



**QUEEN'S
UNIVERSITY
BELFAST**

The critically endangered flapper skate (*Dipturus intermedius*): Recommendations from the first flapper skate working group meeting

Garbett, A., Phillips, N. D., Houghton, J. D. R., Prodöhl, P., Thorburn, J., Loca, S. L., Eagling, L. E., Hannon, G., Wise, D., Pothanikat, L., Gordon, C., Clarke, M., Williams, P., Hunter, R., McShane, R., Brader, A., Dodd, J., McGonigle, C., McIlvenny, H., ... Collins, P. C. (2021). The critically endangered flapper skate (*Dipturus intermedius*): Recommendations from the first flapper skate working group meeting. *Marine Policy*, 124, [104367]. <https://doi.org/10.1016/j.marpol.2020.104367>, <https://doi.org/10.1016/j.marpol.2020.104367>

Published in:

Marine Policy

Document Version:

Peer reviewed version

Queen's University Belfast - Research Portal:

[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights

© 2021 Elsevier Ltd.

This manuscript is distributed under a Creative Commons Attribution-NonCommercial-NoDerivs License

(<https://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits distribution and reproduction for non-commercial purposes, provided the author and source are cited.

General rights

Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

1 INTRODUCTION

2

3 Species in the ‘common skate’ species complex (*Dipturus batis*) display characteristics that
4 make them highly vulnerable to local extirpation, including low fecundity, strong site fidelity,
5 and vulnerability to being captured as bycatch [1, 2, 3]. The ‘common skate’ complex, hereafter
6 referred to as ‘common skate’ is composed of two species; the flapper *Dipturus intermedius*
7 and the blue skate *Dipturus batis* (previously referred to as *Dipturus cf flossada*), respectively
8 [4, 5, 6]. These two species differ in size and general distribution, with the flapper skate being
9 considerably larger and with a more coastal affinity [4, 6].

10

11 Once considered abundant (i.e., ‘common’ skate), the species complex is now listed by the
12 IUCN Red List of Threatened Species as Critically Endangered, with numbers decreasing [7,
13 8]. In 1999, ‘common skate’ was listed on the Biodiversity Action Plan (BAP) in the UK [9],
14 a Priority Marine Feature (PMF) in Scotland and Northern Ireland (NI) [10, 11], and has more
15 recently become a focal point for conservation in the Republic of Ireland. Additionally, in 2006,
16 many fisheries in the UK adopted a voluntary measure refraining from landing ‘common skate’
17 (A. Hood, March 2020, personal communications). As of 2009 the landing of ‘common skate’
18 by commercial fishing vessels has been prohibited in accordance with EU fisheries legislation
19 [12, updated annually]. However, catch and release recreational angling continues in some
20 regions, which can complement research activities. From 2011 onwards, ‘common skate’ were
21 included in the Wildlife (Northern Ireland) Order (1985 (as amended) through the Wildlife and
22 Natural Environment Act (Northern Ireland) 2011), followed by protection in Scotland in 2012
23 (Sharks, Skates and Rays (Prohibition of Fishing, Transhipment and Landing) (Scotland) Order
24 2012). The latter offers strengthened conservation of flapper skate by preventing the
25 recreational sector from landing elasmobranchs listed as Prohibited to commercial sector.
26 Continued research efforts from the Centre for Environment Fisheries and Aquaculture Science

1 (CEFAS) since 2010 has helped improve our understanding of ‘common skate’ through
2 fisheries bycatch monitoring [e.g., 13], with specific reference to the Celtic Sea [14].

3
4 This report focuses on the flapper skate *D. intermedius* species within the ‘common skate’
5 complex. This coastal species is a popular target for recreational sport-fishing and appears to
6 have a more restricted distribution compared to *D. batis* (i.e., with a current distribution
7 throughout the western and northern territorial waters of Scotland and Ireland and occasionally
8 in the Celtic Sea, and appears to have disappeared from much of its former geographical range,
9 including all European waters [4].

10
11 The first stage in developing a coherent regional approach to flapper skate conservation is to
12 reach a consensus across stakeholders in terms of conservation priorities and objectives. To
13 this end, the Flapper Skate Working Group (SWG) was established as a forum where
14 governmental, sports-fishing, non-governmental conservation bodies and scientists from across
15 the three jurisdictions covering most of the current species’ range (the UK, Ireland, and experts
16 from the Netherlands) could discuss, share knowledge and plan future collaborative
17 conservation and research programmes. An overview of the contributions by SWG’s invited
18 speakers are detailed in Appendix A.

