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TESTING DNA, TESTING SUPPLY CHAINS

Project Report

By Liane Arness and Emily De Sousa

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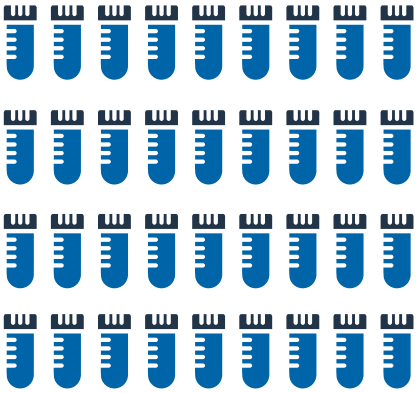
EXECUTIVE SUMMARY

In Canada, a seafood product is considered to be mislabelled if the common name on the label is not an allowable name for that species according to the guidance in the Canadian Food Inspection Agency's (CFIA) **Fish List**. Seafood mislabeling and fraudulent labelling (mislabelling with an intent to deceive) are significant problems with harmful impacts across the supply chain, from consumers to harvesters, and on aquatic ecosystems.

In summer 2021, Organic Ocean, Emily De Sousa, Dr. Robert Hanner and SeaChoice collaborated on a study to investigate whether DNA authentication could be a useful and practical way for a seafood business to mitigate the risk of mislabelling by verifying species' information for its products. Organic Ocean provided samples of its products, Dr. Hanner's lab performed the DNA testing, Emily De Sousa managed the project and promoted it on social media and SeaChoice collected the samples and interpreted the results.

36

samples collected



METHODOLOGY

SeaChoice collected 36 samples from 12 suppliers at Organic Ocean's warehouse in Richmond, B.C. DNA from the samples was extracted, amplified using Polymerase Chain Reaction, sequenced and compared against the reference sequences in the global Barcode of Life Database (BOLD) or, if needed, the GenBank sequence database. The process from collection to results took about two weeks.

For all 36 samples, the genetic barcoding provided:

- The species the DNA sample most closely matched with,
- The "per cent pairwise identity", i.e., how closely the sample matched the reference sequence for that species, and
- The "sequence length", i.e., the number of base pairs in the sequences that were compared.

RESULTS

With this information from the DNA barcoding, the analysis answered three questions:

QUESTION 1 - Was the scientific name listed by the suppliers correct?

Of the eight suppliers that provided scientific names for their products, two product types were identified by DNA analysis to be a different species.

- All three calamari samples, listed by the supplier as *Ommastrephes bartramii*, were matched by the DNA analysis to a different species, *Dosidicus gigas*.
- Two of the three rockfish fillets, listed by the supplier as *Sebastes borealis*, were matched by the DNA analysis to a different species, *Sebastes aleutianus* (the third rockfish fillet was correctly identified as *Sebastes borealis*).

QUESTION 2 - Was the common name listed by the supplier in accordance with CFIA's labelling guidance?

Of the product types tested from 12 suppliers, all but one used an allowable common name for all samples collected.

- The supplier of the rockfish samples gave a specific allowable common name for its products (Shortraker rockfish) and since the DNA analysis indicated that two of the samples were from *Sebastes aleutianus* (specific common name Rougheye rockfish) and not *Sebastes borealis* (specific common name Shortraker rockfish), these two samples would be considered to be mislabelled according to CFIA's guidelines.
- Despite the supplier of the squid samples using the wrong scientific name, it used a generic common name, calamari, which is an allowable common name under CFIA guidelines for both *Ommastrephes bartramii* (the species name given by the supplier) and *Dosidicus gigas* (the species indicated by the DNA analysis).

QUESTION 3 - Was Organic Ocean using a CFIA allowable common name on its online product pages?

Despite the supplier using a generic common name for its squid product (calamari), Organic Ocean was using a more specific common name, Neon flying squid, which is not an allowable common name for the species indicated by the DNA authentication.

Organic Ocean was using a generic common name for its rockfish product (rockfish), so all samples would have been labelled with an allowable common name under CFIA guidelines, even though two of the samples came from different species.

CONCLUSIONS

This study confirmed other published accounts of the usefulness of DNA authentication as a method for verifying the accuracy of labelling information. The DNA results allowed Organic Ocean to know with certainty both the scientific name of the species, and by consulting the Fish List database, its allowable common name(s). From a business perspective, these are both important pieces of information - the first allows for verification of information from a supplier and the second allows the business to ensure it is using an allowable common name for the species it is selling.

However, DNA authentication is only one piece of the seafood labelling puzzle. In order for consumers to really have trust in the seafood sold in Canada, the CFIA's labelling guidelines should be adapted to be more specific to each species. Reducing redundancies in the CFIA Fish List and strengthening its naming guidance would not only allow consumers to know what they're really eating, it would also introduce positive incentives for seafood producers, importers, processors and distributors to invest in better traceability systems so that retailers can label products with all the information that consumers need.

