Marine Resource Residuals in Maine

SEA Maine

Seafood Economic Accelerator

Marine Resource Residuals in Maine

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Cover:
Increasingly sophisticated technologies are being used in Maine to process residuals from the marine resource sector such as shells, seaweed, fish and non-biological materials that can be turned into high value medical products, pest control products, plastics, food additives, and other manufactured goods.

Photo credit (top left):
Portland Press Herald (Sept 28, 2014) article: A Maine Group aims to turn lobster shells into pest repellant.

About this report:
Marine Resource Residuals in Maine was commissioned by the New Opportunities and Emerging Technologies subcommittee of SEA Maine. The subcommittee mandate is to identify opportunities to increase value-added products, strengthen infrastructure, and maximize efficiencies across the seafood value-chain to grow commercialization, business development and jobs. This report examines the types, volumes, and locations of marine resource residuals across the state to help increase value-added processing for the benefit of Maine's economy.

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Executive Summary

Extracting maximum value from marine resources includes full utilization of residuals, and it is critical to know where, how much and what type of residuals are being produced. This report examines the current state of marine resource residuals and considerations going forward that will help to engage private and public sector actors in gaining the full potential of marine resource residuals for the benefit of Maine's economy.

Industry input was obtained through a survey conducted in June and July, 2022 targeting 29 seafood processing companies and 161 active aquaculture lease holders, together representing the marine resource production base in Maine. In addition, 18 interviews gathered information from producers as well as organizations and others with key perspectives on added-value opportunities. A total of 53 people provided information, including 20 (69%) of the seafood processors and 32 (20%) of the aquaculture producers.

An estimated 57 million lbs of residuals are generated per year, representing about 25% of the total volume of seafood generated within Maine. This is based on 2021, and it is broken down for eleven major species groups. Most of this volume is currently disposed as waste, while some goes to low or medium-value applications.

Medium to high-value opportunities can provide revenue streams for companies in the sector. Medium-value opportunities include composting and biodigestion, fertilizer and plant stimulants, fishing bait and animal feed products. Higher value products include pet foods and treats, pest control products, health care and medical applications, textiles and bioplastics, nutritional products and novel food ingredients.

An online map of estimated residuals has been created to support spatial and logistical analysis for potential residuals processing opportunities. A number of existing residuals processing technologies currently used in other jurisdictions are capable of providing a 7% to 26% financial return on investments in Maine. After investing in processing equipment there would be a net revenue opportunity of between $50 and $100 per 1,000 lbs of residuals processed depending on the scale and type of residuals.

Two approaches for next steps include a sector-led approach and an expert-led approach. These approaches can be combined recognizing there are both leaders within the Maine marine resource sector as well as experts around the world that can accelerate opportunities. Bringing them together will be ideal for pin-pointing the best solutions, determining the business case for operators, and addressing gaps in expertise, time, or resources needed to develop the full potential of marine resource residuals.

I Introduction

1. Background and purpose

Marine resources harvested and cultivated in Maine are brought to market by harvesters, aquaculturists, processors, and distributors. At each step in the value-chain there are residual materials that do not make it to markets as the primary product. Biological residuals include fish, shellfish, and seaplant by-products, and non-biological materials include packaging, rope, and other gear. Some residuals end-up as lower grade products or even as waste destined for landfills.

Growing attention toward efficiency, reducing waste, and maximizing value from marine resources is being matched by new technology and innovation turning residuals into value-added products. Highly valuable ingredients from residuals have been discovered for use in: nutraceuticals and nutritional products, medical and personal care products, plastics and textiles, pest control products, and many other manufactured goods.

In order for Maine to extract maximum value from marine resources, it is important to know where, how much and what type of residuals are being produced. This report examines the current state of residuals and considerations going forward that will help to engage private and public sector actors in gaining the full potential of marine resource residuals for the benefit of Maine's economy.

2. Data gathering

Fishery and aquaculture production levels are presented as a backdrop to the residuals analysis and to indicate variability and trends that shape the annual flow of residuals. Production data is primarily based on Maine Department of Marine Resources (DMR) statistics. There are 13 species or groups of species that represent the majority of production (Table 1).

Table 1: Focal species and species groups for marine resource residuals analysis

• Lobster, • Crab, • Tuna, • Scallops (wild and farmed), • Soft-shell clams,	• Atlantic salmon, • Groundfish (e.g. Hake, Haddock, Cod, Pollock) • Mussels (wild and farmed), • Oysters,	• Quahogs, • Seaweed (wild and farmed), • Elver / eel, and • Monkfish

Note: This differs slightly from SEA Maine Baseline study (To be described)

Production data are organized by port, county, and four (4) regions of the Maine coastline: Eastern - Washington and Hancock counties, Mid-coast - Waldo, Knox, Penobscot and Lincoln counties, Western - Sagadahoc, Cumberland, and York counties, and Other – Unspecified counties, and imports (e.g. Other U.S., Canada, U.K.). Where necessary to protect confidentiality, some information from survey and interview activities is reported at county, region, or state levels.

3. Stakeholder survey and interviews

An online survey was conducted from June 9th until July 15th, 2022. Questions concerning residuals were part of a larger survey addressing the needs of other SEA Maine committees at the same time. This omnibus survey was designed to reduce demands on survey participants and present a uniform survey approach across subcommittees. The residuals questions were targeted to twenty-nine (29) seafood processing companies and 184 standard and experimental aquaculture lease holders. The target population count for processors is based on the latest US Department of Labor Statistics' Quarterly Census of Employment and Wages (2020), and the target population count for aquaculture producers is based on the latest registry from DMR. A current list of contacts was provided by DMR staff.

The survey required answers for questions about the respondent and their company contact information so that we could follow-up for clarification if needed. All other questions were voluntary including those about volumes of product, amounts of residuals, how residuals are handled, and views on opportunities and barriers for adding value to residuals. Since there are different numbers of responses for each question the response rates are presented for each one. In some cases data is combined across multiple respondents so that sensitive company information remains protected.

Eighteen (18) interviews were conducted from June 13th to August 3rd, 2022. The interviews supplement the survey data in two main ways: 1) by reaching important contacts not targeted in the survey, and 2) by accessing more detailed insights beyond the survey questions. The interviews targeted processing plants, aquaculture producers, aquaculture and fishing associations, waste management companies, and organizations working on new opportunities for residuals. A list of interview contacts is contained in the Appendix. The interviews were designed to last approximately one hour and were conducted by phone or video meeting.

4. Mapping results

One of the aims of the project is to map findings and show where residuals are located including types and volumes. This is presented in the report as well as online where it can be more readily accessed by stakeholders and updated as new information becomes available. This reflects a recognition that residuals produced by an individual company may not be sufficient for certain value-added opportunities and collection or coordination across multiple producers may be needed to justify investment in certain technologies.

II Maine Marine Resources

1. Commercial fisheries

Production volume and value

The annual production for all commercial fishing landed in Maine is a foundation for discussion (Figure 2). Production in the last ten years (2012 – 2021) averaged 271 million lbs with fluctuations in a range of about plus or minus 55 million lbs. The nominal values of landings are converted to 2021 dollars using the Northeast U.S. consumer price index (all items) so that year to year values are comparable. The average value over the last decade was $687 million with fluctuations ranging from $142 million below the average to $203 million over the average. Note the low was in 2020 during the start of the global covid-19 pandemic with anomalous market conditions.

