PrimeFish

"Developing Innovative Market Orientated Prediction Toolbox to Strengthen the Economic Sustainability and Competitiveness of European Seafood on Local and Global markets"

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D3.3 "Report on costs & benefits of compliance with voluntary market-based labelling & certification Schemes"

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Glossary of Terms and Abbreviations

Term	Description
ASC	Aquaculture Stewardship Council (certification body)
BAP	Best Aquaculture Practices (certification body)
CAB	Conformity assessment body
CoC	Chain of Custody
IUCN	International Union for the Conservation of Nature
IRS	Iceland Responsible Fisheries (fisheries certification body, national)
FoS	Friends of the Sea (aquaculture & fisheries certification body)
GSSI	Global Seafood Sustainability Initiative (environmental standards benchmarking)
GFSI	Global Food Safety Initiative (food safety standards benchmarking)
GSCP	Global Social Compliance Program (food social standards benchmarking)
GSI	Global Salmon Initiative (precompetitive industry certification collaboration)
MSC	Marine Stewardship Council (fisheries certification body)
RFM	(Alaska) Responsible Fisheries Management (fisheries certification body, national)
SFP	Sustainable Fisheries Partnership (fisheries recommendation scheme)
WWF	World Wildlife Fund (eNGO and ASC/ MSC standard developer)

1. Introduction and objectives

Certified food sustainability standards are voluntary, usually third party-verified norms relating to environmental, social, ethical and food safety issues; developed to varying degree in consultation with a range of primary and secondary stakeholders and experts in these fields. They are adopted by companies either as a complement or alternative to their own internal and supply chain quality assurance systems in order to demonstrate acceptable performance of their organizations or products in these areas. As such they are can also be viewed as a market-based approach (Appendix 1) approach to governing negative externalities of business practices. By addressing societally perceived deficits in areas of statutory governance, they offer companies an 'outsourced' means of defending their reputations and brands against civil-society (e.g. NGOs, media, celebrity chefs etc.) campaigns linked to such deficits. Consistent with this brand management rationale; standards may simply operate at a business to business (B2B) and/ or business to consumer (B2C) levels i.e. with or without a consumer-facing label.

Such governance attributes are of particular significance to European and other rich-country seafood buyers given the net global flows in seafood trade to 'rich' from developing economies where both capture fisheries and farmed production are often lightly regulated and value-chains highly fragmented posing challenges for internal quality assurance systems. Civil society campaigns of the kind described above are also likely to have greater influence in these rich markets, providing further impetus for seafood companies to engage in 'ethical supply chain management' of commercial entities beyond their own direct ownership and geographical legal jurisdictions (many standards also incorporate a separate chain of custody (CoC) standard to prevent non-certified products being sold as certified/ labelled along the supply chain).

The credibility, and arguably greatest inherent value of such standards is underpinned by a 'third-party' verification process, whereby in place of self-claims, independent 'certification assessment bodies' (CABs) audit compliance of companies or external suppliers against the standards. Both the eligibility and performance of CABs, along with standards setting procedures are themselves subject to formal accreditation processes and other tiers of normative standards, designed to further enhance credibility of the approach. Figure 1 shows the relations of these elements in a standard setting and certification process.

The first part of this report (Sections 3 and 4) we provide a theoretical overview of voluntary market-based labelling & certification focusing on schemes of greatest relevance to the major seafood commodity groups that are the focus of the PrimeFish project.

In the second part of the report (Section 5) we evaluate the role of sustainability certification in company strategic positioning based on a case study of the Global Salmon Initiative, an industry collaboration predicated on a commitment to 100% ASC certification of all member sites by 2020. In this section we also examine interactions, cost/ benefits and areas of overlap between mandatory and major voluntary certification and recommendation schemes (e.g. MSC, GlobalGAP, ASC, BAP, SFP, Monterey Bays 'Seafood Watch', Greenpeace Red-list), and identify harmonization mechanisms/ equivalence criteria for voluntary and mandatory schemes (e.g. Global Sustainable Seafood Initiative (GSSI)) with the aim of reducing costs to producers and improving overall compliance.

This output complements 'the assessment of consumer attitudes toward certification' schemes outlined in WP4 (Task 4.2).

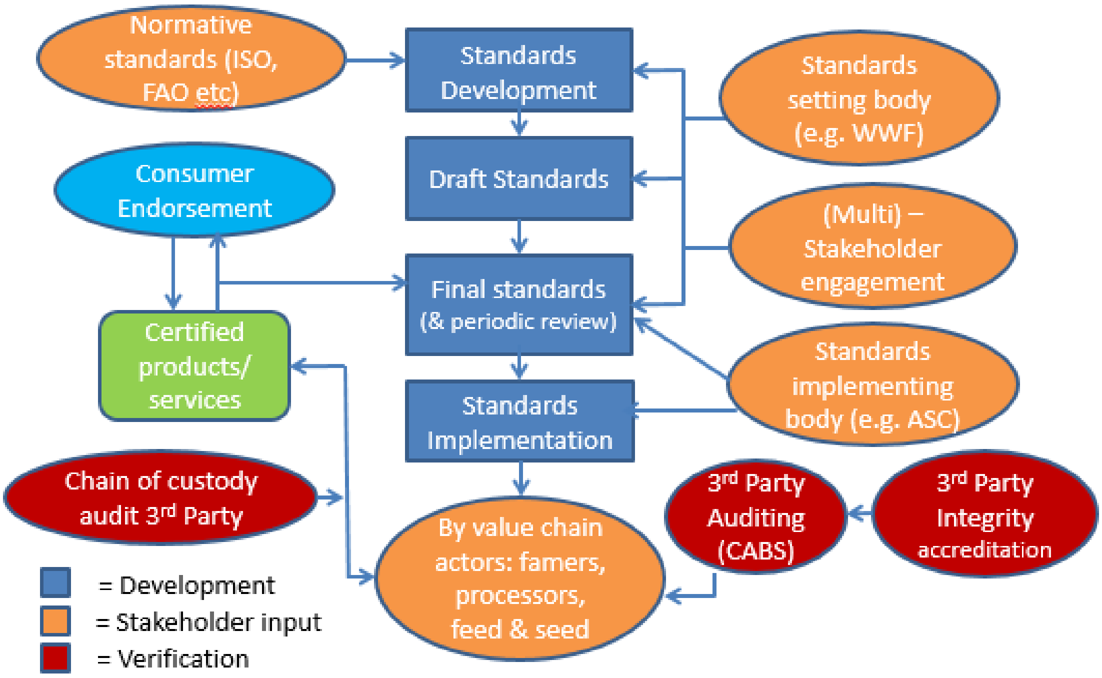


Figure 1. Sustainability standard development and certification processes

2. Methodology

The report includes descriptive analysis of quantitative data on third party certification in aquaculture collected from publicly available sources, as well as a review of relevant literature.

Data on third party certification in aquaculture were extracted from the websites of the following certification bodies: ASC, FoS, GlobalGAP, GAA-BAP (Table 1). The data was compiled into and integrated relational database management system using MS Access (Appendix 2) and analysed using the embedded pivot-chart/ table functionality. The same approach was replicated for analysis of GSI sustainability indicator data (Section 5). GPS coordinates of certified seafood companies (GlobalGAP, FoS) or individual sites where available (ASC and GAA-BAP) was extracted and or interpolated from the same sources and visualised using Google MyMaps and Excel Powerview.

In-depth semi-structured interviews with a range of actors in certification and seafood production provided further explanatory power for interpretation of results. Further methodological and analytical detail is provided in Section 5.4.

Table 1. Data on certification collected from publicly available sources

Category	Data	Certification scheme
Company	Country Address Contact details Value chain structure	ASC, BAP, GlobalG.A.P., FoS ASC, BAP, GlobalG.A.P., FoS ASC, BAP, GlobalG.A.P., FoS BAP
Farm	Location (GPS) Species farmed Harvest volume Production facilities	ASC, BAP ASC, BAP, GlobalG.A.P., FoS ASC ASC
Audit	Certification cycle Dates of certification Auditing body (CAB) Species standard	ASC ASC, BAP, GlobalG.A.P., FoS ASC ASC, BAP, GlobalG.A.P., FoS

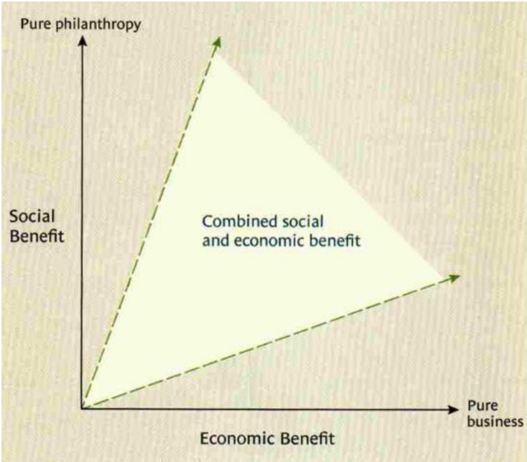
3. Strategic incentives for certification

3.1. Sustainability and competitiveness

Firms are increasingly recognising sustainability issues as an area of strategic interest which does not only add costs but also presents economic opportunities. Such opportunities arise from the potential for (i) "eco-efficiency" - the better utilisation of resources- or (ii) differentiation and exploitation of market niches based on developing more sustainable products and processes.

There has been considerable (and ongoing) debate as to whether sustainability results in better profitability for the businesses engaging in it i.e. as a win-win scenario, or diversion of managerial attention away from stakeholder value and competitiveness (Porter and Kramer, 2002). From a resource based perspective (Barney 1991[1]) , potentials for profitability can be viewed as contingent on economic fundamentals of a specific business i.e. "the structure of the industry in which the business operates, its position within that structure, and its organisational capabilities" (Reinhardt, 1998). In other words, some companies will be better positioned to profit from sustainability initiatives than others whilst not all sustainability initiatives will result in an economic benefit, just as well as not all economic activities will benefit the wider society. The question therefore transitions from "whether" to "when" there is a scope for mutual benefit. Porter and Kramer (2002) suggest that only where social and economic benefits converge with "corporate philanthropy", is the engagement in sustainability initiatives really strategic (Figure 1).

[1] Barney, J. B., "Firm Resources and Sustained Competitive Advantage." *Journal of Management,* Vol. 17, No. 1, 1991, pp. 99–120



Note: The green zone portrays the area of strategic importance with potential for improving the competitive position of a company.

Figure 1. Convergence of social and economic benefit interests. Source: Porter and Kramer (2002)

Orsato (2006) mapped a rational for adoption of environmentally-friendly or socially responsible activities against Porter's (1980) generic competitive strategy theory (Figure 2). The framework envisages achievement of competitive advantage through either 'differentiation' or 'lowered costs' strategies in two focal areas; organisational processes or products (& services). However, the boundary is very blurred for agro-foods, since final product as processes involved in production, which is in turn typically recognised by consumers as an intrinsic feature of sustainably produced/ ethical products.

Figure 2. Generic environmental competitive strategies. Source: Orsato (2006)

Conceivably, environmental improvements may also result in improved efficiency or 'eco-efficiency' and thus reduced costs (Figure 2; strategy 1). Examples from aquaculture might include reduced escapes due to improved containment measures, better growth rates, feed utilisation and general fish health, reduced therapeutic treatment costs and utilisation of processing by-products. However to achieve environmental cost leadership (strategy 4), additional product modification e.g. ecopackaging and new modes of commercialisation, need to be introduced to achieve a combination of lowest cost and environmental impact in the product category.

However, effective utilisation of such cost-efficiencies may also depend on the capabilities and resources available to individual companies' i.e. smaller firms typically being more limited in their responses than larger counterparts. Smaller firms may also be less inclined to believe that that their efforts can significantly lower negative environmental impact or that they will gain significant commercial benefit from tackling such issues. For some firms, large or small environmental certification may be considered overly bureaucratic, too costly or they may have established an independent reputation and relations with their buyers with their own internal quality assurance systems.

Potential commercial benefits of certification include: (1) gaining a premium price, (2) access to otherwise inaccessible markets and (3) reduction of production costs. Success of the first two options depends on the standards market attributes level of demand for the standard in target markets. Benefits may be mutually exclusive i.e. certification may simply ensure continued access to larger more commoditised market segments with no price premium guarantee. Firms may or may not seek direct public recognition for their efforts depending on the type of value chain they participate in (i.e. global vs local) and their position in it, further reflected in choice of certification model; business to business (B2B) or business to consumer with a consumer facing label (B2C). Thus, certification may be part of a direct product (B2C) or wider brand (B2B) level differentiation strategy, with varying potentials to offset some or all of the costs of certification.

Strategy 3 entails differentiation of the final product based on communication of sustainability attributes i.e. typically in a B2C model. Pre-conditions for successful 'eco-branding' are (i) reliable information on product environmental performance made available to consumers e.g. codified in a credible 'sustainability' logo displayed on the packaging, (ii) recognition of, and willingness to pay for the extra sustainability effort and (iii) differentiation should be difficult to imitate.

However seafood commodities, are by definition undifferentiated products where, after food-safety assurance[2], price is the definitive factor in consumer choice. Certification, whether broad or narrow in scope then aims to differentiate products on largely intangible sustainability attributes. Differentiation is successful if it results in a price premium or improved market share (increased sales) compared to the baseline stock. The more stocks become certified, however, the more their uniqueness gets undermined. This tends to be a ubiquitous problem with the exception of more socially focussed standards such as 'Fairtrade' who navigate this problem by embedding an equitable producer-premium as a core market attribute. First-movers seen to be exceeding conventional compliance thresholds (Figure 2, strategy 2), may also gain differentiation advantage until eroded by mass adoption of the same or similar certifications by competitors. A good example being the wider adoption of the RSPCA Freedom Food Standard by the Scottish salmon sector following its successful introduction by a medium-sized independent producer, Loch Duart.

[2] A core attribute of the GlobalGAP standard; also the only farm standard accredited by the Global Food Safety Initiative (GFSI).

The nature of demand for certification has also changed along with enormous changes in food retailing in the developed world over the past few decades. Small independent shops have been displaced by large multinational corporations acting as 'lead companies' and 'gate keepers' to the market (Murray and Fofana, 2002). In a highly concentrated sector such as the modern food retailing, retailers have the power to dictate conditions of supply to their, often much more fragmented, supplier base. Retailers' own strategies are formulated based on opportunities and threats they themselves are facing. Given their global sourcing and position as lead firms in 'global value chains' (Ponte, 2012) retailers are under pressure by various interest group to take ever more proactive roles in sustainability stewardship.

Development and enforcement of relevant national laws, particularly in developing countries, is often perceived as ineffective, while there is a strong emphasis on sustainability in most developed countries. Given that the global trade flows of seafood are largely from the developing to developed countries, the requirements by importing markets for the adherence to sustainable practices and the lack of effective provision of such from exporters has driven demand private (or market-based) governance in the form of third party certification over recent decades (Oosterveer, 2015).

From a retailer perspective, certification commitments also serve as (i) a strategy for codification and independent verification of corporate social responsibility (CSR) efforts in line with increased demand for transparency and ease of monitoring by stakeholders (Dawkins and Lewis, 2003), (ii) to transfer costs of auditing to the previous stages of the value chain and (iii) serve as a means to protect retailers' reputation from attacks by civil-society pressure groups. As such the retail sector has had a major role to play in the proliferation of sustainability standards, and creating a market for sustainability (Bush et al., 2013a).

The role different interest groups in driving this market are postulated in Figure 3. In this conception lead companies and brands in seafood value chains effectively take on the role of sustainability 'choice-editors' as they are compelled to respond to demands of multiple pressure groups. Of particular note here, is the marginal position of consumers, academics and industry bodies as influencers relative to other 'civil society bodies' and 'opinion leaders'. This also underscores the ascendency of polemic (i.e. often based 'worst-worst case' narratives around environmental, social, food-safety or other ethical transgressions) over more evidence-based debate in driving demand for sustainability certification (certification bodies, in turn, compete for recognition and adoption by retailers in order to utilize their leverage over their suppliers). This assessment can be contrasted with the erstwhile theoretical view of consumer choice as the primary driver of demand for sustainability certification i.e. whereby citizens also make inherent sustainability decisions every time they approach the till!

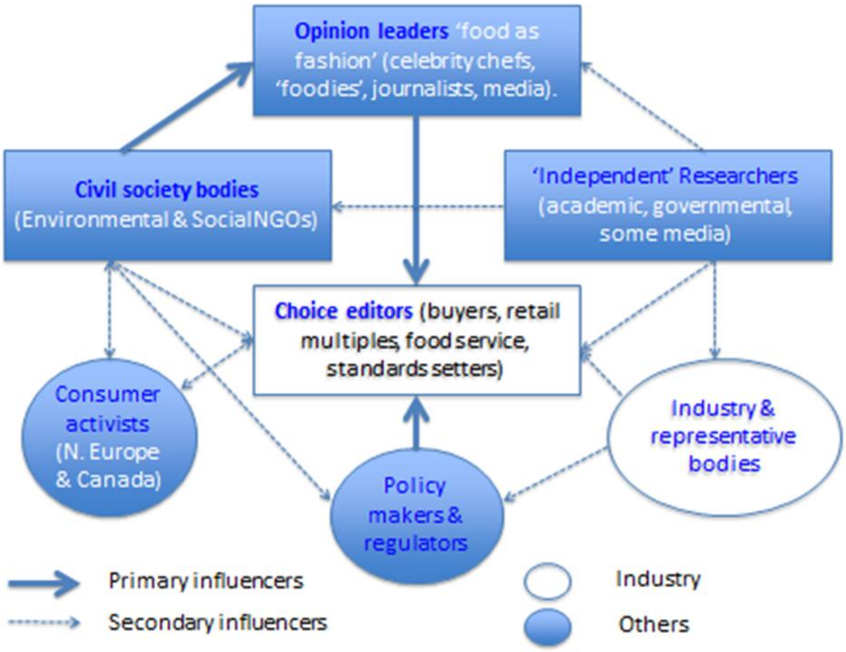


Figure 3. The relative influence of different stakeholder groups in driving demand for third-party certification by leading seafood brands as 'choice-editors' (Murray et al 2014[3]).

3.2.Critiques of sustainability certification

A recurrent opinion voiced in interviews with a diverse range of seafood producers concerned what they perceived as the rent-seeking nature of certification schemes; many using emotive terms such as 'parasitic' and 'self-serving' with regard to this emerging sector. At the crux of these sentiments lay the fact that for many, certification has become a necessity for continued access to sizeable market sectors, without affording a commensurate price premium sufficient to cover additional costs of compliance. Furthermore such costs are amplified where multiple recurrent compliance audits for different standards are required to meet the divergent or overlapping demands of different market segments. Extending this logic, lead seafood companies (especially retailers and processers) are viewed as accruing direct commercial benefits of certification in terms of brand protection whilst passing a disproportionate share of costs onto producers. This argument also has its corollary in an anti-globalisation critique of international trade, whereby the disproportionate financial burden of certification on smaller producers further accelerates sectoral consolidation resulting in their acquisition or exclusion. Furthermore re-enforcing this pressure, standards themselves are subject to periodic revision with intent of driving continuous performance improvement by individual farms.

The rising importance of market based governance and the fact that predominantly western economies have imposed such standards on developing nations has been equated by some as a form

[3] Murray. F., L'Etang. J., Little D., Jahansoozi, J. 2014 Aquaculture's challenging 'communications complex': meanings, discourses and relationships – towards anew research agenda. Unpublished

of neo-imperialism (Vandergeest and Unno, 2012). Others have questioned the effectiveness and extent to which standards can actually improve environmental management (Jacquet and Pauly, 2007) or even how impacts can be reliably measured (Thomson et al 2014) though this debate is largely beyond the scope of this report.

The above equity critique also creates a paradox for standards targeting more equitable social sustainability outcomes. Response to this problem include a range of strategies designed to reduce audit costs for both single standard and multiple audit situations. A range of 'benchmarking' schemes have emerged designed to calibrate degrees of equivalence between standards. Larger standards bodies are also increasingly collaborating on their own inter-standard harmonisation and equivalence efforts as well as launching multi-site and group certification schemes designed to spread and lower costs of individual site audits. These strategies are reviewed in further depth in later sections.

Whilst many standards bodies, particularly those with strong social components (such as the ASC standard), list the ability of producers to secure a price premium to reward their stewardship efforts as a key element of their mission statements. In the next section we review the evidence around attainment of this objective.

3.3. Certification and premium pricing; the evidence

Certified products may fail to generate adequate premium due to a low level of recognition by consumers and concomitant low willingness to pay; especially true of price sensitive markets such as seafood (see below). Secondly, as we have seen, differentiation based competition strategy is fundamentally at odds with the aim of standards bodies to ever expand their customer base in order to maximise sustainability benefits. This means first mover (differentiation) advantage is often only temporary. For example ASC certified salmon is arguably still a niche product preferred by some buyers over non-certified salmon. But as more product becomes certified (>50% of global production is targeted to be certified by 2020) certification would become a normal non-competitive practice e.g. such the ISO industry wide standards, ultimately leading to 'commoditization' of certification.

Divergent pricing strategies of retailers must be considered in any assessment of price transmission and return to 'certification value-added'. For example, differentials between certified and non-certified substitutes may be masked by uniformly higher pricing levels by higher-end retail brands such as Waitrose or Marks & Spencer.

The role of sustainability certification and labelling is to transmit information about an intrinsic quality of a product, e.g. relating to public benefits such as environmental integrity, which is not obvious to consumers when choosing a product. The incentive of producers to augment practices to more sustainable ones has to be in the form of a premium received from the final consumer and transmitted up the value chain to the producer, in order to cover for the increased costs of the augmented practices. Therefore, consumer demand is meant to be the driving force resulting in a more sustainable management at the production level.

However, there has been a debate in the literature (e.g. Bush et al., 2013) as to whether sustainability certification schemes reward the producers or only serve as a 'tickets' to enter a market controlled by powerful retailers. The consensus increasingly focuses on the later. The main argument is that the majority of end consumers do not recognise the labels and are not actively looking for them, but it is the retailers who require that their suppliers obtain the certification, as a form of CSR and reputation management. Moreover, given the commitments of certification bodies and retailers to increase the proportion of certified products, any potential price premium based on uniqueness is likely to suffer as the certification becomes 'the norm', as is the case with many ISO certifications nowadays. Nonetheless, as Asche et al. (2015) point out, even if a price premium for certified products is not observed, a continued access to the market can still be seen as a form of price premium because it relates to the supplier's "market of choice". This "preferred market" it is supposedly the most profitable one for the supplier, who if denied access to that market, must sell to a less preferred one at a higher cost or lower price, resulting in an overall lower profitability. With the majority of seafood nowadays being distributed through multiple retailers, it is a matter of discussion how much "choice" the producers actually have.

Two methods have been used by academics to measure the existence and magnitude of a price premium for a product with specific characteristics. On the one hand, the 'stated preference' studies, aiming to capture the willingness of consumers to pay a premium for a superior product, show evidence for a hypothetical premium for sustainable seafood production methods (e.g. Johnston et al., 2001; Olesen et al., 2010; Uchida et al., 2014). However, as pointed out by Sedjo and Swallow (2002) willingness to pay does not necessarily translate into a market premium, because the method may not reflect the reality i.e. a consumer may not in reality purchase the labelled product (which has been a long standing critique of the stated preference methodology, and/or the retailer may not be able to capture the premium.

On the other hand, 'revealed preference' methods, using actual market data, to decompose the product to its attributes and estimating the contribution of each attribute to the final price through statistical regression, are not numerous and not always conclusive.

MSC is the most studied scheme in seafood utilising revealed preference methods, and the majority of studies cover the UK retail market for white fish. (Sogn-Grundvåg et al., 2013) discovered a 10% premium for chilled MSC haddock and 13% premium for MSC cod and haddock (Sogn-Grundvåg et al., 2014), respectively, in retail market in the Glasgow, UK. A price premium of 10% was estimated for MSC certified cod in Sweden (Blomquist et al., 2015). The highest premium for MSC white fish found was of 14.2% for frozen Alaska pollock in the London metropolitan area (Roheim et al., 2011).

However, Asche et al. (2015) note that the analysis suffers from treating all retailers as identical adds to the analysis by analysing salmon products in the UK also accounting for retailer heterogeneity accounting for the fact that eco-label pricing may be influenced by retailer profiles and competition across labels. Their results show that MSC label achieves an overall price premium of 13.1% but there was a high variation in premiums across retail chains. MSC salmon had a high premium in low-end retail chains but no statistically significant premium in high-end retail chains, thus reflecting the importance of the overall pricing strategy of the retailer. However, MSC certified salmon is always a product of capture fisheries, therefore there might be a co-founding effect arising also from that fact, in a market dominated by farmed salmon.

