

## S1. Calculation of global connectivity metrics

Global network connectivity for each species was measured with the Probability of Connectivity (PC) (Saura & Pascual-Hortal 2007) and Equivalent Connectivity (EC) metrics (Saura et al. 2011). The PC index is the probability that two fishes randomly placed in a seascape fall into habitat patches that are connected. Given a set of  $n$  nodes, Graphab calculates PC as:

$$PC = \frac{\sum_{i=1}^n \sum_{j=1}^n a_i a_j p_{ij}^*}{A_L^2} \quad (1)$$

where  $a_i$  and  $a_j$  are the areas of nodes  $i$  and  $j$  in  $m^2$  (an indicator of their capacity to support populations).  $A_L$  is the total area of the study region.  $p_{ij}^*$  is the maximum product probability of all possible paths between nodes  $i$  and  $j$ , where the dispersal probability ( $p_{ij}$ ) between each node pair is calculated as:

$$p_{ij} = e^{-\alpha d_{ij}} \quad (2)$$

where  $d_{ij}$  is the edge-to-edge least-cost distance between nodes  $i$  and  $j$ , and  $\alpha$  is a cost-distance decay coefficient set such that  $p_{ij} = 0.05$  for the maximum estimated dispersal distance of the focal species. If nodes  $i$  and  $j$  are in close proximity, the maximum probability path will be the direct dispersal link between them ( $p_{ij}^* = p_{ij}$ ). If nodes  $i$  and  $j$  are spatially separated, then the maximum probability path will include the series of intermediate steps that minimizes cost, yielding  $p_{ij}^* > p_{ij}$ . Finally,  $p_{ij}^* = 1$  when  $i = j$  (i.e., a node can always be reached from itself), and  $p_{ij}^* = 0$  when  $i$  and  $j$  are entirely disconnected. The PC index takes on values 0 to 1, with larger values suggesting higher connectivity across the seascape network.

Graphab's global PC metric considers only node areas and inter-node distances as drivers of potential connectivity, however, connectivity for reef fishes is likely influenced by node area and suitability in an interactive manner. To account for variation in node suitability, we calculated quality-weighted areas by multiplying each node's area by its average suitability from the original HSMs of Stuart et al. (2021). Using these quality-weighted areas as node capacities, we then calculated the EC index as:

$$EC = \sqrt{\sum_{i=1}^n \sum_{j=1}^n a_i a_j p_{ij}^*} \quad (3)$$

where  $p_{ij}^*$  is as defined above and  $a_i$  and  $a_j$  now represent the quality-weighted areas of nodes  $i$  and  $j$ , respectively. EC measures the availability and quality of connected nodes across the seascape, considering the estimated dispersal flux between nodes and the overall topology of the network (Saura et al. 2011). Furthermore, the EC calculation does not rely on the overall area of the study region ( $A_L$ ), which may be arbitrarily placed or exceedingly large relative to nodes, leading to small PC values. The EC index increases with improved connectivity.

## S2. Calculation of local connectivity metrics

To evaluate the connectivity contributions of individual nodes, including those considered for restoration under ‘Mission: Iconic Reefs’, we calculated the local Interaction Flux (IF). IF quantifies potential connectivity at the node-scale as the sum of the products of the focal node capacity with all other nodes, weighted by their interaction probability (Foltête et al. 2014, Sahraoui et al. 2017). IF values were calculated as:

$$IF_i = \sum_{j=1}^n a_i^\beta a_j^\beta p_{ij}^* \quad (4)$$

where  $p_{ij}^*$  is as defined above;  $a_i^\beta$  and  $a_j^\beta$  are the capacities of nodes  $i$  and  $j$ , respectively, defined here as their quality-weighted areas; and  $\beta$ , set to 1 in this case, is an optional weighting exponent that adjusts the importance of node capacity relative to inter-node distances in the calculation of IF. IF values represent the contribution of individual nodes to the global EC metric.

## References

- Foltête J-C, Girardet X, Clauzel C (2014) A methodological framework for the use of landscape graphs in land-use planning. *Landscape Urban Plan* 124:140–150.
- Sahraoui Y, Foltête J-C, Clauzel C (2017) A multi-species approach for assessing the impact of land-cover changes on landscape connectivity. *Landscape Ecol* 32:1819–1835.
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- Saura S, Pascual-Hortal L (2007) A new habitat availability index to integrate connectivity in landscape conservation planning: Comparison with existing indices and application to a case study. *Landscape Urban Plan* 83:91–103.
- Stuart CE, Wedding LM, Pittman SJ, Green SJ (2021) Habitat suitability modeling to inform seascape connectivity conservation and management. *Diversity* 13:465.

**Table S1.** Descriptions of fifteen sites considered for restoration under Florida’s ‘Mission: Iconic Reefs’ coral restoration initiative.