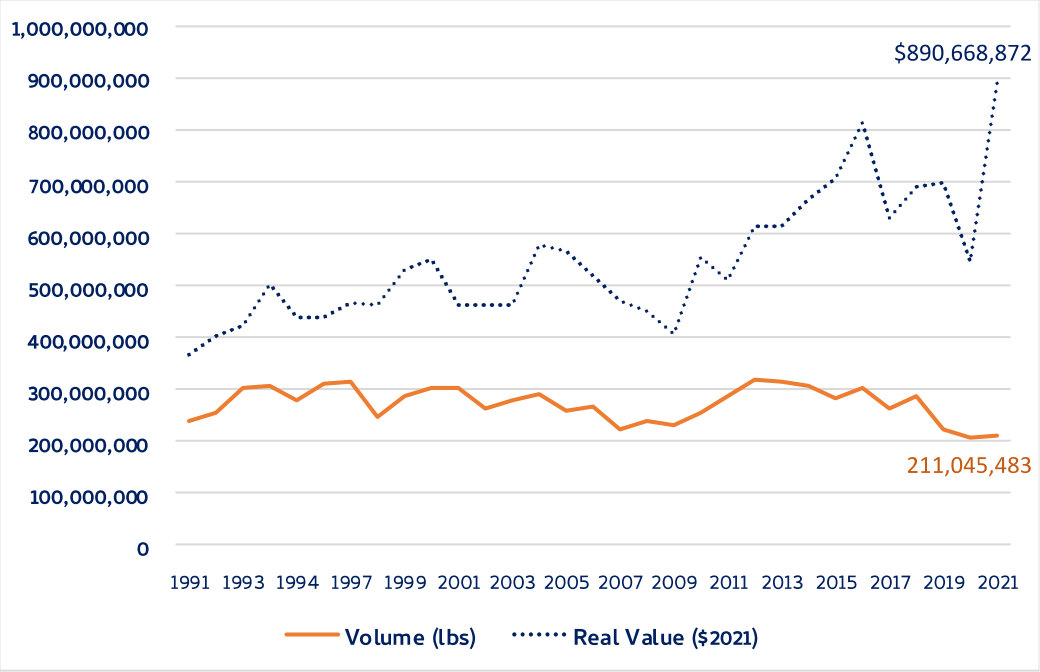

Figure 1 : DMR reported annual commercial fishing landed volumes and values, 1991 – 2021

Production by species and location

The 2021 production volumes (Table 2) show that lobster represents 52% of the total, seaweed represents 7.6%, the remaining balance of shellfish represents 12.7%, and "other species" represents 26.1%, 43% of which is unidentified catch. Salmon aquaculture production is absent since this cannot by published by DMR to protect confidentiality. The South coast accounts for 16.5% , Mid-coast is 23.5%, East coast is 27.9%, and Other sources including unspecified locations and imports (e.g. U.K.) are 32.1%.

Table 2: Production volumes (000s lbs) by focal species and others, by Maine county, 2021

(000s lbs)	South			Mid-coast				East		Other		Total	%
	York	Cumberland	Sagadahoc	Lincoln	Knox	Penobscot	Waldo	Hancock	Washington	Imports	Not-Spec.		
Lobster	4,347	12,616	876	6,389	25,710	-	-	27,334	19,313	-	12,317	108,903	52.5%
Seaweed[1]	-	-	-	-	-	-	-	-	-	-	15,724	15,724	7.6%
Mussels[1]	-	-	-	-	-	-	-	-	-	-	8,540	8,540	4.1%
Clam Soft	-	1,739	252	1,037	528	-	1	976	2,739	-	240	7,512	3.6%
Oysters	-	599	232	2,234	9	-	111	2,662	-	-	458	6,304	3.0%
Crab	-	1	-	-	100	-	-	301	431	-	1,737	2,570	1.2%
Quahog	-	851	389	11	-	-	-	-	-	-	191	1,442	0.7%
Monkfish	-	572	-	-	-	-	-	-	-	-	451	1,023	0.5%
Groundfish	-	308	-	-	1	-	-	2	-	-	530	842	0.4%
Tuna	114	152	-	8	37	-	-	-	-	-	101	411	0.2%
Scallop Sea	-	3	-	-	3	-	-	9	41	-	9	64	0.0%
Elver / eel	0	1	-	1	1	1	0	2	1	-	1	9	0.0%
Other[2]	-	10,599	637	3,110	9,296	-	162	3,450	622	148	26,076	54,099	26.1%
Total	**4,461**	**27,441**	**2,386**	**12,790**	**35,685**	**1**	**275**	**34,734**	**23,146**	**148**	**66,376**	**207,443**	**100%**
%	**2.2%**	**13.2%**	**1.2%**	**6.2%**	**17.2%**	**0.0%**	**0.1%**	**16.7%**	**11.2%**	**0.1%**	**32.0%**	**100.0%**	**0.0%**

Source: DMR, 2022 (online: https://mainedmr.shinyapps.io/Landings_Portal/)

Notes: 1. Volumes for some species are not provided by county to protect confidentiality 2. "Unidentified catch" accounts for 43% of "Other" species.

Since this only represents the volumes produced in Maine, it is important to recognize that some trade in marine resources occurs with other states, and other countries, especially Canada. At certain times of year lobster, for instance, will be brought from Canada to be processed in Maine, and at other times volumes will flow in the opposite direction.

2. Aquaculture sector

Aquaculture leases

There are currently 161 active farms, including: 118 active standard leases and another 43 active experimental leases in the state of Maine[1]. These leases grow more than 30 species of finfish, shellfish, and marine algae. The following figure depicts the approximate locations and number of licenses of all aquaculture leaseholders identified by the Department of Marine Resources (DMR) in the state.

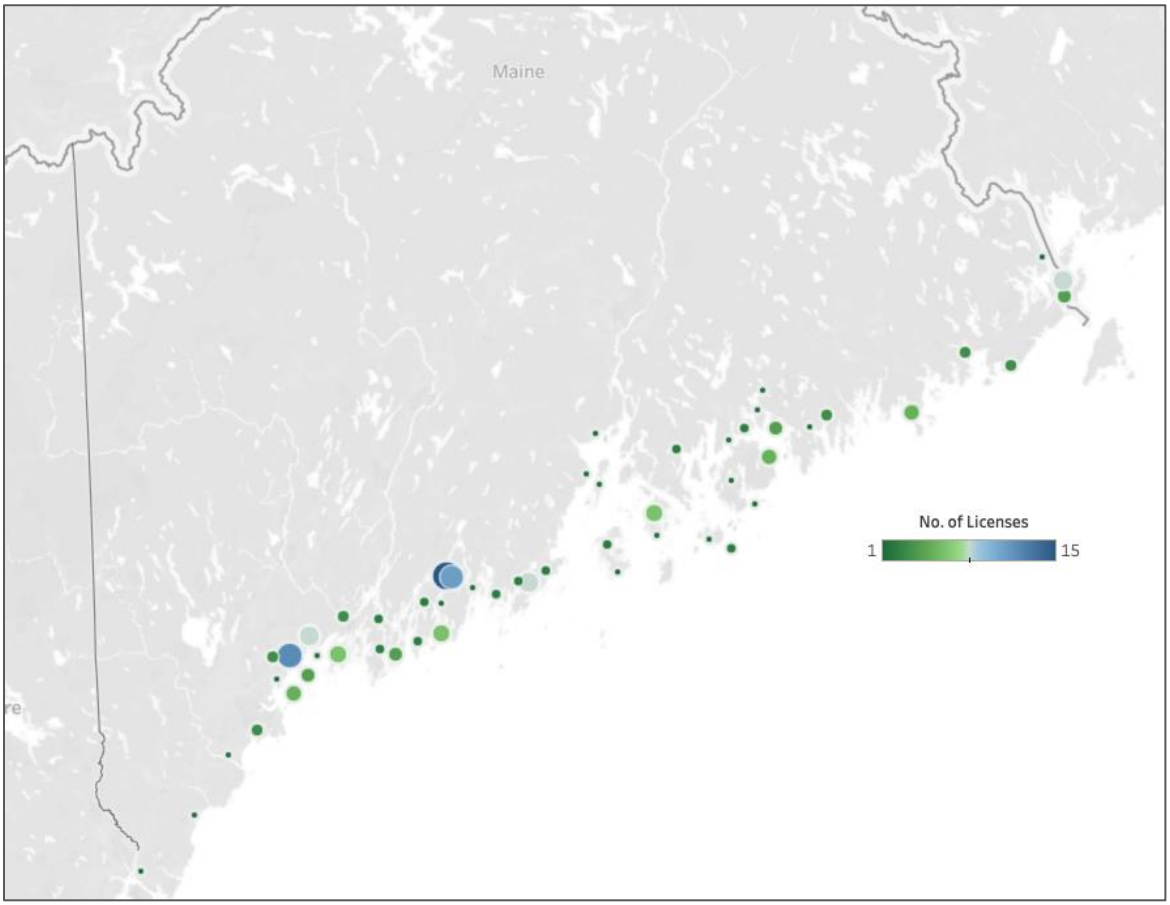

Figure 2 : DMR reported aquaculture lease locations

[1] DMR, 2023. (online: https://www.maine.gov/dmr/aquaculture/maine-aquaculture-leases-and-lpas/aquaculture-lease-decisions-table)

Aquaculture species produced

The production volumes and values for 30-plus species cultivated in Maine are reported by DMR according to four broad categories: American oyster, blue mussels, marine algae, and "other" species mostly represented by finfish[2]. Although 2020 production value was down 27% compared to 2010, this was due to a decline in the "other" category, while mussel production increased 93%, oyster production was up 301%, and marine algae was 33 times higher in 2020. Marine algae production includes sugar kelp for food products, and rockweed for non-food products mainly for soil enhancement in agricultural and landscape applications. The non-food markets have been building steadily for decades, while the sugar kelp production took off in the last 5 years and has grown very rapidly.