INTRODUCTION

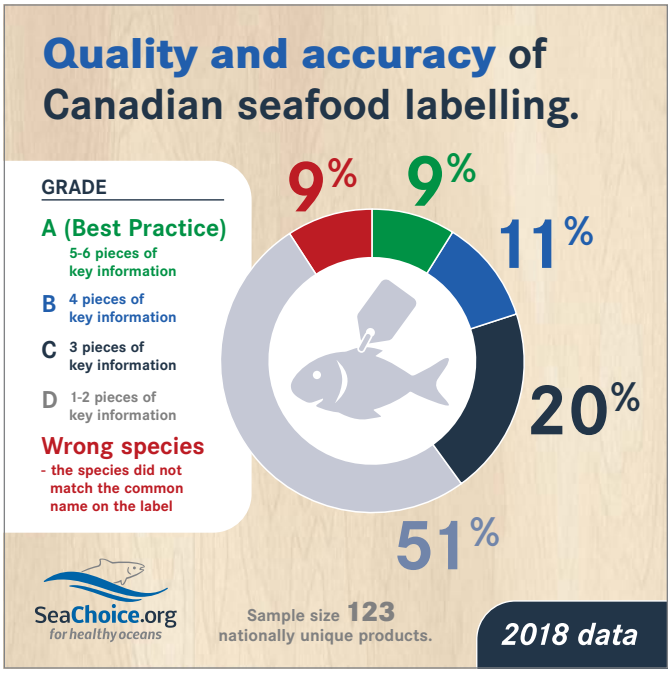
In summer 2021, Organic Ocean, SeaChoice, Emily De Sousa and Dr. Robert Hanner decided to collaborate on a study to investigate whether DNA authentication could be useful and practical for a seafood business to verify species' information for its products. Organic Ocean donated samples of its products for this study and agreed to pay for the DNA testing by Dr. Hanner's lab.

In order for this study to be independently and objectively run, Organic Ocean employed Emily De Sousa, a fisheries scientist and social media influencer to manage the project and run its communications on her website and social media channels. SeaChoice, a sustainable seafood project supported by the David Suzuki Foundation, Ecology Action Centre and Living Ocean Society, participated in the study design, collection of samples, interpretation of results and writing of this report. Dr. Robert Hanner, a world-leading eDNA researcher at the University of Guelph, helped with study design and his lab conducted the DNA amplification and barcoding of samples.

In addition to using this project as a case study for how DNA authentication can be used by seafood businesses to test their supply chains and verify information from their suppliers, this report outlines what seafood mislabelling is and its implications, how DNA authentication can support seafood traceability and labelling, and why the rules and guidance that govern seafood labelling need to be improved.

WHAT IS MISLABELLING AND WHY IS IT IMPORTANT

Seafood is a significant source of protein for three billion people globally and contributes $6 billion to the Canadian economy. Seafood is one of the most highly traded commodities in the world and studies suggest that approximately 30 per cent of seafood products around the world are mislabelled. For example, a 2018 study by OCEANA revealed that Canada is one of the leading culprits of seafood mislabelling: its study suggested up to 44 per cent of seafood sold in Canada might be mislabelled. Other DNA studies, such as those conducted by SeaChoice in 2017 and 2018 on products solely from supermarkets, found much lower mislabelling rates of seven and nine per cent (respectively).



In Canada, a seafood product is considered to be mislabelled if the common name on the label is not an allowable name for that species according to the guidance in the Canadian Food Inspection Agency's (CFIA) Fish List. Sometimes seafood labels are fraudulent, meaning they are mislabelled with an intention to deceive, usually for economic gain. This could include mislabelling a lower value species as a higher value one or misrepresenting another characteristic of the product (e.g. calling it "wild" when in fact it was farmed, calling it "fresh" when in fact it was previously frozen, etc.).

Seafood mislabeling and fraudulent labelling are significant problems with harmful impacts across the supply chain, from consumers to harvesters, and on aquatic ecosystems.

IMPACTS ON CONSUMERS

Many consumers are willing to pay a premium price at the seafood counter for what they believe is a premium product. But what if that expensive product is not the high quality fish that they thought it was, but instead a lower-valued species that has been deliberately or inadvertently mislabelled? Consumers should not be overpaying for seafood products that are being misrepresented in the marketplace. Proper labelling, supported by effective traceability systems, will help to ensure that what consumers are paying for is actually what they are eating.

Mislabelling can also create **health risks for consumers**. For example, people sensitive to mercury (such as pregnant women or children) should try to limit their consumption of certain fish, people with specific allergies need to avoid fish that contain histamines that may trigger an allergic reaction, and everyone should be aware of the risk of gastrointestinal distress caused by fish like escolar, a fish that is often labelled as white tuna.

Studies that bring to light the prevalence of seafood mislabelling in Canada are undermining consumer's confidence in seafood and their desire to eat it. Approximately **55 per cent of consumers doubt** that the seafood they consume is what it says on the package. This may have implications for the health of the Canadian population since many seafood products are loaded with beneficial fatty acids and nutrients. It could also have implications for the environment if consumers replace seafood – a source of protein with a relatively low environmental impact (on average) – with other protein sources that have a higher environmental impact.

