

**CORRECTING THE MISALLOCATION OF NEPHROPS STOCKS IN  
SCOTTISH INSHORE WATERS: UNTAPPING A VAST ECONOMIC  
(AND ENVIRONMENTAL) POTENTIAL**

**SCOTTISH CREEL FISHERMEN'S FEDERATION  
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## EXECUTIVE SUMMARY

Creeling and trawling for Nephrops are not simply alternative methods of harvesting Nephrops in inshore waters. Economically, they are quite separate activities which deliver fundamentally different economic outcomes. What they have in common is that, in Scotland's inshore waters, they compete for access to the same stock of Nephrops.

Currently, in Scotland we have an economically absurd outcome whereby each tonne of Nephrops caught by trawls in areas fishable by creels is contributing to an unnecessary degradation of the Scottish marine environment and a significant reduction in Scottish output, income, employment and profits, particularly in remote/rural areas. This is a manifestation of '**market failure**'. Regrettably, Marine Scotland, which should be correcting the anomaly of excessive trawling effort, has adopted a *laissez-faire* approach. This is precisely the wrong response.

At the same time, whilst Marine Scotland eschews area management, across the inshore area, many mobile operators are imposing their own *de facto* area management with the primary purpose of benefitting themselves at the direct expense of creelers. Creelers have to comply with these creel limits otherwise they face the prospect of their creels being regularly towed away. This is a very costly and inconvenient sanction.

The combination of Marine Scotland "hands off" approach and *de facto* creel limits imposed by the trawl sector has resulted in trawlers managing to secure 87.7% of the Scottish Nephrops catch. This level of access to Nephrops stocks is certainly not warranted by the sector's economic or environmental performance, or indeed any coherent performance indicator.

There is little doubt that exploitation of Scotland's inshore Nephrops stocks has been driven in a direction which has been completely incompatible with Scotland's best interest and the Scottish Government's declared policy objectives. It is clear that Marine Scotland's current *laissez-faire* is entirely inappropriate and deeply damaging, particularly to remote areas in Scotland.

In addressing the issue of which sector should have preferential access to Scotland's inshore Nephrops stocks, the paper considers the question; "**which sector will make best economic use of each and every live weight tonne of Nephrops?**" It transpires that creeling not only delivers more jobs per tonne it catches, it is economically more efficient (i.e. profitable) to catch a tonne of Nephrops using creels rather than trawling the sea bed.

This is a remarkable result. It means that employment and economic efficiency (as reflected in profitability per tonne) would both be increased by allowing a greater Nephrops tonnage to be caught by creelers. At the same time, this would better facilitate the development of Scotland's footprint and reputation as an exporter of quality food and drink.

Apparently, Marine Scotland faces no trade-off between economic indicators. By reallocating access to Nephrops in favour of creeling Marine Scotland has the capacity to increase total employment, total household incomes, total profits /economic efficiency and the number of individual fishing businesses in coastal areas. Many of these areas are remote and suffer from a narrow range of economic opportunity.

In addition, and equally remarkably, because each tonne landed by creelers causes less environmental damage, Marine Scotland does not have to contend with trade-offs between economic and environmental performance indicators. It can therefore improve the economy and the marine environment.

This paper further establishes that the optimum allocation of Nephrops stocks requires that, in future, trawlers should not catch a single tonne of Nephrops which otherwise could have been caught by creelers. This implies that creelers should have exclusive access to some inshore areas. Comparing this with the current reality reveals the full extent of market failure.

Ironically, because of market failure and its own past failure to intervene, Marine Scotland now faces a legacy of a highly significant economic and environmental potential just waiting to be released. Moreover, the release of these economic and environmental benefits would not require a public finance commitment of any magnitude.

In order to provide an insight into particular policy proposals, among other things, the study estimated the net gains in key economic performance indicators. This was done in terms of each 1,000 tonnes of Nephrops transferred to the creeling sector. These are presented in the Table below and represent the gains to the creeling sector minus the losses to the trawling sector. They represent the overall benefit to Scotland as a whole.

**Table 3.3 Net Gains per 1,000 Tonnes Transferred to Creeling**

	Per 1,000 Tonne
<b>Additional Vessels</b>	69
<b>Additional Revenue</b>	£6,776,000
<b>Additional FT Jobs</b>	110
<b>Additional Profit</b>	£407,000

SCFF takes the view that Marine Scotland should regard the re-balancing of fishing effort in the form of **creel only areas** as a quite extraordinary one-off opportunity to realise the massive potential of our inshore Nephrop stocks. Currently this potential is being shamefully squandered.

SCFF now calls on Marine Scotland to accept the conclusions of this paper and to work with the Federation to ensure that inshore Nephrops stocks will now be managed in Scotland’s best interests. Specifically, SCFF is seeking Marine Scotland’s support for a target of a fifty per cent share for creelers of the 0-6NM Scottish Nephrops fishery. SCFF believes that this goal can best be achieved:-

- On the west coast of Scotland through the re-imposition of an 0-3NM mobile gear restriction; and
- On the east coast of Scotland through a network of mobile gear free zones negotiated at local level with the support and guidance from Marine Scotland.

SCFF estimates that the economic benefits of this policy for the west coast alone would include:

- Over 450 additional (small) fishing vessels and businesses
- Over 700 net and new sustainable jobs in fishing
- Nearly £45m additional annual revenue and over £2.5m annual profits which would flow directly into west coast communities

These figures clearly demonstrate that the national interest supports a substantial reallocation of fishing opportunity for Nephrops in Scotland to the creel sector. The SCFF calls on Marine Scotland to start working with it immediately to make its goal a reality by 2022.

**Scottish Creel Fishermen’s Federation  
May 2017.**

## INTRODUCTION

This paper arises from a perception by Scottish Creel Fishermen's Federation (SCFF) of a very serious policy error in the management of Scotland's inshore Nephrops fishery.

It argues that the current balance between trawling and creeling for Nephrops in some inshore areas is, by a significant margin, not delivering best value for Scotland. Each tonne of live Nephrops landed live by a creel vessel generates more revenue, more profits, more jobs, more household income and causes less environmental damage than a tonne of tails or whole Nephrops landed by a trawler.

Despite this, only 12.6 % of the Scottish Nephrops inshore catch tonnage (0-12NM) and 17.6 % of the catch tonnage within 0-3 NM is landed by creelers.<sup>1</sup>

- Section 1 of this paper explains why a combination of market forces and Marine Scotland current policy are responsible for the catastrophic misallocation of Scotland inshore stock of Nephrops.
- Section 2 examines the spatial distribution of the current exploitation levels by static and mobile gear.
- Section 3 addresses the economic evidence of the misallocation and the policy implications.
- Section 4 presents an overall conclusion

The production of this paper was assisted by advice from a number of advisers to the Federation. Alan Radford, an economist who has previously advised and undertaken commissioned research for the Scottish Government on inshore fisheries and related issues, was particularly helpful in developing the economic analysis.

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<sup>1</sup> See Table 2.7

## 1. THE MISALLOCATION AND ITS CAUSE

Scottish creelers land live Nephrops most of which are exported. Live langoustines, especially from the West of Scotland, are internationally recognised as a high quality, luxury food item. Scottish live langoustines, along with products such as malt whisky, Scottish venison and Aberdeen Angus contribute significantly to Scotland's enviable profile as a producer of high quality food and drink.

Only a very small proportion of Nephrops landed from trawlers are sold live. This is because around 40-50% of Nephrops landed on deck are already dead and a proportion of the remainder are likely to die soon after. Whilst shorter tows can increase survival rates, the extra work in catching, processing and landing live Nephrops is not rewarded sufficiently through higher prices for trawl caught live Nephrops. Also, compared to creel caught Nephrops, the general quality of the product and the post landing survival rate is lower. This is a direct result of the damage and stress caused during capture in trawls. Dealers' reputation as suppliers of a live high quality product and their revenue per Kg, are very sensitive to quality and transit survival rates, and this is reflected in the price they are willing to pay. As result, the price of trawl caught live Nephrops is around 50% of live creel caught Nephrops. Therefore, trawlers land few live Nephrops.

Trawlers catching Nephrops are essentially supplying two products; Nephrop tails and whole Nephrops which may be fresh and frozen. When trawlers catch damaged and/or smaller nephrops they retain only the tails. Carapace, claws, legs and other body parts of are discarded at sea. A Nephrop tail is therefore only one third by weight of the whole Nephrop. According to the official conversion factors used by the Marine Management Organisation (MMO), a tonne of landed tails requires 3 tonnes of live weight Nephrops caught in the trawl net.

A recent study by Hambrey *et al* (2015)<sup>2</sup>, estimated that, with respect to Scotland as a whole, around 60% of the trawled product is for the processed tail market<sup>3</sup>. This market for tails is primarily in the UK with most sold via agents to major processors. Hambrey *et al* also stated that 80 to 85% of tail output is sold in the UK as fresh, frozen, processed and cooked products, with roughly half of this ending up as breaded "scampi". A small proportion of tails in various forms is exported.

Around 35% of the trawled whole Nephrops product is destined for the fresh and frozen wholesale market, which is mainly exported to the continent. Hambrey *et al* estimated that between 70 and 90% of fresh and frozen whole Nephrops are destined for the French market, with the remainder going mainly to Spanish and Italian markets.

**It is a mistake to regard Creeling and trawling for Nephrops as simply alternative methods of harvesting Nephrops in inshore waters. Not only do they use different fishing methods, they supply quite different products to different markets. Though deceptively similar, economically, they are quite separate activities which deliver fundamentally different economic outcomes. What they have in common is that, in Scotland's inshore waters, they both target the same stock of Nephrops.**

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<sup>2</sup> Hambrey J., Medley P., Evans S., Carlton C., Beaumont C. and Southall T (2015). Evidence Gathering in Support of Sustainable Scottish Inshore Fisheries: Integrating Stock Management Considerations with Market Opportunities in the Scottish Inshore Fisheries Sector – a Pilot Study. Published by MASTS. 150pp. ISBN 978-0-9934256-6-0

<sup>3</sup> The West Coast is slightly different with smaller trawlers and a higher quality of product. Hambrey *et al* estimate that at least 75% of landings in the West are of fresh whole product. When converted to live weight equivalents, these proportions will change significantly.

Unfortunately, as explained later, this joint exploitation is one of the reasons why Scotland is currently not releasing the vast economic potential of its Nephrops stocks in inshore waters.

### 1.1 The Price Ratio of Live Creel Caught Nephrops to Trawled Nephrops

Since creel caught Nephrops and trawled Nephrops are sold as different products to different consumers we would expect a price differential. Hambrey *et al* provided the following prices

**Table 1.1 Nephrops Categories and Prices (Hambrey *et al*)**

Count/kg	Carapace Length (mm)	Grade	Live creeled	Live trawled	Fresh whole trawled	Trawled Tails
4-7	60 -70	XXL			£14-£18 (£16)	
5-9	54-67	XL	£14-£18 (£15)	£12-£14	£9-£14 (£11)	
10-15	48-54	L	£11-£15 (£12)	£9-£11	£6-£9 (£7.5)	£5 (£1.7 live weight equivalent)
16-20	42-47	M	£8-£12 (£10)	£5-£6	£5-£7 (£6)	
21-30	38-41	S	£7-£10 (£8)	£4-£5	£3-£5 (£4)	
31-40	34-37	XS			£2-£3 (£3)	
41-50	32-34	XXS			£2-£3 (£2)	
more than 50	less than 32	Tails				

Marine Scotland provided the following price data which also describes the differential.