Organic labelling is another voluntary certification on which various studies have focused. Using actual market data, Asche et al. (2015) found around 25% price premium for organic salmon in UK retail. Fresh and smoked salmon in Norway have been shown to attract a premium of 24% and 38% respectively (Aarset et al., 2004), while Ankamah-Yeboah et al., (2016) finds a premium of 20% for organic salmon in the Danish market, using panel data. Similarly, EUMOFA (2017) describes significant price premiums for organically certified seafood in the EU, but not always improv ed profitability.

One of the possible explanation between the substantial difference in premiums for MSC and organic is that the organic label is better known by consumers than the specific sustainability labels such as MSC and ASC (Ankamah-Yeboah et al., 2016).

As a relatively new certification scheme, there are no studies examining the pricing of ASC certified products. However, some evidence suggests that it might be attracting a premium in the UK retail market. Stuart Smith, a technical manager for fish with ASDA says (as reported by Intrafish, November 2010):

"Talking to ASC, their aspiration is to have 10% of farmed seafood certified... which in my opinion is very deliberately driving a product which is seen as premium and delivers a high price... As a budget retailer, we won't see any of that product because we don't have the ability to pay more for it and charge more for it as you would in a high-end retailer."

Currently (as of Oct 2017) there are no ASC certified products in ASDA shops in the UK. ASC products can be found in the UK retailers Waitrose, TESCO, LIDL, ALDI, Sainsbury's and IKEA.

4. Seafood certification standards

The trend for this form of quality assurance steadily gained paced with introduction of consumer-facing eco-labels and organic food standards in the 1980's and 90's. There has since been a proliferation in the development of sustainability standards across the food production systems. According to SustainabilityMap (www.sustainabilitymap.org) there are currently 240 standards relating to agri-food products globally, of which 50 are aquaculture and 46 fisheries related. In 2015 14.2% of the total volume of seafood from capture fisheries and aquaculture was certified sustainable, Figure 4.

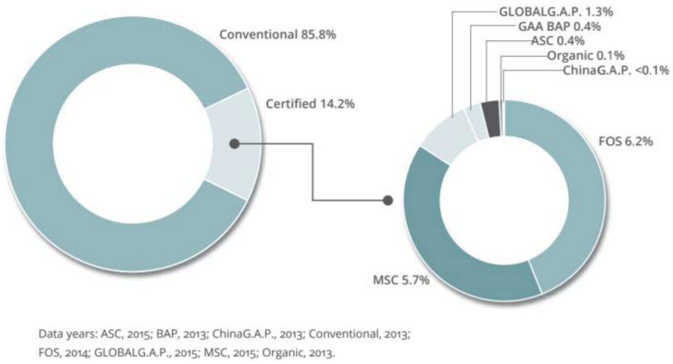


Figure 4. Certified vs certified sustainable seafood production, volume. Source: Potts et al., (2016)

Environmental and social certification schemes of relevance to the fisheries and aquaculture species groups that are the focus of PrimeFish are characterised in Table 2 and the rest of this section. The selection encompasses industry, NGO and state sponsored fisheries and aquaculture schemes.

Table 2 also shows the current accreditation of these schemes against 3 benchmarking schemes, the Global Seafood Sustainability Initiative (GSSI), the Global Food Safety Initiative (GFSI) and the Global Social Compliance Program (GSCP). The schemes evaluate the compliance of schemes with relevant normative standards (e.g. the FAO Codes of Conduct for Responsible Fisheries and Aquaculture Certification Guidelines, ISO quality standards etc) with the ultimate intent of reducing certification transaction costs, for example due to unnecessary duplication of site auditing effort.

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Table 2. Characteristics of selected aquaculture and fisheries sustainability certification schemes

Name & Organisation logo	Consumer-facing logo	Production System (& Founders)	Yr(s) standard [developed] & Initiated	Species scope	Geographic scope	Type certification	Value chain	Benchmarking
Global Aquaculture Alliance Best Aquaculture Practices (GAA BAP) Global Aquaculture Alliance		Aquaculture (Civil society, private sector, producers)	[1974] 2004	Barramundi, catfish, golden pompano, jade perch, mussels, **pangasius, rainbow trout, salmon**, shrimp, tilapia	Asia, Australia Oceania, Central American Caribbean, Europe, N. America, S. America	Individual and multi-star production group along value chain	Seafood processors, farms, feed mills and hatcheries	**GSSI:** 4 Oct 2017 **GFSI**: 16 May 2013 **GSCP**: N/A
Aquaculture Stewardship Council (ASC) Aquaculture Stewardship Council	FARMED RESPONSIBLY asc CERTIFIED ASC-AQUA.ORG	Aquaculture (civil society)	[2010] • Pangasius 2012 • Salmon 2012 • Tilapia 2012 • Shrimp 2014	Abalone, bivalves, **freshwater trout, pangasius, salmon**, shrimp, tilapia	Asia, Australia Oceania, Central American Caribbean, Europe, N. America, S. America	Individual and Group	Farm only	**GSSI**: 2017 (4 of 7 Spp. Standards) **GSFI: N/A** **GSCP: N/A**
The Global Partnership for Good Agricultural Practice (GLOBALG.A.P.) GLOBALG.A.P.	GGN CERTIFIED AQUACULTURE WWW.GGN.ORG; FRIEND OF THE SEA ©	Aquaculture (Private sector: industry, retailers)	[1997] 2004	All spp. finfish, crustaceans molluscs (hatchery-based and passive collection of seedlings from the planktonic phase for molluscs)	30 countries from North, Central and South America; Europe; Asia; Australia and Oceania	Individual and group	Aquaculture hatcheries and farms, compound feed	**GFSI:** 24 April 2013 **GSSI**: N/A **GSCP:** GLOBALG.A.P. Integrated Farm Assurance V5, Produce Safety Standard (PSS) V4 & Harmonized PSS

Friends of the Sea (FOS)		Fisheries and Aquaculture civil society)	[2008] First edition of both wild catch and aquaculture standards 2013	All species of fish, abalone, bivalves, crustaceans	Africa, Asia, Australia and Oceania, Central American and Caribbean, Europe, North America, South America	Individual and group	Fisheries, fish farms, fish meal, fish oil	GFSI: N/A GSSI: N/A GSCP: N/A
Certified Quality Aquaculture (CQA)		Aquaculture (State)	[2016]	Finfish and mussels	Ireland	Individual and group	Hatchery, broodstock facility farm & processing plant	GFSI: N/A GSSI: N/A GSCP: N/A
Naturland (Organic)		Aquaculture (Civil society, private sector, producers)	[1982] • Aquaculture 1996 • Wild Catch 2006	Carp, salmonids, whitefish, mussels, shrimp, tropical FW fish, perch-jack-cod like fish, macro algae. **Wild catch:** all FW & marine finfish & invertebrates	Africa, Asia, Australia and Oceania, Central American and Caribbean, Europe, South America	Individual and group	Producers, processors	GFSI: N/A GSSI: N/A GSCP: N/A
Marine Stewardship Council (MSC)		Fisheries Civil society, private Sector)	[1997] 1998	All species for wild catch fisheries	Africa, Asia, Australia and Oceania, Central American and Caribbean, Europe, North America, South America	Individual and group		GFSI: N/A GSSI: 14 March 2017 GSCP: N/A

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Alaska Responsible Fisheries Management (RFM) Certification Program		Fisheries (State-private)	2011 (V2 in 2016)	Salmon, halibut, pollock, cod, black cod, crab, flatfish	Fisheries operating within the Alaska 200 nm EEZ	Individual and group	Fisheries CoC	GSSI: 12 July 2016 GSCP: N/A GFSI: N/A
Iceland Responsible Fisheries (IRF)		Fisheries (Private)	[2008] 2010	Cod, haddock, golden red fish, saithe	Iceland	Individual and group	Fisheries	GSSI: 8 November 2016 GSCP: N/A GFSI: N/A

4.1. Global trends in fisheries and aquaculture sustainability standards

4.1.1. Marine Stewardship Council (MSC)

Formally registered in 1997 as one of the first sustainable capture fisheries certification schemes the MSC has achieved clear first mover advantage and dominance in this sector . In 2015 it was the second largest in terms of volumes of certified harvest (after Friends of the Sea), accounting for 10% of the global catch, Figure 5. Updated figures for 2017 reveal around 9.5 million tonnes of seafood harvested annually was MSC certified, or around 12% of the global marine catch, while another 2% came from fisheries in MSC assessment (Marine Stewardship Council, 2017). This figure has been reached due to fast growth over the last 17 years, Figure 9.

Three main principles guide the development and implementation process of the standard: (i) sustainable fish stocks: extraction activity does not undermine future stock health; (ii) minimizing environmental impact: maintenance of the integrity of the underlying ecosystem; (iii) effective management: compliance with relevant laws and presence of effective and adaptive management system (Marine Stewardship Council, 2017).

Because of the emphasis on effective management (principle iii), on which the other two principles are largely dependent, certified fisheries have mostly been limited to the large fisheries in already well-managed sea regions. This has resulted in a high concentration of production volume to developed countries, with 10 developed countries accounting for 89% of the global MSC supply in 2015 (Potts et al., 2016). This has attracted significant criticism on the basis of the certification not being accessible to small scale producers in developed countries (Bush et al., 2013c; Gulbrandsen, 2009) and its effectiveness in addressing global fisheries sustainability, given the bias of the certification towards already well-managed fisheries (Ward, 2008). Even though the certification covers more than 100 unique species, concentration is also present at species level with three species groups- cod (including Alaska pollock), herring and tuna – accounting for more than half of the total MSC certified production in 2015 (Potts et al., 2016). All of the main species are marketed as branded products in retail setting, indicating the reliance on retail consumption for future growth. Even though it is one of the better recognised certifications, in 2014 only 33% of end consumers recognised the label, which to a great extent has been overcome through corporate commitments by retailers in sourcing MSC certified stock (Potts et al., 2016). The strong buy-in by multiple retailers points to an effective marketing strategy and brand positioning.

Nevertheless, serious constraints for the certification's future growth strategy also emerge. The retail-lead growth has been concentrated to 12 countries in Europe and North America, where about ¾ of the 3000 MSC products are sold. While further expansion in this sector is likely thanks to the strong positioning of the label, longer term growth objectives would need to include developing country markets, where the demand for the label is weak. Species diversification is another possibility for growth. However, market demand limitations for less common species would be an obstacle. The availability of supply, though, given the requirements for certification, might pose even more significant barrier to expansion.

In addition, Bush et al., (2013c); and Bush and Oosterveer (2015) discuss the strategic positioning of the MSC standard. Since different levels of compliance are given the same value (certified or not) a vacuum of differentiation arises, resulting in the lack of incentive from the fishermen to improve, which is in conflict with the long-term objectives of the certification; or seek additional differentiating features, such as the WWF logo in addition to the MSC logo (co-labelling) to signify beyond compliance performance. Such 'external' driver of differentiation illustrates the need for a multiple certifications from the producer point of view. On the other hand, a single all-encompassing certification is more likely to achieve wider-spread recognition, as well as reduce confusion in consumers resulting from too many certification schemes on the market.

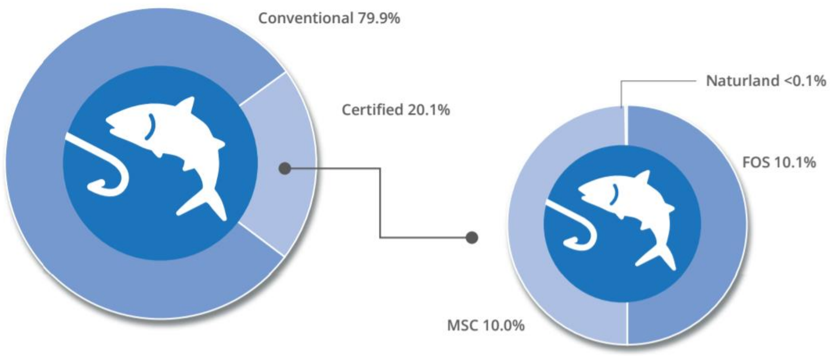


Figure 5. Certified catch as a proportion of total wind catch. Source: Potts et al. (2016)

4.1.2. Friends of the Sea (FOS)

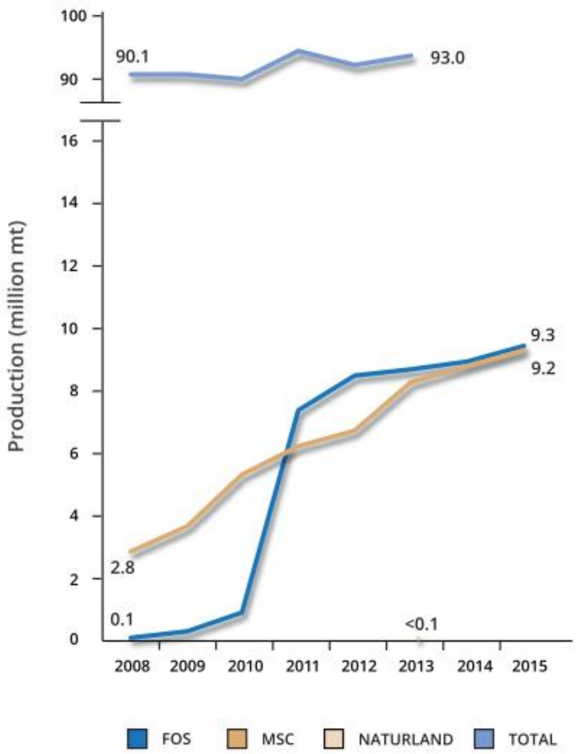
While the origins of the certification can be traced to a single issue of dolphin protection in tuna fisheries, FOS is currently one of the most diversified seafood labelling schemes covering both capture fisheries and aquaculture. Since it was founded in 2008 FOS certified wild capture fisheries production has been growing at an average annual rate of 91% reaching 9.3 million tonnes in 2015, or 10.1% of the global landings (Potts et al., 2016), Figure 6.

The strategy behind the FOS's success has been very different from that of the MSC. With a focus on the actual state of the target fishery (i.e. not over exploited, according to FAO guidelines) rather than the processes leading to sustainable fisheries, the cost of certification has been significantly reduced (reported average €5000 per audit on capture fisheries). This has potentially rendered FOS certification more accessible to developing country producers and particularly relevant to less valuable products such marine ingredients, which have been underserved by other global sustainability certification schemes.

While, similar to the MSC, there is high level of concentration with three countries accounting for more than 80% of the total FOS certified wild catch, these countries are in the developing world (Peru, Chile, the Philippines), points to a strategy targeting developing countries. The entire production of Peruvian and Chilean anchovies, which account for about half of the global fishmeal production, and one of the largest trade flows in the seafood industry, is FOS certified (Potts et al., 2016).

Spanning both fisheries and aquaculture certification, FOS is in the unique position of controlling the distribution of inputs from fisheries to aquaculture feeds and has the potential for developing own internal market for certified marine ingredients. However, the volume of FOS certified aquaculture products in 2015 was disproportionately small, representing only 10% of the total FOS certified seafood, pointing to the need for significant expansion in the aquaculture sector in order to exploit effectively such synergies (Potts et al., 2016).

The vast majority of aquaculture production certified by FOS is mussels and salmonids and unlike capture fisheries, is concentrated in developed countries, particularly South Europe, where the main markets for its label are also located. Clearly a strategy for future growth and exploitation of synergies needs to incorporate a global demand for consumer-facing FOS certified products.



Compound annual growth rates (2008–2015): FOS: 91 per cent; MSC: 18 per cent; Total: 1 per cent.
Source: FAO Fishstat, 2015; FOS, MSC, personal communication, 2015.

Figure 6. Certified wild catch production growth. Source: (Potts et al., 2016)

4.1.3. Aquaculture Stewardship Council (ASC)

The ASC was founded in 2010 as an outcome of the Aquaculture Dialogues lead by the WWF and Sustainable Trade Initiative (IDH). The current eight ASC farm-level standards cover 12 species groups: abalone, bivalves (clams, mussels, oyster, scallop), freshwater trout, pangasius, salmon, shrimp, tilapia, seriola and cobia. There is also a joint ASC-MSC standard for seaweed. Since its inception, ASC adoption has been quick, primarily driven by large scale producers targeting the multiple-retail chains in developed countries, particularly Europe, partly due to the robustness of the scheme and the wide scope of issues addressed.

While it is not clear whether a price premium is achieved, the volumes certified are expected to grow quickly in the near future, due to increasing retailers' demand of the certification as a part of their CSR strategies, on the one hand, and producer initiatives such as the Global Salmon Initiative

(GSI) make commitments for full certification of its members, on the other. The majority of the ASC certified production comes from developing countries in Asia and South America. However, the producers are mostly large-scale enterprises, sometimes foreign owned (e.g. Marine Harvest Chile) targeting the export sector to developed countries, which arises questions of inclusion of more vulnerable actors (Bush et al., 2013a). Europe is the largest market for ASC certified products.

By the end of 2017, an aquaculture feed standard is also expected to be released (ASC, 2017), likely in a move towards greater control of the aquaculture value chain.

4.1.4. Best Aquaculture Practices (BAP)

The BAP standards originate from the effort of the industry members of the Global Aquaculture Alliance (GAA), a trade organisation, primarily focusing on the US market. BAP has three species-specific standards farm-level (finfish and crustaceans, salmon, mussels) as well as other standards covering other links in the value chain (hatcheries, feed and processing). The certification encourages vertical integration, and hazard analysis and critical control points along the value chain, which is reflected on the logo by a number of stars assigned.

At the farm-level there are only four species groups (salmon, tilapia, shrimp/prawns, pangaisus and catfish) over which the certification is concentrated, reflecting the corporate base behind the standard (Potts et al., 2016). Similarly there is a concentrating the countries supplying BAP products, with nearly 70% of the volumes being produced in three countries (Chile, Canada and China) in 2015. BAP is the only major global certification supplying seafood from China and Canada, which points to potential first mover advantage in those countries (Potts et al., 2016).

However, its focus on the North American market can also be seen as a limitation to further growth, especially in the long term and in the context of the need for a global supply base and an increasingly intense competition with GlobalG.A.P., with whom significant overlap in countries like China and Chile exists.

4.1.5. GlobalG.A.P.

GlobalG.A.P. was established in 1997 under EUREPGAP lead by major European retailers' organisation (EUREP), as a form of insurance that the products they were supplying complied with increasingly stringent food safety requirements. It was by far the clear leader in sustainable aquaculture certification currently in terms of volume in 2015, Figure 8.

The certification is predominantly business-to-business, and until recently there was no consumer facing logo. Its rapid growth can be attributed to its stringency and wide scope covering sustainability as well as health and safety, thus ticking multiple boxes in the retailers' own strategies. Also its close relationship with retailers, a relatively mature status, and expansion in the species groups certified have contributed to its growth. The drop in 2011 can be explained by the launch of version 4 of the standard including a requirement for certification along the entire production chain. However, it quickly recovered in the following years.

By 2015, 80% of the volumes certified were salmon, with the rest distributed between pangasius, shrimp/prawns, trout, sea bream and others. Norway, Chile and the UK covered more than 75% of the certified production. Significant overlap with ASC in Norway and BAP in Chile is apparent from analysis of farm-level certifications (Section 5.3).

Recent initiative has been the launch of a consumer label (GGN) and an online portal containing information about the individual producers, in an effort to differentiate from other certificates by adding a layer of "personality" to the product, which seems increasingly important in globalised food supply: "We want an end consumer to be able to reconstruct how a trout grows up in Turkey and how it grows up in Norway. Or what traditional aquaculture in Thailand has in common with modern fish farming in England" (http://www.globalgap.org/uk_en/media-events/news/articles/Aquaculture-with-GGN-GLOBALG.A.P.-Introduces-the-Consumer-Label-at-Seafood-Expo-Global-2016/).

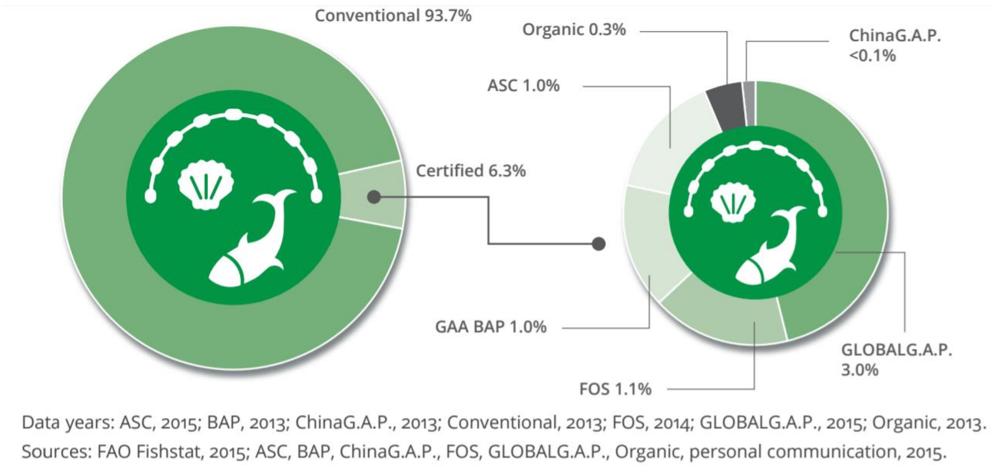
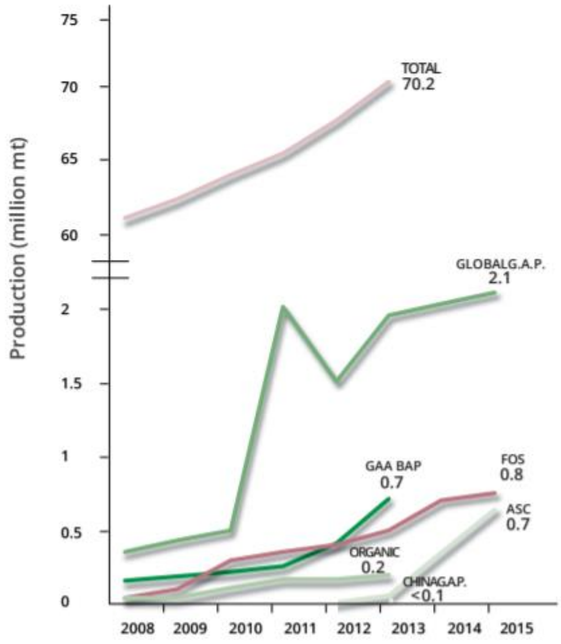
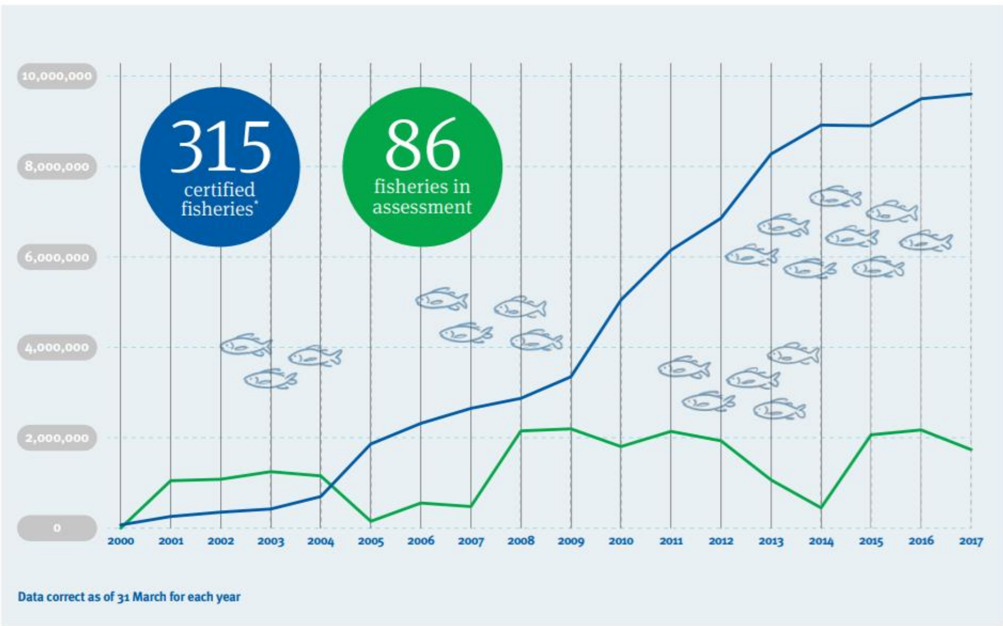


Figure 7. Certified vs conventional aquaculture production. Source: Potts et al., (2016)



Compound annual growth rates (2008–2015): ASC: 98 per cent; BAP: 35 per cent; FOS: 47 per cent; GLOBALG.A.P.: 29 per cent; Organic: 35 per cent; Total: 6 per cent. Sources: FAO Fishstat, 2015; ASC, BAP, ChinaG.A.P., FiBL, FOS, GLOBALG.A.P., MSC, Naturland, personal communication, 2015.