IMPACTS ON HARVESTERS AND SEAFOOD BUSINESSES

Mislabelling can occur at various stages of the seafood supply chain. In addition to fraudulent labelling, where seafood is intentionally mislabelled for economic gain, mislabelling can also occur inadvertently due to the seafood industry's convoluted supply chains and common processing measures which can eliminate any identifying features from a fish.

Cheap or low quality seafood that's mislabelled as a higher quality product can undercut honest harvesters and seafood businesses who play by the rules. It's impossible for a truthfully labelled, high quality seafood product to compete with a mislabelled one, especially when it's challenging or impossible for consumers to tell the difference visually. The result is an unfair marketplace where honest supply chain actors can't make a fair living because they're competing with products that are playing outside the rules.

IMPACTS ON SUSTAINABILITY EFFORTS

Mislabelling also has significant environmental consequences, including compromising sustainable fisheries and undermining conservation efforts. Mislabelling can hide overexploitation in the marketplace by allowing the substitution of a depleted species with a less exploited species. Additionally, mislabelling (and poor labelling in general) can hamper the ability of consumers to avoid species they know to be overexploited by using a misleading or generic common name on the label.

For example, let's look at rockfish. There are over 100 species of rockfish, some of which are abundant and sustainably harvested and some of which are depleted and unsustainably harvested. So if a consumer cares about sustainable seafood, they need to know which species they are considering buying. In 2018, **SeaChoice** determined that of the 22 rockfish species that exist in British Columbia, one was in the critical zone, three were in the cautious zone, six were healthy, and 12 were unknown. The CFIA Fish List allows all of these different species to be called by the generic name "rockfish", despite their very different stock statuses. Adding to the confusion, some rockfish species can be sold under different names entirely, like redfish, ocean perch or Pacific snapper.

Seafood mislabelling can also enable seafood harvested in illegal, unreported or unregulated (IUU) fisheries to make it to the market unchecked. Without being confident in their seafood products, commercial seafood buyers and consumers have no way of knowing if the species they're consuming is from a sustainable, or even a legal, fishery.

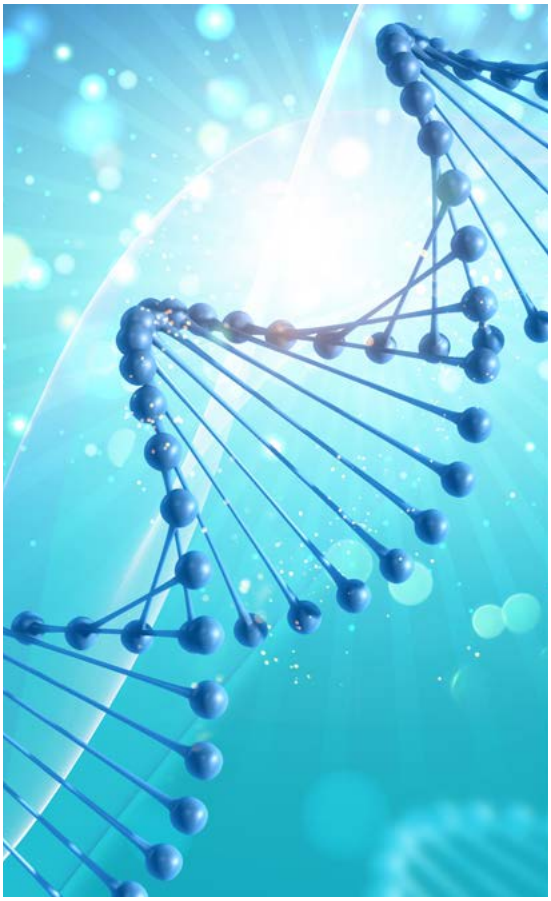
WHAT IS TRACEABILITY AND WHY IS IT USEFUL

Traceability refers to a system for maintaining information about a product on its journey through the production cycle and/or supply chain. For seafood, in addition to food safety information, traceability systems should include tracking the species' scientific name, the country or area where it was caught or farmed, the country of processing, and the fishing gear type or farming method used to harvest it.

Improved seafood traceability can be part of the solution to reducing product mislabelling and verifying species information. In fact, some preliminary research suggests that after the European Union enacted more stringent traceability and labelling laws, seafood mislabelling rates dropped.

Beyond the potential for reduced mislabelling, traceability provides a variety of benefits to the seafood supply chain. If a business has an effective traceability system, it can easily verify the environmental sustainability and social responsibility of products it purchases and sells. Companies (and investors) can be protected from regulatory and reputational risks. At the opposite end of the supply chain, producers and suppliers who maintain sustainable practices can get the recognition they have earned. Finally, with widespread adoption of good traceability systems, governments can better manage their resources and international trade will have the opportunity to become more cost-effective and efficient.

With the longest coastline in the world and waters that support a large and vibrant seafood industry, Canada should be a leader on matters pertaining to ocean sustainability, including seafood. Taking a step in the right direction, the Canadian government has committed to introducing a boat-to-plate traceability system in Canada - though the details of this have yet to be decided. For this new system to have the greatest benefit to Canadian consumers and to be fair across businesses, it should apply to all seafood products whether domestically produced or imported.