**Table 1.2 Nephrops prices per tonne 2015<sup>4</sup>**

Month	Nephrops Tails (Landed Price)	Nephrops Tails		
		(Live Weight Equivalent) <sup>5</sup>	Whole NEP – Creel	Whole NEP - Trawls
1	£5,253	£1,751	£9,882	£4,485
2	£5,280	£1,760	£9,221	£4,450
3	£5,166	£1,722	£8,979	£4,422
4	£5,100	£1,700	£8,595	£5,182
5	£5,064	£1,688	£8,909	£4,536
6	£5,433	£1,811	£9,030	£4,301
7	£5,304	£1,768	£8,068	£4,152
8	£5,250	£1,750	£8,792	£4,499
9	£5,247	£1,749	£9,775	£4,490
10	£5,283	£1,761	£9,767	£4,380
11	£5,289	£1,763	£10,001	£4,579
12	£5,241	£1,747	£14,197	£4,885

On the basis of Table 1.2, the mean (liveweight equivalent) prices for; Nephrop tails, trawled whole Nephrops and Creel caught live Nephrops are £1,747; £4,530; and £9,601, respectively. With some convenient rounding a reasonable working assumption is that the price for live Nephrops landed by creels is £9,500 per tonne. The average liveweight price for tails is £1,750. Whole Nephrops landed by trawlers sell for around £4,500 per tonne.

<sup>4</sup> Personal correspondence with Marine Scotland, April 2017

<sup>5</sup> Note that these prices correspond to a live weight equivalent value which is 1/3 of the landed price. This is because tails comprises only around 1/3 of the whole animal. For every tonne of tails landed, 3 tonnes are caught and 2 discarded.

This means the price ratio of creel caught live Nephrops to tails is 5.5:1 and creel caught live Nephrops to whole trawl caught Nephrops of 2.1:1. These prices and the ratios are not contentious.

These price ratios are important because in almost all areas where live Nephrops are caught by creels, trawlers are also exploiting the same stock, and fishing in the same Functional Units (FU). Indeed, the joint exploitation of the sea bed is the experience of almost every creel operator. Creelers work closer to shore. 79% of the creel catch is caught within 3 Nautical Miles (NM) from the shore and 98% within 0-6NM. Within 0-3NM, trawlers catch only 54% of their total catch within 0-12NM<sup>6</sup>. Thus, virtually all creel activity is characterised by interaction with trawlers, whereas a sizeable proportion of trawler activity does not experience the problems of competing for sea bed space with another potentially incompatible gear type.

The important economic point is that, in inshore areas fishable by creels, trawlers are mostly landing tails which cannot therefore be landed as whole Nephrops by creelers. The tails sell for £1,750 per live weight tonne whereas creel caught live Nephrops would have earned £9,500 per tonne.

## 1.2 Why Has This Revenue Disparity Not Previously Been Highlighted?

Since the disparity is so large, it is surprising this has not been more widely cited and discussed. There are a number of possible reasons for this.

In the past, the creel sector was more atomistic and did not have a sufficiently effective representative body which could advocate on its behalf. The recent emergence of the Scottish Creel Fishermen's Federation (SCFF) with a dedicated staff member has enabled the sector to raise its profile across Government and among other stakeholder groups.

The SCFF has encouraged Government to commission research into the inshore sector. The result is that the sector is now subject to greater scrutiny and the sector's current contribution to the Scottish economy is becoming better understood.

Crucially, for its part, the SCFF now also better appreciates the sector's vast potential and is now energetically committed to ensuring this knowledge is shared with the Scottish Government and other stakeholders. This paper is part of this process.

## 1.3 Why Do the Revenue Ratios Matter?

If the revenue ratios were 1:1, it would not matter much which sector exploited Scotland's inshore Nephrops stocks. However, a ratio of 5.5:1 is indicative that, if we wish to obtain "best value" from Scotland's natural resources then we should not be indifferent to which sector harvests Nephrops in waters which can be fished by creels.

In this context, it should be appreciated that, in the rational world, the "true cost" of anything (such as a tonne of tails worth £1,750) is **what we have to forego in order to have it**. This true cost is known as **Opportunity Cost**. In this instance, in terms of foregone revenue, the true cost or Opportunity Cost of a tonne of tails is £9,500. In other words, in landing a tonne of Nephrop tails we generate revenue of £1,750 (live weight equivalent), but forego revenue of £9,500. Clearly, this is a most undesirable outcome. As we will see, there are similarly large opportunity costs of trawling which relate to forgone profits and forgone employment in creeling.

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<sup>6</sup> See Table 2.3.

If decision makers were to routinely ignore these opportunity costs there would be a catastrophic misallocation of resources, with resulting levels of output and social welfare being only a small fraction of what could be achieved.<sup>7</sup> Thus, the discussion in this paper highlights the opportunity costs of creeling and trawling.

At first sight, the magnitude of the opportunity costs relating to foregone revenue (£9,500) suggests that trawlers should only be allowed to harvest inshore stocks if they could offer some “other advantage” which would counterbalance their relative disadvantage in terms of revenue per tonne of tails. These “other” performance indicators might be more profits per tonne or more employment per tonne, or a more environmentally benign form of harvesting the resource.

The reality is that the trawling sector has another very substantial disadvantage. Nephrop trawls dragged across the sea bed have a greater physical impact on the benthic habitat. This is particularly the case with multi-rigged trawlers using clump weights. Trawls also produce very much more by-catch and cause more discards than strings of creels.

Compared with a tonne of creel caught Nephrops, the landing of a tonne of Nephrops tails will have caused greater reductions in geodiversity, biodiversity and the biomass of benthic species. In some inshore areas, especially nursery areas, there might be adverse knock on consequences for other species, particularly demersal fish species. These species might otherwise be commercially harvested, or be important for recreational activities such as sea angling. Consequently, as well as foregoing higher revenue, Scotland also foregoes the better environment quality that would be associated with using creels rather than trawls (see the Grid Report, 2014).<sup>8</sup>

**The difficulty in making the economic case for trawling is that, if there was some other advantage it would have to be hugely significant to swamp the extremely relatively poor performance in terms of both revenue per tonne and adverse environmental impacts. As outlined later, in reality, profits per tonne and employment per tonne are not higher in trawling. Indeed, this document will demonstrate that they are significantly lower.**

This paper will demonstrate that trawling does not have a single economic advantage which could salvage the economic argument for the continued use of Nephrop trawls in Scottish inshore areas where creels can be deployed. Irrespective of the performance indicator one selects, it would appear that in our inshore areas trawlers appear to generate benefit flows which are a fraction of the opportunity costs.

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<sup>7</sup> In planned economies, opportunity costs were obscured. This was because most prices of inputs and outputs were not determined by the market place. The resource allocation in these economies produced levels of output substantially below potential output.

<sup>8</sup> A recent study commissioned and published by Marine Scotland: The Grid Report (Riddington and Radford 2014, “Management of The Scottish Inshore Fisheries; Assessing the Options for Change”) <http://www.gov.scot/Publications/2015/01/4022/0> quantified the economic benefits from the enhanced environmental service flow that could be realised through a re-balancing of Scottish inshore fishing effort in favour of creeling. Interestingly, even with quite modest improvements in the marine habitat, the magnitude of the potential environmental benefits to stakeholders outside commercial shellfish fishery greatly exceeded the benefits that that could be realised by stakeholders within the fishery. Obviously, if these other environmental considerations were explicitly taken into account the already overwhelming case for changing the balance in favour of creeling would be further strengthened.

#### 1.4 Why Do Trawlers Fish Inshore And Land Tails Which Are 5.5 Times Less Valuable?

The fundamental reason is, of course, that trawlers can still make a profit by landing tails. This is because, over any given time period, a trawler is technically capable of catching a very much larger quantity of Nephrops.

The annual Seafish Fleet Economic Performance Report provides indicators for many fleet segments. This shows that the average landings for the active 90 West of Scotland (WOS) Nephrop trawlers **under 250kW** was 54.0 tonnes live weight in 2015, and 61.9 tonnes in 2014. The equivalent weights for the active 43 WOS trawlers **over 250kW** were 135.1 tonnes and 160.3 tonnes. The total catch by all 133 WOS trawlers was 12,200 live weight tonnes and they employed 527 Full Time Equivalents (FTEs).<sup>9</sup>

The key point is that trawlers simply have to catch these quantities to be profitable. This is because, compared with a creeler, a trawler targeting tails has three obvious disadvantages. First, because the vessels are bigger they need to land a greater tonnage simply to cover overheads. Second, only one tonne of tails is sold for every three tonnes of live Nephrops caught in the net. Third, the landed price is only 18% (the price ratio of 5.5) of the creel caught prices. These disadvantages can only be overcome by catching a very much greater tonnage of Nephrops.

#### 1.4 Why Is The Current Situation Undesirable?

Despite the volumes caught, the net profit for under 250kW trawler was £11,308 (a maximum of £180 per live weight tonne) and £52,500 (a maximum of £330 per tonne) for vessels over 250kW.<sup>10</sup> This is a modest profit for the capital tied up in vessels and gear and the commercial risks. Given the tonnage of whole nephrops killed, and the associated opportunity cost, this is indeed a minimal surplus.

In contrast, the average landing for a full time West of Scotland creeler was 10.0 tonnes in 2015 and 11.9 tonnes in 2014.<sup>11</sup> These 177 vessels employed 296 Full Time equivalents and landed a total of 2,217 tonnes.<sup>12</sup> This is 7.5 tonnes per FTE. The average Net Profit was a modest total of £7,300 (£613 per live weight tonne).<sup>13</sup>

At this stage it is interesting to speculate that, if the WOS Nephrops caught by trawlers (12,200 tonnes) were landed by creelers, then on a linear, pro rata basis:

- There would be 974 vessels and 1,629 FTEs employed in creeling (compared with 133 vessels 527 FTEs in trawling).
- The net profit for the fishery would increase, because each tonne re-allocated to creels on average increasing creeling profits by £613 per tonne whilst decreasing trawling profits by £180 for vessels under 250 kW and by £330 per tonne for over 250kW.

In comparison, the 2,217 tonnes landed by creelers and currently supporting 296 FTEs and 177 vessels would only support 66 jobs and 24 vessels in trawling.<sup>14</sup>

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<sup>9</sup> See Table 3.2

<sup>10</sup> For 2014, the last year operating profit figures are available.

<sup>11</sup> Data provided by Seafish, Edinburgh. For the 41 creelers over 10m creelers the average for 2015 was 15 tonnes

<sup>12</sup> At the time of writing, FTE and equivalent landings data were only available for 2014.

<sup>13</sup> See Table 3.1

<sup>14</sup> Trawlers land 12,200 tonnes and this supports 133 vessels/businesses. Thus each tonne supports 0.011 of a trawling business. The equivalent figure for creeling is 2,217 tonnes, 177 vessels with each tone supporting 0.080 of a business. Every tonne reallocated from trawling to creeling would add a net 0.069 of a vessel/business.

**These estimates are not produced as a strict guide to what would actually happen with a rebalancing of effort. Their purpose here is simply to demonstrate the astonishing scale of the current resource misallocation and the enormous potential of the creel sector not only to increase household income, employment and profitability in remote areas, but to substantially improve the marine environment.**

Against the above background, it is surprising that Scotland is not producing more high value langoustine. Instead, the majority of trawlers' catch is landed as tails much of which is destined for processing into frozen scampi and selling for a fraction of the price of live creel caught langoustines.

