Marine Policy 112 (2020) 103791

Contents lists available at ScienceDirect

Marine Policy

journal homepage: http://www.elsevier.com/locate/marpol

China's Belt and Road Initiative: Conservation opportunities for threatened marine species and habitats

Mischa P. Turschwell [a,*], Christopher J. Brown [b], Ryan M. Pearson [c], Rod M. Connolly [d]

[a] Australian Rivers Institute, Griffith University, Nathan, QLD, 4111, Australia
[b] Australian Rivers Institute – Coast and Estuaries, School of Environment and Science, Griffith University, Nathan, QLD, 4111, Australia
[c] Australian Rivers Institute – Coast and Estuaries, Griffith University, Gold Coast, QLD, 4222, Australia
[d] Australian Rivers Institute – Coast and Estuaries, School of Environment and Science, Griffith University, Gold Coast, QLD, 4222, Australia

ARTICLE INFO

Keywords:
Biodiversity
Global
Infrastructure
Port
Spatial
Threats

ABSTRACT

China's Belt and Road Initiative is the world's largest infrastructure development project aimed at linking Europe and East Africa with Asia. Port infrastructure development associated with the maritime component of China's Belt and Road Initiative (mBRI) could have *trans*-boundary environmental impacts. These impacts are likely to affect key coastal marine habitats (coral reefs, mangroves, seagrasses and saltmarshes) and threatened marine species. We used spatial analyses to quantify the potential impacts of ports and subsequent increased shipping traffic associated with the mBRI for key habitats and species. Significant areas of individual countries coastal marine habitats could be affected by port development. Over 400 threatened marine species, including mammals, could be affected by port infrastructure, while over 200 threatened species are at risk from an increase in shipping traffic and noise pollution. A project of this magnitude provides an opportunity for a central governing body to develop and implement an overarching environmental framework and policy that mitigates risks to biodiversity.

1. Introduction

China's Belt and Road Initiative (BRI), or 'New Silk Road', is the world's largest infrastructure development project, aimed at linking Europe and East Africa with Asia. The initiative combines a large network of terrestrial and maritime routes with the intent of linking over 70 countries, with an estimated investment of US$8 trillion by 2049 [1]. The possible environmental impacts associated with the BRI will be *trans*-boundary in nature and cover enormous areas [2]. The development of infrastructure will likely have negative consequences for terrestrial and marine biodiversity, and key habitats [3]. A number of assessments have been made of the impacts of the BRI on several important terrestrial biodiversity attributes (e.g. threatened species, important bird areas, key biodiversity areas, and global ecoregions - [4, 5]. However, there are also potential impacts of infrastructure development associated with the new maritime trade routes on marine habitats and species. The maritime component of the BRI (mBRI) involves both the procurement and expansion of existing ports and construction of new ports, along with significant expansion of marine trade routes [2].

China has advocated that countries involved in the BRI should cooperate to enhance environmental protection and build a green Silk Road [1,4]. However, there remains scepticism about implementing environmental policy when there are multiple funding pathways and stakeholders involved [6], especially as species boundaries rarely coincide with national boundaries [7,8]. A fundamental step to informing appropriate conservation is quantifying and assessing the spatial patterns and potential ecological impacts of this development on key habitats and species. Global biodiversity assessments can inform conservation policy by highlighting potential hotspots of species or regions most at risk to infrastructure development, and can aid in developing management strategies at multiple spatial scales [9,10]. A project of this extraordinary magnitude may be an ideal opportunity for a central governing body to incorporate ecological best practice and sound *trans*-boundary conservation actions into development at a near global scale [5].

The development and expansion of ports, and increased marine traffic in shipping channels is likely to have profound and widespread impacts on marine ecosystems. Ports, for example, can affect coastal fisheries and their associated key habitats (e.g. seagrasses, mangroves,

* Corresponding author. Australian Rivers Institute, Griffith University, 170 Kessels Road, Nathan, QLD, 4111, Australia.
E-mail address: m.turschwell@griffith.edu.au (M.P. Turschwell).

https://doi.org/10.1016/j.marpol.2019.103791
Received 16 October 2019; Received in revised form 17 December 2019; Accepted 18 December 2019
0308-597X/

Table 1
The direct and indirect impacts of port development on marine species and habitats. The process of impact is described along with the chosen buffer distance(s) and rationale for choosing the buffer(s), with supporting evidence from the literature.

mBRI Threat	Process	Direct and Indirect Impacts	Buffer (s)	Rationale & Mechanisms
Port Infrastructure	Physical port construction	- Physical destruction of habitats	5 km	We measured the maximum linear dimension of ports by inspecting aerial imagery of BRI port sites. We omitted sites without existing ports. The frequency of port sizes at all other sites was predominantly 5 km or just under, with two ports considerable larger. Although all of these sizes are for ports still awaiting development under the BRI project, they indicate that a distance of 5 km for direct port impacts is reasonable. Land reclamation often occurs with port development [11].
	Dredging and channel maintenance	- Physical destruction of habitats - Smothering of habitats - Increased suspended sediment loads		5 km is the likely maximum spatial extent of the impacts of dredging, however this can vary depending on local conditions [23]. Dredging activities can directly remove and smother marine habitats, or increase turbidity and reduce light availability [24]
Noise pollution	Port Construction	- Noise pollution from pile driving and dredging	10 km 50 km	Bottlenose dolphin behaviour can be affected by pile-driving up to 50 km away in the construction of offshore windfarms [25].
	Shipping	- Noise pollution from vessels travelling in and out of port	100 km	Noise of vessels is audible to killer whales 16 km away [26]. Evidence that shipping noise increases stress hormones in North Atlantic right whales [17]. Beluga whales appeared to actively avoid icebreakers at distances of 35–50 km [27,28]. Noise can impact marine mammal behaviours including mating, nursing and feeding. Noise from icebreakers is estimated to be audible to beluga whales up to 78 km away [29]. Loud vessels are potentially audible underwater when >100 km away [30][7].
Shipping traffic	Increased shipping traffic	- Vessel strikes - Light pollution - Oil spills - Physical disturbance	50 km 100 km	Increased shipping traffic increases the risk of collisions (e.g. with coral reefs, or marine mammals) [31,32]. Oil spills can have acute and chronic effects of marine biodiversity across large spatial scales [33]. We examined raw shipping data [34] and found that for many BRI ports, the 90th percentile of shipping traffic (the maximum number of ship tracks recorded in a single 1 km^2 cell) extended over 100 km. The creation of new marine trade routes may therefore increase the potential area affected by increased shipping traffic.

and corals) through coastal land clearing and dredging, which physically destroy habitats and increase sediment deposition and suspension [11–14]. Additionally, increased vessel traffic in ports and shipping channels intensifies risks to ecosystem function through bio-invasion [15], increases the likelihood of shipping accidents, and places stresses on species such as cetaceans through noise pollution and vessel strikes [16,17]. These impacts are likely to affect a wide range of key coastal habitats and species, hence there is a need for an assessment of the potential impacts of the developments associated with the maritime component of the BRI.