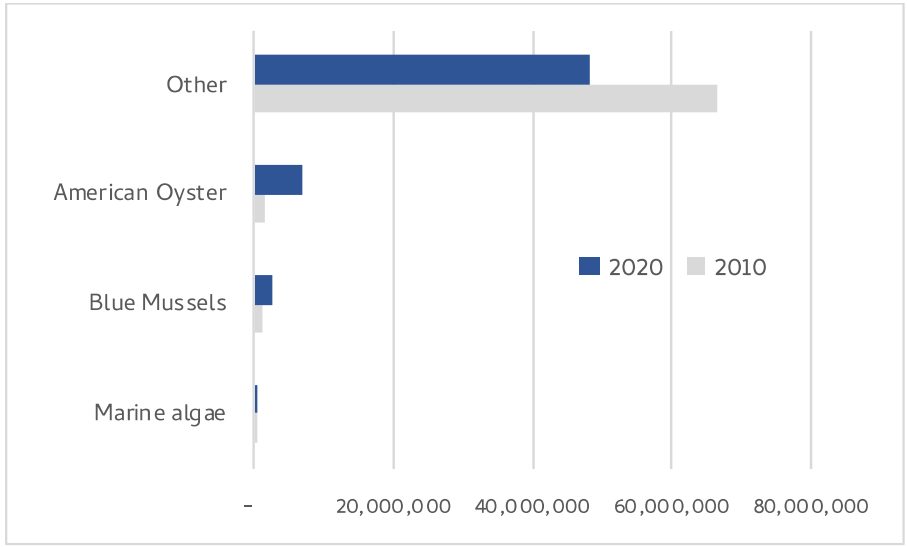

Figure 3 : Value of Maine aquaculture production, 2010 and 2020 (includes LPA in 2020, "Other" is mostly finfish)

Results from the 32 aquaculture leaseholders that responded to the SEA Maine Residuals Survey closely reflect the data published by DMR.

[2] DMR, 2023. Maine aquaculture harvest, lease, and license data (online: https://www.maine.gov/dmr/aquaculture/maine-aquaculture-leases-and-lpas/maine-aquaculture-leases-and-lpas)

2. Seafood Processing Sector

Processing establishments

According to the latest US Department of Labor Statistics' Quarterly Census of Employment and Wages (2020), there were 29 establishments operating in the Seafood Product Preparation and Packaging sector (NAICS 3117) in Maine. The 20 respondents to the SEA Maine Residuals Survey that identified as processors handled a total of 11 species of finfish, shellfish, and seaweed. The following figure depicts the approximate location and concentration of processor respondents by zip code in the state of Maine.

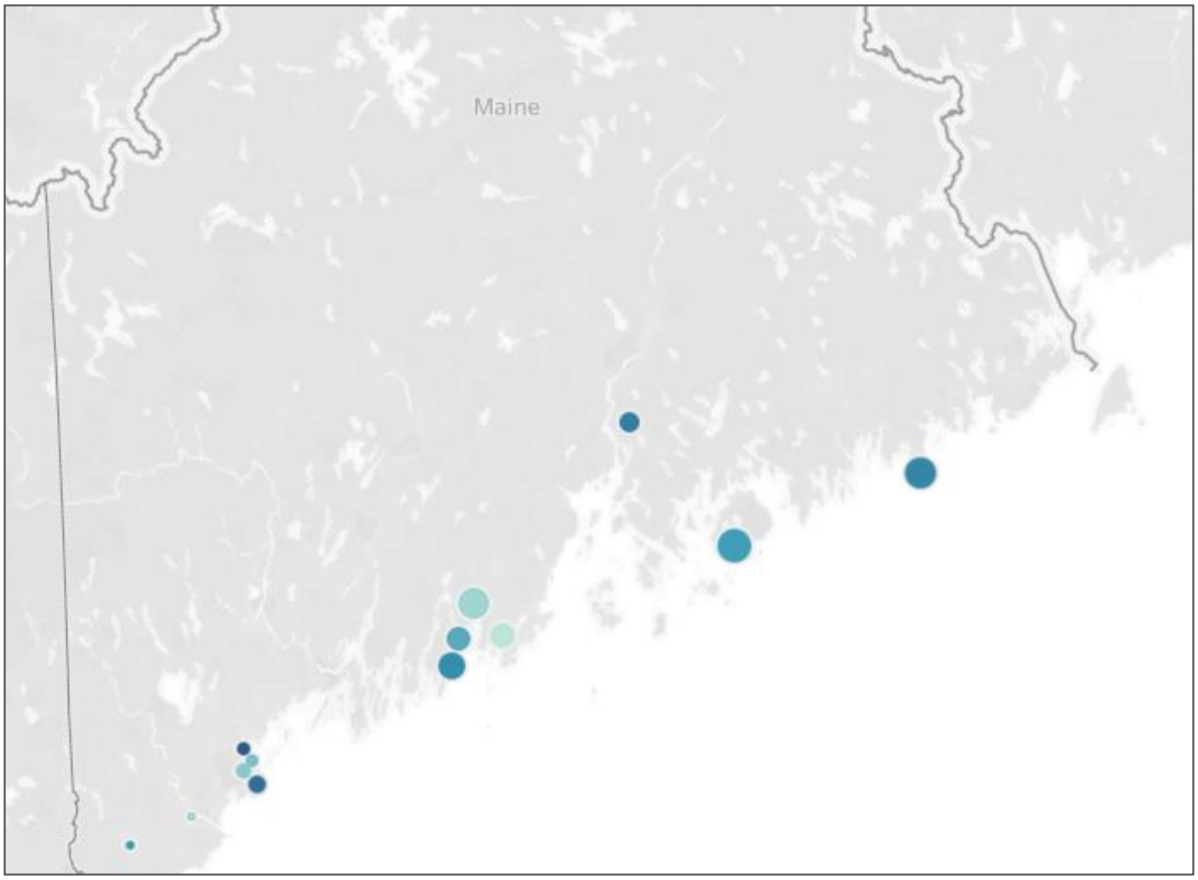

Figure 4 : Locations of seafood processing establishments in Maine

Species processed

Of the 11 species identified by processors in the survey, seaweeds (wild and farmed) are processed most frequently by respondents. Lobster, crab, and soft-shell clam are the next most commonly produced seafood products. The following table depicts the number of processor respondents that produce each species.

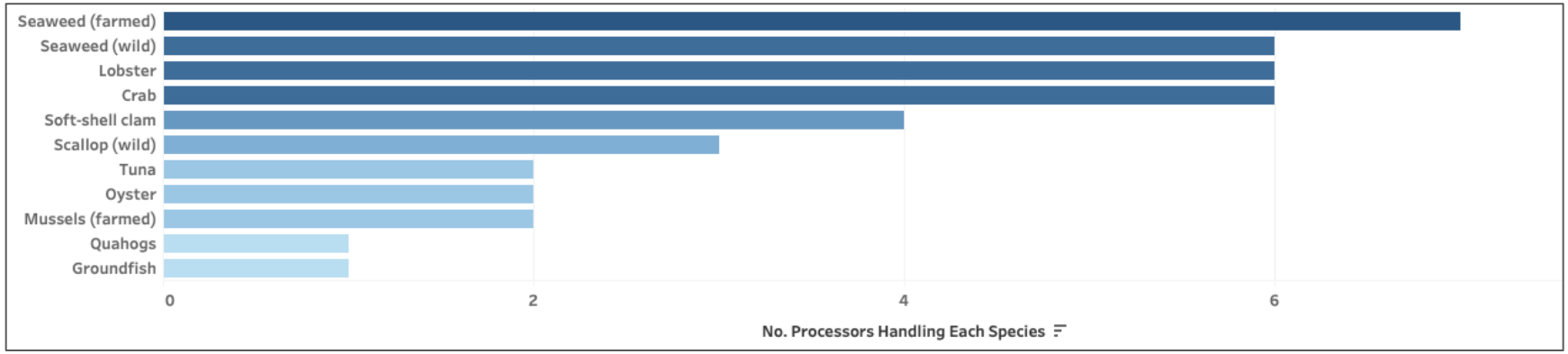

Figure 5 : Number of processors surveyed that process each species

III Survey Statistics

1. Response Rate

Fifty-two (52) people responded to the Seafood Residuals Survey. Thirty-two (32) of those identified as aquaculturalist / farmer / growers, while twenty (20) identified as processor / value-add producers.