At the same time, fish buyers inform SCFF that they cannot get enough supply of creel caught Nephrops to satisfy the demand and further develop their businesses.<sup>15</sup> Suppliers firmly believe there are many untapped markets for live Scottish Nephrops which could be developed, but only if regular supply could be guaranteed. For example, the luxury food markets in the major US cities are undeveloped. Supplies of live langoustines to China and the USA are embryonic but the potential is substantial. Indeed, any country with a strong seafood tradition, good communication links and communities of high net worth individuals are potential markets for Scottish live langoustines. If the latent demand for live langoustines can be exploited, even a quite substantial increase in supply of live langoustines would not necessarily drive down prices in the more established markets in Europe.

**It is clearly desirable that Scotland's footprint as a supplier of high quality food and drink be strengthened and extended. The current balance between creels and trawls is clearly constraining the declared aspiration of the Scottish Government.**

Indeed, landing Nephrop tails, caught in inshore waters, has been likened to wild Scottish salmon being processed into frozen fish fingers rather than being sold fresh or smoked. In fact, the analogy is much worse than this. The correct analogy is three tonnes of whole live Scottish salmon being butchered with two tonnes dumped and one tonne becoming fish fingers. Also, in the process, serious damage is inflicted on the marine ecosystem and, as demonstrated throughout this paper, substantially fewer people are employed, fewer businesses are supported and profits are less.

#### **1.4.1 Empirical Evidence of the Misallocation**

There have been two substantial studies which have demonstrated the lost opportunity as reflected in the estimated economic benefits that might be generated from the expansion of creeling in inshore waters.

The New Economic Foundation, (NEF, Working Paper, 2016) presented 17 criteria for analysing the allocation of opportunities to inshore fishing grounds, in Scotland.<sup>16</sup> Their chosen criteria were aligned with the Scottish government's Strategic Objectives, making Scotland: wealthier and fairer, smarter, healthier, safer and stronger, and greener. NEF developed a multi-criteria decision-making framework to evaluate trade-offs and to determine the relative performance of creelers and trawlers. Their analysis leads them to conclude that the creel fishery should be granted greater spatial access to inshore waters to deliver better value from the resource.

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<sup>15</sup> Personal communication with James Cook of D.R. Collin of Eyemouth

<sup>16</sup> "The Scottish Nephrops fishery: Applying social, economic and environmental criteria (CFP Article 17)" Chris Williams and Griffin Carpenter, New Economics Foundation Working Paper (2016). See Section 3, Page 24. Evaluation Framework. [http://b3cdn.net/nefoundation/21d024b2ce367cac07\\_ybm6bd667.pdf](http://b3cdn.net/nefoundation/21d024b2ce367cac07_ybm6bd667.pdf)

NEF (2106) concluded “Using a range of social, economic and environmental criteria for the Scottish Nephrops fishery, our report finds that for inshore waters, the creel fishery provides better value to Scotland than the trawl fishery. Allocating fishing opportunities to the creel fishery in the form of preferential access to crowded inshore waters would support the creeling fleet and provide a necessary lifeline for highly dependent rural communities, especially on the West Coast of Scotland.”

The previously mentioned Grid Report (2014) commissioned by Marine Scotland used Cost Benefit Analysis and Economic Impact Assessment to provide estimates of the impacts to Scotland of a 0-1 nautical mile (NM) limit and a 0-3 NM limit on the use of mobile fishing gear. The Grid Report concluded that under most specific scenarios and the most conceivable assumptions, Scotland could create more jobs and generate an excess of economic benefits over costs by imposing restrictions on the use of mobile gear, particularly along the West Coast of the mainland.

**Overall, it seems undeniable that the market mechanism seems to be delivering an economically absurd outcome where levels of output, employment and profitability which are manifestly very much less than what should be achieved.<sup>17</sup> This is known as ‘market failure’.**

### **1.5. Market Failure and Scotland’s Inshore Nephrops Fisheries**

Usually, we can rely on the market mechanism to allocate resources to their highest valued use. It does this by, among other things, ensuring the benefit flow from current resource allocation exceeds opportunity cost. By performing that function the market delivers “best value” to society. When markets fail and opportunity costs exceed the flow of benefits there exists a better resource allocation offering more value to society.

Indeed, allowing the market to determine resource allocation is the default position of Western developed market economies. It would be hugely beneficial to our economy if resources were always and everywhere automatically allocated to their highest valued use. In other words, the stream of benefits from using a resource in one activity would always be greater than the opportunity cost. This would also mean there is no imperative for government to become involved. A *laissez-faire* approach to resource allocation would be fully justified and consistent with delivering best value to society.<sup>18</sup>

Unfortunately, the reality is that markets often fail and opportunity costs can exceed the benefits from the use of resources in their current activity. In these circumstances, governments are required to intervene to ensure best value. The corollary is that, if there is demonstrable market failure, a *laissez faire* approach might be misjudged and could be extremely costly in terms of opportunity cost.

**Regrettably, Marine Scotland is currently adopting a laissez-faire approach which, in the presence of market failure, is precisely the wrong response. This is having serious consequences for the marine environment, income and employment in Scotland’s remote areas and Scotland’s reputation as a supplier of high quality food.**

#### **1.5.1 Why We Need To Explain Market Failure**

Neither the GRID Report (2014) nor NEF (2016) sought to explain the features of Scotland’s Nephrops which result in the market mechanism failing to deliver anything approaching an optimal outcome. The absence of an accepted explanation has a number of implications. For example, some

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<sup>17</sup> This situation is so unusual it is difficult to find a comparable situation outside commercial fishing. Within commercial fishing there are similarities with the exploitation of scallops by hand diving and dredgers.

<sup>18</sup> Though, government intervention might be justified on other grounds, such as environmental protection, use of labour, safety etc.

might argue that our current experience merely reflects a process of transition whilst the market mechanism iterates towards a “best value” resources allocation. Also, the absence of an explanation might make it difficult finally to convince Marine Scotland that it should not rely on market forces.

A coherent explanation of market failure means that, irrespective of the time horizon, the market is incapable of delivering best value. It also means that if Marine Scotland is serious about delivering on the Scottish Government’s declared strategic objectives, then under no circumstances should it adopt a “hands off” approach.

Below, we explain the causes of the market failure, the economic forces it generates and the implications for Marine Scotland’s laissez-faire approach.

## **1.6 The Combination of Market Failure and Marine Scotland’s Laissez-Faire Approach.**

Before explaining market failure it is necessary briefly to consider some institutional background relating to licences and quotas.

### **1.6.1 Licensing and Quotas**

All commercial fishing vessels require a licence. In addition some vessels require a quota known as Fixed Quota Allocation (FQA). The Scottish Government issues most of the quota allocations it receives from the EU to Fish Producer Organisations (POs). These POs are made up of member fishing vessels and are administered directly by Marine Scotland. POs manage their members’ quotas on their behalf. Some POs also seek to market their landings. Once allocations are made to POs, the quota is fully within their control (subject to quota management rules). If a vessel requires more FQA it can borrow or lease from its PO. If the owner retires from fishing the FQA can be sold.

Vessels over 10m targeting Nephrops that are not PO members are known as the “non-sector”. There are very few of these. The quotas for the non-sector and the “10 metre and under” fleet are managed directly by the Scottish Government. In these two groups, vessels fish against catch limits set by the Government, which may be monthly or quarterly. There is no FQA for these vessels and catch limits are enforced in fishing licences. Very few of the 10 metre and under fleet fish up to the catch limit and the fleet is not constrained by catch limits. Once a vessel has a licence, or in the case of a PO member a license and FQA, it can fish any particular area of sea bed within the area defined by the relevant Functional Unit.

### **1.6.2 The Absence of Key Property Rights and Market Failure**

In the case of Scottish Nephrops, market failure stems from the absence of property rights to fish a given area of the sea bed within any given Functional Unit. As explained above, each tonne of Nephrops landed by a creeler sells for £9,500, whereas a tonne of whole Nephrops caught by trawlers generates revenue of between £1,750 for tails and £4,500 for whole Nephrops. Despite this, the absence of property rights means that creelers, who might otherwise catch the tonnage dumped by trawlers, cannot outbid trawlers and thereby secure their exclusive access to a preferred area of sea bed.

Similarly, it would be pointless for creelers to try and persuade, or even bribe, trawlers to fish elsewhere. This is because the absence of property rights means that other trawlers could not be prevented from moving into the fishing grounds vacated by those who were persuaded or who accepted the bribe. Theoretically, creelers could seek to purchase Nephrops FQA’s attached to vessels who are members of a PO. However, because the FQA’s are not area specific, creelers would have to purchase all Nephrops FQAs for the relevant Functional Unit to preclude vessels who normally fish outside, say, 3 or 6 NM moving closer to the shore. This is not tenable or consistent with delivering best value.

The absence of property rights to the sea bed means there is absolutely no requirement for fishers to outbid other potential fishers of a particular area of sea bed. In these circumstances, the value of the forgone output of live Nephrops (i.e. the opportunity cost of £9,500) is completely irrelevant to someone with a licence and FQA who wishes to use a trawl and land a tonne of nephrop tails (worth £1,750 per live weight tonne). In this way opportunity costs are being ignored in the allocation process. If these are ignored, it is quite impossible for the market mechanism to deliver best value to society.<sup>19</sup>

Appropriately specified property rights have the highly desirable effect of forcing trawlers (and creelers) explicitly to consider the opportunity costs of their activity. If there were property rights, and someone owned the sea bed, mobile and static operators would have to outbid each other for the right to exploit a particular area of sea bed. This is similar to how tenant farmers have to outbid other farmers to rent a particular piece of grazing land, or to employ a particular agricultural worker. Generally this bidding process ensures that valuable natural resources (land, labour or sea bed) get allocated to their highest valued use and produce a flow of benefits which always exceed opportunity costs.

### 1.7 How Inshore Nephrops Stocks Would Be Allocated Without Market Failure

We can readily observe the symptoms of market failure in the form of excessive opportunity costs. We have also explained why the market has failed to produce flows of benefits which exceed opportunity costs.

We now seek to identify the balance of exploitation by creels and trawls which would emerge **if there was no market failure**. In other words, we are seeking to identify the “best value” outcome. Assuming Marine Scotland regards “best value” as a desirable objective, then it should be very interested in the identification of the resource allocation which would deliver that outcome.

Against that background, it is illuminating to speculate on the direction of travel if there were sea bed property rights and all operators were required to bid for access to each Km<sup>2</sup> of sea bed.<sup>20</sup> Assuming for simplicity that *harvesting costs were zero*, a trawler business landing tails would be willing to bid a maximum of £1,750 p.a. for each Km<sup>2</sup> of sea bed capable of yielding annually one tonne of whole Nephrops (which becomes 1/3 of a tonne of landed tails). In contrast the maximum amount a creeler would bid for one Km<sup>2</sup> acre is £9,500 (the market price of a tonne of live Nephrops).

In the above scenario, a trawler operator wishing to catch whole Nephrops and land tails would now have to outbid creelers who are willing to pay up to 5.5 times more per acre. The opportunity cost of landing tails (i.e. £9,500) is thus no longer an irrelevance to the trawler. It becomes a real cost which trawlers have to cover, just as they have to cover their labour costs. In other words, the flow of benefits from trawling has to exceed opportunity costs otherwise trawlers could not submit a winning bid for sea bed access.

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<sup>19</sup>This discussion could have been framed around Negative Externalities. These are negative impacts which are effectively irrelevant to the person causing the negative impact. If negative externalities are a significant feature of an activity, then opportunity costs become excessive and the market cannot deliver best value to society. Negative externalities and opportunity costs are two ways of explaining the same phenomenon. Both reach the same conclusion.