WHAT IS DNA BARCODING

DNA barcoding is a powerful tool for identifying what species a sample of tissue came from. The technology compares the DNA from the sample against a global database – the Barcode of Life Data System - which contains sequences from hundreds of thousands of species. This public database allows scientists to compare the sample against all other samples in the system, to best determine what the sample species is. DNA authentication is used to verify species identification, using methods like DNA barcoding, to identify mislabelled products.

With that being said, DNA authentication can only do so much. Some of the limitations of DNA authentication include not being able to confirm origin or harvest method, or even whether it was farmed or wild. It also doesn't work (yet) on some types of seafood products, like fish that has been thoroughly cooked to preserve it for a long shelf life - canned tuna is a great example. Additionally, different types of species, like crustaceans or cephalopods, that are only distantly related to finfish (on which most DNA studies have focused) may require the use of different primers for the DNA sequencing to work. A final shortcoming is that DNA authentication will only work if that species' genome has already been decoded and entered into the Barcode of Life. Despite ongoing and concerted efforts by scientists around the world, there are still huge gaps in our knowledge of aquatic species and their genomic sequences.

METHODOLOGY AND ANALYSIS

The process of species identification through DNA authentication happens in two steps:

1. Collect the DNA samples and analyze them in the lab.
2. Compare the findings to the DNA database and interpret the results.

SAMPLE COLLECTION

The samples were collected from Organic Ocean's warehouse, based in Richmond, B.C., by two representatives from SeaChoice. The Organic Ocean team provided them with a list of all the products that they had in stock by species and supplier. After reviewing the list, the SeaChoice team were provided with a box of each product from which they randomly selected three samples. Each box from which samples were taken was photographed and the label information documented so that the common name, and scientific name, if listed, could be compared with the results of the DNA analysis.

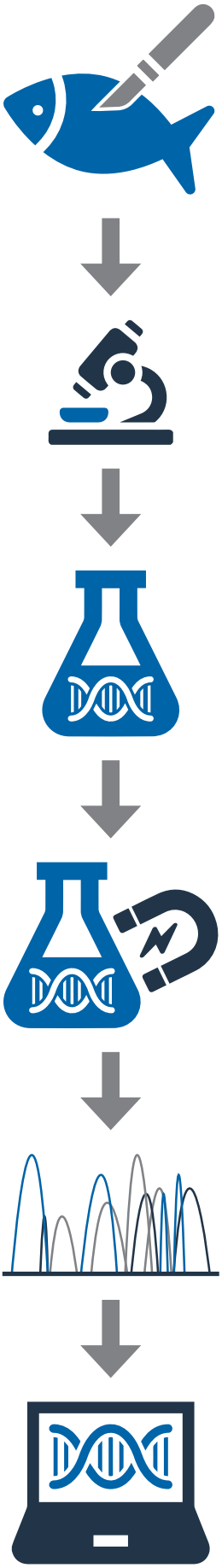
For each sample a sterilized razor blade was used to cut off a small portion of the fish (unless the seafood product could be provided whole, such as a scallop or a shrimp). For frozen-at-sea products (e.g. humpback and sidestripe shrimp), sample material was collected from one individual within the frozen block.

After each sample was isolated it was placed in a plastic bag, numbered on the inside, and that sample's labelling information recorded separately and not sent along with the samples. This ensured that the team performing the DNA analysis did not know which species the sample was supposed to be.

COMMON NAME GIVEN BY SUPPLIER	SCIENTIFIC NAME GIVEN BY SUPPLIER	NUMBER OF SUPPLIERS TESTED
Blue shrimp	N/A	1
Calamari	*Ommastrephes bartramii*	1
Chum salmon	N/A	1
Hokkaido scallops	*Patinopecten yessoensis*	1
King shrimp	*Pandalus hypsinotus*	1
Lingcod	*Ophiodon elongatus*	3
Shortraker rockfish	*Sebastes borealis*	1
Sidestripe shrimp	*Pandalopsis dispar*	1
Sockeye salmon	*Oncorhynchus nerka*	2

***Figure 1.** This figure lists the products selected for genetic testing. If Organic Ocean had products from multiple suppliers, samples were collected from each supplier. Three samples were collected for each product and supplier, for a total of 36 samples. "N/A" means that the supplier did not provide a scientific name on the product box.*

In total, 36 samples were collected and prepared for DNA analysis. The samples were carefully packaged and shipped in an insulated box by overnight courier to Dr. Robert Hanner's Lab at the University of Guelph.



SAMPLE PROCESSING

This section describes how the samples were prepared for DNA barcoding.

EXTRACTION

The DNA extraction process took two days. First, the samples were incubated overnight to lysate the tissue from the seafood sample to release the DNA. The lab team then cut smaller sub-samples with which they mixed several different reagents. The first reagents were solutions to break down materials that would hamper the DNA isolation process. The sub-samples were left to incubate with these reagents overnight to ensure the DNA would be appropriately purified for DNA amplification the following day.

AMPLIFICATION

The amplification process uses Polymerase Chain Reaction (PCR) to make copies of a standardized fragment of the isolated DNA from the sample. Higher concentration of the target DNA fragments makes it much easier to sequence so it can be compared to the sequences in the Barcode of Life database.