19

20 **CONSERVATION PRIORITIES**

21

22 The SWG recognised that effective flapper skate conservation requires both inputs and
23 coordinated efforts from several key stakeholder sectors. Essentially, the group is based on a
24 circular process whereby focussed research informs advocacy and policy, which is supported
25 by public opinion and shapes outreach direction, leading back to directed scientific research

1 (Fig 1). The SWG further acknowledged that for effective flapper skate conservation, the
2 connectivity between each component of this conservation ‘triangle’ (Fig 1) needs to be
3 consistent and prioritised equally. However, without scientific evidence, it is difficult for
4 governments to respond with directed actions or provision of resources.

5

6 Pragmatically, the SWG accepted that conservation efforts to date were at different stages on
7 a regional level, with some areas suggesting limited public awareness of the species (H.
8 McIlvenny, November 2019, personal communications). Despite continued efforts from
9 various outreach initiatives (e.g. The Shark Trust, SeaDeep and CEFAS work with commercial
10 fishermen on handling and identification), flapper skate are yet to pique widescale public
11 interest or concern in the same way as other, perhaps more charismatic, local megafauna (e.g.
12 white-tailed sea eagles, otters, grey seals etc.) [e.g. 15].

13

14 Arguably, the public profile of the flapper skate is hindered by the vernacular name – the
15 Critically Endangered ‘common’ skate seems somewhat contradictory. Such nuances in
16 nomenclature are compounded by the disappearance of the species from much of its native
17 range. Vernacular names can hinder comparisons between historical and contemporary ranges,
18 and can prove difficult in light of shifting baselines [*sensu* 16, 17]. Additionally, the once
19 commonly known species is no longer a commercial fisheries target, leading it to potentially
20 fade from the collective cultural memory in all but a few fishing communities (H. McIlvenny,
21 November 2019, personal communications). Within this overall context, the SWG highlighted
22 the following conservation priorities for flapper skate without implied priority.

23

24 **CONSERVATION PRIORITY 1: POOR TAXONOMIC RESOLUTION**

25

1 As with fundamental research and public awareness, there remains some gaps within policy.
2 All legislative documents pre-dating the species separation [6] relate to the ‘common skate’ or
3 refer to the species as *Dipturus batis* or *Raja batis* [e.g., 12, 18, 7- IUCN] which generates
4 additional confusion. Both of these names are now obsolete synonyms and reflect the early
5 taxonomic efforts of Clark [19] to group together the somewhat similar species of *D.*
6 *intermedius* and *D. batis*. Subsequent genetic and morphological analyses [6] confirmed that
7 the ‘common skate’ is no longer valid and consists of two species. However, legislation and
8 management still refer to ‘common skate’ (e.g., Wildlife and Natural Environment Act
9 (Northern Ireland), 2011 and Loch Sunart to the Sound of Jura Nature Conservation Marine
10 Protected Area Order 2014). Yet, on a broader political scale some efforts have been made to
11 differentiate the two species (e.g., the usage of separate codes (DRJ [*D. intermedius*] and RJB
12 [*D. batis*] by the Food and Agricultural Organization of the United Nations (FAO, 2010-2020)).
13 Thus, support for ongoing efforts to standardise adoption of current nomenclature within
14 legislative frameworks emerged as a clear recommendation from the SWG.

15

16 The SWG also acknowledged that all large batoids in NE Atlantic waters are likely to have
17 data gaps and share similar vulnerabilities to over-exploitation [20]. Under this scenario, the
18 umbrella approach of using one species to confer protection for other similar species [21] might
19 be an appropriate way forward. The SWG recommended that the IUCN status of each species
20 within the ‘common skate’ complex should be reassessed as separate species. Although this
21 separation would not increase species numbers, it would highlight the circumstances of each
22 species and may reveal an even more unfavourable situation which would substantiate the
23 urgent need for further work.