<sup>20</sup> This scenario assumes a single owner of a particular inshore area of the sea bed who is auctioning long term and potentially renewable access to the sea bed. It is also assumed that the optimal sustainable yield is say 3 tons of whole Nephrops per Km<sup>2</sup>.

The scenario is a bit simplistic and fails to recognise that trawler lands a mixture of whole Nephrops and tails. Later in this document (see Table 2.7) we have estimated the proportions of tails and whole Nephrops caught with 0-12 nautical miles (NMs). It is estimated that of the 12,950 tonnes landed by trawlers, 8,336 (64.4%) are Tails and 4,604 (35.6%) are whole Nephrops. Given the price of tails (£1,750) and whole Nephrops (£4,500), these proportions suggest a representative trawl caught price of £2,724 per tonne comprising £1,127 of tails and £1,602 of whole Nephrops.<sup>21</sup> The price of creel caught live Nephrops is therefore nearly 3.5 times greater than the average price of a tonne of trawl (live weight) landings. Thus, even allowing for a proportion of whole Nephrops in the trawler landings, trawlers could not outbid creelers for sea bed access.

The scenario needs to be made even more realistic by recognising that trawlers, despite their greater negative impacts on others, are technically more efficient at catching whole Nephrops. The average cost of catching a tonne is much lower for a trawler than a creeler. Indeed, their costs have to be lower to compensate for the very low price per liveweight tonne (i.e. £2,724 compared with £9,500). The result is that trawlers earn a relatively low profit per tonne (between £180 and £330 per tonne), but manage a modest total annual profit because of the large volumes they catch.

Profits in the creel sector are on average £613 per tonne. On that basis, a typical creeler would be willing to pay (i.e. the profit) for a tonne of Nephrops is 340% greater than the maximum willingness to pay of an under 250kW trawler and 186% greater than the equivalent figure for an over 250kW trawler.<sup>22</sup> Despite lower costs, trawlers would still only have access to those Nephrops which creelers do not want to catch.

**From first principles it is therefore possible to know what a properly functioning market mechanism would deliver as it ensured that flows of benefits always exceed opportunity cost. Given the above scenario, there is little doubt that, if there was no market failure, trawling would be restricted to areas which profit maximising creelers, for whatever reason, simply did not want to exploit. This is probably the only result which ensures that opportunity costs do not exceed the flow of benefits from current resource use.**

It can be concluded that, if access to the sea bed was not free, just as agricultural land, labour or oil extraction is not free, the balance between creeling and trawling for Nephrops would be fundamentally different. There would probably be very little, and probably zero, trawling for Nephrops in inshore areas fishable by creels. Creeling and trawling would be located in areas to which they are best suited. In these circumstances, with markets working as they should, the Scottish Government would be confident that Scotland's inshore Nephrops stock would be spatially allocated to their highest valued use.<sup>23</sup> Observers would no longer wonder why Scotland uses

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<sup>21</sup> This means that a tonne of reallocated from trawling to creeling would increase revenue by £6,776 (i.e. £9,500 creel revenue minus lost trawl revenue of £2,724)

<sup>22</sup> See footnote 12

<sup>23</sup> Historically, the exploitation of wild salmon faced similar issues. It was believed, not unreasonably, that if more wild salmon could by-pass coastal and estuary nets in greater numbers, more high spending salmon anglers would be attracted. Scottish income and employment would increase. In addition, economic benefits would be generated which would exceed economic costs by a considerable margin. There are three similarities between the historic salmon fishery and the current inshore Nephrops fishery. First, a stock was being harvested by two stakeholder groups which produced two different outputs, sold in two different markets. In the case of wild salmon the two products were angling experiences and wild salmon for the table. Secondly one group, namely the in-river salmon interests, were similar to creelers because they lacked any direct threat which could be used to persuade the other to moderate their activities. Third, the Scottish Government generally adopted a laissez faire approach to this conflict of interests. There was one absolutely fundamental key difference. Specifically, the right to net fish is a heritable estate. Therefore with a few exceptions, the in-river interests were able to buy out and retire the coastal and estuary netting stations. In this instance,

trawls, which damage the benthic habitat, to produce tonnes of Nephrop tails which sell for a fraction of the live langoustine price, generate less profit and support fewer businesses and jobs.

The mobile sector should be extremely thankful that, in practice, there is no requirement to compete for the right to catch Nephrops. As things stand, trawlers targeting tails are only able to profitably fish inshore waters because the one input they disproportionately require is free from market competition by creelers. Unfortunately, when they harvest this “free resource” the trawlers generate opportunity costs which massively exceed any of the economic benefits from trawling.

**It should be a matter of deep regret to the Scottish Government that each tonne of tails caught in areas fishable by creels is contributing to a significant degradation of the Scottish marine environment and significant reduction in Scottish output, income, employment and profits.**

From the above discussion, it would seem that, in the interests of the Scottish economy, trawling for Nephrops in inshore areas should be a marginal activity. In complete contrast, as evidenced in Section 2 below, the reality is that Nephrops trawlers land 87.4% of all Nephrops caught within 0-12NM, 78% within 0-1NM (see Table 2.7), and 86.5% within 1-3NM (see Table 2.8). Even within 0-3 NM creelers catch only 17.6% of the live weight Nephrops catch.

We need to explain why trawlers, despite their high costs per tonne, low revenue per tonne and low profitability per tonne have managed to secure 87.7% the Scottish Nephrops catch. One reason for this is that trawlers are best placed to exploit what SCFF are now arguing is the misguided and deeply damaging *laissez-faire* approach currently adopted by Marine Scotland.

### **1.8 How Trawlers Exploit the Capricious Process of Stock Allocation**

The absence of property rights in fishing means that, unless Government intervenes, access to the natural resource in question (Nephrops stocks) will be largely determined by some capricious criterion, such as who gets there first or has most power to fend off competing fishers.

When addressing the issue of the balance between mobile and static gears, Marine Scotland simply encourages operators to negotiate and develop local agreements. Unfortunately, in the absence of property rights and the capacity to financially outbid others, the outcome will favour the party with the most power, rather than the party who most values the resource and serves wider society best. In this context, it is a relatively simple matter for a trawler to tow away static gear. The repeated towing away of gear can impose significant costs on static operators who can offer no countervailing threat of a comparable scale.

The Grid Report examined the gear conflict issue through a survey of Scottish Fishery Officers and inshore vessel owners. It found that the average cost to Nephrop creelers who experienced gear conflict was £6,176 p.a. and the elimination of gear conflict within 3 NM of the Scottish coast would annually save all operators £2.1m. With respect to conflict causation, the Grid document reported that: *“By and large, static operators are stating there is quite widespread deliberate intent on the part of others. Over 67% of all nephrop creelers and 63% of all those using other creels thought conflict was almost certainly a deliberate act by another. A majority of nephrop trawlers stated the conflict was accidental”. On this evidence there would seem to be different declared understandings about how conflicts arise”*.<sup>24</sup>

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because there were property rights, the Government’s *laissez-faire* approach to the allocation issue was probably appropriate. The market mechanism worked, albeit slowly, to eventually deliver best value for Scotland. Regrettably, this will certainly not happen with the Scottish inshore Nephrops fishery.

<sup>24</sup> Page 189

Every creeler will certainly know someone who has had their creels towed, and for many creelers the on-going threat of having gear towed will be buttressed by the actual experience of gear being towed. In these circumstances, the mere threat can be sufficient for the individual creel operator to undertake the avoidance action dictated by the mobile operator. Consequently, there is often not a negotiated outcome. Instead the outcome is imposed by the mobile sector. An example of an imposed limit would be that, “weekends excepted, static gear must not be deployed beyond 9 fathoms, otherwise it will be towed”.

Other than moral suasion, or appeals for Marine Scotland to intervene, creel operators have no countervailing power and typically have to accept the limits imposed upon them. It is not being argued that every inshore area in Scotland is characterised by mobile gear operators imposing area management. Some areas have informal rules which are designed to reduce the possibility of gear conflict. However in practice these local arrangements will not have emerged from a negotiation between two parties with comparable power. The outcome is therefore likely to favour the mobile sector. As the weaker sector in the negotiation, creelers will normally shoulder the greater burden of any avoidance action. In general, the everyday reality for many creelers is a requirement to comply with *de facto* limits on where and/or when they can shoot their creels. SCFF can provide extensive supporting evidence of such *de facto* area management.

**Whilst Marine Scotland eschews area management, across the inshore area, many mobile operators are imposing and enforcing their own *de facto* area management with the primary purpose of benefitting themselves at the direct expense of creelers. Crucially for Marine Scotland, the access to Nephrops stocks secured by the mobile sector is certainly not warranted by the sector’s economic or environmental performance, or indeed any coherent performance indicator.**

Thus, we have a truly extraordinary situation where, the sector determining access to inshore fisheries generates economic benefits which are small fraction of the negative effects it imposes on its competing sector, not to mention negative effects on stakeholder groups whose well-being is impacted by the damage inflicted on the marine environment.

Under these arrangements the balance between static and mobile gears cannot be anywhere near optimal.<sup>25</sup>

## **1.9 Implications for Marine Scotland**

**There is little doubt that exploitation of Scotland’s inshore Nephrops stocks is being driven in directions which will always be completely incompatible with Scotland’s best interest and the Scottish Government’s declared policy objectives. It is clear that Marine Scotland’s current *laissez-faire* is entirely inappropriate and deeply damaging.**

Perhaps Marine Scotland has simply failed to appreciate just how economic forces have been operating completely against Scotland’s best interests. If so, SCFF are convinced that this should no longer be the case. Collectively, the Grid Report (2014), NEF (2016) and this document provide Marine Scotland with an explanation of why the current situation has arisen, why it is so undesirable, as well as the potential benefit flows deliverable through appropriate policy intervention.

**Assuming it is serious about delivering on the Scottish Government’s policy objectives, Marine Scotland urgently needs to abandon its *laissez-faire* approach and actively intervene in this fishery**

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<sup>25</sup> As evidenced by the Grid Report. The Grid Report estimated the economic benefits from a 0-1 and a 0-3 creel only fishing zones around Scotland. The conclusion was that there would be an extraordinary economic and employment gain which would dwarf any costs imposed on the mobile sector.

SCFF are not advocating property rights to the sea bed. Rather, SCFF are arguing that Marine Scotland should engineer broadly the same outcome that a properly functioning market would deliver. Scotland should not tolerate situations where resources are allocated to activities which generate flows of benefits (revenue, profits, jobs, profits, environmental quality) which are a fraction of their opportunity costs. Put simply, it is quite absurd for Scotland to accept less when we could easily have very much more. The SCFF aspiration is not in any sense radical. It is logical and sensible.

The discussion above speculated that the optimal outcome might involve creel only areas. This is because any other configuration where creels and trawls share the sea bed seems to generate opportunity costs which dwarf the benefits from trawling.

In Section 3, we flesh out that conclusion. Prior to that, Section 2 presents the finer detail on the current pattern of exploitation.

## 2. THE SPATIAL DISTRIBUTION OF THE CURRENT ALLOCATION.

Official statistics are based on landings data. Even allowing for misreporting by fishermen and other errors, the belief within Marine Scotland is that landings data are an accurate record of the fish coming ashore in each port. Indeed, they can be checked against the records of registered buyers.

Data provided by the Vessel Monitoring System (VMS) can be manipulated to provide broad estimates about where fish are caught. However, VMS does not apply to vessels 12m and under. There are no direct observations on where these vessels catch fish and shellfish. Thus if the fishing fleet targeting a particular stock comprises a large proportion of vessels 12m or under then generally we don't know exactly where most of that stock is caught.

