

## **ELIMINATING WASTE FROM THE SEAFOOD SUPPLY CHAIN**

### **THE BENEFITS AND CHALLENGES OF “FROZEN”**

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## **FOREWORD**

Thank you for the opportunity to address our work on this topic to date, update the research chef community, encourage them to think differently about retail practices and use instructions for frozen seafood, and preview our future research plans in this area.

## **ABSTRACT**

In 2016, a report published by the Food and Agriculture Organization of the United Nations (FAO) revealed that nearly 90 percent of the world's fisheries were overfished, with 58 percent fully exploited and 31 percent overexploited, depleted, or recovering from depletion. In addition to an already over-taxed system, it is estimated that as much as 47% of edible U.S. seafood supply (domestic and imported) and approximately 50% of the global supply goes uneaten<sup>1</sup>. Sustainable sourcing and waste reduction are therefore strategic imperatives for human consumption of seafood products if we want long-term wild-caught fish stocks and sustainable resource consumption to be a reality for future generations.

There seems to be a widespread retail and culinary perception that an abundant seafood counter full of "fresh" fish on ice is more desirable to consumers than frozen seafood selections. Ironically, the fish at that counter is typically much less fresh than its frozen counterpart since, even in coastal stores, it is typically frozen upon harvest and defrosted before being put on display. Package instructions typically indicate that the fish or seafood must be thawed under refrigeration for several hours or under cold running water (further wasteful from a sustainability standpoint). Consumers report wanting to eat more seafood but find the hurdles to buying and handling the products to be deterrents.

Our project objective is to challenge the culinary and consumer preferences for fresh (spoiling) seafood and investigate if high quality culinary standards could be achieved to the same (or higher) levels by preparing frozen seafood products directly from their frozen state (cook from frozen). This research is especially relevant in both consumer and commercial settings, since the perception of "fresh" is skewed towards higher temperature storage, rather than a consumer reluctance to rate "frozen" as higher quality, even though by food safety, sustainability, and true freshness standards, frozen is superior. Our hypothesis is that the largest perception barrier to frozen seafood is a reluctance to view frozen seafood as desirable from a culinary standpoint. A number of recipes was developed to address these challenges; consumer feedback and data analysis will follow.

## **INTRODUCTION**

In 2016, a report published by the Food and Agriculture Organization of the United Nations (FAO) revealed that nearly 90 percent of the world's fisheries were overfished, with 58 percent fully exploited and 31 percent overexploited, depleted, or recovering from depletion. This overfishing is driven by modern commercial fishing methods such as bottom trawling during which a net with heavy weights is dragged across the seafloor taking in not only the targeted fish species, but also other species which is defined as bycatch, including sharks, whales, dolphins, and sea turtles. Many

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<sup>1</sup> Wasted seafood in the United States: Quantifying loss from production to consumption and moving toward solutions <https://www.sciencedirect.com/science/article/pii/S0959378015300340>

times, the bycatch is wasted and never reaches the consumers. World Wildlife Fund (WWF) [estimates](#) that overfishing and other food production practices have contributed significantly to a 36% decline in marine wildlife populations between 1970 and 2012. This biodiversity loss is unlikely to reverse its course due to anticipated elevated demand in seafood consumption as the world population continues to grow for a foreseeable future and results in irreparable damage in the marine food chain.

With an increase in seafood demand that is outpacing global population growth, aquaculture production has increased to fill the demand that wild-caught production cannot meet. In total, restraints on the scalability of these systems and distribution of available resources may still place a global deficit on available seafood as compared to recommended nutritional profiles for source proteins. Efforts to “sustainably source” wild caught seafood using standards like Marine Stewardship Council (MSC) and the Aquaculture Stewardship Council (ASC) have steadily increased among retailers and seafood purchasing groups. This trend is positive and one that must continue to accelerate.