24

25 **CONSERVATION PRIORITY 2: LACK OF DATA ON LIFE HISTORY**

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

Apart from site specific studies in the Loch Sunart to the Sound of Jura Marine Protected Area (MPA) in Scotland and CEFAS surveys and monitoring in the Celtic Sea, the SWG recognised that conservation of the species is hampered by a lack of data across much of its range [3, 13, 14, 22, 23]. The group acknowledged the value of previous studies but conceded that site-specific findings may not be representative across the entire species' range. Within this context, a number of knowledge gaps emerged (listed without implied priority): longevity, reproduction rates, ontogenetic shifts in habitat use, ontogenetic shifts in diet, sexual space partitioning, territoriality and site fidelity.

CONSERVATION PRIORITY 3: LACK OF REGIONAL APPROACH TO CONSERVATION

The current recognised distribution of *D. intermedius* ranges from Shetland, in a westward coastal arc, to southern Ireland (West Co. Cork) [6, 24]. Records outside this area are in existence [6, 8, 13], but further interrogation of these records is required (S. P. Iglésias, 2020, personal communications, January). Recent efforts in Scotland were heralded as a success, with flapper skate being the only elasmobranch in Europe with a dedicated MPA designation (Loch Sunart to the Sound of Jura MPA in Scotland). However, as a motile species, further protective measures are required on a regional scale. This goal will require regional standardisation in statutory data collection and steps towards a coherent, ecologically relevant MPA network across the species' range.

CONSERVATION PRIORITY 4: ACCOUNTING FOR BROADER ECOLOGICAL SHIFTS IN SKATE CONSERVATION

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

The SWG recognised that the species is unlikely to re-occupy its ‘pre-collapse’ range naturally in the foreseeable future, given the current established fisheries regulations pertaining to the species. Establishing the bounds of historical distribution represents a challenge in itself given that historical landings were recorded under ‘common skate’. While additional mechanisms can be employed to establish historical presence and absence of a species, the historical use of the vernacular name remains an obstacle. The principal driver of extirpation, industrialised fishing, still presents an ongoing threat from incidental catch of both juveniles and adults despite prohibition on targeted fishing [20, 25, 26], but there is scope for improved mitigation. For example, ‘excluders’ built into fishing nets have been shown to reduce bycatch markedly (e.g. sea turtles [27]), with potential to reduce unwanted capture of large ray species [28]. The SWG recommended research into such technical innovations which may reduce skate bycatch [14] including the removal of “tickler” chains on bottom trawlers. This approach could reduce the bycatch of batoids without reductions in the capture of target species [29], but it has not yet been adopted widely.

More broadly, the ecological state of the NE European shelf has changed dramatically since the species was last considered common (a century ago), owing to fisheries-induced trophic shifts [e.g., 30, 31] habitat degradation [32] and climate change [33, 34]. Encompassing such stressors within overall conservation strategies is not easy, but it is essential if genuine restoration is to be achieved.

SWG GENERAL RECOMMENDATIONS

1 The SWG developed a series of research and conservation actions for those working on flapper
2 skate conservation, to focus efforts across the species known range. The resulting framework
3 for decision-making is inclusive of stakeholders, scientists, NGOs and government;
4 transparent, collaborative and co-operative. We advocate three distinct yet interacting
5 conservation ‘nodes’ feeding into policy (research, outreach advocacy and policy; Fig 1). This
6 structure will enable effective conservation through appropriate policy, underpinned by robust
7 science and targeted advocacy, that is communicable through a solid outreach platform. It will
8 also expedite research efforts through the sharing of good practice and advice from more
9 developed conservation programmes. Thus, many of the actions listed are already in place
10 within some jurisdictions but are included as a benchmark to standardise efforts on a regional
11 scale. More specifically, the SWG aspires to mirror recent successes at a national level on a
12 geographical scale that is representative of the species overall range (i.e., the conservation of
13 common natural heritage). Lastly, while a regional approach will be required for flapper skate
14 conservation across its’ remaining range, we acknowledge the need for site-specific
15 management objectives that are not listed here (i.e., what may be suitable for one site may not
16 be transferable to all prospective populations of *D. intermedius*).

17

18

- 19 ● File a petition for change in nomenclature used, to relevant authorities (e.g., IUCN and
20 government bodies), relating to large batoid stock management/conservation.
21 Common/vernacular names should be avoided for scientific and policy documentation
22 as the Linnean system should suffice, with common names such as flapper skate
23 reserved for communication with the general public. For grey areas, when species-
24 specific resolution is uncertain, the use of taxonomic surrogacy to genus level (i.e.,

1 *Dipturus* spp. rather than the vernacular ‘common skate’ is recommended and supports
2 a precautionary approach [*sensu* 35].

