuna Shallow Reef | 1 | 0.864 | 2.713 | 0.114 | 0.002 | 0.015 |
| Black Jack Mesophotic Reef vs. Barracuda Mesophotic Reef | 1 | 0.744 | 2.167 | 0.236 | 0.012 | 0.048 |
| Black Jack Mesophotic Reef vs. Sardine Mesophotic Reef | 1 | 0.683 | 2.092 | 0.230 | 0.012 | 0.048 |
| Black Jack Mesophotic Reef vs. Frigate Tuna Shallow Reef | 1 | 0.951 | 3.374 | 0.252 | 0.005 | 0.026 |
| Black Jack Shallow Reef vs.  Frigate Tuna Shallow Reef | 1 | 0.737 | 2.544 | 0.203 | 0.004 | 0.022 |
| Barracuda Mesophotic Reef vs. Frigate Tuna Shallow Reef | 1 | 0.773 | 2.848 | 0.180 | 0.001 | 0.011 |
| Sardine Mesophotic Reef vs. Frigate Tuna Mesophotic Reef | 1 | 0.956 | 3.146 | 0.222 | 0.004 | 0.021 |
| Frigate Tuna Shallow Reef vs. Frigate Tuna Mesophotic Reef | 1 | 0.798 | 2.881 | 0.171 | 0.003 | 0.018 |