Sustainable sourcing is only part of what should be our collective call to action. In addition to an already over-taxed system, it is estimated that as much as 47% of edible U.S. seafood supply (domestic and imported) and approximately 50% of the global supply goes uneaten. Sustainable sourcing and waste reduction are therefore strategic imperatives for human consumption of seafood products if we want long-term wild-caught fish stocks and sustainable resource consumption to be a reality for future generations. Love and colleagues estimate that the amount of seafood that is wasted each year globally is enough to meet the protein needs over 10 million people. According to WWF, fish may become unaffordable for most people as the world’s seafood supply can potentially become severely depleted by 2050. However, the situation is salvageable as research from the Johns Hopkins Center for a Livable Future (CLF) indicates that the 36% gap between current seafood consumption and the levels recommended by the 2010 U.S. Dietary Guidelines can be closed by recovering the seafood that is wasted.

By eliminating seafood waste throughout the supply chain, we can encourage more efficient utilization of production yields, increase seafood availability to the end consumer, potentially reduce pressure on fisheries and farms and decrease price volatility throughout the seafood supply chain. While not addressed in this research, it’s also important to understand that better temperature control can also maintain higher product values of seafood products, which can financially benefit small and large-scale fishermen and return higher profits<sup>2</sup>.

In order to achieve these goals, consumption patterns must be re-imagined and adjusted. Consumer focused pilots can address issues around consumer-generated seafood waste, such as frozen vs. fresh product, proper handling and preparation, more efficient packaging that increases merchandising appeal and retail sales and the importance of sustainable purchases.

## **OBJECTIVE**

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<sup>2</sup> Leaving Value on the Boat <http://www.brinknews.com/leaving-value-on-the-boat/> Jason Clay, 2017.

Our project objective is to challenge the culinary and consumer preferences for fresh (previously frozen) seafood and investigate if high-quality culinary standards can be achieved to the same or higher levels by preparing frozen seafood products directly from their frozen state, which we call “cooking from frozen”. This research is especially relevant in consumer and commercial settings, since the perception of “fresh” is skewed towards higher temperature storage, rather than a consumer reluctance to rate “frozen” as higher quality, even though by food safety, sustainability, and true freshness standards, frozen is far superior. Our hypothesis is that the largest perception barrier to frozen seafood is a reluctance to view frozen seafood as desirable from a culinary standpoint.

Food safety plays a large role in behaviors and patterns. Once defrosted, most fish cannot be safely re-frozen and typically goes to waste if not purchased or prepared. Defrosted fish also has a higher likelihood of being wasted at the household level. Purchased fish sits in a refrigerator and, as dinner plans change, it may be discarded without being cooked or re-frozen by the consumer after increased opportunity for microbial growth and oxidative rancidity (resulting in the characteristic fishy smell) from the defrosted stage.

Further, in speaking with consumers, we learned that the step of defrosting frozen seafood is a deterrent to purchasing it. Package instructions typically indicate that the fish or seafood must be thawed under refrigeration for several hours or under cold running water (further wasteful from a sustainability standpoint). Consumers report hurdles associated with either of these scenarios including: not being organized enough to plan dinner days in advance and move seafood from freezer to refrigerator; not being patient enough to wait for defrosting under water; not wanting to waste water; and changing plans resulting in not getting around to cooking the defrosted seafood as intended. In addition, some consumers share insecurities with regard to proper handling and cooking of seafood, especially finfish, as well as expressing displeasure in having to handle raw fish during cooking. In short, consumers report wanting to eat more seafood but find the hurdles to buying and handling the products to be deterrents.

The Drexel Food Lab, a research lab in Drexel University’s Center for Food and Hospitality Management, is a product development and culinary innovation lab at Drexel University that engages university students studying culinary arts, hospitality management, food science, nutrition and related fields with industry leaders and faculty to solve real world problems in the areas of sustainability, health promotion, and inclusive dining. Inspired by knowledge of loss rates in the retail seafood supply chains, Pete Pearson, director of food waste for WWF, asked Prof. Jonathan Deutsch of Drexel if it would be possible to cook fish directly from its frozen state at high culinary quality, the way one cooks a frozen hamburger patty. The Drexel Food Lab investigated and found that, with some caveats, the answer is “yes”.

Our research objective evolved and expanded to gather real consumer feedback and also see how these recipes and this knowledge can influence sales. In collaboration with Brown’s ShopRite, part of the Wakefern cooperative, we are obtaining retail data and piloting a variety of interventions in stores. They confirm extensive shrink and little conversion to prepared product at the fish counter and further confirm that they have better margins on frozen fish (both in terms of gross margins on

the products themselves and reduced staffing and shrink from waste) and therefore welcome the opportunity to encourage a shift in sales to frozen seafood.