- 3
- 4 ● Identify ontogenetic shifts in distribution and critical habitats used by the species.
5 Subsequently, the SWG recommends limitations on / or modifications to trawling
6 within these areas, should evidence dictate, and that they are managed through national
7 legislation where appropriate (e.g. Fisheries Act (Northern Ireland) [36], Marine
8 (Scotland) Act 2010). The group noted that funding is required and should be sought
9 for research into and implementation of ‘skate excluders’ on commercial fishing
10 vessels/nets.

 - 11
 - 12 ● The development of a coherent and ecologically relevant network of marine protected
13 areas would be highly valuable to link fragmented habitats, ensure genetic diversity and
14 support species recovery across differing life stages. Quantifying connectivity between
15 hotspots is vital for the conservation of species with transnational ranges, evidenced by
16 ongoing genetics and tracking programmes.

 - 17
 - 18 ● Develop shared educational resources to avoid duplication of effort and provide a
19 unified conservation message (e.g., resources developed by Shark Trust, SeaDeep, and
20 CEFAS). Continued engagement with anglers/commercial fishers is encouraged to
21 support co-development of identification and reporting protocols (e.g., to remove
22 ambiguity surrounding *D. intermedius* morphology at different life history stages). This
23 approach would encourage the documented release of incidentally caught individuals;
24 or the retention (where permitted) of deceased skate to support research [e.g., 37].
- 25

- 1 ● Foster communication and coordination between all points of the ‘conservation
2 triangle’ (Fig 1) to raise the profile of the species, especially through the sharing of
3 media. The main objective will be the development of a sense of public ownership of
4 the species (mirroring successes amongst other species such as the otter, golden eagle,
5 salmon etc.). Annual SWG workshops will serve as catalysts for collaboration, but
6 mechanisms for routine communication between partners requires further development.
7
- 8 ● Produce a collective guidance document aimed at conservation managers, politicians
9 and legal practitioners etc. This is actionable science to support the development of an
10 evidence base for policy implementation in Northern Ireland and the Republic of
11 Ireland in particular. Furthermore, science would support reviews of existing protective
12 measures in Northern Ireland and Scotland.
13
- 14 ● Agree upon a standardised approach for statutory data collection where appropriate,
15 such as a standardised method for logging bycatch/angling records or collecting
16 morphological data. The SWG agreed that methods developed within the skate tagging
17 programme in the Loch Sunart to the Sound of Jura MPA in Scotland, could serve as a
18 template across the species range. This applies particularly to genetic sampling, animal
19 handling, and recreational fishing best practice. This approach will enable future
20 researchers to pool data across the region when required or deemed appropriate.
21 Additionally, the SWG advocated for increased coordination and data-sharing to both
22 promote and enhance conservation efforts. This applies to all links within the
23 conservation triangle (Fig 1), with particular emphasis on collaborations between
24 outreach programmes.
25
26

