Review of Seafood Research & Development Programs in Newfoundland and Labrador

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Department of Fisheries and Aquaculture

Submitted by:

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1. Context

CETA creates opportunities to expand the value of trade with the EU

The Canada-European Union (EU) Comprehensive Economic and Trade Agreement (CETA) was signed in October 2013, and is expected to enter into force in 2016. CETA provides a framework for eliminating tariffs on a range of goods and services traded between Canada and the EU. Tariffs will be eliminated on 99% of the province's seafood exports as soon as CETA enters into force, with 100% of products tariff-free within seven years.

The EU is an important market for the Newfoundland and Labrador (NL) fishing industry, in recent years accounting for as much as 25% of the province's total exports. Tariffs have cost the industry an estimated $25-30 million annually. Their elimination creates opportunities to expand the range and value of products, though success in seizing those opportunities depends in part on improving competitiveness through investments in such areas as research and development (R&D), measures to enhance the productivity and efficiency of the harvesting and processing sectors, and market development.

Objective: identify lessons from experience to guide R&D investment

Central to the agreement by NL to accept the CETA terms and conditions was the creation of a Fisheries Investment Fund that would provide resources to help the industry improve its capacity to compete more effectively in EU and global markets. Such support would build on existing initiatives with a similar aim. Over the past 25 years, various federal and provincial R&D programs have supported the growth and development of the fisheries and aquaculture industries in NL through cost-shared funding and loans totaling some $175 million (about $75 million for aquaculture).

This report provides a review of these programs, as well as similar R&D initiatives in other jurisdictions. The aim is to derive lessons from experience that would guide the future direction and investment that may be required through the Fisheries Investment Fund.

State of the industry – higher productivity, but uncertainty ahead

The NL fishing industry has been working through a protracted adjustment since the collapse of the cod and other groundfish stocks off its coast over 20 years ago. Against the backdrop of several reversals of fortune during the 1990s and 2000s, the industry emerged in 2014 with a record landed value ($645 million) and produced the highest level of exports in over a decade ($865 million).

While these output values are encouraging in their own right, they also embody higher levels of industry productivity: labour and capital in the industry have declined markedly since 1990, with the numbers of fishing vessels, harvesters, processing plants and plant workers all down by over 60%. To a large extent this reflects the shift to a shellfish fishery. And though the industry requires less labour it faces a serious challenge – a declining and aging workforce in coastal communities. Addressing this challenge would become more urgent with the return to a groundfish fishery.

From modest beginnings in the 1990s, aquaculture has emerged as a major contributor to the coastal NL economy, with the value of output approaching $200 million in 2013. Within the finfish sector, Atlantic salmon is the dominant species, with small quantities of steelhead trout and Arctic char also produced. The blue mussel dominates shellfish production, with efforts to culture oysters in the early stages.

2. R&D program support

R&D support reduces risk

Providing R&D support to private enterprises through publically funded programs is the norm in most industrial economies. It allows governments to target particular sectors that are crucial to national or regional economies, and which hold out the prospect for export-led growth and development. R&D support can be vital to offsetting the research and financial risks associated with technology, process and product development.

Several programs offer R&D support to fisheries and aquaculture in NL

- Department of Fisheries and Aquaculture (DFA) administers the Fisheries Technology and New Opportunities Program (FTNOP). Annual budget $2.0 million. Fisheries and aquaculture only.
- Canadian Centre for Fisheries Innovation (CCFI) plays an intermediary role with industry and academic partners, identifying industry needs and funding and/or managing R&D projects. Annual budget $0.5 million (funded by province).
- Research & Development Corporation (RDC) administers four programs: R&D Proof of Concept (POC), R&D Vouchers, Industrial R&D Fellowships, and Ocean industries Student Research Awards. Annual R&D investment: $22-24 million (all industries).
- Atlantic Canada Opportunities Agency (ACOA) administers the Business Development Program (BDP), Atlantic Innovation Fund (AIF) and the Innovative Communities Fund (ICF). Open to all industries.
- National Research Council administers the Industrial Research Assistance Program (IRAP). Annual budget $6-8 million for NL. Open to all industries.
- Fisheries and Oceans Canada administers the Aquaculture Collaborative Research and Development Program (ACRDP). National budget $2.0 million. Aquaculture only.

All programs impose eligibility criteria applying to sector of activity and status of applicant. Levels of funding support are limited by percentage of project cost covered (60-75%) and the maximum amount provided (ranging from $100,000 to $3.0 million). Programs tend to allow stacking or leveraging, allowing a project to secure funding from more than one program (up to the percentage limit). Funding support takes the form of grants under all R&D programs with the exception of ACOA's BDP, where funding for certain projects (e.g., aquaculture development) takes the form of interest-free loans.

3. Findings on program impact

Uptake by program varies from over subscribed to partially utilized

The available data indicate that current R&D programs have supported over 1,570 projects and provided almost $175 million in financial support to the fisheries and aquaculture industries over the past 25 years (Table S.1). Complete project data sets were not available at the time of writing for CCFI, IRAP and ACRDP.

- The distribution of program funding across sectors indicates that aquaculture has attracted slightly more funding than harvesting and processing combined. This reflects the substantial growth of this industry since 2000.
- ACOA: Aquaculture accounts for about 60% of project funds (, which have been used to establish or expand salmon farms under BDP (with support to the mussel sector also). Funds advanced under BDP have been primarily in the form of repayable loans, not grants. AIF has funded one aquaculture and two processing sector projects. Uptake by the aquaculture sector has been strong. Program managers explain that with the move away from grant funding in 1996, uptake by the fishing industry fell off sharply.
- FTNOP: Funds have been distributed about evenly between the harvesting and processing sectors, reflecting the original mandate (aquaculture was included in 2013). Uptake tends to be strong, with the applications for funding exceeding the annual budget.
- RDC: of the several programs offered by RDC, the R&D Proof of Concept aimed at prototype development and commercialization attracts the most interest from fisheries and aquaculture, though uptake is limited. Most (70%) of the projects tend toward the research end of the R&D spectrum, originating either with Memorial University or the Marine Institute. The program manager expressed the view that the program is not attracting “nearly enough” applications from industry, attributing this to the limited industry capacity to specify and implement projects, and also to the constraint imposed by need for a cash contribution from proponents.
- CCFI: supports projects in each sector (details not available prior to 2006). Annual uptake is sufficient to exhaust the budget.

Table S.1: R&D Program funding by sector

		Harvesting		Processing		Aquaculture		Total	
Years	Program	Projects	Funding	Projects	Funding	Projects	Funding	Projects	Funding
1989-2014	CCFI							761	33,555,168
1988-2014	ACOA	21	18,136,428	256	32,897,682	202	72,177,456	479	123,211,565
2007-2014	FTNOP	120	5,579,667	123	5,783,284	28	1,147,876	271	12,510,827
2009-2014	RDC	13	2,596,493	4	866,391	14	1,547,740	31	5,010,624
	Total	154	26,312,588	383	39,547,357	244	74,873,073	1,542	174,288,185

Source: DFA (FTNOP), CCFI, ACOA, RDC

Generally positive impacts, with a need to broaden participation

Formal evaluations conducted on three programs identify several positive impacts, along with a recognition that more needs to be done to attract participation by smaller enterprises in both the harvesting and processing sectors:

- Resource – improved understanding, enhanced sustainability
- Harvesting sector – improved gear technology, greater fuel efficiency, higher quality
- Processing sector – improved quality, great efficiency, product development, increased access to markets, improved competitiveness
- Aquaculture – new production technologies, improved fish production, greater production capacity

Key differences in program design limit the extent of overlap in delivery

The programs share a common goal, namely to enable the NL fisheries and aquaculture industries to compete effectively in global markets through continuous improvement in productivity, quality, diversification and sustainability. Though there is some overlap in scope and eligibility, there are important differences in these features, and also with respect to mode of delivery, cost coverage, form of funding and funding limits.

Gaps in program delivery are attributable to program design and industry capacity

Generally, industry feels the current programs cover the ground well in terms of the range of R&D support provided, whether through own resources or third-party contractors (including academic institutions). Industry representatives consulted during this study expressed confidence in the quality of technical advisors, institutional capabilities and the excellence of test facilities.

Nonetheless, some gaps exist, both on the supply side (program delivery) and the demand side (industry). The more serious ones would appear to lie with industry with respect to its capacity to taking advantage of R&D opportunities.

- **Terms of access:** Only one program that is readily accessible by industry – FTNOP – provides grant assistance that extends to equipment (alternative/innovative technology). This makes it an attractive option for those seeking R&D support, and not surprisingly, the limited budget is fully subscribed. The other programs (RDC, IRAP, ACRDP, CCFI) essentially cover only soft costs, or offer loans, not grants.
- **Industry financial capacity:** The issue of terms of access becomes a gap when considered in the context of industry ability to participate. Grant support for innovative technology limited and requires the applicant to cover part of the project cost. Requiring applicant equity is entirely reasonable, but much of the NL fishing industry (harvesting and processing) simply lacks the financial capacity to participate, thereby limiting uptake.
- **Industry resources**: A relatively short list of companies has participated in R&D programs because many in the industry lack the resources to identify opportunities to improve productivity and efficiency, to prepare proposals, and to implement R&D projects to exploit those opportunities.
- **Collaboration**: The lack of collaboration in the industry inhibits implementation of the kinds of industry-wide R&D initiatives that would benefit all stakeholders (whether harvesting or processing technology, or marketing efforts); and, it can inhibit the diffusion of results from R&D projects conducted by individual companies. The industry is the first to admit collaboration is elusive.

4. Lessons from R&D program experience

Commonality among programs and lessons learned

The NL, Norwegian and Icelandic R&D programs share one important feature – the commonality among objectives and priority areas. And notwithstanding the absence of formal program evaluations that identify and measure impacts, the results of consultations with program managers also indicate some commonality among key lessons learned.

R&D success relies on a progressive industry with a strong market focus
If the industry is to extract as much value as possible from the resource, then developing a market focus on quality is the starting point. Education, industry-wide commitment, and a supportive policy framework are essential to achieving this focus.

Industry needs sufficient interest and resources to engage in R&D
The issue in NL would not appear to be a lack of awareness about the availability of R&D support; nonetheless, further steps may be needed, e.g., an extension program to develop interest and advise on programs and options. If a lack of resources is the issue, then this raises the policy question of whether eligibility criteria should be tailored to reflect capacity.

Industry needs institutional capacity to design and conduct R&D projects
The NL fishing and aquaculture industries benefit from considerable institutional R&D capacity. This is evident from the role played by CCFI and the Marine Institute and by the FFAW and NAIA in implementing projects with industry-wide impacts. A close look at the project lists of the various programs reveals that goods and services suppliers to industry have also participated as proponents, but only to a limited extent. Participation is encouraging because these linkages to other sectors contribute to the economic importance of the industry and strengthen its ability to grow and develop.

Effective technology and knowledge diffusion to industry is essential
Notwithstanding requirements to provide results of publicly funded R&D, it requires special efforts to ensure knowledge diffusion actually occurs in a timely fashion. Further work may also be needed to promote uptake, including greater emphasis on using a top-down approach to identify, design and implement R&D projects with industry-wide potential. This is not just a matter of financial resources on the part of the potential client group, but also a question of having or creating a progressive, innovative culture.

Adequate long-term funding to support R&D programming
The federal and provincial governments have provided almost $175 million in R&D support to the NL fisheries and aquaculture industries over the past 25 years. This support has facilitated the transition from an industry based on groundfish, to one sustained by shellfish. The fisheries industry now appears to be facing a transition back to groundfish. This transition will require substantial R&D support if the industry wishes to compete in today's market.

5. FIF priorities and delivery options

Investment is recommended in each segment of the seafood value chain
The seafood value chain extends from the water to the table, and each link requires strengthening in order to meet market requirements and to maximize the value of the resource. Using a top-down approach to design and implement projects with sector- and industry-wide application could be used to address limited uptake by smaller enterprises.

- **Harvesting**: the general objective is to land higher quality fish over a longer season, while meeting resource sustainability goals. For all fisheries – whether shellfish or eventually groundfish – this requires investigation of options with respect to gear technology, vessel characteristics and fleet size, and training to adapt to stricter quality and sustainability standards. Some combination of fleet adaptation and investing in larger and more capable vessels to meet extended season, quality and sustainability objectives would seem to be needed. All fisheries would eventually require certification that the resource is being harvested sustainably.

- **Logistics**: moving raw material efficiently from landing sites to processing plants is a key requirement for maintaining quality. This has presented a challenge for the industry over the years, and could do so in the future with the transition to a groundfish fishery. Logistics requires careful consideration in planning and allocating FIF resources.
- **Processing**: with limited groundfish processing capacity in NL, the combined pressures of a resurgent groundfish resource, scarcity of labour, and the need to meet new and strict product and market requirements, means that investment in processing capacity is essential. This may take the form of new plants as well as adaptation of existing facilities (in strategic locations), including in both cases investment in equipment to automate processing operations. Plants would benefit from third-party certification to the BRC standard, with full product traceability.
- **Labour**: The workforce in coastal communities is declining and ageing. Policies and programs to facilitate fleet consolidation are beginning to show results, but representatives indicate that further adjustment is needed, not just to address labour issues, but also to improve income levels. For the processing sector, investment in plant automation would seem to be essential.
- **Marketing**: Elimination of tariffs presents opportunities for all products, shrimp and snowcrab in particular. Groundfish recovery would also offer potential, but gaining access to the EU market would present a major challenge to NL exporters, given the dominant position held by Iceland, Norway and EU member states. The same argument could be made for the US market. Regardless of species and product, considerable resources will have to be devoted to market development.

Deliver FIF support through a specialized agency

Much remains to be done to plan and shape the size, scope, objectives and structure of the FIF, making a preferred delivery option difficult to define. Among the options: Status Quo (DFA and ACOA as lead agencies for defined aspects of the respective FIF contributions); Distributed Programming (assign FIF components to specialized agencies); Single Window (assign responsibility to a single agency, with federal and provincial representation). Each has its pros and cons.

The preferred option would appear to be a single window, one that combines industry knowledge with experience in delivering R&D programming to the fisheries and aquaculture industries. CCFI is one possibility. The organization would operate within a governance structure (board of directors) composed of stakeholders from key sectors. The Board would establish objectives, strategy, priorities, a provisional allocation of funds among priorities, and operating guidelines (eligibility criteria, funding guidelines, application and award process, reporting, evaluation).

Making optimal use of FIF resources requires a measured approach

The FIF timetable should be determined, not by a schedule, but by careful consideration of industry objectives and needs, as well as its capacity to absorb the level of support contemplated. The objectives and needs will be determined by resource and fishing opportunities, and also by market requirements and competitive conditions. These factors can be expected to shift over time, so priorities and allocations under the FIF should allow for adaptation to changing circumstances.

1. Background and objective

1.1 CETA and the Fishery Investment Fund

Internal discussions within the EU aimed at developing an agenda for competitiveness in the global economy, including a revised trade policy, began in 2005. The initiative gained focus and momentum in 2008 during the Canada-Europe Roundtable, with formal negotiations launched in May 2009 following publication of a joint Canada-EU Scoping Report that established a negotiating agenda. The agenda covered trade in goods and services, investment, government procurement, regulatory cooperation, intellectual property, labour mobility, competition policy and environment. The proposed agreement was formally named the 'Comprehensive Economic and Trade Agreement' (CETA).

Following several rounds of negotiations over four years, the Government of Canada announced the signing of an Agreement-in-Principle on CETA in October 2013. Working out the detailed provisions has taken another year, with the Agreement signed in September 2014. CETA is expected to enter into force in 2016, following ratification by the parties.

Eliminating tariffs for goods and services entering the EU was one of the main negotiating objectives for Canada. To a large degree, this objective was achieved. Tariffs will be eliminated on 95% of seafood products as soon as CETA enters into force, with 100% of products tariff-free within seven years thereafter.

Within two weeks of the CETA announcement, the Premier of Newfoundland and Labrador announced the creation of a $400 million federal-provincial Fisheries Investment Fund aimed at "assuring the success of provincial harvesters and processors as they deliver products to tables in the European Union, and throughout the world". The fund, cost shared on a 70:30 basis by the federal and provincial governments, is widely seen as a trade-off for the province's agreement to eliminate Minimum Processing Requirements (MPR) for the EU market.[1] The announcement indicated that the fund would be released once CETA is fully in place, with spending phased-in over a three-year period (consistent with the phase-out period of MPR).

Specifics about how the fund will be used have not been developed. The public statement announcing the fund (Oct. 29, 2013) casts the net broadly, identifying four main pillars: "The fund will be used to invest in research and development, new marketing initiatives, fisheries research, and enhancements to provincial fisheries infrastructure, all with the goal of improving the industry's capacity to compete globally". The official expectation is that elimination of the trade barriers coupled with a resurgent fishing industry will "…add an estimated $25-30 million back into the fishing industry through immediate tariff relief each year, in addition to establishing new opportunities that could add over $100 million annually to the industry."

[1] Minimum Processing Requirement stipulates that fish intended for marketing must be directed into a product form that meets final market specifications. The requirements are authorized under the NL *Fisheries Act, Fish Inspection Act* and *Fish Inspection Regulations*, and issued by the Minister of Fisheries and Aquaculture as a condition of all fish processing licences. The MPR are intended to maximize the economic and employment benefits of the fishery resource for the people of Newfoundland and Labrador.

1.2 Objective and scope of work

Against the backdrop of the current state of the industry, the Fisheries Investment Fund (the 'Fund') has the potential to contribute greatly to improving industry competitiveness and putting it on a path to greater viability, thereby providing an excellent basis for taking advantage of the opportunities arising from CETA as well as global markets more generally.

Though the pillars for fund support have been identified, considerable work remains to be done to flesh out Fund specifics, including programs, funding levels and delivery mechanisms. This assessment of past and current R&D programs is intended to identify lessons learned, and specifically successes and failures and factors contributing thereto, and thereby providing key input into developing these Fund specifics.

To this end, the main objective of this project is to:

- Provide a review of existing and past seafood research and development programs in Newfoundland and Labrador, assess key successes and failures, and make recommendations for future direction and investment that may be required through the Fisheries Investment Fund.

The scope of work covers past and existing federal and provincial programs that support seafood value chain research and development activities for aquaculture, fish harvesting and processing. The RFP identifies several key programs including:

- DFA's Fisheries Technology and New Opportunities Program (FTNOP)
- Canadian Centre for Fisheries Innovation (CCFI)
- ACOA's Atlantic Innovation Fund (AIF), Business Development Program (BDP) and Innovative Communities Fund (ICF)
- NRC's Industrial Research Assistance Program (IRAP)
- Research and Development Corporation (Business-led and Academic-led Programs)
- DFO's Aquaculture Collaborative Research and Development Program (ACRDP)

1.3 Approach

The conclusions and recommendations contained in this report are based on a combination of document review and interviews. The study scope and schedule ruled out primary data gathering. More specifically:

- **Document review:** we obtained program descriptions, and where available, take-up and expenditure results by industry sector (fish harvesting and processing – both large and small scale processors – and aquaculture), and interim and final evaluations of results and impacts. Documents were also reviewed for lessons learned about the factors contributing to success/failure and impacts, and for any recommendations for future program design.

- **Interviews:** we conducted interviews with each department/agency program manager to gain insight into the design and implementation of the various programs, and to obtain perspectives on factors contributing to take-up, delivery, and success or failure in achieving program objectives. We also conducted interviews with industry representatives in each sector to gain their insights into program design of and participation in the various programs. These interviews are particularly important since they provide guidance on what has worked or not worked in the past and why, while also providing valuable input on recommendations for Fund program design and implementation.

1.4 Contents

Following this introduction, Chapter 2 provides an overview of the state of the NL fishing industry, describing shifts in resource abundance and effects on landings, exports and harvesting and processing capacity. This is followed by a brief look at developments in the aquaculture sector, and finally, a breakdown of global markets for NL fisheries and aquaculture products.

Chapter 3 contains an overview of R&D programs in NL, providing details of program objectives and delivery, sector and eligibility criteria, forms and levels of funding support, as well as summary data on program specifics: number of projects, overall funding and total expenditures over the lives of the programs.

Chapter 4 examines program performance, with a focus on uptake by sector and program. It presents a detailed breakdown of uptake by industry component – harvesting, processing and aquaculture – cross-referenced against various participant groups within the industry: inshore and offshore harvesting, large and small processors, suppliers of goods an services, shellfish and finfish producers, industry associations, institutions and government. A detailed breakdown of program support by type of project is also provided in order to gain insight into priority areas as determined by industry. Chapter 4 closes with an overview of program impacts.

Chapter 5 contains a review of R&D programs in other jurisdictions, specifically, Iceland (Added Value for Seafood, AVS), Norway (Fishery and Aquaculture Research Fund, FHF) and the U.K. (European Maritime and Fisheries Fund, EMFF). The review covers mandate, history, objectives, funding level and arrangements, program criteria and operations, and impacts where available. Concluding observations highlight key success factors and lessons learned.