As a result, our research has several aims:

- Complete recipe development and testing of Cook from Frozen recipes
- Engage a graphic designer for the layout and printing of customer marketing materials
- Pilot recipes at supermarkets
- Collect consumer acceptance feedback on the appeal of buying frozen fish as well as the success of the recipes.

## **PROTOCOL**

The project protocol consists of four parts:

1. Recipe development, writing and editing (complete)
2. Communication (complete)
3. Consumer feedback (in process)
4. Data analysis (to come)

### Recipe development, writing and editing

In Spring 2017, students in Drexel's Food Lab class addressed Pearson's question: Can you cook fish directly from frozen to acceptable (or even preferred) levels of quality? Students handled a variety of fresh and frozen seafood items. The primary items were shrimp, salmon and tilapia as proxies for a variety of related crustaceans, fatty fish and lean fish. Students found that methods like roasting, poaching, and baking en papillote were particularly effective, while frying and grilling resulted in difficulty achieving thorough cooking directly from frozen. Students developed recipes and cooking recommendations (see below) for these products. They were later refined and adapted by Drexel Food Lab Manager Alexandra Zeitz to align with the specific products identified as priorities for both margin and sustainability by the seafood and sustainability leads at Wakefern (the parent co-op company of the ShopRite brand), in consultation with WWF.

### Communication

Following recipe testing, Brown's and Wakefern, in consultation with the Drexel Food Lab and WWF, designed a consumer education brochure (attached) with the goal of distributing it in the frozen seafood section of the supermarket. The brochure contains recipes for cook-from-frozen seafood, an explanation of the sustainability, food safety and convenience aspects of cook from frozen seafood, a description of the partnership/project, and an explanation of the company's overall work on sustainable seafood. Designed to be piloted at one store, if effective in generating positive consumer feedback and increased sales of frozen seafood, the brochure would be revised and distribution expanded company-wide.

### Consumer feedback

In the same store (a suburban Philadelphia location attracting both city-dwellers and suburbanites) where the brochure is displayed, four weekly in-store tasting sessions will be held. Patrons will have the opportunity to taste a cook-from-frozen fish dish (a tilapia curry) and provide feedback via a one-minute survey. Consumer incentive is a \$5 gift card for the supermarket. Approximately 250 samples will be served weekly and a 10% response rate will yield 100 completed surveys. Shoppers will be asked if they would like to sample a cook-from-frozen fish dish and will be ineligible if they have any food allergies. Recipes and brochures will be provided. Those who complete the tasting will be asked if they would like to complete the survey as well.

#### Data analysis

In addition to descriptive data from the survey, Brown's will provide comparative sales data for previous months and years to help determine whether the interventions (both in-store tasting and brochure) had any effect on sales of frozen seafood or the ratio of sales between the seafood counter and frozen seafood case. One-way analysis of variance (ANOVA) will be used to determine any statistically significant differences in responses between each of the four in-store tasting sessions.

### **METHODOLOGY**

Survey instrument:

1. How often do you buy fish?
  - a. Once a week or more
  - b. Once a month or more
  - c. A few times a year
  - d. Never
  
2. Do you typically buy frozen fish or fish from the counter?
  - a. From the counter
  - b. Frozen
  - c. Equally counter and Frozen
  - d. Mostly counter; Some Frozen
  - e. Mostly Frozen; Some counter
  
3. How is the quality of frozen fish compared to fish from the fish counter?
  - a. Higher quality
  - b. Same quality
  - c. Lesser Quality
  
4. How is the freshness of frozen fish compared to fish from the fish counter?
  - a. Fresher
  - b. Same freshness
  - c. Less fresh

5. If you buy frozen fish, do you defrost it first or cook it directly from frozen?
- Defrost
  - Cook from Frozen
  - Not applicable—I don't buy frozen fish
6. If you defrost the fish first do you:
- Run it under cold water
  - Leave it in the sink or on countertop
  - Defrost in the refrigerator
  - Other:
7. How do you like the sample that you tried?
- Liked a lot
  - Liked a little
  - Just OK
  - Disliked a little
  - Disliked strongly

