Marine Ecology and Conservation Assessment 2.

An essay on anthropogenic impacts of the oceans, national and international policy implementation and local restoration projects across Scotland.

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Abbreviations used:

CAOLAS	Community Association Of Lochs And Sounds
COAST	Community of Arran Seabed Trust
DEFRA	Department for Environment Food and Rural Affairs
EEZ	Exclusive Economic Zone)
ha	hectares
HES	Historic Environment Scotland
HWDT	Hebridean Whale and Dolphin Trust.
JNCC	Joint Nature Conservation Committee
km	kilometres
MMO	Marine Management Organisation
MPAs	Marine Protected Areas
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
PCB	Polychlorinated Biphenyls
SAMS	Scottish Association for Marine Science
SEPA	Scottish Environmental Protection Agency
UK	United Kingdom of Great Britain and Northern Ireland
UNCLOS	United Nations Convention on the Law of the Sea

Word count: 2386

Introduction

Looking out to the seas of Scotland, Great Britian and beyond a silent crisis is unfolding. Through anthropogenically induced activities we have started to alter the delicate balance of our blue planet. From plastic and microplastic pollution, over-fishing across most of our seas and chemical and noise pollution affecting huge swathes of marine flora and fauna, Earth's oceans have been pushed towards the brink, altering the delicate balance of marine ecosystems and the huge number of species that depend on them.

While the future of our seas remains unknown, there has been local, national and international acknowledgement of the challenges oceans face, with measures implemented to restore and protect them. Measures include creations of marine protected areas (MPA's), habitat restoration, fish management and pollution control and reduction. In-direct measures have also been created to help restore and protect the marine environment via community engagement, education and awareness campaigns, international cooperation and climate change mitigation.

This is essay is to look at the threat that human-activities pose upon the oceans, challenges faced and any progress made via legislation, policy and conservation, to overcome the complex multi-faceted challenges standing between us today and the future health of our seas.

Current Challenges

Threats to our oceans include, but are not limited to:

- **Fishing activities** – Globally 30-35% of fish populations are classified as being fished unsustainably, additionally 60% of stocks are classified as fully fished (Link et al., 2019). Globally, over-fishing has been found to re-construct marine food chains, altering distribution and abundance resulting in greater extinctions and invasion of non-native species (Sumaila et al., 2020). In Scotland, the Scottish Marine Assessment 2020 found 46% of stocks evaluated are being overfished (Scottish Government, 2020) with our seas still suffering from historical over fishing, like oysters in the Firth of Forth (Thurstan *et al.*, 2013). Furthermore, locally Puffin numbers have declined by 25% since 2000 due to over-fishing of sand eels (RSPB, 2024) while an estimated 80% of minke whales and 50% of humpback whales have become entangled in creel fishing activities around the Scottish coastline (Calderan, 2024).

- **Habitat destruction** – Dredging to aid construction of infrastructure can result in marine plant habitat degradation via physical removal, smothering and decreasing light availability. Globally 21,000 ha of seagrass beds were lost by just 26 dredging projects (Todd *et al.*, 2015). Seagrass removal can directly affect the survival, distribution and feeding habits of Sirenia's by removing their food source (Jefferson et al., 2008).
  In-directly sea-grass removal has affected bottlenose dolphins who prey upon fish that reside in sea-grass meadows (Todd *et al.*, 2015). Across the UK, between 2023-2024 there was 33,000 hours of suspected trawling activities in UK waters (OCEANA, 2024) with the UK Government concluding that just one trawl pass can destroy entire seabed habitats that could take at least 5 years to recover (UK

Government, 2025).

- **Chemical and noise pollution** – Oceans can become contaminated from agricultural run-off and industrial discharges from untreated sewage, oil leaks and household and commercial chemical discharges. Every summer a 22,000 km^2 area south of the Mississippi river-basin (Gulf of Mexico) becomes a dead-zone due to hypoxia attributed to nutrient run-off (EPA, 2025).

  Further chemical pollution can be carried via rivers and streams to estuaries which are highly productive areas for shell and other fish which can pick up chemical and metal contaminants like mercury. These harmful chemicals and metals can be passed onto humans through direct consumption, or onto to other marine life via the food chain (Chen *et al.*, 2023). Historical chemical contaminants such as PCBs, banned in UK since 1986 (HSE, 1998) still affect Scottish marine life today. Lulu from West of Scotland pod of killer whales was found to have had 80 times greater than accepted PCB toxicity threshold, potentially making her and her entire pod infertile (HWDT, 2017).