Table 3: Response rates by type of company

	Number	Share of Total	Approximate Industry Coverage
Processing Sector	20	39%	69%[3]
Aquaculture Sector	32	61%	19.9%[4]
Total	**52**	**100%**	-

It appears that the survey reached most establishments classified as seafood / marine product processors in the state of Maine. By marine industry survey standards, a 16% response rate from the aquaculture sector is also significant. Some discrepancy may exist between DMR records, Census Bureau numbers, and the survey, as respondents were asked to self-identify. Response rates to each question in the survey are shown in Appendix B. The responses from the survey are aggregated to protect confidentiality and results are presented in the tables for Section IV and Section V below.

2. Summary of Text Responses

Biological Residuals

When asked what is done with biological residuals, all respondent processors and aquaculture producers stated that they dispose of them by composting, dumping in the ocean, or sending material to a landfill. Two companies state they also use residual shells for driveway or road covering. Two respondents indicate they sell some residuals to another company for use in agricultural and biomedical research, and fertilizer production. Three state that they use some of their residuals to make value-added products, such as painted shells, fertilizer, and bioplastics.

[3] U.S. Department of Labor Statistics' Quarterly Census of Employment and Wages (2020) identified 29 processing establishments in Maine. Also note: United States Census Bureau estimated there were 21 all-employer establishments operating in the Seafood Product Preparation and Packaging sector (NAICS 3117) in Maine in 2019.
[4] DMR reports 161 active standard farms, including: 118 active standard leases and another 43 active experimental leases that produce finfish, shellfish, and sea vegetables (https://www.maine.gov/dmr/aquaculture/maine-aquaculture-leases-and-lpas/aquaculture-lease-decisions-table).

Identified potential revenue streams include composting for fertilizer, feed or compost additives, and soil amendment or mulch. The most common reason for not taking advantage of these potential streams is that processing volumes are too low. A lack of technology or equipment, and a lack of staff expertise or time are identified as barriers.

Other Residuals

There was very limited information provided by survey and interview respondents regarding non-biological residuals. This finding in itself can be an indicator that there are few pressing problems related to the non-biological residuals. The lack of responses could mean that either the problems are not top of mind, or they do not see any significant opportunities worth reporting.

Where a few responses were obtained, the main materials cited were packaging, cardboard, and plastics. Respondents indicated these materials were disposed of at a cost of between $0 and $200 per month. These types of materials are not necessarily unique to the marine resource sector so perhaps waste management programs and operators already have the ability to collect large volumes across businesses and households and scale up recycling or processing facilities that are needed.

A couple respondents mentioned that packaging, cardboard and plastics produce residuals that are not associated with the marine resource sector since these are passed on to food service, retail, and end-consumers to deal with. The problem becomes de-centralized as shipments go to Maine, other states, and other countries. Maine operators recognize they still have a role to play in developing global solutions with biodegradable or easily recycled materials.

To supplement the findings, the following is a prime example of re-use and recycling for non-biological residuals in Maine. **Net your problem** (www.netyourproblem.com) is an organization that operates across multiple U.S. locations including a U.S. Northeast Division based in Portland, Maine. The Rope Depot in Maine is also associated with net your problem. The list of materials they work with includes: cable, bottom trawl net, footrope, purse line, soft buoys, gillnet web and many other types of fishing gear. In some cases gear can be re-used for other purposes, and in other cases the material is recycled into new products. Two products they promote are sunglasses and handplanes made from their recycled fishing gear. Some plastic materials are exported internationally to Plastix in Norway where they are turned into kayaks, mobile phone cases, and garden chairs.

IV Understanding residuals

1. Residuals factors

Some key factors affect the amount of residuals generated and the ability to capture value-added opportunities in Maine. The following were raised in interviews and are important to keep in mind when considering initiatives and long-term options.

- **Quality** - Maintaining high product quality along the value chain is the foundation for minimizing residuals and should be the first consideration. Fresh raw material produced, landed, and processed will maximize the portion that reaches markets as the target products, namely seafood. From harvesting and handling, then storage and processing, to shipping and distribution, this must be done in a timely manner with equipment, facilities, vehicles, and practices that maintain product quality. When product quality drops it may only be suitable for lower value residual products or even disposal.

- **Seasons** – Since lobster is a dominant component of the marine living resources in Maine, it is important to recognize that the early season soft-shell lobster landings limit the product options and increase the residuals produced. Up to 50% less seafood product is derived from soft-shell lobster than Fall or late season hard-shell lobster. Though not related to residuals production, these soft-shell lobsters cannot travel as far to reach higher value markets in parts of Europe and Asia. Maine summer lobster landings do serve high local demand linked to tourism that wants fresh live product. This has the effect of shifting residuals from the processing plants to the retail and food service sectors where they are more difficult to re-capture for any value-added opportunities. To the extent that more landings later in the season is possible, this will generate less residual material and more options for products and by-products.

- **Technology** – More advanced recent processing technologies for fish and shellfish have a substantial impact on the yield of meat extracted, particularly for lobster and crab. High pressure processing equipment can reduce residuals by about half (50%). The same is true for other fish where modern processing equipment can increase utilization (yield) rates. Not all processors in Maine have recently upgraded their equipment so there is a range of residuals production rates depending on the facility.

- **Seafood trade and processing capacity** – There are inter-state and international seafood trade dynamics that affect the amount of residuals in Maine. When Maine production is shipped out for processing (e.g. Canada) the residuals leave the state and are dealt with elsewhere, and the reverse is true where Maine imports products from other states or countries. In 2020, Maine exported 39.3 million lbs of lobster (99% live) to Canada, while 23.5 million lbs was imported (98% live) from Canada. In 2021, Maine exported 52.0 million lbs of lobster (up 32%) to Canada, while 19.9 million lbs was imported (down 17%) from Canada. As Maine processing capacity (relative to the volume of landings) changes and opportunities for raw material imports change, this will affect the overall production of residuals in the state. There are seasonal aspects to processing capacity as well, where at times it is beneficial to trade in order to keep plants running or make use of plant capacity that may be underutilized.

- **Consumer preferences** – The pandemic caused a dramatic shift in product forms where certain markets closed or nearly so for a period (e.g. zero-covid policy in China), or demand shifted from foodservice (tourism drop during pandemic) to retail (cooking at home). This drives seafood sector decisions to produce live or fresh seafood products (foodservice sector) versus more processed fresh or frozen products (retail) with implications for residuals that flow from each type of product. The more seafood is processed in the state versus shipping in live or whole form, the more residuals will be retained in the state. Though the pandemic is hopefully a limited case, consumer preferences are constantly shaping the demand for different product forms and will have effects on the residuals supply. In a high inflation environment, for instance, consumers may become more cost sensitive thereby shifting sales from higher priced dining-out to more economical processed retail products for home use.

- **Fish size** – Head-on gutted fish for some fish produce only 10-15% residuals (e.g. 16 inch haddock) while smaller sizes will produce 25-30% residuals for the same product. The is generally true for other fish species where the proportion of residuals increases as the meat ratio to overall size diminishes. Size is primarily affected by stock dynamics and management of the resource, therefore both policy (we can influence) and other ecosystem dynamics (we can't easily influence) are important.

- **Ocean disposal** – By-catch, mortalities, undersized catch, and processing-at-sea all affect the volume of residuals available. Fishing gear technologies (e.g. smart trawl) are reducing by-catch to meet sustainability requirements. Mortalities can occur in traps or in transit back to shore depending on trap "soak" times, duration of trips, handling and storage practices. Undersized catch is primarily influenced by fish stock dynamics, and to a lesser extent fishing gear specifications. Processing and harvesting activities at sea notably for groundfish, shrimp, and seaweed make it efficient to return residuals to the ocean. This presumes a low market value of all these residuals left at sea, but this could change if value-added production could justify bringing more of these to shore for processing. The ecological value of returning residuals to the ocean is also recognized, as returned biomass will contribute to productivity of market and non-market species.