Comments:

8. Will you buy the fish that you sampled today?
- Definitely
  - Probably
  - Might or Might Not
  - Probably not
  - Definitely not
9. If you were to buy the fish you sampled today would you:
- Defrost and cook
  - Cook from frozen
  - Eat raw
  - NA—would not buy
10. In general, would you cook fish directly from frozen in the future?
- Definitely
  - Probably
  - Might or Might Not
  - Probably Not
  - Definitely Not



## CONSENSUS

In all, consensus is that cook-from-frozen fish has potential to be acceptable to consumers and may obviate waste generated by traditional seafood counter retailing. We look forward to analyzing the results of our consumer data and sales data in order to share more robust conclusions.

From a culinary perspective, cook-from-frozen remains a promising cooking method, offering consumers a more convenient, safer, and more sustainable solution than buying fresh-from-frozen or defrosting at home. Quality of finished dishes was on par with fresh. While culinary students attested that they lost some nuance in, for example, roasting a salmon fillet to a perfect medium temperature as they might have done with a fresh fillet or fresh-from-frozen fillet, our consumer conversations revealed that the typical consumer of supermarket seafood (as opposed to a specialty seafood store) is not cooking to that level of precision. For the typical consumer, cook-from-frozen seafood is an appealing alternative. Benefits include:

- Limited handling required
- Simple preparation
- Preparation requiring little active time; “set it and forget it.”
- Obviates advance meal planning
- Saves water in defrosting
- Preserves cold chain at zero degrees until the point of cooking.

Benefits to retailers include:

- Reduced personnel needs
- Reduced need for trained/specialty personnel
- Reduced shrink
- Reduced labor in disposal/conversion of seafood
- Reduced store footprint (receiving, prep area and display)
- Promotion opportunity via easy recipes that demystify cooking seafood for consumers

Recipes, lab photos (they will be professionally styled and shot if project proceeds), and nutrition facts for the seafood part of the recipes follow in attachment.

Sample recipe:

Roasted Salmon Sheet Tray Dinner with Soy Ginger Sauce

Serves: 4

2 tablespoons olive oil

4 ShopRite Preferred Brand frozen salmon fillets

¼ cup soy sauce

2 tablespoons sesame oil

1 tablespoon minced ginger  
1 tablespoon honey  
1 pound snap peas  
8 ounces mushrooms  
2 bell peppers, chopped  
Salt and pepper to taste

1. Preheat oven to 350 degrees.
2. On a baking sheet tray, drizzle olive oil. Place salmon on one section of the tray and roast for 20 minutes.
3. Meanwhile, in a small bowl, add soy sauce, sesame oil, ginger and honey. Stir.
4. Once the salmon is partially cooked, add snap peas to a section of the tray, mushrooms to another, and peppers in remaining area. Drizzle soy ginger sauce over salmon and vegetables.
5. Return tray to oven and cook for 20-25 minutes, or until vegetables are tender and salmon is cooked through.
6. Serve salmon, snap peas, mushrooms and peppers with brown rice.





## CONCLUSION

A 2017 report from IRI shows that fresh seafood has seen marked increases in consumer interest, where total sales have grown 3.8 percent in dollars, and 5.3 percent in pounds. At the same time, it's estimated that 51-63% of total US seafood loss happens in retail and consumer homes.

Customer demands for fresh products, especially seafood, are increasing and are often derived from a perception that thawed fish is "fresh" simply because it most closely resembles the state of fish pulled immediately from the water or their farmed environment. Once a human intervention is imposed (i.e., fish is frozen), consumers perceive that the fish is no longer "fresh". In reality, given the distances and the complexities of our fresh food supply chains, delivering *truly fresh* fish under these visually appealing circumstances is extremely costly and reduces the shelf-life of the product.