  Noise pollution is also harmful for marine environment and is recognised as a significant threat. Noise can be produced by shipping, surveying, operation and construction of offshore windfarms and oil rigs and drilling and pile driving. Noise omitted from these activities can mask communication between marine wildlife affecting mate-calling, locating prey and escaping predators as well as creating physiological stress that can result in behavioural change and death of offspring (Chahouri et al., 2022).

- **Plastic and debris pollution** – Currently there is an estimated 50-75 trillion pieces of plastic and microplastics in the oceans with more being added every year. 80% of this comes from land with the remaining 20% of plastic and debris coming from discarded fishing gear. By 2050 plastic waste in the oceans could outweigh all the fish in the seas (UN, 2022). A total of 822 marine species have ingested microplastics that can cause injury or death with the microplastics making their way up the food chain (Marmara *et al.*, 2023). Discarded fishing gear (ghost gear) is considered the most harmful of marine debris with one net capable of killing 500,000 invertebrates, 1700 fish and 4 seabirds (Wilcox *et al.*, 2016) as well dolphins, whales and turtles (WWF, 2020).

- **Climate change** – Climate change can result in warming waters and ocean acidification, resulting in the bleaching and dying of coral reefs. Over 4000 species of fish rely on coral reefs for food and shelter (Munday *et al.*, 2008). Currently NOAA's Coral Reef Watch Alert remains at the highest, level 5. This is after 99.7% of Atlantic tropical coral reef areas experienced heat-stress and bleaching between 2023-2024 (Thiem, 2024). In a separate bleaching event between 2014-2017, 65.7% of global coral reef areas were impacted (Scott *et al.,* 2018). Locally in Scotland, a reduction in blue mussels which is a vital food source for otters and oystercatchers has been attributed to warmer rocky shores (SAMS, 2025).

Key policies and legislation

A number of local, national and international policies and legislative measures have been passed to halt marine degradation and to start restoration. One key international treaty is the United Nations Convention on the Law of the Sea (UNCLOS). Adopted in 1982 with 170 signatories it defines the maritime zones and sets out rules governing countries uses of oceans, and outlines the rights and obligations such as promoting peaceful use, regulating resources exploitation and protecting the marine environment (UK Parliament, 2022).

While UNCLOS set out to be a cornerstone of maritime law and has contributed to global peace and security (Dame, 2023) there are some criticisms of it. One major criticism is that in the EEZ (Exclusive Economic Zone) countries with long-distance fishing fleets (US, Japan, EU, UK and Russia) are allowed to overfish with impunity (abetted by state subsidises). Another criticism is 31 licences issued for deep sea-bed mining despite no independent scientific council to advise on this practice. Licences are typically issued to highly technological companies from wealthy nations, further confirming the notion that UNCLOS is a treaty set out to favour wealthier nations (Standing, 2022).

An example of national legislation is Marine (Scotland) Act 2010 (Scottish Government, 2014) and the UK Marine and Coastal Access Act 2009 (UK Government, 2009). These set out the framework for designating MPAs and empowers the Scottish Government to designate MPAs within Scottish waters that are up to 12 nautical miles from the coastline. There are 240 marine protected areas with the purpose of these to protect marine life and habitats from further damage from activities such as bottom-trawler fishing.

While MPA's cover around 37% of Scotland's seas, a criticism is that they are protected areas in name only. Only a minority of designated sites have fishery management measures in place and despite the Scottish Government acknowledging the need to reduce the most damaging aspects of commercial fishing they are allowed to continue in all but just a few MPAs. NatureScot issued further advice on what needs to happen in each MPA to properly protect species and habitats. Despite Scottish Government consultations, little to nothing has been done with this NatureScot report (NatureScot, 2014).

An example of local policy to protect marine environment is Target 7 of City of Edinburgh Biodiversity Plan 2020-2027 "reduce chemical and plastic pollution until not harmful to biodiversity and ecosystems by 2030" (City of Edinburgh Council, 2022). By reducing plastic and chemical pollution within city boundary, it would stop run-off and plastic pollution entering the Firth of Forth directly or via its tributaries.

Conservation Measures

There are direct and indirect conservation measures and these can come from statutory bodies (associated with "the State") and non-statutory bodies who can be associated with the government or an NGO. In Scotland, statutory regulatory bodies include Marine Scotland, SEPA, NatureScot (with JNCC) as well as HES and Crown Estates Scotland. Governmental non-statutory bodies include DEFRA and MMO amongst others. Non-governmental non-statutory bodies include organisations like National Oceanographic Centre, Oil and gas Authority & SAMS (Marine Scotland, n.d) as well as conservation and advisory NGOs like Restoration Forth, Seawilding, CAOLAS and Hebridean Whale and Dolphin Trust.