Before moving on to the next step, researchers need to make sure that the amplification process was successful and that they were actually able to create more copies of the DNA. To test this, the sample is injected into wells within a gel made of agarose powder and an electric current is run through the gel, a process known as gel electrophoresis. The gel electrophoresis will negatively charge one end of the gel and positively charge the other end. DNA is negatively charged, so it will move through the gel towards the positive end of the gel. Researchers are looking for the presence of DNA to determine if the extraction was successful and if there are enough DNA copies to work with. Higher concentration of extracted DNA will give a stronger signal on the gel. Researchers can assess the image on the gel and determine whether or not there is enough genetic material to move onto the next step of the process.

After amplification, the DNA must be “cleaned” using a solution of magnetic beads to improve the likelihood of getting a good sequence match. Since the long DNA strands are negatively charged, they will attach to the magnetic beads in the solution and separate from other elements in the solution, including the shorter DNA strands. After the long DNA strands that are required for sequencing have been separated, the samples are washed in ethanol. Then, the DNA is released from the magnetic beads using an elution buffer. This should leave a solution containing a high concentration of the target section of DNA.

In order to check that the cleaning process has worked before sending it off for sequencing, the samples were tested again using gel electrophoresis to confirm that the cleaning process was successful in eliminating everything except the high concentration of long strand DNA.

If the gel indicates that the amplification and cleaning have been successful, the sample is sent to the genomics lab for sequencing. The genomics lab sequences the DNA and produces a sequence file with the scientific names of the species the sample most closely matched with, how similar the sample was to the reference sample and how many base pairs of DNA the comparison was based on.

DNA ANALYSIS

The amplified and cleaned DNA from the samples were sequenced at the University of Guelph's Advanced Analysis Centre/ Genomics Facility. Lab technicians used a DNA sequencing machine to read the "DNA Barcode" sequence from each of the samples. In order to identify which species the samples came from, each DNA sequence was compared against the reference sequences in the global Barcode of Life Database (BOLD) or, if needed, the GenBank sequence database. The BOLD database contains the DNA sequences for over 750,000 species and is used widely by scientists for DNA authentication.

With the sequenced DNA from the genomics lab, we were able to see how closely the DNA from the samples matched the DNA sequences of species already in the system. These results allowed us to compare the species indicated by the DNA results to the common name listed by Organic Ocean's supplier (and scientific name, if given) and see if the product is labelled correctly, i.e., in accordance with the naming guidance in the CFIA's Fish List.

The results for some of the samples came back with inconclusive results (indicated by a relatively low pairwise identity to the species it matched most closely to) and so they were reanalyzed. This was the case for one of the rockfish samples and all three scallop samples. In order to try and get a more conclusive result for the scallop samples, Dr Robert Hanner's lab team used different primers and PCR conditions that had been tested specifically in molluscs[1].

RESULTS

In this study, the Genomics lab provided us with:

- The molecular ID, meaning the species the DNA sample most closely matched with.
- The "per cent pairwise identity", meaning how closely the sample matched the reference sequence for that species. The higher the per cent pairwise identity, the more confident we can be that the sample is from that species.
- The "sequence length", meaning the number of base pairs in the sequences that were compared. A high per cent pairwise identity over a long sequence length indicates a higher likelihood of a species match than a high per cent pairwise identity over a short sequence length.

The DNA analysis for all 36 samples was successful in identifying a species-level result. With this information, our analysis aimed to answer three questions:

1. Was the scientific name listed by Organic Ocean's suppliers correct, as indicated by the DNA analysis?
2. Was the common name listed by Organic Ocean's suppliers in accordance with CFIA's labelling guidance, given the species indicated by the DNA analysis?
3. Was Organic Ocean using a CFIA allowable common name on its online product pages, given the species indicated by the DNA analysis?

1 The primers and PCR conditions they tried for the reanalysis are described in Masahiro Matsumoto and Itaru Hayami, (2000) *Phylogenetic Analysis of the Family Pectinidae (Bivalvia) Based on the Mitochondrial Cytochrome C Oxidase Subunit I*. Journal of Molecular Studies, 66, 477-488.

RESULTS OF SCIENTIFIC NAME ANALYSIS

We collected samples of nine product types (labelled as: blue shrimp, calamari, chum salmon, Hokkaido scallops, lingcod, shortraker rockfish, sidestripe shrimp and sockeye salmon) from 12 suppliers. Eight of the suppliers included a scientific name on their product box, four did not. The full results of the DNA analysis for all 36 samples can be found in the Appendix.

Of the eight suppliers that provided information, two product types were identified by DNA analysis to be a different species. This information is summarized in Figure 2, below.

- All three calamari samples, listed by the supplier as *Ommastrephes bartramii*, were matched by the DNA analysis to a different species, *Dosidicus gigas*, with a match of 99.5-100 per cent across 658 base pairs.
- Two of the three rockfish fillets, listed by the supplier as *Sebastes borealis*, were matched by the DNA analysis to be a different species, *Sebastes aleutianus*, with a match of 100 per cent across 652 base pairs. The third rockfish fillet was identified as *Sebastes borealis*.

