



FISHY

FALSEHOODS

A series of papers debunking
myths about our industry

06



**Lamlash Bay:
the evidence**

The Claim

The Lamlash Bay No-Take Zone (NTZ) has been widely cited as providing evidence of the 'benefits' of no-take zones to fish stocks and the fishing industry, and of justifying the creation of Highly Protected Marine Areas (HPMAs), or similar strict conservation measures, in Scotland:

- ❖ *The evidence, not least from the no-take zone in Lamlash Bay, is clear. Protected areas benefit both fishers and fish. **Kenneth Gibson MSP¹***
- ❖ *... the no-take zone in Lamlash Bay has had no adverse impact whatsoever and, indeed, has shown that conservation can help to revitalise our fishing sector ... **Kenneth Gibson MSP²***
- ❖ *Where no take zones have been introduced they have been successful, and have seen real benefits to marine ecosystems and local fisheries. This is what has happened in Lamlash Bay in Arran. **Ariane Burgess MSP³***

FACT

The evidence from the Lamlash Bay NTZ is extremely limited. In particular, there is no evidence of any benefits to fish stocks or fisheries.

FACT

Lobsters are the only commercial species whose abundance has increased in the Lamlash Bay NTZ (but the larger lobsters there suffered more damage and injuries).

FACT

The abundances of brown crabs and juvenile lobsters fell inside the NTZ.

FACT

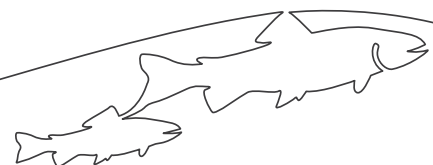
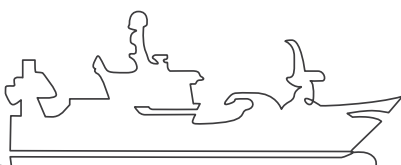
Although the abundance of scallops increased inside the Lamlash Bay NTZ there was a greater increase outside it.

FACT

There is no evidence that the Lamlash Bay NTZ has had any effects on the abundance of fish inside or outside the NTZ.

FACT

There is very little evidence of 'spillover' from the Lamlash Bay NTZ and no evidence that it has benefited commercial fisheries in the surrounding area.



Background⁴

Lamlash Bay No-Take Zone

The Lamlash Bay No-Take Zone (NTZ) was designated in September 2008 following a long campaign by the Community of Arran Seabed Trust (COAST). The NTZ occupies a relatively small area (2.67 km²) in the northern part of Lamlash Bay in Arran, between Holy Island and Arran (Figure 1). Within the NTZ all forms of fishing are prohibited.

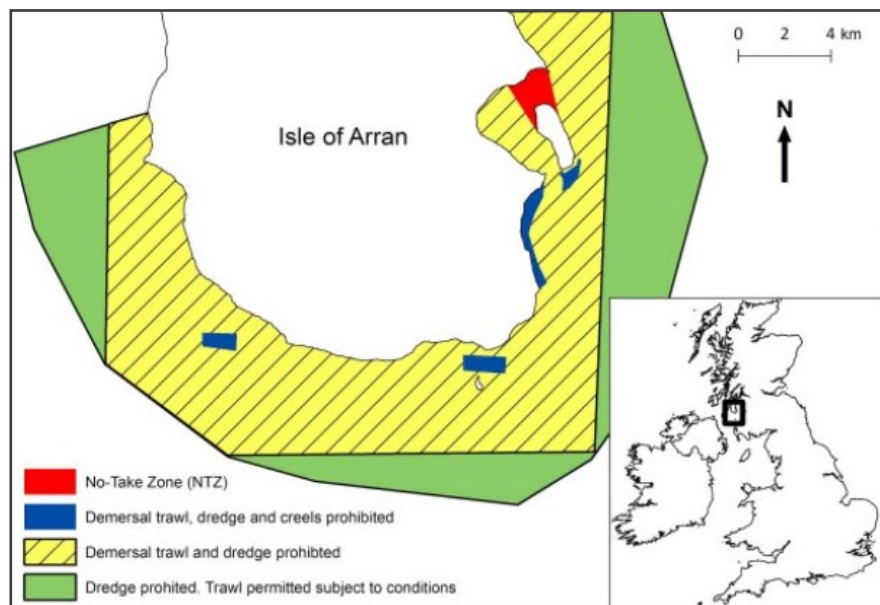


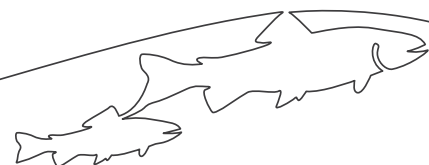
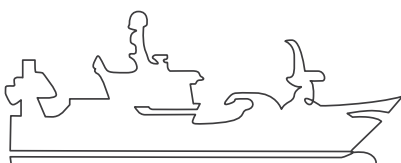
Figure 1 The areas of the Lamlash Bay No-Take Zone (red) and the wider South Arran Marine Protected Area (green, yellow and blue).⁵

Aims of the Lamlash Bay NTZ

The Lamlash Bay NTZ was 'specifically designed to provide benefits for both fisheries and conservation' (Stewart *et al.* 2020)⁶.

Its aims were to:

- ❖ regenerate and enhance local fish and shellfish populations.
- ❖ protect the maerl beds present.
- ❖ investigate the fishery benefits of a NTZ and MPA, particular with regard to scallops.



By protecting and regenerating maerl, other seabed habitats, fish and scallop populations in Lamlash Bay, COAST's aims were to:

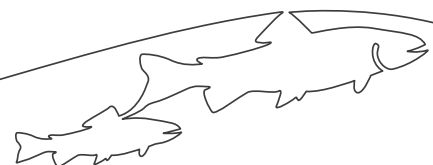
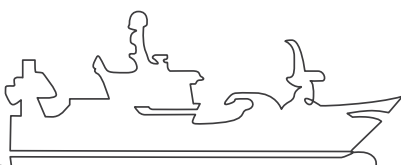
- ❖ Improve the local marine environment.
- ❖ Help sustain livelihoods of those dependent on fishing and tourism.
- ❖ Increase the popularity of Arran as a diving and tourist destination.
- ❖ Reverse the decline of local finfish stocks.
- ❖ Educate future generations on the need for marine conservation.

South Arran Marine Protected Area

From 2010 COAST began to campaign for the establishment of a larger Marine Protected Area (MPA) around the south of Arran, using the experience from the Lamlash Bay NTZ as a justification. The South Arran MPA, covering an area of some 250 km² (Figure 1), was designated in 2014 as one of 30 nature conservation MPAs in Scotland.

Scallop dredging has been prohibited throughout the South Arran MPA since 2016 and trawling is only allowed in the outer regions. Creel fishing is also banned within certain areas of the MPA judged to be particularly sensitive.

The aims of the South Arran MPA do not appear to have been as clearly stated as those of the NTZ but included 'benefiting tourism and sustainable fisheries'.