Here we make a synoptic assessment of the spatial footprint of the development and expansion of ports associated with the mBRI for coastal wetlands (here defined as seagrass, mangrove and saltmarsh habitats), coral reefs, and all threatened species (from IUCN assessments) that exist near planned developments. Coastal wetlands and coral reefs are critical marine habitats that provide a range of valuable ecosystem services including blue carbon storage, coastal protection, biodiversity conservation of charismatic megafauna and contribution to fisheries production [18–22]. In this study, we quantify the potential impacts of ports on (i) coastal wetlands and coral reefs (ii) threatened marine species, and (iii) key ecoregions (biodiversity areas and protected areas) for nations and marine regions that will be directly affected by the mBRI through infrastructure development. Specifically, we aim to identify hotspots of potential impact to coastal wetlands and coral reefs at the country or marine ecoregion level, as well as identify threatened marine species most likely to be affected by the mBRI. Our results may be used to inform policy considerations in the development of an overarching environmental framework that mitigates risks to biodiversity.

2. Methods

2.1. Data

2.1.1. Ports

We determined the location of the 70 ports proposed to be expanded or developed in association with the mBRI (Source: Mercator Institute for China Studies). Note that not all countries included in these analyses are BRI signatories, however for the purposes of this study we refer to all ports as BRI ports. Sixty-one ports were able to be extracted from the point layer of existing port locations around the world (available from Google data - https://goo.gl/Yu8xxt). The other nine ports were not listed, so these were added manually based on visual inspections of the proposed port locations using Google Earth. To help select a suitable buffer distance, we measured the maximum linear dimension of ports by inspecting aerial imagery of BRI port sites. We omitted sites without existing ports. The frequency of port sizes at all other sites was predominantly 5 km or just under, with two ports considerable larger. Although all of these sizes are for ports still awaiting development under the BRI project, they indicate that a distance of 5 km for direct port impacts is reasonable. This is supported by previous work that suggests port related dredging activities are unlikely to extend beyond 5 km [14]; Table 1). Increased shipping traffic beyond a 5 km radius is addressed in our separate analyses of shipping routes. We note that indirect effects (e.g. increased pollution) may extend beyond 5 km, but in the absence of local data in every case, we cannot estimate the broader footprint of indirect effects at this stage. Thus, the impact footprint of port infrastructure we use should be considered a minimum.

2.1.2. Coastal marine habitats

Spatial information on the global distribution of coral reefs, mangroves, seagrasses and saltmarshes was obtained from the United Nations World Conservation Monitoring Centre (UNEP WCMC - http://data.unep-wcmc.org/- see Table S1 for full dataset details). The detrimental impacts of port infrastructure have been well established for the coastal wetland habitats and for coral reefs where they occur close to