COMMON NAME GIVEN BY SUPPLIER	SCIENTIFIC NAME GIVEN BY SUPPLIER	MOLECULAR ID (RESULTS OF DNA ANALYSIS)	PER CENT PAIRWISE IDENTITY/ SEQUENCE LENGTH (BP)	SUPPLIER USING THE CORRECT COMMON NAME?	SUPPLIER LISTING THE CORRECT SCIENTIFIC NAME?
Calamari	*Ommastrephes bartramii*	*Dosidicus gigas*	100/658	Yes	Likely mislabelling
Calamari	*Ommastrephes bartramii*	*Dosidicus gigas*	100/658	Yes	Likely mislabelling
Calamari	*Ommastrephes bartramii*	*Dosidicus gigas*	99.5/658	Yes	Likely mislabelling
Shortraker rockfish	*Sebastes borealis*	*Sebastes aleutianus*	100/652	Likely mislabelling	Likely mislabelling
Shortraker rockfish	*Sebastes borealis*	*Sebastes aleutianus*	100/652	Likely mislabelling	Likely mislabelling

***Figure 2.** A summary of results for the products which DNA analysis matched with a different species than the species indicated by the supplier.*

RESULTS OF COMMON NAME ANALYSIS

Canada's naming guidance for seafood products is detailed in the CFIA's Fish List. The Fish List allows some species to go by various common names and allows multiple common names to apply to the same species. The Fish List also allows many different species - including from different genera or families - to be called by generic common names (e.g., snapper). Since common names are required for seafood products and scientific names are not, we assessed whether the common name given by the supplier was an allowable common name for the species indicated by the DNA analysis (see Figure 2, above).

SUPPLIERS

The supplier of the squid samples gave a generic common name, calamari, which is an allowable common name for both *Ommastrephes bartramii* (the species name given by the supplier) and *Dosidicus gigas* (the species indicated by the DNA analysis). So even though the DNA analysis indicated that the samples came from a species in a different genus than that listed by the supplier, by CFIA's guidelines the common name was still correct.

The supplier of the rockfish samples gave a specific allowable common name for its products, however the DNA analysis indicated that two of the samples were from *Sebastes aleutianus* (specific common name Rougheye rockfish) and not *Sebastes borealis* (specific common name Shortraker rockfish). Even to experienced eyes, these two species look very similar and are caught in similar areas. These samples would be considered to be mislabelled according to CFIA's guidelines.

ORGANIC OCEAN

The common names that Organic Ocean used on its online product pages at the time of the study were almost all in line with CFIA's guidelines. The common name that was not correct was for the product called calamari by the supplier and "Neon flying squid" by Organic Ocean - likely due to the incorrect scientific name given by the supplier. This has since been rectified on the product page to reflect an allowable common name for the species indicated by the DNA authentication (*Dosidicus gigas*; Humboldt squid).

Organic Ocean was using a generic common name for its rockfish products, "rockfish", and so all samples would have been labelled with an allowable common name under CFIA guidelines, even though the samples came from different species.

If one were to be very picky, there was a slight discrepancy with *Pandalopsis dispar*, listed by Organic Ocean and its supplier as Sidestripe shrimp and which CFIA lists as Side-stripe shrimp. It is not clear why CFIA spell this common name with a hyphen when this is uncommon in the literature and does not align with the common name used by the Government of Canada's fisheries management body, DFO (which also refers to *Pandalopsis dispar* as Sidestripe shrimp), but it serves as a good example of the arbitrary nature of some of CFIA's allowable common names.

DISCUSSION

This study confirmed other published accounts of the usefulness of DNA authentication as a method for verifying the accuracy of labelling information. The DNA results allowed Organic Ocean to know with certainty both the scientific name of the species, and by consulting the Fish List database, its allowable common name(s). From a business perspective, these are both important pieces of information - the first allows for verification of information from a supplier and the second allows the business to ensure it is using an allowable common name for the species it is selling.

An important takeaway from this study is the need for more research into primers and PCR methodology for non-finfish species commonly found in the Canadian marketplace. While the methods for DNA barcoding of finfish species is well established, Dr. Hanner's laboratory team had to experiment with novel primers in order to find one that would effectively amplify the DNA from the scallop samples. It would also be beneficial to develop reliable and affordable methods for testing cooked products (e.g. canned tuna) and products made from multiple species, such as pet food and nutritional supplements.

This study provided Organic Ocean with an indication of the supply chain(s) and/or suppliers which may need a greater investment in traceability. The study provided assurance that Organic Ocean was, for

When we asked Organic Ocean's founder and CEO, Dane Chauvel, whether DNA authentication was a good investment for his business, he said:

> **"I'm not sure that our commitment to sustainability and traceability enables us to sell our seafood at a higher price, or sell more of it, but those values are core to who we are and what we do. DNA authentication allows us to provide transparency of the highest order; our customers benefit from the assurance that they are getting what they want and that their commitment to sustainability isn't being compromised."**