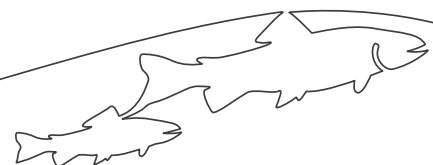
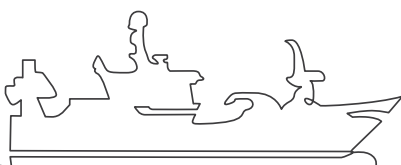
Research on the Lamlash Bay NTZ

There has not been a systematic long-term programme of routine monitoring of the Lamlash Bay NTZ. Rather, most published information has come from limited-term projects spanning periods up to a few years in most cases. A large proportion of this research has been carried out by staff and Masters students from the University of York.

A weakness of the studies of the Lamlash Bay NTZ is the lack of before and after comparisons. Although Stewart *et al.* (2020) refer to a number of surveys of Lamlash Bay before the NTZ was designated none of these appear to have been published and none of the later (post-designation) studies refer to them or make any comparisons with data they collected.

Rather, most of the studies of Lamlash Bay have relied on making comparisons between the area inside the NTZ and 'control' areas outside its boundaries with any differences attributed to the effects of the NTZ. (For example, if there are more lobsters in the NTZ than in the control area it is assumed that is because of the NTZ.) Many of the studies included 'near-control' sites within 2.5 km of the NTZ and 'far-control' sites which were substantially further away (see Figure 1 in Howarth *et al.* 2016).

It is not clear from the published research how these control areas were chosen or what evidence there was that they were comparable to the area inside the NTZ. The possibility that differences between the NTZ and the control areas might be due to inherent differences between the areas rather than to the effects of the NTZ cannot therefore be entirely discounted. (That is, the NTZ area might always have been different from the control areas.)



Before and After

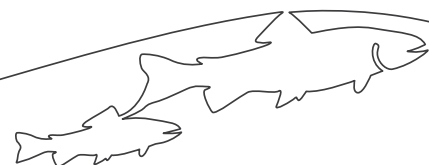
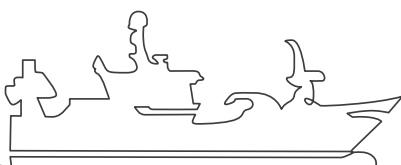
The optimum way to demonstrate the effectiveness of a No-Take Zone would be to measure suitable parameters (such as the number of fish, for example) in the area before the NTZ was designated and again sometime later. Ideally one would also compare the number of fish in a similar 'control' area where fishing is allowed to continue. If the number of fish increases in the NTZ over time but not in the control area that would be good evidence that the NTZ has been successful at increasing the abundance of fish. That would be especially true if the 'before' surveys had confirmed that the control and NTZ areas were indeed similar. If the abundance of fish increased in the NTZ but also increased in the control area (or increased more in the control area) it would be unlikely that the NTZ had caused the increase.

Research Results

Publications about the Lamlash Bay NTZ are listed in the bibliography and summarised in the Appendix.⁷ These include six papers published in peer-reviewed scientific journals, nine project reports by postgraduate students⁸, and four other reports.

A survey of the seabed habitats in Lamlash Bay and the surrounding area was carried out for Scottish Natural Heritage (SNH; now NatureScot) in 2010 (Munro *et al.* 2014). A survey of scallop abundances inside and outside the Lamlash Bay NTZ was carried out by Marine Scotland in 2009 and 2010 (Boulcott *et al.* 2012). Although these were both described as 'baseline' surveys they were carried out after the NTZ was designated (in 2008). There appears to have been no follow-up to the SNH survey, but the scallop survey was repeated in 2014 (see page 8).

The first studies under the auspices of the University of York and COAST were carried out in 2010 and 2011 and the first student projects in 2013. Four papers describing the results of research on the Lamlash Bay NTZ over the period from 2010 to 2015 were published between 2015 and 2018. These were followed by a series of further student projects (2015 to 2020) and a review paper in 2020.



Lobsters

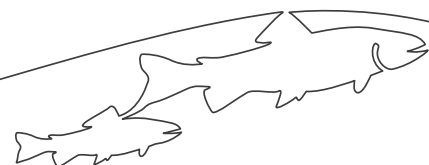
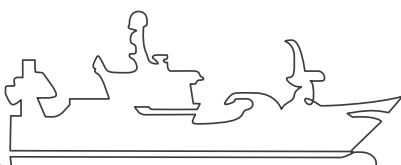
- ❖ Catch rate of lobsters higher inside NTZ.
 - ◆ Catch rate of legal sized lobsters higher inside NTZ.
 - ◆ Catch rate of sub-legal lobsters lower inside NTZ.
- ❖ Lobster larger and heavier on average inside NTZ.
- ❖ Greater frequency and severity of injuries amongst larger lobsters.
- ❖ Catch rates of legal sized lobsters outside NTZ higher close to boundaries and declined with distance.
 - ◆ Catch rate of sub-legal lobsters increased with distance away from NTZ.
 - ◆ Small number of tagged lobsters moved out of or into NTZ.

(See Crimmins, 2018; Howarth *et al.* 2016; Stewart *et al.* 2020.)

Surveys between 2012 and 2018 (except 2016) found that the catch rates of lobsters inside the NTZ were consistently higher than those in areas outside it although there were large fluctuations in the catch rates in all areas. The difference in catch rates inside and outside the NTZ was larger for legally sized lobsters (>88mm). However, the catch rates of sub-legal lobsters (<88mm) were generally **lower** inside the NTZ.

Lobsters inside the NTZ were larger (by 10 to 15 mm) and heavier on average than those outside but had a greater severity and frequency of injuries.

Three lobsters tagged inside the NTZ were recaptured outside it which has been taken as evidence of 'spillover' although four lobsters tagged outside the NTZ were also recaptured inside it. The catch rates of legal sized lobsters declined with distance from the NTZ boundary although the higher catch rates were mainly within 2 km. The catch rate of sub-legal lobsters **increased** further away from the NTZ. (See below, 'Evidence of Spillover', for more details.)



Crabs

- ❖ Catch rates of brown crabs lower inside NTZ.
- ❖ Catch rates of brown crabs increased with distance away from NTZ.
- ❖ Velvet crab catch rates very variable but tended to be higher inside NTZ.

(See Howarth *et al* 2017; Stewart *et al.* 2020.)

Surveys between 2012 and 2018 (except 2016) found that the catch rates of brown (edible) crabs were substantially **lower** inside the NTZ than in areas outside it and increased further away from the NTZ. There also tended to be fewer crabs in areas where there were more lobsters. Catch rates of velvet crabs varied widely from year to year across all areas but tended to be higher inside the NTZ.

Scallops

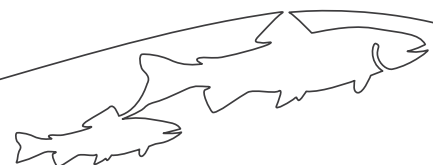
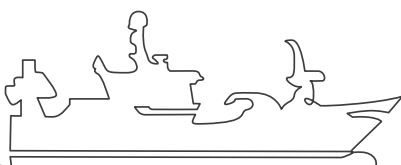
- ❖ No differences in densities of king scallops inside and outside NTZ.
- ❖ Average age, size and weight of king scallops all higher inside NTZ.
- ❖ Abundance of juvenile king scallops greater inside NTZ.
- ❖ Densities and other characteristics of queen scallops varied widely with no consistent differences inside and outside NTZ.