2. Highest and best use

In-keeping with the goal to maximize value from marine living resources, there is a need to not only utilize residuals but to find their best use. This suggests an on-going process of opportunity identification and development, evaluation of feasibility, and commercialization at scale. The following table illustrates the concept of higher and better utilization of residuals as a backdrop to the assessment of current residuals uses in Maine. The underlying assumption below is that "value" represents the net-value (accounting for costs) or marginal value (compared to your next best alternative use) per lb or ton to the producer of the residuals (not the price of the consumer product that may be obtained by the buyer after they complete processing). This is not an exhaustive list and the order can change depending on circumstances of residual supply and demand.

Table 4: Value categories for potential uses of marine living resource residuals

Value	Use types	Notes
Negative	Landfill/effluent discharge	Societal and company costs can be high, but traditionally an easy option that meets requirement to move materials off-site
Low	Return to ocean	Low cost of avoided transport, some indirect value to future productivity
	On-site use	Avoided disposal costs, minor benefit to site driveway, yard, or storage pads
	Stabilization	Small costs offset by small revenues as this may increase options for transport and markets
Medium	Composting / biodigestion	Well matured compost offers high value for landscape and agriculture applications
	Fertilizer / plant stimulant	Depending on bulk sale or retail market, this can be medium or high value
	Bait / Animal feed	This can be medium or high value depending on traditional and alternative bait supply/prices
High	Pet food / treats	This market can be more profitable especially with specialized products
	Aquaponics / co-processing	Capturing value on-site, internalizing profit margins rather than hand-off to others
	Pest control product	Longer time to market given EPA efficacy and safety requirements, but high value once proven
	Health care / medical	Very long time to market with rigorous product testing, but very high value and returns
	Personal care / cosmetic	Numerous products with growing consumer demand for bio-active and natural products
	Textile / manufactured goods	Leather, bio-plastics, and other goods can be high value based on unique properties and sustainability
	Nutritional product / novel ingredient	Nutrient supplements, neutraceuticals, novel ingredients in foods, may even be primary product for sugar kelp and others

3. Current uses in Maine

The following is based on survey and interview responses and it shows in general how each species is being used in Maine. Determining the specific processes, arrangements, volumes, and values for each residual application would require more in-depth conversations with the producers. However, this provides a good indication of how residuals are currently being handled. Although many indicate the landfill disposal is still common, there are more advanced residuals uses for almost every species across the sector. Nearly all producers are keen to find better alternatives to their current use of residuals.

Table 5: Species residual uses reported by producers in Maine

Species	Product	Residuals type	Current use
Lobster	Live	Mortality	Disposed waste, sold, value-added, composted
	Processed	Shells, tomali, guts	Disposed waste, compost, wastewater
Seaweed/algae		Seaweed stipe, holdfasts, other	Compost, returned to ocean
Mussels		Shells	Disposed waste, driveway surfacing
Clam, Monkfish, Elver/eel		Shells, offals	Disposed waste, compost, lobster bait, value added product
Oysters		Shells	Disposed waste, driveway surfacing, returned to ocean, sold or kept for value-added products
Crab		Shells	Disposed waste, sold, compost
Quahog		na	na
Groundfish		Offals	Fishmeal, pet foods/treats, fertilizer, cosmetics, returned to ocean
Tuna		None reported	None reported
Scallop Sea		None	None reported
Salmon	Hatcheries	Effluent	Fertilizer
	Grow-out	Mortalities, Processing	Disposed waste, compost, pet food
Other (unspecified)		na	na

Note: “na” signifies “not available” due to insufficient or no responses collected from survey and interviews.

V Maine residuals analysis

1. Residuals in Maine

Combining the results from survey responses, interviews, and estimates based on public data, the following shows estimated supply of residuals volumes by species in 2021 for Maine. This is considered a lower-bound estimate for several reasons as follows:

- Emerging from the pandemic, 2021 was a year with lower landings than the decade average.
- There are substantial imports of fish from other states and other countries that are not accounted for, while these estimates are simply based on landings and aquaculture production in Maine.
- There is another 60 million lbs of seaweed noted below the table that is brought into Maine from elsewhere in the U.S. that is highly relevant to the development of opportunities for residuals.
- The SEA Maine Baseline report outlook for production is positive for a number of species, particularly seaweed (both sugar kelp and rockweed), and other fish stocks that are expected to respond favourably to climate change impacts on Maine waters (i.e. NOAA ratings).
- Two proposed land-based farms and one marine-based farm could increase salmon production ten-fold (10x) if the announced capacity of these project is fully realized. There is also a proposed Dutch yellowtail land-based aquaculture project in Jonesport, Maine.

Table 6: Estimated residuals volumes (000s lbs) by species in Maine, 2021

Species	Product	Volume	Residual %	Residual volume
Lobster[1]	Live	54,451	4%	2,042
	Processed	54,451	38%	20,419
Seaweed/algae[2]		15,724	2%	338
Mussels		8,540	1%	85
Clam, Monkfish, Elver/eel		8,544	49%	4,219
Oysters		6,304	6%	378
Crab		2,570	55%	1,413
Quahog		1,442	na	na
Groundfish[3]	Haddock	192	50%	96
	Hake	248	50%	124
	Cod	47	35%	16
	Halibut	32	60%	19
	Pollock	323	50%	162
Tuna		411	3%	10
Sea Scallops[4]		64	0%	-
Salmon[5]	Hatcheries	1,884	1%	19
	Grow-out	16,960	3%	509
Other		54,099	50%	27,050
Total		**226,288**	**25%**	**56,900**

Notes:

1. Lobster product 50% split is currently an estimate (to be confirmed).
2. Not included in the seaweed volume - Casella Waste Management Systems gave permission to report an additional 60 million lbs of seaweed collected from other states for bulk sale to farmers without processing, and there is interest in developing value-added opportunities.
3. By-catch not included (e.g. dogfish bycatch), residuals estimated volume and percentage is a minimum since information not available for all species.
4. Scallops are reported as meat waste so no waste reported, however about 65% of harvested weight is shell waste primarily returned to ocean.
5. Confidential data not available so salmon estimates are based on export data to Canada (New Brunswick) where salmon are processed. Proposed land-based RAS will have processing capacity in future (salmon and Dutch yellowtail).

2. Weighting of residuals estimates

The residuals percentage rates shown in the table above are based on "weighted" rather than "simple" averages of the responses collected in surveys and interviews. The example below illustrates the approach:

Hypothetical survey responses:

Respondent A - reports processing 20,000 lbs of oysters resulting in 1,000 lbs of residuals (5%)

Respondent B - reports processing 5,000 lbs of oysters resulting in 500 lbs of residuals (10%)

Residual rate calculation:

Simple average - residuals rate is 7.5% (average of 5% and 10%), which is not correct since this would imply 1,875 lbs of residuals instead of the 1,500 lbs actually reported (1,000 lbs + 500 lbs).

Weighted average – is the 1,500 lbs (1,000 + 500 lbs) of actual residuals divided by the 25,000 lbs of oysters processed yielding an overall average of 6%.

The weighted average percentage of residuals preserves the accuracy of the estimated total residuals across all respondents. Processors and aquaculture operators with large volumes are "weighted" appropriately in the final results.

2. Caveats and considerations

The following topics emerged from the analysis, interviews, and literature review. These would be important to recognize as opportunities for added-value processing of residuals are explored.

- **Understanding of residuals** – Some operators may have different perspectives on what is a "residual" and part of the effort moving forward will be to promote a common understanding of the topic. Some operators may already be adding value to what used to be residuals, and they no longer think of these as residuals. For instance, if it does not go in the landfill as waste, it may not be considered a residual. It is possible that more marine resource residuals exist in Maine as a result. It may be appropriate to

frame residuals as by-products aside from the primary product (e.g. food) that is produced. Therefore residuals going to pet food or compost are still tracked even if they are revenue generating products of the operation.