Fortunately, the Grid Report used Scotmap data to estimate catch locations for smaller vessels. At the time the Grid Report was undertaken VMS did not apply to vessels 15m and under. Scotmap data related to vessels under 15m and under. Combining Scotmap data with VNS estimates the Grid Report estimated the location of inshore catches for most major species, by gear type, by vessel size for 0-1NM, 0-3NM, 0-6NM and 0-12NM. This information was based on monetary value and is presented below.

### 2.1 Current Allocation by Value.

The Grid Report baseline estimates of Nephrops catch location for the Scottish inshore fisheries area for 2011 are presented below.

**Table 2.1 Nephrops Catch Value by Gear Type by all Vessels by Distance from Shore<sup>26</sup>**

	NEPHROPS 0-1 NM	NEPHROPS 0-3 NM	NEPHROPS 0-6NM	NEPHROPS 0-12NM
<b>Demersal Trawl</b>	£300,954	£670,359	£883,679	£1,317,273
<b>Nephrops Trawl</b>	£8,304,536	£18,216,393	£26,883,622	£33,968,590
<b>Pelagic Trawl</b>	£0	£0	£0	£0
<b>Pelagic Lines</b>	£0	£0	£0	£0
<b>Other Trawl</b>	£5,776	£14,463	£16,957	£17,580
<b>Dredge</b>	£0	£0	£0	£0
<b>Pots<sup>27</sup></b>	£8,437,920	£14,049,232	£17,316,041	£17,710,403
<b>Hand Dive</b>	£0	£0	£0	£0
<b>Total</b>	<b>£17,049,186</b>	<b>£32,950,447</b>	<b>£45,100,300</b>	<b>£53,013,846</b>

Table 2.2 below was constructed from Table 2.1.

**Table 2.2 Scottish Vessels Nephrops Catch Value by Trawls and Creels by Distance from Shore**

	0-1 NM	%	0-3 NM	%	0-6NM	%	0-12NM	%
<b>Trawls</b>	£8,611,266	51%	£18,901,215	57%	£27,784,258	62%	£35,303,443	67%
<b>Creels</b>	£8,437,920	49%	£14,049,232	43%	£17,316,041	38%	£17,710,403	33%
<b>Total</b>	<b>£17,049,186</b>	<b>100%</b>	<b>£32,950,447</b>	<b>100%</b>	<b>£45,100,300</b>	<b>100%</b>	<b>£53,013,846</b>	<b>100%</b>

<sup>26</sup> Constructed from Table 8.6.3, Table 8.6.6, and Table 8.6.9 in Riddington and Radford "Management of The Scottish Inshore Fisheries; Assessing the Options for Change"

<sup>27</sup> The term "Pots" in this section embraces creels and pots.

For each area of sea (0 to 1NM, 3NM, 6NM or 12NM), trawls catch more Nephrops by value than creels. As expected the percentage of Nephrops by value caught by creels declines with distance from the shore. Static gear catches about one third by value of all Nephrops caught in the entire inshore area (0-12NM). Whilst catches will have changed since 2011, the relative proportions are of interest and might also have altered but not significantly.

The Table below gives, for each gear type, the percentage of the catch value by various distances from shore.

**Table.2.3 Distribution of each Gear Type Catch (Value) by Distance from Shore**

DISTANCE FROM SHORE	Trawls	Creels
Within 1 NM	24%	48%
Within 3 NM	54%	79%
Within 6NM	79%	98%
Within 0-12NM	100%	100%

Of all Nephrops value caught by static operators 48% are caught within 1NM of the shore. The equivalent estimate for trawls is 24%. Nearly 80% of all Nephrops value caught by creels is caught within 0-3NM. The equivalent estimate for trawls is 54%.

Using Table 2.2, the value of the catch within defined distance zones is easily calculated. This table below essentially re-states in a slightly different form the key message of Table 2.2.

**Table 2.4 Distribution of each Gear Type Catch Value by Defined Distance Zone**

	0-1 NM	%	1-3 NM	%	3-6NM	%	6-12NM	%	Total
<b>Trawls</b>	£8,611,266	51%	£10,289,949	65%	£8,883,043	73%	£7,519,185	95%	£35,303,443
<b>Pots</b>	£8,437,920	49%	£5,611,312	35%	£3,266,809	27%	£394,362	5%	£17,710,403
<b>Total</b>	<b>£17,049,186</b>	<b>100%</b>	<b>£15,901,261</b>	<b>100%</b>	<b>£12,149,852</b>	<b>100%</b>	<b>£7,913,547</b>	<b>£1</b>	<b>£53,013,846</b>

In the 0-1NM zone, trawls and creels catch the same amount of Nephrops (by value), but as distance from shore increases the proportion caught by trawls in each defined zone increases steadily. In the 6-12NM zone, trawls land 95% of the total inshore catch.

The Table below gives, for each gear type, the percentage of the gear type catch value within each zone.

**Table 2.5 Distribution of Nephrops Catch (by Value) for each Gear Type by Defined Distance Zone**

DEFINED DISTANCE ZONE	Trawls	Creels	All Gear
0-1 NM	24%	48%	32%
1-3 NM	29%	32%	30%
3- 6NM	25%	18%	23%
6-12NM	21%	2%	15%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

From Table 2.5 the trawls catch by value is quite evenly distributed across the four zones. As expected the catch by creels is heavily dependent on the 0-1NM and 1-3NM zones.

### 2.1.1 Key Points on Allocation by Value.

1. Two thirds of the Scottish Nephrops catch by value within 0-12NM is caught by trawls.

2. The trawl catch is distributed quite evenly within 0-12NM.
3. Creels catch one third of the Nephrops catch by value and around 80% of that catch is within 0-3nm and 48% within 0-1NM

## 2.2 Current Allocation by Weight.

The estimates from the Grid Report are estimates by value as provided by vessels' landing declarations matched with VMS location data. The value estimates relate to landings value and not liveweight equivalents. Because the creel catch achieves higher prices and creel live weight tonnage is always the same as landings tonnage we can expect the proportion of the total tonnage taken by trawls to increase significantly.

To calculate the creels tonnage we can simply divide the Grid Report creel value by the price per tonne (a price of £9,500). The Grid Report trawl catch is a bit more complicated because trawls land whole Nephrops (£4,500 per tonne) and tails (having a maximum £1,750 per tonne live weight).

We therefore need to know the composition of the catch. SCFF requested bespoke data from MMO. This is presented in the Table below.

**Table 2.6 Nephrops Catch (2015) by Demersal Trawl and Demersal Seine under 250kW**

	Landed Weight kg	%	Live Weight kg	%	Revenue	%	Price kg landed weight	Price kg live weight
Tails	1,008,753	37.62%	3,026,257	64.40%	£5,145,158	40.14%	£5.10	£1.70
Whole Shellfish	1,672,798	62.38%	1,672,798	35.60%	£7,671,363	59.86%	£4.59	£4.59
<b>Total</b>	<b>2,681,551</b>	<b>100.00%</b>	<b>4,699,055</b>	<b>100.00%</b>	<b>£12,816,521</b>	<b>100.00%</b>	<b>£4.78</b>	<b>£2.73</b>

Two thirds of the WOS catch by live weight is tails (64.4%). If the proportions of tails to whole Nephrops in the WOS under 250kW segment are representative of catch composition for the inshore mobile sector then tails account for 64.4% of the live weight volume but only 40.14% of the revenue.

We can partition the (landed) weight revenue of trawlers in the Grid Report as follows. We know 40.14% of the landed revenue is from tails and every £1.70 of that proportion represents a liveweight equivalent kilo of whole Nephrops. By the same reasoning, 59.86% of the catch revenue is whole Nephrops and every £4.59 of that revenue represents a kilo of whole Nephrops. This information is used to convert Table 2.1 from landed revenues to live weight equivalents.

**Table 2.7 Scottish Nephrops Catch (Tonnes) Live Weight by Trawls and Pots by Distance from Shore**

	0-1 NM	% of Total	0- 3 NM	% of Total	0-6NM	% of Total	0-12NM	% of Total
Trawls Tails	2,033	50.3%	4,463	53.1%	6,560	54.6%	8,336	56.3%
Trawls Whole	1,123	27.8%	2,465	29.3%	3,623	30.2%	4,604	31.1%
<b>Trawls Total</b>	<b>3,156</b>	<b>78.0%</b>	<b>6,928</b>	<b>82.4%</b>	<b>10,184</b>	<b>84.8%</b>	<b>12,940</b>	<b>87.4%</b>
<b>Pots Total</b>	<b>888</b>	<b>22.0%</b>	<b>1,479</b>	<b>17.6%</b>	<b>1,823</b>	<b>15.2%</b>	<b>1,864</b>	<b>12.6%</b>
<b>Total</b>	<b>4,045</b>		<b>8,407</b>		<b>12,007</b>		<b>14,804</b>	

Creelers are responsible for only 12.6 % of the total catch by weight within 12 NM of the coast, compared with 33% by value. Even within 0-3 NM creelers catch only 17.6% of the live weight Nephrops catch, compared with 43% by value.

Using Table 2.7 above, the weight of the catch within defined distance zones is easily calculated. This table below re-states in a slightly different form the key message of Table 2.7

**Table 2.8 Distribution of each Gear Type Live Weight Catch (tonnes) by Defined Distance Zone**

	<b>0-1 NM</b>	<b>% of Total</b>	<b>1-3 NM</b>	<b>% of Total</b>	<b>3- 6NM</b>	<b>% of Total</b>	<b>6- 12NM</b>	<b>% of Total</b>
<b>Trawls Tails</b>	2,033	50.27%	2430	55.70%	2097	58%	1775.41	63.46%
<b>Trawls Whole</b>	1,123	27.77%	1342	30.76%	1158	32%	980.61	35.05%
<b>Trawls Total</b>	3,156	78.04%	3772	86.46%	3256	90%	2756.02	98.52%
<b>Pots Total</b>	888	21.96%	591	13.54%	344	10%	41.51	1.48%
<b>Total</b>	4,045		<b>4362</b>		3600		<b>2797.53</b>	<b>14,804</b>

### 2.2.1 Key Points on Allocation by Weight

1. Creelers are responsible for only 12.6% of the total catch within 12 NM of the coast compared with 33% by value.
2. Within 0-3 NM creelers catch only 17.6% of the live weight Nephrops catch, compared with 43% by value.
3. Within 1-3 NM creels land only 13.54% of the total Nephrops caught within 1-3 NM, compared with 35% by value.

### 3. COMPARATIVE ENVIRONMENTAL AND ECONOMIC PERFORMANCE

When markets work then it should not be possible substantially to increase “best value” to society by reallocating resources between competing activities. A substantial difference in performance across key economic performance indicators would confirm that opportunity costs are excessive and there is serious market failure. This implies that by reallocating resources between competing activities the Government could substantially increase the overall magnitude of key economic indicators.

Later we demonstrate there are indeed substantial disparities between creeling and trawling, which are consistent with market failure. Before presenting this evidence, below we briefly consider the comparative environmental dimension.

#### 3.1 Comparative Environmental Performance

##### 3.1.1 A Tonne Landed By Creels Requires Less Sea Bed

Zeigler (2006)<sup>28</sup> estimated that the entire Swedish west coast creel fishery affects the same seafloor area during one year as does one hour of trawling<sup>29</sup>. The same study provided the following comparative impacts for each Kg of Nephrops landed:

**Table 3.3 Comparative Impact of Nephrops Trawling and Creeling**

Impact per Kg of Nephrops	Trawling	Creeling
Diesel	9.0 litres	2.2 litres
Area of Sea Bed Swept	33,000m <sup>2</sup>	1.8m <sup>2</sup>
Undersized fish and Nephrop Mortality	4.5Kg	0.15Kg

Negative aspects of creel fisheries cited by Ziegler (2006) were: safety and working conditions onboard which in Sweden are better on the trawlers; a higher risk of ghost fishing and higher risk of recruitment overfishing because creels capture a higher proportion of berried females.