Figure 8. Certified aquaculture production growth, 2008-2015. Source: Potts et al., (2016)



* Includes 17 fisheries for which MSC certification is currently suspended

Figure 9. MSC certified catch, volume (tonnes), 2000-2017. Source: MSC (2017)

5. The Global Salmon Initiative (GSI)

As a voluntary regulatory instrument, sustainability certification has become an increasingly important element of market-based governance. Whereas traditional corporate social responsibility' (CSR; AKA 'corporate philanthropy') and sustainability certification may both contribute to the same over-arching goals of improved business and brand reputation management, CSR implies company-led change, whilst third-party certification responds more directly to wider civil society and (theoretically) consumer concerns. This case-study examines the strategic co-evolution of the Global Salmon Initiative (GSI), a collective CSR initiative and the Aquaculture Stewardship Council's (ASC) Salmon Standard, a third-party audited ecolabel initiated by the World Wildlife fund (WWF).

Launched in August 2013, the GSI is a pre-competitive industry commitment toward greater transparency and cooperation for continuous improvement in the environmental and social performance of salmonid aquaculture around the world. Following a meeting of 6 Norwegian, Scottish and Chilean farmed salmon CEOs in 2012 the GSI was framed around a perceived need, and opportunity for greater dialogue, cooperation in an increasingly consolidated sector; 'to 'reach the global potential of the salmon [farming] industry'. More specifically, the GSI aims to secure greater social license and market acceptability by demonstrating industry sustainability leadership. This is achieved through regular disclosure of performance metrics against a suite of environmental and social indicators ('increased transparency'), along with positive messaging around the health-benefits of eating salmon and the [superior] performance of salmon farming on a range selected indicators (e.g. yield, feed, protein and energy conversion ratios) compared to animal protein substitutes.

To better understand the genesis of the GSI one must also examine the concurrent emergence of the ASC Salmon Standard; two 'USPs' underpinning the development of which would be instrumental in shaping the GSI. First was the 'multi-stakeholder' nature of the Salmon Aquaculture Dialogue (SAD) initiated by the WWF in 2004 to engage industry, social and environmental NGO consensus in drafting the standards. Uniquely amongst aquaculture sustainability standards, the WWF adopted the ISEAL Alliance code of good practice. Second was the WWF focus on 'metrics-based' standards, whereby as far as possible indicators are audited against quantitative performance thresholds, themselves subject to periodic revision in order to 'drive continuous-improvement'. Standards drafts were finally released for public comment in August 2010 and May 2011. The first operational version (1.0) was launched in January 2012 (prior to the GSI inception meeting) and the first farm (in Norway) certified in January 2014. Version 1.1 released in April 2017 included minor revisions.

The SAD proved to be one of the most protracted of several concurrent WWF aquaculture dialogues, each focussing on different commodity species. This was a consequence of several factors (i) the relative power of fewer, larger-producer voices in this compared to other dialogues (ii) location of much of the global salmon production base in developed-economy countries with strong civil society institutions (ii) a diverse range of environmental, social and regulatory challenges associated with the sectors global geography. For many of the largest multi-national companies this also meant a mix of overlapping and divergent sustainability issues across their global farming reach.

Consensus-building was further challenged by the WWF focus on 'metrics-based' standards; with the salmon standard containing more metrics than any other standard. The Scottish industry for example faced particular challenges with sea lice thresholds as well as the standard's intent to phase-out of open cage-culture of smolts in freshwater bodies within 5 years of the standards launch in 2012.

Strategically, the framing of the GSI mission around improved transparency and progressive improvement' provided a means for industry stakeholders to reassert themselves as sustainability leaders whilst accommodating objectives of the WWF. This includes a commitment of the membership to achieve ASC certification of all their farming operations by 2020 and the interim publication of annual 'Sustainability Reports' documenting performance against 14 groups of environmental and social indicators (Table ??). As a number of the indicators correspond directly with ASC standard in some of the most contentious areas of the SAD, they also give some indication of indication of industry progress towards their 2020 commitment. On a more immediately practicable level, data disclosure in the GSI sustainability reports and website also serves to achieve compliance against a range of ASC standards on transparency requirements such as sea lice-loads, and wild-life mortalities etc.

A further pre-completive basis for collaboration emerged during analysis. PR Company Axon[4] recruited to promote the GSI and develop its website also had a remit to 'build on-going relationships with strategic partners; environmental, consumer and industry'. Their success in helping expand membership from 6 larger founding members, many multi-nationals to encompass medium-sized companies in Chile, Australia, New Zealand and latterly Norway was also brokered on the potential of this demonstration of sustainability stewardship to support the company's medium-term expansion ambitions and associated licensing requirements. The enormous potential for growth in less exploited southern regions may in part explain the especially high level of industry participation in Chile[5].

The global scope of this systematic sustainability indicator collection exercise offers a rare opportunity for a time-series comparison of key sustainability performance metrics on a country, company and species (salmonid) basis.

The country-company matrix shown in Table 1 also provides opportunity to address the hypothesis that management systems of multi-nationals operating in two or more countries (Table ??) are likely have greater commonality than independent companies across the same jurisdictions. Thus allowing inferences to be made regarding interactions between management, regulatory and environmental factors underlying significant differences in sustainability-metric performance outcomes between these domains. Based on this context the aims of the study were as follows:

1. To attempt such company-country-species sustainability indicator comparisons following extraction and meta-analysis of the underlying GSI sustainability indicator data points

[4] http://www.axon-com.com/case_studies/improve-reputation-industry/
[5] https://www.reuters.com/article/us-chile-salmon/chiles-salmon-output-may-increase-more-than-expected-help-shares-idUSKBN19V2N0

2. To assess country-company specific progress toward the 2020 GSI ASC certification commitment, where possible assessing GSI member performance against ASC standards compliance thresholds.
3. To gain further insights into strategic decision-making based on the overlap of GSI - ASC site certification with other major standards
4. To comment on data limitations and provide suggestions for improved transparency consistent with the GSI CSR mission statement

5.1 GSI membership

As of February 2017 the GSI had 17 members with farming operations in eight countries in both northern and southern hemispheres. Chile with 9 had most members, followed by Norway with 6. Three of these members are multi-nationals farming in from 3 to 6 different countries (Table 3). The GSI also has 10 affiliate 'cooperation partners' including the WWF, FAO and major 8 feed and service-provision value-chain intermediaries.

Since 2013 membership has fluctuated from 12-18 companies, 7 companies joining and leaving between 2013[6] and 2015, 4 medium-sized companies joined in July 2017 whilst Tassal, Australia's largest salmon producer (with 10 sites ASC certified or under-assessment) joined in February 2018[7] (Table 3). Norwegian departees included two large multi-nationals; Leroy and SalMar in 2013 followed by Norway Royal Salmon, all of which remained commited to ASC certification with 20, 14, 11 sites certified or under assment as of October 2017. Leroy and SalMar citing 'resource limitations' as the reason for their departure[8]. Icelands Fjardalax withdrew all 3 sites undergoing ASC audits, whilst 3 other early-departees never commissioned any site audits. These included the Scottish Salmon Company and Scottish Sea Farms (the latter a Leroy and Salmar joint-venture) and Chile's Pacific Star which facing insolvency problems rebranded as Salmonis Austral following a 2013 aquisition and merger. These trends, especially the departure of Leroy and SalMar underly the fluctuating share of global salmon production accounted for by GSI member companies; down from >70% in 2013[9] to >50 in 2017, rising again to >55% by February 2018 (GSI 2013 & 2018).

Atlantic Salmon is farmed by the 17 current GSI members in all listed countries except New Zealand, who's single member uniquely specialises in Chinook salmon (listed under its premium brand name 'King Salmon' on the GSI website). In 2013 Grieg Seafood Canada switched it's entire production to Atlantic salmon from Pacifics (Chinook and coho) last harvested in Q3 2015. Chile has the greatest diversity with 6 of 9 companies farming Atlantic salmon, coho and/ or rainbow trout in marine cages as multi-species operations (Table 3 & Table 4 and Figure 10).

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[6] https://www.undercurrentnews.com/2015/06/05/large-norway-scotland-farmers-quietly-exit-sustainable-salmon-group/
[7] https://globalsalmoninitiative.org/en/news/
[8] http://www.intrafish.no/nyheter/744839/salmar-og-leroy-ute-av-gsi
[9] https://globalsalmoninitiative.org/en/news/global-salmon-initiative-gsi-announces-three-new-members-from-new-zealand-tasmania-and-chile/

Table 3. GSI member companies by countries of operation and species-farmed (Source: GSI sustainability reports 2013-2016).

SN	Company	Operational Countries					
		Chile	Norway	Canada	Scotland	Faeroes(DK)	Other
1	Marine Harvest	A	A	A	A	A	Ireland (A)
2	Cermaq	A,Co,R	A	A			
3	Grieg Seafood		A	A (Ch)[1]	A		
4	Empresas Aquachile SA[3]	A,Co,R					
5	Salmones Blumar SA	A					
6	Camanchacha	A					
7	Los Fiordos SA	A,Co[2],R					
8	Multiexport Foods SA	A,R[2]					
9	Ventisqueros SA	A,Co,R					
10	Bakkafrost					A	
11	Huon Aquaculture[10]						Australia (A,R)
12	New Zealand King Salmon						NewZealand (Ch)
13	Australis Seafoods	A,Co,R					
14	Bjørøya Fiskeoppdrett AS		A				
15	Midt-Norsk Havbruk AS		A				
16	Nova Sea AS		A				
17	Tassal[311]						Australia (A)
18	Pacific Star Salmon SA[12]	A, Co					
19	SalMar AS		A				
20	Norway Royal Salmon AS		A				
21	Leroy Seafood Group		A				
22	Fjarolax ehf[13]						Iceland (A)
23	Scottish Sea Farms				A		
24	The Scottish Salmon Company				A		

Key: A = Atlantic salmon, Co = Coho Salmon, Ch = Chinook salmon, R = rainbow trout)

Notes: Companies 1-13 (white) are longstanding GSI members submitting sustainability reports from 2013-2016

Companies 13-14 (green) became members since the last (2016) annual GSI sustainability reports were submitted.

Companies 17-23 (orange) are former members for which no sustainability data is collated on the GSI website

[1] Last Chinook farming harvested by Grieg Canada in 2015 & not included in sustainability indicators

[2] Species reported as farmed on company websites with no corresponding data on GSI indicators

[10] https://globalsalmoninitiative.org/en/news/global-salmon-initiative-gsi-announces-three-new-members-from-new-zealand-tasmania-and-chile/

[11] **3** Tassal was the most recent member to join the GSI in Feb 2018 https://thefishsite.com/articles/tassal-joins-sustainable-farmed-salmon-initiative

[12] Merged with Trussal to become Salmonis Austral in 2013; annual production capacity = 58,000 T WFE.
http://www.assetchile.com/case-studies-natural-resources-others/merger-of-trusal-and-pacific-star/
https://www.undercurrentnews.com/2013/11/15/pacific-star-invests-4-4m-in-two-new-salmon-farms/

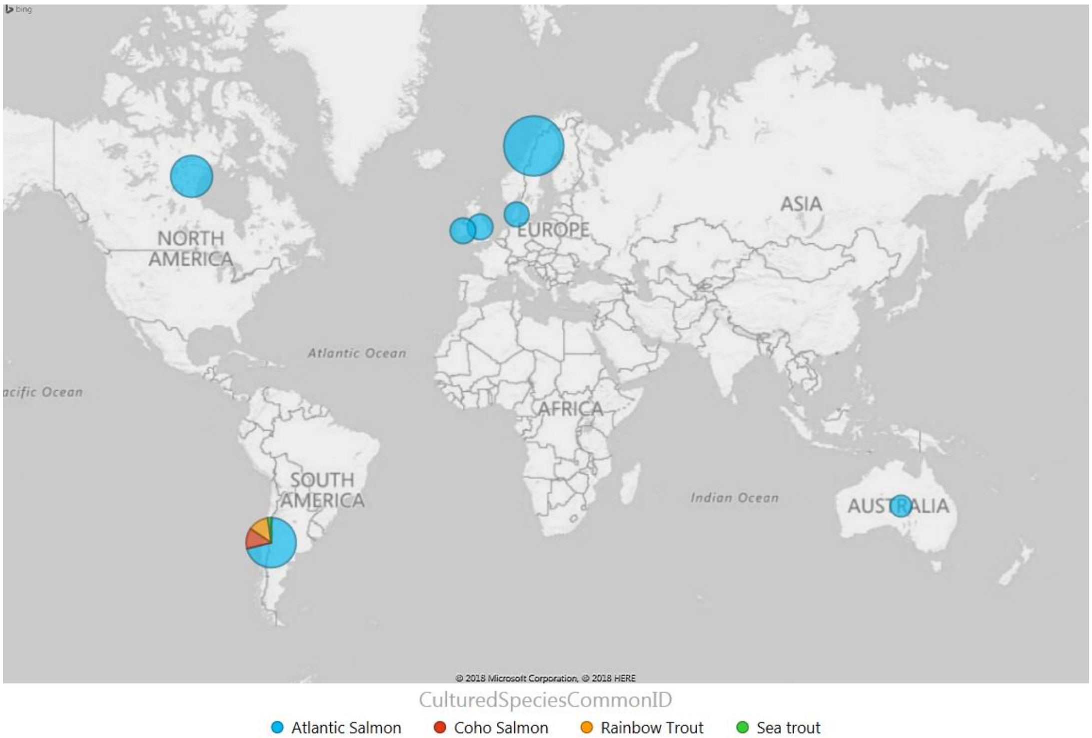
[13] https://globalsalmoninitiative.org/en/news/global-salmon-initiative-gsi-further-expands-its-global-membership-base-with-the-addition-of-fjardalax-ehf/

[3] Includes Invermar SA sites acquired by Aquachile in 2014.

Table 4. GSI companies reporting metrics by species & country 2013-2018 (Source: GSI 2018)

Country/Species	Atlantic Salmon	Chinook Salmon	Coho Salmon	Rainbow Trout	Total
Chile	8 (1)		4 (1)	5 (1)	**17 (3)**
Norway	3 (3)				**3 (3)**
Canada	3	1			**4**
Scotland	2				**2**
Faeroes	2				**2**
Ireland	1				**1**
Australia	1(1)			1	**2(1)**
New Zealand		1			**1**
Total	**20 (5)**	**2**	**4 (1)**	**6 (1)**	**32 (7)**

Note: Bracketed numbers are GSI members joining post 2016 with, as yet no collated GSI sustainability indicator data



Note: one GSI member; New Zealand King Salmon (coho) currently has no ASC certified sites

Figure 10. Map showing numbers of GSI member sites, under assessment or with ASC certification, by production species as of Oct 2017 (Source: GSI 2017 and ASC 2018).

5.2 GSI sustainability reports, performance indicators & data limitations

Twelve of the 17 current GSI members have each submitted four annual sustainability reports covering the years 2014 to 2016. Five recent members (Table 3) still to submit their first reports are included in an analysis of certifiaction trends (Section 0) but excluded from the GSI indicator performance analysis (Section 0).

Sustainability reports are posted on individual GSI member websites as interactive pages or downloadable pdfs. Data on selected environmental and social indicators is then systematically compiled in a database accessed via an interactive GSI website 'dashboard'[14]. Users can retrieve annual or monthly data-points based on indicator, company and country selection criteria. Only data on 'fish escape' numbers is differentiated between fresh and seawater production phases (though not always associated causal factors or mitigation strategies which must then be inferred from qualitative descriptions[15]). Similarly data are wholy or only partially differentiated by salmonid production species on 4 environmental indicators by multi-species operations in Chile (Table 3).

On the dashboard, indicators are grouped into 9 sets of environmental and 5 sets of social indicators based on impact categories. These incorporate a total of 21 seperate indicators; 14 environmental and 7 social; 1-3 per impact group (Table 8). Two indicators; 9 (Certification and Environmental Licences) and 13 (R&D investment) are not systematically compiled, instead users are routed from the dashboard to company websites. Several have 'mirror' sustainability dashboards (e.g. Huon[16]), but many require users to search for data on these indicators embedded across website pages or in downloadable reports.

GSI metrics are presented as annualised means, (net) totals, or treatment-frequencies; with varying degrees of data-normalisation i.e. with respect to site biomass, stock number, number of cages/ sites etc. Data on escapes and antibiotic-use are particularly deficient in this respect. We infer that sustainability indicators summarise performance across entire company-country sectors i.e. including ASC certified and non-certified sites, although this not-explicit and the GSI site provides no relevant information e.g. on member site numbers or their production capacity.

Data is compiled as monthly means for the only metric with any graphical interface; sea-lice counts consistent with the ASC load thresholds on farmed animals during sensitive periods for wild-salmonid migration. Data is presented on a case-by-case basis for indicators associated with irregular events e.g. fish escapes, fines for environmental/ labour standards infringements.

Clearly, trade-offs must also be made between long-term consistency of approach and indicator refinements. Although there has been some evolution of more qualitative social indicators, the core quantitiative indicators have remained unchanged over 4 years of data compilation.

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[14] http://globalsalmoninitiative.org/sustainability-report/sustainability-indicators/

[15] Although certification under the ASC 'Salmon' is limited to marine production, in the absence of a separate hatchery/nursery standard, certified sites must also ensure their FW smolt supply stages also comply with an abridged list of ASC sustainability indicators.

[16] https://dashboard.huonaqua.com.au/

5.3 GSI sustainability indicator selection criteria

Whilst the GSI offers no explicit justification for selection of indivual indicators; two key areas of environmental focus are emphasised (i) improved biosecurity management, especially with respect to sea lice impacts (ii) sustainable sourcing of feed ingredients in a context of growing demand (more pragmatically, several indicators also directly meet ASC indicator requirements for public disclosure).

Consitent with the GSI strategic social licence objective, we limit our in-depth focus to indicators dealing with arguably the most contentious environmental impact areas challenging the global marine salmonid industry. For example Monteray Bay Aquarium's influential consumer guide 'Seafood Watch' on its webite, advises avoidance (i.e. 'red-lists') most net-cage farmed Atlantic salmon from Chile, Norway, Scotland and Canada (with exception of a limited number of brands and regions). Indicators with recurrent 'red' scoring include 'escapes' and the inter-linked issues of 'disease' and 'chemical use' (Table 5). These criteria correspond directly with GSI indicators on escapes (escapes), sea-lice counts (disease) and antibiotic-use and sea lice treatments (chemicals). Although only yellow-listed by Seafood Watch, two other corresponding GSI indicator sets are included as highly media-sensitive topics; wildlife interactions (mortalities) and use of marine feed ingredients. This selection also includes all GSI indicators with corresponding ASC metric thresholds, also allowing inferences to be drawn regarding company certification performance.

Table 5. Monteray Bay Aquarium 'Seafood Watch'sustainability criteria scores and consumer guidance for salmon farmed in marine net-pen (Source: Seafood Watch 2018[17]).

Species/ Country/ Criterion	Atlantic Salmon				Chinook
	Chile[1]	Norway[2]	Canada[3]	Scotland[4]	New Zealand[5]
1. Data	6.36	7.50	7.22	7.27	9.20
2. Effluent	5.00	4.00	5.00	5.00	8.00
3. Habitat	5.87	6.27	5.72	6.27	7.73
4. Chemicals	0.00	2.00	1.00	1.00	10.00
5. Feed	4.70	4.86	6.59	3.58	4.96
6. Escapes	4.00	1.00	2.00	2.00	10.00
7. Disease	4.00	1.00	3.00	1.00	8.00
8. Source	-0.00	-0.00	-0.00[6]	-0.00	10.00
9. Wildlife mortalities	4.00	-4.00	-5.00	-4.00	-6.00
10. Escapes (other Spp.)	-0.40	-4.00	-0.20	-3.60	-0.80
Overall Score	**3.65**	**2.66**	**4.42**	**2.65**	**7.63**

Note: Green = Best, Yellow = Good, Red = Avoid

For indicators 1-7 higher scores indicate greater impact & for indicators 8-10 more negative scores indicate higher impact

[1] Excluding 2 brands: 'Sixty South' (Nova Austral) & 'Verlasso' (AquaChile-Dupont), both given yellow status

[2] Excluding 1 brand: 'Blue Circle Foods' (Kvarøy and Selsøyvik farms) and Salten Aqua Group farms, given yellow status

[3] Excluding farms in British Colombia, given yellow status

[4] Excluding farms in Orkney Islands, given yellow status

[17] https://www.seafoodwatch.org/seafood-recommendations/groups/salmon?o=1064582210

[5] Scores relate exclusively to GSI member New Zealand King Salmon

6 Interpolated as -0.00 from an off-scale 10.00 on website

5.4 Analytical approach

The GSI database provides systematic performance data for twelve long-term GSI companies on eight countries were assessed on 8 environmental and 3 social indicator groups (Table 8; Indicators SN 1-8 and 10-12). The analysis presented in this report was limited to 7 sub-indicators with directly corresponding ASC indicators with defined compliance thresholds (Table 8).

Data covering four sustainability report years, from 2013-2016 was extracted from the GSI website 'dashboard' and compiled in a relational database (ACCESS 2010: Appendix 2) for analysis using embedded query, pivot-chart and pivot-table functionalities. Due to resource limitations, data was compiled for only 2 years; 2013 and 2014 for the four following sub-indicators: 1.2 Escape causes, 9 Social compliance, 10 Occupational health and safety, 11 Community Interactions - and 3 years; 2013 to 2015 for one sub-indicator: 4 Sea-lice counts. Several qualitative indicators e.g. describing management methods or corrective actions, were subject to further classification and re-coding prior to analysis.

Additional data was extracted from an online ASC audit registry[18] for all companies with sites certified under the ASC marine salmonid ('Salmon') standard and compiled in a linked ACCESS database (Appendix 2). Audit data included; certification status (initial/ current/ expired/ withdrawn & associated dates), site location (country & GPS coordinates), production data (species cultured, system type – and where available site production capacity).

Site-level audit data was also used to estimate total farmed output corresponding with different certification categories for GSI and 'non-GSI' member companies. Output was calculated as (i) the maximum annual output recorded across individual audits (available for 157 of 268 sites) and, in absence of this data as (ii) as 77% of maximum site biomass capacity with the correction factor estimated from output data of the previously mentioned 157 sites (23 sites). For the remaining sites output was imputed from (iii) company-country (25 sites) or (iv) country maximum-output averages (28 sites). Finally company level annual production data from 2013 to 2016 (Kontali) was also compiled in order estimate national sectoral outputs in order to compare and profile certification trends against global production.

As far as possible any company merger and acquisitions over the 2013-2014 period were also accounted for in the analysis (e.g. Aquachile acquired Invermar 2014 which trades under its own name and has its own ASC certified sites; accounting for AquaChile includes both companies).

Finally data on the geographic distribution of 3 other dominant aquaculture certification schemes; GAA-BAP, GlobalGAP and FoS (Section 2, Appendix 2) compiled in the same ACCESS data base, was used to gain further comparative insight into to the potential strategic advantage of ASC certification and GSI membership.

[18] https://www.asc-aqua.org/what-you-can-do/take-action/find-a-supplier/

5.5 GSI member and non-member progress toward ASC certification

As of Oct 2017, 134 marine net-cage salmonid farms operated by GSI members had achieved on-going ASC certification, with 38 more still under assessment (ASC 2017: Figure 11 and Figure 12), whilst 67% of a total of 201 sites certified under the ASC salmon standard in October 2018, were operated by GSI members (Figure 18). This total excludes 16 sites with expired or withdrawn certification, only 4 of which are operated by current GSI members (2 by Chilean companies; Camanchacha and Multiexport Foods and 2 by Australia's Tassal).

