The following supplement accompanies the article

Size estimation of circular home range from fish mark-release-(single)-recapture data: case study of a small labrid targeted by recreational fishing

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Supplement 3. Setting realistic extreme scenarios of low and high fishing mortality in Palma Bay.

An estimate of the fishing mortality rate (F) can be obtained from Eq. (S7) in Supplement 2 (www.int-res.com/articles/suppl/m430p087_supp/).

$$F + M = \frac{1}{mean(t_i)} \qquad \text{(S7)}$$

Natural mortality (M) of *Coris julis* based on Pauly (1980, his Eq. 12) is approximately 0.4 yr^{-1}. Assuming this value of M, F_{est} = 0.0192 d^{-1}. This estimate is certainly crude because F is plausibly not spatially homogeneous; however, the objective here is not to obtain an accurate estimate of F but only to obtain a reasonable interval of the spatial variability of F and for use as extreme values (high and low fishing effort) for Simulation Expt 2.

We are actively working (D. March et al. unpubl. data) to determine fishing effort (measured as number of boats km^{-2} and boats d^{-1}) in Palma Bay. More than 200 visual censuses have been completed over the course of nearly 3 yr. In each census, the GPS position of all boats that were fishing was recorded. Therefore, reliable estimates of fishing effort at all sites where marked fish were released are available. The results of these censuses indicate that the ratio between the most- and least-fished sites where marked fish were released is roughly 5:1.

The relationship between F (instantaneous fishing mortality) and fishing effort can be assumed to be proportional (Quinn & Deriso 1999), with the catch rate (C) being proportional to fishing effort E and the number of fish through the catchability coefficient ρ, such that.

$$C = \rho E N \qquad \text{(S8)}$$

Accordingly, a plausible range for F could be determined by combining the following 2 equations:

$$F_{\text{est}} \approx \frac{F_{\text{upper}} + F_{\text{lower}}}{2} \approx 0.0192\,\text{d}^{-1} \qquad \text{(S9)}$$

$$\frac{F_{\text{upper}}}{F_{\text{lower}}} = \frac{E_{\text{upper}}}{E_{\text{lower}}} \approx 5 \qquad \text{(S10)}$$

To ensure that simulations include all possible values of F, the ratio between F_{lower} and F_{upper} was considered to be 2 times larger than the value suggested by our data (i.e. 10 instead of 5).

That is, $F_{lower} \approx 3.5 \times 10^{-3}$ d^{-1} and $F_{upper} \approx 34.9 \times 10^{-3}$ d^{-1}. Remember again that this is certainly an approximation because F is plausibly not spatially homogeneous.

Using all of these values (for F_{lower}, F_{upper}, N_0, R and M), the expected number of returned fishes in relation to time (Supplement 2, Eq. 6) at the 2 extreme F values is shown in Fig. S1.

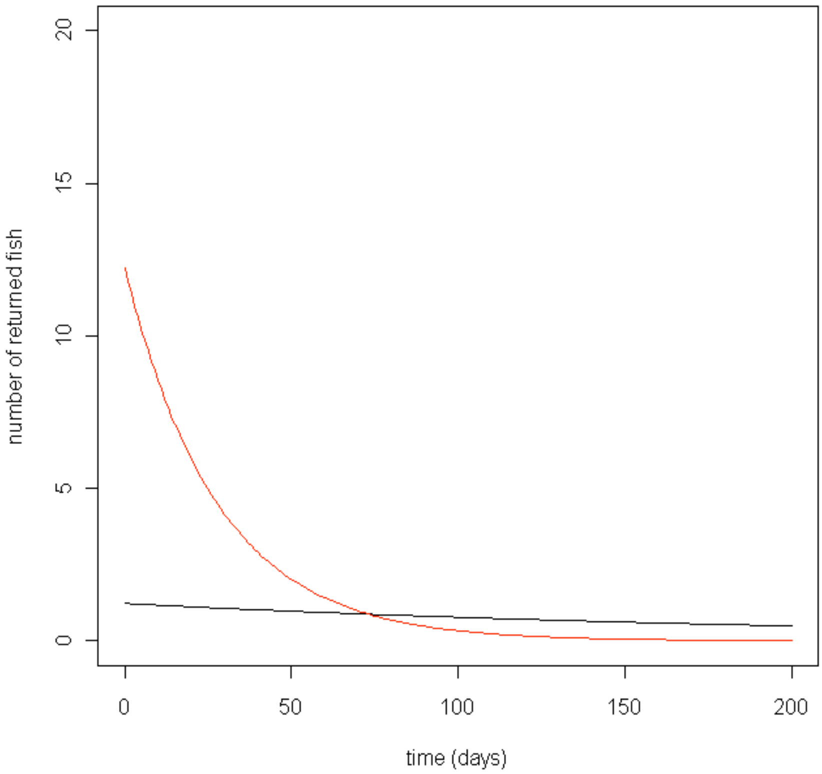

Fig. S1. Expected distributions of recaptures in relation to time (days-at-liberty). The red line represents the scenario with large fishing effort and the black line the scenario with low fishing effort.