(See Boulcott *et al.* 2018; Howarth *et al* 2015b; James, 2019; Stewart *et al.* 2020.)

Surveys between 2010 and 2013 found no differences in the densities of king scallops inside and outside the NTZ, although the average age, size and flesh weight were all greater inside the NTZ as was the abundances of juveniles. A further survey in 2019 also found no difference in the densities of king scallops inside the NTZ and in the previously surveyed areas outside it, although the densities had increased substantially in all areas.

The 2019 survey did find that the density of king scallops inside the NTZ was significantly greater than in a fished area some distance from the NTZ. However, as that area had not been surveyed previously that finding has little meaning (it cannot be known whether the difference is due to the existence of the NTZ).

The densities and other biological characteristics of queen scallops varied widely and apparently randomly during the period from 2010 to 2013 with no consistent differences found between the NTZ and areas outside it.



Fish

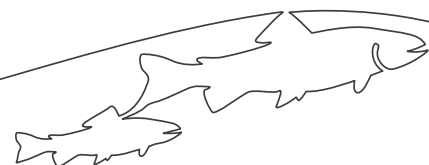
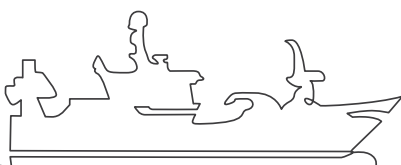
- ❖ No differences in numbers of species or diversity of fish inside NTZ.
- ❖ No differences in numbers of individual species of fish inside the NTZ.
- ❖ Gadoid fish as a group slightly more abundant inside NTZ.
(see Pickup, 2013)

There appears to have been relatively little research on fish in the NTZ. Stewart *et al.*'s (2020) review of research on Lamlash Bay does not include information on fish and the only publication specifically on the topic appears to be a student thesis (Pickup, 2013). This found no differences in the numbers of fish species, the diversity of fish, or the numbers of fish (including cod, haddock, whiting, dogfish and flatfish) inside and outside the NTZ although the abundance of gadoid fish as a group was slightly higher inside the NTZ. Howarth *et al.* (2015a) also mention that there was no difference in the abundance and size of fish inside and outside the NTZ.

Other Benthic Organisms

- ❖ Abundances of a variety of benthic organisms greater inside NTZ.
- ❖ Composition of sea-bed communities different inside NTZ.
 - ◆ More complex habitats inside NTZ.
- ❖ Little difference in abundances of mobile fauna inside NTZ.
(See Howarth *et al.* 2015a; Stewart *et al.* 2020)

Surveys between 2010 and 2013 found that the abundances of a variety of benthic (bottom-living) organisms including live maerl, macroalgae (seaweed), sponges, hydroids, and feather stars, were greater inside the NTZ than in areas outside it. Also, that the overall composition of sea-bottom communities was significantly different inside the NTZ with a greater abundance of complex habitats providing nursery habitats for juvenile cod and scallops. However, little difference was found in the abundances of mobile bottom-living animals such as crabs or starfish inside the NTZ.



Evidence of Spillover

One of the principal claimed benefits of No-Take Zones is that there will be a 'spillover' from the NTZ of fish or other exploited animals which will benefit fisheries in the surrounding area. The theory is that fish (for example) will become more abundant inside a NTZ and that their abundance in the surrounding area will be enhanced through the dispersal out of the NTZ of eggs, larvae, juveniles and/or adult fish. The theory predicts that the abundance of fish will be highest inside a NTZ and will decline with distance away from its boundary.

Dubois (2013) found no significant relationship between the catch rate or size of lobsters and distance from the Lamlash Bay NTZ boundary, although there was a very minor trend for legal-sized lobsters.

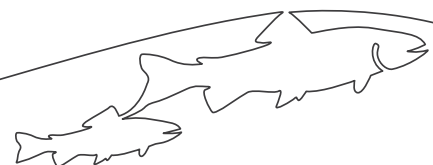
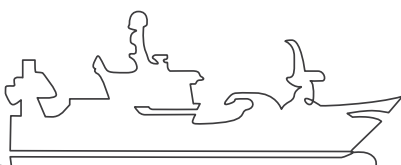
Christie (2015) also found a relationship between the catch rate of legal-sized lobsters and distance from the NTZ although the higher catch rates tended to be within 2 km of the NTZ boundary. However, the catch rate of all lobsters in the 'far control' area was almost the same as that inside the NTZ and much greater than in the closer 'near control' area (see Figure 3 in Christie, 2005).

Howarth *et al.* (2015) found that the density of scallops declined significantly with increasing distance from the NTZ boundary but the higher densities outside the NTZ were all within 1 km of its boundary (see Figure 6 in Howarth *et al.* 2015).

Howarth *et al.* (2016) reported that the catch rate of legal-sized lobsters declined with increasing distance from the NTZ boundary although catch rates were only higher within 2 km. However, the catch rate of sub-legal lobsters and brown crabs both increased further away from the NTZ (see Figure 3 in Howarth *et al.* 2016).

Howarth *et al.* (2016) also reported that three lobsters tagged within the NTZ had been recaptured outside it. According to Crimmins (2018) one of these lobsters was recaptured 20 km and one 40 km from their release locations⁹. Four lobsters tagged outside the NTZ were recaptured within it, but another 71 tagged lobsters that were recaptured had not move in or out of the NTZ.

All these studies were based on experimental fishing and surveys in the NTZ and in areas outside the NTZ. There are no reports of higher catch rates in commercial fisheries in relation to the NTZ.



Overall, the evidence from these studies of spillover from the Lamlash Bay NTZ is very weak (at best). Although some studies found higher catch rates of lobsters closer to the NTZ boundary this was limited to legal-sized lobsters with sub-legal lobsters and brown crabs showing the opposite trend (higher catch rates further away from the NTZ).

For both lobsters and scallops it was clear that any increase in catch rates or abundances outside the NTZ were present only within a relatively short distance from the boundary (1 to 2 km).

The recapture of three tagged lobsters outside the NTZ has been frequently cited as evidence of spillover from the NTZ into the surrounding area despite the very small number involved (and the fact that four tagged lobsters moved into the NTZ).

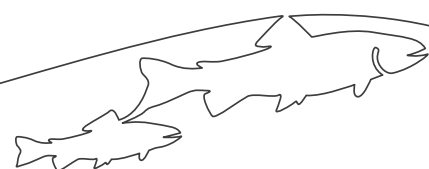
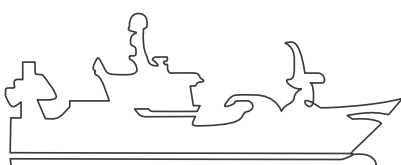
Finally, there is no evidence of any increases in commercial fisheries catch rates in the area around the Lamlash Bay NTZ.

Discussion of Research Findings

There is a substantial amount of hype around the results of the research carried out in the Lamlash Bay NTZ. COAST state on their website that it shows 'how spatial management measures like marine protected areas are good for both fisheries and conservation'.¹⁰

This hype has also extended into the scientific literature: Stewart *et al.* (2020) stating that 'Research within Lamlash NTZ continues to provide invaluable evidence that temperate marine reserves can help to restore exploited stocks and the wider marine environment'.