1 REFERENCES

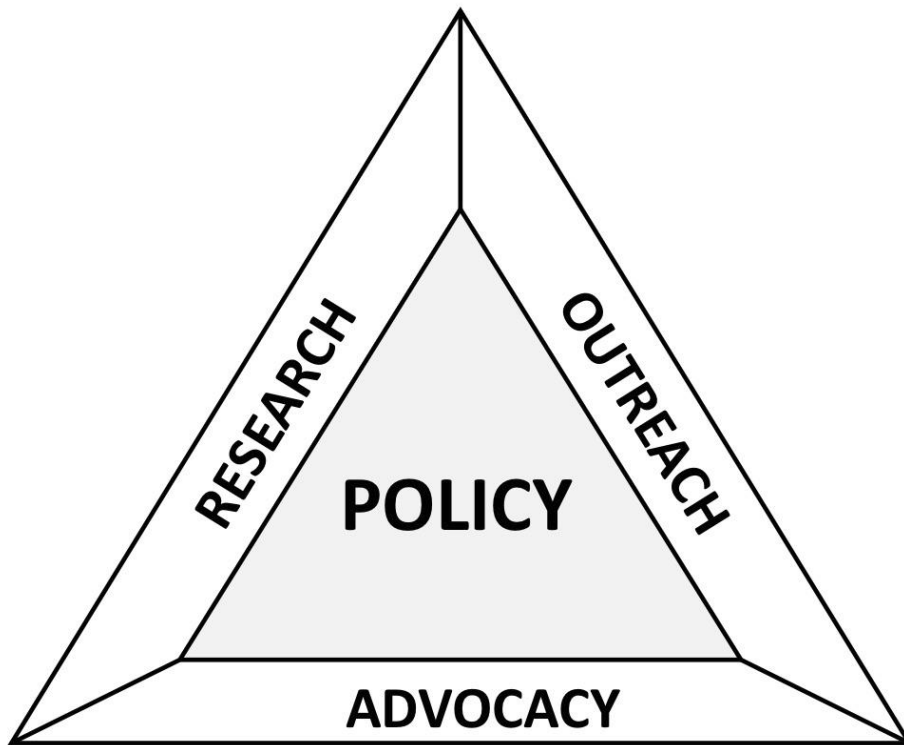
- 2
- 3 1. K. Brander, 1981. Disappearance of common skate *Raia batis* from Irish Sea, *Nature*
- 4 **290**: 48–49.
- 5 2. N. K. Dulvy., J. D. Metcalfe., J. Glanville., M. G. Pawson., J. D. Reynolds, 2000.
- 6 Fishery stability, local extinctions, and shifts in community structure in skates,
- 7 *Conservation Biology* **14**: 283–293.
- 8 3. F. Neat., C. Pinto., I. Burrett., L. Cowie., J. Travis., J. Thorburn., F. Gibb., P. J.
- 9 Wright, 2015. Site fidelity, survival and conservation options for the threatened
- 10 flapper skate (*Dipturus cf. intermedia*). *Aquatic Conservation: Marine and*
- 11 *Freshwater Ecosystems*, **25**(1):6-20.
- 12 4. A. M. Griffiths., D. W. Sims., S.P. Cotterell., A. El Nagar., J.R. Ellis., A.
- 13 Lynghammar., M. McHugh., F. C. Neat., N. G. Pade., N. Queiroz., B. Serra-Pereira,
- 14 2010. Molecular markers reveal spatially segregated cryptic species in a critically
- 15 endangered fish, the common skate (*Dipturus batis*), *Proceedings of the Royal Society*
- 16 *B: Biological Sciences*, **277**(1687):1497-1503.
- 17 5. P. Last., G. Naylor., B. Séret., W. White., M. de Carvalho., M. Stehmann, eds., 2016.
- 18 Rays of the World. CSIRO Publishing.
- 19 6. S. P. Iglésias., L. Toulhoat., D. Y. Sellos, 2010. Taxonomic confusion and market
- 20 mislabelling of threatened skates: important consequences for their conservation
- 21 status, *Aquatic Conservation: Marine and Freshwater Ecosystems*, **20**(3):319-333.
- 22 7. N. K. Dulvy., G. Notarbartolo di Sciarra., F. Serena., F. Tinti., N. Ungaro., C.
- 23 Mancusi., J. Ellis, 2006, *Dipturus batis*. *The IUCN Red List of Threatened*
- 24 *Species* 2006. viewed 19th March
- 25 2020.:e.T39397A10198950. [https://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T3939](https://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T39397A10198950.en)
- 26 [7A10198950.en](https://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T39397A10198950.en).
- 27 8. ICES, 2014. Report of the Working Group on Elasmobranch Fishes (WGEF), 17-26
- 28 June 2014, Lisbon, Portugal. ICES CM 2014/ACOM: 19. International Council for
- 29 the Exploration of the Sea (ICES), Copenhagen, Denmark.
- 30 9. ‘Common Skate’ Species Action Plan, 1999. vii. Common Skate (*Raja batis*). Species
- 31 Action Plan. viewed 12 May 2020
- 32 <http://www.ukbap.org.uk/asp/UKPlans.asp?UKListID=543>.
- 33 10. H. Tyler-Walters., B. James., M. Carruthers (eds.), C. Wilding., O. Durkin., C.
- 34 Lacey., E. Philpott., L. Adams., P. D. Chaniotis., P.T.V. Wilkes., R. Seeley., M.
- 35 Neilly., J. Dargie., O.T. Crawford-Avis, 2016. Descriptions of Scottish Priority
- 36 Marine Features (PMFs). Scottish Natural Heritage Commissioned Report No. 406.
- 37 11. DAERA, 2014. Marine Conservation Zones in the Northern Ireland inshore region –
- 38 Justification report for selection of proposed marine conservation zones (pMCZ)
- 39 features. *Department of Agriculture, Environment and Rural Affairs*, viewed 16 May
- 40 2020. [https://www.daera-](https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20selection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%209%20features.pdf)
- 41 [ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20se-](https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20selection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%209%20features.pdf)
- 42 [lection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%2](https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20selection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%209%20features.pdf)
- 43 [9%20features.pdf](https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Justification%20report%20for%20selection%20of%20proposed%20Marine%20Conservation%20Zones%20%28pMCZs%209%20features.pdf)
- 44 12. European Union, 2009. Council Regulation (EC) No 43/2009 fixing for 2009 the
- 45 fishing opportunities and associated conditions for certain fish stocks and groups of
- 46 fish stocks, applicable in Community waters and, for Community vessels, in waters
- 47 where catch limitations are required. *Official Journal of the European Union*, L 22,**52**.