Chapter 6 looks ahead with an assessment of issues affecting Fisheries Investment Fund program design, including program delivery with a focus on areas of overlap among existing programs and any gaps in delivery in terms of access to funds, industry financial capacity, industry resources, and the prospects for collaboration.

Chapter 7 sets out key areas for Fund investment within each of the sectors, and then turns to an assessment of options for delivery, within existing programs or through mechanisms external to government.

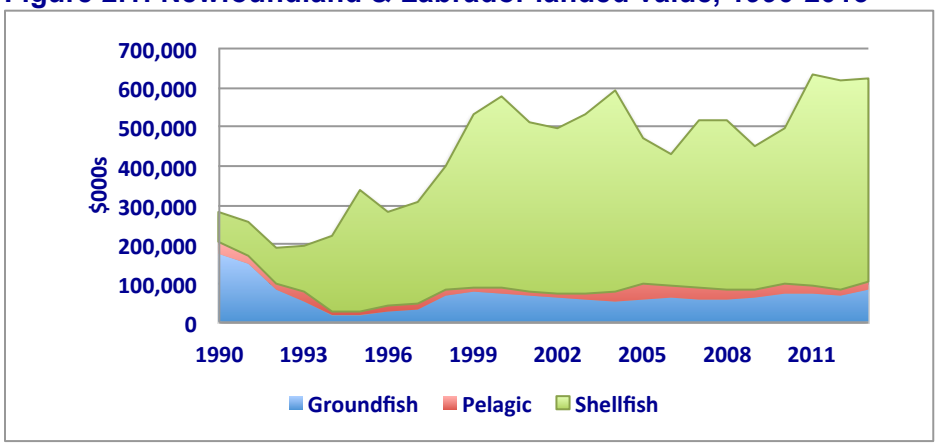
Each chapters ends with concluding observations by the consultant.

2. The state of the NL seafood industry

2.1 Capture fisheries

The NL fishing industry has been working through a protracted adjustment since the collapse of the cod and other groundfish stocks off its coast over 20 years ago. Against the backdrop of several reversals of fortune during the 1990s and 2000s, the industry emerged in 2011 with a record landed value (Figure 2.1 and Table 2.1), and in 2014 produced the highest level of exports in over a decade ($865 million). These achievements are all the more impressive given that they were realized through a substantial increase in industry productivity, as capital and labour have declined by over 60% in the past 25 years.

Figure 2.1: Newfoundland & Labrador landed value, 1990-2013



Source: DFO

The growth of shrimp and crab stocks in the 1990s mitigated the impact of the groundfish crisis somewhat, but it created its own set of adjustment challenges. Though much harvesting and processing capacity was withdrawn from the industry over the years, much was also added (mainly shrimp and crab processing plants) and re-purposed (mainly fishing vessels shifting from groundfish to shrimp and crab).

The transition from a groundfish to a shellfish industry in the decade between 1990 and 2000 was difficult, due to plant closures and the challenges surrounding decisions on the number and location of new capacity. The process was also costly, with hundreds of millions spent on adjustment measures for the thousands of individuals affected by the cod moratorium.

As various reports indicate, the adjustment process created too much plant capacity, which too often was located some distance from landing sites, thereby adding to transportation cost and affecting quality. The inshore shrimp fleet, the beneficiary of large allocations as stocks increased, consisted of converted groundfish vessels, most of which faced difficulties in landing high quality raw material. The crab fleet grew from a few hundred to over 3,000 vessels. In both fisheries, the substantial increase in harvesting capacity resulted in short seasons, gluts, intense competition for raw material, cash flow constraints for plants and limited scope for product and market development.

Table 2.1: NL landed value by species, selected years, 1990-2013 ($000s)

	1990	1995	2000	2005	2010	2013
Groundfish						
Cod	134,600	908	43,059	17,415	12,122	8,215
Haddock	875	92	216	255	117	78
Redfish spp.	7,340	1,956	3,360	3,590	1,603	5,907
Halibut	830	767	1,702	2,757	3,405	5,576
Flatfishes	16,742	1,355	10,376	12,873	6,360	14,697
Turbot	13,853	11,703	14,427	18,710	50,921	50,257
Pollock	607	291	334	254	199	93
Hake	155	583	388	1,350	179	233
Cusk	0	3	0	2	1	0
Catfish	143	88	209	16	0	0
Skate	1	1,577	324	360	86	42
Dogfish	0	3	0	1	0	0
Other	115	539	311	2,569	405	272
Total	**175,260**	**19,866**	**74,706**	**60,150**	**75,399**	**85,368**
Pelagic & other finfish						
Herring	3,493	3,362	2,611	6,143	5,156	8,149
Mackerel	856	653	1,467	20,693	14,627	2,836
Swordfish	16	585	1,430	166	0	0
Tuna	2,004	146	2,328	275	256	175
Alewife	0	0	0	0	0	0
Eel	560	431	341	30	194	196
Salmon	2,714	351	0	0	0	0
Smelt	32	27	3	1	0	1
Capelin	20,059	52	3,605	10,241	2,939	6,021
Other	203	311	106	21	32	42
Total	**29,937**	**5,917**	**11,890**	**37,572**	**23,208**	**17,421**
Shellfish						
Clams/quahaug	3,345	17,531	12,829	18,112	35,093	35,670
Oyster (1)	2	0	0	0	0	0
Scallop (2)	624	14,277	4,227	7,345	1,719	3,281
Squid	1,086	32	133	95	57	0
Mussel (3)	42	33	0	0	0	0
Lobster	12,700	24,595	19,282	32,755	18,851	17,526
Shrimp	47,292	79,283	183,986	174,509	181,963	237,263
Crab, Queen	13,159	176,207	268,002	140,190	155,448	219,458
Crab, Other	0	1,228	667	405	197	61
Sea urchin	0	340	1,431	327		1,159
Other	1	32	283	1,232	4,876	7,565
Total	**78,252**	**313,559**	**490,839**	**374,970**	**399,920**	**522,515**
Seafish/Shellfish	283,449	**339,343**	**577,435**	472,692	498,527	625,304
Marine plants	0	0	0	0	0	0
Lumpfish roe	1,303	7,839	4,603	4,145	1,365	0
Miscellaneous (4)	754	2,117	2,281	17,202	10,806	14,563
Total	2,057	9,956	6,884	21,348	12,171	14,563
GRAND TOTAL (5)	**285,506**	**349,299**	**584,319**	**494,040**	**510,699**	**639,868**

http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2013av-eng.htm

By the early 2000s, the industry found itself in a weak position to address its several underlying issues. These issues, finding their expression in the precarious financial health of the industry, only became more acute as the decade progressed. An in-depth review of the processing sector in 2003 served to highlight the challenges and provided several recommendations aimed at controlling capacity, promoting its more effective utilization, and providing a basis for rationalization.[2] Considerable controversy surrounded the implementation of certain key recommendations.

The collapse of crab markets and weak shrimp markets in 2005-2006 – these two species accounted for over 75% of industry landed value prior to the market collapse – brought the industry to a crisis point. In May 2006, the provincial and federal governments set in motion a Fishing Industry Renewal (FIR) process aimed at creating "…a sustainable, economically viable, internationally competitive and regionally balanced industry…" Industry restructuring formed a key strategic thrust. The process relied mainly on several rounds of industry consultations, which produced a diverse set of recommendations but no consensus.

Nonetheless, in early 2007 the federal and provincial governments each produced a set of recommendations aimed at improving efficiency and productivity in harvesting and processing sectors, while recognizing it would take some years for the measures implemented to achieve their objectives. Among the federal measures were allowing enterprises to combine licences, changes to the vessel replacement policy. Among the provincial measures was the creation of the Fisheries Technology and New Opportunities Program (FTNOP) and a recommendation to create a seafood marketing council (the latter ultimately failed to gain support from industry).

The global recession in 2008 resulted in sharp downward pressure on seafood prices in key markets in 2009, further undermining the financial position of the NL harvesting and processing sectors. This created a challenging environment for the collective bargaining process to produce acceptable shore prices for shrimp and crab. A protracted strike over shrimp prices caused the provincial government and the parties to realize that they could not expect markets to provide an answer to the industry's poor financial health; the time had come to take restructuring seriously in order to reduce capacity and costs.

The upshot was a Memorandum of Understanding (MOU) on Fishing Industry Rationalization and Restructuring entered into in July 2009 by the provincial government, the FFAW and the Association of Seafood Producers (ASP). The MOU was designed to provide the level of financial analysis needed to inform the debate on the rationalization and restructuring needed to ensure the long-term stability of the fishing industry. The MOU report, completed in early 2011, concluded that:

- One- to two-thirds of vessels were not viable (prices too low; costs too high). To provide a reasonable return on equity and acceptable incomes for owners and crews in the inshore fleet would require levels of rationalization ranging from 30 to 80%, and for the nearshore fleet (larger vessels), levels ranging from 0 to 50%. The ranges depend on licenses held and fishing areas.

[2] Eric Dunne, *Fish Processing Policy Review*, 2003.

- The level of profitability of the processing sector was below Canadian seafood norms and not sufficient to all companies to secure capital for investments needed to achieve long-term viability. To achieve acceptable profitability levels would require a minimum cut of 30% of processing capacity in both the crab and shrimp sectors. To become globally competitive would require restructuring through "…technological innovation that utilizes a highly skilled workforce and produces a supply of high quality, differentiated products to distributors who are willing to pay premium prices."[3]

The industry put forward a price tag of $450 million to achieve these rationalization and restructuring goals. The provincial government reviewed the proposals but rejected most of them for want of detail on how they would achieve the restructuring objectives.

Against the backdrop of the major resource shifts and adverse market conditions, the levels of labour and capital in the industry have declined markedly, reflecting a major improvement in productivity. The changes are summarized in Table 2.2 using key industry statistics. What is not evident from these figures is the demographic challenge facing the industry – it employs an aging workforce in coastal communities that are themselves aging as the younger demographic seeks opportunities elsewhere. Faced with this reality, the operators of fish processing plants consulted as part of this study see no alternative but to rely increasingly on automated systems to meet production needs.

Table 2.2: NL fishing industry – key statistics, 1980-2014

Number	1980	1990	2000	2010	2014p
Fishing vessels	19,684	16,636	9,227	7,884	6,916
Harvesters (registered)	28,587	28,830	14,102	10,943	9,465
Processing plants	214	268	148	121	86
Plant workers	20,148	30,098	12,400	10,090	7,881
Landings (tonnes)					
Groundfish	392,800	336,600	69,109	39,663	34,372
Shellfish	41,700	47,300	162,961	198,601	151,203
Pelagic	64,200	160,000	49,913	83,625	57,980
Landed value (current $)	165,900	285,506	584,319	510,699	645,154

DFO http://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/vess-embarc/ve10-eng.htm

DFA http://www.fishaq.gov.nl.ca/stats/industry/index.html

DFA http://www.fishaq.gov.nl.ca/publications/SYIR_2014.pdf

Cashin, R. 1993, Charting a New Course: Towards a fishery of the future, Appendix C

DFO http://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm

The main contributors to industry revenues – crab and shrimp – face resource challenges. The shrimp resource has declined in recent years, resulting in cuts to quotas, particularly to the inshore sector. This has adversely affected not just the inshore fleet, but also the 10 shrimp processing plants dependent on this source of supply. Though crab quotas and landings have remained steady in the past few years, DFO indicates that recruitment is expected to decline in the next 2-3 years due to a recent warm oceanographic regime that could affect recruitment in the long term. On the positive side, the warming waters also seem to be contributing to a recovery of cod stocks, contributing to speculation that a fishery could resume in northern waters in the next 5-10 years.

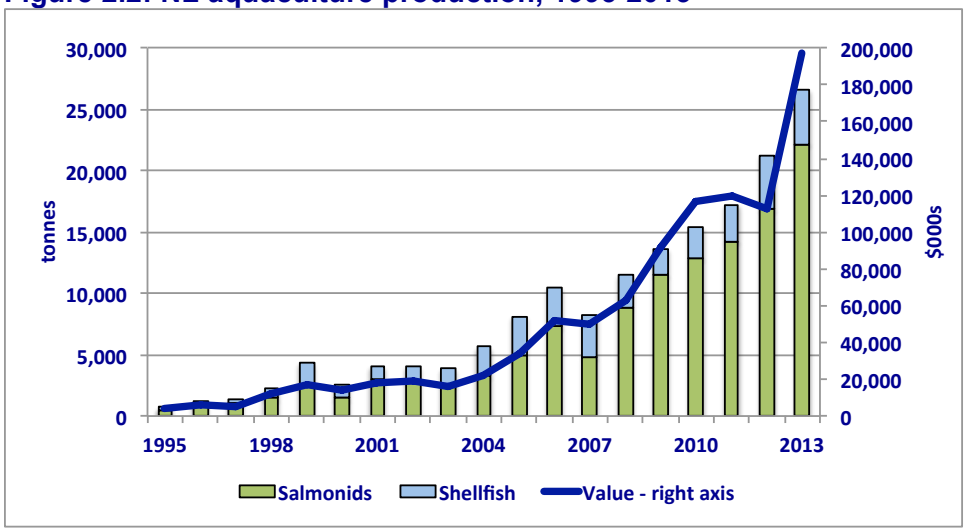
[3] Report of the Independent Chair: MOU Steering Committee, *Newfoundland and Labrador Fishing Industry Rationalization and Restructuring*, 2011.

2.2 Aquaculture

From modest beginnings in the 1990s, aquaculture has emerged as a major contributor to the coastal NL economy. Within the finfish sector, Atlantic salmon is the dominant species, with small quantities of steelhead trout and Arctic char also produced. The blue mussel dominates shellfish production, with efforts to culture oysters in the early stages.

Preliminary data show that the value of production approached a record $200 million in 2013, accounted for mainly by Atlantic salmon (Figure 2.2). Production data indicate a period of relatively slow growth between the mid-1990s and early 2000s, followed by rapid expansion after 2005. Among the factors contributing to this expansion were the recognition within the industry of the excellent biophysical conditions in the Coast of Bays region, the limits to expansion facing industry in other provinces, and the direct and indirect support in the form of financial and research assistance provided to companies through provincial and federal funding programs. The industry has benefitted from considerable research into biophysical conditions and production techniques, as well as investment in infrastructure support (laboratories, wharves, roads, etc).

Figure 2.2: NL aquaculture production, 1995-2013



Source: DFA

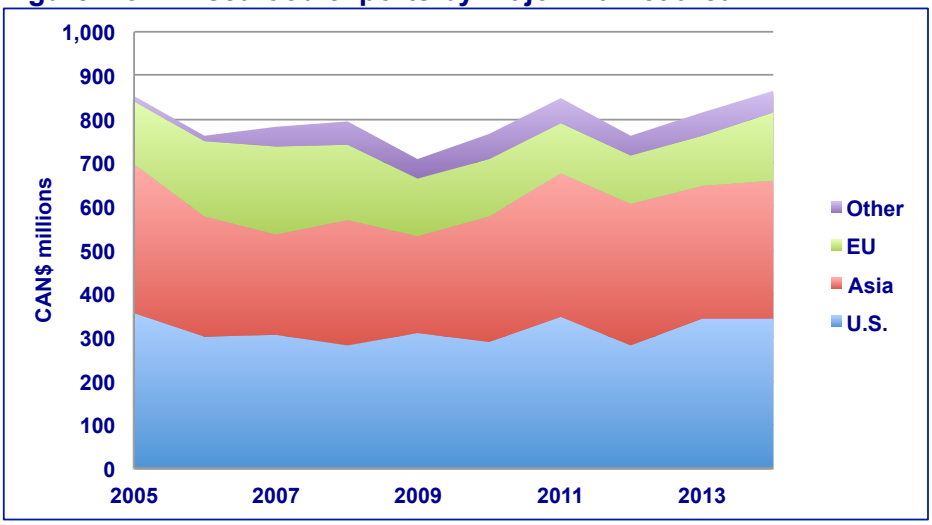
2.3 The CETA opportunity

CETA represents an attractive opportunity for the NL seafood industry. As soon as CETA enters into force, 99% of NL's seafood products would enter tariff-free. Tariffs represent a major competitive obstacle to a wide range of seafood products from Canada generally, adding as much as 20% to product costs. NL products such as cooked and peeled shrimp, frozen shrimp, fresh halibut, salmon, and frozen herring and mackerel face tariffs in the 12-20% range. To support the negotiations, the Government of Newfoundland and Labrador agreed to eliminate the MPR on exports of fish and seafood to the EU over a three-year transition period after CETA enters into force.

What CETA might mean to NL in dollar terms is difficult to say. The EU is the world's largest seafood market, with per capita consumption expected to continue to increase. With declining fish stocks in European waters, the EU has been relying increasingly on imports, particularly for whitefish species (cod, haddock, pollock). The NL seafood industry exports to the EU consist mainly (±90%) of shrimp (cooked & peeled and frozen), but overall, the EU market ranks behind the U.S. and Asia for NL, accounting for about 18% of total seafood exports from the province in 2014 (Figure 2.3). This is down from a 25% share in 2007, when C&P shrimp were double the 2014 value.

The importance of the EU to NL could change substantially over the next several years, with the elimination of end-use restrictions on C&P shrimp and if species such as snowcrab, now subject to tariffs, are marketed successfully. Also, the EU represents a well-developed market for groundfish. If the recovery of northern cod provides the basis for a return to a commercial fishery in the coming years, the EU could provide an excellent market opportunity. But seizing this opportunity would require a major re-development of the NL harvesting and processing sectors to be able to compete effectively with suppliers such as Norway and Iceland.

Figure 2.3: NL seafood exports by major market area



Source: Statistics Canada

2.4 Concluding observations

The NL fishing industry has been working through a protracted adjustment since the collapse of the cod and other groundfish stocks off its coast over 20 years ago. Against the backdrop of several reversals of fortune during the 1990s and 2000s, the industry emerged in 2014 with a record landed value ($645 million) and produced the highest level of exports in over a decade ($865 million).

While these output values are encouraging in their own right, they also embody higher levels of industry productivity: labour and capital in the industry have declined markedly since 1990, with the numbers of fishing vessels, harvesters, processing plants and plant workers all down by over 60%. To a large extent this reflects the shift to a shellfish fishery. And though the industry requires less labour it faces a serious challenge – a declining and aging workforce in coastal communities. Addressing this challenge would become more urgent with the return to a groundfish fishery.

3. R&D program overview

3.1 The programs

Providing R&D support to private enterprises through government programs is the norm in most industrial economies. It allows governments to target particular sectors that are crucial to national or regional economies, and which hold out the prospect for export-led growth and development. R&D support can be vital to offsetting the research and financial risks associated with technology, process and product development.

Funding for R&D in the fisheries and aquaculture industries is available through several provincial and federal programs in NL. The main provincial programs are:

- Department of Fisheries and Aquaculture (DFA) administers the Fisheries Technology and New Opportunities Program (FTNOP) and the Aquaculture Capital Equity Program (ACEP).
- Canadian Centre for Fisheries Innovation (CCFI), playing an intermediary role with industry and academic partners, to identify industry needs and fund and/or manage R&D projects (Technical Assistance – TA);
- Research & Development Corporation (RDC) administers four programs: R&D Proof of Concept (POC), R&D Vouchers, Industrial R&D Fellowships, and Ocean industries Student Research Awards.
- Business, Tourism, Culture and Rural Development (BTCRD) administers three programs: Business Investment Program (BIP), the Regional Development Program (RDP), and the Fisheries Loan Guarantee Program (FLGP).

The main federal programs are:[4]

- Atlantic Canada Opportunities Agency (ACOA) administers the Business Development Program (BDP), Atlantic Innovation Fund (AIF) and the Innovative Communities Fund (ICF);
- National Research Council administers the Industrial Research Assistance Program (IRAP);
- Fisheries and Oceans Canada administers the Aquaculture Collaborative Research and Development Program (ACRDP);

These programs may be divided into two broad categories: most focus mainly on providing financial and technical assistance for R&D in the strict sense of the term, while one focuses more on providing financial assistance for business investment, expansion or innovation (often with little or no funding of actual R&D). This high-level distinction is important for differentiating programs and their impacts, and for understanding why some programs attract greater uptake than others. That said, in practical terms, the

[4] Not included in this report is the Natural Sciences and Engineering Research Council of Canada (NSERC). It provides grant funding for basic research, not applied R&D, in the fields of natural sciences and engineering. Researchers at Memorial University and the Centre for Cold Ocean Research have been awarded research grants (covering all categories) with a total value in the $6-8 million range annually since 2000. Researchers active in the fields of fisheries and aquaculture have been awarded research grants totaling $3.5 million since 2000.

distinction is not always clear; programs in one category may shade over into another for certain projects. Accepting this distinction, the programs are divided into the two categories in Table 3.1. Six of the 11 programs fall into the R&D category, while five are essentially financial assistance programs. Of the latter, BDP and ACEP have provided the major sources of funds for companies seeking to establish or expand their enterprises. ICF and RDF have been utilized minimally if at all, while FLGP provides guarantees, but does not actually advance funds unless bank loans are in default.