The actual scientific evidence is much less convincing and does not appear to justify statements such as those above. The only commercially exploited species which have been shown to have higher catch rates inside the NTZ are lobsters and (sometimes) velvet crabs. On the other hand, the catch rates of brown crabs (and juvenile lobsters) are **lower** inside the NTZ.



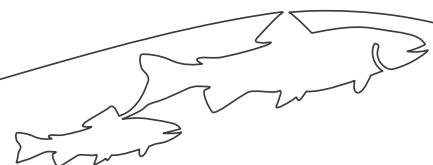
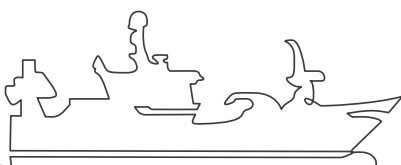
The abundances (densities) of king scallops and queen scallops inside the NTZ are no different to those outside. Nor have any differences been found in the abundances of a variety of fish species inside and outside the NTZ. Both lobsters and king scallops have been found to be larger, heavier and older inside the NTZ (although the larger lobsters also suffered more damage and injury). Any evidence of spillover from the NTZ into the surrounding area is very limited.

Given the focus on commercial fisheries in the aims and objectives for the NTZ and in claims such as those quoted above it is surprising that no research appears to have been carried out on commercial fisheries in relation to the NTZ. As a result, there appears to be no evidence of any actual effects of the NTZ on commercial fish catches in the surrounding area.

The research results that have been published on the Lamlash Bay NTZ hardly appear to justify claims such as those cited above. On the contrary, the evidence from Lamlash Bay does **not** show that NTZs are 'good for fisheries'. Nor does it provide evidence that NTZs 'can help to restore exploited stocks'.

The research results from NTZ do indicate changes in the sea-bed habitats including increases in the abundances of various organisms and an increase in the complexity of sea-bed structures which could justify some of the more conservation-oriented claims made about the NTZ. However, despite what might be seen as the importance of this aspect of the NTZ there again seems to have been curiously little research focus on this issue.

It is striking that much of the published research on the Lamlash Bay NTZ appears to have been written from a 'pro-NTZ' perspective where fishing is almost invariably presented in negative terms and no-take zones in positive terms. That is, rather than impartially assessing what (if any) changes have occurred since the NTZ was established, much of the research appears to have proceeded from an assumption that the Lamlash Bay NTZ is a 'good thing' and sought evidence to support that conclusion. On occasion that appears to have crossed into active advocacy of NTZs and extended to the selective (and arguably misleading) reporting of results (see below: 'Misrepresenting the Science?').



Misrepresenting the Science?

The results of the research that has been published on the Lamlash Bay NTZ are not as clear-cut as its advocates may proclaim. For example, the Community of Arran Seabed Trust (COAST) states on its website¹¹ that a scientific paper shows that 'numbers of some species have increased nearly four-fold' in the Lamlash Bay NTZ, and that 'there are nearly four times more king scallops in the area since 2010.'

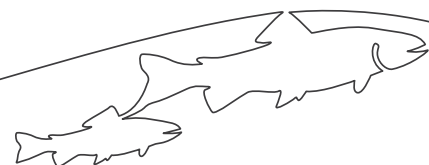
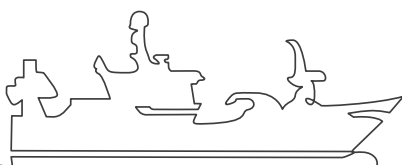
The paper referred to (Howarth *et al.* 2020) states that 'king scallop density in the NTZ has since increased dramatically and is now more than 3.7 times higher than it was in 2013.'

That paper referred to a MSc Thesis (James, 2019) which found that the density of scallops inside the NTZ had increased by 3.4 times between 2013 and 2019. But over the same period **the density of scallops outside the NTZ had increased more (by 4.4 times at a site near the NTZ and 6.2 times at a more distant site)**. Furthermore, the densities of scallops inside and outside the NTZ were not different (in statistical terms) in 2019.

Howarth *et al.* (2020) reported only the increase in the density of scallops inside the NTZ (exaggerating it slightly from 3.4 to 3.7 times). COAST then repeated that, further inflating the increase to 'nearly four-fold', while also implying that the increase applied to more than one species ('numbers of some species'). Neither Howarth *et al.* (2020) nor COAST mentioned the greater increase in the density of scallops outside the NTZ nor the fact that there was no difference between the densities of scallops inside and outside the NTZ in 2019.

While this may all appear somewhat pedantic and pernickety it does point to a selective (and not entirely accurate) use of scientific data to exaggerate the supposed 'benefits' of the Lamlash Bay NTZ. By reporting (and exaggerating) only the increase in the abundance of scallops inside the NTZ (and ignoring the greater increases outside it) both Howarth *et al.* (2020) and COAST clearly gave the impression that the creation of the Lamlash NTZ had resulted in a substantial increase in the abundance of scallops inside the NTZ.

At best this selective reporting of the scientific evidence is careless. At worst it appears calculated to exaggerate the supposed benefits of the Lamlash Bay NTZ (and of MPAs in general) in the minds of journalists, politicians and members of the public who would not normally be expected to scrutinise the original research on which these claims are supposedly based.



Conclusions

Has the Lamlash Bay NTZ Been a Success?

The Lamlash Bay NTZ was 'specifically designed to provide benefits for both fisheries and conservation' (Stewart et al. 2020).

The aims of the Lamlash Bay NTZ were to regenerate and enhance local fish and shellfish populations, to protect the maerl beds present, and to investigate the fishery benefits of a NTZ and MPA, particularly with regard to scallops.

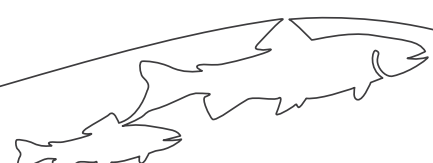
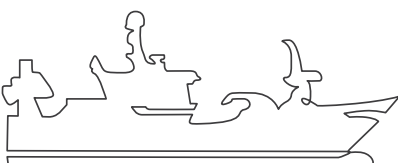
By these objectives the success of Lamlash Bay must be seen as mixed at best with one success and two failures. Undoubtedly it has protected the maerl beds present in the area and other conservation benefits might be claimed (greater abundances of various benthic organisms, for example).

From a fisheries perspective, however, the Lamlash Bay NTZ cannot be claimed as a success. Only one exploited species (lobsters) has been shown to be significantly and consistently more abundant inside the NTZ; there is very little evidence of spillover into the surrounding area; and brown crabs and juvenile lobsters are less abundant in the NTZ. There is no evidence that scallops, which were a particular focus of the original NTZ objectives, have become more abundant because of the NTZ (despite some misleading claims to the contrary). And, overall, there is no evidence of benefits to commercial fisheries in the area.

Lobsters and scallops have been shown to be larger inside the NTZ, but larger lobsters also suffered more injuries and damage. Many of the fisheries-related benefits claimed for the Lamlash Bay NTZ, for example that the larger scallops inside the NTZ will produce more eggs and thus enhance stocks or that the habitats will protect juveniles with the same result, are entirely speculative and unproven.