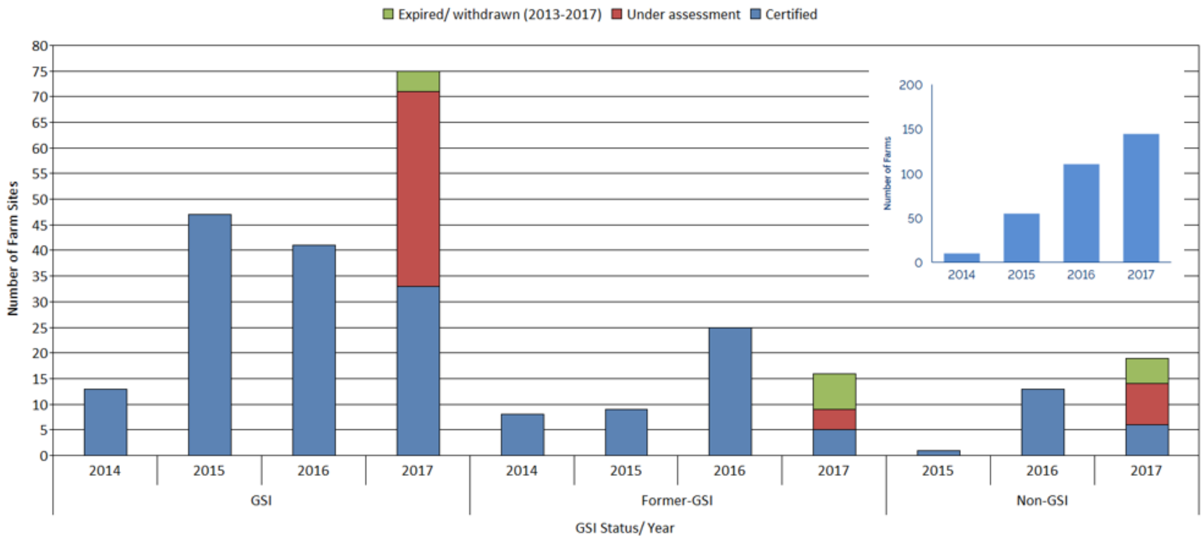

Figure 11. Number of farms audited against the ASC 'Salmon' standard by GSI membership, certification status and year (Source: ASC 2017). Inset: cumulative number of GSI member sites with ASC certification 2014-2017 (Source: GSI 2017)

Figure 12, Figure 13 and Figure 15 show the geographic distribution of GSI member certified sites to be broadly consistent with global production trends; Norway leading with 60 sites, followed by Chile with 34 and Canada with 22. The UK trails with only 2 certified sites (with four more under assessment) for reasons discussed in Section 5. Norway also has the lowest proportion of it's ASC certified sites operated by GSI members (55%), largely due to the withdrawal of SalMar and Leroy, its 3rd and 4th ranked producers by output in 2016 (Section 0).

Chile has the highest share of ASC certified production output farmed by GSI members; 81% of 147,339T whilst in Norway the corresponding figures were 58% and 444,863T. Based on our output estimates , 6 GSI companies; Marine Harvest, Cermaq, Bakkafrost, Los Fiordos and MultiExport Foods and Tassal (Figure 16) are close to achieving the 2020 commitment i.e. excluding any future growth.

By October 2017, we estimate that 'GSI-sites' accounted for 68% (523,695t WFE) of a total of 772,379T of ASC certified marine salmonid output globally. These figures respectively correspond to 20% and 30% of global production in 2016 (2,596,700T). In turn the total GSI certified output corresponds to 48% of the total 1,091,824T harvested by the 17 current members in 2016 (Table 6).

The sustained growth in GSI site certification over its first 5years (Figure 11) demonstrates good progress toward the 2020 GSI commitment of 100% site certification. However our estimates also

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indicate that approximately 568,129T of GSI member production capacity remains to be certified over the next 3 years, at the same time global production continues to expand. Furthermore it seems reasonable to assume that sites with the least intractable compliance issues will have been the first to be certified.

Perhaps, most challenging in terms of wider collective reputational benefit may be (i) the slower growth in non-GSI site certification and their greater propensity for de-certification. This amounted to 18% of non-GSI certified sites up to Oct 2017, compared to 3% of GSI sites – and (ii) free-riding effects of companies with no capacity and/ or intent to become certified. Conversely, arguably greatest scope for growth exists amongst the GSI membership as a consequence of its mix of (i) larger nationals and multinationals with capacity to acquire smaller operators as the industry continues to consolidate (ii) success in enlisting membership in jurisdictions with greatest potential for short term organic growth, most notably southern Chile.

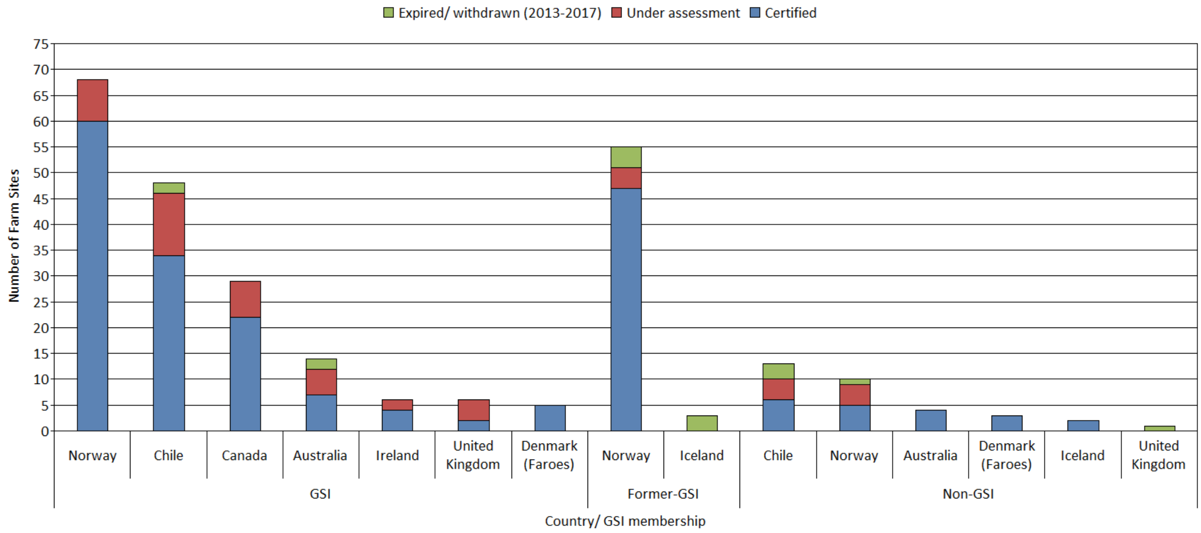

Figure 12. Country-wise distribution of ASC certified marine salmonid cage sites by GSI membership and certification status as of Oct 2017 (Source: ASC 2017, GSI 2017)

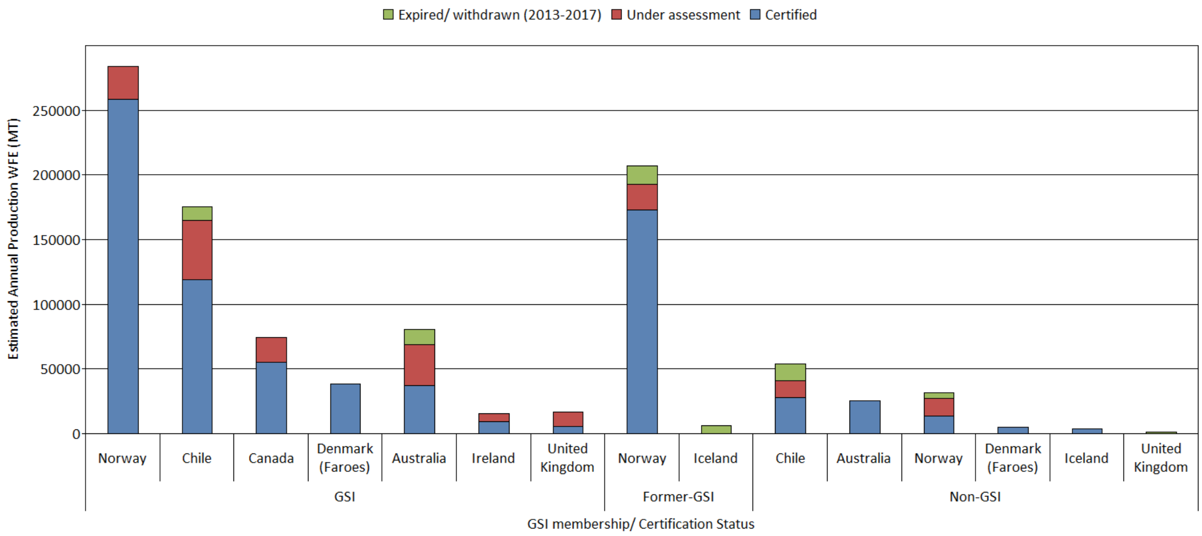

Figure 13. Estimated total annual output (WFE) of ASC certified marine salmonid cage sites by GSI membership, country and certification status as of Oct 2017 (Source: ASC 2017, GSI 2017)

Table 6. Global marine salmonid output by country and 11 GSI companies in 2016 T WFE (Source: Kontali 2017 & indicated company websites)

Farmed	Total	Norway	Chile	North America	UK	Faeroe Islands	Australia & N Zealand	Others
By Species								
Atlantic Salmon	2,166,100	1,171,200	504,500	168,500	157,400	77,300	50,900	36,300
Large Trout	280,800	84,500	74,200	2,500	4,700	0	4,000	110,900
Coho	130,800	0	119,800	1,000	0	0	0	10,000
Chinook	19,000	0	300	2,500	0	0	6,300	16,200
Total	**2,596,700**	**1,255,700**	**698,800**	**174,500**	**162,100**	**77,300**	**61,200**	**173,400**
By GSI Company								**Ireland**
Marine Harvest	423,000	262,200	41,000	48,200	50,100	12,100	0	9,400
Cermaq	135,500	64,500	0	48,000	23,000	0	0	0
Grieg Seafood	71,900	45,000	0	11,900	15,000	0	0	0
AquaChile	81,616	0	81,616	0	0	0	0	0
Multiexport Foods	60,900	0	60,900	0	0	0	0	0
Los Fiordos	60,708	0	60,708	0	0	0	0	0
Australis Seafoods	53,700	0	53,700	0	0	0	0	0
Bakkafrost	52,800	0	0	0	0	52,800	0	0
Camanchacha	32,600	0	32,600	0	0	0	0	0
Nova Sea	41,200	41,200	0	0	0	0	0	0
Tassal	25,000	0	0	0	0	0	25,000	0
Ventisqueros	21,000	0	21,000	0	0	0	0	0
Huon	17,552	0	0	0	0	0	17,552[19]	0
Invermar	15,000	0	15,000	0	0	0	0	0
Midt-Norsk Havbruk	9,900	9,900	0	0	0	0	0	0
Bjoroya	9,300	9,300	0	0	0	0	0	0
NZ King Salmon	6,300	0	0	0	0	0	6,300[20]	0
GSI Total	**1,117,976**	**432,100**	**366,524**	**108,100**	**88,100**	**64,900**	**48,852**	**9,400**
GSI % Global Output	**43%**	**34%**	**52%**	**62%**	**54%**	**84%**	**80%**	**(5%)**
GSI-ASC avg site T[1]	**3,908**	**4,311**	**3,505**	**2,517**	**2,825**	**7,632**	**5,304**	**2,394**
Max Site T	11,882	8,108	6,000	5,373	4,200	11,882	5,980	3,127
Min Site T	385	979	847	498	1,450	4,350	1,245	385
Site Std Deviation	1,983	1,998	1,036	1,178	1,945	3,246	1,790	1,340

[1] Mean Max site output of sites 2013-2016 of ASC certified to Oct 2017; est. from farm audit data (ASC 2017)

[19] http://investors.huonaqua.com.au/FormBuilder/_Resource/_module/y8hXOlgfx0a4WjSUgjZk7A/docs/Reports/Annual/2017/HTML1/key_financials.htm

[20] https://www.kingsalmon.co.nz/kingsalmon/wp-content/uploads/2016/10/3309_NZKS_PDS_v26-no-forms.pdf

The capacity of ASC certified sites, estimated as the mean maximum annual output from 2013 to 2016 ranged from 7,632T-5304T in the Faroes and Australia to 4,311-3,505T in Norway and Chile and 2,825-2,394T in the UK, Canada and Ireland (Table 6, Figure 14). The Faroes' Bakkafrost and multi-nationals Marine Harvest and Cermaq have the largest individual certified sites with outputs ranging from 11,882-8,108T over the same period. The mean capacity of certified GSI sites also declined steadily from 5,538T in 2014 to 3,460T in 2017, with sites under-assessment in 2017 averaging 3,661T (skewed by a single Houn site with an estimated annual output of 7,775T).

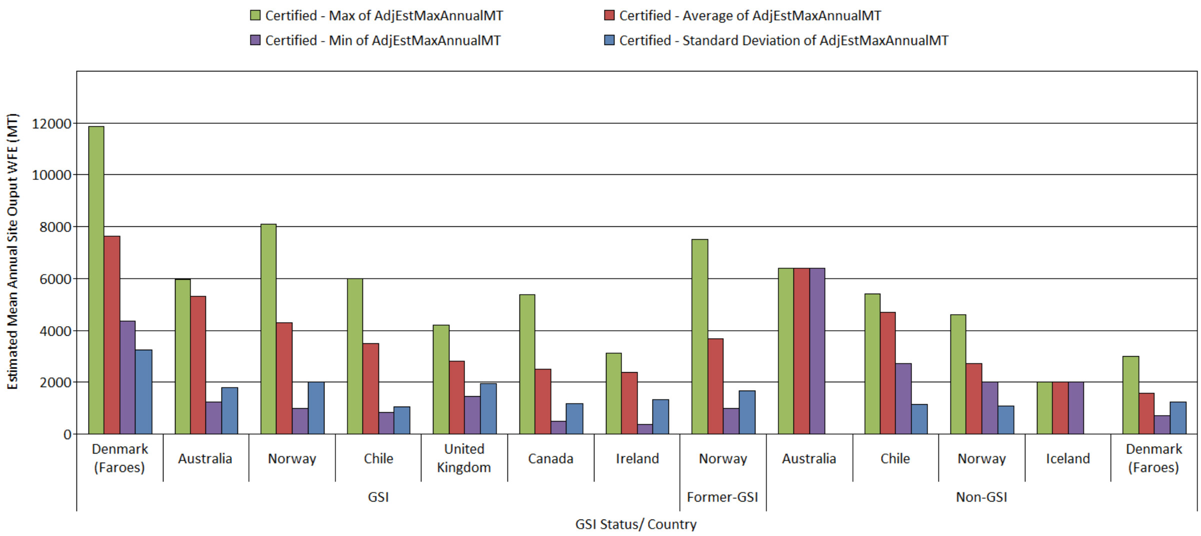

Figure 14. Mean estimated max production output of certified ASC production sites by GSI status and country 2016 (ASC 2017)

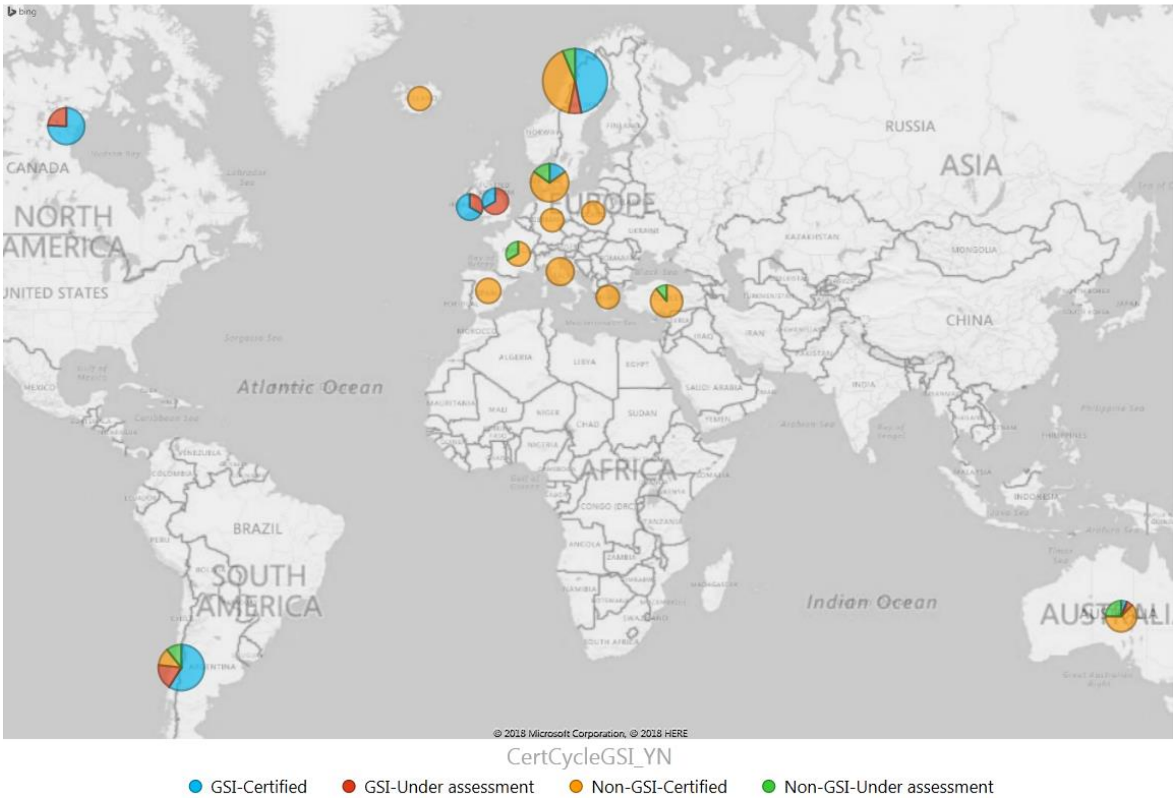

Figure 15. Country-wise distribution of ASC certified marine salmonid cage sites by GSI membership and certification status, as of Oct 2017 (Source: ASC 2017, GSI 2017)

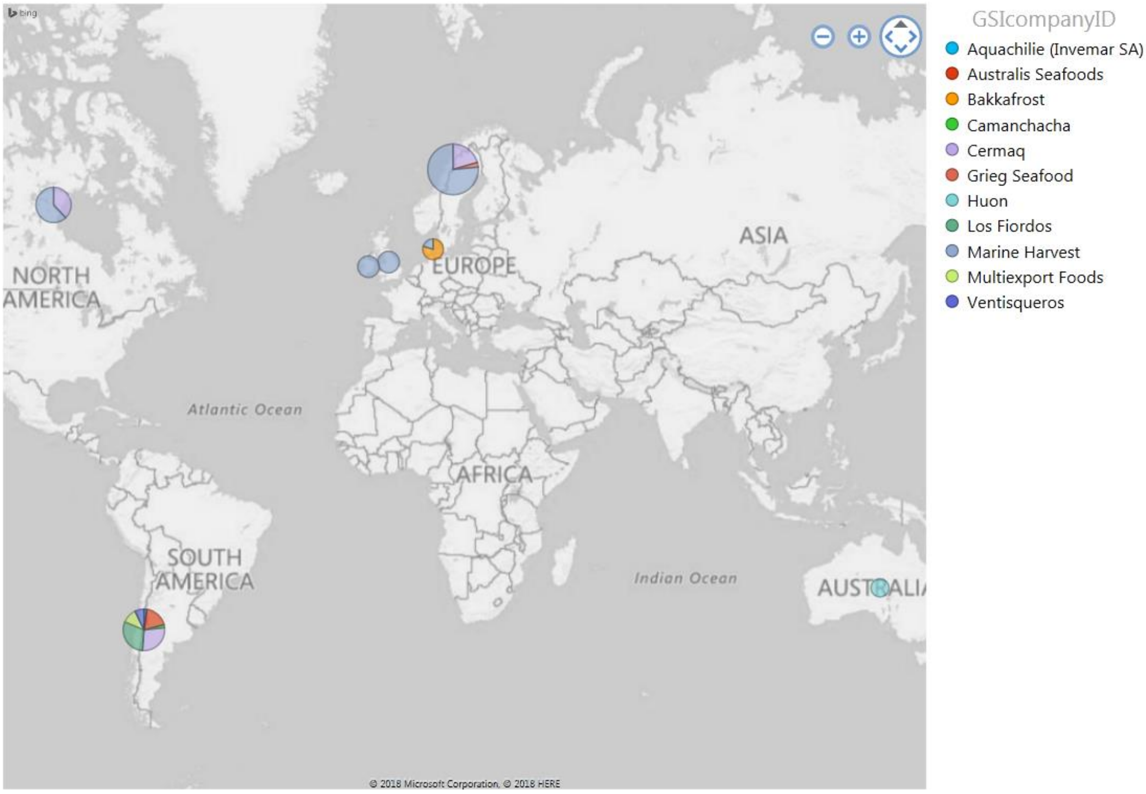

Figure 16. Country-wise distribution of GSI member ASC certified marine salmonid cage sites by company and certification status, as of Oct 2017 (Source: ASC 2017, GSI 2017)

5.6 Global distribution of GSI-ASC, other certification schemes & strategic implications

Theoretically the geographic distribution and overlap between alternative certification schemes can be attributed to (i) proximity to and ability to supply demand in certification-centric markets (ii) more local reputational considerations responding to regulatory and advocacy group pressures (iii) location and industry-specific challenges in meeting scheme-specific compliance requirements (note this also assumes that opportunities for premium-pricing are a subordinate factor for reasons discussed in Section 3). In this section we evaluate the first 2 attributes in terms of company strategic positioning, whilst the influence of differences and inconsistencies between scheme compliance requirements for selected environmental indicators are considered in Section 0.

Figure 17, Figure 18, Figure 19 and Figure 20 map the global distribution of value-chain entities involved in production of four major finfish commodity groups; marine and freshwater salmonids (salmon and trout), sea-bass/ sea bream and pangasius[21], certified under the four major aquaculture schemes; GlobalGAP, GAA-BAP, ASC and FoS (Section 4). Whilst ASC currently only offer farm-level certification (a feed standard is being launched), each of the other schemes offer 'integrated' standards variously covering input suppliers (hatchery/ nurseries, feed-mills) and processors (food and pharma); Figure 18. Some 44% (269) of all 786 mapped BAP certified entities fall into such non-grow-out farm categories, whilst the 'integrated farm-standard' approach of GlobalGAP (covering 336 entities including 33 bearing the FoS logo; see below) and FoS (83 entities), results in species-specific grow-out and non-grow out entities belonging to individual companies being combined in a single certificate. GlobalGAP and FoS[22] also incorporate compliance requirements for all farmed species including salmonids into a single 'integrated farm assurance standard', whilst ASC and BAP have developed a dedicated marine salmonid farming standard under which the first farms were certified in in 2011 and 2014 respectively.

Although, the ASC 'salmon' standard (covering production of all salmonids in marine net cages and pens) also incorporates detailed requirements for sustainable smolt production and feed ingredients, it effectively falls to the marine farmer to ensure their third-party compliance unless inputs are sourced from suppliers certified under other standards with recognised equivalence. Arguably this feature in itself increases compliance challenges for ASC versus 'integrated-schemes' (Section 0).

Figure 17 to Figure 20 clearly demonstrate the broader market segmentation of different schemes; consistent with their regional genesis and stakeholder involvement in historic standard-setting efforts. Thus, BAP dominates marine salmonid certification in the Americas having become a requisite B2C standard for continued access to large segments of the US market. Conversely it has negligible presence in Northern European market where GlobalGAP dominates with its B2B standard and emerging B2C labels (starting with an option to incorporate an FoS B2C label under defined

[21] Tilapia a 5th finfish commodity group with strong certification demand is beyond the scope of this study.
[22] Consequently both GlobalGAP and FoS lack site-specific resolution e.g. GlobalGAP lists 367 certified national companies farming marine salmonids globally, though the exact number of sites associated can not be reliably determined from their online database.

certification equivalence conditions, prior to developing its own 'GGN' Chain of Custody number as a consumer label); Figure 19. The ASC certified salmonid sites exhibit the broadest distribution, consistent with the WWF (a highly devolved global e-NGO) lead-facilitation role in stakeholder 'dialogues' that were the precursor to the ASC salmon (& other species) standards. Nevertheless with just 46 sites certified or under-audit in Chile as of October 2017, ASC lags along way behind BAP with 330 certified entities including 245 cage grow-out sites. Although BAP clearly enjoys some first mover advantage[23], the scale of this differential in a context of high GSI member and sector commitment to ASC certification (Section 0, Table 6) also appears indicative of standard specific-challenges in complying with certain requirements of the ASC standard (Section 0). A similar differential exists in Canada with 29 ASC and 155 BAP certified sites; though against of a lower sectoral GSI commitment.

Using data in ASC audit reports, Figure 21 shows the extent to which sites certified under the ASC Salmon Standard have also achieved multi-certification under GlobalGAP and/ or BAP standards. Results are broadly consistent with the above observations i.e. almost all ASC sites share GlobalGAP certification in Norway whilst BAP overlap is limited to Chile (16% of all ASC sites) and Canada (20% of ASC sites); in both cases all GSI member operated. The surprisingly low overlap level in Chile and Canada given the extensive BAP presence there, may be in part due to selective reporting in ASC audits; there is no stipulation for CABs to report this information. However, Figure 17 (inset) indicates a degree of geographic seperation in Chile; BAP achieving almost blanket coverage of sites in the longer established and denser farming concentrations in Regions X and X1; including many smaller sites in smaller sheltered channels. Whilst ASC also has certified sites in the both these regions (mainly in larger channels closer to the mainland) it, exclusively has also certified 13 sites (operated by Cermaq, Nova Austral and Australis Mar) in the pristine and isolated Antartic Magallanes Region XII (BAP and GlobalGAP certification is limited to 3 processors and smolt-producers in the region).