Table 3.1: Fisheries/aquaculture programs by category

R&D programs	Financial assistance programs
DFA - FTNOP	ACOA – BDP/ICF
CCFI - TA	DFA – ACEP
RDC - POC	BTCRD – RDF & FLGP
ACOA - AIF	
NRC - IRAP	
DFO - ACRDP	

Four caveats are in order before examining program details. These concern: specifying uptake by sector, distinguishing pure R&D from investment assistance, quantifying the extent of leveraging, and reporting on impacts.

- **Uptake by sector**: sector uptake information is good for most programs, but insufficient detail is provided in some program reports to identify actual proponents and to which sector they belong. Sometimes project titles provide guidance, but even this information is not always conclusive. In light of this constraint, sector uptake estimates should be regarded as indicative rather than definitive.
- **R&D vs. investment assistance:** a minor point perhaps, but some projects listed as R&D would appear to fall more appropriately into the investment assistance category because funding supports the acquisition of established technology (though perhaps innovative in NL), rather than its local development. While from a productivity standpoint this is a good thing, such investment should not be confused with the process and outcomes of R&D.
- **Leveraging**: leveraging refers to the use of program funds to secure funds from other sources, including other R&D programs. All programs require proponent contributions, which could include funds obtained from other programs. Programs track leverage ratios as an indicator of the program's value/importance to project proponents as well as to broader program objectives, but this information is not always available in standard reports.
- **Impacts**: while short-term outputs of individual projects may be relatively easy to measure, measuring how projects affect proponents and the industry more generally in the longer term presents a challenge, given the range of factors influencing impacts and the difficulty of isolating the project contribution. Judging from program reviews, in too few instances were impact indicators selected and data systematically collected at the project level that would have enabled impacts to be measured. Consequently, program impacts, if measured at all, tend to be expressed in qualitative terms.

3.2 Program profiles

Whether targeted specifically at the fisheries and aquaculture industries, or more generally at a broader spectrum of industry sectors, the programs under review share same general rationale: namely, delivering various forms of public support to reduce the risks associated with identifying and developing the actions needed to compete effectively in global markets, thereby enabling industry to achieve productivity, diversification, innovation, quality and sustainability objectives.

Not all programs state this rationale explicitly in descriptive material, but it is confirmed through interviews with program officials and is implicit in program objectives, scope and eligibility criteria (if not stated explicitly). Programs are summarized in Table 3.2.

Program objectives flow from goals, and while substantive objectives are broadly similar across programs, differences arise in details concerning target group, mode of delivery and leverage requirements. The specialized fishing/aquaculture industry programs are:

- FTNOP: the objective is to support R&D to promote diversification, innovation and marketing, initially for the harvesting and processing sectors, and since 2013, also for aquaculture when it absorbed the Aquaculture Strategic Development Program (ASDP). FTNOP operates with an annual budget of $2.0 million. Funding for this program continues to March 31, 2016.
- CCFI is not primarily a funding agency; its mandate is to encourage innovation. CCFI does this primarily by identifying, shaping and administering projects with the collaboration of industry and university/institutional partners. It funds the participation of staff and the use of facilities at Memorial University (including the Marine Institute), while also making direct contributions to projects when circumstances warrant. Between 1989 and 2009 CCFI had been funded by ACOA, with an annual average budget of $1.4 million. Since 2009, the provincial government has funded CCFI, with an annual budget of $1.0 million ($0.5 million for project investment). Funding for this program continues to March 31, 2016.
- ACRDP focuses on R&D in aquaculture, with multiple objectives: increasing collaborative research, improving industry sustainability, facilitating tech transfer and increasing scientific capacity. The program is national in scope, operating with an annual budget of $2.0 million.

RDC, BTCRD, NRC (IRAP) and ACOA (BDP/AIF/ICF) offer support to industry and institutions generally, including the fisheries and aquaculture industries.

- The RDC mandate is to strengthen R&D in NL, which it seeks to achieve through one of five programs, each with a different focus and objective. For the seafood industry and aquaculture, R&D Proof of Concept and Leverage R&D are by far the most heavily utilized of the five. Their objectives are to reduce technical and financial risk of pre-commercial R&D (Proof of Concept), and to support academic-led research that attracts R&D investments in priority areas where the majority of funds are coming from non-provincial sources (Leverage R&D). RDC has an annual budget in the $22-24 million range; funding for fishing industry/aquaculture projects averaged $1.0 million annually between 2009 and 2014 (±5%).

Table 3.2: Overview of R&D programs available to the fishing and aquaculture industries in NL

	Fisheries Technology and New Opportunities Program (FTNOP)	Fisheries and Oceans Canada Aquaculture Collaborative Research and Development Program (ACRDP)	Canadian Centre for Fisheries Innovation (CCFI)
Objectives	• Provide support for harvesting, processing, aquaculture, marketing initiatives. • Increase overall viability of NL seafood industry.	• Improve industry sustainability. • Increase collaborative research. • Facilitate technology transfer. • Increase industry scientific capacity.	• Apply the science and technology capability of universities and colleges to the problems and potential of the fishing industry.
Target areas	• R&D in resource, harvesting, processing, product & market development • Aquaculture development	• Industry-science collaboration on priority aquaculture R&D issues.	• NL aquaculture, harvesting, processing sectors.
Eligibility	• Industry members, associations, institutes, R&D firms. • R&D projects that support seafood industries.	• Must be an aquaculture producer operating in Canada.	• Projects assessed based on importance to industry, project impact, degree of innovation, and likelihood of success. • Must align with CCFI themes.
Administration	• Application and project proposal required. • Internal review and assessment. • Proponents must submit a written comprehensive final report.	• Administered by the Strategic and Regulatory Science Directorate of DFO. • Application and project proposal required. • Internal and peer review.	• Project proposal and letter of support from industry partner required. • Internal review.
Funding	• Max 60% of project costs. • $100,000 max. • May provide complementary support to other programs • Annual budget $2.0 million allocated to 5 program areas.	• Negotiated for each project. • Minimum industry contribution of 30%. • Annual budget: $2.0 million.	• No funding min/max. • Industrial partners must contribute. • Project funding often leveraged by government programs. • Annual budget: $0.5 million.
Uptake	• 437 applications received • 271 projects approved (to 2014). • $16 million committed. • $12.5 million spent since 2008. • $46.7 million total project value including industry & other program support	• 31 projects in NL 2001-2014. • Funding support unavailable.	• 267 projects (2006-2014) • $3.98 million invested • $39.19 million total project value including industry and other program support
Impact	• Strong industry support. • Low participation from small processors, inshore harvesters, aboriginal groups. • Increased employment in some firms. • Development and implementation of new infrastructure. • Increased production efficiencies and decreased cost. • Increased access to new markets. • Harvesting sector: improved gear technology, fuel efficiency, quality & safety. • Processing sector: improved quality & efficiency; product development, increased revenues.	• 2005 report notes many projects have generated tangible benefits to the industry. • 2012 evaluation notes projects have led to new technologies and practices that have improved fish production. • Major deficiency cited: research results not adequately shared with all industry stakeholders and partners due to delays in completing and peer-reviewing research reports.	• Over 760 R&D projects since 1989 (±$33.6 million CCFI support) • 2012 evaluation impacts: resource sustainability enhanced, industry employment maintained, productivity and efficiency improved, new processing technology and value added products created, energy efficiency improved, rural industry diversified. • Also notes that wider industry only benefits in about half the cases.

Table 3.2 (cont'd): Overview of R&D programs available to the fishing and aquaculture industries in NL

	Atlantic Canada Opportunities Agency Atlantic Innovation Fund	Atlantic Canada Opportunities Agency Business Development Program	Research and Development Corporation (RDC) R&DProof of Concept	National Research Council Industrial Research Assistance Program (IRAP)
Objectives	• Bring to market innovative new products and services. • Maximize benefits from national R&D programs. • Foster research and commercialization	• Support initiatives that foster: • Greater productivity • The commercialization of innovative technologies. • Improved global competitiveness. • Skills development.	• Reduce technical and financial risk of pre-commercial research R&D.	• Support the development and commercialization of technologies by small and medium-sized enterprises in Canada.
Target entities	• Atlantic Canadian private-sector businesses, universities, colleges, NGOs, and provincial Crown corporations.	• Value-added sectors • Services to business and tourism.	• Innovative businesses, located in NL with pre-commercial R&D needs & high growth potential.	• SME in Canada. • Aquatic and crop resources destined for bio product sectors.
Eligibility	• Must be a target entity operating in Atlantic Canada. • Project must involve R&D with a strong potential for commercialization.	Must demonstrate: • Economic benefit to an area or a community • Viability and need • Develop new/improved products, technologies • Acquiring innovative technologies to enhance productivity	• R&D projects with potential for commercialization . • Incorporated companies in NL.	• SMEs in Canada, with < 500 FTEs • Develop innovative, technology-driven new or improved products, services.
Administration	• Letter of intent required. • Internal review and assessment.	• Letter of intent required. • Internal review and assessment.	• Application and project proposal required.	• Application and project proposal • Internal review • Advisory Board external advice.
Funding	• Over $500,000 and up to $3 million. • Up to 80% of costs for projects led by not-for-profit organizations; up to 75% for private-sector-led projects • Funds advanced in the form of grants.	• Up to $500,000 • Maximum 50% or 75% of eligible costs depending on program • Funding in the form of interest-free loans • Loans either unconditionally or conditionally repayable depending on risk	• Up to 75% project costs. • $250,000 max.	• Up to 75% or $1,000,000/year. • Regular project $250,000 max; • Small (ARP) project $50,000 max.
Uptake	• By fishing industry - one processing sector project: conditionally repayable $2.4 million loan • By aquaculture sector – two technical support projects (salmon and cod): conditionally repayable and non-repayable loans, $13.4 million.	• Uptake mainly from aquaculture ($32.3 million for aquaculture) • Limited uptake from fishing industry since 1996 and program shift from grant to repayable loan: $10.7 million processing, $2.5 million harvesting	• Uptake mainly by Memorial University: marine science ($11.5 million); aquaculture ($1.5 million); fisheries/process ($2.6 million) • Uptake by fishing/processing industry: 6 projects $860,588	• Project or financial information could not be provided because data are inaccessible due to computer restrictions.
Impact	• Programs have contributed to the expansion and sustainability of the NL aquaculture industry. • No formal evaluation conducted that focuses on fishing industry or aquaculture sectors	• Programs have contributed to increased productivity, capacity, and competitiveness of the NL fisheries, processing, and aquaculture industries. • No formal evaluation conducted that focuses on fishing industry or aquaculture sectors	• Attraction of industry to program has been low. • No evaluation of this program has been completed yet. • Program reports activities and outcomes, not impacts.	• Impact cannot be stated with confidence due to reporting limitations • Tracking of near term results not always done by clients. • Longer-term impacts are not required.

- BTCRD supports organizations that are developing and implementing economic initiatives aimed at diversification, innovation and development through its Regional Development Program. This includes fishing industry/ aquaculture organizations, though program officials contacted as part of this study indicated that the RDP currently does not have any active fisheries/aquaculture projects.
- IRAP is a national program, funding technical assistance for the development and commercialization of technologies by small and medium sized enterprises (SME). IRAP's total annual budget across the Atlantic Provinces is in the $25 million range, of which NL receives $6-8 million per year. The program manager estimates that fishing/aquaculture industry projects typically secure $700-800,000 in funding annually (±10%).
- ACOA has provided financial support to the fisheries and aquaculture industries through several programs since the late 1980s. Currently, three programs are in effect. The BDP provides assistance to SMEs to expand or modernize, and to finance the development of innovative ideas to improve competitiveness. The ICF invests in strategic projects that strengthen communities. The AIF objective is to encourage partnerships among businesses, universities and research institutions to develop and commercialize new or improved products and services. Since 1990, these three programs have committed over $123 million to the fisheries and aquaculture industries (excluding direct funding to CCFI).

3.3 Sector and eligibility criteria

The sector-specific programs, FTNOP, CCFI and ACRDP, were established to address R&D opportunities in the fisheries and aquaculture industries, and consequently, are staffed by personnel with subject-matter expertise who are able to provide technical support (if needed) to refine and assess project concepts.

RDC, and the long-established NRC (IRAP) and ACOA programs, are not sector-specific, but are open to industry generally. NRC, itself, provides R&D services for the fisheries and aquaculture industries (fee for service).

Eligibility criteria typically address two considerations: the nature of the applicant and the characteristics of the project.

- For the sector-specific programs, the common criterion is that the applicant must be engaged directly in one or more of fish harvesting, processing or aquaculture. Applicants could be individuals, corporations, associations or institutions. ACRDP requires that applicants be marine aquaculture producers (or producer associations) directly involved in production. FTNOP and CCFI also accept applications from firms engaged in R&D for the sector, though not directly engaged in production (e.g., net or equipment design/manufacture).

  The FTNOP and CCFI mandates extend to R&D projects in the fisheries and aquaculture industries, while ACRDP limits its scope to the aquaculture sector. ACRDP also sets research priorities (e.g., health management, environmental impacts), which can vary from year to year. Typically, proposed projects would also have to meet various other criteria, including compatibility with program objectives, technically sound, demonstrate economic benefits to province/region, and be incremental.

- Applicant criteria for the non-sector-specific programs pertain to status: applicants must be SMEs (IRAP), incorporated companies in NL (RDC), or private sector businesses, institutions and research organizations, or Crown corporations (AIF). These criteria would appear to exclude unincorporated harvesters (who until recently, were prohibited from incorporating by regulation).

  To be eligible, projects typically have to demonstrate potential for commercialization (RDC) or development of innovative, technology-driven new or improved products or services (IRAP/AIF). And again, typically, proposed projects would also have to demonstrate technically soundness, incrementality and economic benefits to province/region.

3.4 Level of funding support

The level of funding support for all programs is restricted in two ways, and varies from program to program: by percentage of total project costs covered, and the maximum amount provided. Programs tend to allow stacking or leveraging, so provided other criteria are met, a project could secure funding from more than one program (up to the percentage limit). This collaborative or partnership approach is common for the programs under consideration, resulting in lower contributions for project proponents and reduced risk. Other things equal, this would be expected to increase the overall amount of R&D work conducted in the province.

- For the sector-specific programs, the level of project costs covered ranges from 60% for FTNOP, with a maximum contribution of $100,000, to 70% for ACRDP (technically, the minimum applicant contribution is 30%), with the maximum negotiated on a project-by-project basis. CCFI operates more as an intermediary than a funding agency (bringing institutions, industry partners and R&D funders together), so does not impose strict funding or coverage restrictions.
- For the non-sector-specific programs, both IRAP and RDC cover up to 75% of project costs with a $250,000 maximum (for technical problem solving projects under IRAP's Accelerated Review Process – ARP – the maximum drops to $50,000). The maximum coverage under AIF is also 75%, though projects may be considerably larger – up to $3.0 million – with a $500,000 minimum size. ACOA officials note that AIF funding has supported several marine sector projects in NL over the past several years, virtually all in aquaculture.

Examining the program experience set out in Table 3.3, it is clear that funding arrangements have contributed to the commitment of substantial levels of private sector investment over the past 5-10 years. Private sector investments have been greatest under the BDP/AIF programs, producing a leverage ratio of 6.3, mainly arising from expansion in the aquaculture sector. It should be noted that project totals in Table 3.3 are not additive because commitments made by one program may be included in the project totals under another program (e.g., CCFI figures include projects to which it makes a contribution, but is not the primary funding agency). ACOA data exclude funds directed to CCFI (core and project funding). The time frame captured in Table 3.3 should also be noted – it covers the past decade only – in part because this covers the lives of the programs in question (FTNOP and RDC), and in part because of data availability (CCFI and ACOA). Note also that RDC funding excludes $11.6 million for marine science research (not included because the funding is not directly applicable to fisheries and aquaculture R&D).

Table 3.3: R&D projects, funding and leveraging ($000s)

	FTNOP	ACOA	CCFI	RDC (1)
	2007-2014	2004-2014	2006-2014	2009-2014
Projects	271	106	267	30
Funding	12,511	39,712	3,978	5,011
Project total	46,700	249,312	39,191	n.a.
Leverage	3.7	6.3	9.9	n.a.

Source: DFA (FTNOP), ACOA, CCFI, RDC

1. Excludes $11.6 million in funding for marine science

3.5 Concluding observations

Providing R&D support to private enterprises through government programs is the norm in most industrial economies. It allows governments to target particular sectors that are crucial to national or regional economies, and which hold out the prospect for export-led growth and development. R&D support can be vital to offsetting the research and financial risks associated with technology, process and product development.

Whether targeted specifically at the fisheries and aquaculture industries, or more generally at a broader spectrum of industry sectors, the programs under review share same general rationale: namely, delivering various forms of public support to reduce the risks associated with identifying and developing the actions needed to compete effectively in global markets, thereby enabling industry to achieve productivity, diversification, innovation, quality and sustainability objectives.

The NL fisheries and aquaculture industries have the option to draw on programs that are specialized or of general application. The specialized programs are FTNOP, ACRDP, CCFI, while the programs available to industry generally include RDC, ACOA and IRAP. While substantive objectives are broadly similar across programs, differences arise in details concerning target group, mode of delivery and leverage requirements.

The level of funding support for all programs is restricted in two ways: by percentage of total project costs covered, and the maximum amount provided. These restrictions vary from program to program. Programs tend to allow stacking or leveraging, so provided other criteria are met, a project could secure funding from more than one program (up to the percentage limit). This collaborative or partnership approach is common for the programs under consideration, resulting in lower contributions for project proponents and reduced risk.

4. Program performance

4.1 Uptake

Uptake in the context of this report refers to the level of participation in R&D programs by fishing, processing and aquaculture interests, where level is measured in dollar terms as well as number of projects.

There is no absolute standard against which levels of uptake by sector can be assessed. Consequently, any assessment would instead examine such indicators as relative levels of participation by sector and sub-sector: inshore and offshore vessels/fleets; small/large processors; aquaculture companies; as well as the diversity of participation within sectors (wide – by many firms/institutions, or narrow – by a few repeat participants). Uptake would also refer to the extent to which available funds offered by each program are subscribed.

As noted earlier, none of the R&D programs anticipated the need to report uptake according to these sector and sub-sector classifications. At best, program reporting is at the sector level, providing financial information by project name and client. CCFI data are available in aggregate terms going back to 1989, but at the project level only going back to 2006. For IRAP, no project or financial information could be provided because data are inaccessible due to computer restrictions.

The available data indicate that current R&D programs for which information is available have provided about $174 million in financial support to the fisheries and aquaculture industries over the past 26 years. Program officials indicate that funding under IRAP in recent years has ranged between $700-800,000 per year for fisheries and aquaculture in NL, so the total level of program funding could exceed $180 million. A breakdown of the number of projects and funding levels by program and sector is set out in Table 4.1.

Table 4.1: NL fisheries and aquaculture industries R&D funding by program

		Harvesting		Processing		Aquaculture		Total	
Years	Program	Projects	Funding	Projects	Funding	Projects	Funding	Projects	Funding
1989-2014	CCFI							761	33,555,168
2001-2014	ACRDP					31		31	
1988-2014	ACOA	21	18,136,428	256	32,897,682	202	72,177,456	479	123,211,565
2007-2014	FTNOP	120	5,579,667	123	5,783,284	28	1,147,876	271	12,510,827
2009-2014	RDC	13	2,596,493	4	866,391	14	1,547,740	31	5,010,624
	Total	154	26,312,588	383	39,547,357	275	74,873,073	1,573	174,288,185

Source: DFA (FTNOP), CCFI, ACOA, RDC

Some interpretation of the information in Table 4.1 would be helpful.

- The information covers the time period over which each program has been in operation. Where available, the breakdown by sector is based on information provided by each program; and where not, it is allocated to sectors by the consultant based on project titles.
- A breakdown of CCFI funding allocation by sector is not available for the full period, so only the total is shown in Table 4.1. The CCFI director indicates that annual uptake is sufficient to exhaust the budget.