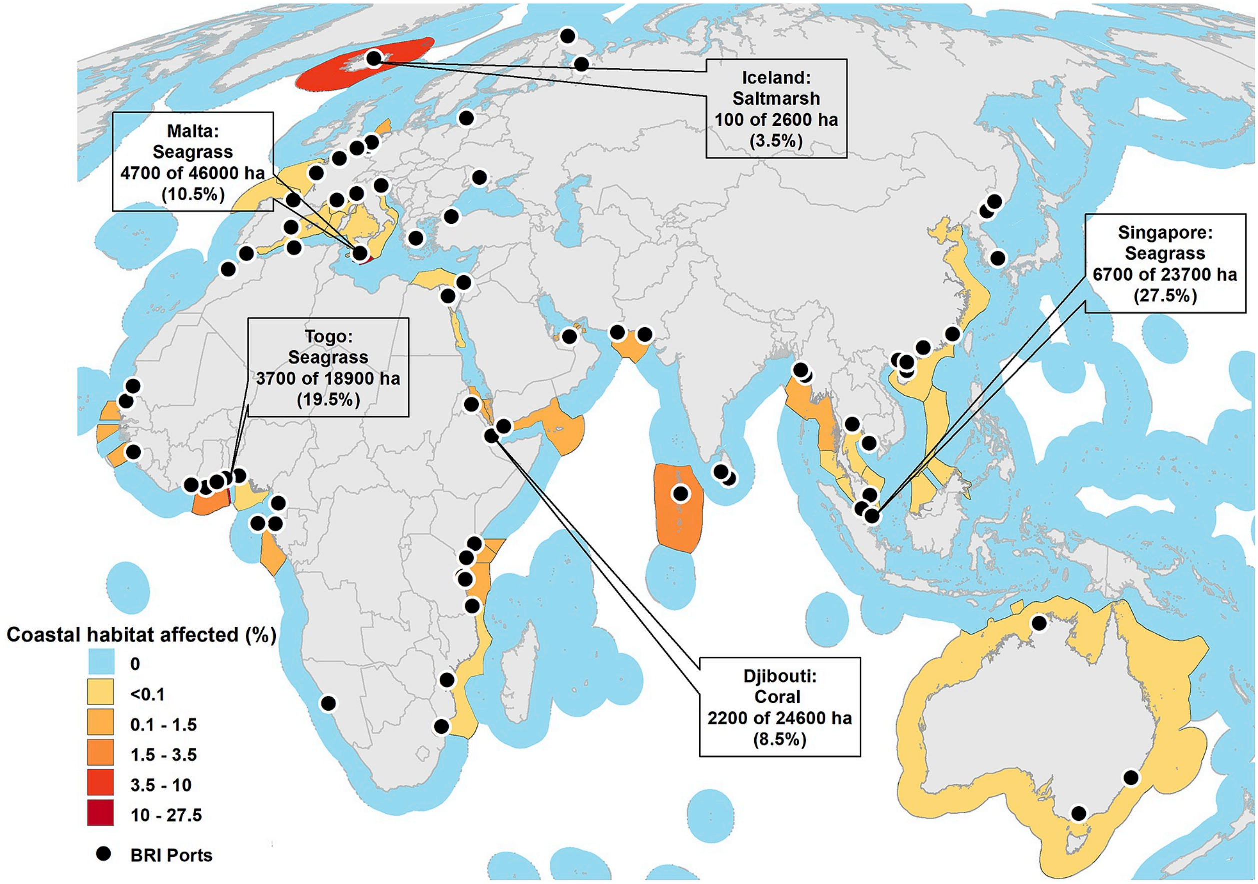

Fig. 1. Country scale percentages of area of coastal habitats (coral, mangrove, seagrass and saltmarsh) potentially affected by ports associated with the maritime component of the Belt and Road Initiative. Percentages are visualised by country and exclusive economic zone (EEZ). Countries (**bold**) and specific habitat types (*italics*) with the highest percentages of their distributions affected are highlighted.

shore [24,35].

2.1.3. Marine protected areas and key biodiversity areas

We assessed the potential impact of ports on marine protected areas (MPAs) and marine key biodiversity areas (KBAs) by quantifying spatial overlaps. Spatial information for MPAs was extracted from the 2017 World Database on Protected Areas (WDPA) (https://www.protectedplanet.net/). Marine KBAs were extracted from the global dataset containing the current boundaries for KBAs (http://www.keybiodiversityareas.org/home).

2.1.4. Threatened species

We collected spatial information on threatened marine taxa from the IUCN red list of threatened species (http://www.iucnredlist.org/technical-documents/spatial-data - full search criteria are listed in Table S2). All species considered threatened (those assessed as Vulnerable, Endangered, or Critically Endangered) and present in coastal and marine habitats were included in spatial analyses. Spatial information on the distributions of threatened species was available for 837 plant and animal species.

2.2. Spatial analyses

Spatial processing was conducted using ESRI ArcGIS 10.1 and R statistical software [36] using the *sf* package [37]. Spatial layers were projected into the World Mollweide Projection prior to analyses.

2.2.1. Spatial footprint of ports on coastal habitats and protected areas

We used geometric intersections between each of the individual habitat layers and the buffered ports to quantify the potential area of each coastal habitat type affected within the 5 km port buffer (Table 1). We then intersected each habitat layer with country level (economic exclusion zone - EEZ) data [38], as well as the marine ecoregions of the world (MEOW - [39] to calculate the total area of each type of coastal habitat present within each country's EEZ and marine ecoregion. We applied a 50 km buffer into land to the MEOW layer to ensure that we captured the full extent of coastal mangrove and saltmarsh habitats, because their distributions were often further inland than the existing extent of the MEOW layer. Following intersections, we calculated the total area that may be affected by ports at both the country (EEZ) and marine province (MEOW) level and joined this information to the corresponding layer. We then calculated the percentage of total habitat area potentially affected by ports within either country or MEOW using the following formula:

$$\% = \frac{Area\ impacted\ by\ ports^{Region}}{Total\ habitat\ area^{Region}} \times 100$$

2.2.2. Spatial footprint of ports on threatened species

We used the same methodological approach as described above for coastal habitats and protected areas to calculate the percentage of total range of each threatened species potentially affected by ports in both countries and MEOW provinces.

2.2.3. Potential impacts of shipping and noise pollution on threatened species

We also assessed the potential impact of increased shipping traffic and noise pollution on threatened animal and plant species by testing whether species ranges intersected within the buffers on BRI ports that