This might be taken as evidence of a social license strategy in support of contested site-licensing requirements for organic growth i.e. with 8 of the 13 Region XII ASC sites being operated by GSI member Cermaq. The most southerly site, the first in the pristine Magellan Strait, operated by Nova Austral and owned by GSI 'cooperation partner' EWOS (a multi-national feed company) has four more sites were under initial ASC audit (the company is also one of only 2 in Chile to achieve Monteray bay yellow-status; Section 0). In 2015 GSI multi-national, Marine Harvest Chile operated 22 fresh water and 53 sea water sites supplying its 4 processing plants; although 21 of the marine sites had achieved BAP certification, non had achieved ASC certification or were under assessment as of October 2017. Significant losses due to infectious salmon anamia in its core operations-base in region X (Los Lagos) has prompted the company sell some of its sites with a view to relocating further south to Region XI (Aisén) [24] i.e. also consistent with the above hypothesis. Similarly GSI member NZ King Salmon which has 9 BAP certified marine farm sites has also yet to achieve any ASC certification; likely due to standard-specific compliances challenges discussed below.

[23] The first BAP finfish standards were launched in 2002 prior to a specialised salmon standard being launched in 2011. http://www.worldfishing.net/news101/industry-news/first-salmon-farm-earns-bap-certification
[24] https://en.wikipedia.org/wiki/Marine_Harvest, Annual Results 2015"

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 635761

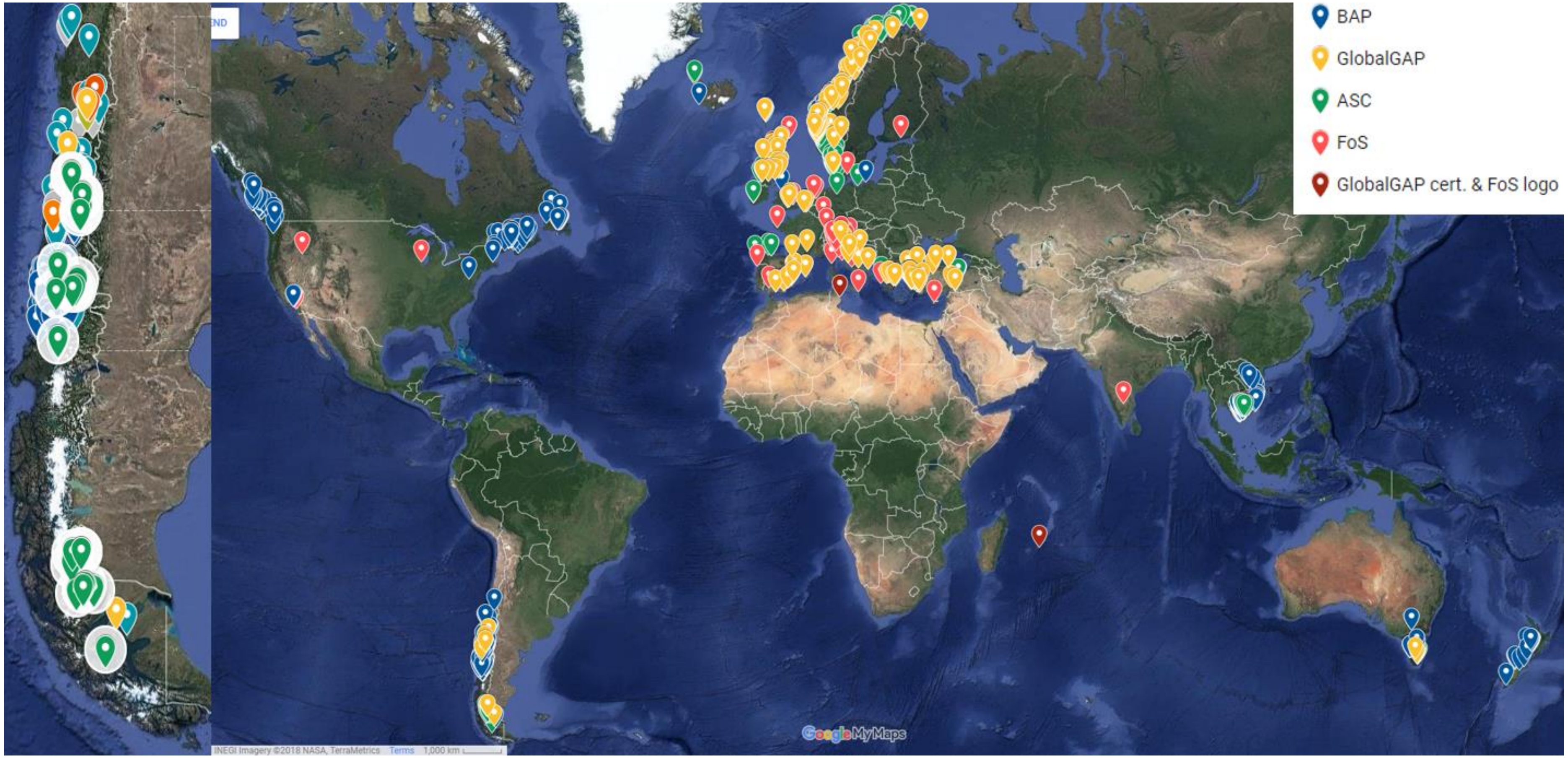

Figure 17. Global distribution of individual certified aquaculture production entities by standard body as of Oct 2017: certified entities include farms, hatcheries/nurseries, feedmills, processing plants and pharma units (n = 1,383; Source: BAP, ASC, GlobalGAP, FoS websites). Inset left; Chile enlarged with ASC farm-sites highlighted in green

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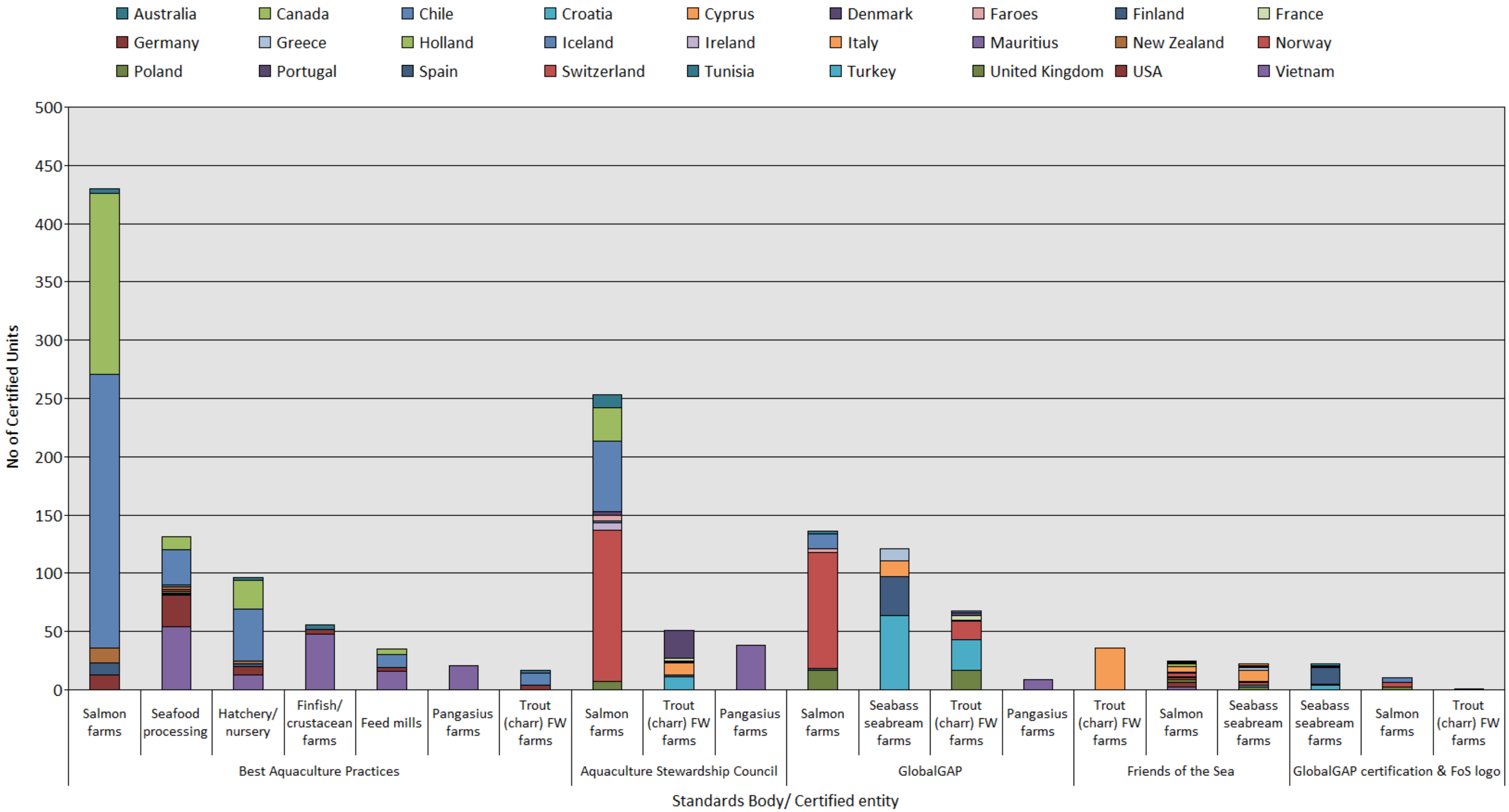

Figure 18. Distribution of certified aquaculture production entities by standard body, species/ value chain position and country as of Dec 2017 (n= 1,578, Source: BAP, ASC, GlobalGAP, FoS websites)

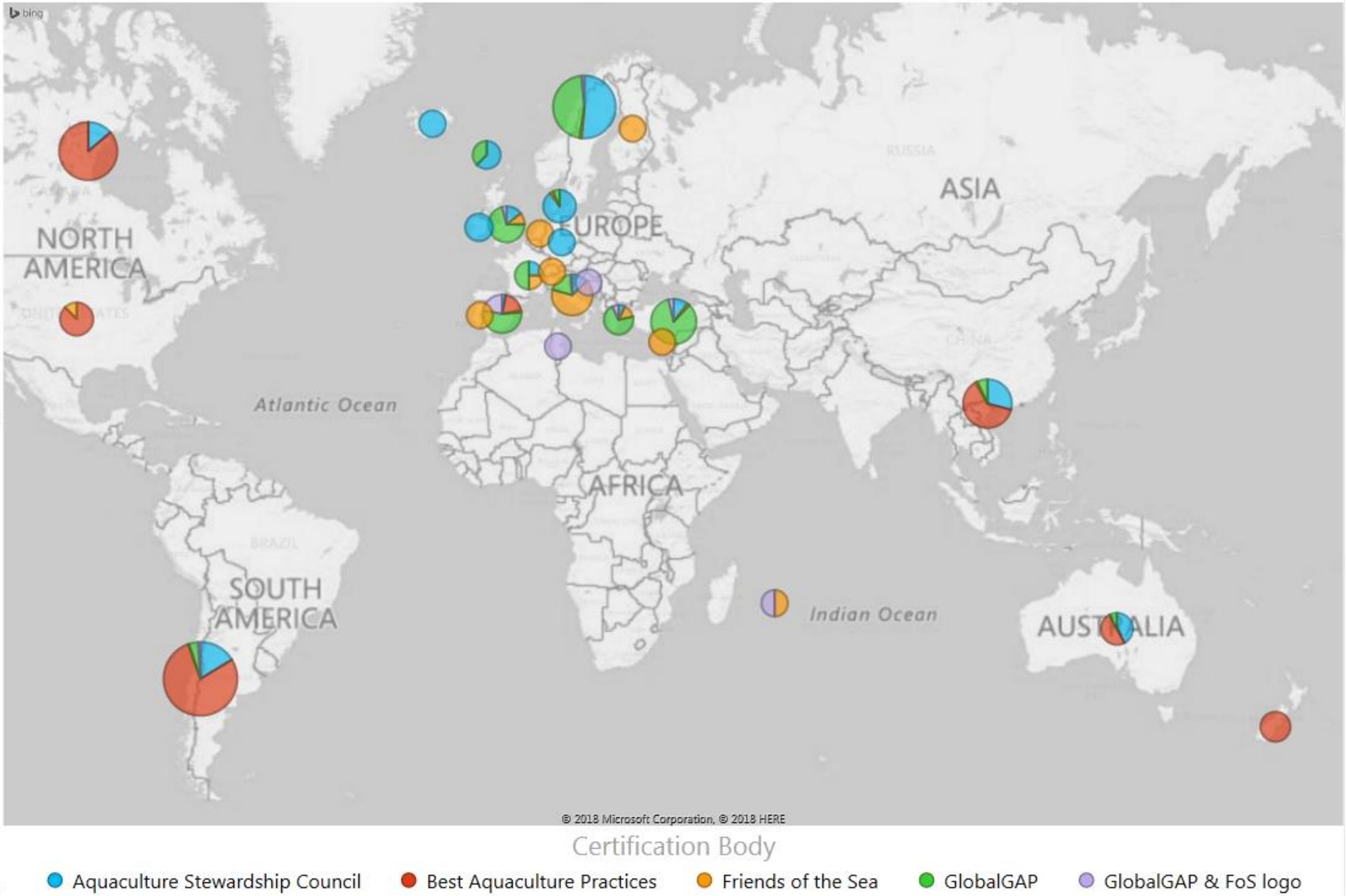

Figure 19. Global distribution of certified aquaculture farms by standard body as of Oct 2017[25] (Source: BAP, ASC, GlobalGAP, FoS websites)

[25] **Note:** Pie-chart totals do not allow for overlap between farms certified under multiple schemes.

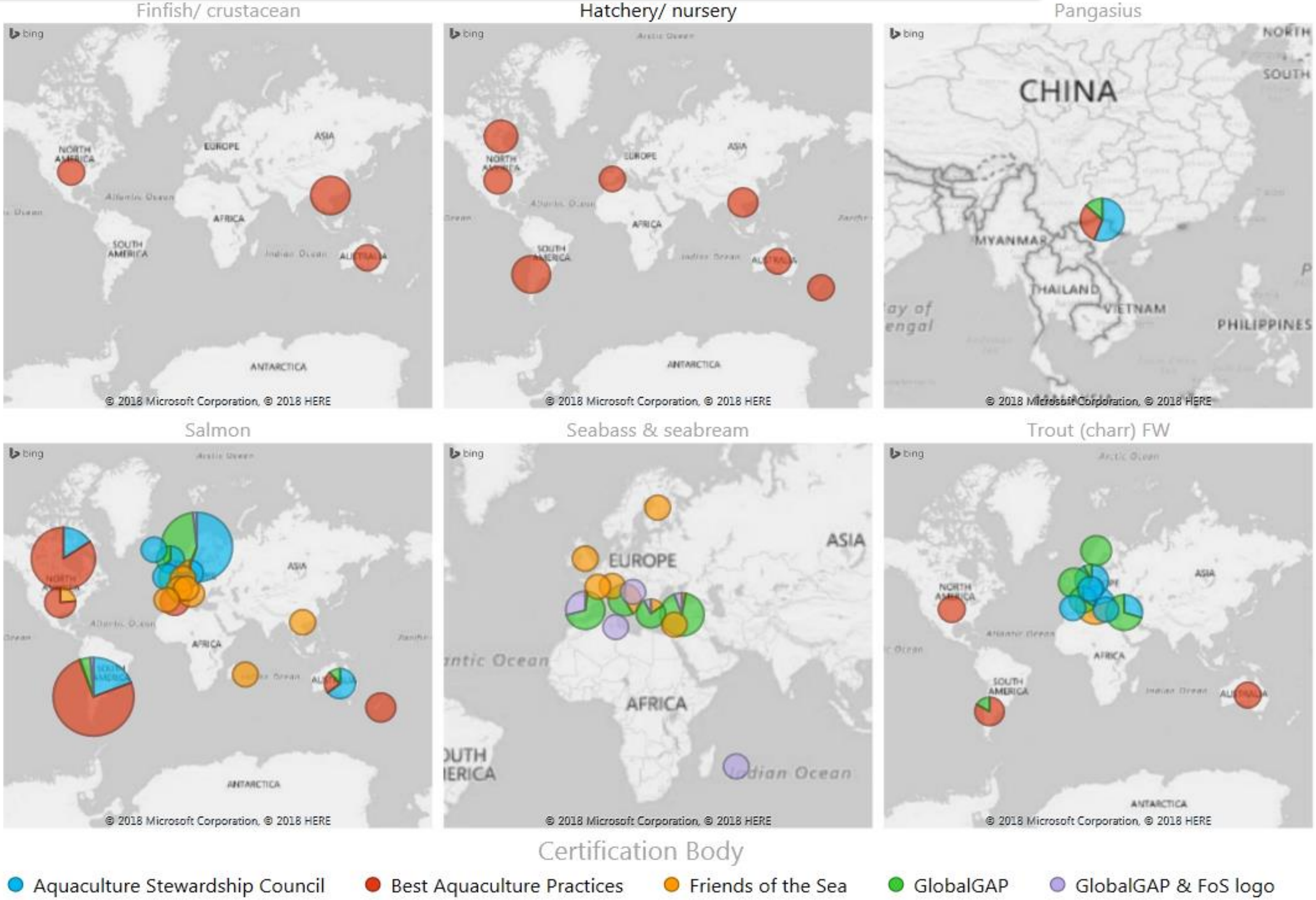

Figure 20. Global distribution of certified aquaculture farms by spp. group & standard body as of Oct 2017 (Source: BAP, ASC, GlobalGAP, FoS websites)

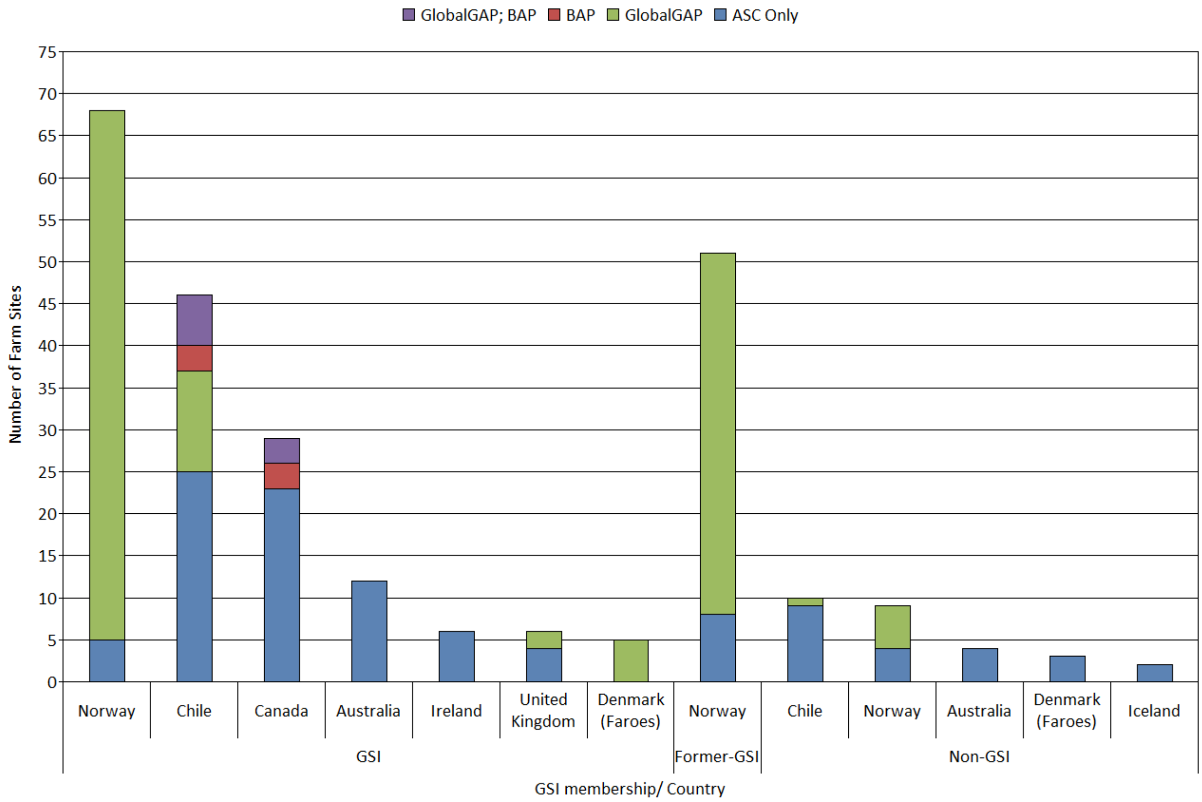

Figure 21. Frequency of secondary sustainability-certification under alternative schemes, for GSI member and non-member company ASC certified sites, Oct 2017 (Sources: GSI 2017, ASC 2017).

5.7 Company-country-species performance on GSI Indicators

In this section we evaluate the performance of 12 GSI founder members on five selected environmental indicators (Section 0) over four years of sustainability reporting, 2013-2016. Results are compared against ASC compliance thresholds on these indicators and where feasible those of alternative aquaculture standards schemes. Complementarities and inconsistencies between the different schemes are highlighted and inferences drawn for company strategic-decision making around certification choices. A summary of all GSI performance indicators and their equivalent ASC salmon standard compliance criteria are presented in Table 8.

Of the four major Aquaculture standards ASC and BAP can be considered 'metrics based' i.e. where possible setting indicators that can audited against quantitative performance thresholds. The ASC standard has arguably gone furthest down this route, seeking to differentiate itself from other standards on this and its ISEAL compliant stakeholder engagement approach (Section 4.1). Furthermore the ASC Salmon standard has highest number of such metrics of all it's species standards consistent with highly consolidated nature of the sector & a continuous improvement ethos. The underlying approach of GlobalGAP and friends of the sea is to base compliance on conformity against other normative or third-party standards and local regulations.

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research and innovation program
under grant agreement No 635761

For example all the schemes make reference to sourcing of marine feed ingredients from fisheries certified under MSC or IFFO (Marine Ingredients Organisation) Responsible Sourcing (RS) standards or, given supply limitations, interim fisheries sustainable management assessment schemes, notably the Sustainable Fisheries Partnership's (SFP) 'Fish Source' scoring system. However only ASC and BAP go on to incorporate thresholds within their farm standards requiring to reduce overall dependency on marine ingredients linked to sourcing decisions and improved husbandry/ feed management efficiency (Table 7). This 'addititivity' clearly creates greater compliance challenges for farmers in these performance areas, differentials which in turn point to strategic differentiation opportunities in company choice of standards schemes, discussed in the concluding section.

Table 7. Selected Environmental GSI indicators & corresponding ASC & BAP compliance thresholds (Source: ASC and BAP aquaculture standards 2017)

GSI Indicator	ASC	BAP
1.1 Fish Escapes	≤300 over the most recent production cycle	≤3 escapes of >500 fish from individual cages or cumulatively >5,000 fish over 2 consecutive production cycles, or any single escape >5,000 fish
2 Antibiotic Use	≤3 over the most recent production cycle	Evidence of procedures in place to address criterion
5.1 Sea lice treatments – in bath	NS: addresses ASC 'therapeutic treatments' criterion	
5.2 Sea lice treatments – in feed		
4 Sea lice counts	< 0.1 mature ♀ lice/ farmed fish, during sensitive periods for wild salmonids	
7.1 Wildlife interactions: birds	< 9 lethal incidents over the prior 2 years Inc. ≤ 2 marne mammal deaths	
7.2 Wildlife interactions: mamals		
8.1 Use of Marine Ingredients in Feed – Fish Meal	Fish Meal Forage Fish Dependency Ratio (FFDRm) <1.2	The facility shall calculate and achieve a final fish in : fish out ratio of 1.5 or less for each year class harvested
8.2 Use of Marine Ingredients in Feed – Fish Oil	Fish Oil Forage Fish Dependency Ratio (FFDRo) <2.52	

Notes: See Table 8 for full list of GSI indicators and ASC compliance criteria and thresholds.
GlobalGAP and FoS do not directly impose quantitative compliance thresholds within their own standards.