To randomly simulate spatial heterogeneous scenarios, fishing mortality was assumed to be normally distributed with mean $F = 0.0192$ d^{-1} and 95% confidence intervals $F_{lower} = 3.5 \times 10^{-3}$ d^{-1} and $F_{upper} = 34.9 \times 10^{-3}$ d^{-1}. Moreover, the random spatial scenarios were assumed to have the same amount of spatial autocorrelation as the observed fishing effort (Fig. S2; D. March et al. unpubl. data).

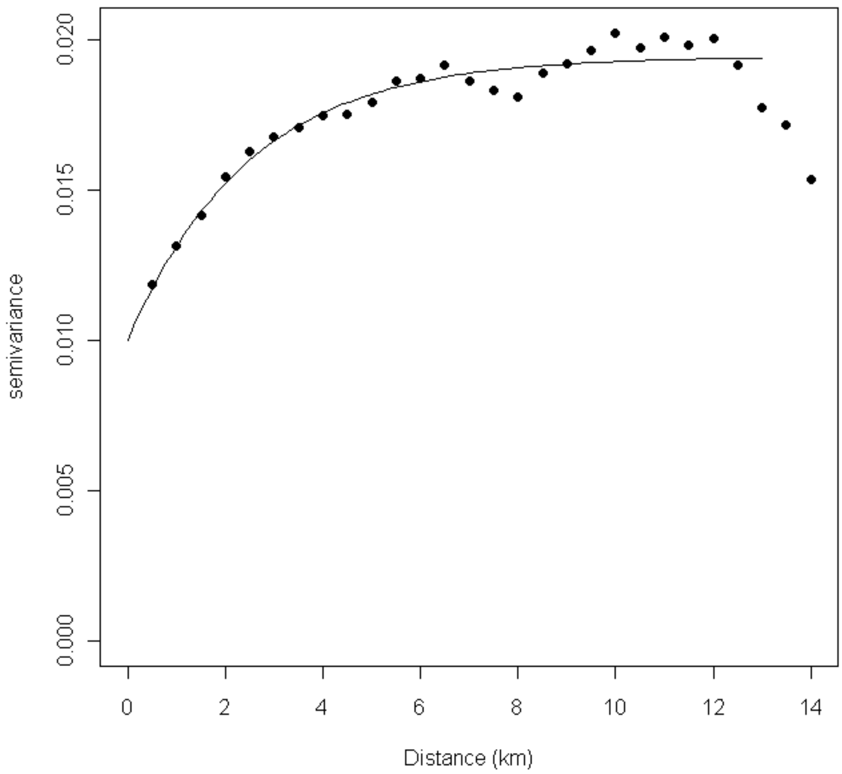

Fig. S2. Empirical semivariogram obtained from the observed spatial distribution of fishing effort (points). The line is the fitted exponential model to these points. The parameters of the fitted model were used to simulate random spatial scenarios

Cell size was set to 1 km^2 (i.e. we assume that fishing effort is constant within a cell) and the scenario comprises 100 x 100 cells. Random scenarios were produced using the *RandomFields* library of R. An example of a simulated spatial scenario is shown in Fig. S3.

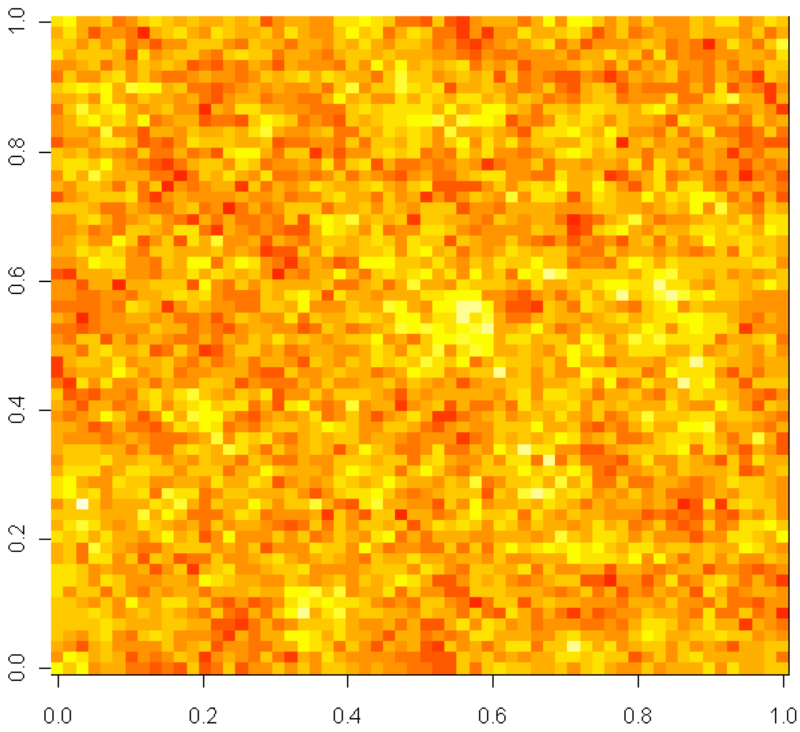

Fig. S3. Example of a random spatial scenario of fishing effort (red = high effort, orange = medium effort, yellow = low effort, white = no effort) with the same spatial autocorrelation as the observed data set. Cell size is 1 km^2

LITERATURE CITED

Pauly D (1980) On the relationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J Cons Int Explor Mer 39:175–192

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