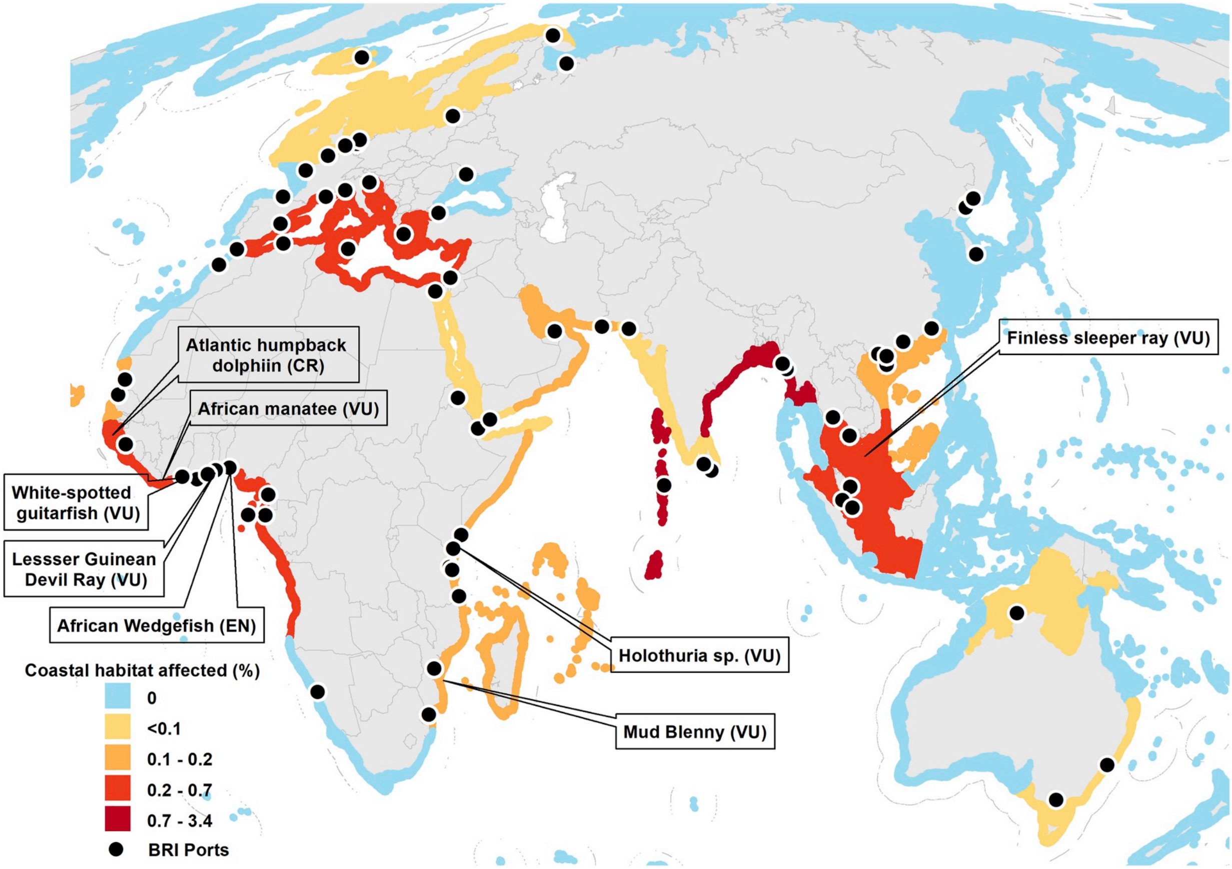

Fig. 2. Province scale percentages of potential impacts on habitats and species. Area of coastal habitats (coral, mangrove, seagrass and saltmarsh) potentially impacted by ports associated with the Belt and Road Initiative. Percentages were calculated by MEOW Provinces. Threatened species with the highest percentages of their ranges affected are highlighted and their Red List status highlighted. CR = critically endangered, EN = Endangered, VU = vulnerable.

represented shipping traffic and noise pollution (Table 1). From the initial IUCN search criteria, we selected the subset of species listed as under threat by either 'Shipping lanes' or 'Noise pollution', resulting in a total of 290 species.

To assess shipping lanes, we tested two potential buffers (Table 1) around BRI ports and intersected these with the spatial distribution of each species specifically listed as threatened by shipping lanes. We visually inspected shipping traffic near BRI ports based on the 90th percentile of raw shipping data [34]. We found that the extent of shipping lanes extended to around 100 km for several BRI ports, so tested both 50 km and 100 km buffers as proxies for increased shipping traffic due a paucity of data predicting new shipping routes and traffic increases associated with BRI development. If a species range intersected with the buffer, we deemed that species may be affected by either new or increased shipping traffic due to the large and spatially variable impacts of shipping [12].

To assess noise pollution, we also tested a number of potential buffers around BRI ports based on literature searches (Table 1). Due to the variability in distances that species are affected by noise pollution, we tested three buffer distances and intersected these with the spatial distribution of each species listed as threatened by noise pollution. As with shipping traffic, if a species range intersected with the port buffer, we deemed that species would likely be affected by noise pollution from either port construction or through shipping noise.

3. Results

3.1. Ports

We found that ports associated with the mBRI could negatively impact a range of important coastal marine habitats (Fig. 1) and up to 410 threatened species across large spatial scales (Fig. 2). Overall, using a 5 km buffer to represent the effects of infrastructure development, we found that ports could potentially affect 55 300 ha of seagrass, 8400 ha of coral, 4000 ha of mangrove and 2100 ha of saltmarshes. Within a country, the highest proportion of coastal marine habitat potentially impacted by ports associated with the mBRI is 27.5% (Fig. 1). Countries with the highest proportional impacts are generally small, and these impacts are generally dominated by a particular habitat type (Fig. 1). For example, Togo has 3700 of 18 9000 ha (19.5%) of seagrass area potentially affected, Djibouti has 2200 of 24 600 ha (8.5%) of coral, and Singapore has 6700 of 23 700 ha (27.5%) of seagrass (Fig. 1).

At the marine province level ('realm' in brackets), the province expected to be most impacted is the Central Indian Ocean Islands (Western Indo-Pacific), with 3.4% of the total coastal marine habitat area at risk from port development and expansion (Fig. 2). The Bay of Bengal (0.7%) (Western Indo-Pacific), Sunda Shelf (0.4%) (Central Indo-Pacific), Mediterranean Sea (0.3%) (Temperate Northern Atlantic) and Gulf of Guinea (0.3%) (Tropical Atlantic) are also relatively vulnerable to port development (Fig. 2, Table S3).

A total of 410 vulnerable, threatened, or critically endangered plant and animal species have ranges intersecting with mBRI ports - 33 species are critically endangered, 67 endangered and 310 vulnerable. The most commonly affected species classes are sea anemones and corals (Anthozoa - 181 species), cartilaginous fishes (Chondrichthyes - 104 species), ray-finned fishes (Actinopterygii - 78 species), and mammals (Mammalia - 21 species). Eight species have over 0.1% of their range potentially affected (Fig. 2), and the most impacted species – the African Wedgefish (*Rhynchobatus luebberti*) – has 0.23% potentially affected. The central West African coast shows a high density of the most impacted