Table 8. GSI and corresponding ASC indicators and metrics

Indicator SN	Sub Indicator SN	Sustainability Area	Indicator Description	By Species?	By Fresh or Sea water Phase?	Years	GSI Calculation of Indicator Metric	ASC indicator: None Specific (NS) or *[metric compliance threshold]*
1	1.1	Environment	Fish escapes	Y/N	FW/SW	2013-2016	Net number of escapes (following any recapture) from January to December. Losses also differentiated by fresh or seawater containment and by date of individual loss events.	*[≤300 over most recent production cycle]*
1	1.2	Environment	Fish escape cause	Y/N	FW/SW	2013-2016	Reason for losses assoc. with each loss reported against Indicator 1.1	**NS:** Evidence of escape prevention planning & unexplained loss
1	1.3	Environment	Fish escape mitigation	Y/N	FW/SW	2013-2016	Mitigation strategy/ corrective action associated with each loss reported against Indicator 1.1	**NS:** Evidence of escape prevention planning
2	2	Environment	Fish mortality	Y	SW	2013-2016	12 months rolling mortality = [(total # of mortalities in sea last 12 months - total # of culled fish due to illness or similar and not in harvest figures) / (closing # of fish in sea + total # of mortalities in last 12 months + total # harvested fish in last 12 months + total # of culled fish in sea)]*100	**NS:** Evidence of farm specific mortality reduction program against annual targets
3	3	Environment	Antibiotic use	N	Combined?	2013-2016	Calculated as the number of antibiotic treatments over the entire production cycle.	*[≤3 over most recent production cycle]*
4	4	Environment	Sea lice counts	Y	SW	2013-2016	Calculated as the average no. of total adult lice per month (mobiles & gravid females).	*[< 0.1 mature ♀ lice/ farmed fish, during sensitive periods for wild salmonids]*
5	5.1	Environment	Sea lice treatments – in bath	Y	SW	2013-2016	In-bath treatments: Calculated as the amount of active pharmaceutical ingredients (API) used (in grams) per tonne of fish produced (LWE) - as monthly averages	**NS:** addresses ASC 'therapeutic treatments' criterion
5	5.2	Environment	Sea lice treatments – In Feed	Y	SW	2013-2016	In-feed treatments: calculated as the amount of active pharmaceutical ingredients (API) used (in grams) per tonne of fish produced (LWE) - as monthly averages	**NS:** addresses ASC 'therapeutic treatments' criterion
6	6	Environment	Non-medicinal methods (sea lice)	N	SW	2013-2016	In-feed treatments: Description of non-medicinal approaches that can also be used to combat sea lice & 'continuing use' status.	**NS:** addresses ASC 'therapeutic treatments' criterion

7	7.1	Environment	Wildlife Interactions	N	Combined?	2013-2016	Birds: Total number of interactions divided by the total number of sites from January to December each year.	*[< 9 lethal incidents over the prior 2 years]*
7	7.2	Environment	Wildlife Interactions	N	Combined?	2013-2016	Mammals: Total number of interactions divided by the total number of sites from January to December each year.	*[< 9 lethal incidents over the prior 2 years]*
8	8.1	Environment	Use of Marine Ingredients in Feed – Fish Meal	N	SW only?	2013-2016	Quantity of live fish from small pelagic fisheries required to produce the amount of fishmeal needed to produce a unit of farmed salmon: Uses tASC's FFDRm calculation	*[Fish Meal Forage Fish Dependency Ratio (FFDRm) <1.2]*
8	8.2	Environment	Use of Marine Ingredients in Feed – Fish Oil	N	SW only?	2013-2016	Quantity of live fish from small pelagic fisheries required to produce the amount of fish oil needed to produce a unit of farmed salmon: Uses ASC's FFDRo calculation.	*[Fish Oil Forage Fish Dependency Ratio (FFDRo) <2.52]*
9	9	Environment (& Social)	Certification & Environmental licenses	N	Y	2013-2016	Website Link & Sustainability Reports (Added in 2016)	**NS:** Meets transparency requirements across ASC criteria
10	10	Social	Legal Compliance	N	Y	2013-2016	The total number of non-compliances resulting in fines (USD) from January to December.	**NS:** Meets transparency requirements across ASC criteria
11	11.1	Social	Occupational Health & Safety - Fatalities	N	Combined?	2013-2016	Fatalities: No. of fatalities of workers and contractors working at company premises between January – December	**NS:** Evidence that all health & safety-related accidents are recorded
11	11.2	Social	Occupational Health & Safety - Injury	N	Combined?	2013-2016	Lost Time Injury Rate: No. of injuries at work/ work-related, inc. fatalities, leading to unfitness for work & absence next working day or shift - Jan to Dec Calc. as: (Total No. of lost time injuries/total No. working hrs) x 1,000,000.	**NS**: Evidence that all health & safety-related accidents are recorded
11	11.3	Social	Occupational Health & Safety - Absence	N	Combined?	2013-2016	Absence Rate: All absence related to one's own personal health. Calculated as: Total number of absent days / Total work days	**NS**: Evidence that all health & safety-related accidents are recorded
12	12	Social	Interactions with the Community	N	Combined	2013-2016	Number, community group and type of engagement	**NS**: Addresses ASC work environment health/ safety criterion
13	13	Social	Direct Labour	N	Combined	2013-2016	Calculated as the number of full-time permanent employees per calendar year.	**None Specific** CSR indicator
14	10.1	Social	R&D Investment	N	Combined?	2015-2016	Website Link & Sustainability Reports (Added in 2015)	**NS:** Transparency reqs. across ASC criteria

5.7.1 Fish Escapes

GSI indicator 1.1: Escapes are defined '*as the net number following any recapture from January to December*' (Table 8), being directly comparable to the equivalent ASC indicator. The ASC threshold of ≤300 escapes over the most recent production cycle is more conservative than the BAP standard limit of <5,000 fish over 2 consecutive production cycles (Table 7). However, the BAP standard also stipulates escape limits for individual cages, whilst ASC allows for a once in 10 year extreme event-loss where the company is deemed to have taken reasonable management steps to prevent the loss.

GIS data is broken by date of escape incident, species and marine or freshwater phase (Figure 22, Figure 23 and Table 10). Escape causes and corrective actions and mitigation steps are differentiated as sub-indicators 1.2 (Figure 24) and 1.3 in Table 8.

Total reported escapes are heavily biased by a single storm related loss suffered by AquaChile in 2013; 787,929 fish amounting to 64% of all combined reported losses of 1,228,955 fish from 2013 to 2016 (Figure 22). Thereafter combined losses from Chile (all Atlantic Salmon) totaled 2,000 fish in 2014, 14,844 in 2015 and, remarkably no losses were reported in 2016. Similarly, 6 of the 12 GSI members including 4 Chilean companies; Blumar, Camanchaca, Los Fiordos and Multiexport as well Australia's Huon and NZ King Salmon reported no escapes in any of the 4 years whilst Canada's Grieg reported total losses of only 1-4 fish in any reporting year (a recent escape of 21,700 fish was reported from one it's Scottish sites in February 2018[26]). Bakkafrost in the Faroes reported the second highest national multi-year (2013-2016) loss of 115,903 fish (10% of all reported losses) again due to storm damage; whilst Marine Harvest lost 178,769 fish from its sites in Norway Scotland and Chile (2013-2016).

Only 4 fresh water smolt losses, all Atlantic of Salmon were reported; ranging from 1-200 in Scotland (2013 and 2014) with the worst single loss of 14,400 smolts in Norway (2014). Whilst losses of Atlantic salmon in each of 2015 & 2016 totalling 96,346 and 10,124 fish respectively were unattributed to grow-out phase in aggregate data. The largest such loss of 65,500 fish in Norway (2015) was likely to be from sea-water cages as most FW production in Norway is in closed containment (Figure 23).

Total reported losses show a declining trend; from 1,048,530 fish in 2013 to 73,995 (2014), 96,349 (2015) and only 10,124 in 2016. Reasons may include improved containment and farm management, fewer or less extreme storms and/ or under-reporting. The GSI 'dashboard' provides no detail on recapture approaches or duration after loss events.

[26] https://www.pressandjournal.co.uk/fp/news/north-east/1419067/campaigners-criticised-escape-21000-farmed-salmon-highland-loch/

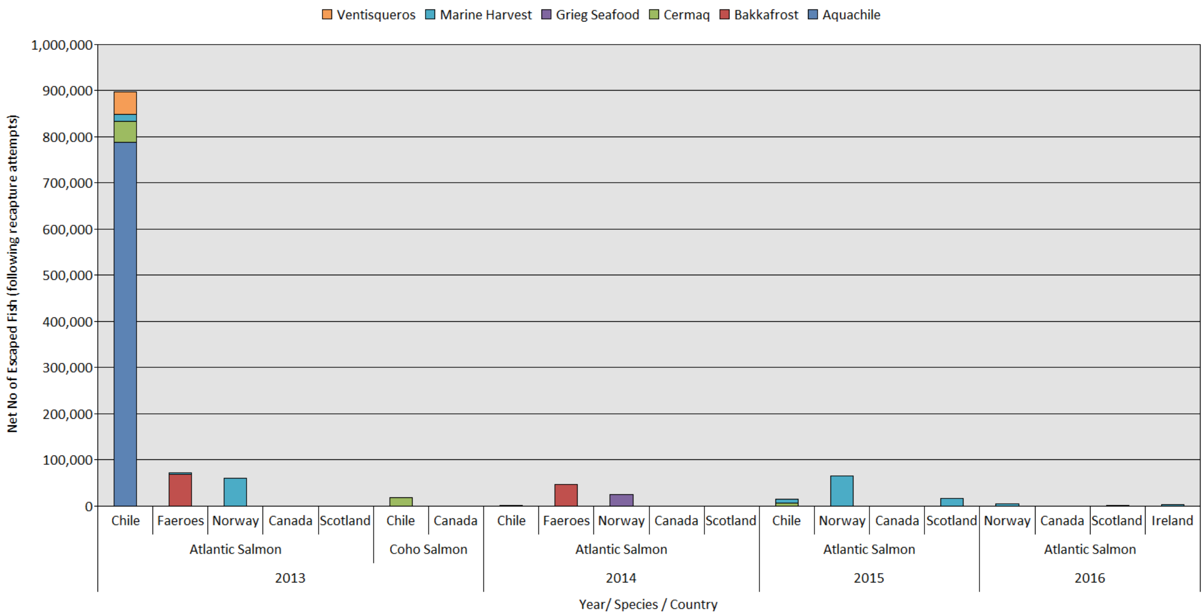


Figure 22. Escapes reported by species and country 2013 – 2016

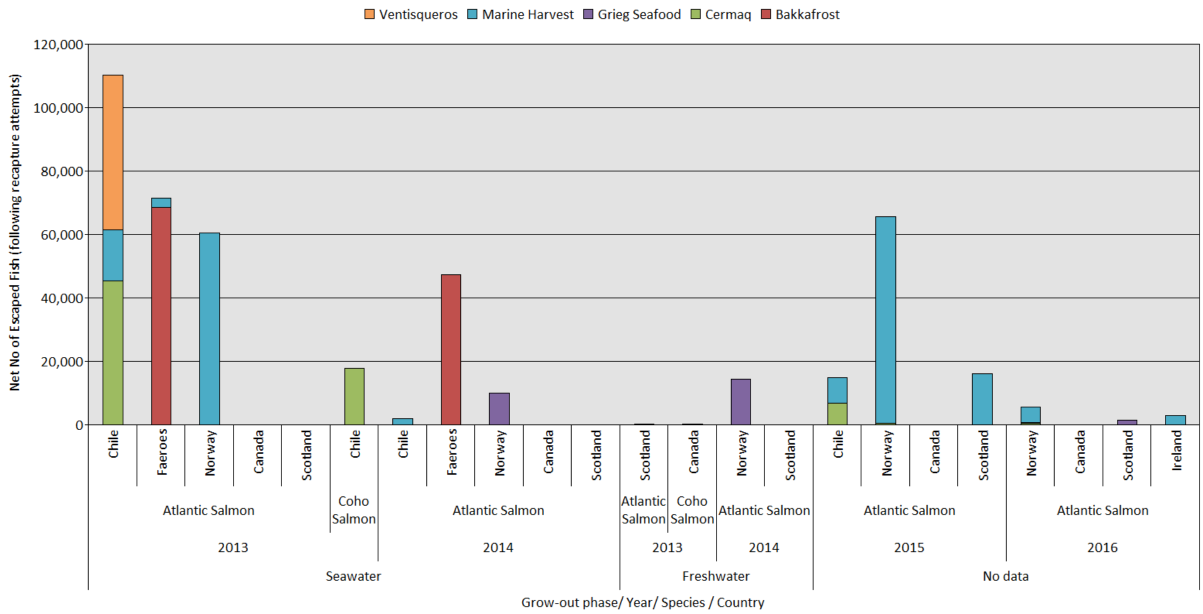


Figure 23. Escapes reported by grow-out phase, species & country 2013 – 2016 (exc. extreme loss of 787,929 fish from marine cages by Aquachile in 2013)

In order to analyse trends in escape causes, qualitative attributions of a total of 42 reported events were re-coded into the eight categories shown in Figure 24 (for 2013 & 2014 data only). Six were associated with minor handling losses during sampling/ inspection events with loss of only 1 or 2 fish (several during external inspection visits). The most serious losses resulted from torn nets (22 events) variously associated with storms/ bad weather, husbandry events, dead lift installation or collision with boats/ barges during fish transfer. Six storm events resulted in the greatest numerical losses (Figure 22). Eight losses were discovered during or directly associated with suspected damage associated with movement of cages and mooring lines during sealice $H_2 0_2$ bath treatments.

Although site-specific data would be required to determine compliance with ASC or BAP requirements, these results clearly show the significant challenges both scheme thresholds present for certification. Also clearly much will depend on the more subjective interpretation around reasonable management steps taken to mitigate extreme-event losses. Whereas media attention is likely to spur reporting of major losses, ensurance of compliance for more low-level losses is also likely to be a significant challenge for auditors.

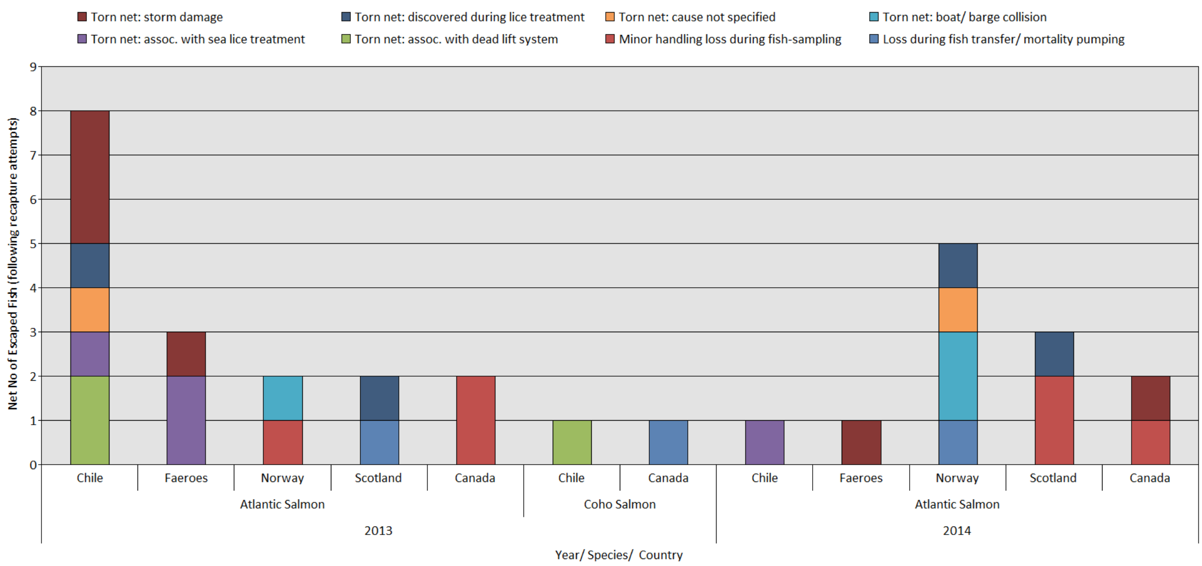


Figure 24. Causes of escapes reported by species and country 2013 – 2014

5.7.2 Antibiotics Use Index (AUI)

GSI Indicator 2: The AUI is calculated as: *'the number of treatments over the entire production cycle (under veterinary prescription and supervision by certified fish health professionals)'*. A single treatment is defined as '*an application of a specific medication or multiple, consecutive applications with no more than a 7–15 day gap between applications of the same medication for the same diagnosis'*. A production cycle is defined as *'the total number of fish stocked at a farm site from smolt to harvest'*. Using these definitions the total number of fish per treatment is divided by the total of smolts stocked in the same site over a production cycle and calculations repeated for all treatments and sites per company region to derive a weighted average index. The GSI also cautions that inter-company comparisons 'should be avoided' due to 'differences in regional treatment regulations and practices'. Furthermore, GSI data is not systematically differentiated between farmed species or, more critically between sea and freshwater culture phases. Active ingredient concentration is also not incoporated in the metric. Qualitative stipulations e.g. a prohibitions on prophylactic treatments or use of antibiotics designated by the WHO as critical for human health fall under the scope of separate indicators. Antibiotic treated fish can not be marketed with the ASC label, though non-treated fish on the same site retain eligibility.

The primary intent of these ASC indicators, and by inference the GSI AUI is to mitigate development of anti-microbial resistance (AMR) to antibiotics (food-safety being a secondary outcome). This is an extremely complex issue and interpretation of additional active ingredient, dose and treatment duration data linked to sub-therapeutic dosing would be challenging.

The ASC salmon standard imposes an absoloute limit of upto 3 such treatments in the most recent production cycle i.e. not subject to the above weigthing approach, whilst there is no directly comparable compliance threshold in the BAP standard. Thus the GSI data as presented can only provides an indicative assessment of company ASC compliance performance.

Results show 18 country/ company combinations with positive AUIs in one or all four reporting years (Figure 25 and Table 11). Geographical trends are broadly consistent with recognised health status and challenges across GSI countries i.e. the highest recorded AUI were recorded in Chile and the lowest in the Faeroes benefiting from its oceanic off-shore' location whilst NZ King Salmon's zero-use status is consistent with the premium market positioning of its exotic Chinook Salmon (*Oncorhynchus tshawytscha*).

Eleven companies operating in Chile and Canada recorded AUI from 1.9 to 4.2 to in 2016, significantly higher AUI than recorded in any other country (Figure 25). Eight of these companies recorded small rises in AUI over 2013 to 2016 whilst 3 reduced or stabilised AUI in 2016. Seperately, the Canadian industry reported declining antibiotic use from a peak mean of 350 grams/tonne in 2002 to less than 50 grams in 2014, much of the drop accounted for by 'a shift from Pacific to more pathogen resistant Atlantic salmon' (in British Columbia) and on-going vaccine development[27]). However this trend is not apparent for the 2 GSI member Atlantic Salmon operations on the Atlantic Seaboard. The intermediate AUI reported by Marine Harvest Scotland are more likely to be associated with FW rather than marine treatments.

Over 2015 to 2016, 3 companies, both operating in Chile, Multiexport Ventisqueros and AquaChile (2015 only) recorded mean AUI across all their operations (i.e. certified and uncertified) exceeding the ASC compliance threshold of ≤3 treatments. Only Multiexport has reported values above this threshold in all four years, whilst the 2016 result represented a single year reversal for Ventisqueros.

27 http://www.vancouversun.com/salmon+farmers+publish+monthly+lice+numbers/11469675/story.html

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 635761

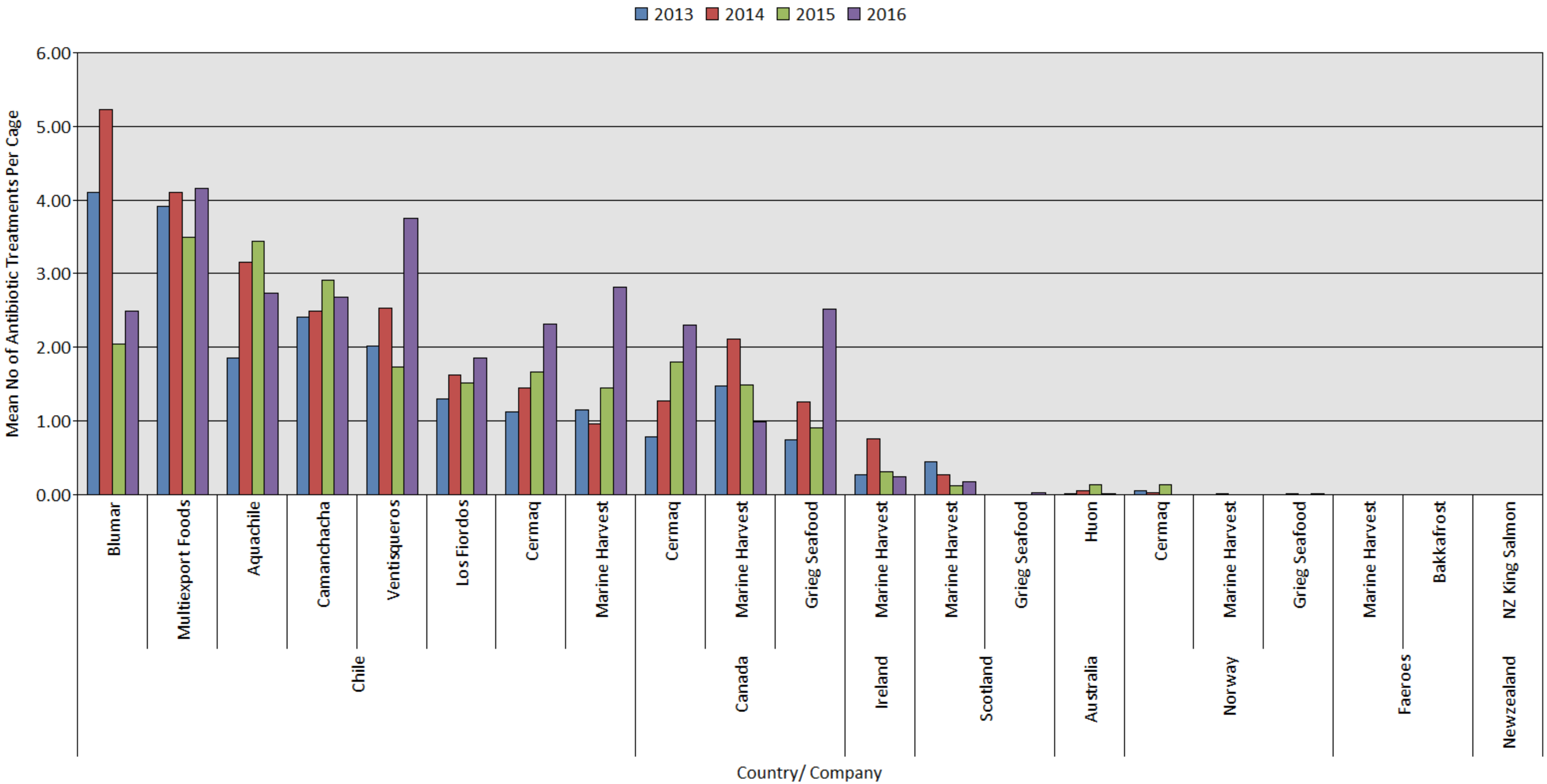


Figure 25. Antibiotic Use Index (AUI) scores for 12 GSI companies operating in 8 countries 2013-2016 (Source GSI 2017)

5.7.3 Sea lice treatments

GSI Indicators 5.1 and 5.2: The amount of treatment used is calculated as the amount of active pharmaceutical ingredients (API) used (in grams) per tonne of fish produced (LWE) - as monthly averages. Medicinal treatments defined as those using a pharmaceutical and/or other treatments requiring a prescription. This excludes H_20_2[28] which breaks down rapidly and harmlessly[29]. For bath treatments production is estimated as: closing biomass (T) + biomass of harvested fish (T) – opening biomass of fish (T) in the reporting period. For in feed treatments using anti Sea Lice products production is estimated as: closing stock + harvested fish – opening Stock i.e. being calculated on a population rather than biomass basis. The metric is calculated separately for-bath and in-feed treatments, and in some instances differentiating between production species and production phase (grow-out or broodstock).