- 1 13. V. A. Bendall., P. Jones., R. Nicholson., S. J. Hetherington., G. Burt, 2017. Common
2 skate survey Annual Report (ELECTRA MF6001: Work Package Task 1.4) Cefas. 39
3 pp.
- 4 14. S. J. Hetherington., R.E. Nicholson., P. Nelson., R. Skirrow., S. Elliott., J.
5 Richardson., T. Barreau., M. Spence, 2018. Remote Electronic Monitoring (REM) of
6 Common Skate Bycatch II (ELECTRA MF6001: Work Package Task 1.3). Project
7 Report (Cefas). 46 pp.
- 8 15. T. O'Brien, 2020. Second white-tailed sea eagle chick for nature reserve. Irish Times.
9 viewed 10 Feb 2020. [https://www.irishtimes.com/news/ireland/irish-news/second-](https://www.irishtimes.com/news/ireland/irish-news/second-white-tailed-sea-eagle-chick-for-nature-reserve-1.4230841)
10 [white-tailed-sea-eagle-chick-for-nature-reserve-1.4230841](https://www.irishtimes.com/news/ireland/irish-news/second-white-tailed-sea-eagle-chick-for-nature-reserve-1.4230841)
- 11 16. S. T. Turvey., L.A. Barrett., H.A.O. Yujiang., Z. Lei., Z. Xinqiao., W. Xianyan., H.
12 Yadong., Z. Kaiya., T.O.M. Hart., W. Ding, 2010. Rapidly shifting baselines in
13 Yangtze fishing communities and local memory of extinct species. *Conservation*
14 *Biology*, **24**(3):778-787.
- 15 17. A.A. Plumeridge., C.M. Roberts, 2017. Conservation targets in marine protected area
16 management suffer from shifting baseline syndrome: A case study on the Dogger
17 Bank. *Marine pollution bulletin*, **116**(1-2):395-404.
- 18 18. ICES, Committee Meetings Documents, 2005. (N:06). ICES, Copenhagen, Denmark.
- 19 19. R.S. Clark, 1926, Rays and skates. A revision of the European species. *Fishery Board*
20 *for Scotland Scientific Investigations* **1**: 1–66.
- 21 20. R. Enever., T.L. Catchpole., J.R. Ellis., A. Grant, 2009. The survival of skates
22 (Rajidae) caught by demersal trawlers fishing in UK waters. *Fisheries Research*, **97**:
23 72–76.
- 24 21. J.M. Roberge., P.E.R. Angelstam, 2004. Usefulness of the umbrella species concept
25 as a conservation tool. *Conservation biology*, **18**(1):76-85.
- 26 22. SNH, 2013. Scottish MPA Project: Assessment against the MPA Selection Guidelines
27 (Loch Sunart to the Sound of Jura possible nature conservation MPA). Viewed 20
28 March 2020, <http://www.snh.gov.uk/docs/A987882.pdf>
- 29 23. J. Thorburn., J. Dodd., F. Neat, 2018. Spatial ecology of flapper skate (*Dipturus*
30 *intermedius* – *Dipturus batis* complex) and spurdog (*Squalus acanthias*) in relation to
31 the Loch Sunart to the Sound of Jura Marine Protected Area and Loch Etive. Scottish
32 Natural Heritage Research Report No. 1011.
- 33 24. ISFC, Irish Specimen Fish Committee., 2019. *Annual Report of The Irish Specimen*
34 *Fish Committee 2019*, Inland Fisheries Ireland & DAERA, viewed 19th March 2020,
35 <http://irish-trophy-fish.com/annual-reports/>
- 36 25. S. Shephard., H. Gerritsen., M.J. Kaiser., D.G. Reid, 2012. Spatial heterogeneity in
37 fishing creates de facto refugia for endangered Celtic Sea elasmobranchs. *PLoS ONE*
38 **7**:1–8.
- 39 26. J.F. Silva., J.R. Ellis., T.L. Catchpole, 2012. Species composition of skates (Rajidae)
40 in commercial fisheries around the British Isles and their discarding patterns. *Journal*
41 *of Fish Biology*, **80**: 1678–1703.
- 42 27. L.D. Jenkins, 2012. Reducing sea turtle bycatch in trawl nets: a history of NMFS
43 turtle excluder device (TED) research. *Marine Fisheries Review*, **74**(2):26-44.
- 44 28. T. Willems., J. Depestele., A. De Backer., K. Hostens, 2016, Ray bycatch in a tropical
45 shrimp fishery: do bycatch reduction devices and turtle excluder devices effectively
46 exclude rays?. *Fisheries Research*, **175**:35-42
- 47 29. R.J. Kynoch., R.J. Fryer., F.C. Neat, 2015. A simple technical measure to reduce
48 bycatch and discard of skates and sharks in mixed-species bottom-trawl fisheries.
49 *ICES Journal of Marine Science*, **72**(6):1861-1868.