So, overall, the Lamlash Bay NTZ has failed to regenerate and enhance local fish and shellfish populations, or to demonstrate any fisheries benefits, two of its stated objectives.

Indeed, given that the 'evidence' from Lamlash Bay was used to help justify restrictions on fishing in the much larger South Arran Marine Protected Area the only demonstrable effect of the Lamlash Bay NTZ on commercial fisheries has been negative.



Does the Evidence from Lamlash Bay Justify the Creation of Marine Protected Areas?

Whether or not the evidence from Lamlash Bay justifies the creation of marine protected areas (such as Highly Protected Marine Areas) depends on what the supposed objectives of such areas are to be. If the aim is simply to ban fishing, then perhaps Lamlash Bay does provide evidence of the changes that might occur in comparable areas when fishing is prevented.

But if the claimed objectives of marine protected areas are to regenerate or enhance fish or shellfish stocks or provide fisheries benefits outside the closed areas then the evidence from the Lamlash Bay NTZ does not justify their creation.

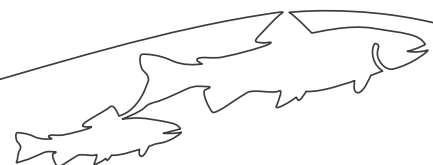
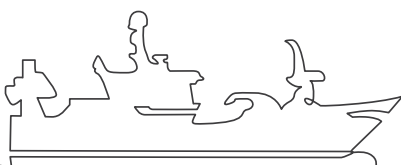
In any case, extrapolating from a single no-take zone covering less than 3 km² to a network of Highly Protected Marine Areas covering at least 46,000 km² (at least 10% of Scotland's sea area) is a very substantial jump.

Research Issues

The hype about the Lamlash Bay NTZ has far outrun the actual scientific evidence, and to some extent has become a self-fulfilling prophecy. Claims about the evidence from Lamlash Bay are often made by advocates of marine protected areas and uncritically accepted and repeated by others who lack any detailed knowledge of the subject, perpetuating and expanding a belief that the Lamlash Bay 'proves' the 'benefits' of no-take zones.

In their review of the Lamlash Bay NTZ Stewart *et al.* (2020) state that 'detailed research has created a case study that clearly demonstrates the benefits of protection in an area where little such evidence is available. This case has been used repeatedly to support efforts for increased protection of UK waters to help rebuild marine ecosystems and enhance their resilience in an uncertain future.'

Yet, an impartial examination of the (published) scientific evidence hardly supports such a claim. At best, the evidence of the 'benefits' of protection is mixed, especially as regards supposed fisheries benefits, and in some cases it is clearly negative (more lobsters but fewer brown crabs, for example).



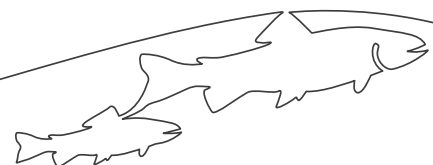
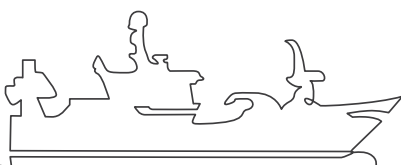
A major weakness of the research efforts in the Lamlash Bay NTZ has been the lack of a pre-planned, systematic, long-term and independent monitoring programme. Ideally this would have started before the NTZ was designated to allow for 'before and after' comparisons and for the selection of appropriate control sites.

Rather, the 'monitoring' of the Lamlash Bay NTZ appears to have consisted largely of a series of disconnected projects running over relatively short periods of time. Further, much of this research appears to have been undertaken by, or in close association with, advocates of the NTZ and of marine protected areas in general.

Recommendations

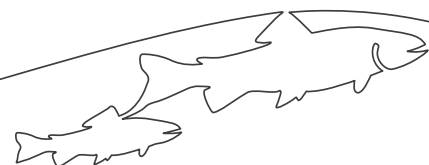
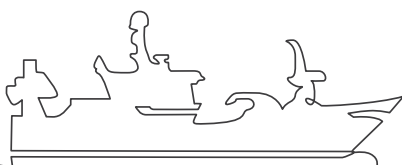
There should be a comprehensive, independent, critical and impartial review and re-analysis of all the available data from the research carried out on the Lamlash Bay NTZ before any further claims are made about the evidence from the NTZ and before that evidence is used to justify the creation of Highly Protected Marine Areas.

For any future no-take zones (including any HPMA) appropriate pre-planned, systematic, long-term and independent monitoring programmes should be implemented **before** they are designated, to allow for their effects to be effectively and critically evaluated. The monitoring scheme put in place for the Sullom Voe Oil Terminal provides a useful example of how a monitoring programme should be planned and implemented.¹²



References

- Boulcott, P., McLay, H.A., Allan, L., Clarke, S. 2012. Scallop Abundance in the Lamlash Bay No Take Zone: A Baseline Study. Marine Scotland Science, Scottish Marine and Freshwater Science Vol 7, No. 3. <https://www.gov.scot/publications/scottish-marine-freshwater-science-volume-3-number-7-scallop-abundance/>.
- Boulcott, P., Stirling, D., Clarke, J. & Wright, P. 2018. Estimating fishery effects in a marine protected area: Lamlash Bay. Aquatic Conservation 28; 840-849. <https://doi.org/10.1002/aqc.2903>.
- Carney, W. 2017. The influence of the Lamlash Bay no-take zone, Firth of Clyde, on spatial and temporal variation in the recovery of commercially exploited crustaceans. MSc Thesis, University of York. <https://www.arrancoast.com/the-influence-of-the-lamlash-bay-no-take-zone-in-the-recovery-of-crustaceans-carney-w/>.
- Christie, B. 2015. The effects of a No-Take-Zone on crustacean population recovery in Lamlash Bay, Scotland. MSc Thesis, University of York. <https://www.arrancoast.com/the-effects-of-a-no-take-zone-on-crustacean-population-recovery-in-lamlash-bay-scotland/>.
- Crimmins, É. 2018. The influence of the Lamlash Bay no-take zone, Firth of Clyde, on spatial and temporal variation in the recovery of commercially exploited crustaceans. MSc Thesis, University of York. <https://www.arrancoast.com/the-influence-of-the-lamlash-bay-no-take-zone-on-spatial-and-temporal-variation-in-the-recovery-of-commercially-exploited-crustaceans-crimmins-e/>.
- Dubois, P. 2013. The Response of Commercially Exploited Crustaceans to Protection in Scotland's First No Take Zone – Lamlash Bay, Isle of Arran. MSc Thesis, University of York. <https://www.arrancoast.com/the-response-of-commercially-exploited-crustaceans-to-protection-in-scotland-s-first-no-take-zone-lamlash-bay-isle-of-arran-dubois-p/>.
- Dunnet, G. 1995. The Shetland environment, the establishment of the Sullom Voe Environmental Advisory Group, development of Shetland Oil Terminal Environmental Advisory Group and its monitoring strategy. Proceedings of the Royal Society of Edinburgh, Section B: Biological Sciences 103: 11 – 20. <https://doi.org/10.1017/S026972700000590X>.
- Foxton, P. 1981. The SOTEAG programme of monitoring in Sullom Voe. Proceedings of the Royal Society of Edinburgh, Section B: Biological Sciences 80: 19 – 32. <https://doi.org/10.1017/S0269727000006473>.
- Howarth, L.M. 2010. Is there early evidence of the Lamlash Bay No Take Zone providing scallop fishery benefits? Science Report for COAST, September 2010, University of York. <https://www.arrancoast.com/is-there-early-evidence-of-the-lamlash-bay-no-take-zone-providing-scallop-fishery-benefits-howarth-l/>.
- Howarth, L.M. 2012. Exploring the fishery and ecological effects of Lamlash Bay No Take Zone. Science Report for COAST, April 2012, University of York. <https://www.arrancoast.com/exploring-the-fishery-and-ecological-effects-of-lamlash-bay-no-take-zone-howarth-l/>.
- Howarth, L.M., Wood, H.L., Turner, A.P., Beukers-Stewart, B.D. 2011. Complex habitat boosts scallop recruitment in a fully protected marine reserve. Marine Biology 158: 1767-1780. <https://doi.org/10.1007/s00227-011-1690-y>.