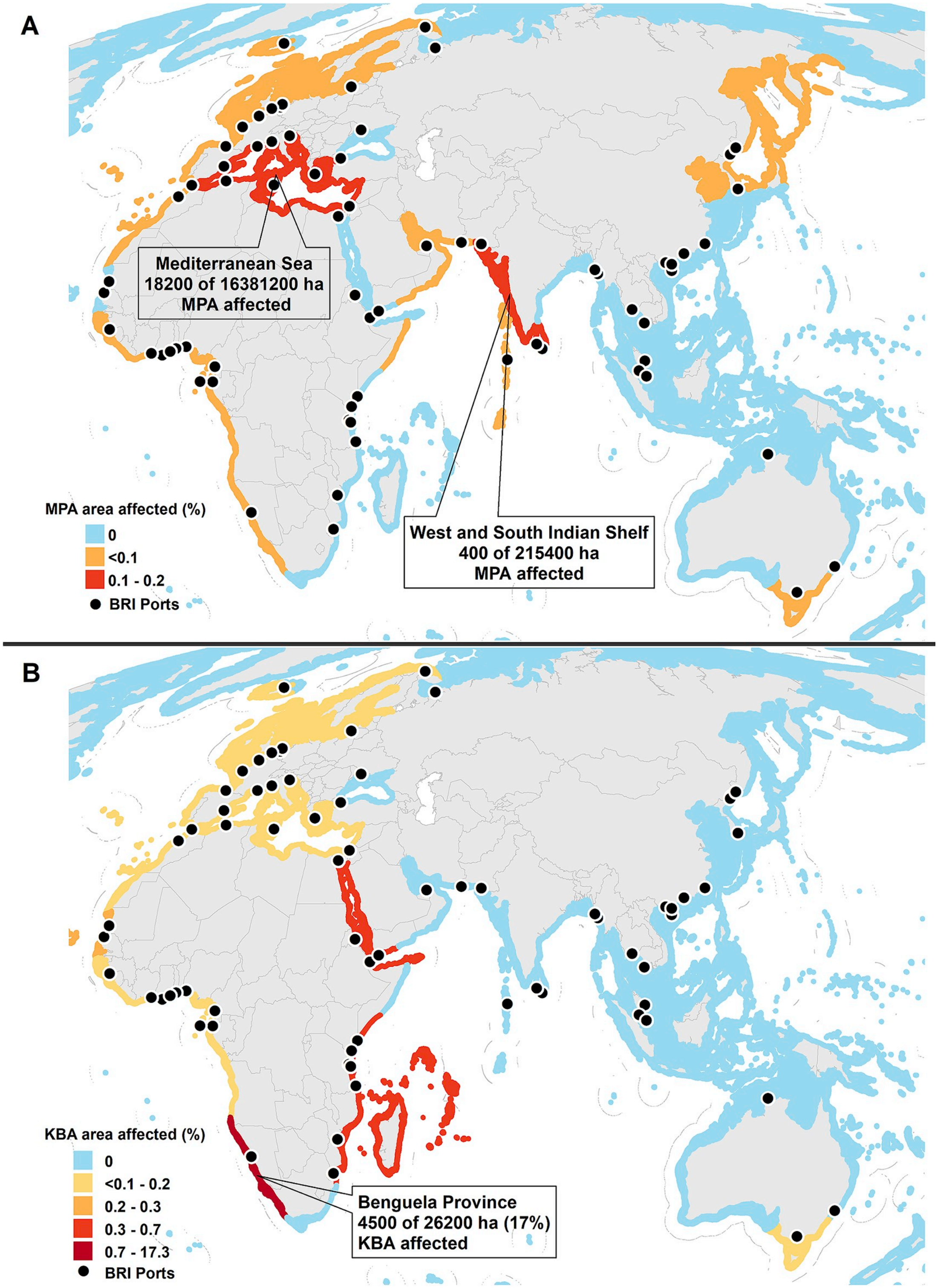

Fig. 3. Province scale percentages of area of A) Marine protected areas (MPAs) and B) Key biodiversity areas (KBAs) potentially impacted by ports associated with the Belt and Road Initiative. MPAs and KBAs with the highest percentages of their areas affected are highlighted.

species, including iconic species such as the vulnerable African manatee (*Trichechus senegalensis*), three vulnerable or endangered chondricthyans, and the critically endangered Atlantic humpback dolphin (*Sousa teuszii*) (Fig. 2).

We also found potential for ports to impact MPAs and KBAs, however the spatial patterns of potential impacts differed at the marine province level (Fig. 3A and B respectively, Table S4). The two most potentially impacted marine provinces for MPAs are the West and South Indian Shelf (0.2%) (Western Indo-Pacific) and Mediterranean Sea (0.1%) (Temperate Northern Atlantic) (Fig. 3A). Key Biodiversity Areas are expected to experience larger area percentages affected compared with MPAs. The marine province of Benguela (Temperate Southern Africa) is the most vulnerable with 4500 of 26 200 ha (17.3%) of marine KBA potentially impacted (Fig. 3B). The Red Sea and Gulf of Aden (0.6%) and Western Indian Ocean (0.3%) (both Western Indo-Pacific) are also ranked highly in terms of percentage of KBAs impacted by ports