- **Year to year variations** – In the last decade (2012 – 2021) the overall DMR reported landings and production have fluctuated by about +/- 20% (low of -24% and high of +17%). The fluctuations by species may differ, where lobster varied from -15% to +13% over the last decade. Finally fluctuations may differ by location, where lobster volumes in Sagadahoc and Waldo counties varied from -60% to + 90%, compared to Washington county with +/- 8% over the last decade. Investments in added-value processing should consider more than just volume at certain locations, but also stability of volumes.
- **Lobster product** – has a large influence on the amount of residuals produced seasonally and from year to year depending on the amounts that are processed versus live lobster. The summary reflects roughly 50% of lobster going into each of these markets, but there is an order of magnitude difference in the residuals that are produced from each.
- **Technological investments** – Processors and aquaculture growers will continue to invest in their equipment and facilities over time. Investments often try to minimize residuals and maximize production of their primary food product. There are already remarkable differences between some processors with more recent investments from those who have not yet upgraded their systems to the latest available. Any assumptions about future volumes of residuals that would support investment in added-value opportunities should confirm with processors or aquaculture growers whether they have recently or plan to imminently invest in their operations such that residuals outputs will be affected.
- **Quality of residuals** – Recognizing not all residuals are created equal in terms of whether they are pure or mixed with any other by-products, whether they are dried or stabilized in any way to preserve key attributes of the residuals, or any other treatment has been applied. Detailed examination of residuals processing opportunities will need to include contact with the sources to confirm the condition and specifications of their residuals stream.
- **Other residuals sources** – Some value-added opportunities for marine resource residuals could utilize residuals from other food manufacturing facilities, other agricultural wastes, or even municipal programs that separate organic materials from the waste stream. This is more likely the case for medium value opportunities related to composting, fertilizers, and alternative bait manufacturing where other residuals could play a role.

3. Valuing the opportunities in Maine

Since there are a variety of value-added opportunities for each species and uncertainty regarding what volumes and locations are viable for value-added opportunities, the following presents a scenario to show how the opportunity can be valued at a statewide scale. The assumptions and inputs to this scenario are briefly outlined below:

- **25% of residuals** - Tackling the easiest and best opportunities in the near-term (3-5 years) may focus on one-quarter (25%) of all residuals in Maine.
- **Medium value opportunities** – moving from current residual disposal at a cost or neutral to a small revenue-generating opportunity. The net operational revenue, aside from capital investments, is $100

per 1,000 lbs. A 2016 estimate of fishmeal value in the U.S. was $1,213 per metric ton (about $550 per 1,000 lbs)[5]. Some residuals developments will produce more or less value and this is a conservative estimate since the trend is toward developing higher-value products. This is the return to the residuals suppliers, and additional revenue may be earned by a processor that sets up to handle the residuals.

- **Net revenues** – (gross profits) assuming 50% costs, means $100 per 1,000 lbs yields $50 in net revenue (excluding capital financing costs).
- **5% interest –** is assumed for loans and returns on alternate investments (opportunity cost of investments).

Based on the above assumptions, a $5 million investment in residuals processing equipment and facilities provides a 7% internal rate of return, and a net present value of about $470,000 over a ten-year period. This could be investments in equipment for multiple locations, facility renovations to accommodate logistical requirements, or storage and transportation systems. Increasing the net revenue from $50 to $100 per 1,000 lbs increases the internal rate of return to 26% and the ten-year net present value to $5.7 million. As long as residuals can be moved at low cost for an opportunity that provides a healthy revenue stream, multi-million dollar investments quickly become attractive. This return on investment calculation illustrates how residuals opportunities can be assessed, and more detailed analysis can be performed for specific opportunities.

VI Mapping Results

1. Mapping approach

The online map powered by an ESRI ArcGIS Online Web Mapping Application can be accessed with a password from SEA Maine at this link[6]. The web map combines Maine DMR annual landings and production volumes with the rates of residuals production presented by species in this report. There is no confidential information revealed since data is only mapped at port and county levels rather than specific locations and facilities. Data are shown for the period 2007 to 2021 and new data will be added each year following release by Maine DMR. The map layers and other features such as streets, terrain, ocean characteristics, and rail networks are obtained from public sources, including the Government of Maine. The web map is best viewed in a web browser on a large computer monitor, although it is available on mobile phones and tablets.

[5] Johannesson, H., T. Sigfusson. 2016. The U.S. Seafood Industry and Utilization of By-Products (for the Iceland Ocean Cluster).

[6] The following web address can be used if the link in text does not work: https://emaps.maps.arcgis.com/apps/webappviewer/index.html?id=1eb34088b0e84d269d0fe9bf9de23a46

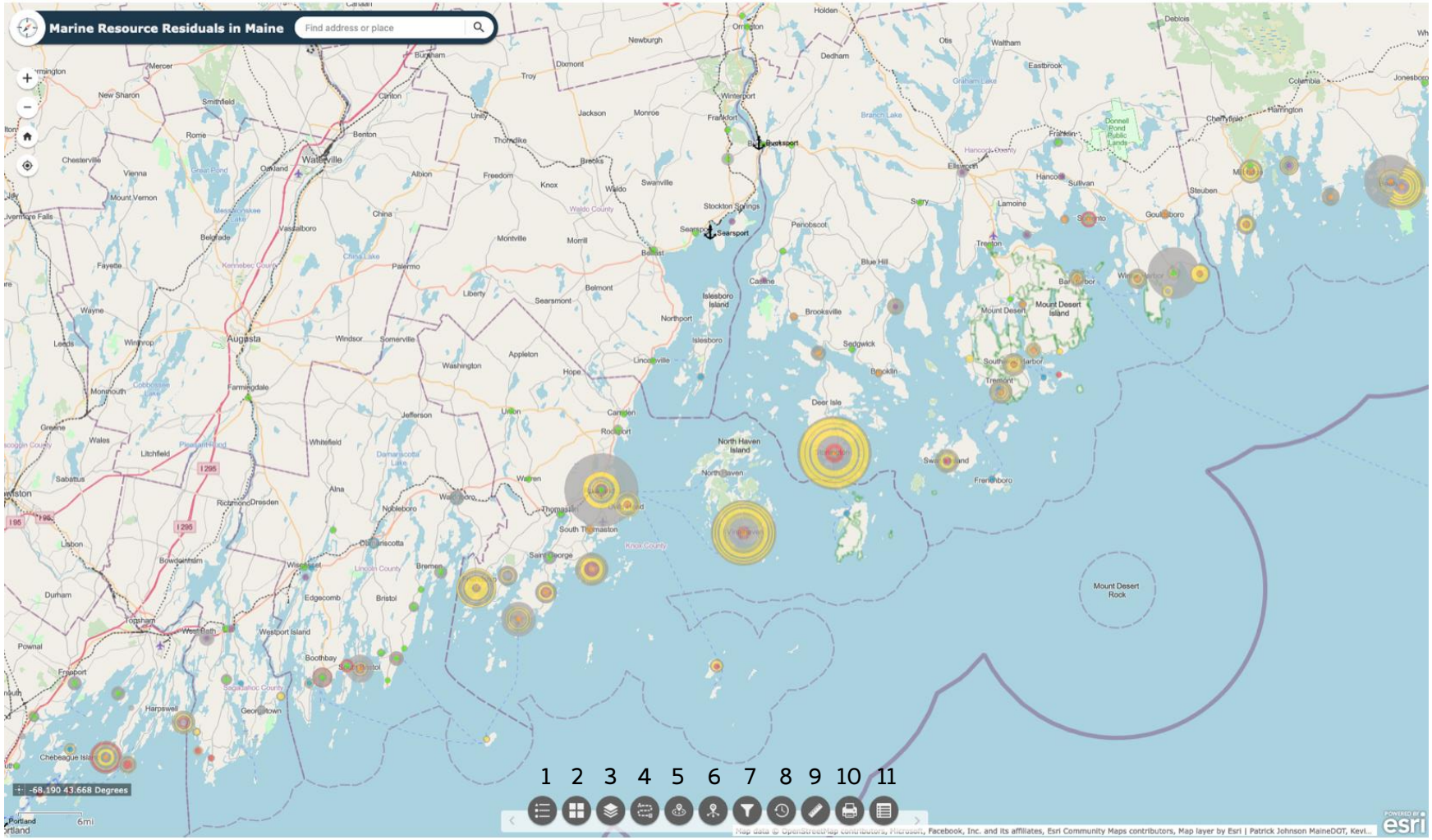

Figure 6 : Screen capture of online residuals map with numbers for each icon

2. Analytical capabilities

The map aims to support assessment of opportunities for residuals value-added processing. Where certain types of residuals by species are of interest, this can be visualized on the map. This is the default view when opening the map. Where certain volumes are needed within a maximum proximity, the map can be used to determine travel distances and volumes available within counties or within a certain radius of a central point.