Not exclusively, but typically governmental statutory bodies conserve the marine environment via policy, regulation, enforcement and research. Marine Scotland's (Directorate of Scottish Government) main purpose is to oversee licensing, fishing quotas, regulations and marine economic growth. They don't appear to implement physical and direct changes to better Scotland's seas, but do-so via policy like banning sand eel fishing and creating MPAs. One large criticism of MPA's in Scotland is how power was de-centralised from coastal communities to government, with a report claiming that for MPAs to work, they should be subject to the rights of local communities, and were local communities are impacted, it should be a just transition with them involved (Harrison, 2024).

One example of how government policy and local communities can work in tandem is the "No Take Zone" by COAST. Lamlash Bay is one of the largest maerl mussel beds in Scotland and home to sea grass and kelp forests. The conservation group COAST via Scottish Government policy has created a $3km^2$ no fishing zone within a larger MPA. Since the No Take Zone was implemented, some species have increased by 400% (Notely, 2019) proving how successful community groups and government policy can be if some power is de-centralised and local communities consulted, with this sentiment also being the position of the organisation Rewilding Britain (Rewilding Britain, 2023). This approach has proven to work in Madagascar where local communities have setup their own democratically controlled temporary and permanent No Take Zones with great success (Zafimahatradraibe *et al.*, 2025) with similar results in co-managed MCAs in Zanzibar (IUCN, 2020).

Another key organisation that doesn't directly implement change in Scotland seas are SAMS. SAMS research's how marine environments operate, any changes and why and use this knowledge to educate and communicate their discoveries to government and industry. It's achieved via education programmes from their Oban facilities utilising their staff, research fellows and latest technology to ensure that via their findings we can have healthy and productive seas (SAMS, n.d). One minor criticism of SAMs appears to be their small number of partners who are typically Highland and Island based. Given it's a Scottish organisation and with the dynamic of the oceans, perhaps it would be more beneficial if they partnered and collaborated with other coastal-related institutions all around Scotland and beyond.

Organisations that make direct changes to Scotland's seas are projects like Seawilding. Seawilding through oyster and sea-grass restoration aims to restore degraded marine habitats by restoring over 350,000 oysters and 400,000 seagrass seeds in Loch Craignish and subsequent monitoring and mapping of these new habitats (NatureScot, 2024). Another key aim of Seawilding is partnering with other local marine restoration projects like CAOLAS who are restoring oyster populations in Lochaline (CAOLAS, 2024).

CAOLAS and Seawilding are strong advocates of working with local communities to promote sustainability for recreation and economic development and aim to do this via education for all ages, research programmes and community engagement. CAOLAS acknowledge that without local community involvement they are likely to be unsuccessful in their aims (CAOLAS, 2024) while Seawilding also owe their success to the local community who contribute so much. Another important aspect of Seawilding is educational partnerships with 5 local primary schools (Seawilding, n.d) which is something CAOLAS might want to consider to further cement links to the Morvern community. Another mutual aim of both CAOLAS and Seawilding is de-centralising of power within the groups and creating further opportunities for community and individual involvement via citizen science.

Citizen science is the public participation in scientific research, typically via data collection and analysis (Haklay *et al.*, 2021). It's a proven way of getting the public to understand

scientific content (Bonney *et al.*, 2016). A fantastic example of Scottish citizen science in marine ecology and conservation is HWDT. Via their smartphone application “Whaletrack”, users all around the UK and Republic of Ireland can setup a profile, input some key parameters for the day (Time, weather etc) and enter in any sightings of whales or dolphins they have seen. This has resulted in 20 species of whale and dolphin being recorded across 51,000 sightings with all data logged into a centralised database and shared with various partners (HWDT, 2025). This data has then been used to build evidence and lobby for MPAs, prevent whale entanglement (40% of minke whale mortalities coming from this) while tracking and monitoring Scotland’s pods and communities of whales, dolphins and porpoises to assess the marine environment (HWDT, n.d).

Conclusion

Scotland and the worlds seas are at a critical juncture due to anthropogenic activities and changes such as over fishing, habitat destruction, pollution and climate change. With these threats and challenges there is recognition at international, national and local levels of the need to protect and restore the marine environments. Efforts have been made via policies such as MPA creation and fishing quotas, and while progress has been made through legislative measures, it is evident that more robust and enforceable laws and policies are needed nationally and internationally to ensure long-term health of Earths oceans.

Marine habitat restoration projects along with community involvement and education have also played crucial roles in fostering a sustainable future for our sea’s. The involvement of local communities and de-centralisation of some power is essential to the success of marine ecology conservation. To secure thriving and robust marine ecosystems, governments, industry, conservation groups and communities must continue to fund, collaborate, research and innovate with the hope of overcoming complex challenges to Save Of Seas!

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