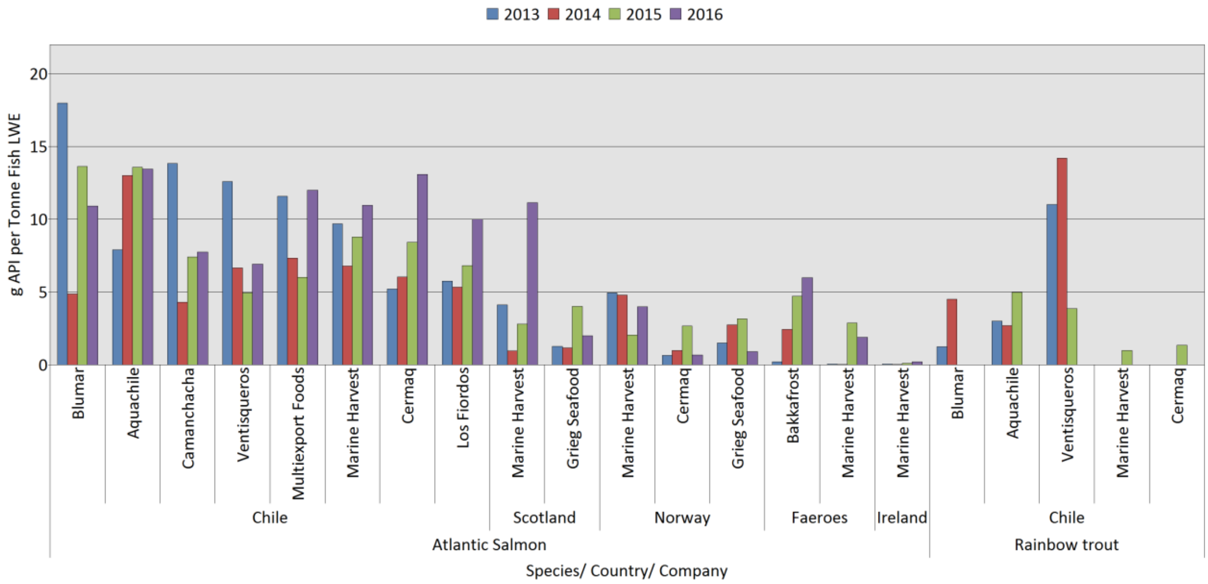
In their 2016 sustainability report, GSI members with Chilean operations add a second calculation approaches the second adjusted to account for high mortalities associated with a harmful algal bloom (HAB) as follows: (i) for the population '*surviving*' & finally harvested following HAB related mortalities: Production = (closing biomass + harvest biomass) - opening biomass and (ii) for the '*original*', pre-mortality population. Production = closing biomass + harvest biomass + mortalities biomass + biomass of culled fish) - (Opening biomass - stocking biomass).This adjustment means 'surviving' API values are substantially lower (and only in one case equal) to 'original' API values. For comparative purposes, only data based on the 'original' g API calculation in the following analysis (noting cases of high mortality levels (e.g. the 2013 - 37% loss in Ireland) results could still be significantly biased by timing of the loss).

Most Chilean operations appear increasingly reliant on bath treatments for Atlantic Salmon (especially) and rainbow trout (Figure 26 A&B). Only Blumar significantly increased in-feed delivery whilst most other Chilean operations recorded dramatic drops from 2013 peaks; many almost terminating this form delivery by 2015. Only Los Fiordos (6) and Blumar (10) reported significant in-feed rises in 2016 compared to previous years. Atlantic salmon farms in Scotland, the Faroes and Norway show a more mixed pattern. In-bath delivery is generally increasing, though 2015-16 levels of 2-5g API remain much lower than the 5-14g range in Chile in the same years. Six of 8 companies in Chile, MH Scotland and Norway and Faroes' Bakkafrost recorded a year on year increase in in-bath API in 2016, with substantial rises in 5 of 9 of these cases in Chile & Scotland.

Some companies in Scotland, the Faroes and Norway also recorded large increases in in-feed delivery, notably Grieg in Scotland (18g) and Marine Harvest in Norway (8g). Operations in Canada and Ireland report very low reliance on either bath or in-feed treatments. Only Marine Harvest Norway recorded broodstock as well as production/ grow-out scores. Broodstock in-bath and in-feed API scores respectively ranged from 8.2 – 2.5g and 0.1-3.3g from 2013-2015. Cermaq & Los Fiordos recorded zero scores against broodstock treatment, possibly due to data omission. Similarly, no in-bath or in-feed treatments were recorded for Coho or Chinook salmon.

[28] H202 also controls AGD (subject 15oC upper threshold or shorter bath time).
[29] Though MultiExport Foods in Chile still reported this as non-medicinal method in 2015 (Indicator 6)

Interpretation of potential environmental impacts would also be enhanced if APIs were presented together with treatment frequency data[30] e.g. potentially giving some idea of the risk of sub-therapeutic dosing. ASC (or BAP) has no directly equivalent indicator; ASC instead relies on a contested Parasiticide Treatment Index (PTI) based on an aggregate (ordinal) scoring of therapeutants on toxicity, persistence, resistance, 'sensitive timing' and treatment-mode factors.



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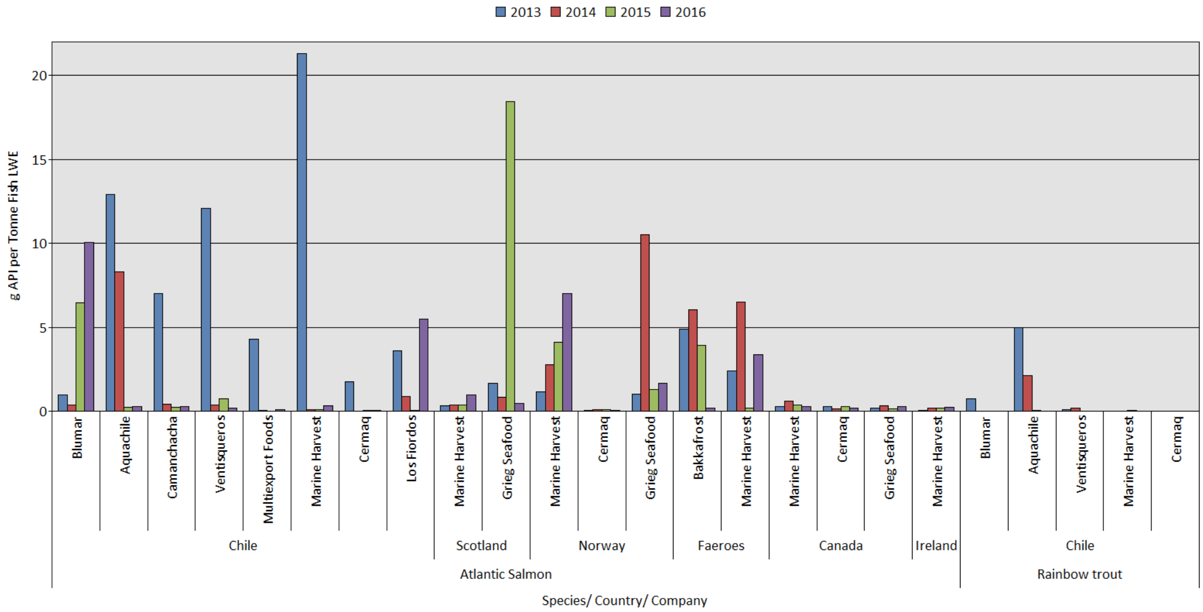

B

Figure 26 A&B. Grow-out bath (A) and in-feed (B) sea lice treatments by species (Atlantic salmon & rainbow trout), country & company 2013-2016 as g active pharmaceutical ingredient per tonne fish, WFE. Note: only Atlantic salmon data presented for 2016 (Source: GSI 2018)

30 Chile currently depends heavily of Azomethiphos (an organophosphate) bath-treatments. Emamectin Benzoate ('SLICE', an avermectin) was the (in-feed) treatment of choice in the N. Hemisphere since 1999. Treatments were effective for 7-9weeks prior to build up of drug-resistance.

5.7.4 Sea lice counts

GSI Indicators 8.1 and 8.2: Are calculated as the average no. of total adult lice per month (mobiles and gravid females). This is the only GSI metric compiled on a monthly basis.

Before reviewing findings the following factors complicating ability to compare results should be noted. Although lice sampling-designs may be specified as components of 'local action limits' for treatments (LALs: Table 9), there is no standardisation of approach across countries (i.e. number of fish or cages sampled, randomisation v risk-based approaches etc.). Consistent with lack of standardisation, results are variously reported as counts of four increasingly inclusive life-stage classifications: (i) gravid females (ii) adult females (iii) mobile adults inc. gravid females and (iv) mobile pre-adults and adults[31]. Seven of 8 companies operating in Chile use Class iii, whilst all other companies use Class ii (only Cermaq reports using class i in Chile, but uses Class iv. in Canada). Since 2016 all counts as reported 'average number of gravid females' i.e. class i. though retrospective adjustments are not feasible.

Table 9. National (local) sea lice action-level (LAL) limits ranked in order of stringency.

Rank	Country	National action-levels (mean lice/ fish)	Seasonal operation	Voluntary or Mandatory
1	Norway	0.5 adult females	All year	M
2	Scotland*	3 gravid females	All year	M[2]
3	Ireland	2 adult females	Jun to Feb	M
		0.3-0.5 adult females	Mar to May	
4	Faroes	2 adult females 10 mobiles	All year	?
5	Chile	3 adults (mobiles and gravid females)	All year	V
6	Canada	3 mobiles (all pre-adults and adults)	1 Mar to 3 Jun	?
No lice problems reported in Australia or New Zealand				

Notes: *'Recommended as good practice' [2] Pending statutory revision to a mandatory year-round requirement to submit a treatment plan to the regulator (Marine Scotland) at counts reaching a avaeragel of 3 gravid females/ fish. The current Scottish LAL based on the SSPO Code of Good Practice is as follows: (i) 01 Feb – 30 Jun: 0.5 gravid females/ fish (ii) 01 Jul – 31 Jan: 1.0 gravid females/ fish.

Finally it must be noted that Chile suffers from *Caligus rogercressyi* parasitism whilst *Lepeophtheirus salmonis* is present in all the other lice affected countries in the northern hemisphere (though there are epidemiological/ pathology differences exist between Pacific and Atlantic infections). *C. elongatus* also presents a lesser threat to salmonids and other fish species in Europe[32].

[31] Classes i and ii have the most direct environmental impact relevance in-terms of transmission risk and are diagnostically also more robust i.e. for *L. salmonis*; it is much more difficult to differentiate early adults and pre-adult chalimus stages morphologically (size being the most obvious factor) compared to male and female adults

[32] http://www.sciencedirect.com/science/article/pii/S004484861100250X: Caligus elongatus can be the cause of summer/ autumn count spikes in N. Europe (Faeroes an exception. Is transmitted by >100 host wild fish spp.

Most companies farming multiple species (i.e. predominantly in Chile) differentiate lice counts by production species. Blumar (farming Atlantic salmon and susceptible Rainbow trout), Los Fiordos and Multiexport Foods (both farming Atlantic and Coho salmon) yet their sea-lice counts are reported exclusively for Atlantic salmon.

Table 9 also clearly highlights a wide divergence in the stringency of LALs underscoring the regulatory influence on performance outcomes. This may be a significant factor contributing to marked performance differences (on this and other indicators) between the countries for the 3 multi-national GSI members.

Figure 27 and Figure 28 show annual and monthly mean counts to persistently higher in Chile than other countries though overall levels show some decline. Counts appear to be rising in Ireland, Scotland (especially) and Canada – perhaps reflecting the Pacific –Coho to Atlantic species shift described above in the case of Canada. Norway with the most strict national treatment action-levels records by far the best count performance with most monthly means <0.2 lice/ fish (Class ii – adult females) and a maximum of 0.41 lice per fish over the 4 year period.

Figure 28 also shows how maximum count levels remain elevated through the year in Chile (with monthly maxima of 4-5 lice per fish, data not shown), whilst Ireland Scotland and Faroes variously have more marked seasonal peaks between August and December (i.e. out-with the main wild juvenile salmonid spring out-migration in vulnerable areas).

Rainbow trout appear as susceptible as Atlantic salmon to *C. rogercressyi* parasitism in Chile, though infection levels also appear to have declined since 2013 (Figure 29). Coho Salmon (in Chile) appear much more resistant to *C. rogercressyi* parasitism in Atlantic salmon or Rainbow trout, with mean parasite loads never exceeding a mean of 0.2 lice/ per fish between 2013 and 2015 (class i and iii definitions; data not shown). Pacific salmon (i.e. inc. Coho and Chinook) mount strong tissue responses to attaching lice increasing likelihood of rejection during early infection. However, *Caligus* spp. do transfer readily between different fish species making cross-infection between co-located salmon and sea trout farms in Chile a far greater risk than in regions of *L. salmonis* infestation.

The intent of the aligned ASC indicator to mitigate negative impacts on wild salmonid populations means this and associated lice indicators including a requirement to participate in area-based management schemes, do not apply to Chile, Australia or New Zealand where there are no wild local salmonid populations. In other jurisdictions however the ASC indicator threshold of '*< 0.1 mature ♀ lice/ farmed fish, during sensitive periods for wild salmonids* (Table 8), combined with growing resistance to available therapeutants, clearly poses a major on-going challenge for certification of inshore (i.e. with lower flushing rates and higher lice transmission risk) producers of salmon in European and N. American countries.

and although easy to treat, this more 'catholic' adult mobile transmission and associated planktonic presence constitutes a large infection reservoir. However the migratory non-specificity of such populations compared to salmonids, also reduces drug- resistance selection pressure.

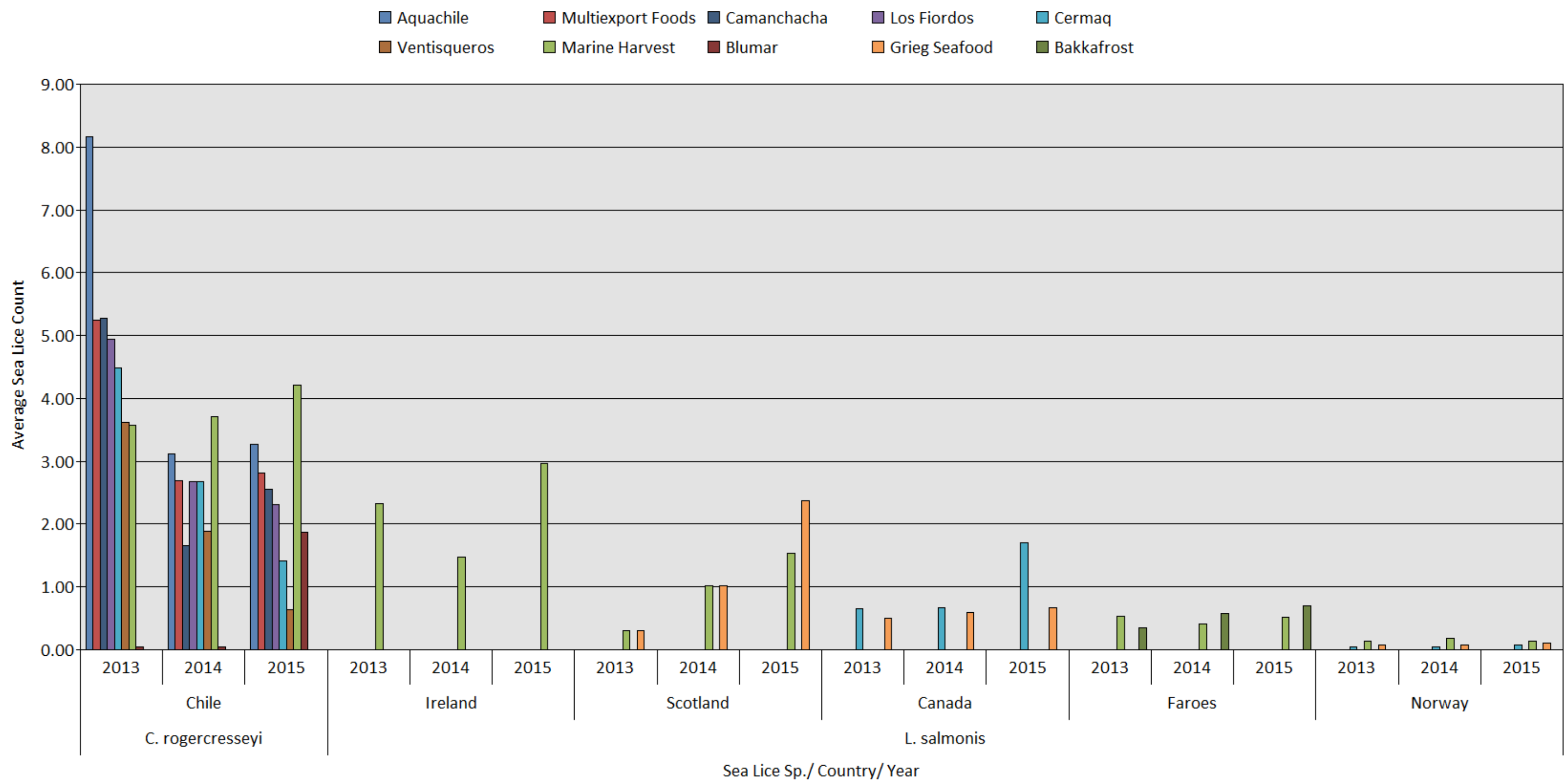

Figure 27. Atlantic Salmon mean sea lice count by company and country 2013-2015 (Source: GSI 2018)

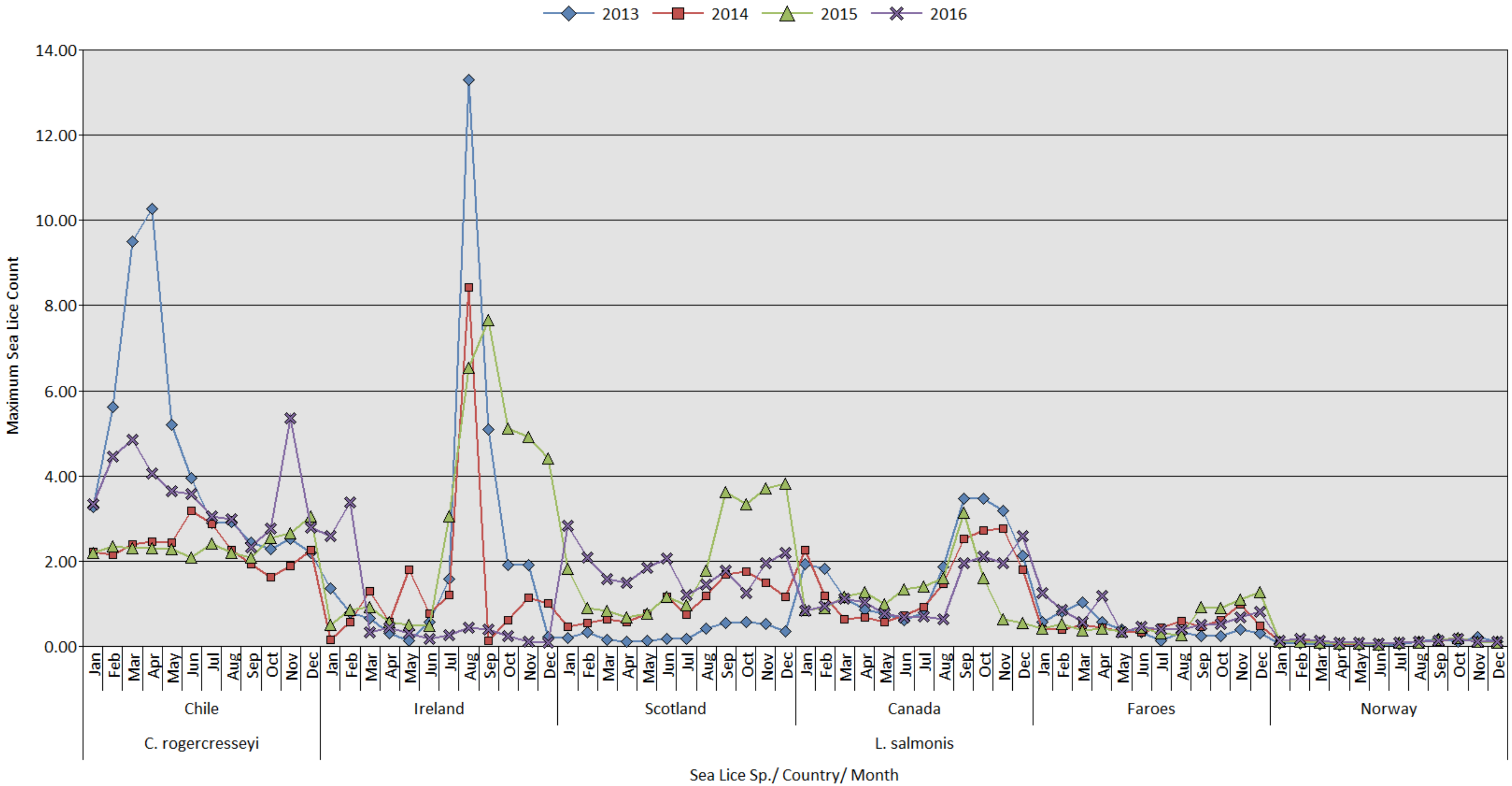

Figure 28. Atlantic salmon maximum mean sea lice count, all companies by country and month 2013-2015 (Source: GSI 2018)

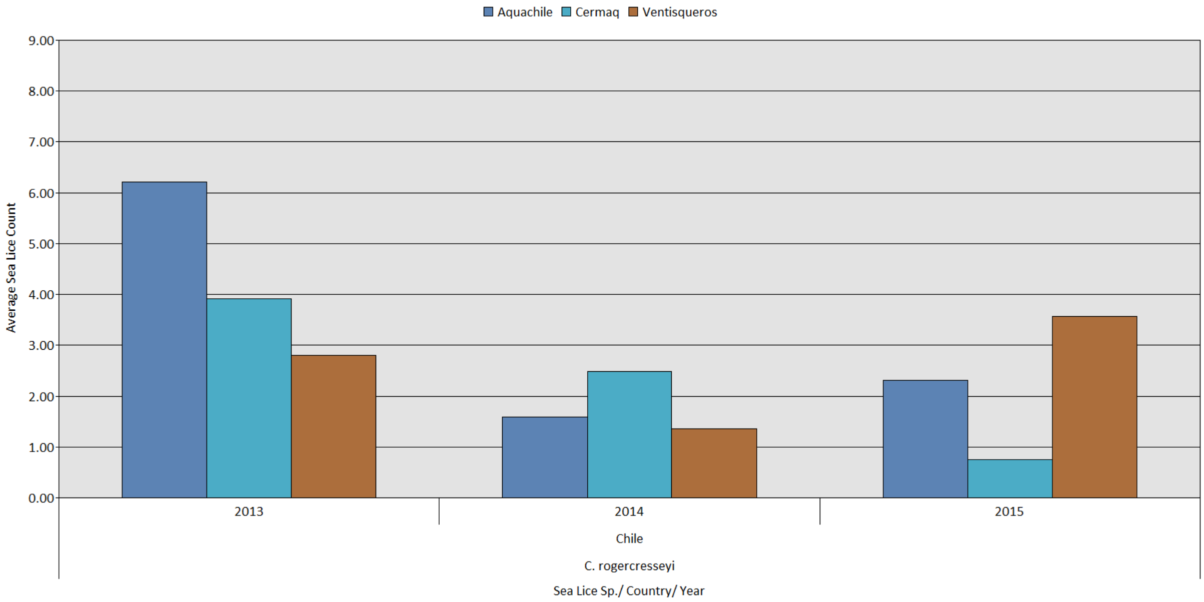

Figure 29. Rainbow trout mean sea lice count by GSI company in Chile 2013-2015 (Source: GSI 2018)

5.7.5 Wildlife interactions

GSI Indicators 7.1 and 7.2: Are defined as the *'total number of lethal incidents (both accidental and intentional) by species divided by the total number of sites from January to December each year'* calculated separately for birds (7.1) and mammals (7.2). Corresponding ASC compliance thresholds are <9 mortalities bird or mammal, inclusive of ≤2 marine mammal deaths over the previous 2 years (a separate ASC indicator also proscribes any killing, intentional or accidental or any IUCN red-listed species).

Figure 30 reveals that only 7 of 12 companies reported any lethal incidents from 2013-2016 and only one company Cermaq operating in Chile (averaging 0.02/site in 2014) which may be indicative of under reporting on this metric. Only 2 companies reported marked year-on-year rises (mainly bird mortalities) between 2015 and 2016; Cermaq Norway (4.3 – 6) and Huon Australia (1.6-12.8).

Mean incident rates reached maxima of 11-16/ site for the two Faroese companies (2013-2014) and Australias Huon in 2016, with intermediate maxima of 6 in Norway (2013 and 2016) and 4 in New Zealand (2016). Bird mortalities were reported as being entirely accidental in both countries whilst Faroese operations were responsible 97% of all intentional mammal mortalities linked to seal predation (intentional mortalities were associated entirely with mammals). Reported mortalities (all types) fell from an average of 37.3/ site in 2013 to 21.7/ site in 2014, with the proportion of intentional mortalities also declining from 54% to 42%. Much lower rates of mammal mortality, primarily accidental are reported in Australia, New Zealand and Canada.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 635761

It is observed that reporting against a heterogeneous range of site-scales has potential to significantly bias results; production capacity or harvest LWE could offer an improved basis for comparison. However, the equivalent ASC indicator also makes no such distinction and results show for a small number of companies; notably Bakkafrost and Marine Harvest in the Faroes and Huon in Australia facing on-going marine-mammal predation challenges.