The following functions are provided with the map (see numbered icons in Figure 6):

- **Legend** (1st icon at bottom) – The legend shows the symbology of the layers that are turned on. turning off a layer will remove it from the legend. It will explain in detail the size and colors of the circles that represent the Species, Value and Residuals Volume information.
- **Basemap gallery** (2nd icon) - shows map layers available for use including terrain and topography, ocean features, roads, rail networks and more. The default basemap Is called "OpenStreetMap".
- **Layers (3rd icon)** – Toggle the check boxes to switch the data presented from landings volume to landings value or residuals volume, as well as the Sea Ports and Railroads.
- **Directions (4th icon)** – Allows measurement of travel distances using road or rail networks. This will facilitate feasibility analysis involving transport of residuals between facilities. It Includes many options such as Driving Time, Driving Distance, Trucking Time, and more. That information does not take into account local knowledge of roads.
- **Near me (5th icon)** – This will identify all points within a certain distance to examine residuals volumes within a certain radius of a central location chosen by the user.
- **Info summary (6th icon)** – This will show summary information for points that are currently viewed in the map window. This information Is dynamic based on the layers that are turned on.
- **Filter (7th icon)** – For each of the three data layers (landings volume, value, and residuals), the filter helps focus on certain counties, ports, species, and years. Use the filter to narrow the search for data of interest and have this displayed on the map. Single or multiple ports, years and counties selections are available. The default view does not show any filters.
- **Time slider (8th icon)** - This is another quick way to present only certain years of data on the map. You can also select the first year and press “play” to see the map data change from year to year and show fluctuations over time at certain locations. This tool also allows single or multiple-year selections. It is also dependent on the Filters that are switched on.
- **Measurement (9th icon)** – Allows measurements of distance, area and locations.
- **Print (10th icon)** – This will “print” a PDF document that you can download and print on your own printer. The printout will reflect what is currently being viewed in the map window.
- **Attribute table (Last icon)** – This shows all of the data associated with points currently displayed in the map window and according to any filtering or time slider selections. The attribute table can be downloaded as an Excel spreadsheet for further analysis or input to other analytical software. The attribute table Is dependent on the Filters that are switched on.

VII Conclusions

The opportunities and recommendations begin with the challenges and barriers that must be addressed to move forward. Those who were surveyed or interviewed said the main reasons they had not yet pursued opportunities for added-value processing of residuals included the following:

- **Volumes of residuals –** are too low from their operations. This suggests they are already aware of opportunities and these simply require higher volumes of material to become financially feasible. In these cases, solutions will involve coordination between multiple operators to obtain the critical mass of residuals required.
- **Technology and equipment –** are needed to further process residuals. This also suggests they are aware of opportunities and the changes to their processing that are required, but there is a capital cost barrier preventing them taking the next step. Often focused on their primary product development and addressing the day to day marine sector challenges in the business, some assistance or incentive may be required to stimulate solutions for residuals.
- **Time and expertise –** are needed to determine feasibility. This is the only barrier suggesting that in some cases the solutions are not obvious. There can be technical challenges to overcome involving testing of residuals for certain attributes, determining how a new processing stream can be integrated with their existing operations, or simply evaluating the business case for investing based on markets and revenues that will offset start-up costs. This may require someone with the technical and/or business expertise to support multiple operators in making decisions regarding residuals opportunities.

This report brings together residuals estimates across the marine resource sector based on responses and input from businesses. The volume, types, and locations of residuals are mapped to support further analysis and next steps. Finally, the opportunity for Maine and economic value proposition is presented to help engage stakeholders in moving solutions forward.

There are at least two broad approaches to support next steps

- **Sector-led approach** – Through the interviews and surveys it is clear that there are a lot of very capable operators with great ideas. Some individuals are further along the path to solutions and some may have different ideas that could lead to solutions. This is a situation that is perfectly suited to a workshop or roundtable session to share ideas, especially where combining residuals volumes is likely to be part of the solution. Although an expert-led approach is explored next, the sector-led approach does not prevent experts from being involved to hear from operators, answer key questions, and support discussion of potential solutions. This will be more successful where all operators can gain from common information about residuals opportunities, but also have the ability for break-out sessions with the operators that are likely to share the same opportunities and challenges.

- **Expert-led approach** – recognizes that meeting one on one or in very small groups with operators in the same situation will be most effective. This would be a more in-depth consultation to gather the

technical and business feasibility details to support evaluation of residuals opportunities. This does not preclude the use of a workshop or roundtable to convene operators, but this would likely follow the expert-led discussions with each business so they are ready to have discussions with other operators. This requires one or more experts to be identified to fulfill this role and, although there are definitely several in Maine, there may be others outside the State worth contacting to support operators with specific needs.

In both cases, making this report available to focus attention on residuals and share foundational information is a helpful next step. Those interviewed for this report are interested in reading the findings of this study since they would like to help realize the economic opportunities for residuals in Maine. In particular, the New England Ocean Cluster (www.newenglandoceancluster.com) in association with the Iceland Ocean Cluster has a keen interest in working towards 100% utilization of fish for producing valuable products. Their insight and ongoing work in Maine could play a role in next steps.

Ultimately, a commitment to results will make solutions viable over the long-term. Pin-pointing the best solutions, determining the business case for operators, and addressing the gaps in expertise, time, or resources will help build commitment of operators across the marine resource sector.

Appendix A - Interview Participants

Processing:

- **Bristol Seafood Inc.** - Peter Handy, President and CEO - Portland, Maine
- **Great Eastern Seafood** - Robby Brando, Sr. Mgr. - Boston / NE / Gulf of ME
- **Ready Seafood** - Curt Brown, Marine Biologist – Saco, Maine
- **Sea Fresh USA Inc.** - Paula Tucker, Sales - Rhode Island & Maine
- **Tri-State Seafood Inc.** - Jeff Jordan, Owner / President - New Hampshire & Maine
- **North Atlantic Inc**. - Jerry Knecht – President – Portland, Maine
- **PJ Merrill Seafood Inc.** - Tim Merrill, Sr. Mgr. – Portland, Maine
- **Cousins Maine Lobster** - Annie Tselikis - South Portland, Maine

Aquaculture:

- **Cooke Aquaculture** - Andrew Lively, VP Global Marketing – Machiasport, Maine
- **Islesboro Marine Enterprises** - Shey Conover, Owner – Islesboro, Maine
- **Maine Aquaculture Association** - Christian Brayden, Proj. Mgr. – Hallowell, Maine
- **Ocean Organics** - George Seaver, VP – Waldoboro, Maine

Associations:

- **Maine Lobstermen's Assoc.** - Patrice McCarron, Ex. Director, Kennebunk, Maine
- **Maine Lobster Dealers Assoc.** - Annie Tselikis, Ex. Director, Portland, Maine
- **Maine Fishermen's Assoc.** - Ben Martens, Ex. Director, Brunswick, Maine

Other:

- **Casella Waste Management** - Jeff McBurnie, Regional Mgr. - Hermon, Maine
- **Net-Your-Problem** - Nicole Baker & Erin Addams - Maine
- **New England Ocean Cluster** - Patrick Arnold, CEO - Portland, Maine
- **PERC** - Scott Pero, Operations Mgr. - Orrington, Maine
- **Waste Management Co.** - Sean Graney. Major Accounts Mgr. - Portland, Maine

Appendix B – Survey Response Rates

1. Response Rates for Processors

The following tables outline the response rate for processing sector survey questions. The first set of questions collects information about the respondents and their company.

Table B-1: Response rate for processing sector company questions

Processing Sector Company Information	Response Rate
Please select the ONE category that BEST describes your organization.	100%
Which of the following species do you / your company handle?	100%
What was your most recent full year of seafood production?	79%
Are you operating in 2022?	79%
How many processing sites does your company operate in the state of Maine?	74%

The following set of questions asks what volume of input for each species is processed by the company. Respondents can indicate any species that are applicable so multiple responses are possible.

Table B-2: Response rate for processing sector volumes of raw materials inputs by species questions

Processing Sector Volumes by Species	Response Rate
How many POUNDS of each species that came INTO your facility did you process?	
Lobster	16%
Crab	16%
Tuna	5%
Scallops (wild)	5%
Scallops (farmed)	0%
Groundfish	0%
Mussels (wild)	0%
Mussels (farmed)	5%
Oysters	5%
Soft shell clams	5%
Quaghogs	0%
Seaweed (wild)	32%
Seaweed (farmed)	32%
Atlantic salmon	0%
Elver / eel	0%
Monkfish	0%

The next set of questions gathers information about residuals that may be produced. The initial question in some cases indicates they produce zero residuals, then they would not provide any further information at the

species level. On the other hand those that do produce residuals could then indicate the amount by weight (lbs) or as a percentage of the volumes they reported above.