##### 3.1.2 A Tonne Landed By Creels Causes less Habitat Damage and Benthic Organism Mortality

All forms of fishing are damaging; however compared with using creels and pots, the dragging of gear across the sea bed would appear to have a greater physical impact on the sea bed. Depending on the nature of the sea bed, trawls can smooth the seafloor, destroy emergent epifauna, remove or bury plants and may adversely affect the habitat for juvenile fish and crustaceans.<sup>30</sup>

It has been argued that trawling and dredging has beneficial effects through the occasional turning over of the sea bed; in much the same way that ploughing agricultural land improves crop yields. The implication being that biomass might be reduced if restrictions are imposed on trawling for Nephrops. To SCFF’s knowledge, there is no supporting scientific evidence to support this hypothesis.

##### 3.1.3 Each Tonne of Nephrops Landed by Creels Causes Less Discard Mortality

<sup>28</sup> Ziegler, F (2006). Environmental Life Cycle Assessment of Norway lobster (*Nephrops norvegicus*) fished by creels, conventional and species-selective trawls along the Swedish west coast. Swedish Institute for Food and Biotechnology, Report 746

<sup>29</sup> In the process the Swedish west coast creel fishery caught 20% of the west coast catch.

<sup>30</sup> The impact is highly variable. Nephrop trawls towed over mud, or dredges used in high energy locations subject to high levels of natural disturbance, would be less damaging than dragging trawls over low energy areas.

Compared with mobile gear, it is reasonable to suggest that ratio of discards to landed Nephrops would be less for creel operators. Nephrops self select to enter a creel. Mobile gear is less discriminatory. Also, smaller individuals can more easily egress from a creel whilst on the seabed or during hauling, whereas a bigger proportion of non-target species caught by trawls or dredges can have their egress prevented through entanglement with other organic and inorganic matter in the net. Even with escape panels, Nephrops gear may still capture significant numbers of small fish. There are also differences in discard survival rates with a higher proportion of mobile caught discards being returned dead or dying. This is because with mobile gear there is a greater opportunity for injury during towing and hauling and a longer time lag between being landed on deck and being returned to the sea.

#### **3.1.4 A Tonne Landed By Creels Causes Less Damage to Other Fisheries**

In nursery areas, habitat damage and benthic organism mortality could compromise the area's role as a nursery for cod, herring, whiting, and scallops. In addition, the associated increased by-catch mortality of non-target fish species would also cause further negative impacts on local demersal fish populations. This could negatively impact on local and regional commercial and recreational fishing for other species.

### **3.2 Comparative Economic Performance**

The current total magnitudes of key economic indicators, such as total employment in trawling or total profits in creeling, are interesting in terms of describing the situation as it exists now. These totals, of themselves, do not provide sufficient justification for changing the existing balance between creeling and trawling. Just because an economic activity is large (small) does not mean that more (less) resources should be devoted to it.

Rational decision making requires that policy initiatives should be evaluated in terms of their consequences.<sup>31</sup> Thus, the current absolute number of jobs supported by creeling, or by trawling for Nephrops, is not particularly relevant to a discussion of the rebalancing of fishing effort between these two sectors. When it comes to decisions about changing resource allocation, size should not matter. What matters is the sensitivity of the respective economic indicators to particular policy interventions. Policy discussion therefore needs to be couched in terms of the resulting *change* in economic indicators. This is termed the *marginal impact*. This document therefore does not focus extensively on information on the total number of vessels, total catch, total employment etc.

The focus is on a marginal analysis, where the legitimacy of the effort rebalancing proposal hinges on whether, as a direct result of the rebalancing, the increase in creeling profits, jobs and income exceeds the decrease in these indicators in the trawling sector.

#### **3.2.1 A Note on Marginal and Average Values**

In an ideal world, it would be desirable to have available a full set of unambiguous marginal values. For example, it would be desirable to know how many jobs would be lost in trawling if the present annual catch level was reduced by a specific tonnage. We would also like to know how many jobs would be gained in creeling if the current annual catch was increased by the same tonnage.

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<sup>31</sup>In the realm of general advocacy and competition for government support, representatives of stakeholder groups often come equipped with a set of big statistics such as total sales, total FTEs and total income generated etc. These are designed to demonstrate the extent of the activity's current economic contribution. Competing interests often then feel compelled to commission and display economic indicators reflecting their economic significance. Decisions about changes in resource allocation decisions require a more subtle use of economic information.

The problem is that typically we only know the average values for each activity. An example is the number of jobs per tonne. This particular average value is found by dividing the current total landing by the current total number of jobs. This describes what happens on average, but is not always the same as what happens at the margin.

A hypothetical example can clarify. We might suspect that, both in the creeling and trawling sectors, catch tonnage increases with employment (FTEs), but at a decreasing rate. Since we know we are dealing with a non linear relationship, then immediately we know a number of things about average and marginal values.

- Average tonne per FTE will be declining as FTE's increase.
- Since tonnage is increasing at a decreasing rate, we know that the last (i.e. marginal) FTE added less tonnage than the previous FTE. Thus, we know marginal values are also declining.
- We also know that if the average is declining then the marginal is dragging down the average. The marginal must therefore be lower than the average.

Thus, if we have estimated the current average value of tonnage per FTE's (i.e. Total Tonnage / Total FTE's), for both creeling and trawling then we know:

- For each activity, the marginal change in tonnage will be less than the current average.
- If FTE's are increased (decreased) both the average tonnage and marginal per FTE will be positive but declining (increasing).

Therefore using the current average to make predictions about what happens at the margin is potentially problematic. In the above example, the average values in each sector would overestimate the marginal impacts. Thus, it is possible that the beneficial impact on economic indicators relating to creeling would be over-estimated. Fortunately, there would also be an overestimation of the adverse consequences for Nephrop trawling. There is some comfort in knowing that one sector is not being over-estimated whilst the other is underestimated.

It is noted that, in the above example, average and marginal values change as fishing effort is rebalanced. Specifically they would be decreasing for the sector which is expanding (e.g. creeling) and increasing for a sector that is contracting. However, this convergence is not a problem in terms of delivering best value to Scotland. Convergence is confirmation that the reallocation was entirely justified. Indeed, when the marginal values are broadly equal, "best value for Scotland" has been optimised and no further rebalancing is required.

### **3.2.2 The Uncertainty Problem**

The real problem is that marginal values are unknown. Consequently, there is some uncertainty about precisely when the rebalancing should cease. The uncertainty about when to stop rebalancing becomes more significant when large changes are being considered.

Uncertainty should be less of a problem when:

- The changes are relatively small
- The starting point is a large difference between the current average values for the two sectors
- The relationships are linear or, more likely, approximate to linear over the range being considered. In this case, the problem of uncertainty disappears because, if the marginal and average values of activity (A) always exceed the values of competing activity (B), then activity (B) should not exist where (A) exists.

Thus, if the marginal and average values for creeling always exceed the average and marginal values for trawling, the latter should cease in those areas where creeling can be profitably prosecuted.

It should therefore be recognised that there are circumstances where it is appropriate to use the current average. Using the current averages for each activity to inform policy is certainly better than nothing, and in some circumstances can be entirely suitable. The general message is that care should be exercised when using average values.

### 3.2.3 West of Scotland Average Values

As explained above, this document should not dwell on information on the total number of vessels, total landings, total employment etc. In presenting the case for a rebalancing the focus of this document is what happens at the margin, particularly in the West of Scotland. There are a number of reasons for this. Nephrops constitute a bigger proportion of the shellfish catch. The quality and size of Nephrops are reputed to be better, the gear conflict issue is more pronounced on the West Coast and there is better data available for the West of Scotland.

The Table below presents summary estimates provided by Seafish for Scottish registered creel vessels fishing in the West of Scotland for Nephrops. Seafish were able to supply data disaggregated by vessel size and activity levels. The only variables calculated by this study were rows (9) and (10)

From the table below, in 2014 there were 222 active creeling vessels. Of these, 177 are high activity creelers which employ 296 FTEs and land 1,765 tonnes worth £13.3m. The low activity creelers are mostly part-time or hobby fishers.

**Table 3.1 Scottish Creel Vessels Fishing Principally for Nephrops in West of Scotland**

		High Activity Creelers			Low Activity Creelers		All Creelers
		All Lengths	Over 10m <sup>32</sup>	Under 10m	All Lengths	Under 10m	
1. Number of Active Vessels	2014	186	42	146	36	34	222
	2015	177	41	137	29	28	206
2. Total Landings (tonnes)	2014	2,217	787	1432	24	22	2,241
	2015	1,765	690	1077	21	19	1,786
3. Fishing Income (£million)	2014	13.3	4.8	8.6	0.2	0.2	13.5
	2015	12.7	5.5	7.3	0.1	0.1	12.9
4. FTE's	2014	296	115	182	7	7	303
	2015	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
5. Average Landings (tonnes)	2014	11.9	18.7	9.8	0.7	0.7	10.1
	2015	10	16.8	7.9	0.7	0.7	8.7
6. Average Fishing Incomes	2014	71.6	113.6	58.6	4.7	4.5	60.7
	2015	72	133.6	53.1	4.8	4.7	62.5
7. Fishing Income Per FTE (£'000)	2014	44.9	41.5	47	23.6	23.5	44.4
	2015	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
8. Average Net Profit (£'000)	2014	7.3	16.4	4.5	-0.1	0.2	6.1
	2015	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
9. Average Net Profit Per Tonne	2014	£613.4	£877.0	£459.2	-£142.9	£285.7	£604.0
	2015	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
10. Average FTE Per Tonne	2014	0.168	0.167	0.169	0.333	0.368	0.170
	2015	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

The Table below presents comparable data for West of Scotland Nephrops trawlers. In 2014 there were 132 active vessels which employed 527 FTE's and landed 10,664 tonnes worth £29.5m.

<sup>32</sup> In supplying the data it was assumed that over 10m creelers would be high activity. There was no classification of low activity creelers over 10m. In practice there are some over 10m who might be classed as low activity in a given year because they being repaired or other factors prevented them being fished enough to be classed as high activity. It was not worthwhile to add a column for low activity over 10M creelers. Hence the totals do not quite add up.

Inspection of the performance indicators demonstrates that on average trawlers underperform when compared with creelers.

**Table 3.2 Scottish Trawlers Fishing Principally for Nephrops in West of Scotland**

		Trawlers Under 250kW	Trawlers Over 250kW	Total
1. Number of Active Vessels	2014	91	41	132
	2015	90	43	133
2. Total Landings (tonnes)	2014	5,629	6,571	12,200
	2015	4,856	5,808	10,664
3. Fishing Income (£million)	2014	15.4	14.1	29.5
	2015	13.3	13.4	26.7
4. FTE's	2014	334	193	527
	2015	N.A.	N.A.	N.A.
5. Average Landings (tonnes)	2014	61.9	160.3	92.5
	2015	54	135.1	79.2
6. Average Fishing Incomes	2014	168.9	344.2	223.3
	2015	148.2	310.7	198.7
7. Fishing Income Per FTE (£'000)	2014	46	73.1	54.4
	2015	N.A.	N.A.	N.A.
8. Average Net Profit (£'000)	2014	11.3	52.5	24.1
	2015	N.A.	N.A.	N.A.
9. Average Net Profit Per Tonne	2014	£183	£328	£228
	2015	N.A.	N.A.	N.A.
10. Average FTE Per Tonne	2014	0.069	0.033	0.06
	2015	N.A.	N.A.	N.A.