Howarth, L.M., Pickup, S.E., Evans, L.E., Cross, T.J., Hawkins, J.P., Roberts, C.M., Stewart, B.J. (2015a). Sessile and mobile components of a benthic ecosystem display mixed trends within a temperate marine reserve. *Marine Environmental Research* 107: 8-23. <https://doi.org/10.1016/j.marenvres.2015.03.009>.

Howarth, L.M., Roberts, C.M., Hawkins, J.P., Steadman, D.J., Beukers-Stewart, B.D. 2015b. Effects of ecosystem protection on scallop populations within a community-led temperate marine reserve. *Marine Biology* 162: 823-840. <https://doi.org/10.1007/s00227-015-2627-7>.

Howarth, L.M., Dubois, P., Gratton, P., Judge, M., Christie, B. Waggitt, J.J., Hawkins, J.P., Roberts, C.M., Stewart, B.D. 2016. Trade-offs in marine protection: multispecies interactions within a community-led temperate marine reserve. *ICES Journal of Marine Science* 74: 263-276. <https://doi.org/10.1093/icesjms/fsw166>.

Howarth-Forster, L. Marine Social Attitudes on Arran. MSc Thesis, University of York. <https://www.arrancoast.com/marine-social-attitudes-on-arran-howarth-forster-l/>.

James, L. 2019. The recovery of the commercially valuable scallop species, *Pecten maximus*, under different forms of protection around the Isle of Arran. MSc Thesis, University of York. <https://www.arrancoast.com/the-recovery-of-the-commercially-valuable-scallop-species-under-different-forms-of-protection-around-the-isle-of-arran-james-l/>.

Jones, I. Investigating spatial trends in biodiversity around the South Arran MPA. MSc Thesis, University of York. <https://www.arrancoast.com/investigating-spatial-trends-in-biodiversity-around-the-south-arran-mpa-jones-i/>.

Munro, C.D., Baldock, L., Brown, K., Lindsley-Leake, S. 2014. Lamlash Bay, Arran, 2010 survey report. Scottish Natural Heritage Commissioned Report No.619. <https://www.nature.scot/doc/naturescot-commissioned-report-619-lamlash-bay-arran-2010-survey-report>.

Notley, W. 2019. The recovery of Lamlash MPA No Take Zone and South Arran MPA: Has protection led to improved biodiversity and habitats? MSc Thesis, University of York. <https://www.arrancoast.com/the-recovery-of-lamlash-mpa-no-take-zone-and-south-arran-mpa-has-protection-led-to-improved-biodiversity-and-habitats-notley-w/>.

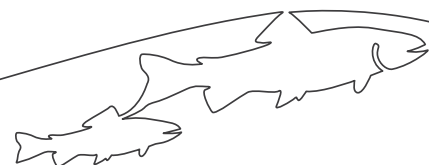
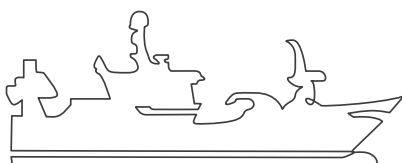
Pickup, S. 2013. The effect of Lamlash Bay No Take Zone on fish abundance and diversity. MSc Thesis, University of York. https://www.arrancoast.com/__trashed/.

Ritchie, W. 2004. Monitoring long-term environmental change: Some lessons from Sullom Voe, Shetland Islands. *WMU Journal of Maritime Affairs* 3: 193-204. <https://doi.org/10.1007/BF03195059>.

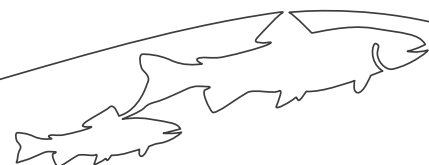
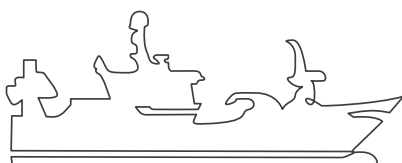
Steadman, D. 2013. Gimme Shell-ter: Abundance, age/size, structure and fecundity of *Pecten maximus* and *Aequipecten opercularis* inside and outside a temperate no take zone. MSc Thesis, University of York. <https://www.arrancoast.com/gimme-shell-ter-abundance-age-size-structure-and-fecundity-of-pecten-maximus-and-aequipecten-opercularis-inside-and-outside-a-temperate-no-take-zone-steadman/>.

Stewart, B.D., Howarth, L.M., Wood, H., Whiteside, K., Carney, W., Crimmins, É., O'Leary, B.C., Hawkins, J.P., Roberts, C.M. 2020. Marine Conservation Begins at Home: How a Local Community and Protection of a Small Bay Sent Waves of Change Around the UK and Beyond. *Frontiers in Marine Science* 7: 76. <https://doi.org/10.3389/fmars.2020.00076>.

Skerritt, D.J., Robertson, P.A., Mill, A.C., Polunin, N.V.C., Fitzsimmons, C. 2015. Fine-scale movement, activity patterns and home-ranges of European lobster *Homarus Gammarus*. *Marine Ecology Progress Series* 536: 203-219. <https://doi.org/10.3354/meps11374>.