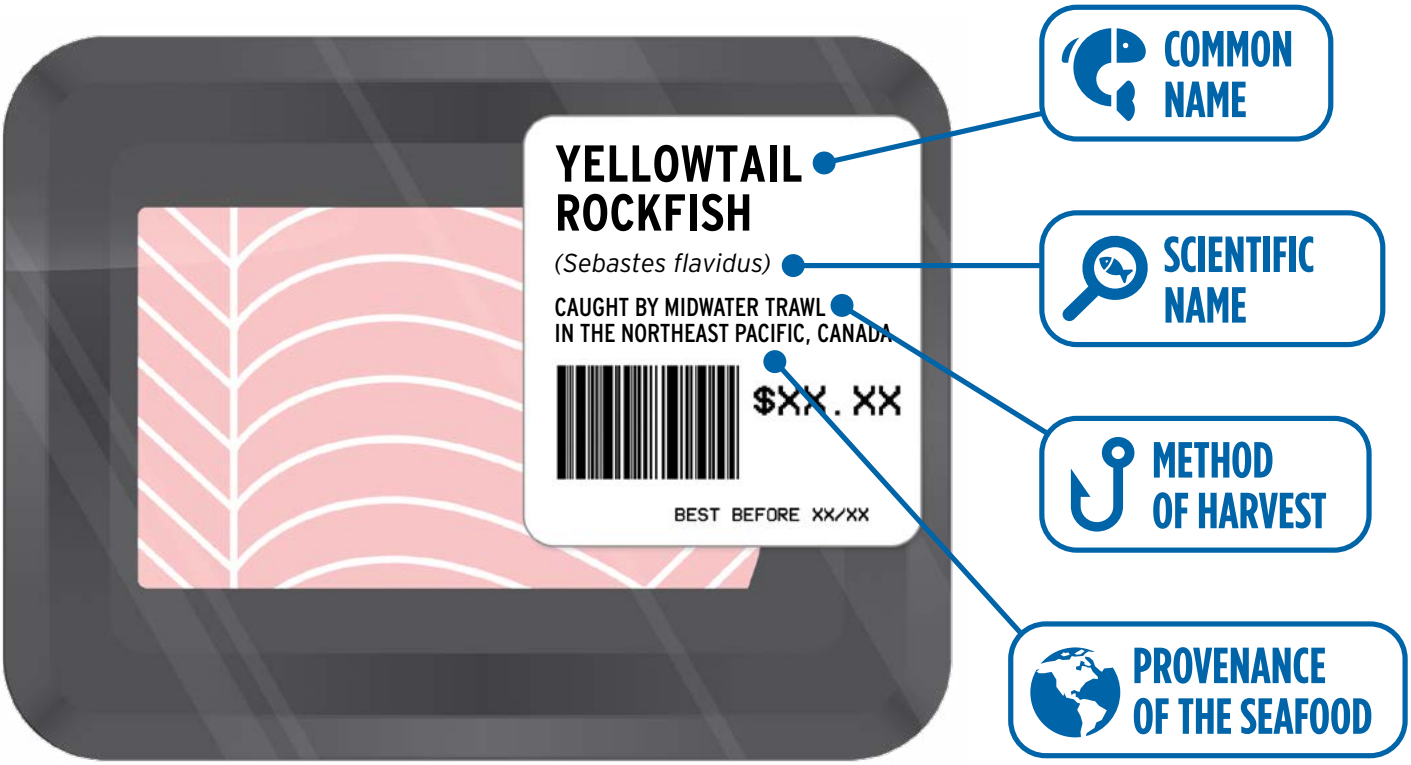
eight out of nine product types tested, using allowable common names under CFIA's guidelines. The DNA authentication gave Organic Ocean the opportunity to change its labelling of its squid/calamari products and, if desired, work with its supplier of that product on its labelling and/or traceability procedures.

However, DNA authentication is only one piece of the seafood labelling puzzle. In order for consumers to really have trust in the seafood sold in Canada, the CFIA's labelling guidelines should be adapted to be more specific to each species. Reducing redundancies in the CFIA Fish List would not only allow consumers to know what they're really eating, it would also introduce positive incentives for seafood producers, importers, processors and distributors to invest in better traceability systems so that retailers can label products with all the information that consumers need.

SeaChoice has already produced a detailed report (the **Fish List Wish List**) with recommendations for how the Fish List should be improved, starting with high priority species groups like rockfish/Pacific snapper, sole/flounder, shrimps/prawns and shark/dogfish. This study has also shown that the labelling of squid/calamari should also be improved. Progressive businesses can use the Fish List Wish List report to start improving their own labelling, but without a change to requirements at the national level, many businesses are likely to continue utilizing the "flexibility" provided by the current rules - to the detriment of consumers and businesses voluntarily doing better.

CONCLUSION

DNA authentication is one tool we have to address seafood mislabelling and other issues within the seafood supply chain. Combined with other measures such as improved labelling laws and traceability programs, DNA authentication can play an integral role in verifying that the rules governing the safety and identification of seafood products are working, and help create a more transparent seafood industry.



APPENDIX

This table lists the DNA results, scientific name and common name analysis for all 36 samples collected. "N/A" means that the supplier did not provide a scientific name on the product box.