- The CCFI total includes administrative costs, whereas other programs show only funds actually disbursed to industry. Including administrative costs in the level of support provided by CCFI seems reasonable, given the key role staff plays in formulating and implementing or administering projects.
- The distribution of program funding across sectors indicates that aquaculture has attracted slightly more funding than harvesting and processing combined. Were data available for CCFI and IRAP, the balance would likely shift a bit more towards harvesting and processing, but would not likely result in a significant change to the overall distribution of spending in favour of aquaculture.
- ACOA funding is weighted heavily in favour of aquaculture. Most of the funds have been used to establish or expand salmon farms under BDP (with support to the mussel sector also), with AIF funding just one aquaculture and two processing sector projects. Funds advanced under BDP have been primarily in the form of repayable loans, not grants. Uptake by the aquaculture sector has been strong. Program managers at ACOA explain that with the move away from grant funding in 1996, uptake by the fishing industry fell off sharply.
- FTNOP was originally intended to serve the fishing industry, but in 2013 its mandate was extended to include aquaculture. The distribution of funding among the sectors largely reflects the original mandate. Uptake tends to be strong, with the amount of funding applied for exceeding the annual budget.
- RDC: R&D Proof of Concept, aimed at prototype development and commercialization, is the program that attracts most interest from the fisheries and aquaculture industries. The program manager expressed the view that the program is not attracting “nearly enough” applications from these industries. This is attributed to the limited industry capacity to specify and implement projects, and also to the constraint imposed by need for a cash contribution from proponents. Most (70%) of the projects tend toward the research end of the R&D spectrum, originating either with Memorial University or the Marine Institute.

A better sense of uptake is possible by examining figures at the sub-sector level, and also in terms of proponent characteristics. Generally, the programs attract proponents from three sources: industry, industry associations and university/ institutes, and in a few instances, from government. Within the industry sector are harvesting, processing and aquaculture enterprises; and within these sub-sectors a further sub-classification by size is also provided. This last classification addresses the question of whether an applicant originates in the inshore or offshore harvesting sector, are small or large processing plants, or associations representing these respective interests. An estimate of program investment by sector and category is provided in Table 4.2.

The data in Table 4.2 cover programs for which complete data sets covering the period 2004-2014 are available: FTNOP, ACOA, CCFI and RDC (IRAP and ACRDP were unable to provide data). The key points to note are:

- Direct participation in R&D projects by the fishing industry has been limited (about 16% of total program spending), particularly by enterprises in the harvesting sector (±4% for the inshore and offshore combined). Processing sector participation has been higher (±11%), with the few large companies making relatively greater use of the programs than their smaller counterparts.

Table 4.2: R&D uptake by sector and sub-sector – 2004-2014 ($)

	Harvesting	Processing	Aquaculture	Total	
	$	$	$	$	% of total
Fishing industry					
Inshore	1,354,825			1,354,825	2%
Offshore	852,635			852,635	1%
Suppliers	395,543			395,543	1%
Small processor		2,726,189		2,726,189	4%
Large processor		4,537,015		4,537,015	7%
sub-total	**2,603,003**	**7,263,204**		**9,866,207**	**16%**
Aquaculture					
Shellfish			6,328,378	6,328,378	10%
Finfish			22,262,484	22,262,484	36%
Suppliers			2,604,586	2,604,586	4%
sub-total			**31,195,448**	**31,195,448**	**51%**
Association					
Inshore	3,174,045	389,681		3,563,726	6%
Offshore	101,600	160,170		261,770	0%
Industry			2,933,672	2,933,672	5%
sub-total	**3,275,645**	**549,851**	**2,933,672**	**6,759,168**	**11%**
Institution (CCFI/MI)	8,348,708	1,349,531	2,419,935	12,118,174	20%
Government	313,832	136,610	821,646	1,272,088	2%
sub-total	**8,662,540**	**1,486,141**	**3,241,581**	**13,390,262**	**22%**
Total	**14,541,188**	**9,299,196**	**37,370,701**	**61,211,085**	**100%**

Source: FTNOP, ACOA, RDC, CCFI

- Companies in the aquaculture sector have used program resources most intensively, accounting for just over 50% of total funding. Funds have been used mainly to establish and expand production capacity of salmon (36%) and mussel farms (10%), and also to develop technical support facilities.
- Suppliers to the fishing and aquaculture industries have also benefitted from program support to develop equipment and services to meet industry needs (1% and 4%, respectively). Within the fishing industry, the initiatives focused mainly on gear and vessel efficiencies, while in aquaculture the emphasis was on business development for the provision of support services.
- The limited capacity of individual inshore enterprises to participate in R&D programs is addressed by harvester associations (FFAW and CCPFH). The 6% of overall program spending accounted for by these organizations was directed towards sustainability and quality objectives including fisheries stewardship, gear technology, vessel energy efficiency and handling practices, as well as market assessments.
- CCFI and the Marine Institute (MI) conduct industry-driven R&D, providing invaluable service for the harvesting and processing sectors. Combined, these organizations account for about 20% of program support, implementing or supporting projects covering such diverse areas as vessel design, gear selectivity and efficiency, improved holding and handling facilities and methods, and processing and packaging technology development (shellfish and finfish).
- Diversity of direct industry participation in R&D is low. Detailed program information indicates that direct participation in harvesting sector projects extended to only about 15 inshore enterprises. The larger integrated companies

all participated. Limited involvement is evident also in the processing sector, where only 12-15 of the province's 60-70 smaller processors participated directly in projects; the 4-5 larger (multi-plant) processors participated more extensively.

The limited direct participation by inshore interests, whether harvesters or plant owners, was a recurring theme in consultations with programs officials and industry representatives. They offered several reasons for this: that the financial resources needed to qualify for funding were lacking – most are just trying to survive; that smaller enterprises lack the human resources to identify, formulate and implement R&D projects; and, that many owners are older, operating traditional low-volume groundfish or pelagic plants and would be unlikely to see a return on any investment before they retire.

While these are all sound reasons, it is also the case that many projects are carried out by such institutions as CCFI and MI, or the industry associations such as FFAW and NAIA, on behalf of industry. In other words, taking a collaborative approach to addressing collective challenges. Provided the processes are in place to ensure the knowledge gained through these collaborative approaches is diffused throughout the industry, actual uptake of the technologies and approaches would be expected to occur as resource and market conditions warranted.

4.2 Program support by type of project

In the discussion of uptake, it is also instructive to consider how program funds were used. A breakdown of the types of projects each program supported is set out in Table 4.3. The categories were developed by the consultant based on a review of project titles. The assignment to categories was somewhat arbitrary, given the sometimes limited information the titles contained. The programs themselves do not assign categories, except at the sector level.

Among the points to note in Table 4.3 is that overall the programs provided coverage across a wide range of issues. That FTNOP and CCFI addressed a wider range of issues than ACOA and RDC should not be surprising, since the former are industry-specific. It is encouraging from a developmental perspective that a high proportion of the FTNOP and CCFI funds were directed towards such areas as gear technology, operational efficiency and onboard handling in harvesting, and towards technology, operating efficiency and value-added product development in processing. ACOA and RDC made major contributions to salmon aquaculture and fish harvesting in the province through substantial support to research and development facilities and activities.

4.3 Impact

Impact tends to be one of the main factors used to evaluate federal and provincial programs, generally. It is also one of the most difficult factors to measure with confidence. Typically, if a program were going to be assessed in terms of its impacts, then a formal evaluation framework would be established at the planning stage and integrated into the implementation activities. The evaluation framework would set out impact indicators, data requirements, data collection protocols (e.g., who is to collect data, how and when), and reporting form and frequency.

Adding to the challenge of designing and implementing an effective impact assessment system is the difficulty of interpreting results if projects and the industry function in a

dynamic context – one where external conditions can change abruptly and without much warning. Both the fishing and aquaculture industries operate in a highly dynamic context, heavily influenced by resource and environmental conditions on the one hand, and market conditions on the other. Shifting conditions, ones over which the industries have no control (resource, environment, exchange rates) or limited influence (markets), can make it difficult to isolate and measure program impacts.

Table 4.3: Program support by type of project – 2004-2014 ($)

Harvesting	FTNOP	ACOA	RDC	CCFI	Total
Training and technology transfer	673,392	300,769	136,751	254,952	1,365,864
Experimental / exploratory fishery	771,607			295,820	1,067,427
Certification / traceability	366,112	328,025		36,307	730,444
Gear technology	1,538,243		349,197	535,494	2,422,934
Operational efficiency	703,290			119,553	822,843
Onboard handling	780,281			71,714	851,995
Resource assessment/sustainability	461,879	848,438		103,356	1,413,673
Research and consulting		3,221,834	2,110,545	248,766	5,581,145
Other	284,863				284,863
sub-total	**5,579,667**	**4,699,066**	**2,596,493**	**1,665,962**	**14,541,188**
Processing	**FTNOP**	**ACOA**	**RDC**	**CCFI**	**Total**
Marketing	1,397,570	50,000			1,447,570
Value-added/product development	1,427,153			709,030	2,136,183
Processing capacity / technology	1,894,761	1,094,350	866,391	249,298	4,104,800
Operational efficiency	218,349			159,304	377,653
Chilling and packing	662,459				662,459
Product quality and handling	182,992			174,730	357,722
Administration and staffing		29,250			29,250
Research and consulting		50,250		76,079	126,329
Other				57,230	57,230
sub-total	**5,783,284**	**1,223,850**	**866,391**	**1,425,671**	**9,299,196**
Aquaculture	**FTNOP**	**ACOA**	**RDC**	**CCFI**	**Total**
Marketing	620,618	201,375		9,006	830,999
Production capacity / technology	356,608	19,539,943		226,391	20,122,942
Value-added product development		48,150	99,000	4,000	151,150
Certification and traceability	170,650			18,554	189,204
Training and technology transfer		763,420		34,078	797,498
Research and consulting		10,833,407	1,448,740	593,891	12,876,038
Industry project staffing		892,943			892,943
Unspecified NAIA projects		1,509,927			1,509,927
sub-total	**1,147,876**	**33,789,165**	**1,547,740**	**885,920**	**37,370,701**
Total	**12,510,827**	**39,712,081**	**5,010,624**	**3,977,553**	**61,211,085**

Source: FTNOP, ACOA, RDC, CCFI

Funding to industry associations assigned to project types where details provided.

The approach to program evaluation varies amongst the six programs reviewed. Formal evaluations are available for the three sector-specific programs, FTNOP (2013), CCFI (2011) and ACRDP (2005, 2012). These evaluations form the basis for the impacts summarized below, with input from program managers and industry representatives.

- **FTNOP:** the evaluation focused on the impacts of 32 individual projects, using nine indicators. It found the impacts were generally positive, noting specifically that: the harvesting sector is more environmentally sustainable and opportunities for cost reduction had been identified through various projects; and, the processing sector is more cost competitive, with reduced product waste and expanded markets.

  The evaluation report noted the strong industry support for the program, but also the need to improve the turn-around time of applications and the communication of results to stakeholders. These points were echoed during consultations with industry. The report also noted the low participation level from small processors, inshore harvesters and aboriginal groups; this was attributed to the constraint created by the need for the applicant to contribute 40% of a project cost in cash. The FTNOP program manager underscored these challenges, noting also in the case of small processors the limited capacity to identify and implement projects. The manager also indicated that the industry is highly competitive internally, resulting in limited collaboration and sharing of project results.

- **CCFI:** the evaluation covers the period 2009-2011, when 56 projects were initiated. The report identifies several benefits/impacts flowing from these projects: enhancing resource sustainability, maintaining employment in the industry, improving industry productivity and efficiency, creating new processing technology and value added products, improving energy efficiency, and diversifying rural industry.

  Project proponents endorsed CCFI's role in R&D, indicating it provides much-needed advisory and technical support that the industry (much less individual companies) does not have the resources to sustain. The report notes that CCFI's role in supporting industry in terms of advancing knowledge, improving sustainability, fostering innovation, and facilitating commercialization meets or exceeds its mandate according to stakeholders. CCFI is also able to leverage its assistance effectively by drawing in support from federal and other provincial agencies. One weakness noted in the report is that, while the results flowing from CCFI's assistance benefits the project proponent, the wider industry only benefits in about half the cases.

- **ACRDP:** this national research program was evaluated in 2005 (using a case study approach) and again in 2012. To date, 31 projects have been implemented in NL. The 2005 report comments on results/ success generally, indicating that, "... many projects have generated tangible benefits to the industry, or have the potential to provide benefits in the near future". This observation is not specific to NL (only one of 10 NL projects at the time – cod broodstock management/ development – was included in the review).

  The 2012 report addresses effectiveness and efficiency (not impacts), and provides only high-level perspectives. A major deficiency cited is that "... results from research projects are not adequately being shared with all industry stakeholders and partners". We note that of the 31 NL projects, only seven have resulted in publications/final reports for general distribution. The report recommends that final reports that are easily understood and in plain language should be produced for all projects on a timely basis.

The impacts resulting from the three non-sector-specific programs are based on the consultation with program managers. The RDC programs are relatively recent (from 2009), with reporting of activities and outcomes (not impacts); no evaluation has yet been conducted. ACOA conducts periodic evaluations of its programs, but none was available for AIF and BDP that could provide results for fisheries and aquaculture projects. IRAP produces project reports, but these do not address impacts (in any event, reports were not available due to a security breach in the NRC computer system) and no evaluation has been conducted in recent years.

4.5 Concluding observations

Uptake by program varies from over subscribed to partially utilized. The available data indicate that current R&D programs have supported over 1,570 projects and provided over $174 million in financial support to the fisheries and aquaculture industries over the past 25 years.

Overall, the programs provided coverage across a wide range of issues. It is encouraging from a developmental perspective that a high proportion of the FTNOP and CCFI funds were directed towards such areas as gear technology, operational efficiency and onboard handling in harvesting, and towards technology, operating efficiency and value-added product development in processing. ACOA and RDC made major contributions to salmon aquaculture and fish harvesting in the province through substantial support to research and development facilities and activities.

The limited direct participation by inshore interests, whether harvesters or plant owners, was a recurring theme in consultations with programs officials and industry representatives. They offered several reasons for this: that the financial resources needed to qualify for funding were lacking – most are just trying to survive; that smaller enterprises lack the human resources to identify, formulate and implement R&D projects; and, that many owners are older, operating traditional low-volume groundfish or pelagic plants and would be unlikely to see a return on any investment before they retire.

Formal evaluations conducted on three programs identify several positive impacts, along with a recognition that more needs to be done to attract participation by smaller enterprises in both the harvesting and processing sectors:

- Resource – improved understanding, enhanced sustainability
- Harvesting sector – improved gear technology, greater fuel efficiency, higher quality
- Processing sector – improved quality, great efficiency, product development, increased access to markets, improved competitiveness
- Aquaculture – new production technologies, improved fish production, greater production capacity

5. R&D programs in comparable jurisdictions

5.1 Overview

This chapter provides an overview of R&D programs in three external jurisdictions: Iceland, Norway and the U.K. (the programs are summarized in Table 5.1). These jurisdictions were selected because their fishing and aquaculture industries share important characteristics with NL. Among the areas of commonality are: location in the northern latitudes, species mix in the commercial fisheries, vessel types, fishing gear used, emphasis on primary processing, aquaculture industry and species (salmon), and current and target markets (U.S., Asia, EU). Of course, there are differences in industry scale and structure, and these factors should be considered in any comparison of R&D programs.

5.2 Iceland: Added Value for Seafood (AVS)

AVS began its work in 2004, following an analysis of the seafood value chain that indicated weak performance of Icelandic seafood exports. Extracting maximum value from the fishery resource is clearly critical for Iceland, a small country (population 300,000) heavily dependent on the fishery and the cluster of enterprises it supports to generate the direct and indirect employment, income and export earnings the country needs to sustain its high standard of living.

Creation of the AVS was a joint initiative of the Ministry of Fisheries, the Icelandic Fisheries Laboratories, the fishing and fish processing sectors, and companies in various support and service sectors. The overall goal of the program is to increase the value of Icelandic seafood. The AVS aims to achieve this goal through support to applied research and development projects generating new developments in the fishing, fish farming and fish processing industries. The AVS provides grants to companies, research organizations and joint projects who respond to annual proposal calls with projects in one of four areas: aquaculture, harvesting and processing, biotechnology and marketing.

Iceland's Ministry of Fisheries administers the AVS. Uptake is high. Selection criteria are: i) expected impact in terms of increasing value added in the seafood industry and the width of diffusion of results; ii) the intrinsic quality of the proposal; and, iii) extent of collaboration (not an obligation but an asset). Proposals are assessed by four committees composed of technical experts in each of the target areas. The Minister makes the final decision. The AVS pays up to 50% of R&D eligible costs (excludes investment in equipment). The annual budget varies with the fiscal capacity of government, which is heavily influenced by the exchange rate. Over the past four years the budget has fluctuated between 230 and 495 million krona/year (CAD$2.1-3.5 million/year at today's exchange rates).

No official evaluation has been conducted, but stakeholders consider the AVS a success as reflected by the increasing number of proposals received and the general strength of the Icelandic fishing industry and support sectors in recent years.
The full economic significance of the fishing industry is difficult to measure, but one thing is certain: using conventional indicators such as direct contribution to GDP, employment and exports understates its true value to the Icelandic economy. The fishing industry is the base upon which an impressive cluster of enterprises has formed over the years

(Arnason 2011). Some 70 companies have evolved over the years to supply the Icelandic fishing industry and the export market with various technologies and services. These include niche companies, as well as well-known names in the industry such as Marel (fish processing equipment) and Hampidjan (fishing gear). Without the fishery as the basic source of demand, these Icelandic service and supply companies are unlikely to have developed.

Of course, a fishing industry does not in and of itself cause a technology supply and service cluster with export capabilities to emerge. Much depends on the characteristics of the fishery, which in turn depend on local conditions (resource and climate), management, as well as the economic context. The Icelandic fishing industry benefits from a substantial resource (mainly groundfish and pelagic species) and favourable climate allowing a year-round fishery with an export value in the $2.5 billion range (about three times that of NL). Iceland's relative isolation and limited range of wealth-generating options have contributed to a highly self-reliant economy. Extracting the maximum value from the resource is critical. This means producing the highest quality products for the highest valued markets, and doing so at the least possible cost.

The fishing industry is structured to meet these operating conditions. Over the past 10-15 years, it has become increasingly vertically integrated and highly concentrated, with 10 companies holding about 50% of the quota. As Sveinn Margiersson, Director of Matis (publically held Icelandic Food Research Company) noted in an interview for this study, vertical integration coupled with individual quota holding has allowed greater responsiveness to market conditions with respect to decisions on what is caught, when, and in what quantities. This represents a significant departure from the traditional volume-driven approach. And with larger and more financially stable companies, the capacity to conduct R&D has also increased. For the AVS, this has meant a greater recognition of applied R&D needs, as well as the means to implement results.

5.3 Norway: Fishery and Aquaculture Industry Research Fund (FHF)

The FHF began funding projects in 2002. The FHF traces its history to the recognition that industry-specific R&D was needed, but that the generally small-scale and fragmented fishing industry enterprises lacked the capacity and resources to fund their R&D projects through then conventional channels. The main industry sectors agreed on the imposition of a levy (0.3%) on the export value of seafood to fund R&D under a specialized agency that became known as the FHF.

The goal of the FHF is to create value added for the seafood industry. The results of R&D initiatives are intended to be for the benefit of the industry as a whole, not for individual enterprises (except when they adopt the innovations). This is accomplished by the way in which R&D priorities are specified and projects carried out. The FHF does not call for proposals for funding by industry interests (which is the typical approach for most programs of this type). Instead, the FHF sets out priorities each year and establishes terms of reference for specific programs/projects to address these priorities. Requests for proposals are circulated to research institutions and contractors to carry out the projects. This is intended on the one hand to promote a healthy competition amongst the organizations, while on the other hand also providing a basis for collaboration among them to reach sound solutions. The results are made available to industry according to the rules that FHF incorporates into contracts as standard terms and conditions for reporting.

The FHF has a board composed of seven members appointed by the Ministry of Fisheries. These appointments are from nominees by the Norwegian Seafood Federation (3), the Norwegian Fishermen's Association (2), and the Norwegian Confederation of Trade Unions (2). Among the Board's key functions is to determine research priorities. Decisions of the Board must be unanimous. In recent years, the FHF has had a budget in the CAD$30-35 million range. Uptake is not an issue, since the Board determines projects and the flow of funds to implement them.

Examples of priority areas in recent years for the FHF include:

- **Vessel technology**: projects to automate tasks and processes on board, to reduce energy costs, and to improve quality, all aimed at increasing profitability. R&D is also aimed at finding ways of downsizing successful automation projects for adaptation to smaller vessels in the coastal fleet.
- **Resource utilization**: with declining landings of shrimp and crab, the FHF has placed high priority on improving resource utilization through technological solutions aimed at increasing yield and quality.
- **Gear technology**: projects to design and develop environmentally friendly fishing gear to reduce bait requirements, improve selectivity and fish quality, all resulting in more profitable fisheries.
- **Processing technology**: projects to automate production of fillets for the fresh and frozen markets, with the aim of reducing labour requirements and improving yields. Developing technology to remove pinbones was one of the most important (and costly) projects the FHF has supported (more on this below).
- **Productivity and efficiency**: in both the conventional (saltfish, clipfish and stockfish) and pelagic sectors, the FHF directs R&D work towards increased automation and more efficient production processes, with a focus on quality, yield improvement and energy conservation.
- **Markets and market development**: this is a priority area because, unlike the aquaculture sector, the fishing/processing industry is composed of many small companies that lack the resources to carry out their own market research to investigate product requirements, standards and areas of opportunity. The FHF works closely with the Norwegian Seafood Council in delivering market research.