We already know that revenue per tonne for creelers exceed revenue for trawled tails by a 5.5:1 ratio and whole trawled Nephrops by 2.1:1. Using the two tables above, we can highlight comparative performance (based on the current average) with respect to employment and profitability.

### 3.2.3.1 Employment<sup>33</sup>

Trawlers on average require revenue of £54.4k to support one full time job. Excluding the low activity or hobby operators, the creeling sector requires only £44.9k for one FTE. This suggests a comparable employment performance.

However, as repeatedly emphasised, because these two activities are competing for a common natural resource, we need to consider the opportunity cost. In that context, trawlers need to land a much greater tonnage to generate revenue of £54.4k. This is because of lower prices and because the live weight of tails is 3 times the landed weight. This greater tonnage means a high opportunity cost. **A coherent discussion must focus on employment per tonne. Only this can expose the true opportunity cost in terms of employment.**

The more revealing comparison is therefore between FTE's per tonne. Every tonne of Nephrops (live weight) supports 0.06 trawling jobs, whereas each tonne landed by creels supports 0.17 FTEs. We can therefore say

- **On average, each tonne landed by creels rather than trawlers will create a net 0.11 FTE's.**

<sup>33</sup> This analysis ignores the on-shore sector including firms servicing and supplying vessels and on-shore processing of the catch. This is discussed in Appendix 1.

One FTE in trawling would require 16.7 tonnes to be landed annually. In the creel sector, one FTE would require only 5.9 tonnes to be landed annually. Depriving creels of 16.7 tonnes would mean an opportunity cost of 2.8 creeling jobs. We can therefore also say:

- **Each FTE lost in trawling could be replaced by 2.8 jobs in creeling.**

If the Scottish Government has a policy of supporting employment in remote rural communities a rebalancing of fishing effort in favour of creeling would certainly support this ambition.

With respect to the uncertainty about how far the re-balancing should go, it is comforting that there is currently such a large disparity in these average and marginal values. Indeed, it is entirely possible that, over the range being considered, the marginal values and average values for creeling in inshore waters will always exceed those for trawling. In other words, if trawling and creeling co-exist, the employment opportunity costs of trawling will always exceed the FTE's it generates.

Unlike trawling, there are few economies of scale in creeling. This is because each vessel can only operate one pot hauler at a time. Since each creel is handled in sequence using a single pot hauler, over a given time period, one six ton vessel is unlikely to be able to process as many creels as two three ton vessels. However, with trawling there are economies of scale associated with larger vessels. These relate to bulk handling, larger volume nets, more specialised machinery and crew. The absence of economies of scale in creeling will act as a significant constraint on the possibility, within creeling, of substituting capital for labour. As far as creeling is concerned, there are no technical changes on the horizon and in creeling labour required per tonne of live weight is always likely to exceed trawling

Currently creeling requires more FTE's per tonne and this will continue. For example, it is inconceivable that FTE's per tonne in trawling would ever be comparable with creeling. If trawlers employed 0.17 FTEs per tonne (the creeling average), then in 2014 an under 250kW Nephrop trawler would have a crew of 10.5 catching 61.9 tonnes. An over 250kW trawler would have 27.3 FTEs landing 160.3 tonnes. Trawlers could not profitably harvest Nephrops using as much labour as creelers.

**The SCFF are absolutely confident that, if the Scottish Government is serious about increasing employment opportunities in remote areas, trawlers should not be catching Nephrops which could otherwise have been profitably caught by creels.**

There might be lingering doubts about the above conclusion. These doubts might relate to the "relative technical efficiency" of the two fishing sectors. The counter argument would start from the reasonable tenet that, it is preferable to produce output using less rather than more of our scarce resources, including labour. The argument would conclude that, since creeling catches less tonnage per person, it is less efficient and should not be promoted at the expense of trawlers which are more efficient at catching Nephrops.

Though the underlying tenet is sound, the reasoning is economically absurd. This is because, as this document repeatedly emphasises, creeling and trawling are producing different products for different markets. Just as it is senseless to compare tonnage per person in shipbuilding and car production, a comparison between tonnage per person in creeling and trawling is similarly illogical. When deciding whether Nephrops should be creeled or trawled, crude measures of technical efficiency are unimportant.

If fishers want profitably to supply live Nephrops they must shoot creels from an appropriately equipped vessel of the right size.<sup>34</sup> If fishers want profitably to supply Nephrop tails and/or dead whole Nephrops a Nephrop trawler is required. In that context, creeling is undoubtedly the most efficient technology for supplying live high quality, just as Nephrops trawlers are most efficient when producing tails and whole fresh Nephrops.

If the question being addressed was; “*which sector has the greatest Nephrops mortality per FTE?*”, then the trawling sector is a clear winner. Unfortunately, by itself, this could never be a desirable characteristic.

In addressing the issue of which sector should have preferential access to Scotland’s inshore Nephrops stocks, the relevant question is; “***which sector will make best economic use of each and every live weight tonne of Nephrops?***” Thus far, it can be concluded that because of technological constraints, creelers require more labour per tonne and therefore generate more FTEs per tonne. This will continue for the foreseeable future. This is a highly desirable characteristic, especially against a background where the Scottish Government is seeking to maintain the economic and social viability of remote/rural areas.

### **3.2.3.2 Economic Efficiency and Profitability**

Scotland should not be profligate in devoting its scarce resources, including labour, to the creeling sector. Consequently, in addressing the question; “*which sector will make best economic use of each and every live weight tonne of Nephrops?*” we also want to be economically efficient. This is achieved by generating the largest difference between the values of economic outputs and the value of the economic inputs used. Profitability per tonne is essentially the difference between the value of output per tonne and the value of inputs per tonne. Profitability per tonne is therefore an excellent indicator of economic efficiency.

**It should be clear that there is no *a priori* reason to expect creeling vessels to be less profitable per live weight tonne, simply because over a year they catch much less. After all, creeling output sells for up to 5.5 times more per tonne. Also creelers are not discarding two tonnes for every tonne (of tails) they land.**

From Table 3.1 and 3.2 above, high active creelers profit per tonne is £613, whereas the WoS trawler average is £228 per tonne. Creelers are nearly three times more profitable per tonne. The opportunity costs imposed on creelers in terms of profits per tonne is therefore nearly 3 times the profits generated by trawlers. Each tonne of live weight equivalent transferred from creeling to trawling will increase overall profits by £384.

If fact, the effort transfer occurs in near shore inshore waters, say 0-3NM, then the vessels displaced are more likely to be under 250kW trawlers. These trawlers profits are £183 per tonne which is only 30% of the profit that might be earned by a creeler. Overall profit would increase by £430 for each tonne reallocated.

There is no doubt there should be a reallocation the only uncertainty is the magnitude. The large difference between average values somewhat reduces the uncertainty about the optimal level.

#### **3.2.3.2.1 Price Changes and Post Reallocation Profitability**

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<sup>34</sup> Trawlers do produce some live Nephrops, but these are a by-product and sell for half the price of live creel caught Nephrops.

However, it should be recognised that prices for creel caught live Nephrops shellfish might reduce with negative consequences for profit per tonne. In mitigation, suppliers firmly believe, if regular supply could be guaranteed, there are many untapped markets for live Scottish Nephrops which they could develop. If so, increased supply of Scottish creel caught live Nephrops might not significantly reduce Nephrop prices across fish markets in Spain, France, Italy and Portugal.

With Brexit, there is the possibility of tariffs on UK exports of fishery products. Brexit might add impetus to the further development of non-EU markets to counterbalance reduction (if any) in exports to the EU. The outcome is unknown and we simply note the added uncertainty.

There is also the possibility that prices of tails and whole and frozen Nephrops could increase. This would increase profitability per live weight tonne from trawling. This is a possibility.

It is revealing to speculate about the magnitude of price change that would accompany a radical change in the current allocation. If the entire trawling catch within 0-3NM was reallocated this would represent 54% of all trawler landings by Scottish vessels operating within 0-12NM (see Table 2.7). At first sight one would expect a significant price effect. There are a number of mitigating factors.

First the 54% ignores landings by Scottish vessels operating outside 12NM and landings into Scotland by non-Scottish vessels. Also, a proportion of the trawling effort previously fishing within 0-3NM would re-locate and target areas outside 3NM. Overall supply from trawlers would certainly not fall by 54%.

Second there are two markets for trawler landings and these need separate considerations. Hambrey *et al* reported that 60% of the trawled product is tails and 35% fresh and frozen whole Nephrops most of which is exported to the continent.<sup>35</sup> The reduction by (less than) 54% in the 60% supplied to tail processor would translate into a smaller absolute amount than implied by the total tonnage reduction. It should be appreciated that some of the decrease in these supplies from inshore areas would be replaced with more supply from those trawlers displaced and fishing outside 3NM. Also, many processors import raw materials and they might be able to replace locally caught with additional imports.

With respect to whole Nephrops the 35% tonnage reduction of the overall 54% will be a smaller proportion of the total market supply which comprising supplies from other countries. Brexit adds some uncertainty.

Third, no-one has ever advocated a Nephrops trawler ban along the entire coast.<sup>36</sup> However, even with such a radical change, the resulting price differential is probably insufficient to completely eradicate the profit differential of 300%.

Even if the profit differential were eradicated this would only signal that the change had optimised overall profit from the fishery. We would only conclude that the re-balancing had gone too far if the differential was reversed and profit per live weight tonne was greater in trawling than in creeling.

### **3.3. The Economic and Environmental Opportunity Facing Marine Scotland.**

Because of technological constraints creelers require more labour per tonne and generate more FTEs per tonne and this will continue for the foreseeable future. This is a highly desirable characteristic, especially against a background where the Scottish Government is seeking to

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<sup>35</sup> This document estimated 53.1% and 29.3% within 0-3NM (see Table 2.7).

<sup>36</sup> The Grid Report suggested that the 0-3NM trawler restriction should be limited to specific areas.

maintain the economic and social viability of remote/rural areas. At the same time creeling is more profitable per tonne of Nephrops caught.

Normally, when government agencies pursue an efficiency agenda, it results in the substitution of capital for labour. For example, salmon fish farms become more economically efficient and profitable by using more capital and less labour in fish husbandry and handling. Thus often governments face difficult trade-off between employment and efficiency objectives. SCFF has established that this particular trade-off does not exist in the exploitation of Scotland's inshore Nephrops stocks.

**Creeling not only delivers more jobs per tonne, it is economically more efficient (i.e. profitable) to catch a tonne of Nephrops using creels than trawls. This is a remarkable result. It means that employment and profitability / economic efficiency would both be increased by allowing a greater Nephrops tonnage to be caught by creelers. There is no economic trade-off facing Marine Scotland. It can increase total employment, total household incomes, total profits /economic efficiency and the number of individual fishing businesses in coastal areas, many of which are remote and suffer from a narrow range of economic activity.**

**At the same time, this would facilitate the development of Scotland's footprint and reputation as an exporter of quality food and drink.**

**Further, and equally remarkably, there is no trade-off between economic and environmental performance indicators.**

The Scottish Government and Marine Scotland face a highly unusual opportunity which, in the view of SCFF, is rarely encountered in public policy. The rarity arises because economic systems usually tweak and finesse to ensure any potential economic gains are realised and not left to accumulate. Similarly, in public policy areas there is normally a process of on-going performance review and adjustment. What has happened with the Nephrops fishery is that both a market failure and a public policy failure has remained uncorrected.

