



## Space invaders; biological invasions in marine conservation planning

Sylvaine Giakoumi<sup>1,2\*</sup>, François Guilhaumon<sup>3</sup>, Salit Kark<sup>2</sup>, Antonio Terlizzi<sup>4,5</sup>, Joachim Claudet<sup>6,7</sup>, Serena Felling<sup>4</sup>, Carlo Cerrano<sup>8</sup>, Marta Coll<sup>9,10</sup>, Roberto Danovaro<sup>5,8</sup>, Simonetta Fraschetti<sup>4</sup>, Drosos Koutsoubas<sup>11,12</sup>, Jean-Batiste Ledoux<sup>10,13</sup>, Tessa Mazar<sup>14</sup>, Bastien Mérigot<sup>15</sup>, Fiorenza Micheli<sup>16</sup> and Stelios Katsanevakis<sup>11</sup>

<sup>1</sup>Université Nice Sophia Antipolis, CNRS, FRE 3729 ECOMERS, Parc Valrose, 28 Avenue Valrose, Nice 06108, France, <sup>2</sup>The Biodiversity Research Group, ARC Centre of Excellence for Environmental Decisions and NESP Threatened Species Recovery Hub, School of Biological Sciences, The University of Queensland, Brisbane, QLD, Australia, <sup>3</sup>Institut de Recherche pour le Développement (IRD), MARBEC - Biodiversité Marine et ses usages, UMR 9190, University of Montpellier, Montpellier, France, <sup>4</sup>Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, CoNISMa, Lecce 73100, Italy, <sup>5</sup>Stazione Zoologica Anton Dohrn, Villa Comunale I, Napoli, Italy, <sup>6</sup>National Center for Scientific Research, CRIOBE, USR 3278 CNRS-EPHE-UPVD, Perpignan, France, <sup>7</sup>Laboratoire d'Excellence CORAIL, Perpignan, France, <sup>8</sup>Dipartimento di Scienze della Vita e dell'Ambiente, Università Politecnica delle Marche, UO CoNISMa, via Brecce Bianche, I-60131 Ancona, Italy, <sup>9</sup>Institut de Recherche pour le Développement (IRD), UMR MARBEC & LMI ICEMASA, University of Cape Town, Private Bag X3, Rondebosch, Cape Town 7701, South Africa, <sup>10</sup>Institut de Ciències del Mar CSIC, Passeig Marítim de la Barceloneta 37-49, Barcelona E-08003, Spain, <sup>11</sup>Department of Marine Sciences, University of the Aegean, University Hill, Mytilene 81100, Greece, <sup>12</sup>National Marine Park of Zakynthos, Zakynthos 29100, Greece, <sup>13</sup>CIIMAR/CIMAR, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Porto, Portugal, <sup>14</sup>CSIRO Oceans and Atmosphere Flagship, EcoSciences Precinct 41, Brisbane, Qld, Australia, <sup>15</sup>UMR 9190 MARBEC, University of Montpellier, Station Ifremer, Avenue Jean Monnet, BP 171, Sète Cedex

### ABSTRACT

**Aim** Biological invasions are major contributors to global change and native biodiversity decline. However, they are overlooked in marine conservation plans. Here, we examine for the first time the extent to which marine conservation planning research has addressed (or ignored) biological invasions. Furthermore, we explore the change of spatial priorities in conservation plans when different approaches are used to incorporate the presence and impacts of invasive species.

**Location** Global analysis with a focus on the Mediterranean Sea region.

**Methods** We conducted a systematic literature review consisting of three steps: (1) article selection using a search engine, (2) abstract screening and (3) review of pertinent articles, which were identified in the second step. The information extracted included the scale and geographical location of each case study as well as the approach followed regarding invasive species. We also applied the software MARXAN to produce and compare conservation plans for the Mediterranean Sea that either protect, or avoid areas impacted by invasives, or ignore the issue. One case study focused on the protection of critical habitats, and the other on endemic fish species.

**Results** We found that of 119 papers on marine spatial plans in specific biogeographic regions, only three (2.5%) explicitly took into account invasive species. When comparing the different conservation plans for each case study, we found that the majority of selected sites for protection (ca. 80%) changed in the critical habitat case study, while this proportion was lower but substantial (27%) in the endemic fish species case study.

**Main conclusions** Biological invasions are being widely disregarded when planning for conservation in the marine environment across local to global scales. More explicit consideration of biological invasions can significantly alter spatial conservation priorities. Future conservation plans should explicitly account for biological invasions to optimize the selection of marine protected areas.

### Keywords

alien species, biological invasions, conservation planning, impacts, management actions, marine biogeographic regions, marine protected areas, Mediterranean Sea.