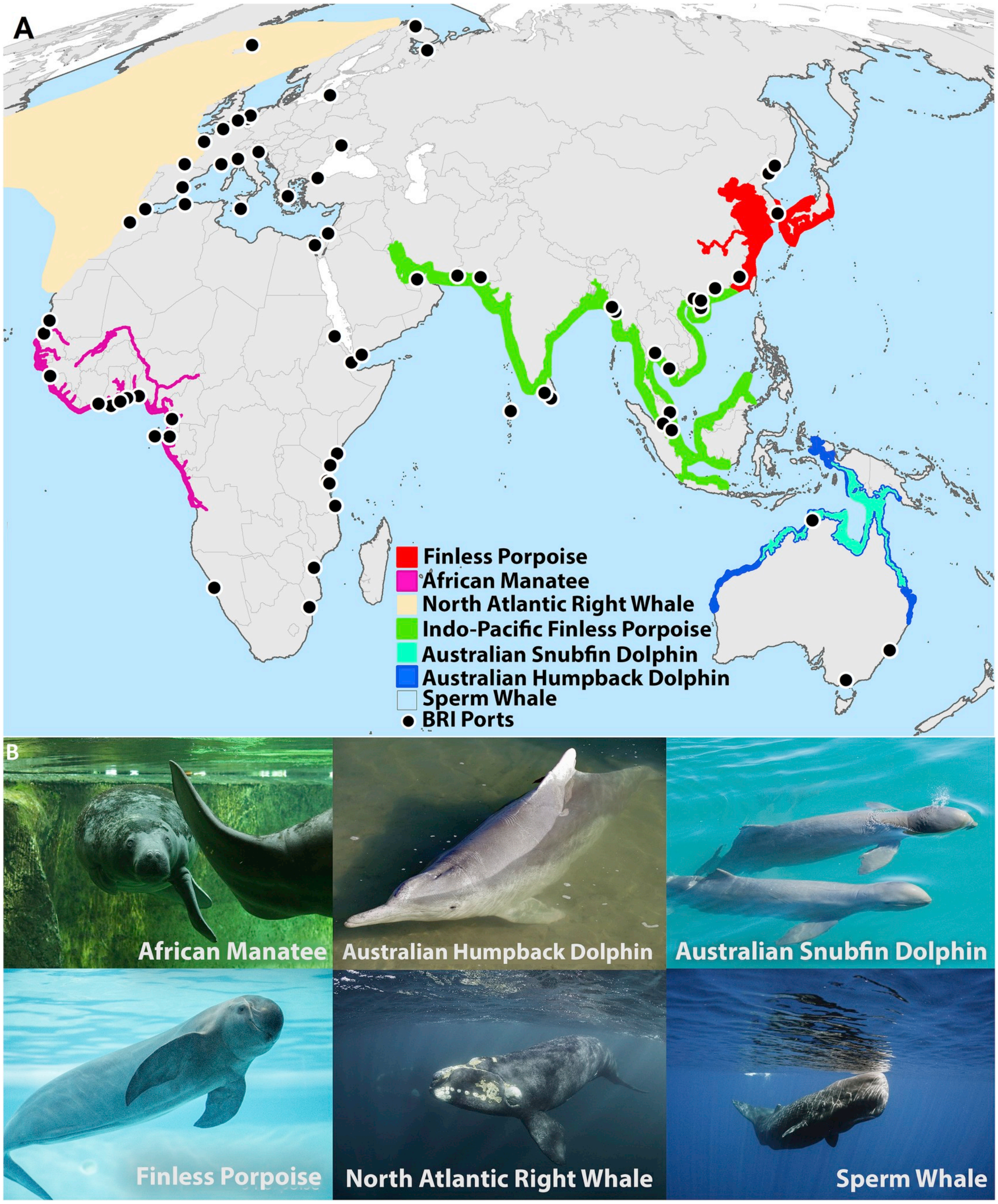

Fig. 4. A) Ranges of seven highlighted marine mammal species impacted by both shipping lanes and noise pollution. These species ranges intersect within both 50 and 100 km of at least one port associated with the maritime component of the Belt and Road Initiative. B) Images of the primary species impacted by both shipping lanes and noise pollution.

(Fig. 3B).

3.2. Shipping and noise

For threatened species with spatial data available (284 species), we found 209 species that are negatively impacted by shipping traffic. The same number of species were impacted under both the 50 km and 100 km buffers. The primary classes affected are sea anemones and corals (181 species), mammals (16 species), and cartilaginous fishes that include sharks and rays (7 species). Three species are listed as critically endangered, 22 endangered, and 184 vulnerable.

We found that 10 species are negatively impacted by noise (8 mammals and 2 ray-finned fishes), 4 of which are listed as endangered and 6 as vulnerable. The same species were affected under all three buffer distances (10 km, 50 km and 100 km). We also identified seven threatened marine mammals that could be simultaneously affected by both shipping lanes and noise pollution (Fig. 4A and B, Table S5). These seven species distributions cover a broad geographical extent, highlighting the global nature of the mBRI.

4. Discussion

Our spatial analysis shows that infrastructure development associated with the construction of new ports and expansion of existing ports for the mBRI could affect coastal marine habitats and a large number of threatened marine species across a very large area. We found the proportional impacts of the mBRI could be highest in small countries with relatively small coastal areas (e.g. Togo, Djibouti, and Malta) where considerable proportions of the total area of coastal marine habitat could be affected. The proportional impacts to marine ecoregions were lower compared to countries, however certain marine ecoregions such as the Western Indo-Pacific could still be considerably affected. A large number of marine threatened species, including mammals, could be impacted by port infrastructure and an increase in shipping lane traffic and associated noise pollution, highlighting the need to develop and implement comprehensive conservation practices for the mBRI.

We used globally available data-sets and standardized buffer distances to assess the impact of ports on biodiversity. It is likely that the true footprint of impacts would vary regionally due to ecological, geographic and oceanographic differences between local ports sites (e.g. Ref. [14]. However, it was necessary here to use these global data-sets and generic layers so that our large-scale analysis was spatially consistent across regions with varying information levels and data coverage. The spatial impact of ports is likely to be context-dependent, and will vary based on the existing level of infrastructure and planned expansion. The creation of new ports will impose novel impacts on local marine biodiversity, however the expansion of established ports still poses risks to coastal ecosystems through dredging, land reclamation, and increased shipping traffic and accidents [11]. Future studies and environmental impact assessments should assess the impacts of individual ports with finer-scale data and local knowledge. Nevertheless, our results highlight the potential of such a large-scale infrastructure development project to impact threatened habitats and species.

Mitigating the risks to biodiversity from port development can be challenging due to political and socio-economic factors [11] but there are, nevertheless, still actions that can be taken to minimise risks. For example, the impacts of increased suspended sediment associated with dredging around ports could be mitigated for seagrasses by monitoring benthic light availability and temporarily halting dredging when light levels fall below thresholds for seagrass growth [40]. Similarly for fish, the introduction of seasonal restrictions in sediment loads during critical life history stages may reduce sediment induced mortality [14]. Increased shipping traffic offers different challenges for the management of marine biodiversity, as impacts including oil spills, noise disturbance and direct strikes can occur over larger spatial extents [33]. Mitigation measures such as enforced speed restrictions, designated areas to be avoided (ATBAs), and altered vessel routes during seasonal migratory periods and within key feeding and nursery areas can be effective for marine mammals [41]. Improved oil spill prevention, communication and reporting can reduce the probability of other risks to marine species and habitats [33]. Conservation practices are most effective when supported by scientific evidence [42] and the development of threat management plans to offset the impacts of the mBRI could employ an ecosystem-based approach to deliver sustainable development for coastal marine environments [43].

Mitigating the environmental impacts associated with the mBRI is complex and multi-scaled. China has recently strengthened environmental regulations and environmental governance frameworks, though questions surrounding how these regulations compare to international best practice still remain [44,45]. Similarly, environmental policies are being developed and implemented with specific regard to BRI projects, however, there is apprehension about translating these policies into practice, especially for *trans*-jurisdictional projects [45]. Recent works have started to investigate the economic and logistic implications of the mBRI [46,47], however guidelines and policy for biodiversity conservation in the marine sector are currently lacking.

5. Conclusions

The mBRI project provides an opportunity to take an internationally coordinated approach to ecologically sensitive development (*sensu* [48]. Environmental planning for the mBRI could use newly developed environmental governance frameworks [49], or improve on existing frameworks for environmental impact assessments, strategic environmental assessments, and strategic land use planning [50] to minimise the risks of port and shipping development and expansion on marine biodiversity. There are a number of existing solutions to minimise the impacts of shipping, though such measures would need to be implemented internationally given the near global nature of the mBRI project. The implementation of an overarching framework is especially needed in regions most at risk of biodiversity and habitat loss, as well as in countries lacking the financial backing to implement proper environmental protection policies [51]. Local or regional EIAs may become redundant without an overarching enforceable policy that has biodiversity conservation as its core principle [5]. One of the advantages of the many port developments coming under the single umbrella of the BRI project is that a central governing body has the opportunity to request and potentially help develop such a framework for environmental protection. The framework would need to include provisions to ensure its support in countries that lack the capacity to undertake such work. The global integration of conservation measures for the mBRI could ensure the best possible outcomes for biodiversity conservation.

Declaration of competing interest

The authors of this manuscript have no conflict of interest to declare.