Freezing fish has always been one of the best ways to maintain freshness as products travel through the supply chain. In fact, retailers in France like Picard Supermarket focus their

<b>Nutrition Facts</b>	
1 Fillet (nutrition facts are for cooked fish only)	
Serving size	
Amount Per Serving	<b>260</b>
<b>Calories</b>	<b>260</b>
	% Daily Value*
<b>Total Fat</b> 13g	<b>17%</b>
Saturated Fat 2g	<b>10%</b>
Trans Fat 0g	
Polyunsaturated Fat 6g	
Monounsaturated Fat 5g	
<b>Cholesterol</b> 70mg	<b>23%</b>
<b>Sodium</b> 420mg	<b>18%</b>
<b>Total Carbohydrate</b> 6g	<b>2%</b>
Dietary Fiber 0g	<b>0%</b>
Total Sugars 6g	
Includes 5g Added Sugars	<b>10%</b>
<b>Protein</b> 28g	<b>56%</b>
Vitamin D 14.4mcg	<b>70%</b>
Calcium 26mg	<b>2%</b>
Iron 2.52mg	<b>15%</b>
Potassium 470mg	<b>10%</b>

\*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

merchandising strategy almost entirely on high-quality, frozen products. Unlike perceptions of frozen food in the US, French customers with demanding culinary expectations view Picard's product selection as being very high quality, even a luxury item<sup>3</sup>.

Since it is standard practice for many retailers to thaw previously frozen fish for display, we can conclude that re-thawing fish to display it as "fresh" is merely a marketing strategy to satisfy consumer visual impulses to see fish that was just pulled out of the river or ocean. Loss or shrink is accepted in retail systems as a price of doing business, since it's assumed and seldom challenged that customers want to see thawed fish. Furthermore, loss or shrink rates are rarely if ever made public and are guarded under strict business confidentiality. Anecdotally, loss rates are typically between 8-20% of total sales at most seafood counters.

This study will test the proposition that frozen fish can be merchandised as high-quality and that preparation can be just as convenient as thawed fish from the seafood counter. If in-store marketing campaigns can sell the benefits of frozen and alternative packaging models, and if these new products can maintain or even increase seafood sales, it becomes a multi-faceted win for retailers: increased sales, less in-store shrink (increased margin), happy customers, and less stress on the environment.

This preliminary research by Drexel represents the start of a series of connected and needed research projects if we are to create a highly efficient and sustainable seafood supply chain. Certified sustainable sourcing programs like the Marine Stewardship Council (MSC) must become the norm in all retail operations but sustainable sourcing must be also connected to waste reduction. When analyzing loss, more research is needed in several areas.

The causes of seafood losses at home are more difficult to identify and more research is needed to understand causes for seafood waste in the home. We need to understand if sales of thawed fish sold to customers at higher temperatures increases the probability of bacterial growth and likely reduces shelf life at home, and if purchasing frozen seafood or alternative packaging reduce loss rates at home. Enhanced packaging of either thawed or frozen seafood is another promising option that can decrease shrink in retail and reduce loss in homes. Studies are needed to understand consumer preferences of frozen vs. fresh seafood and alternative packaging that extends shelf life. There are also energy tradeoffs when looking at changing refrigerated and frozen cases in retail, which also need to be considered when analyzing the total footprint cost of frozen vs. thawed. In addition, food safety is yet another area that needs to be explored, as wider adoption of frozen seafood sales might reduce foodborne illness both commercially and at home.

In summary, maintaining a seafood delivery system that is appealing to consumers produces waste and does not ensure long-term sustainable fish stocks and resource consumption

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<sup>3</sup> France's Favorite Grocery Store Only Sells Frozen Food. Surprised? You Shouldn't Be.  
<https://www.thekitchn.com/frances-favorite-grocery-store-only-sells-frozen-food-surprised-you-shouldnt-be-233463>

globally. We encourage more research to investigate the benefits of extending seafood shelf life throughout the entire supply chain from sea to fork, in addition to looking at other enhanced packaging options for reducing waste, making cooking easy and delicious, and maintaining higher value on both farmed and wild caught seafood products. These changes will require a simultaneous change within retail marketing and customers' preferences and behavior.

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ReFED Roadmap to Reduce Food Waste by Twenty Percent. [https://www.refed.com/downloads/ReFED\\_Report\\_2016.pdf](https://www.refed.com/downloads/ReFED_Report_2016.pdf)

## Appendix 1 Recipes, Photos and Nutrition Facts

## Appendix 2 Brochure