Contacts at the FHF indicate that evaluations of the program have not been conducted, so no assessment of impacts is available.

To illustrate the work of the FHF, summaries of several projects are set out below, with more detailed descriptions in Annex 1:

- **Pinbone detection and removal**: this project aims to automate the process of detecting pinbones in fillets. The project, on-going for several years, involves collaboration between Marel (the processing equipment manufacturer), SINTEF (the Norwegian research organization). FHF has also funded a project aimed at developing an X-ray based automatic pinbone cutting equipment (a collaboration between Valka the Icelandic equipment designer and manufacturer and AVS of Iceland). Valka now sells this equipment. http://valka.is/products/flowlines/cutting/

- **Development of gutting machine in the coastal fleet and industry:** this project aims to develop a simple gutting machine for on-board use to reduce the time and labour required to gut whitefish effectively without damaging the intestines.
- **Testing of production and market for shipboard produced cod cheeks and tongues:** this project aims to utilize residual material from the cod fishery in a more effective and profitable way. The project involves an extension of work originating with Matis in Iceland (and the equipment manufacturer MESA) by testing equipment on board a trawler owned by the Norwegian company, Havfisk.
- **R&D competence program for the seafood industry:** SINTEF Fisheries and Aquaculture in collaboration with the University of Nordland mapped the need for increased R&D expertise within the seafood sector. Their report recommended the creation of continuing education with a focus on R&D strategy and management. FHF accepted the results of the needs analysis, but developed a model based on a strategy of strengthening R&D results through joint implementation by seafood companies and technology suppliers (learning by doing, rather than learning in the abstract). The proposal call was issued in late 2014 and is aimed at four priority areas: the cod fishing, vessel technology, and conventional and pelagic sectors.

Inviting direct proposals from industry represents a significant departure for the FHF. For the first decade of the organization's existence with a top down approach to project selection, there was a limited basis for determining stakeholder interest in, and uptake of, technological innovation. This new model – though only a project at this stage – could provide valuable insight into more effective approaches of technology diffusion.

5.4 U.K. – the European Maritime and Fisheries Fund (EMFF)

The U.K. fisheries operate within the framework of the EU's Common Fisheries Policy (CFP). The CFP sets terms of access for member states, as well as management and technical measures governing gear usage and where and when fisheries are conducted. The European Maritime and Fisheries Fund (EMFF 2014-2020) is the successor to the European Fisheries Fund (2007-2013). It contributes to the implementation of Common Fisheries Policy (CFP) objectives in member states, including the conservation and sustainable use of marine resources and supporting industry profitability. The EMFF has a total budget of about $10 billion.

EMFF financial support is aimed at promoting conservation measures in the form of improved gear selectivity, greater vessel efficiency, improved fish handling and quality, and product and market development (innovation generally). It is more a mechanism for structural adjustment of the industry than a vehicle for R&D, though R&D projects that contribute to the broad objectives would be funded. Support for collective action is also available, for example, to improve port infrastructure and services, and to promote partnerships between scientists and operators in the fisheries sector.

Funds are allocated to each member states based on the size of its fishery, and pursuant to national strategic plans developed by each state. The plans provide an overview of resource base and industry, including a SWOT analysis. These form the basis for the development of objectives and priorities, as well as the themes through which these objectives will be realized. The overarching aim of the UK is to have a fishing industry that is sustainable and profitable, well managed and internationally competitive.

Table 5.1: Overview of R&D programs in Iceland, Norway and the UK

	Iceland Added Value for Seafood (AVS)	Norway Fishery and Aquaculture Industry Research Fund (FHF)	European Fisheries Fund (UK)
Objectives	• To increase the export value of Icelandic Seafood. • To provide support to sectoral innovation in manufacturing. • To provide direct support of business R&D (grants and loans).	• To increase financing of R&D. • To increase added value and innovation in fisheries and aquaculture industries.	• To help the fishing industry to become more sustainable and to remain profitable. • To ensure conservation and sustainable use of marine resources. • To contribute to the implementation of CFP.
Target areas	• All Icelandic seafood companies. • Higher educational institutions (HEI) research units/centres. • Other non-profit research organisations (not HEI). • Technology and innovation centres (non-profit). • Focus on aquaculture, harvesting & processing, biotechnology and marketing.	• Aquaculture companies: strong and robust fish, sea lice control, prevention of fish escapes, and increased quality in fish fillet processing. • Wild fish companies: fisheries and vessel technology, marine resources, fresh/frozen cod, pelagics, and shellfish.	• Aquaculture, inland fishing, and processing industries.
Eligibility	• Based on the expected impact of the project in terms of increasing value added for the seafood industry in Iceland and width of diffusion of results.	• Projects funded in close consultation with industry. • Assessed on professional expertise and cost / benefit to industry.	• Vessel owners in the private sector active in the commercial fisheries. • SMEs in the private aquaculture sector.
Administration	• AVS is a public body, financed by the Government of Iceland. • Annual call for proposals. • Minister appoints 4 expert committees that assess proposals and make recommendations. • Final decision made by Minister.	• FHF is a public body under the Ministry of Fisheries and is financed 100% by industry through an R&D tax on exports of all seafood of 0.3%. • Ministry of Fisheries appoints 7-member Board that sets priorities and formulates projects for competitive bid by institutions and companies.	• The EFF administered by European Commission. • Funds available to all EU members. • Administered separately in each EU member state. • Marine Management Organization (MMO) responsible authority in England.
Funding	• Overall budget: $2.7 to $4.5 million CAD. • Max research grant: $76,000 CAD for up to 3 years. • Max pre-commercial: $9,500 CAD up to 1 year. • Pay up to 50% of R&D eligible costs. • Co-financed by private sector. • No funding for capital assistance / investment in equipment. • Funds advanced in form grants. • Companies receive 3-year protection on IP or discoveries generated.	• Budget of $35 million CAD. • Allocated according to FHF priorities. • Funding up to 50% for private sector projects where companies gain valuable IP • Institutional projects may be fully funded	• Overall EFF budget: $6.2 billion CAD. • UK: $200 million CAD distributed from 2007 to 2013 across projects related to improvements in vessel and processing efficiency & productivity, working conditions, and to fisheries local action groups. • Funds up to 40% of costs • Funds not to be directed to increasing fishing capacity.
Uptake	• No ex ante allocation of funding, historically 40% funding to processing, 20% each to aquaculture, biotech, and marketing.	• High uptake in response to FHF RFPs.	• 1,509 projects funded from 2007 to 2013. • Uptake fell short of budgeted amounts due partly to reimbursement approach
Impact	• Companies benefit through greater productivity and efficiency; improved capacity to access capital. • No formal evaluation conducted to date.	• Development of many productivity and sustainability enhancing technologies • No formal evaluation or assessment of impacts has been conducted	• Funding has helped small to medium-sized processing and aquaculture companies save up to 40% of costs

The UK allocation under the EMFF is about $350 million over the 2014-2020 period (it was about $200 million under the EFF).

The UK plan sets out various sustainability objectives including achieving a balance between fishing effort and opportunity (through fleet adaptation and increased unit value of fish landed); and maximizing returns by increasing quality and improving marketing. Funds are not to be directed towards increasing fishing capacity. Once the European Commission approves the national plan, it is up to the member state authorities to decide which projects will be funded.

The Marine Management Organisation (MMO) is the responsible authority for EMFF funding in the UK. The MMO, established in 2009, is an executive non-departmental public body operating under the authority of the UK Department for Environment, Food & Rural Affairs (DEFRA). It is responsible for regulating the marine fisheries in UK waters (corresponding to the regulatory function of DFO), including managing and monitoring fleet size and catch quotas; ensuring compliance with fisheries regulations (issuing fishing licences, time at sea, quotas); compiling and publishing catch and effort statistics; and, managing funding programs for fisheries activities. Included in the latter is providing support to industry participants to gain access to grants from the EMFF. MMO allocates EFF grant funds across four categories: modernizing fishing vessels (40% of eligible costs); establishing or modernizing fish processing and marketing facilities (40% of eligible costs); measures of common interest (port facilities, pilot projects to test innovative technology, methods to reduce by-catch and discards, promotional campaigns); organizations promoting sustainable fisheries. Total funding for projects in these categories under the EFF was about $50 million. Program funding allocations and arrangements under the EMFF have yet to be developed by MMO.

MMO publishes details of grants awarded in the same way as FTNOP or ACOA does (names, year, project title and amount). A review of these reports (2009-2014) suggests take-up falls short of the budgeted amounts (for example, in the five years MMO has had responsibility for administering the EFF fund – 2009-2014 – only about 100 vessels had applied for grants out of a total fleet of about 6,500 vessels). Officials at the Seafish Authority confirm this observation, noting in an interview for this study, that the EFF/MMO requires applicants to apply and receive approval for their projects before starting, but must complete their projects before submitting claims for the approved grant support. This process tends to act as a disincentive to seeking grant support (T. Pickerell, Seafish, pers. comm.).

5.5 Concluding observations

These jurisdictions offer substantially different models of delivering R&D programs. Iceland and Norway present the most striking difference.

- Iceland is characterized by a fairly typical bottom-up application-driven model reflecting the R&D interests of individual companies and institutions (with some industry-wide issues also possibly finding their way onto the research agenda). The industry is engaged and has the capacity to identify opportunities for productivity and efficiency gains, and to conduct and implement R&D initiatives. The impressive ocean cluster of technology and service companies facilitates the process.

- By contrast, Norway has a top-down model where industry representatives determine priorities and set the R&D agenda, with projects carried out by research organizations or technology companies (often in collaboration). The model appears to work well in terms of technology development, but does not embody a clear path for technology diffusion to the industry. This would be expected to be a high priority, given the scale of the industry and its many smaller enterprises. This may be changing with the implementation of a recent project aimed directly at addressing the challenge of industry engagement in developing and adopting innovative technology and processes.
- The UK (and all other EU members) occupies a middle ground, with government setting the strategic direction and broad contours of the program, with industry responding (or not) to various avenues of support to increase productivity and efficiency, enhance sustainability and attain greater profitability through improved quality and marketing. The uptake of the EFF funding has been low, due at least in part to the design of the process. In general, the program has less to do with R&D than supporting innovation and technology adoption.

The NL, Norwegian and Icelandic R&D programs share one important feature – the commonality among objectives and priority areas. And notwithstanding the absence of formal program evaluations that identify and measure impacts, the results of consultations with program managers provide a basis for comment on some key lessons learned.

The major lessons point to several key ingredients for a successful R&D program:

i) **A progressive industry with a strong market focus**: this is essential because without a market focus, companies lose sight of why they are in business – to supply the consumer with quality food products on a timely and consistent basis. This is a challenge for much of the industry throughout Atlantic Canada. The focus tends to be on production – harvesting and processing – and too little on what markets want and how to deliver it. The larger companies understand this, but many of the smaller ones with limited direct exposure to customer needs do not.

   If the industry is to extract as much value as possible from the resource, then developing a market focus on quality is the starting point. Education is a big part of this (understanding what quality means and how to achieve it), and so too is ensuring that each sector of the industry shares the objective and is able to operate within a framework that supports it. This could mean regulatory change to increase operating flexibility and greater efficiency. It would also mean that incentives – prices – are structured in a way that rewards quality.

ii) **Sufficient interest and resources to engage in R&D:** this is essential, because without the capacity to innovate, even the best of intentions go nowhere. R&D in this case is broadly defined to include the full range of activities from identifying a problem (or opportunity), conducting applied research, developing prototypes, and working towards commercialization, to simply innovating by applying established (but new) technology to achieve productivity or efficiency objectives. Before R&D occurs, there has to be a recognition that there is an issue to be resolved and an interest in resolving it. And even where there is interest, there is not necessarily action because R&D and innovation are, or can be, expensive and beyond the resources of individual enterprises. This is why, in even the most advanced economies, governments provide support through various R&D programs.

Among the challenges is designing an effective R&D program is to ensure enterprises that could benefit from support are aware it is available and how innovation could help. The issue in NL would not appear to be a lack of awareness. But further steps may be needed, e.g., an extension program, to develop that initial interest among enterprises in actually taking action. It then becomes a matter of applying resources to create solutions. What to do when the obstacle to taking action is that enterprises lack resources is another challenge. A policy question where this may be the stumbling block would be to determine whether eligibility criteria should be tailored to reflect capacity (though this would have its own pitfalls).

iii) **Capacity to design and conduct R&D projects.** This is an obvious strength in Iceland and Norway, though their programs use different approaches to identify priorities (bottom-up vs. top-down). But common to both countries is the use of collaborative (private-public) approaches to conduct R&D and find solutions. Both countries have well developed institutional strength, and also highly developed private sector capacity. Indeed, Iceland, with its relatively small population and economy, is home to many of the leading manufacturers of fish harvesting and processing equipment.

The NL fishing and aquaculture industries benefit from considerable institutional R&D capacity. This is evident from the role played by CCFI and the Marine Institute in designing, administering and implementing many successful projects over the years. Strong industry associations such as FFAW and NAIA have also played a key role in implementing projects with industry-wide impacts. A close look at the project lists of the various programs reveals that goods and services suppliers to industry have also participated as proponents, but only to a limited extent. Participation is encouraging because these linkages to other sectors contribute to the economic importance of the industry and strengthen its ability to grow and develop. Whether a technology and ocean sector cluster similar to Iceland's may evolve is difficult to say, but the possibility should be recognized and encouraged through proactive efforts to attract greater participation in R&D by supply and service companies.

iv) **Effective technology and knowledge diffusion to industry**: for innovation to occur, breakthroughs have to become available to industry. This would not ordinarily be expected to be a problem as companies seek to capitalize on their discoveries. But if the company making the breakthrough is in the business of producing seafood, not marketing technology or services, then there is an incentive to keep any breakthroughs from competitors. R&D programs recognize this and generally stipulate that technology or processes developed with program assistance must be made public within a specified time (1-3 years).

Notwithstanding requirements to provide results of publicly funded R&D, it requires special efforts to ensure knowledge diffusion actually occurs in a timely fashion. This is the experience in NL, as well as Iceland and Norway. It takes time to compile results and prepare reports, etc., but this is only part of the challenge. Further work may be needed to promote uptake. This is not just a matter of financial resources on the part of the potential client group, but also a question of having or creating a progressive, innovative culture. This may require its own initiative, as Norway has recognized with a recent project aimed specifically at industry engagement.

v) **Adequate long-term funding to support R&D programming.** The global leaders in technology development, regardless of industry, understand that support for R&D needs to be adequate and available over many years in order to foster the innovation that allows industries to develop and grow. The federal and provincial governments have provided almost $175 million in R&D support to the NL fisheries and aquaculture industries over the past 25 years. This support has facilitated the transition from an industry based on groundfish, to one sustained by shellfish. It has also provided the funding for the development and substantial growth of aquaculture. Combined, these industries generated over $850 million in seafood exports for the province in 2014.

The fisheries industry now appears to be facing a transition back to groundfish. But if so, this would not represent a return to industry conditions that prevailed in the late-1980s. Competitive conditions have changed substantially in terms of both demand and supply, creating major challenges for any producer wishing to enter the market. Those challenges start with meeting more stringent product specifications, and would influence every aspect of the fishing industry from the table to the water: marketing, logistics, product development, processing and harvesting. This transition will require substantial R&D support if the industry wishes to compete.

6. FIF program design considerations

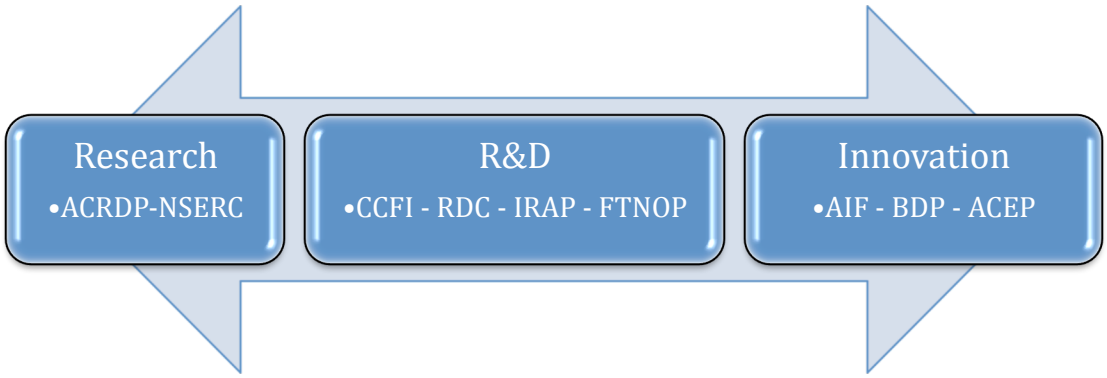
6.1 Some issues

This chapter examines several considerations that emerged in the course of the review of existing programs. Each of them, to some degree at least, could have a bearing on FIF program design. The first matter concerns overlap in delivery among the programs to identify whether duplication exists in terms of objectives, coverage and target group. Next, the question of whether gaps in scope and access exist, i.e., aspects off fisheries and aquaculture industry operations or segments of the industry not covered by existing programs. And finally, looking ahead, this chapter examines the implications of the changing resource regime in NL waters, what the fishing industry may need to do to adapt, and how the FIF could contribute to the adaptation process in terms of programming that would enhance industry's ability to compete effectively in the EU market and globally.

6.2 Program delivery – overlap

The programs share a common goal, namely to enable the NL fisheries and aquaculture industries to compete effectively in global markets through continuous improvement in productivity, quality, diversification and sustainability. How the programs pursue this enabling function differs, though there is some overlap in scope and eligibility. There are also differences in the form of assistance provided; grants in some cases and repayable loans in others.

At the risk of oversimplification, the programs may be divided into two types: those providing support for R&D and those also providing assistance for the purchase of capital equipment or to fund certain operating expenses. A review of the projects supported across programs indicates that this distinction is not sharp, with programs lying on a spectrum with applied research at one extreme and capital assistance at the other, and R&D broadly defined occupying the middle ground.



ACRDP, with its focus on applied research, sits at the research extreme; CCFI and RDC, IRAP and FTNOP occupy the R&D middle ground; ACOA's AIF and BDP, and DFA's ACEP, with their emphasis on innovation and capital support, tend towards the business development (establishing and expanding) end of the spectrum.

To facilitate a comparison, Table 6.1 contains an overview of five key indicators for each program. The general conclusion we reach after examining the indicators is that there is overlap in only the most general sense that all programs provide support of some form to at least one or more components of the fisheries and aquaculture industries. But important differences exist in the specifics of the extent of sector support, the types of projects supported, who is eligible, the type of support provided, and the funding limits.

Table 6.1: R&D program elements

	Sector	Project type	Eligibility	Support	Funding limit
ACRDP	A	Research/Academic	Aqua producer	SCE(G)	70%/Negotiated
CCFI	F-P-A	R&D/Academic	Industry	SC(G)	NS/Negotiated
RDC*	I-F-P-A	R&D/Innov/Comm'l	Incorporated	SCE(G)	75%/$250K
IRAP*	I-F-P-A	R&D/Comm'l	SME	SC(G)	75%/$250K
FTNOP	F-P-A	R&D/Aqua growth	Industry/Support	CO(G)	60%/$100K
ACEP	A	Aqua growth	Incorporated	CO(E/L)	20%/>$100K/$250K
AIF*	I-F-P2-A	R&D/Innov/Comm'l	Industry/PS/CC	CO(L)	75%/>$500K<$3,000K
BDP*	I-F-P2-A	R&D/Tech/Comm'l	Business/Support	CO(L/G)	75%/<$500K

* Denotes programs of general application to industry. Others are specialized to seafood and aquaculture.
Sector - I: Industry; F-P-A: Fishing, Processing (primary/secondary), Aquaculture; P2: Secondary processing;
Eligibility – SME: small medium enterprise (<500 emp.); PS: Post-Secondary; CC: prov'l Crown Corporations;
Support - SCE: Soft costs (salaries/travel/R&D equipment); CO: capital/operating costs; (L): loan; (E): equity; (G): grant

- **Sector**: Only ACRDP and ACEP are specialized to a single sector – aquaculture; all others support the fisheries and aquaculture industries broadly, with the exception of AIF and BDP, which exclude primary processing from eligibility. But between ACRDP and ACEP there is no overlap, since the former funds basic research and the latter is a capital program, funding the establishment or expansion of aquaculture facilities.
- **Funding source**: the programs divide into two groups by source of funding – provincial and federal – and are further subdivided into specific (fisheries and aquaculture: FTNOP, ACEP, CCFI, ARCDP) and general (RDC, IRAP, AIF and BDP). Funding from one source does not preclude funding from another; indeed, leveraging funds from sources beyond industry is encouraged (particularly provincially funded projects securing funds from federal programs) and is a common practice.
- **Project focus**: This indicator pertains to project objectives, and may be divided into three categories: i) research or R&D conducted wholly or in part through collaboration with scientists or academic institutions (ACRDP/CCFI); ii) R&D at the developmental or proof of concept stage, where support is directed mainly to technical assistance, but not acquisition of capital or equipment except as needed to implement the R&D (RDC/IRAP); iii) R&D with a strong innovation orientation, where support may include capital investment (mainly equipment) and specified operating costs (FTNOP/AIF/BDP).
- **Eligibility**: This indicates who may be eligible for support, and has two dimensions: the status of the applicant and nature of participation in the industry. Applicants must be incorporated entities for some programs (RDC, IRAP, ACEP,

AIF, BDP) and could be unincorporated (e.g., owner-operators or licence-holders) for others (ACRDP, CCFI, FTNOP). With the exception of FTNOP, RDC and BDP, where eligibility extends to entities providing support services to industry participants, the programs are aimed at entities with direct involvement in the industry.