CRediT authorship contribution statement

Mischa P. Turschwell: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Christopher J. Brown:** Funding acquisition, Methodology, Writing - original draft, Writing - review & editing, Visualization. **Ryan M. Pearson:** Data curation, Writing - original draft, Writing - review & editing, Visualization. **Rod M. Connolly:** Supervision, Conceptualization, Funding acquisition, Investigation, Writing - original draft, Writing - review & editing, Visualization.

Acknowledgements

We acknowledge support from multiple sources: CJB - Early Career Researcher Award (DE160101207) from the Australian Research Council; CJB, RMC and MPT - Discovery Project (DP180103124) from the Australian Research Council; all authors from The Global Wetlands Project. We thank J. Ibarra and J. Chapman for assistance with data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpol.2019.103791.

References

[1] J.W. Kirchherr, L. Repp, R. van Santen, P. Verweij, X. Hu, J. Hall, Greening the Belt and Road Initiative WWF's Recommendations for the Finance Sector, World Wildlife Fund, Gland, Switzerland, 2018.
[2] F. Ascensão, L. Fahrig, A.P. Clevenger, R.T. Corlett, J.A. Jaeger, W.F. Laurance, H. M. Pereira, Environmental challenges for the Belt and road initiative, Nat. Sustain. 1 (2018) 206–209.
[3] A.M. Lechner, F.K.S. Chan, A. Campos-Arceiz, Biodiversity conservation should be a core value of China's Belt and Road Initiative, Nat. Ecol. Evol. 2 (2018) 408–409.
[4] WWF, The Belt and Road Initiative - WWF Recommendations and Spatial Analysis. World Wildlife Fund - EU, 2017. Available at: http://awsassets.panda.org/downloads/the_belt_and_road_initiative__wwf_recommendations_and_spatial_analysis__may_2017.pdf.
[5] A.C. Hughes, Understanding and minimizing environmental impacts of the Belt and road initiative, Conserv. Biol. 33 (2019) 883–894.
[6] R.E. Grumbine, Using transboundary environmental security to manage the Mekong river: China and South-East Asian countries, Int. J. Water Resour. Dev. 34 (2018) 792–811.