Site	‘Iconic Reef’	Site description	Node area (m <sup>2</sup> )		Distance from node to mangrove (m)		Distance from node to seagrass (m)	
			<i>L. griseus</i>	<i>H. sciurus</i>	<i>L. griseus</i>	<i>H. sciurus</i>	<i>L. griseus</i>	<i>H. sciurus</i>
Turtle Reef <sup>†</sup>	No	Mid-channel patch reef	606400	1042000	7675.78	7744.21	893.51	860.09
Horseshoe Reef	Yes	Mid-channel patch reef	316500	2485400	6583.00	6817.69	1075.83	574.01
Elbow Reef	No	Reef margin/fore reef	492900	1589600	10207.00	10298.05	2647.72	2998.98
Key Largo Dry Rocks	No	Reef margin/fore reef	47800	56400	7309.46	7314.44	2126.55	2129.03
French Reef	No	Reef margin/fore reef	857200	4450600	9539.40	9098.33	729.07	1119.42
Molasses Reef	No	Reef margin/fore reef	622800	4450600	8943.65	9098.33	1288.60	1119.42
Hen and Chickens	No	Mid-channel patch reef	37800	38100	3322.17	3322.13	52.67	52.41
Davis Reef	No	Reef margin/fore reef	112400	451400	7693.12	7722.50	492.30	647.21
Cheeca Rocks	Yes	Inshore patch reef	14100	915300	6434.26	6480.71	14.09	88.84
Tennessee Reef	No	Reef margin/fore reef	175300	362400	6954.30	7061.38	1665.11	1635.42
Coffins Patch	No	Offshore patch reef	131700	131300	6467.76	6469.37	170.81	169.18
South of Key Colony Beach	No	Mid-channel patch reef	18600	18400	4283.31	4283.66	20.75	20.96
Sombrero Reef	Yes	Reef margin/fore reef	914900	1603300	7475.39	7508.08	1043.59	1087.57
Newfound Harbor	Yes	Inshore patch reef	486300	70519600	1072.40	1209.96	153.45	308.88
Looe Key Reef	Yes	Reef margin/fore reef	489900	950100	8957.09	9005.25	339.94	490.23

<sup>†</sup>Turtle Reef — a mid-channel patch reef within the state waters of John Pennekamp Coral Reef State Park in the Upper Keys — may also be referred to as Turtle Rocks or East Ocean Reef in other sources.

**Table S2.** A comparison of candidate ‘Mission: Iconic Reefs’ site rankings for sub-adult *Lutjanus griseus* based on Interaction Flux (IF) measures of local connectivity (assuming a 10 km dispersal threshold) and empirical observations from daytime reef fish surveys that spatially coincided with suitable nodes.

Site	‘Iconic Reef’	IF <sub>10 km</sub>	Site ranking by IF <sub>10 km</sub>	Number of <i>in situ</i> surveys	Proportion of surveys with sub-adult <i>L. griseus</i> present	Site ranking by proportion of positive surveys
Turtle Reef	No	2.93 x 10 <sup>13</sup>	4	1	1.00	1
Horseshoe Reef	Yes	1.41 x 10 <sup>13</sup>	7	6	0.33	3
Elbow Reef	No	1.67 x 10 <sup>13</sup>	6	15	0.27	6
Key Largo Dry Rocks	No	2.44 x 10 <sup>12</sup>	13	10	0.30	5
French Reef	No	3.70 x 10 <sup>13</sup>	3	14	0.14	9
Molasses Reef	No	2.66 x 10 <sup>13</sup>	5	21	0.19	8
Hen and Chickens	No	4.51 x 10 <sup>12</sup>	12	4	0.75	2
Davis Reef	No	5.57 x 10 <sup>12</sup>	11	2	0.00	10
Cheeca Rocks	Yes	1.86 x 10 <sup>12</sup>	15	0	N/A	N/A
Tennessee Reef	No	7.44 x 10 <sup>12</sup>	8	20	0.00	10
Coffins Patch	No	6.78 x 10 <sup>12</sup>	9	13	0.00	10
South of Key Colony Beach	No	2.18 x 10 <sup>12</sup>	14	0	N/A	N/A
Sombrero Reef	Yes	4.28 x 10 <sup>13</sup>	2	22	0.32	4
Newfound Harbor	Yes	4.99 x 10 <sup>13</sup>	1	10	0.20	7
Looe Key Reef	Yes	6.37 x 10 <sup>12</sup>	10	18	0.33	3

**Table S3.** A comparison of candidate ‘Mission: Iconic Reefs’ site rankings for sub-adult *Haemulon sciurus* based on Interaction Flux (IF) measures of local connectivity (assuming a 10 km dispersal threshold) and empirical observations from daytime reef fish surveys that spatially coincided with suitable nodes.

Site	‘Iconic Reef’	IF <sub>10 km</sub>	Site ranking by IF <sub>10 km</sub>	Number of <i>in situ</i> surveys	Proportion of surveys with sub-adult <i>H. sciurus</i> present	Site ranking by proportion of positive surveys
Turtle Reef	No	6.44 x 10 <sup>13</sup>	8	1	1.00	1
Horseshoe Reef	Yes	1.22 x 10 <sup>14</sup>	5	17	0.71	2
Elbow Reef	No	8.92 x 10 <sup>13</sup>	6	34	0.59	5
Key Largo Dry Rocks	No	3.13 x 10 <sup>12</sup>	13	11	0.64	3
French Reef	No	2.84 x 10 <sup>14</sup>	2	56	0.32	10
Molasses Reef	No	2.84 x 10 <sup>14</sup>	2	56	0.32	10
Hen and Chickens	No	5.73 x 10 <sup>12</sup>	12	5	1.00	1
Davis Reef	No	4.20 x 10 <sup>13</sup>	9	18	0.61	4
Cheeca Rocks	Yes	1.31 x 10 <sup>14</sup>	4	15	0.53	7
Tennessee Reef	No	2.97 x 10 <sup>13</sup>	10	24	0.04	12
Coffins Patch	No	1.06 x 10 <sup>13</sup>	11	13	0.31	11
South of Key Colony Beach	No	2.86 x 10 <sup>12</sup>	14	0	N/A	N/A
Sombrero Reef	Yes	1.64 x 10 <sup>14</sup>	3	34	0.38	9
Newfound Harbor	Yes	1.19 x 10 <sup>16</sup>	1	16	0.44	8
Looe Key Reef	Yes	7.37 x 10 <sup>13</sup>	7	23	0.57	6