- **Support**: This indicates which costs each program covers. The programs at the R&D end of the spectrum fund mainly soft costs including salaries, contractor technical services, testing expenses and specialized equipment (ownership of the latter may be retained by the program). Support is in the form of a grant in all cases. The programs at the innovation and business development end of the spectrum also support capital and operating costs, though in the case of AIF/BDP this support is ordinarily in the form of a repayable loan (though under BDP, repayment may be up to 50-75% of eligible equipment costs, depending on the nature of the technology and risk). ACEP takes an equity position in the funded company to match private sector cash investment, with the latter at a minimum of 20% of total assets.
- **Funding limit:** In all but one program (CCFI), the mandatory applicant contribution percentage is specified, ranging from 25 to 40% (and a minimum 20% equity position in the case of ACEP). Funding limits are specified for all programs except ACRDP and CCFI, where the support level is negotiated, and ACEP where the limit is linked to the investor's equity position). The grant programs have lower support levels than the loan programs.

To conclude, though the field of programs looks crowded, the actual overlap is fairly limited when differences in objectives, eligibility criteria, delivery and funding limits are considered. The programs are arguably more complementary than duplicative or competitive.

Similarities and differences among programs are evident from the indicators set out in Table 4.2 (red X denotes areas of difference):

- **FTNOP** provides the broadest industry coverage among programs in terms of eligibility, project types (mainly funding innovation) and costs covered. It is attractive to industry for these reasons, and also because it offers support in the form of grants, rather than loans, covering both capital and project-related operating costs. Projects tend to be relatively small because of the $100,000 funding limit, though leveraging support from other programs is permitted.

- **RDC** is focused on industry and academia generally, including the fishing and aquaculture industries, offering a range of support programs with a clearly articulated and strictly applied focus on R&D at the pre-commercial stage (this excludes simply investing in innovative technologies). Funding covers costs associated with R&D activities only (up to $250,000); it does not extend to capital and operating costs of technologies simply because they are innovative. Perhaps because of the strict eligibility criteria, RDC has received few applications from industry (most projects funded originate in academia).

Table 6.2: R&D program comparison of key indicators

	FTNOP	ACEP	RDC	CCFI	ACRDP	BDP	AIF	IRAP
Sector								
Aquaculture	X	X	X	X	X	X	X	X
Fish harvesting	X		X	X		X	X	X
Primary processing	X		X	X				X
Secondary processing	X		X	X		X	X	X
Industry generally			X			X	X	X
Funding source								
Provincial	X	X	X	X				
Federal					X	X	X	X
Industry	X	X	X	X	X	X	X	X
Project type								
Basic research (collaborative)					**X**			
Research & development	X		**X**	X	X	X	**X**	X
Innovation	**X**	X	X	X		**X**	X	X
Development/expansion		**X**				**X**		
Marketing	**X**					**X**		
Eligibility								
Unincorporated enterprise	**X**			X	X			
Incorporated enterprise	X	X	X	X	X	X	X	X
Service and support suppliers	X		X					
Industry associations	X			X		X		
Universities/Institutions	X		X	**X**	**X**	X	X	
Provincial department	X							
Federal department					X			
Costs covered								
Salaries/wages			**X**			X	X	X
Technical assistance	X		X	**X**	X	X	X	**X**
R&D equipment	X		X		X	X	X	X
Capital costs	**X**	X				**X**	**X**	
Operating costs	**X**						**X**	
Working capital		X						
Marketing activities	X					X		
Form of support								
Grant	X		X	X	X		X	X
Forgiveable loan						X		
Repayable loan						**X**		
Equity		**X**						
Funding limit per project								
20%		**X**						
60/80% to max $100K	**X**							
70%/negotiated					X			
75%/$250K			**X**					X
75%/<$500K						**X**		
75-80%/>$500K<$3,000K							**X**	
Subject to negotiation				X				
Annual budget limit								
$1.0 million				X				
$2.0 million	X				X			
Not specified		X	X			X	X	X

X denotes program is applicable to indicator: e.g., aquaculture is funded by all programs

X denotes difference among programs: e.g., ACRDP funds only basic research; ACEP takes equity position

- **CCFI** occupies a unique role within the range of R&D programs, acting as an intermediary between industry and academia in the provision of technical assistance, while also offering project management services for broad collaborative initiatives with industry-wide application. One of its greatest achievements is strengthening the connection between the expertise available in the various academic and research institutions in NL and the fishing industry. While this obviously benefits industry, it also provides the academic and institutional community with practical opportunities beyond the conduct of basic, curiosity-driven research.
- **ACRDP** is a national program supporting collaborative basic research to assist aquaculture producers. This highly specialized focus distinguishes it from other federal and provincial R&D programs.
- **BDP** applies to industry generally, offering support for business development and expansion through investment in innovative technologies and marketing. There are similarities with FTNOP in terms of project type, eligibility and costs covered, but BDP differs in three main respects: it does not fund primary processing projects; it has a substantially higher funding limit; and offers support in the form of loans, not grants, for commercial projects. Uptake of BDP support has been strong by the aquaculture sector, moderate by the processing sector and negligible from the harvesting sector.
- **AIF** funds R&D and innovation projects in industry generally, including the harvesting, processing (not primary) and aquaculture sectors. The emphasis is on industry-institution collaborative R&D, in some ways comparable to RDC, though with substantially higher funding limits. In spite of the attractiveness of grant funding and a high limit per project, uptake by the fishing and aquaculture industries has been limited to three projects since the program's inception in 2002.
- **IRAP** has been offering technical assistance and financial support for R&D to industry generally since the 1950s. There could be some overlap between IRAP and RDC, since sector coverage, project type, eligibility criteria and funding levels are similar. In both cases, program officials report limited uptake by commercial interests in the fishing and aquaculture industries.
- **ACEP** operates in the aquaculture sector only, providing capital and working capital assistance to establish or expand facilities. It shares this focus with BDP, though ACEP does not fund R&D. Support takes the form of equity participation by government, while BDP support is by loan (which could be conditionally repayable, depending on the nature of the technology and degree of risk).

6.3 Program delivery – gaps

The question of gaps in current R&D program delivery formed a key element of consultations with industry and R&D program managers. Generally, industry feels the current programs cover the ground well in terms of the range of R&D support provided, whether through own resources or third-party contractors (including academic institutions). Industry representatives consulted during this study expressed confidence in the quality of technical advisors, institutional capabilities and the excellence of test facilities.

Nonetheless, some gaps exist, both on the supply side (program delivery) and the demand side (industry). The more serious ones would appear to lie with industry. The gaps on both sides were explored in the FTNOP Review and Evaluation Forum in 2012. Many of the conclusions reached in that Forum apply equally to other programs, particularly as they pertain to the challenges faced by industry in taking advantage of R&D opportunities.

- **Terms of access:** With at least eight programs to choose from, there would not appear to be a shortage of R&D delivery capacity. But one issue from an industry standpoint concerns the terms of access. Only one program that is readily accessible by industry – FTNOP – provides grant assistance that extends to equipment (alternative/innovative technology). This makes it an attractive option for those seeking R&D support, and not surprisingly, the limited budget is fully subscribed. The other grant programs (RDC, IRAP, ACRDP, CCFI) essentially cover only soft costs. ACOA, the major source of industry support in dollar terms, provides assistance on an interest-free loan basis for most BDP projects (exceptions are ones deemed to involve high technical or market risk that may be classified as conditionally repayable). AIF offers support on a grant basis, but the limited interest it has attracted (three projects in over 10 years) has come primarily from the aquaculture sector.
- **Industry financial capacity:** The issue of terms of access becomes a gap when considered in the context of industry ability to participate. Not only is grant support for innovative technology limited, but to qualify, the applicant must cover part of the project cost (at least 40% in the case of FTNOP). Requiring applicant equity is entirely reasonable, but much of the NL fishing industry (harvesting and processing) simply lacks the financial capacity to participate. This contributes to the limited uptake by stakeholders in both sectors under most programs. Uptake by aquaculture interests has been much stronger because it is a profitable, growth industry.
- **Industry resources**: Financial resources are not the only factor limiting industry participation in R&D. There is also the question of industry capacity – resources and facilities – to identify opportunities to improve productivity and efficiency, and to design and implement R&D projects to develop the technology or processes to exploit those opportunities. A review of client names associated with past projects across all programs shows that over the years a relatively short list of companies has participated in R&D programs. Five or so are the larger, diversified processing companies, and the other 10 are smaller processors, some engaged in the aquaculture sector. Only a handful of inshore vessel owners have participated. Possible steps to address industry capacity are set out in the following chapter.
- **Collaboration**: The lack of collaboration in the industry contributes to a gap in the delivery of the benefits of R&D. This occurs in two ways: it inhibits implementation of the kinds of industry-wide R&D initiatives that would benefit all stakeholders (whether harvesting or processing technology, or marketing efforts); and, it can inhibit the diffusion of results from R&D projects conducted by individual companies. Programs would typically contain provisions ensuring that industry benefits from project results. For example, the FTNOP Policy and Procedures Manual, states that patents, copyrights, and other intellectual property resulting from work performed under the Program shall be disposed of, licensed, or otherwise dealt with as DFA determines (and this is stipulated in the contract). The industry is the first to admit collaboration is elusive (seeking MSC certification for

the shrimp and crab fisheries are the only examples of collaboration industry representatives could think of). Some program managers express pessimism that this is likely to change given the competitive environment in the industry.

Though not an aspect of program delivery, industry structure also represents a gap, or perhaps more accurately, a deficit – a deficit in the sense that it contributes to the weak financial position of the industry (harvesting and processing), limiting its ability to innovate and market effectively, and be as competitive as it needs to be in global markets. Industry representatives and program managers alike question the capacity of the industry to absorb productively the substantial level of investment the FIF promises without taking action to address sources of structural weakness. To this end, the Icelandic model is referred to frequently as an example. Adjustments to the current regulatory framework would not have to extend as far as allowing vertical integration; even just relaxing some of the licencing, quota and vessel restrictions to allow more flexibility in optimizing fleet capacity and lengthening fishing seasons would improve the prospect for a more cooperative and productive industry.

Lastly, the marine environment in NL waters appears to be going through a regime change that is providing more favourable biophysical conditions for groundfish and less favourable for crustaceans. Northern cod stocks are recovering, though a return to a commercial fishery would appear to be some years away. Conditions in groundfish markets have changed considerably since the late 1980s when NL was last a significant participant. Industry representatives state that the NL fishing industry would have limited groundfish harvesting and processing capacity to meet EU and global product requirements and standards if the fishery were to re-open today. The question for the longer terms is how the industry would develop this capacity if uptake under current program design continues to be limited to a small minority of fishing vessels and processing plants. Of more immediate concern is how the industry will position itself to compete effectively in the EU market by the time CETA is implemented.

6.4 Concluding observations

Key differences in program design limit the extent of any overlap in delivery. The programs share a common goal, namely to enable the NL fisheries and aquaculture industries to compete effectively in global markets through continuous improvement in productivity, quality, diversification and sustainability. Though there is some overlap in scope and eligibility, there are important differences in these features, and also with respect to mode of delivery, cost coverage, form of funding and funding limits.

Generally, industry feels the current programs cover the ground well in terms of the range of R&D support provided, whether through own resources or third-party contractors (including academic institutions). Industry representatives consulted during this study expressed confidence in the quality of technical advisors, institutional capabilities and the excellence of test facilities.

Nonetheless gaps exist in program delivery. These are attributable to both program design and industry capacity. Sources of shortcoming include terms of access, industry financial capacity, industry resources, and a general lack of collaboration to implement initiatives leading to industry-wide benefits.

7. Delivery options for FIF components

7.1 Recommended areas for program investment within the FIF

The key areas for program investment within the FIF will depend to a large extent on what the future holds for the NL resource, and also future conditions in the EU market.

The demand for seafood in the EU is expected to increase over the next several years. In the face of a continued decline in marine wild resources within regional waters, the EU is expected to grow increasingly dependent on imports across all species groups including farmed products (mainly salmon).[5] The key factor behind the increasing demand is growing per capita consumption, which is expected to rise from 22 to 24 kg/year by 2030. Relatively high prices for seafood products generally in the EU (compared with the US), coupled with declining tariffs and the elimination of trade preferences, make the EU an attractive market for exporters able to meet product specifications and standards.

The future of the NL resource is perhaps less certain, both with respect to the nature of changes in the species mix and the magnitude and timing of such changes. For purposes of identifying key areas of investment, industry representatives make the assumption that the decline in shrimp is likely to continue and that a recovery of the cod stocks (and other groundfish species) seems likely within the next 5-10 years.

Though not the focus of this study, industry representatives made several suggestions about priority areas for the FIF. Not surprisingly, the suggestions address a broad range of issues covering various aspects of harvesting, processing and marketing (including market access measures such as sustainability and food safety certifications). They are united by a single theme: the challenge of meeting EU market requirements in terms of quality, quantity, timing and price. And while industry believes that R&D in a strict sense could form an important element of meeting certain aspects of this challenge, the general view is that this is likely to be largely a matter of assessing, adapting and investing in known technologies (some of which may be innovative in NL).

Specific opportunities for technological and process innovation are thoroughly reviewed on a sector and species basis in the 2015 DFA report, *NL Seafood Value Chain Infrastructure Benchmarking Assessment*, prepared by Pisces Consulting Limited. This report identifies the general areas suggested by industry, but does not go into specifics.

- **Harvesting**: the general objective is to land higher quality fish over a longer season, while meeting resource sustainability goals. While this would apply to all species, an important focus of future investment in fleet capability would lie in what appears to be an eventual transition from a shellfish fishery back to a groundfish fishery. This requires investigation of the options with respect to gear technology, vessel characteristics and fleet size, and training to adapt to stricter quality and sustainability standards. Even if an adaptation program were possible, there would likely be a need to invest in larger and more capable vessels to meet extended season, quality and sustainability objectives (as well as

[5] FAO, *Future Prospects for Fish and Fishery Products: Fish consumption in the European Union in 2015 and 2030*, FAO Fisheries Circular No. 972/4, Part 1.

address labour shortages). All fisheries would eventually require certification that the resource is being harvested sustainably.

- **Processing**: with limited groundfish processing capacity in NL, the combined pressures of a resurgent groundfish resource, scarcity of labour, and the need to meet new and strict product and market requirements, means that investment in processing capacity is essential. This may take the form of new plants, but at the very least it would require adaptation of existing facilities (in strategic locations), including in both cases investment in equipment to automate processing operations. Plants are likely to require third-party certification to the BRC standard, with full product traceability.
- **Labour**: harvesting, processing and aquaculture representatives emphasize the labour force challenges the seafood industry faces already faces in finding and retaining crews and plant workers. The workforce in coastal communities is declining and ageing. Policies and programs to facilitate fleet consolidation are beginning to show results, but representatives indicate that further adjustment is needed, not just to address labour issues, but also to improve income levels. For the processing sector, plant automation would seem to be essential.
- **Marketing and logistics**: NL's exports to the EU are heavily concentrated (±90%) in a single species – shrimp – with the balance consisting of frozen crab, lobster and scallop. Elimination of tariffs presents opportunities for these products, though in terms of volume, only crab offers significant potential at present. Groundfish recovery would change this. But gaining access to the EU market would present a major challenge to NL exporters, given the dominant position held by Iceland, Norway and EU member states. The same argument could be made for the US market. Considerable resources would have to be devoted to market development, including establishing efficient logistical networks.
- **Aquaculture**: this sector has been the major beneficiary of program support over the past decade, with most of the funds used to expand capacity. It is still in expansion mode (salmonids and mussels), and could be expected to draw on ACOA, ACEP and the other programs in the future. Salmon aquaculture is a relatively new industry in NL, already using the latest technology and operating competitively in a global market. To date, with the large and accessible U.S. market on the doorstep, Canadian salmon producers have had little incentive to export to the EU. In any event, in the EU market, they would compete head to head with Norway, the world's dominant producer.

7.2 Program delivery options

Using existing resources

The case is strong for using the FIF to support R&D and investment in the innovative harvesting and processing capacity needed to meet EU product requirements and quality standards. A case can also be made that support would have to be available either on more favourable terms or in more creative ways than currently exists if FIF funds are expected to be accessed by more than the small minority of industry stakeholders who in recent years have had the financial resources to meet the cash contribution requirements.

Since 1990, the fisheries and aquaculture industries have received well over $175 million in developmental funding. This works out to over $7 million per year over 25 years. Support since 2004 has amounted to over $60 million, with 40% going to the fishing industry and 60% to aquaculture (Table 4.3). Uptake is high at programs offering the most attractive terms and conditions, with demand for funding exceeding supply (FTNOP, CCFI). The combined budget for these programs is $3 million. Uptake is low by the harvesting and processing sectors at programs imposing limitations on how funds can be spent (RDC), or where support is in the form of a repayable loan (BDP). Projects have not been declined in either program due to budget limits.

The Terms of Reference for this study asks for options and suggestions about how the FIF could be administered, recognizing that much remains to be done to plan and shape its size, scope, objectives and structure. The discussion of options outlined below confines its attention to administration, setting aside such questions as whether and how priorities would be set (top-down or bottom-up); what kinds of activities would be funded (R&D and/or capital investment); application process (specified deadline/continuous); approval process (internal/industry input); eligibility criteria (status and affiliation); level of support (proponent contribution); terms of support (grant and/or loan); reporting requirements (form and content); and, diffusion of results to industry (method/timeliness).

Three options are examined, though other combinations and permutations are possible.

Option 1: Status Quo – Establish DFA and ACOA as the lead agencies with administrative responsibilities for the provincial and federal fund components. Each agency would adjust delivery capacity as required by the FIF mandate, objectives and life of the fund. Other programs would continue as at present, providing support according to their current mandates and budgets. In short, it would be business as usual, just with larger and perhaps more structured budgets for DFA and ACOA.

Pros

- Allows federal and provincial priorities to be pursued
- Makes use of existing capacity and processes
- Reduces learning time and expenses
- Familiar to client group

Cons

- Requires negotiation to allocate specific FIF areas of responsibility
- Requires negotiation of common set of principles and operating procedures
- Requires coordination to avoid overlap
- Requires industry to deal with two agencies

Option 2: Distributed programming – Divide the FIF into specific sub-programs according to agreed components (research and development, new marketing initiatives, fisheries research, enhancements to provincial fisheries infrastructure, structural adjustment). Assign each component to a department or agency offering specialized services in that area. Based on program experience over the past 5-10 years, for example: R&D to CCFI, fisheries research to RDC, fisheries infrastructure to ACOA, structural adjustment to DFA.

Pros

- Engages specialized program resources for each component

- Limits the need to expand resources or create new capacity
- Reduces learning time and expenses
- Each is familiar to the client group

Cons

- Could require allocating federal funds to third-party delivery
- Requires negotiation of common set of principles and operating procedures
- Requires considerable coordination to avoid overlap
- Requires industry to deal with multiple agencies

Option 3: Single window agency – Establish a single organization for FIF delivery, with federal and provincial representation on administrative structure. Since the FIF would have a defined purpose and lifetime, there may be merit in establishing a new agency specifically to administer the program. It would be staffed through secondments from government and industry.

Within this arrangement, three options for delivery are open: the top-down approach used by Norway with its Fishery and Aquaculture Industry Research Fund (where ministerial appointees from government and industry decide on priorities and initiatives); a bottom-up approach where industry and institutions submit applications for funding in response to annual or periodic calls for proposal; or, a hybrid of the two, where the FIF budget is divided between top-down priorities and bottom-up initiatives. Existing fisheries-specific funding programs would be discontinued. CCFI, with its capacity to delivering technical support, would continue.

Pros

- Offers single window
- Simplifies application and approval process
- Allows industry input on critical decisions
- Avoids overlap among programs
- Would require high level of federal-provincial cooperation

Cons

- Would require extensive planning and federal-provincial coordination
- Could require lengthy period to achieve required level of fed-prov cooperation
- Finite agency life could limit interest from most qualified staff
- Dismantling the organization could create adjustment problems

Using resources external to government

The preferred option would appear to be a single window, one that combines industry knowledge with experience in delivering R&D programming to the fisheries and aquaculture industries. CCFI is one possibility. The organization would operate within a governance structure (board of directors) composed of stakeholders from key sectors. The Board would establish objectives, strategy, priorities, a provisional allocation of funds among priorities, and operating guidelines (eligibility criteria, funding guidelines, application and award process, reporting, evaluation).

