Study sites

The study was conducted on the Pacific coral reefs of Palmyra Atoll (5°53’N, 162°5’W;) and Moorea Island (17°32’S 149°50’W). Palmyra Atoll (USA) is a remote uninhabited island that forms part of the northern Line Islands archipelago in the Central Pacific. Moorea (French Polynesia) is an inhabited island (population 17,816 in 2017) that forms part of the Society Islands archipelago in the South Pacific (INSEE 2017). Schooling surveys and focal follows (described below) were conducted at four sites on the backreef of Palmyra Atoll and four sites on the backreef of Moorea.

Palmyra Sites

WT: 5.882234, -162.123690

 LL: 5.877881, -162.114265 RP: 5.875142, -162.120279

PS: 5.870679, -162.109125 SIB: 5.875445, -162.107227

Moorea Sites

TIAHURA: -17.485822, -149.890088

TEMAE: -17.508686, -149.763688

TIKI: -17.543092, -149.900736 PUBLIC: -17.523421, -149.917574

HILTON: -17.482513, -149.845671

Schooling behavior surveys We conducted 30-min roving diver surveys (A. Rassweiler et al., 2020; Schmitt et al., 2002) to compare the prevalence of schooling behavior across both islands. An observer snorkeled in a random pattern for 30 minutes and recorded any focal species individuals observed. For A. triostegus, C. spilurus, and M. flavolineatus, we counted every individual, as schooling tendency could result from conspecific density, and assessed whether the fish were in a school (and noted school size) or solitary. School sizes were approximated to the number of individuals when possible and approximated in bins of 5, 10, or 50 in larger or fast-moving schools. For this study, schooling refers to three or more fish exhibiting organized group behavior and may include synchronized and parallel swimming behaviors (as defined by T. J. Pitcher, 1983), but we did not include any spawning aggregation behavior.

Some species of herbivorous fish that form schools are known to use their numbers to overwhelm territorial herbivores to force access into their guarded territories (Choat & Bellwood, 1985; Eurich et al., 2018; Foster, 1985). Thus, to control for the potential of variation in the numbers of territorial herbivores affecting schooling behavior differentially among islands, we also surveyed the abundance of these territorial herbivores (i.e., Acanthurus lineatus, Acanthurus nigricans, and Stegastes nigricans on Palmyra Atoll and Acanthurus nigrofuscus and Stegastes nigricans on Moorea).

Acanthurus triostegus behavioral observations

We conducted 30-60min focal follows on A. triostegus to evaluate movement and behavior of schooling and solitary fish subject to different predator abundances. We assessed three metrics of fish behavior for defined portions of these focal follows: proportion of time spent non-vigilant, distance traveled, and area covered via calculation of a 95% kernel utilization distribution (KUD).

Snorkeling observers (four observers on Palmyra Atoll, two on Moorea, lead observer (ASG) were present on both islands) followed solitary or schooling A. triostegus while towing a GPS device that recorded location every 60s. Initial follows were conducted at both islands to assess appropriate distance for following fish that would not impact normal foraging nor initiate a flight response. Every 60s, the observer would note school size (if applicable) and whether the focal individual(s) was exhibiting non-vigilant grazing behavior, a position in which the fish had their body oriented towards the substrate in a nose-down grazing position at time of observation, or vigilant behavior with an upright body orientation whether the fish was swimming or stationery. This behavior was classified as non-vigilant grazing as these nose-down grazing positions can reduce a prey fish’s ability to visually scan for predators (Krause & Godin, 1996). Observations on schools were done by recording behavioral information based on the behavior of 50% or more of the individuals in the school (e.g., school was recorded as ‘non-vigilant grazing’ if at least half of the school was in a nose-down position at the 60s mark). If a school was widely dispersed or in a line formation, the observer followed the last 1/3 for the school and recorded the information for that subset of the school. If an observer lost sight of a solitary fish or school of fish, they were able to search for the fish for up to two minutes. If, after two minutes, the fish were not located, the focal follow would be terminated.