Seafood in the context of the Nutrient Reference Values for Australians

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Australian Government

Fisheries Research and Development Corporation

Project No. 2006/407

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Shawn Somerset and Martin Bowerman. 2009

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ISBN 978-0-9807055-0-8

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1. Non Technical Summary

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OBJECTIVES:

1. To develop products arising form the project that can be used in Seafood Industry publications and distributed to the wider media

2. To develop substantiated data from the project that can be used in a future rewrite of the FRDC "What's so Healthy about Seafood"

3. To review the NH&MRC NRVs and associated material as they relate to seafood

4. To interpret the information arising from the NHMRC NRV's report and the proceedings from the Seafood for Life and ISSFAL Conferences to rewrite in an easy to read and understandable format

OUTCOMES ACHIEVED TO DATE

The substantial role of seafood in meeting the NRVs for Australians has been confirmed. Seafood retailers and marketers can say with confidence that seafood provides nutritional value to the diet far beyond its content of long chain omega-3 oils, and that consuming seafood regularly can contribute significantly to meeting recommended intakes of important nutrients in the diet. These nutrients include not only omega-3 but also protein, iodine, selenium, Vitamin B12, zinc and copper.

Interest from the media (both trade and general) during work on this project has led to a number of interviews, and to a media release summarising the principal author's views being distributed to media outlets nationally. These media interaction have already made some seafood producers, marketers and consumers more aware of the benefits of seafood in meeting some significant nutrient intake goals recommended by the NHMRC NRVs. (A summary of progress results from this project have been featured on the Seafood Services Australia website, providing a permanent and readily accessible resource for seafood marketers and journalists to base communication on the health benefits of seafood.)

This report has provided a basis for the Australian seafood industry to advocate for better representation in national nutrition policy initiatives, such as the National Nutrition Survey, the Australian Dietary Guidelines and the Australian Guide to Healthy Eating.

A ready-to-use reference for the nutritional value in relation to the NRVs for specific seafood species is now available through this report.

In 2006, the Australian National Health and Medical Research Council (NHMRC) published a set Nutrient Reference Values (NRVs), which identify the quantities of specific nutrients Australians should consume for optimal health, based on the best scientific information available. These NRVs are standards used by nutritionists, dietitians and other health professionals to provide advice to the general public on how to consume a healthy diet.

The 2006 NRVs differ from previous recommendations because they incorporate key changes with an increase in the range of nutrients for which reference values were provided, and specific advice for various age groups, genders and pregnancy status. For the first time, there also were formal recommendations for intakes of long chain omega-3 fatty acids, for which seafood is the primary natural source. The recent past has seen a substantial expansion of processed food products using the NRVs to place their intake into the context of a healthy diet. On a competitive level, it is crucial that seafood also take advantage of this important development in nutrition policy and practice in Australia.

This report addresses the issue of how Australian seafood fits into the context of the new NRVs. Specifically, it presents calculations for a sample range of popular seafood (fish, molluscs and crustaceans) which estimate the amounts of each required to meet the NRVs for a range of nutrients. The document provides a guide upon which evidence-based communication about the health benefits of seafood can be derived (although it is not intended to be a promotional vehicle in itself). This has been done by analysing how the consumption of seafood can contribute to meeting the newly developed Nutrient Reference Values (NRVs) for Australia. The composition of a series of individual seafood species were used to calculate how much of each species would need to be consumed to meet these new NRVs.

The resulting analysis confirms that:

- Seafood is an excellent source of protein, and, furthermore, provides high-quality protein at a comparatively low "cost" in calories, making it a potentially valuable and advantageous food source to help combat Australia's obesity problem.
- Seafood also is an excellent source of essential long-chain omega-3 oils: The NRVs for long-chain omega-3 oils can be met by the consumption of many forms of seafood.
- Many seafood species can also be considered as rich sources of Iodine, Selenium and Vitamin B12.
- Shellfish are an excellent source of both Zinc and Copper. The NRVs for Zinc and Copper can be met by regular shellfish consumption.

For example, a 150g serve of Sydney Rock Oysters provides about 25mg of zinc and 2.36mg of copper. This represents approximately 1.8 and 2.1 times the RDI for zinc for men and women, respectively. It also provides approximately 1.4 and 2.0 times the Acceptable Intake (AI) level for copper for men and women, respectively. However, there are still many gaps in data on the composition of seafood and this should be taken into account when referring to individual seafood species in relation to NRVs.