Table B-3: Response rate for processing sector residuals by species questions

Processing Sector Residuals by Species	Response Rate
Did your company produce seafood residuals?	63%
What was the volume and/or percentage of seafood residuals produced when processing each species:	
Lobster (% of Volume)	11%
Lobster (lbs)	5%
Crab (% of Volume)	11%
Crab (lbs)	11%
Tuna (% of Volume)	0%
Tuna (lbs)	0%
Scallops (wild) (% of Volume)	0%
Scallops (wild) (lbs)	0%
Scallops (farmed) (% of Volume)	0%
Scallops (farmed) (lbs)	0%
Groundfish (% of Volume)	0%
Groundfish (lbs)	0%
Mussels (wild) (% of Volume)	0%
Mussels (wild) (lbs)	0%
Mussels (farmed) (% of Volume)	0%
Mussels (farmed) (lbs)	0%
Oysters (% of Volume)	5%
Oysters (lbs)	5%
Soft shell clams (% of Volume)	5%
Soft shell clams (lbs)	5%
Quahogs (% of Volume)	0%
Quahogs (lbs)	0%
Seaweed (wild) (% of Volume)	5%
Seaweed (wild) (lbs)]	0%
Seaweed (farmed) (% of Volume)	16%
Seaweed (farmed) (lbs)	5%
Atlantic salmon (% of Volume)	0%
Atlantic salmon (lbs)	0%
Elver / eel (% of Volume)	0%
Elver / eel (lbs)	0%
Monkfish (% of Volume)	0%
Monkfish (lbs)	0%

The last set of questions below helps understand what companies do with their residuals, what costs and benefits are involved, whether they are aware of higher value opportunities, and what barriers prevent them from capturing those opportunities.

Table B-4: Response rate for processing sector residuals handling questions

Processing Sector Residuals Handling	Response Rate
What was done with the seafood residuals you produced? Please select all that apply.	42%
For the residuals that were disposed, how were they disposed?	21%
How much did it cost to dispose of your seafood residuals? [$]	5%
How much did it cost to dispose of your seafood residuals? [per]	5%
For the residuals that were sold, what did the other company / companies use them for?	16%
How much did the company / companies pay you for your seafood residuals? [$]	5%
How much did the company / companies pay you for your seafood residuals? [per]	5%
What product(s) did you produce with your seafood residuals?	11%
What was the value generated by those value-added products in terms of revenue?	0%
Are there any potential revenue streams from your seafood residuals that exist but that you DID NOT take advantage of?	63%
What are they?	16%
Why aren't you currently taking advantage of them? Select all that apply.	16%
If you could take advantage of potential revenue streams, approximately how much revenue could they generate?	0%
Did your company produce other residuals?	63%
What were the TOP other residuals your company produced the most?	16%
What were the TOP other residuals your company produced the most?	5%
What was done with the other residuals you produced? Please select all that apply.	16%
For the other residuals that were disposed of, how were they disposed?	11%
How much did it cost to dispose of your other residuals? [$]	11%
How much did it cost to dispose of your other residuals? [per]	11%
For the residuals that were sold, what did the other company / companies use them for?	0%
How much did the company / companies pay you for your other residuals?	0%
What product(s) did you produce with your other residuals?	5%
How much annual revenue did you generate with those value-added products? [$]	5%
How much annual revenue did you generate with those value-added products? [per]	5%
Are there any potential revenue streams from your other residuals that exist but that you DO NOT take advantage of?	63%
What are they?	0%
Why aren't you currently taking advantage of them?	0%
If you could take advantage of potential revenue streams, approximately how much revenue could they generate?	0%

2. Response Rates for Aquaculture

The following tables outline the response rate for aquaculture sector survey questions. The first set of questions collects basic information about the respondents and their company.

Table B-5: Response rate for aquaculture sector company questions

Aquaculture Sector Survey Questions	Response Rate
Please select the ONE category that BEST describes your organization.	100%
Which of the following species do you / your company handle?	100%
What was your most recent full year of seafood production?	97%
Are you operating in 2022?	97%
How many processing sites does your company operate in the state of Maine?	97%

The following set of questions asks what volume of input for each species is processed by the company. Respondents can indicate any species that are applicable so multiple responses are possible.

Table B-6: Response rate for aquaculture sector volumes of raw material inputs by species questions

Aquaculture Sector Volumes by Species	Response Rate
How many POUNDS of each species that came INTO your facility:	
Lobster	3%
Crab	0%
Tuna	9%
Scallops (wild)	0%
Scallops (farmed)	9%
Groundfish	3%
Mussels (wild)	3%
Mussels (farmed)	13%
Oysters	53%
Soft shell clams	0%
Quaghogs	0%
Seaweed (wild)	0%
Seaweed (farmed)	16%
Atlantic salmon	0%
Elver / eel	3%
Monkfish	0%

The next set of questions gathers information about residuals that may be produced. The initial question in some cases indicates they produce zero residuals, then they would not provide any further information at the species level. On the other hand those that do produce residuals could then indicate the amount by weight (lbs) or as a percentage of the volumes they reported above.

Table B-7: Response rate for aquaculture sector residuals by species questions

Aquaculture Sector Residuals by Species	Response Rate
Did your company produce seafood residuals?	91%
What was the volume and/or percentage of seafood residuals produced when processing each species:	
Lobster (% of Volume)	0%
Lobster (lbs)	0%
Crab (% of Volume)	0%
Crab (lbs)	0%
Tuna (% of Volume)	0%
Tuna (lbs)	0%
Scallops (wild) (% of Volume)	0%
Scallops (wild) (lbs)	0%
Scallops (farmed) (% of Volume)	0%
Scallops (farmed) (lbs)	3%
Groundfish (% of Volume)	0%
Groundfish (lbs)	0%
Mussels (wild) (% of Volume)	0%
Mussels (wild) (lbs)	0%
Mussels (farmed) (% of Volume)	3%
Mussels (farmed) (lbs)	0%
Oysters (% of Volume)	19%
Oysters (lbs)	6%
Soft shell clams (% of Volume)	0%
Soft shell clams (lbs)	0%
Quahogs (% of Volume)	0%
Quahogs (lbs)	0%
Seaweed (wild) (% of Volume)	0%
Seaweed (wild) (lbs)]	0%
Seaweed (farmed) (% of Volume)	3%
Seaweed (farmed) (lbs)	3%
Atlantic salmon (% of Volume)	0%
Atlantic salmon (lbs)	0%
Elver / eel (% of Volume)	3%
Elver / eel (lbs)	3%
Monkfish (% of Volume)	0%
Monkfish (lbs)	0%

The last set of questions below helps understand what companies do with their residuals, what costs and benefits are involved, whether they are aware of higher value opportunities, and what barriers prevent them from capturing those opportunities.

Table B-8: Response rate for aquaculture sector residuals handling questions

Aquaculture Sector Residuals Handling	Response Rate
What was done with the seafood residuals you produced?	41%
For the residuals that were disposed, how were they disposed?	25%
How much did it cost to dispose of your seafood residuals?	16%
For the residuals that were sold, what did the other company / companies use them for?	3%
How much did the company / companies pay you for your seafood residuals ($)?	3%
What product(s) did you produce with your seafood residuals?	9%
What was the value generated by those value-added products in terms of revenue?	3%
Are there any potential revenue streams from your seafood residuals that exist but that you DID NOT take advantage of?	91%
What are they?	19%
Why aren't you currently taking advantage of them? Select all that apply.	22%
If you could take advantage of potential revenue streams, approximately how much revenue could they generate? [$]	13%
If you could take advantage of potential revenue streams, approximately how much revenue could they generate? [per]	9%
Did your company produce other residuals?	0%
What were the TOP other residuals your company produced the most?	0%
What was done with the other residuals you produced? Please select all that apply.	0%
For the other residuals that were disposed of, how were they disposed?	0%
How much did it cost to dispose of your other residuals?	0%
For the residuals that were sold, what did the other company / companies use them for?	0%
How much did the company / companies pay you for your other residuals?	0%
What product(s) did you produce with your other residuals?	0%
How much annual revenue did you generate with those value-added products?	0%
Are there any potential revenue streams from your other residuals that exist but that you DO NOT take advantage of?	0%
What are they?	0%
Why aren't you currently taking advantage of them?	0%
If you could take advantage of potential revenue streams, approximately how much revenue could they generate?	0%