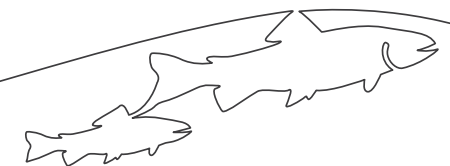
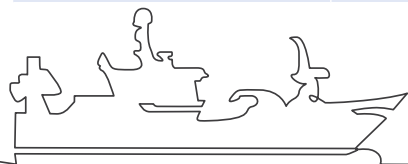
- 1 Kenneth Gibson MSP, Scottish Parliament, 21 March 2023. https://www.parliament.scot/chamber-and-committees/official-report/search-what-was-said-in-parliament/meeting-of-parliament-21-03-2023?meeting=15214&iob=129739#orscontributions_M2110E426P762C2478590.
- 2 Kenneth Gibson MSP, Scottish Parliament, 20 April 2023. https://www.parliament.scot/chamber-and-committees/official-report/search-what-was-said-in-parliament/meeting-of-parliament-20-04-2023?meeting=15249&iob=130067#orscontributions_M2110E426P762C2484332.
- 3 Ariane Burgess MSP. Highly Protected Marine Areas vital to protecting Scotland's waters. <https://greens.scot/news/highly-protected-marine-areas-vital-to-protecting-scotlands-waters>.
- 4 For the history and aims of the campaign to establish a No-Take Zone in Lamlash Bay and the South Arran MPA see Stewart *et al.* (2020) and the COAST website: <https://www.arrancoast.com/no-take-zone/> and <https://www.arrancoast.com/south-arran-mpa/>.
- 5 The Fishing Daily, 23 February 2020. <https://thefishingdaily.com/latest-news/isle-of-arran-ntz-project-breathes-new-life-into-marine-environment/>.
- 6 'Stewart *et al.* (2020)' refers to the paper written by Stewart and others and published in 2020. Full details of all sources referred to in this way are listed in the References section.
- 7 Relevant publications were identified by searching the Aquatic Sciences and Fisheries Abstracts (ASFA) database (<https://www.fao.org/asfa/en>) for publications that referred to 'Lamlash Bay' and from the Research section of the COAST website: <https://www.arrancoast.com/research/>.
- 8 It is assumed that these student reports were theses presented to fulfil part of the requirements of a Master of Science degree although that is not always clear.
- 9 Perhaps surprisingly, the veracity of the reported recaptures of lobsters 20 and 40 kms from where they were tagged does not appear to have been questioned although these distances greatly exceed those that lobsters are normally assumed to travel (figures of 2 to 3 km are often quoted). See for example Skerrit *et al.* (2015).
- 10 Recovery of Lamlash Bay NTZ. COAST. <https://www.arrancoast.com/recovery-of-lamlash-bay-ntz/>
- 11 Lamlash Bay NTZ paves the way for revival of UK seabeds. COAST. <https://www.arrancoast.com/lamlash-bay-ntz-paves-the-way-for-revival-of-uk-seabeds/>
- 12 See, for example, Dunnet (1995), Foxton (1981), Ritchie (2004) and <https://www.soteag.org.uk/environmental-monitoring/>.



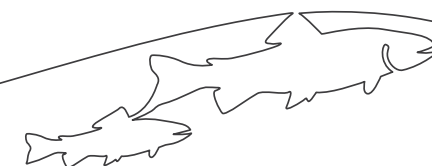
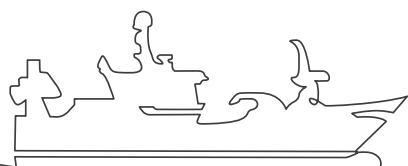
Appendix - Literature Summary

Summary of publications on the effects of the Lamlash Bay NTZ including their type (paper = peer-reviewed paper published in a scientific journal), the main species covered, the period when the research was carried out (period of study) and main findings. Publications are ranked in the approximate order in which the research was carried out (period of study). See References section for full details of publications including links. All student reports are referred to as 'theses' although it is not always clear if that is the case.

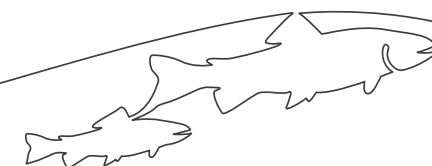
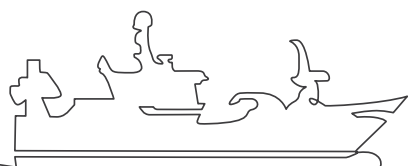
Authors	Pub' Year	Type	Title	Species	Period of Study	Main Findings
Munro, Baldock, Brown & Lindsey-Leake (Scottish Natural Heritage)	2014	Report	Lamlash Bay, Arran, 2010 survey report	❖ Various	2008 - 2009	Surveys mapped the seabed habitats of Lamlash Bay and surrounding area. 10 biotopes were mapped; no differences between main biotopes inside and outside NTZ; condition of areas near NTZ consistent with effects of mobile fishing gear; extensive areas of maerl gravel but little live maerl in northern part of Bay.
Boulcott, McLay, Allen & Clarke (Marine Scotland)	2012	Report	Scallop Abundance in the Lamlash Bay No Take Zone: A Baseline Study	❖ King Scallops ❖ Queen Scallops	2009 - 2010	Baseline survey of scallop abundances inside and outside NTZ. No evidence of higher abundances inside NTZ.
Howarth	2010	Report	Is there early evidence of the Lamlash Bay No Take Zone providing scallop fishery benefits?	❖ King Scallops ❖ Queen Scallops	2010	Age, size and biomass of scallops greater inside NTZ but not density. Abundance of juvenile scallops greater inside NTZ, related to greater abundance of macroalgae which encouraged spat settlement.
Howarth, Wood, Turner & Beukers-Stewart	2011	Paper	Complex habitat boosts scallop recruitment in a fully protected marine reserve	❖ King Scallops ❖ Queen Scallops ❖ Benthos	2010	Abundance of juvenile scallops greater inside NTZ than outside. Related to greater presence of macroalgae and maerl within the NTZ - complex hab-itat encouraged spat settlement. Density of adult scallops not greater inside NTZ but age, size and biomass were greater.



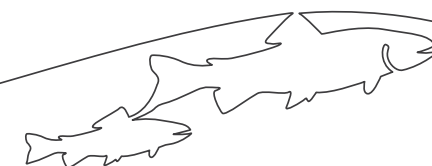
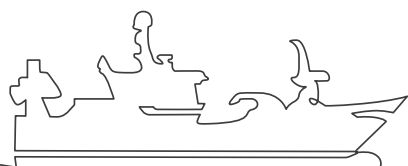
Authors	Pub' Year	Type	Title	Species	Period of Study	Main Findings
Howarth	2012	Report	Exploring the fishery and ecological effects of Lamlash Bay No Take Zone	❖ Benthos ❖ Scallops	2010 - 2011	Evidence that ecological communities inside the NTZ are more diverse and more abundant and that scallop populations inside the NTZ are older, larger and more abundant.
Pickup	2013	Thesis	The effect of Lamlash Bay No Take Zone on fish abundance and diversity.	❖ Fish	2013	Numbers of species, numbers of individuals and diversity of fish not different inside NTZ. Abundance of gadoid fish greater inside NTZ; other groups not different.
Steadman	2013	Thesis	Gimme Shell-ter: Abundance, age/size, structure and fecundity of <i>Pecten maximus</i> and <i>Aequipecten opercularis</i> inside and outside a temperate no take zone.	❖ King Scallops ❖ Queen Scallops	2013	Scallops were larger and older and biomass was greater inside NTZ but abundances were not different. Nor were scallops inside NTZ growing faster.
Howarth, Pickup, Evans, Cross, Hawkins, Roberts & Stewart	2015a	Paper	Sessile and mobile components of a benthic ecosystem display mixed trends within a temperate marine reserve	❖ Benthos	2010 - 2013	Maerl, macroalgae, sponges, hydroids, feather stars and eyelash worms significantly more abundant inside NTZ. Overall composition of epifaunal communities inside NTZ significantly different. Greater abundance of complex habitats inside NTZ apparently providing nursery habitat for juvenile cod and scallops. Little difference in abundances of mobile benthic fauna, such as crabs and starfish inside the NTZ and no difference in abundance and size of fish.
Howarth, Roberts, Hawkins, Steadman & Beukers-Stewart	2015b	Paper	Effects of ecosystem protection on scallop populations within a community-led temperate marine reserve	❖ King Scallops ❖ Queen Scallops	2010 - 2013	Abundance of juvenile scallops significantly greater inside NTZ. Related to greater presence of macroalgae and hydroids inside NTZ. No difference in density of adult scallops inside NTZ. Age, size and biomass of king scallops greater inside NTZ. Little difference in queen scallops inside NTZ.