[7] L. López-Hoffman, R.G. Varady, K.W. Flessa, P. Balvanera, Ecosystem services across borders: a framework for transboundary conservation policy, Front. Ecol. Environ. 8 (2010) 84–91.
[8] A.V. Vitkalova, L. Feng, A.N. Rybin, B.D. Gerber, D.G. Miquelle, T. Wang, H. Yang, E.I. Shevtsova, V.V. Aramilev, J. Ge, Transboundary cooperation improves endangered species monitoring and conservation actions: a case study of the global population of Amur leopards, Conserv. Lett. 11 (2018), e12574.
[9] N. Myers, R.A. Mittermeier, C.G. Mittermeier, G.A. Da Fonseca, J. Kent, Biodiversity hotspots for conservation priorities, Nature 403 (2000) 853–858.
[10] R.A. Mittermeier, W.R. Turner, F.W. Larsen, T.M. Brooks, C. Gascon, Global Biodiversity Conservation: the Critical Role of Hotspots, Biodiversity hotspots. Springer, 2011, pp. 3–22.
[11] A. Grech, R. Coles, H. Marsh, A broad-scale assessment of the risk to coastal seagrasses from cumulative threats, Mar. Policy 35 (2011) 560–567.
[12] A. Grech, M. Bos, J. Brodie, R. Coles, A. Dale, R. Gilbert, M. Hamann, H. Marsh, K. Neil, R.L. Pressey, M.A. Rasheed, M. Sheaves, A. Smith, Guiding principles for the improved governance of port and shipping impacts in the Great Barrier Reef, Mar. Pollut. Bull. 75 (2013) 8–20.
[13] L.C. Cullen-Unsworth, R. Unsworth, A call for seagrass protection, Science 361 (2018) 446–448.
[14] A.S. Wenger, C.A. Rawson, S. Wilson, S.J. Newman, M.J. Travers, S. Atkinson, N. Browne, D. Clarke, M. Depczynski, P.L.A. Erftemeijer, R.D. Evans, J.P.A. Hobbs, J.L. McIlwain, D.L. McLean, B.J. Saunders, E. Harvey, Management strategies to minimize the dredging impacts of coastal development on fish and fisheries, Conserv. Lett. 11 (2018), e12572.
[15] H. Seebens, M. Gastner, B. Blasius, The risk of marine bioinvasion caused by global shipping, Ecol. Lett. 16 (2013) 782–790.
[16] H.P. Huntington, A preliminary assessment of threats to arctic marine mammals and their conservation in the coming decades, Mar. Policy 33 (2009) 77–82.
[17] R.M. Rolland, S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S. K. Wasser, S.D. Kraus, Evidence that ship noise increases stress in right whales, Proc. R. Soc. Biol. Sci. 279 (2012) 2363–2368.
[18] C.H. Ainsworth, P.J. Mumby, Coral–algal phase shifts alter fish communities and reduce fisheries production, Glob. Chang. Biol. 21 (2015) 165–172.
[19] T.B. Atwood, R.M. Connolly, H. Almahasheer, P.E. Carnell, C.M. Duarte, C.J. Ewers Lewis, X. Irigoien, J.J. Kelleway, P.S. Lavery, P.I. Macreadie, O. Serrano, C. J. Sanders, I. Santos, A.D.L. Steven, C.E. Lovelock, Global patterns in mangrove soil carbon stocks and losses, Nat. Clim. Chang. 7 (2017) 523–528.
[20] J.P. Hochard, S. Hamilton, E.B. Barbier, Mangroves shelter coastal economic activity from cyclones, Proc. Natl. Acad. Sci. 116 (2019) 12232–12237.
[21] K. Rogers, J.J. Kelleway, N. Saintilan, J.P. Megonigal, J.B. Adams, J.R. Holmquist, M. Lu, L. Schile-Beers, A. Zawadzki, D. Mazumder, C.D. Woodroffe, Wetland carbon storage controlled by millennial-scale variation in relative sea-level rise, Nature 567 (2019) 91–95.
[22] M. Sievers, C.J. Brown, V.J.D. Tulloch, R.M. Pearson, J.A. Haig, M.P. Turschwell, R.M. Connolly, The role of vegetated coastal wetlands for marine megafauna conservation, Trends Ecol. Evol. 34 (2019) 807–817.
[23] A. Grech, E. Hanert, L. McKenzie, M. Rasheed, C. Thomas, S. Tol, M. Wang, M. Waycott, J. Wolter, R. Coles, Predicting the cumulative effect of multiple disturbances on seagrass connectivity, Glob. Chang. Biol. 24 (2018) 3093–3104.
[24] P.L. Erftemeijer, R.R.R. Lewis III, Environmental impacts of dredging on seagrasses: a review, Mar. Pollut. Bull. 52 (2006) 1553–1572.
[25] H. Bailey, B. Senior, D. Simmons, J. Rusin, G. Picken, P.M. Thompson, Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals, Mar. Pollut. Bull. 60 (2010) 888–897.
[26] C. Erbe, Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model, Mar. Mamm. Sci. 18 (2002) 394–418.
[27] K.J. Finley, G.W. Miller, R.A. Davis, C.R. Greene, Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian high arctic, Can. Bull. Fish. Aquat. Sci. 224 (1990) 97–117.
[28] S.E. Cosens, L.P. Dueck, Icebreaker noise in Lancaster Sound, NWT, Canada: implications for marine mammal behavior, Mar. Mamm. Sci. 9 (1993) 285–300.
[29] C. Erbe, D.M. Farmer, Zones of impact around icebreakers affecting beluga whales in the Beaufort Sea, J. Acoust. Soc. Am. 108 (2000) 1332–1340.
[30] W.D. Halliday, S.J. Insley, R.C. Hilliard, T. de Jong, M.K. Pine, Potential impacts of shipping noise on marine mammals in the western Canadian Arctic, Mar. Pollut. Bull. 123 (2017) 73–82.
[31] J. Hazel, I.R. Lawler, H. Marsh, S. Robson, Vessel speed increases collision risk for the green turtle *Chelonia mydas*, Endanger. Species Res. 3 (2007) 105–113.
[32] T. Priyadarshana, S.M. Randage, A. Alling, S. Calderan, J. Gordon, R. Leaper, L. Porter, Distribution patterns of blue whale (*Balaenoptera musculus*) and shipping off southern Sri Lanka, Reg. Stud. Mar. Sci. 3 (2016) 181–188.
[33] H.P. Huntington, R. Daniel, A. Hartsig, K. Harun, M. Heiman, R. Meehan, G. Noongwook, L. Pearson, M. Prior-Parks, M. Robards, G. Stetson, Vessels, risks, and rules: planning for safe shipping in Bering Strait, Mar. Policy 51 (2015) 119–127.
[34] B.S. Halpern, M. Frazier, J. Potapenko, K.S. Casey, K. Koenig, C. Longo, J. S. Lowndes, R.C. Rockwood, E.R. Selig, K.A. Selkoe, S. Walbridge, Spatial and temporal changes in cumulative human impacts on the world's ocean, Nat. Commun. 6 (2015) 7615.
[35] T. Spencer, M. Schuerch, R.J. Nicholls, J. Hinkel, D. Lincke, A.T. Vafeidis, R. Reef, L. McFadden, S. Brown, Global coastal wetland change under sea-level rise and related stresses: the DIVA Wetland Change Model, Glob. Planet. Chang. 139 (2016) 15–30.
[36] R Development Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2017, p. 2016.
[37] E. Pebesma, Sf: Simple Features for R. R Package Version 0.5-0, 2017.
[38] Flanders Marine Institute, Maritime Boundaries Geodatabase: Maritime Boundaries and Exclusive Economic Zones (200NM), Version 8, 2014.
[39] M.D. Spalding, H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdaña, M. Finlayson, B. S. Halpern, M.A. Jorge, A. Lombana, S.A. Lourie, Marine ecoregions of the world: a bioregionalization of coastal and shelf areas, AIBS (Am. Inst. Biol. Sci.) Bull. 57 (2007) 573–583.
[40] K.M. Chartrand, C.V. Bryant, A.B. Carter, P.J. Ralph, M.A. Rasheed, Light thresholds to prevent dredging impacts on the great barrier reef seagrass, *Zostera muelleri* ssp. capricorni, Front. Mar. Sci. 3 (2016) 106.
[41] P.B. Conn, G.K. Silber, Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales, Ecosphere 4 (2013) art43.
[42] W.J. Sutherland, A.S. Pullin, P.M. Dolman, T.M. Knight, The need for evidence-based conservation, Trends Ecol. Evol. 19 (2004) 305–308.
[43] F. Douvere, The importance of marine spatial planning in advancing ecosystem-based sea use management, Mar. Policy 32 (2008) 762–771.
[44] X. Sun, L. Gao, H. Ren, Y. Ye, A. Li, M. Stafford-Smith, J.D. Connor, J. Wu, B. A. Bryan, China's progress towards sustainable land development and ecological civilization, Landsc. Ecol. 33 (2018) 1647–1653.
[45] H.C. Teo, A.M. Lechner, G.W. Walton, F.K.S. Chan, A. Cheshmehzangi, M. Tan-Mullins, H.K. Chan, T. Sternberg, A. Campos-Arceiz, Environmental impacts of infrastructure development under the Belt and road initiative, Environments 6 (2019) 72.
[46] P.T.W. Lee, Z.H. Hu, S.J. Lee, K.S. Choi, S.H. Shin, Research trends and agenda on the Belt and Road (B&R) initiative with a focus on maritime transport, Marit. Policy Manag. 45 (2018) 282–300.
[47] X. Qiu, E.Y. Wong, J.S.L. Lam, Evaluating economic and environmental value of liner vessel sharing along the maritime silk road, Marit. Policy Manag. 45 (2018) 336–350.
[48] A. Lechner, N. McIntyre, K. Witt, C. Raymond, S. Arnold, M. Scott, W. Rifkin, Challenges of integrated modelling in mining regions to address social, environmental and economic impacts, Environ. Model. Softw 93 (2017) 268–281.
[49] N.J. Bennett, T. Satterfield, Environmental governance: a practical framework to guide design, evaluation, and analysis, Conserv. Lett. 11 (2018), e12600.
[50] W.F. Laurance, I.B. Arrea, Roads to riches or ruin? Science 358 (2017) 442–444.
[51] N. Butt, H. Beyer, J. Bennett, D. Biggs, R. Maggini, M. Mills, A. Renwick, L. Seabrook, H. Possingham, Biodiversity risks from fossil fuel extraction, Science 342 (2013) 425–426.