Though there may be other non-government options, CCFI occupies a unique position with its 25-year history in the industry, including third-party delivery of R&D projects to a broad cross-section of harvesters, processors and their associations. Taking on this

function would require a substantial increase in resources, though such an increase is likely to be required regardless of how the FIF is delivered.

Making optimal use of FIF resources requires a measured approach

The FIF timetable should be determined, not by a schedule, but by careful consideration of industry objectives and needs, as well as its capacity to absorb the level of support contemplated. The objectives and needs will be determined by resource and fishing opportunities, and also by market requirements and competitive conditions. These factors can be expected to shift over time, so priorities and allocations under the FIF should allow for adaptation to changing circumstances.

7.3 Concluding observations

Investment is recommended in each segment of the seafood value chain. The seafood value chain extends from the water to the table, and each link requires strengthening in order to meet market requirements and to maximize the value of the resource.

- Harvesting
- Logistics
- Processing
- Labour
- Marketing

Consider delivering FIF support through a specialized agency. Much remains to be done to plan and shape the size, scope, objectives and structure of the FIF, making a preferred delivery option difficult to define. Among the options: Status Quo (DFA and ACOA as lead agencies for defined aspects of the respective FIF contributions); Distributed Programming (assign FIF components to specialized agencies); Single Window (assign responsibility to a single agency, with federal and provincial representation). Each has its pros and cons.

The preferred option would appear to be a single window, one that combines industry knowledge with experience in delivering R&D programming to the fisheries and aquaculture industries. CCFI is one possibility.

Making optimal use of FIF resources requires a measured approach. The FIF timetable should be determined, not by a schedule, but by careful consideration of industry objectives and needs, as well as its capacity to absorb the level of support contemplated. The objectives and needs will be determined by resource and fishing opportunities, and also by market requirements and competitive conditions. These factors can be expected to shift over time, so priorities and allocations under the FIF should allow for adaptation to changing circumstances.

ANNEX 1: NORWAY R&D PROFILES

3D pin bone detection and residue pin bone control

Prosjektnr: 900994 Status: Pågår Startdato: 01.06.2014 Sluttdato: 31.12.2015

Fagfelt: Industri/foredling Hvitfisksektoren

Enkelte eldre prosjekter i databasen, særlig fra før år 2008, kan fremstå med mangelfull informasjon på grunn av overgang til nytt nettsted. Vi jobber fortløpende med forbedringer, skulle du oppdage feil, ikke nøl med å ta kontakt med prosjektansvarlig hos oss.

Bakgrunn

Background
Automation, efficiency and optimized use of fish raw material are essential to keep the Norwegian whitefish industry profitable, environmentally sustainable and globally competitive. Cheap labor in competing low cost countries and increased quantities of cheap farmed non-Nordic whitefish (i.e. tilapia and pangasius and other residue bones) means that the industry now faces three challenges they need to address:
1. Minimizing the labor costs, by automating manual work;
2. Ensuring quality – prolonging shelf life and guaranteeing a boneless product; and
3. Maximizing use of raw material, especially the primary product yield.

Today, fillet trimming is the most labor-intensive and expensive operation in fish processing. This operation requires hard-to-find skilled operators for optimal results. The most critical task of this trimming process is to remove the pin bones and other residue bones through a manual v-cut. This provides more work and less quality product than what automation can provide.

Marel is in collaboration with SINTEF ICT developing a fully automatic system for real-time detection and removal of pin bones in cod in the APRICOT project (*see* "APRICOT anatomy: Avbildning og kvantifisering av tykkfiskbein i ulike fiskeslag" (FHF-900814)). The technology used in this machine is 2D X-ray, which means that a 2 dimensional image of the fillet is taken. However, to perform an optimal cut with a minimum waste of the high value part of the fillet (loin), there is a requirement to measure the position and orientation of the pin bones in 3 dimensions (X,Y,Z), combined with a flexible cutter. In the project applied for here we will estimate the 3D pin bone position by developing an x-ray stereo vision system, based on the APRICOT technology. This output can also be used in the development of technical solution for pin bone pulling.

Resultatmål

Objectives
To develop an x-ray stereo vision lab prototype for optimal 3D pin bone cutting and optimal yield.

Forventet nytteverdi

Expected project impact
Detecting 0.2 mm pin bones and localizing them in 3D is a challenging task. X-ray technology breakthroughs have provided high-resolution sensors, and the technology is now ready to make such a high-resolution detection unit a reality.

The economic potential of this innovation is increased yield and improved profitability in the white fish industry. The economic potential is related to an annual production of 450.000 tons of cod products per year, which is the annual grand total cod production in Norway. By automatically cutting the bones out from the fillet based on 3D X-ray imaging, the primary product ratio is estimated to increase by 1-2 percent points.

At the same time the mince ratio will decrease by the same level. Implementing this technology in the Norwegian cod industry could increase the annual product value by 3 MNOK for each average processing plant producing 25 tons of raw material per day.

Gjennomføring

Project design and implementation
The 3D position of the pin bones will be estimated using two x-ray sensors (stereo x-ray). The pin bone detection system will perform localization in XYZ, using APRICOT technology as the primary sensor providing XY position. Concepts for a secondary sensor (for full XYZ localization) will be evaluated and tested. Image analysis algorithms will perform separate detection of pin bones from each sensor using APRICOT bone detection algorithms. Results will be combined through customized stereo algorithms for final XYZ localization, where knowledge of fish anatomy is used as a prior. Given an optimal cutting pattern, the accuracy of the water cutting will be analyzed. Finally, the system will be tested and evaluated. The outcome of this work will result in the needed information (feasibility, increased yield, cost etc) to complete the developing of the system to a prototype.

Project organization
Marel is the project owner and project leader. Marel's primary role will be to develop the prototype, converting software to run-time and perform testing and evaluations. They will also build the actual machine, ensuring robustness, industrial quality and clean room hygienic standard.

Norway Seafoods primary responsibilities will be to define the specification of the systems to ensure it meets their current and future needs. Norway Seafoods will also enabling benchmarking of the methodology and provide fillets for testing

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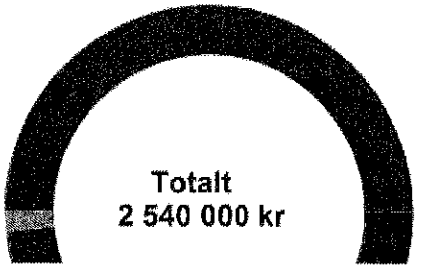
Budsjett

Budsjettallene viser den totale ressursinnsatsen i prosjektet, i form av økonomisk tilskudd fra FHF eller andre kilder og i form av egenandel fra f. eks. FoU-institusjoner



provide fillets for testing.

SINTEF ICT is the research partner and will in close collaboration with Marel develop the lab prototype for stereo x-ray vision system, evaluate different x-ray technologies for residue pin bone detection and develop algorithms for residue bone detection and position.

Formidlingsplan

Dissemination of project results
The results will be summarised in report and presented at FHF-seminar and meetings with stakeholders from the seafood industry.

Marel Norge AS, 1230000 kr
Norway Seafoods AS, 40000 kr
FHF (Fiskeri- og havbruksnæringens forskningsfond), 1270000 kr

Relaterte prosjekter

Automatic pin bone cutting for cod, saithe, haddock and salmon

Fagfelt: Industri/foredling

Pin bone pulling

Fagfelt: Industri/foredling

Fjerning av tykkfiskbein i laksefilet: forprosjekt

Fagfelt: Havbruk

Workshop: Fjerning av tykkfiskbein (pin bone) i hvitfisk

Fagfelt: Industri/foredling

APRICOT anatomy: Avbildning og kvantifisering av tykkfiskbein i ulike fiskeslag

Fagfelt: Industri/foredling

Faglig forskermøte om feste av tykkfiskbein i laks og hvitfisk

Fagfelt: Havbruk

Automatisk etterkontroll av rest-tykkfiskbein i pre-rigor laksefilét

Fagfelt: Havbruk

Feste av tykkfiskbein i torsk og laks: Bindevevets rolle og prosesser involvert i nedbryting av dette

Fagfelt: Industri/foredling

Teknologi for automatisk fjerning av tykkfiskbein i hvitfisk

Fagfelt: Industri/foredling

Automatic pin bone cutting for cod, saithe, haddock and salmon

Prosjektnr: 900991 Status: Pågår Startdato: 01.06.2014 Sluttdato: 15.09.2015

Fagfelt: Industri/foredling Hvitfisksektoren

Enkelte eldre prosjekter i databasen, særlig fra før år 2008, kan fremstå med mangelfull informasjon på grunn av overgang til nytt nettsted. Vi jobber fortløpende med forbedringer, skulle du oppdage feil, ikke nøl med å ta kontakt med prosjektansvarlig hos oss.

Bakgrunn

Background
Valka started in 2009 to work on automatic cutting of pin bones from fish fillets. Valka engaged in a development project with HB Grandi, Samherji and Ný-fiskur. The aim in the first project was set on vertical cut based on 2D analyses. The project was supported by the AVS research fund. An x-ray guided cutting machine for small redfish based on technology from Valka was delivered to HB Grandi in August 2012. That machine has now been up and running for about one and a half year operating at the accuracy and throughput promised. What primary remains in that project is to remove the fillet section which contains the bones automatically but that is being done manually in the current line.

On the basis of these promising results it was decided to take the project to the next level such that the machine could cut bones from cod, saithe, haddock and salmon fillets of any size. Early in the year 2013 it was decided to make a test on the machine in HB Grandi in Reykjavík in cutting cod fillets with vertical cut. The results gave better results than expected. It turned out that the yield loss when the pin bones are cut out of cod fillets of various sizes ranges from 5–7 per cent which is quite compatible to the yield loss obtained with manual cutting. HB Grandi decided then to go ahead and purchase a machine for cutting cod fillets and that machine was installed in August 2013. One similar machine was in the beginning of 2014 sold to Gryllefjord Seafood AS in Norway.

At this point Valka has developed a prototype of the system where the pin bones are removed by using 2D shadow picture. The next step is to extend the technique for cod, haddock, pollock and other fish with sloping pin bones. This can be done by generating 3D picture, instead of 2D shadow picture, for detection of the pin bones. The 3D information of the position of the pin bones will be used to cut out the pin bones with maximum utilization of the fish fillet. This can only be achieved using cutting pattern that can follow the slope of the pin bones. The machines already sold can be upgraded to perform angular cut and thus reduce the yield loss.

Resultatmål

Objectives
To be able to cut pin bones automatically from cod, saithe, haddock and salmon with better accuracy than can be done manually today.

Forventet nytteverdi

Expected project impact
With this system it is possible to increase the fillet utilization and gain more accuracy in pin bones removal than is currently known in the industry. The cutting robot will also be used to cut the fillet into desirable pieces, with maximum utilization in mind. It is estimated that utilization of the fish fillets can be increased by 1.5–2.5 per cent for cod and 1–2 per cent for pollock and haddock.

An added benefit is savings in human resources. It is estimated that the performance of the cutting machine equals performance of 5–7 people.

Gjennomføring

Project design and implementation
Cutting pin bones automatically is achieved by using X-ray camera to detect the exact location of the bones in the fillet. The picture from the camera is used to create a path for a water jet cutting robot, which removes the pin bones.

For cutting large fillets with acceptable accuracy it is necessary to measure the 3D position of the bones and use angular cut.

An automatic pin bone cutting machine will revolutionize how fillet production is organized. Defining a new processing concept around this new technology is therefore of great importance as well.

Today the most common cutting pattern focuses on maximizing the size of the loins and such cuts cannot be made with traditional portioning machines found in the fishing industry. An important aspect is as well more efficient portioning.

The project is split into six parts:
1. Improving the bone detection on soft bones and partly soft bones as are commonly found in cod and salmon.
2. Utilizing stereo vision techniques to obtain the 3D position of bones with maximum accuracy and defining optimum cutting paths around the bones based on capability of a cutting robot with multiple degrees of freedom.
3. Testing of the methods above with fish from various part of Norway in various conditions – most importantly

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NTNU – Norges teknisk-naturvitenskapelige universitet - Professor

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Haftor Runarsson
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Hinrik Somonarson
Valka AS -

Styringsgruppe

3. Testing of the methods above with fish from various part of Norway in various conditions – most importantly both pre-rigor and post-rigor.
4. Definition of a complete processing line built on this new technology which will make Norwegian fillet production more competitive in the world market. The economical aspect of the new processing technology will be evaluated as well.
5. Identify causes for formation of white material when salmon fillets are cut with waterjet cutting technology and test different alternatives to eliminate or reduce this formation.
6. Automation of sorting of portions after cutting.

Project organization
Valka is the project owner and is leading the project. Valka will hold the primary responsibility for all development work in the project. As well Valka will supervise the work done for individual tasks in co-operation with other project members. Several people from Valka will have input into various tasks.

NTNU will assist with the development of vision algorithms to obtain 3D images of bones from multiple x-ray images. The aim will be to find a master student interested in working on the project as a key component in a master's thesis.

Gryllefjord Seafood AS and Båtsfjordbruket AS assists in the development of a new factory layout based on the new processing technology and participation and review of test results. Gryllefjord Seafood AS has already purchased a machine which is capable of making vertical cuts and that machine will be used for performing tests on cod and haddock from various fishing grounds. The input from the processing experts at the Norwegian processing plants is especially valuable in task 4.4 and the plan is to perform part of the tests in task 4.3 in Gryllefjord.

HB Grandi will participate in developing a new factory layout based on the new processing technology, and will supply fish for the tests to be performed in the project in Iceland. As well they will provide factory space for performing initial testing of equipment developed in the project. Input into task 4.4 will be valuable as well.

Nofima's primary focus will be on analyzing the formation of white material when salmon is cut with water jet as is outlined in section 4.5.

Formidlingsplan

Dissemination of project results
The results will be described in a project report and by presentation on a workshop arranged by FHF.

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Innovasjon Norge -

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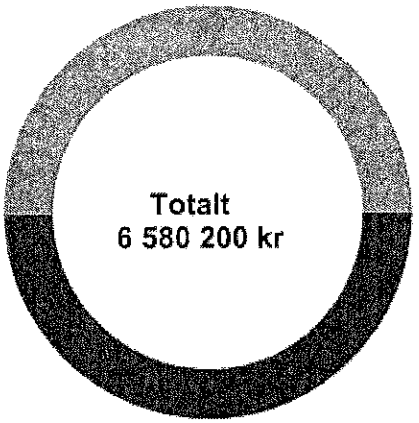
Båtsfjordbruket AS - Daglig leder

Torfi H. Thorsteinsson
Production Manager - Groundfish

Gunnar Holm
Gryllefjord Seafood AS - Produksjonsleder

Budsjett

Budsjettallene viser den totale ressursinnsatsen i prosjektet, i form av økonomisk tilskudd fra FHF eller andre kilder og i form av egenandel fra f. eks. FoU-institusjoner



Valka AS, 3280100 kr
FHF (Fiskeri- og havbruksnæringens forskningsfond), 3300100 kr

Relaterte prosjekter

3D pin bone detection and residue pin bone control

Fagfelt: Industri/foredling

Pin bone pulling

Fagfelt: Industri/foredling

Fjerning av tykkfiskbein i laksefilet: forprosjekt

Fagfelt: Havbruk

Workshop: Fjerning av tykkfiskbein (pin bone) i hvitfisk

Fagfelt: Industri/foredling

Development of gutting machine in the coastal fleet and industry

Project: 900247 Status: Closed Start date: 01/09/2009 End Date: 01/07/2010

Discipline: Common Measures Total Utilization of fish feed

Some older projects in the database, especially from before the year 2008, may appear with incomplete information due to transition to the new website. We work continuously with improvements. should you discover mistakes, do not hesitate to contact the project coordinator with us.

Achieved results

Phase 1: Development of gutting machine for whitefish
Under documentation was machine tested against hand gutted cod, which was undertaken by trained personnel under commercial conditions. This is to check if the machine would meet certain quality requirements with respect, damage carcass and viscera such as liver, gonads and gallbladder. The results show that the machine works well under commercial conditions. Besides being fast is not observed any case of damage to carcass through mistakes or lacerations. It suggests that the fish is stable inside the machine and the rotary blade is well adapted cod and its shape. However, had the machine higher percentage cuts on Hepatobiliary learn, but this is considered to be of less importance. Damage to bile compensated by the fish gutted with abdominal wall down so that the abdomen is not as easily be contaminated as by hand gutting. It was not registered significant differences in gonads. Here there was considerable damage by both methods, but it is because the fish were mature and had large gonads that pressed against the abdominal wall and were highly susceptible to the knife.

The capacity was 30-60 fish per minute, depending on size. The experiments were performed on fish size variation from 1.7 to 4.5 kg. Device Dimensions in mm 2130/780/1300. It is concluded that the machine can replace hand gutting without causing quality challenges. On the basis of the positive results planned in Phase 2 with wild fish on land.

Publications (1)

Final Report: Development of gentle gutting machine for whitefish: Phase 1 - farmed cod
RUBIN report 195/2010.

These publications are available via this address:
http://www.fhf.no/prosjektdetaljer/?projectNumber=900247

Background

Until today there has been no simple gutting machines for whitefish both gutting fish effectively while being gentle on the intestines so that it is possible to sort and sell to the consumer. First and foremost, such a machine has been clamoring for greater coastal boats, but also onshore see the need to streamline slack no without compromising the quality of the rest raw materials. On the basis of an American gutting machine developed for wild salmon, put the Norwegian technology company SeaSide in Stranda Started with the further development of this with regard to the use of whitefish. After initial promising modifications were initiated a development project funded by RUBIN with the goal to provide a machine suitable for use on both farmed cod and wild fish. The machine will continue to be used both onshore and on board the boat, including trawlers and coastal fleet.

Targets

To develop a gutting machine for whitefish. The machine should be:
- gentle to both fish and intestines
- adapted for use both on land, including slaughterhouses for farmed cod, and decommissioning of wild fish aboard boat, including trawlers and coastal fleet.

Expected benefits

It is the desire to develop a gutting machine for cod that can replace hand gutting without causing quality deterioration and simultaneously fast and meets commercial terms.

Implementation

The project is divided into three phases,
- Phase 1 includes gutting machine for farmed cod
- Phase 2 wild on land and
- Phase 3 wild aboard boat.

It's Phase 1 will be completed and reported here.

Phase 1 includes the provision of prototype testing of prototype large scale facility for farmed cod, modification of the prototype and the final documentation of the machine of Nofima Mat.

Dissemination Plan

Project report for phase 1 is posted on Rubin (www.rubin.no), which RUBIN report 195, and the FHF website. In addition, the description of the project in RUBIN-again.

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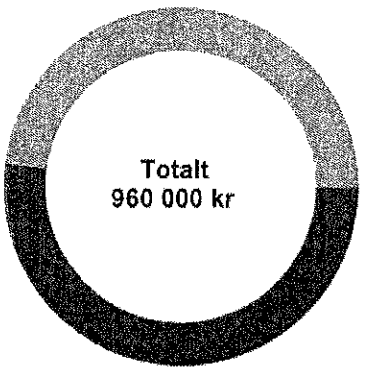
Budget

The budget shows the total resources used in the project, in the form of financial grants from FHF or other sources and in the form of a contribution from f. Ex. R & D institutions



FHF (Fiskeri- og havbruksnæringens forskningsfond), 500000 kr
Seaside AS, 460000 kr

Related projects

Effective gutting seine fleet

Discipline: Common Measures

Development of head caps and gutting machine for tusk and ling aboard autolines vessels

autonomous vessels

Discipline: Fishing and hunting

Go to the project database

FHF

FISKERI- OG HAVBRUKSNÆRINGENS FORSKNINGSFOND
Fisheries - and Aquaculture Industry Research Fund (FHF)

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Development and testing of gutting machine for Whitefish: Adaptation fishing fleet

Project: 900720 Status: Closed Start date: 06/12/2011 End Date: 16/01/2012

Discipline: Common Measures Total Utilization of fish feed

Some older projects in the database, especially from before the year 2008, may appear with incomplete information due to transition to the new website. We work continuously with improvements, should you discover mistakes, do not hesitate to contact the project coordinator with us.