- 1 30. P.A. Walker., J.R.G. Hislop, 1998. Sensitive skates or resilient rays? Spatial and
2 temporal shifts in ray species composition in the central and north western North Sea
3 between 1930 and the present day. *ICES Journal of Marine Science* **55**: 392–402.
- 4 31. A.K. Salomon., S.K. Gaichas., N.T. Shears., J.E. Smith., E.M. Madin., S.D. Gaines,
5 2010. Key features and context-dependence of fishery-induced trophic
6 cascades. *Conservation Biology*, **24**(2):382-394.
- 7 32. A. Rogers., O. Aburto-Oropeza, et al. 2020. Critical Habitats and Biodiversity:
8 Inventory, Thresholds and Governance. Washington, DC: World Resources Institute.
9 Available online at [www.oceanpanel.org/blue-papers/critical-habitats-and-](http://www.oceanpanel.org/blue-papers/critical-habitats-and-biodiversity-inventory-thresholds-and-governance)
10 [biodiversity-inventory-thresholds-and-governance](http://www.oceanpanel.org/blue-papers/critical-habitats-and-biodiversity-inventory-thresholds-and-governance).
- 11 33. M. Winder., D.E. Schindler, 2004. Climate change uncouples trophic interactions in
12 an aquatic ecosystem. *Ecology*, **85**(8):2100-2106.
- 13 34. M.C. Jones., S.R. Dye., J.A. Fernandes., T.L. Frölicher., J.K. Pinnegar., R. Warren.,
14 W.W. Cheung, 2013. Predicting the impact of climate change on threatened species in
15 UK waters. *PLoS One*, **8**(1).
- 16 35. Rio declaration on environment and development, 1992. In: Brown Weiss, Edith
17 (Ed.), *International Environmental Law: Basic Instruments and References*,
18 1992e1999. Transnational Press, Ardsley, NY. 1999.
- 19 36. Fisheries Act (Northern Ireland) 1966. Available at:
20 <http://www.legislation.gov.uk/apni/1966/17> (Accessed: 24 March 2020).
- 21 37. N. Phillips., D.L. Kubicek., N.L. Payne., C. Harrod., L.E. Eagling., C.D. Carson., V.
22 Cappanera., J.D. Houghton, 2018. Isometric growth in the world’s largest bony fishes
23 (genus *Mola*)? Morphological insights from fisheries bycatch data. *J. Mor-phol.*, **279**:
24 1312-1320
- 25

1 **Figures**

2



3

4 **Fig 1. The Conservation Triangle** - this triangle denotes the essential components required
5 for effective conservation. 1) Research, 2) Outreach, 3) Advocacy & 4) Policy. All four
6 elements are the foundation of conservation efforts. The sides of the outer triangle are equally
7 important and need to work in unison for proactive conservation, feeding into policy for
8 effective implementation.