Authors	Pub' Year	Type	Title	Species	Period of Study	Main Findings
Boulcott, Stirling, Clarke & Wright	2018	Paper	Estimating fishery effects in a marine protected area: Lamlash Bay	❖ King Scallops ❖ Queen Scallops	2009 - 2014	No significant increase in adult scallop abundance within the NTZ. No evidence of dispersal of adults into surrounding areas.
Howarth, Dubois, Gratton, Judge, Christie, Waggitt, Hawkins, Roberts & Stewart	2017	Paper	Trade-offs in marine protection: multispecies interactions within a community-led temperate marine reserve	❖ Lobsters ❖ Brown Crabs ❖ Velvet Crabs	2012 - 2015	Catch rate and size of lobsters greater inside NTZ. Greater incidence of damaged lobsters inside NTZ (linked to greater body size). Catch rates of brown crabs lower inside NTZ. Catch rate of velvet crabs higher inside NTZ in most years.
Christie	2015	Thesis	The Effects of a No-Take-Zone on Crustacean Population Recovery in Lamlash Bay, Scotland	❖ Lobsters ❖ Brown Crabs ❖ Velvet Crabs	2015	Catch rates of lobsters and velvet crabs greater inside NTZ but catch rate of brown crabs was lower. Prevalence of lobster damage and disease not different inside NTZ. Lobsters larger inside NTZ and size declined with distance from NTZ.
Carney	2017	Thesis	The influence of the Lamlash Bay no-take zone, Firth of Clyde, on spatial and temporal variation in the recovery of commercially exploited crustaceans.	❖ Lobsters ❖ Brown Crabs ❖ Velvet Crabs	2017	Catch rates and sizes of lobsters greater inside NTZ. Lobster size declined with distance from NTZ. Brown crabs had lower catch rates inside NTZ; differences negligible for velvet crabs.
Crimmins	2018	Thesis	The influence of the Lamlash Bay no-take zone, Firth of Clyde, on spatial and temporal variation in the recovery of commercially exploited crustaceans.	❖ Lobsters ❖ Brown Crabs ❖ Velvet Crabs	2018	Catch rates and size of lobsters greater inside NTZ. 3 lobsters inside NTZ recaptured outside. Catch rate of brown crabs lower inside NTZ; no difference for velvet crabs.
Jones	2018	Thesis	Investigating spatial trends in biodiversity around the South Arran MPA	❖ Fish	2018	Investigated fish assemblages and biodiversity within the South Arran MPA. Biodiversity was higher in kelp habitat and areas with greater 3D complexity.



Authors	Pub' Year	Type	Title	Species	Period of Study	Main Findings
Notley	2019	Thesis	The recovery of Lamlash MPA No Take Zone and South Arran MPA: Has protection led to improved biodiversity and habitats?	❖ Various	2019	Investigated changes in biodiversity in NTZ and South Arran MPA. Biodiversity had generally increased inside NTZ. Evidence of increased kelp cover inside NTZ and MPA.
Howarth-Forster	2020	Thesis	Marine Social Attitudes on Arran	❖ Humans	2020	Surveyed attitudes of Arran residents and visitors towards the NTZ and South Arran MPA. Awareness of and support for the NTZ and MPA were both high.
Stewart, Howarth, Wood, Whiteside, Carney, Crimmins, O'Leary, Hawkins & Roberts	2020	Paper	Marine Conservation Begins at Home: How a Local Community and Protection of a Small Bay Sent Waves of Change Around the UK and Beyond	❖ Various	2008 - 2019	General description of the background to the NTZ and developments since its creation. Includes a review of previous findings about various species.



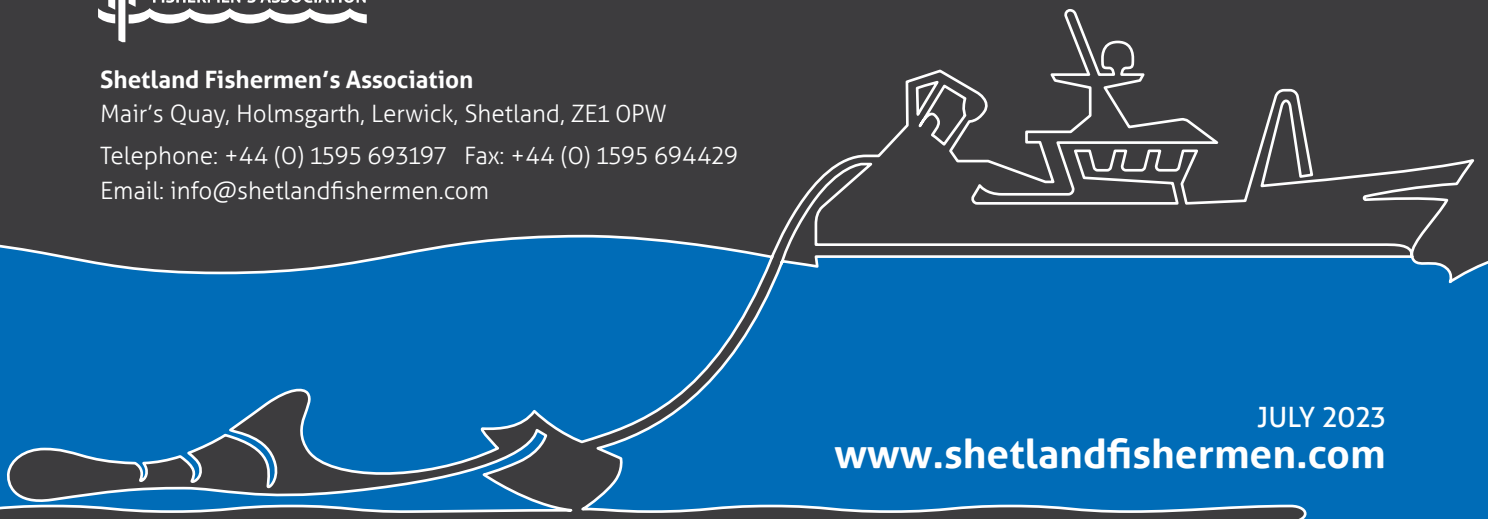


Shetland Fishermen's Association

Mair's Quay, Holmsgarth, Lerwick, Shetland, ZE1 OPW

Telephone: +44 (0) 1595 693197 Fax: +44 (0) 1595 694429

Email: info@shetlandfishermen.com



JULY 2023

www.shetlandfishermen.com