The legacy is a highly significant economic and environmental potential waiting to be released by Marine Scotland. Moreover, the release of these benefits would not require a public finance commitment of any magnitude.

### **3.3.1 The Magnitude of the Economic Opportunity.<sup>37</sup>**

Bringing together the various insights of the paper, we can conclude that every tonne transferred potentially delivers:

- A net increase in the total number of fishing businesses by 0.069 (see footnote 14)
- A net increase in the revenue from the fishery by £6,776 (see footnote 20)
- A net increase in total employment in the fishery by 0.11FTEs (see 3.2.3.1)
- A net increase in total profitability from the fishery by £384-£430 with a midpoint of £407 (see 3.2.3.2)
- Improvement in the quality of the marine environment.
- Enhancement of Scotland's reputation as a supplier of quality food and drink.

The above are net figures. They are the balance of the gains to the creeling sector over losses to the trawling sector. They represent the net benefit to Scotland as a whole. It is more appropriate to

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<sup>37</sup> See the Grid Report (2014), for quantitative estimates of the economic value of the enhanced flow of environmental services.

describe these net gains in terms of 1,000 tonnes rather than individual tonnes. Accordingly, the following simple table can be used to provide some insight into any specific proposal.

**Table 3.3 Net Gains per 1,000 Tonnes Transferred to Creeling**

	Per 1,000 Tonne
<b>Additional Vessels</b>	69
<b>Additional Revenue</b>	£6,776,000
<b>Additional FT Jobs</b>	110
<b>Additional Profit</b>	£407,000

### 3.3.2 The Economic Imperative for Creel only Areas

As repeatedly stated, there are limitations in using average values. This is because, if economic relationships are non-linear, the reallocation process can change the average values bringing them closer together as reallocation proceeds. Unfortunately there is insufficient data to enable this paper to predict precisely how average values will change. Thus, while we know there should be some reallocation, there is some uncertainty about how much.

What we do know is that, if the average values broadly converge, the process has reallocation process has duly optimised the allocation of stocks between creeling and trawling. If, as a consequence of reallocation, trawling averages for profit and employment eventually exceed the comparable averages for creeling then the reallocation has gone too far.

The SCFF previously argued that it is almost inconceivable that profit or employment per live weight tonne in trawling would ever exceed the creeling averages. This is an important point and is briefly re-stated below.

With respect to profits per live weight tonne, creeling output sells for up to 5.5 times more per tonne and creelers are not discarding two tonnes for every tonne (of tails) they land. Moreover, creelers have lower overheads and running costs. Trawlers generate larger total profits because they catch a much greater tonnage but, compared with creelers they will always make smaller profit per tonne.

With respect to labour requirements, the pot hauler constrains the possibility of substituting capital for labour. If trawlers were to operate with the same labour requirement per tonne as creel vessels, an under 250kW trawler would require a crew of 10.5 FTEs and an over 250kW trawler would require 27.3 FTEs. Thus trawlers could not profitably catch Nephrops if they used the same labour per tonne as creelers

**The conclusion that creeling averages will always exceed trawling averages is massively important because the implication is that we should never allow trawlers to catch a single tonne of Nephrops which otherwise could profitably be caught by creelers. This means that creelers should have exclusive access to inshore areas. Comparing this with the reality indicates the scale of market failure in this fishery.**

In the absence of a counter economic or environmental argument, SCFF are confident that the analysis presented here means that Marine Scotland must introduce creel only areas in Scotland's inshore waters if it wants to deliver on the Scottish Government's declared objectives.

In Section 3.4, despite the deceptive simplicity of using averages we have all the ingredients to enable an economic analysis of most realistic policy options. Some of these are considered below.

### 3.4 Assessment of Policy Options.

We consider two illustrative options: a 3NM creel only area on the West Coast of Scotland; a creel only area in the Clyde Fishery.

#### 3.4.1 3NM creel only area on the West Coast of Scotland

Presently the live weight catch of the 133 WoS Nephrop trawlers is 12,200. Of the catch with 12NM this paper estimated that 54% by weight of the trawler catch was within 0-3NM. This would translate to 6,588 tonnes. Using Table 3.3, we would conclude that a creel only area, in addition to the environmental benefits, has the potential to deliver the following:

**Table 3.4 Net Economic Gains from a West of Scotland 0-3 NM Creel Only Area**

<b>Additional Vessels</b>	455
<b>Additional Revenue</b>	£44,640,288
<b>Additional FT Jobs</b>	725
<b>Additional Profit</b>	£2,681,316

#### 3.4.2 Creel Only Firth of Clyde Fishery

The Clyde creel fleet lands 165 tonnes. Heumacher and Rader (2014)<sup>38</sup> estimate this is 3% of the total catch. This implies a total catch of 5,500 tonnes. However, ICES advice suggests a quota of 5,000 tonnes. For illustrative purposes we assume that 5,000 tonnes is closer to the true trawler catch.

**Table 3.5. Net Economic Gains from a Creel Only Clyde Fishery.**

<b>Additional Vessels</b>	345
<b>Additional Revenue</b>	£33,880,000
<b>Additional FT Jobs</b>	550
<b>Additional Profit</b>	£2,035,000

#### 3.4.3 Progressing Options

The two illustrative options above demonstrate the impressive value of creel only areas and are designed to stimulate future policy discussion. Other more spatially-targeted options have been tabled by members of the SCFF in response to recent marine planning issues. For example, the fishing restrictions associated with the expansion of the British Underwater Test & Evaluation Centre (BUTEC) military range have reduced our members' opportunity to fish in the Kyle and Skye area. Establishing a creel only zone within the Inner Sound area<sup>39</sup> represents another viable and localised management option and presents a major economic opportunity which could secure the livelihoods of many within the rural communities of that area.

It is imperative that the Scottish Government now considers these options and starts to manage our Nephrops stocks in Scotland's best interests at both a national and regional scale.

<sup>38</sup> "Recommendations for Management of Firth of Clyde Nephrops" Heumacher and Rader, Environmental Defence Fund, 2014.

<sup>39</sup> Publicly-available economic analysis of this fishery is pending the publication of a Highlands and Islands Enterprise report on socio-economic assessment of the BUTEC range expansion [http://ifgs.org.uk/files/2314/7151/6267/NWIFG\\_2016\\_01\\_15\\_minute\\_final.pdf](http://ifgs.org.uk/files/2314/7151/6267/NWIFG_2016_01_15_minute_final.pdf)

## 4. CONCLUSION AND THE FEDERATION'S VISION

This paper argues that, using basic economic theory, we can easily explain the economic absurdity of the Scottish inshore Nephrops fishery. It arises because of a combination of market failure and Marine Scotland's laissez-faire approach. The undesirable consequences are further exacerbated by the imposition by the mobile sector of *de facto* area management. This paper takes the view that there is absolutely no need to undertake further research into the root cause of the current fiasco.

Not only do we now understand the cause, we also know the magnitude of the enormous benefits we are currently foregoing by allowing this situation to perpetuate. Indeed the Grid Report and the NEF 2016 study demonstrated that, if we were to alter the balance between static and mobile gear, the benefits to Scotland would massively exceed the costs.

SCFF takes the view that there is no requirement for any further research to confirm that, where practically possible, replacing Nephrop tails with creel caught live Nephrops generates flows of economic benefits which exceed costs by a considerable margin. Indeed we have demonstrated that trawlers should never catch a tonne of Nephrops which otherwise would have been caught by creels. There is therefore an economic (and environmental) imperative for creel only areas.

Marine Scotland is not only complicit in the current economic shambles, but it is the only body who can correct the endemic market failure. If Scotland is to realise the enormous economic potential offered by its stock of Nephrops, then explicit and possibly extensive intervention by Marine Scotland is a necessary pre-condition.

SCFF takes the view that Marine Scotland should regard the re-balancing of fishing effort in the form of creel only areas as an extraordinary opportunity to realise the massive economic potential of our inshore Nephrop stocks. Currently this potential is being shamefully squandered and, quite literally, is being dumped at sea.

### 4.1 The Vision

SCFF now calls on Marine Scotland to accept the conclusions of this paper and to work with the Federation to ensure that inshore Nephrops stocks will be managed in Scotland's best interests.

Specifically, SCFF is seeking Marine Scotland's support for a target of a fifty per cent share for creelers of the 0-6NM Scottish Nephrops fishery. SCFF believes that this goal can best be achieved:-

- The SCFF requires of Government that a West Coast network of creel only zones are created in a timely manner, with the ultimate goal of achieving the re-instatement of a three mile limit around the West Coast. The purpose of which is with a view to recovery of the marine environment, fish stocks and the economic benefits as displayed within this report.
- On the east coast of Scotland through a network of mobile gear free zones negotiated at local level with the support and guidance from Marine Scotland.

SCFF estimates that the economic benefits of this policy for the west coast alone would include:

- Over 450 additional (small) fishing vessels and businesses
- Over 700 net and new sustainable jobs in fishing
- Nearly £45m additional annual revenue and over £2.5m annual profits which would flow directly into west coast communities

These figures clearly demonstrate that the national interest supports a substantial reallocation of fishing opportunity for Nephrops in Scotland to the creel sector. The SCFF calls on Marine Scotland to start working with it immediately to make its goal a reality by 2022.

## APPENDIX 1 UPSTREAM AND DOWNSTREAM JOBS

There are two types of jobs supported by the shellfish catching sector. There are upstream firms which supply the catching sector with chandlery supplies, fuel, machinery and repair and maintenance of vessels and gear. Other firms are involved in downstream handling and processing of the catch. We are not interested in the total number of FTE's currently supported in upstream and downstream activity. The focus should be on the marginal impact.

With respect to upstream jobs, catching live Nephrops using many small vessels is likely to result in a greater demand for servicing and repair work. For example the average over 250kW trawler lands 160 tonnes live weight. This would support 16 creel vessels all of which have engines which need servicing and hulls which have to be maintained. Servicing and repairing 16 small vessels will demand more labour than one large vessel. There is unlikely to be any activity on one large vessel which is going to require 16 times as much upstream labour as required by one small vessel. Unfortunately, we don't have sufficient direct information which would enable these effects to be incorporated into the analysis.

With respect to downstream FTE's, the handling demands of live Nephrops support FTE's. Though, unlike fresh and frozen whole products, there is less packaging involved. Also Nephrop tails, especially those sold as scampi require more processing, much of which takes place in large industrial units located some distance from remote coastal areas. A rebalancing of fishing effort would decrease in employment in the handling, processing and packaging of whole Nephrops and tails. It should be appreciated that some of the decrease in these supplies from inshore areas would be replaced with more supply from trawlers displaced and fishing outside creel only areas. Also, many processors import raw materials and they might be able to replace locally caught with additional imports. These effects would mean mitigate the FTE loss.

There are some good descriptions of the processing sector. In particular, the biannual Seafood Processing Industry Report describes the UK fish processing sector but is not sufficiently disaggregated for the purposes of this document. The lowest level of disaggregation is "shellfish" and this does not enable a comparison of live and whole or tailed Nephrops. In the absence of primary research, we can only speculate whether the additional upstream jobs supported by creeling, plus the additional jobs handling live Nephrops will exceed the loss of downstream jobs in processing, packaging and marketing of whole Nephrops and Nephrop tails. The substitution of routine factory jobs in West Central Scotland by more skilled servicing and repair work in remote, rural areas might be an attractive prospect.