COMMON NAME GIVEN BY SUPPLIER	SCIENTIFIC NAME GIVEN BY SUPPLIER	COMMON NAME USED BY ORGANIC OCEAN (ONLINE PRODUCT PAGE)	MOLECULAR ID (RESULTS OF DNA ANALYSIS)	PER CENT PAIRWISE IDENTITY/ SEQUENCE LENGTH (BP)	SUPPLIER USING AN ALLOWABLE COMMON NAME?	SUPPLIER LISTING THE CORRECT SCIENTIFIC NAME?	ORGANIC OCEAN USING AN ALLOWABLE COMMON NAME?
Blue shrimp	N/A	Blue shrimp	*Litopenaeus stylirostris*	99.5/658	Yes	N/A	Yes
Blue shrimp	N/A	Blue shrimp	*Litopenaeus stylirostris*	99.5/658	Yes	N/A	Yes
Blue shrimp	N/A	Blue shrimp	*Litopenaeus stylirostris*	99.5/657	Yes	N/A	Yes
Calamari	*Ommastrephes bartramii*	Neon flying squid	*Dosidicus gigas*	100/658	Yes	Likely mislabelling	Likely mislabelling
Calamari	*Ommastrephes bartramii*	Neon flying squid	*Dosidicus gigas*	100/658	Yes	Likely mislabelling	Likely mislabelling
Calamari	*Ommastrephes bartramii*	Neon flying squid	*Dosidicus gigas*	99.5/658	Yes	Likely mislabelling	Likely mislabelling
Chum salmon	N/A	Keta salmon	*Oncorhynchus keta*	100/652	Yes	N/A	Yes
Chum salmon	N/A	Keta salmon	*Oncorhynchus keta*	100/652	Yes	N/A	Yes
Chum salmon	N/A	Keta salmon	*Oncorhynchus keta*	100/652	Yes	N/A	Yes
Hokkaido scallops	*Patinopecten yessoensis*	Hokkaido scallops	*Patinopecten yessoensis*	95.4/594	Yes	Yes	Yes
Hokkaido scallops	*Patinopecten yessoensis*	Hokkaido scallops	*Patinopecten yessoensis*	98.8/920	Yes	Yes	Yes
Hokkaido scallops	*Patinopecten yessoensis*	Hokkaido scallops	*Patinopecten yessoensis*	99.2/847	Yes	Yes	Yes
King shrimp	*Pandalus hypsinotus*	Humpback shrimp	*Pandalus hypsinotus*	100/658	Yes	Yes	Yes
King shrimp	*Pandalus hypsinotus*	Humpback shrimp	*Pandalus hypsinotus*	100/658	Yes	Yes	Yes
King shrimp	*Pandalus hypsinotus*	Humpback shrimp	*Pandalus hypsinotus*	100/658	Yes	Yes	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/652	Yes	Yes	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/653	Yes	Yes	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/652	Yes	Yes	Yes
Lingcod	N/A	Lingcod	*Ophiodon elongatus*	100/652	Yes	N/A	Yes
Lingcod	N/A	Lingcod	*Ophiodon elongatus*	99.8/652	Yes	N/A	Yes
Lingcod	N/A	Lingcod	*Ophiodon elongatus*	100/652	Yes	N/A	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/652	Yes	Yes	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/652	Yes	Yes	Yes
Lingcod	*Ophiodon elongatus*	Lingcod	*Ophiodon elongatus*	100/652	Yes	Yes	Yes
Shortraker rockfish	*Sebastes borealis*	Rockfish	*Sebastes aleutianus*	100/652	Likely mislabelling	Likely mislabelling	Yes
Shortraker rockfish	*Sebastes borealis*	Rockfish	*Sebastes borealis*	100/652	Yes	Yes	Yes
Shortraker rockfish	*Sebastes borealis*	Rockfish	*Sebastes aleutianus*	100/652	Likely mislabelling	Likely mislabelling	Yes
Sidestripe shrimp	*Pandalopsis dispar*	Sidestripe shrimp	*Pandalopsis dispar*	100/653	Yes	Yes	Yes
Sidestripe shrimp	*Pandalopsis dispar*	Sidestripe shrimp	*Pandalopsis dispar*	100/654	Yes	Yes	Yes
Sidestripe shrimp	*Pandalopsis dispar*	Sidestripe shrimp	*Pandalopsis dispar*	100/653	Yes	Yes	Yes
Sockeye salmon	*Oncorhynchus nerka*	Sockeye salmon	*Oncorhynchus nerka*	100/652	Yes	Yes	Yes
Sockeye salmon	*Oncorhynchus nerka*	Sockeye salmon	*Oncorhynchus nerka*	100/652	Yes	Yes	Yes
Sockeye salmon	*Oncorhynchus nerka*	Sockeye salmon	*Oncorhynchus nerka*	99.8/652	Yes	Yes	Yes
Sockeye salmon	N/A	Sockeye salmon	*Oncorhynchus nerka*	100/652	Yes	N/A	Yes
Sockeye salmon	N/A	Sockeye salmon	*Oncorhynchus nerka*	100/652	Yes	N/A	Yes
Sockeye salmon	N/A	Sockeye salmon	*Oncorhynchus nerka*	100/652	Yes	N/A	Yes

Seaside with Emily

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