Achieved results

Based on the feedback we have received from the fleet during the project period, one might conclude that gutting machine so it stands today, has a better use of the coastal fleet that deliver fresh fish to buy than trawlers that freeze the fish on board. The coastal fleet bleed mostly all fish before gutting and gutting machine can fit into such operations. The coastal fleet also delivers greater extent fish head on to the buyer in relation to the trawler which mostly produces HG fish (gutted and headed fish) on board. To seine vessels machine can fit well when they do not get as large a share "large cod "(> 5 kg) as yarn boats. The machine can also have good use of longline vessels. Gutting machine is less suitable for trawlers who have higher levels of efficiency, and that direct gutting fish. Trawlers often require too decapitation in the same operation as this gutting machine does. The machine is not suitable for boats that operate without bleed the fish. The machine is easy to operate and involve simple maintenance requirements and expertise. The machine has low requirement. The machine damages the intestines small, which is an advantage for the utilization of residual materials.

Publications (2)

Report: Gentle gutting machine for fleet (phase 3)
Seaside report. 10/01/2013. By Frode Håkon Kjølås.

Videotape: SeaSide its gentle gutting machine for cod and haddock
Published on YouTube on 20 December 2012. By Fred Martin Langøy.

These publications are available via this address:
http://www.fhf.no/prosjektdetaljer/?projectNumber=900720

Background

Until today there has been no simple and robust gutting machines for whitefish both gutting fish effectively while being gentle on the intestines so that it is possible to sort and sell fractions for consumption. First and foremost, such a machine has been clamoring in the fleet, but also onshore need to streamline slack no without compromising the quality of the rest raw materials.

Based on an American gutting machine developed for wild salmon, wanted the Norwegian technology company SeaSide AS Stranda to develop this machine for whitefish. After initial promising modifications funded Foundation RUBIN a development at SeaSide, where in the course of the first phase would provide a machine and test this for farmed cod. The results were positive and showed that the machine worked well under commercial conditions. Besides being fast is not observed any case of damage to carcass through mistakes or lacerations. It suggests that the fish is stable inside the machine and the rotary blade is well adapted cod and its shape. Although the machine had a higher proportion of lacerations to the liver and gallbladder than by hand gutting was not considered a problem since damage to bile compensated by the fish gutted with abdominal wall down so that the abdomen is not as easily be contaminated as by hand gutting. It was not registered significant differences in gonads. The capacity was 30-60 fish per minute, depending on size. The experiments were performed on fish size variation from 1.7 to 4.5 kg. It is concluded that the machine can replace hand gutting without causing quality challenges. On the basis of the positive results planned in Phase 2 with wild fish on land.

In phase two, which was funded by RUBIN in 2010 were machine tested on wild fish at shore facilities, preferably cod, haddock and themselves, and of variable size. This phase has now been completed and the report gives the same conclusions as in Phase 1.

The idea was to continue the project location and testing of machine boat. Many players within the fleet has shown interest in the machine and can imagine such a machine on board to take care of rest raw materials. Instead of placing the machine out on the boat in uttestingsperioden has concluded that the machine should be demonstrated for fishing boat owners / fishermen while standing on the shore so that most people can gain

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Project

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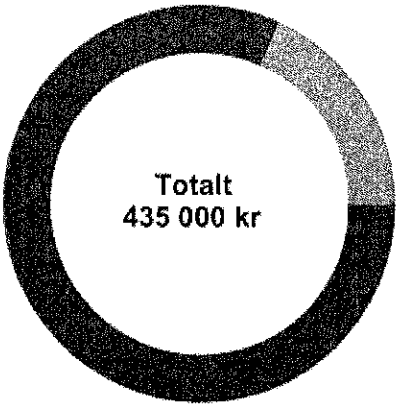
Langøy Consult AS - CEO

Budget

The budget shows the total resources used in the project, in the form of financial grants from FHF or other sources and in the form of a contribution from f. Ex. R & D institutions



FHF (Fiskeri- og havbruksnæringens forskningsfond), 355000 kr
Seaside AS, 80000 kr

Related projects

Insight into the function and have the opportunity to give feedback to the manufacturer. It is therefore planned a project to identify, invite and conduct a presentation of machine for a variety of shipowners while standing at a fish landing in Finnmark and use feedback to finalize the machine so that it can be commercialized. According SeaSide machine stable and robust, and little different to use onboard conditions on land. Seaway will not affect the actual operation since the fish is pressed into a groove and and being cut without movement of the boat will change shack inclsion.

Targets

To get an assessment from the fishing fleet about a new gentle gutting machine from SeaSide can be implemented in vessel intends to take care of the raw material and produce and sell this. This will be done through a presentation by fish now Nordvågen AS.

Secondary objectives
• To evaluate efficiency improvements compared to manual evisceration.
• To prepare presentation materials (video, brochure) which can be used to shipowners who are not present at the demonstration.

Expected benefits

The project will help provide fishing fleet technology gutting machine and still ways to take care of rest raw materials since gutting machine treats entrails in a gentle way.

Implementation

A testing machine and presentation by fish now Nordvågen AS will provide opportunities to get feedback from several shipowners if the machine is efficient and good enough to be installed, or whether it should be made substantial modifications. Efficiency improvements compared to manual gutting would also be an aspect which will be considered by potential users. The assessment will emphasize capacity and quality of collated biråstofffraksjonene. There will also be developed presentation materials (video, brochure) which can be used to shipowners who are not present at the demonstration. One should also designing opportunities for integrating decapitation as part of the process either before or after gutting. ***Highlights approach*** • Identify and contact relevant fishing boat owners from different vessel groups tråle-, autoline- and seine boats. • Invite a choice fishing companies to Nordvågen to demonstrate gutting machine • Restatement, erection and commissioning of the machine • Presentation of the machine to get instant feedback in relation to the use of the sea. Project management will be present in Nordvågen during the visit and experiment. • Production of materials, video and a presentation that presents gutting machine • Shipowners will also after the test to be visited to identify the need for modification and adaptation to gutting machine to work well on each boat, and discuss the likelihood of investment by the machine for better utilization of the raw material in the future. • Technical assessment of decapitation and possible. customization of machine input from shipowners • Reporting from the testing, demonstration and of input and feedback from fleet operators ***fact implementation*** It was completed test and display of machine with Gunnar Klo, department Steady in December 2012. Present on view were representatives from the following shipping: • Prestfjord AS • Aker Seafood ASA • M / S Havbåra machine has been used by Gunnar Klo dept Steady ago August 2012. It was rigged with feed trough and conveyor for removal of residual material. Gutting machine has been used by the production company throughout the fall, mainly haddock when the supply of cod in autumn 2012 was very poor. It has nevertheless been enough access so that the machine has been tested on cod with satisfactory results. When it comes to efficiency is gutting machine 50% faster than manual gutting of haddock and 30% faster than manual gutting cod (reference: RUBIN report No. 213, http://www.rubin.no/images/files/documents/4419 -213_nordvgen.pdf). Same calculation with the same result is done under test in Gunnar Klo AS. For optimum operation of the machine, the following preparatory work with the fish be done: • All fish must be bled and taking out should be cut across. • Pre-rigor fish works best in the machine (all fish gutted fleet is pre-rigor). • Fish can be run with or without head in gutting machine. Heading is not part of the process in SeaSide its gutting machine.

Dissemination Plan

The results are presented in a final report posted on Rubin / FHF website and possibly. Emitted actively relevant fleet operators. The results are also presented at relevant meetings and conferences. It shall also be made a video that appears to interested stakeholders in relevant forums.

Utilization of residual materials from groundfish by Nordvågen AS Nordkapp: testing and commercial evaluation of new gutting machine and total process line for sorting of residual materials

Discipline: Common Measures

Utilization of rest raw materials from groundfish industry in Havøysund in Finnmark: Phase 1.

Discipline: Common Measures

Go to the project database

Testing of production and market for shipboard produced cod cheeks and tongues

Project: 901022 Status: In progress Start date: 08/11/2014 End Date: 30/04/2015

Discipline: Common Measures Total Utilization of fish feed

Some older projects in the database, especially from before the year 2008, may appear with incomplete information due to transition to the new website. We work continuously with improvements, should you discover mistakes, do not hesitate to contact the project coordinator with us.

Background

The overall idea of this project is to utilize fractions of cod heads to high-quality consumer products. Cod heads represents approximately 17% of whole fish weight and therefore constitutes a major raw material potential in the Norwegian fisheries. In 2013, Norway had a residual feedstock potential of 867,000 tonnes of residual materials. Approximately 69% of the raw material utilized (600,000 tons). whitefish sector has displayed the lowest utilization, since only 33% were utilized in 2013 (124,000 tons). Volume-wise, fish heads the faction of whitefish sector the largest share feedstock basis of 94 000 tonnes in 2013. Only 13% of marine residual raw materials used for human use (Olafsen et al 2014). It is a goal to increase the profitability of the fleet through increased use of residual materials. It has previously completed several projects that have focused on manufacturing and market development for tongues, cheeks and clave heads both in the fleet and in industry (Kjerstad et al 1996 Tønnsberg et al, 1996, Helgason et al 1997 FjÃ‚,rtoft et al 1997 Nakken 1998 FjÃ‚,rtoft 2000 Helde, Stoknes and Hellevik, 2000, 2002, Stoknes and Okland 2002 Kjørstad 2004 Nybø 2004a, 2004b, Aas and Kjerstad 2008 Kjerstad et al 2014). Unsuitable or poor adaptive technology, small and short-term efforts to introduce products in the market and low prices has so far meant that one has not succeeded. Havfisk ASA together with Møreforsking and Matis closed preliminary study "Aboard Production of consumer products from fish heads" with funding from FHF. The overall objective of the study was to explore the possibilities for establishing a profitable production of consumer products from cod heads aboard the trawler. One has mapped available production technology and summarized Norwegian and Icelandic experience with production and mechanical equipment. Through collaboration with the research institute Matis is conducted testing MESA 900 Cheek and tongue machine in Iceland. In the pilot project has tested how MESA 900 Tongue and cheek machine works for cod heads. The test is carried out in cooperation between Havfisk , MESA , and research institutes Matis and Møreforsking . A achieved a production yield of about 3.8% for tongues and 17% for cheeks with skin and bones. To obtain more accurate estimates of production yield for different size of fish heads, it is necessary to implement enhanced yield trials over a longer period aboard. The machine worked best for heads between 600-1300 gr. Through the pilot project has MESA improved feed unit to ensure the safety of the operator, and optimized machine in general. It conducted the pilot project has yielded promising results in terms of opportunities to develop a profitable production and sales of the cheeks and tongues aboard havfiskflåten (Kjerstad m.fl . 2014). Havfisk install a MESA 900 Tongue and cheek machine aboard the trawler M / S Havtind. Havfisk will continue the pilot project in a major project with large-scale production aboard M / S Havtind and with the launch of products in the market.

Targets

To achieve profitable production and turnover of board produced frozen cheeks and tongues of cod in Havfisk ASA. ***Secondary objectives*** • To develop procedures for optimal production of tongues and cheeks. • To produce and test market customized consumer products cod heads. • To implement large-scale production of tongues and cheeks from cod aboard Havtind period June to December 2014. • To produce a minimum of 25 tonnes cheeks and 5 tons tongues at a total estimated value of 575,000 kr aboard the M / S Havtind during the project period.

Expected benefits

Norway has a strong population of cod and high quotas. This forms a good basis to develop methods to better utilization of residual materials in fishing fleet. Production of market customized consumer products will contribute to increased processing, development of new innovative products and improve the competitiveness of the Norwegian fishing fleet. In market it is an advantage to have access to large volumes and regular deliveries and to start development period for cod heads when access to heads is great. At any reduction of the cod quota, it is important that one has succeeded in creating values of residual material. Havfisk ASA is Norway's largest fishing vessel company. The company has 11 trawlers. The company has built three new trawlers and plans further renewal of the fleet. New technology and modern vessels provide shipping new opportunities for production and product development. In 2013 fishing Havfisk ASA 36 165 tonnes of cod (gutted without head) to

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Tone Myklebust
Havfisk ASA - Sales Director

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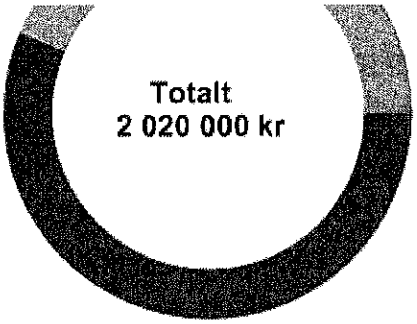
Budget

The budget shows the total resources used in the project, in the form of financial grants from FHF or other sources and in the form of a contribution from f. Ex. R & D institutions

a value of 492 million. Based on catches in 2013, the company has a theoretical raw potential of 9222 tonnes of cod heads. Based Havfisk their quotas can production of tongue and cheeks increase profitability and sustainability of the company. The production technology will be tested on one of the trawlers, but will be implemented in several boats for a successful development project. About fish heads manufactured properly and put in place technological solutions to ensure efficient production can cod heads used for multiple products. For Havfisk this gives a theoretical raw material of 350 tons tongues and 1567 tonnes cheek based on the company's overall cod quota in 2013. If one achieves 35 kr / kg frozen tongues and NOK 15 / kg for cheek can provide an additional income of 34.7 million lion before wrapping and freezing costs are deducted. M / S Havtind have remaining quota of 1825 tonnes round weight (TAC was at 2929 tonnes for 2014). The remaining quota amounting approximately 310 tons heads. The results of the project are used consecutively in "business to business" -relasjoner to customers in the market. The project will also help to improve the environmental profile, increase the degree of processing and the reputation of the entire Norwegian oceangoing fleet. One should apply residual material aboard a new and more kindly way. Whether a success with innovation, several vessels in the ocean-going fleet benefit from the project by installing similar technology on board.



Havfisk ASA, 1140000 kr
FHF (Fiskeri- og havbruksnæringens forskningsfond), 880000 kr

Implementation

The project is divided into two work packages:
• Work Package 1: Production and product
• Work Package 2: Market development and profitability calculations

Work Package 1: Production and product
Installation of machines and logistics solutions
Havfisk will buy MESA 900 Tongue and cheek machine and install it on board M / S Havtind in June 2014. Equipment Provider Optimar will prepare good logistics solutions for transportation, irrigation and caching heads, tongues and cheeks. Tongues and cheeks are flushed in water after cutting. One will have buffer tanks with water flow to ensure this. *Optimizing MESA 900 Tongue and cheek machine* to optimize production and train crew in sharp tongues and cheeks shall machine manufacturer in MESA Árni Sigurðsson be on board in a shorter period. Adaptations machine will be performed and functionality for production of cod heads of various sizes will be surveyed. Yield measurements in the completed pilot project were few and requires more data to conclude safer when it comes to dividends and functionality of the machine. It is necessary to carry out more extensive testing and optimization of machine and process logistics, and extended yield measurements over a longer period aboard the M / S Havtind to get accurate estimates of yield for different sizes of heads. It is important that the yield trials are based on the heads and sizes representative of cod heads Havfisk will have access to in their catches. Havfisk envisages that they are going to produce fish in between size, the largest and smallest heads are probably not suitable for machining cutting consumer products. Machine capacity in relation to volume and size of the heads will be examined. Møreforsking will attend yield measurements on board when the boat unloads the catch. Factory Manager aboard the M / S Havtind will conduct occasional yield measurements on board during the project period. Møreforsking will conduct statistical analyzes of yield figures. *Product* Havfisk will collect information about how the market wants products to be produced, sorted, packaged and packed aboard. Tongues and cheeks will be produced by market preferences. The products will be packaged and frozen into 25 kg half blocks. *Large-scale Production* M / S Havtind will complete production of tongues and cheeks cod in a 6 month period. The boat will optimize production and aims to have a continuous production of a large volume products. Methodology: • Yield Measurements and testing machine. • Møreforsking will prepare an experimental setups for the work to be carried on board. • Testing effects of dividends measurements at different sizes on the heads statistically. ***Work Package 2: Market development and profitability calculations*** *Test Sales of cheeks and tongues* Test Sales will start in August / September when Havtind landed products from its large-scale production. Havfisk will conduct test sales in the market during a 6 month period. Havfisk have ongoing dialogue with customers about volume, price and reviews on product and market potential for the products. Test Sales should answer the following questions: • Achieved acceptance in the market for frozen cheeks and tongues? • Is frozen cheeks and tongues substitute for other product? • Is the quality of products satisfying? - Shape, color and consistency - Desired weight gradings / size of products - Packaging and packaging • What price levels can be expected for frozen tongues and cheeks? • Which product variants are most interesting? • What volume would market? • Clarify whether there are seasonal variations for sales and consumption of frozen tongues and cheeks. *Profitability Calculations* Based on the information that has emerged during production and market development should Møreforsking and Havfisk preparing profitability calculations for the production and sale of tongues and cheeks aboard M / S Havtind. Quota Basis for cod, investment costs, production output and prices in the market forms the basis for margin calculations. Potentially production volume and revenue per trip and catch season will be surveyed. Methodology: • Havfisk will conduct test sales through its established customers. Havfisk is responsible for implementation and reporting of this work. Havfisk will gather information about the experiences and acceptance of products through meetings with customers. • Møreforsking will prepare profitability calculations (DB calculation) based on investment costs aboard, production yield and prices obtained in the market.

Related projects

Aboard of cod tongues and -kjaker: Pilot project

Discipline: Common Measures

Frozen groundfish residual materials: From fishing fleet marine ingredients

Discipline: Common Measures

Go to the project database

R & D competence program for the seafood industry: Research Project

Project: 900819 Status: In progress Start date: 15/01/2013 End Date: 15/01/2016

Discipline: Common Measures Competency Program

Some older projects in the database, especially from before the year 2008, may appear with incomplete information due to transition to the new website. We work continuously with improvements, should you discover mistakes, do not hesitate to contact the project coordinator with us.

Publications (4)

Brochure skills program

Fact Sheet 1-13 Competency Program

Tender for purchase of Continuing Education in R & D strategy and management
Tender published on Doffin

Report: Pilot project: Competence Program R & D strategy and R & D management geared toward seafood sector
SINTEF report A21465. 12/09/1011. Roar Solbakken SINTEF Fisheries and Aquaculture and Soviet Fastvold, University of Nordland

These publications are available via this address:
http://www.fhf.no/prosjektdetaljer/?projectNumber=900819

Background

On behalf of FHF, SINTEF Fisheries and Aquaculture with the University of Nordland mapped the need for increased R & D (research and development) more expertise in the seafood sector, and in what areas and how the sector want such expertise. The report concludes by suggesting the creation of continuing / further education within R & D strategy and management on two levels; a shorter courses (level 1) as FHF can develop and implement even in cooperation with Innovation Norway and the Research Council, and a more comprehensive offering (level 2) to be provided by an approved educational institution and give credits.

FHF board decided on the basis of the report to initiate a major project with its own project.

Targets

• To increase R & D activity in the seafood industry to ensure the greatest possible value creation and profitable business.
• To contribute to individual companies and corporate networks entrepreneurial skills with the aim of:
o strategically anchored project formulation and active participation in the implementation of user driven research
o better utilization of available instruments for R & D in the enterprise
o strengthened innovation in the enterprise / network through effective identification and application of research results that exist
o active participation in prioritizing funding for marine research through input to the funding agencies of strategy and planning.

Expected benefits

Better utilization of næringrettete instruments and R & D results in the seafood industry.

Implementation

The project will develop and offer a competence program within the R & D strategy and R & D management in the seafood industry. Offer Level 1 will give the food industry an introduction to research and funding agencies as a contributor to R & D projects for the seafood industry. Offer at Level 2 will give participants insight into how one can actively engage in and lead research work in the enterprise in a way that strengthens value creation and competitiveness. Level 2 will be offered by an approved educational institution and give credits.

Continuing / further postgraduate courses developed specifically for the seafood industry and is based on industry academic and practical needs

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Observers

Astrid Haug Light (historical connection)
FHF (Fisheries and Aquaculture Research) -

Janita Arhaug
Møre og Romsdal Fishermen BA -

Budget

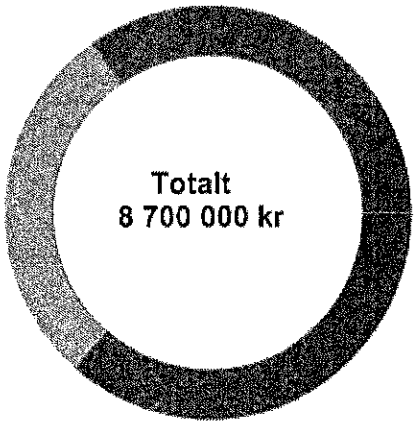
industry academic and practical needs.

Dissemination Plan

Expertise program marketed and recruited to courses through the industry their organizations, the media and the venues where industry players meet. It prepared a separate marketing plan for the courses in the project.

Budget

The budget shows the total resources used in the project, in the form of financial grants from FHF or other sources and in the form of a contribution from f. Ex. R & D institutions



- FHF (Fiskeri- og havbruksnæringens forskningsfond), 3180000 kr
- Innovasjon Norge, 2500000 kr
- Andre, 3020000 kr

Related projects

Continuing offer in R & D strategy and management

Discipline: Common Measures

Courses in research and policy instruments for the seafood industry

Discipline: Common Measures

Go to the project database

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