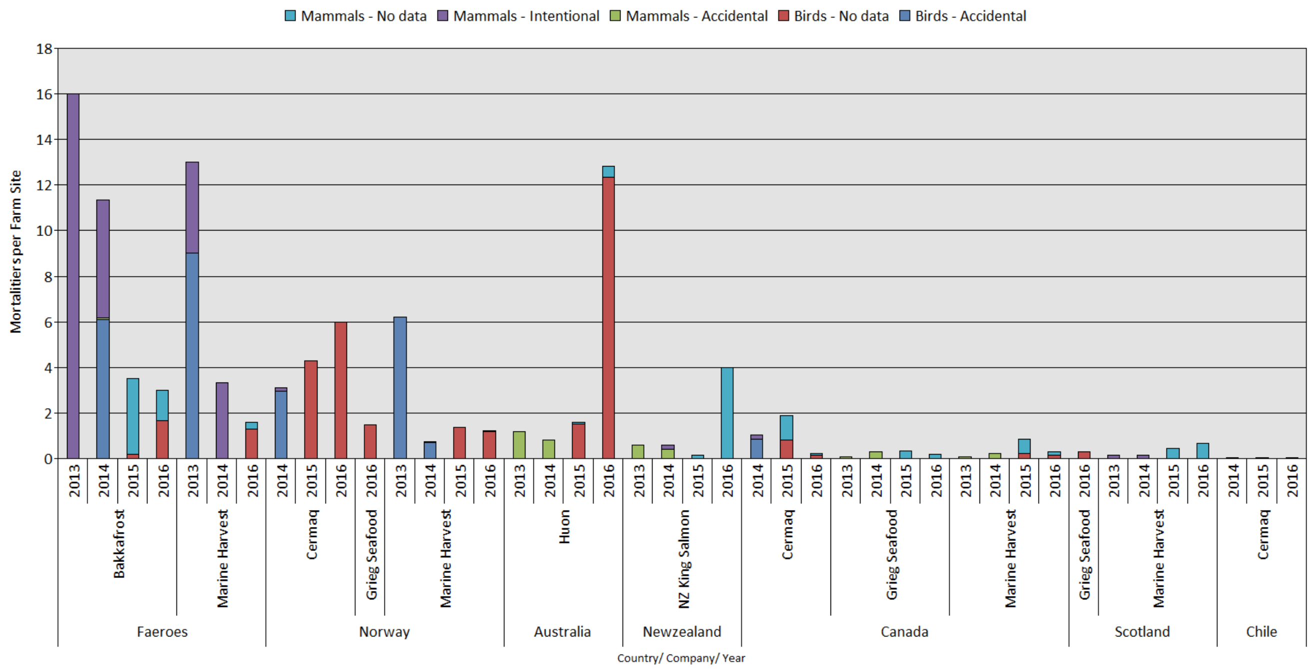

Figure 30. Mean number of bird and mammal mortalities per farm-site by country and GSI company 2013-2016 (Source: GSI 2018)

5.7.6 Use of marine ingredients

GSI Indicators 8.1 and 8.2: Fishmeal and Fish Oil Dependency Ratio (FFDRm & FFDRo). The calculation is directly based on the the ASC's calculation for forage fish dependency ratio, in order to '*demonstrate improvements being made in improving the efficient use of marine ingredients*'.

Figure 31 and Figure 32 reveal only marginal change in FFDRm and FFDRo year on year for most companies. NZ King Salmon recorded the largest individual FMDR increase (from 0.62 to 1.27) and Grieg Seafood in Scotland the largest decrease from 1.24 to 0.73 over the reporting period.

Marine Harvest demonstrates the best overall and country-wise FFDRm performance with 2014 levels ranging from 0.25 in Ireland and 0.95 in Scotland. These outcomes may be linked to market-differentiation strategies i.e. organic in Ireland and Label Rouge in Scotland. This is also consistent with the absence of reported fish oil use in Ireland over both years.

Bakkafrost (1.17), Huon (1.06) and NZ King Salmon (1.27) recorded the highest FFDRm scores in 2014.

FODR show a more mixed trend between 2015 and 2016, with marked rises or falls in the case of 7 companies in each case. Three companies showed the large changes overall, all declines: Cermaq Canada and Chile and NZKS in Chile (again from the highest base). MH Norway, Scotland and Faroes and Grieg Canada and Huon Australia reported the highest rises between 2015 and 2016.

All companies, including NZ King Salmon (2.88) reported values below the ASC FFDRo compliance threshold of <2.95 in 2016. Similarly all reported FFDRm values fall below the ASC compliance threshold of 1.35, with the notable exception of NZ King Salmon which has exceeded this threshold in each of the four years, although it showed the biggest sing improvement (declining from 1.74 to 1.37 between 2015 and 2016. The elevated scores consistent with a high reported FCR of 1.7 for their premium Chinook Salmon may be a key reason why the companies has as yet to achieve ASC certification of any of its 9 farming sites. The findings also point to inconsistencies between different standards; NZ King Salmon being the only marine-cage salmon site to achieve Monterey Bay's Seafood Watch 'green' status, whilst all 9 sites have also achieved GAA-BAP certification.

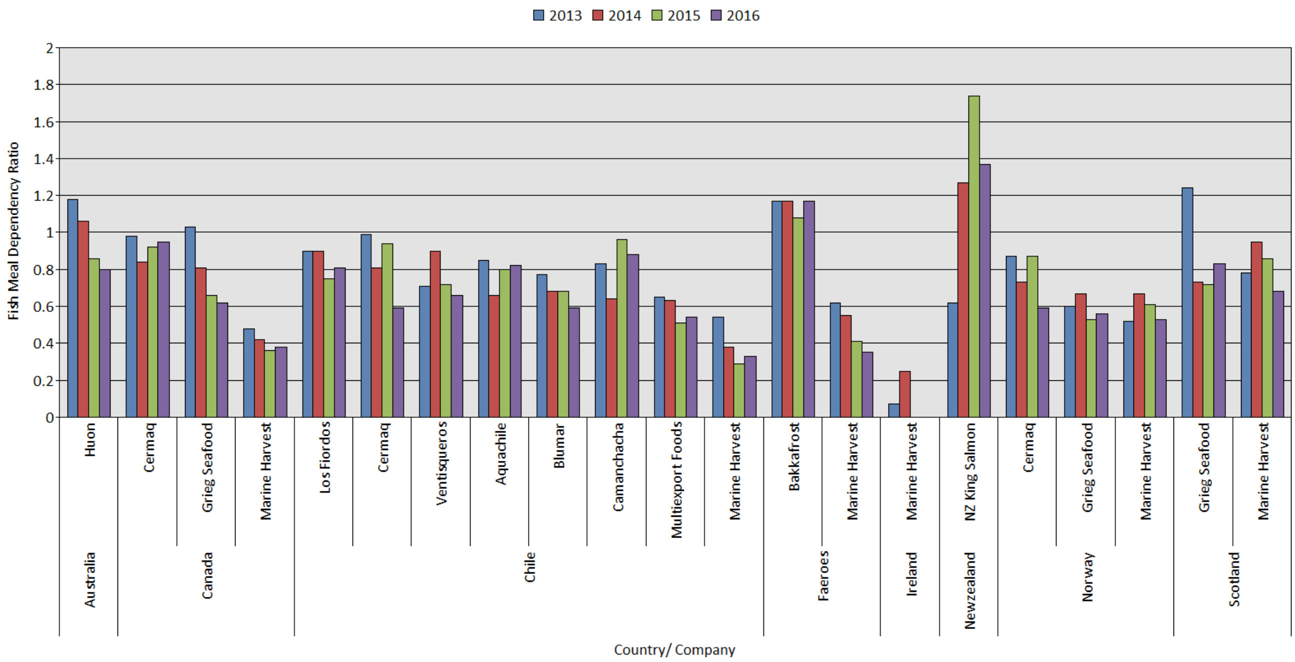

Figure 31. Fish Meal Dependency Ratio (FMDR) by country and company 2013-2016 (Source: GSI 2018)

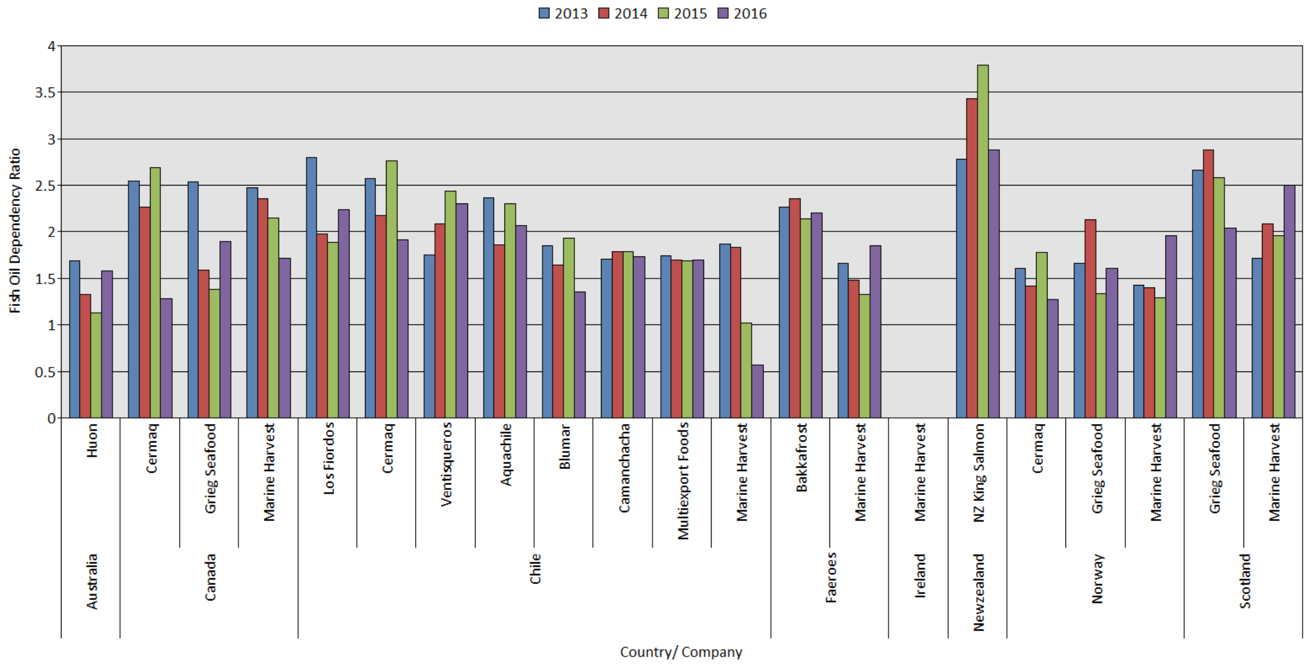

Figure 32. Fish Oil Dependency Ratio (FODR) by country and company 2013-2016 (Source: GSI 2018)

6. Conclusions

Our preliminary finding point to a growing consensus around the following points (i) other than for earlier adopters, or schemes with in-built premium guarantees (e.g. FairTrade); most voluntary sustainability standards guarantee continued access to certification-centric market segments (linked to reputational issues and advocacy group pressure) over and above any price-premium (ii) the burden of compliance and auditing transaction costs fall most heavily on producers low in the value-chain.

Multi-site and group certification, Inter and intra scheme harmonisation and equivalence measures, benchmarking entities such as the GSSI are steps being taken by the certification sector to deal with this problem. Within this context we use a corporate social responsibility (CSR) case-study of the Global Salmon Initiative (GSI) as an example of industry re-asserting strategic control of the sustainability agenda to achieve a pre-competitive objectives, through a membership commitment to achieving 100% certification of their marine net-cage sites under the ASC salmon standard by 2020. Members also commit to annual disclosure of performance metrics on 9 environmental and 5 social indicator groups over the interim period.

Our analysis indicates the following potential strategic advantages associated with GSI membership. Firstly by posting of the aforementioned data on the GSI and member websites members direct compliance with requirements of multiple ASC standards for public-disclosure. More significantly by demonstrating collective industry leadership the GSI aims to achieve social license in order to achieve (i) greater market acceptability for global salmon production compared to other animal protein substitutes (ii) improve more local acceptance of the industry which is in turn aligned with growth aspirations in a sector subject to some of the most stringent licensing regulations of any major aquaculture commodity sector.

These observations are affirmed by the evolving GSI membership mix and their certification progress. With 9 operators Chile has the highest number of members, including 3 multi-nationals and the highest proportion of ASC certified production from GSI members, 81% of 147,339 T of certified output (representing 21% of 2016 national output) compared to only 58% of 444,863T of certified output in Norway (35% of national output in 2016). Potentials for organic growth are limited by stringent site-licensing restrictions in many countries; whilst almost uniquely Chile has huge and largely untapped resource in it isolated Region XII Magellan Antarctic Region. With many of the largest multi-national salmon producers being GSI members with operations in Chile; licensing objectives may provide a particularly strong strategic incentive for membership.

In Australia GSI members Tassal and Huon have faced strong environmental advocacy pressure (not least from the ASC salmon standard originator WWF) particularly in relation to environmental capacity issues in Tasmania's Macquarie Harbour inlet. The companies have a more localised need for social license around collective responsibility for improved 'area-based' environmental performance. The following declaration by Tassal in its 2017 annual report adds credence[33] to this supposition:

'Tassal is independently assessed by both WWF-Australia and ASC. Maintaining ASC certification is a priority, being very difficult to obtain and maintain. Tassal was the first salmon producer globally to achieve ASC certification across its entire business – and remains one of only two producers globally (Petuna Aquaculture Group Pty Limited being the other) that has ASC certification across all harvest sites. Tassal has consistently stated that it would be ideal if all three salmon growers in Tasmania were able to attain ASC certification across their entire businesses. Should this happen, it would be a global first to have an entire salmon industry ASC certified for all its harvest fish'

We estimate that 17 current GSI members, with 134 ASC certified sites accounted for 68% of a annualised total of 772,379T (WFE) certified output as Oct 2017, values in turn corresponding to 20% and 30% of an estimated global production of 2,596,700T in 2016. Norway, Chile and Canada lead with 60, 34 and 22 sites respectively. Despite promising progress we also estimate that 568,129T of GSI annual production capacity remains to be certified over the next 3 years to the 2020 commitment (we estimate 6 GSI members are close to achieving this goal) and presumably this residual also contains sites with more intractable certification issues. GSI membership, currently standing at 17, has fluctuated from 12 to 24 members since it's' inception in 2013. The early withdrawal of major Norwegian multi-nationals Leroy and SalMar was a notable set-back, though both companies remain committed to ASC certification. More challenging to wider reputational benefit could be free-riding effects of (smaller) companies lacking capacity to become certified and the slower certification rate and a greater de-certification propensity for non-GSI members (18% compared to only 3% of GSI sites).

Results also point to important inconsistencies between different standards setting schemes and approaches. Perhaps most notably GSI member NZ King Salmon is the only marine-cage salmon site to achieve Monterey Bay's coveted Seafood Watch 'green' status added to which 9 sites have also achieved GAA-BAP certification. Yet based on their average reported performance on a marine fishmeal feed efficiency (FFDRm) indicator on the GSI website, none of these sites, as yet appear capable of meeting the ASC threshold compliance requirement on this metric.

[33] http://www.tassal.com.au/wp-content/uploads/2017/09/1717106-2017-Annual-Report.pdf

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Appendix 1: Governing Sustainability

The importance of governing sustainability for the continued existence and progress of the human species has been globally recognised and reflected in a series of international efforts in sustainable development from the second part of the 20th century and continuing today, such as the World Commission on Environment and Development (or Brundtland Commission), where the most commonly accepted definition for sustainable development was set:

"…development that meets the needs of the present without compromising the ability of future generations to meet their own needs." WCED (1987)

The concept of what constitutes sustainable development has evolved over time to the present-day (2015) UN Sustainability Goals which cover three broad domains of sustainability: environmental, social and economic, and which are to be implemented and achieved by every country. The sustainable exploitation of aquatic ecosystems has been the core of initiatives relating to specific ecosystems such as "The Blue Economy" and "Blue Growth".

Private businesses are the main actors through which these goals are to be achieved. Different factors predispose businesses to engage in socially responsible behaviour (e.g. McWilliams et al., 2006), ranging from formal government action to voluntary initiatives.

At the government level, different instruments exist to enact these principles. In terms of environmental protection, three main approaches have been used: legislation and regulation (laws e.g. relating to licenses, discharge limitations), market-based principles, and voluntary agreements. Market-based (economic) instruments here mean these measures involving financial incentives or disincentives in influencing business behaviour e.g. environmental taxes/subsidies and tradable pollution permits, which have been also described as hybrid approaches between government regulation and free-market forces (Gunningham and Grabosky, 1998).

Governments may also use voluntary approaches, aiming to entice firms to improve their environmental performance beyond legal requirements. The main types of voluntary approaches include: public voluntary programmes, e.g. the EU's Eco-Management and Audit Scheme (EMAS), negotiated agreements, resulting from bargaining between a public body and an industry; and unilateral commitments, which are programmes set up by the industry independently of government but aiming at forestalling government regulation.

Apart from direct government involvement, however, businesses might be driven to change behaviour because of genuine ethical concerts emanating from within the business itself. The organisational culture may be attuned to ecologically or socially responsible approach to business, prioritised over considerations of economic benefits.

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Appendix 2: GSI Analysis Relational Database Management Systems

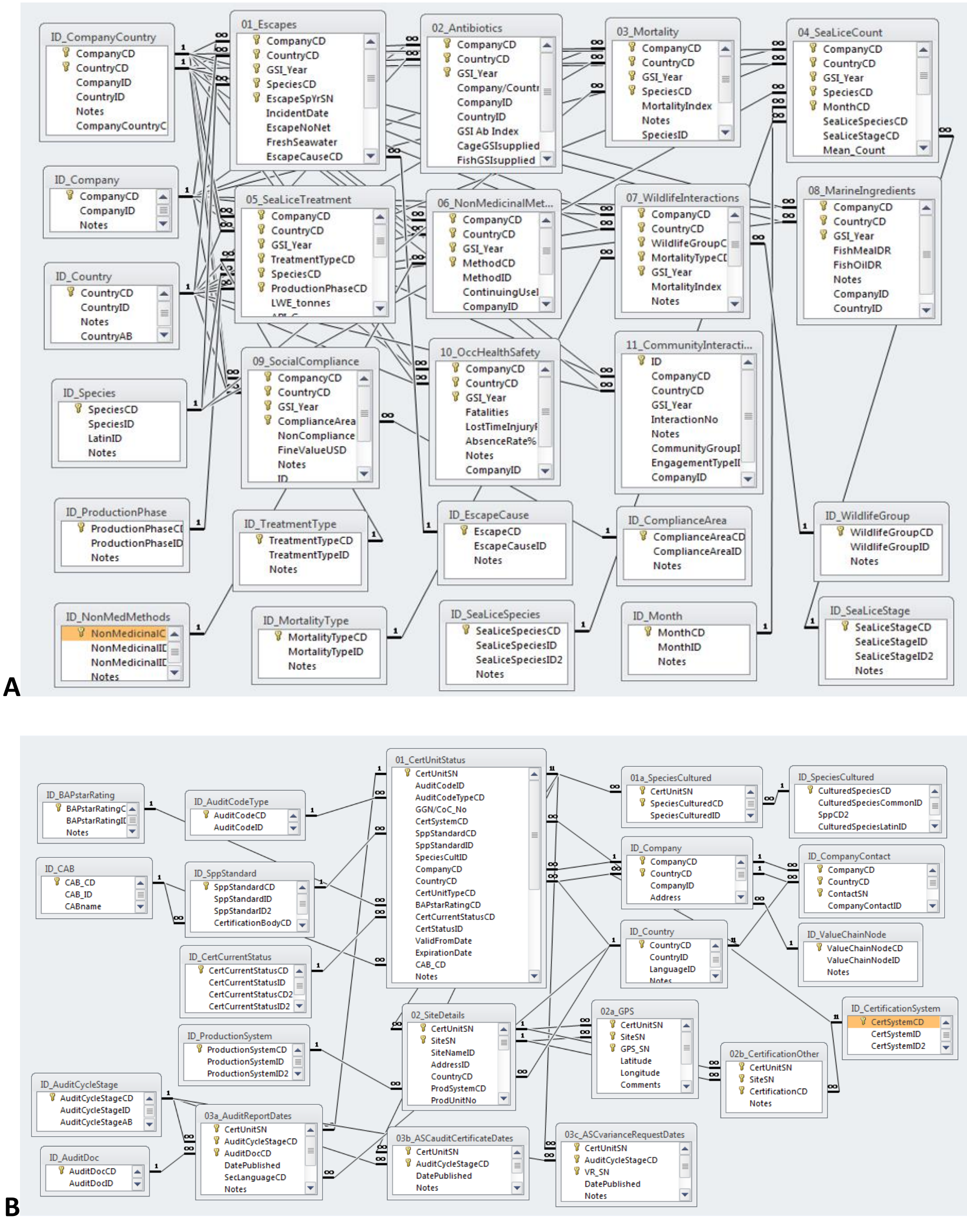

Figure A2a & A2b. Relational Database management system developed for analysis of (A) GSI sustainability report metrics data (B) ASC audit information for marine and FW salmonid sites operated by GSI and 'non-GSI' member companies

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Appendix 3: GSI Indicator Summary Data Tables

Table 10. Total escapes reported by species and country 2013 – 2016

			CompanyID						
			Aquachile	Bakkafrost	Cermaq	Grieg Seafood	Marine Harvest	Ventisqueros	Grand Total
GSI_Year	SpeciesID	CountryID	Sum of EscapeNoNet	Sum of EscapeNoNet	Sum of EscapeNoNet	Sum of EscapeNoNet	Sum of EscapeNoNet	Sum of EscapeNoNet	Sum of EscapeNoNet
2013	Atlantic Salmon	Chile	787,929		45,444		15,921	48,912	898,206
		Faeroes		68,500			3,000		71,500
		Norway					60,534		60,534
		Canada				1			1
		Scotland					210		210
		Total	787,929	68,500	45,444	1	79,665	48,912	1,030,451
	Coho Salmon	Chile			17,829				17,829
		Canada				250			250
		Total			17,829	250			18,079
	Total		787,929	68,500	63,273	251	79,665	48,912	1,048,530
2014	Atlantic Salmon	Chile					2,000		2,000
		Faeroes		47,403					47,403
		Norway				24,479	48		24,527
		Canada			21				21
		Scotland					4		4
		Total		47,403	21	24,479	2,052		73,955
	Total			47,403	21	24,479	2,052		73,955
2015	Atlantic Salmon	Chile			6,844		8,000		14,844
		Norway			500		65,000		65,500
		Canada			2				2
		Scotland					16,000		16,000
		Total			7,346		89,000		96,346
	Total				7,346		89,000		96,346
2016	Atlantic Salmon	Norway			425	200	5,000		5,625
		Canada			1		2		3
		Scotland				1,446	50		1,496
		Ireland					3,000		3,000
		Total			426	1,646	8,052		10,124
	Total				426	1,646	8,052		10,124
Grand Total			787,929	115,903	71,066	26,376	178,769	48,912	1,228,955

Table 11. Summary of GSI AUI scores across 12 companies and 8 countries 2013-2016

		GSI_Year				
		2013	2014	2015	2016	Grand Total
CountryID	CompanyID	Average of GSI Ab Index	Average of GSI Ab Index	Average of GSI Ab Index	Average of GSI Ab Index	Average of GSI Ab Index
Chile	Blumar	4.11	5.23	2.05	2.49	3.47
	Multiexport Foods	3.92	4.10	3.50	4.16	3.92
	Aquachile	1.85	3.15	3.44	2.74	2.80
	Camanchacha	2.41	2.49	2.91	2.68	2.62
	Ventisqueros	2.02	2.53	1.74	3.75	2.51
	Los Fiordos	1.30	1.62	1.52	1.86	1.58
	Cermaq	1.13	1.45	1.67	2.32	1.64
	Marine Harvest	1.15	0.96	1.45	2.82	1.60
	Total	2.24	2.69	2.29	2.85	2.52
Canada	Cermaq	0.79	1.27	1.80	2.30	1.54
	Marine Harvest	1.48	2.11	1.49	0.99	1.52
	Grieg Seafood	0.75	1.26	0.91	2.52	1.36
	Total	1.01	1.55	1.40	1.94	1.47
Ireland	Marine Harvest	0.27	0.76	0.31	0.24	0.40
	Total	0.27	0.76	0.31	0.24	0.40
Scotland	Marine Harvest	0.45	0.27	0.12	0.17	0.25
	Grieg Seafood	0.00	0.00	0.00	0.03	0.01
	Total	0.23	0.14	0.06	0.10	0.13
Australia	Huon	0.02	0.06	0.14	0.02	0.06
	Total	0.02	0.06	0.14	0.02	0.06
Norway	Cermaq	0.06	0.03	0.14	0.00	0.06
	Marine Harvest	0.00	0.01	0.00	0.00	0.00
	Grieg Seafood	0.00	0.01	0.00	0.02	0.01
	Total	0.02	0.02	0.05	0.01	0.02
Faeroes	Marine Harvest	0.00	0.00	0.00	0.00	0.00
	Bakkafrost	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00
Newzealand	NZ King Salmon	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00
Grand Total		1.03	1.30	1.10	1.39	1.21