Calculations for long-chain omega-3 consumption from seafood in this study were based on a standard serving size of 150g. Increasing standard serving sizes to 200-250g and extending recommendations for consumption from twice a week to four times per week would enhance the ability of seafood to meet the NHMRC Suggested Dietary Target (SDT) for long-chain omega-3 oils. Through the evaluation of Australian seafood in the context of the 2006 NRVs, the following conclusions have emerged:

<u>Practical advice for nutrient intake</u>

- A commonly used serving size for seafood in Australia is 150g. Results from this analysis show that seafood is clearly an excellent source of dietary long chain omega-3 oils. If consumers were encouraged to increase serving size for home consumption seafood would be enhanced further as a viable omega-3 source
- Australian consumers can meet national nutrient intake recommendations (the NRVs) for long chain omega-3 oils entirely from

the consumption of certain species of seafood without the necessity of consuming either omega-3 supplements or foods artificially fortified with omega-3 oils

- The omega-3 requirements of individuals can also be met by combining seafood consumption with foods which are artificially enriched with omega-3 oils.
- Seafood is not just a good source of omega-3 oils: Amounts of (certain) seafood which are commonly consumed can meet the NRVs for certain other nutrients such as Selenium, Zinc, Copper, Iodine and Vitamin B12, nutrients often lacking in foods that are artificially enriched with omega-3 oils
- The amounts of key nutrients such as long chain omega-3 oils, zinc, iron, iodine, selenium and vitamin B12 vary between species of seafood. It is therefore prudent to advise consuming a variety of seafood rather than favouring specific species individually.

<u>Specific information on nutrient content of seafood</u>

- Of the 20 seafood species included in this analysis, all (except Orange Roughy) were good sources of long chain omega-3 oils and Selenium in relation to the NHMRC NRVs.
- All species except Sea Mullet were good sources of Vitamin B12
- Sydney Rock Oyster, Mud Crab and Arrow Squid were good sources of copper
- Sydney Rock Oyster was a comprehensive source of Iron, Zinc, Selenium, Copper and Vitamin B12

<u>General issues</u>

- The quality and depth of published information on the composition of seafood varies, and is generally weak. There are substantial gaps in species-specific information on the composition of seafood, especially in critical nutrients such as zinc, selenium, iodine, vitamin D and copper. Investment to expand published compositional data for seafood would enhance the evidence base for promoting the health benefits of seafood.
- Given the importance of the inclusion of recommended intakes for long-chain omega-3 oils and other key nutrients in the Australian NRVs, public health would benefit from an increase in recommendations on the amount of seafood that should be consumed from the current twice per week to four times per week.
- In addition to essential long chain omega-3 oils, minerals and vitamins, the NHMRC (through the published NRVs) also recognises seafood as a major source of protein in the Australian diet

Recommendations

From the findings in this report, certain gaps in scientific information about seafood were identified. In response to these, it is recommended that the seafood industry:

- Advocate the inclusion of identification of specific fish species in the next Australian National Nutrition Survey (which is currently under development by the Federal Government)
- Develop species-specific compositional information on seafood, especially for key nutrients such as zinc, selenium, iodine, vitamin D and copper.
- Consider a focus on seafood as an important Iodine source in view of decreased consumption of iodised salt and progressively decreasing iodine content in dairy foods
- Recommend to consumers the consumption from a broad range of seafood species, to maximise health benefits.
- Extend the "eat seafood twice a week" message to 4 times per week
- Consider research into serving size recommendations for the Australian population
- Clarify the optimal frequency of seafood consumption (for example, small amount daily, every three days, twice weekly, 8 times/month, etc)

KEYWORDS: **Nutrition, Nutrient Reference Values, Omega-3 oils, Health Benefits**

2. Acknowledgments

This project was funded through a grant from the Fisheries Research and Development Corporation (FRDC)

Seafood Services Australia and Mr Roy Palmer provided integral advice and input into this project.

3. Background

In September 2005, the National Health and Medical Research Council (NHMRC) endorsed the Nutrient Reference Values (NRVs) for Australia. The NRVs are a set of standards outlining the recommended intakes for a range of nutrients specific to the Australian population. These NRVs were published in 2006 by the NHMRC[1], and superseded the Recommended Dietary Intakes (RDI 1991) which were previously used to guide nutrient intakes in Australia.

Nutrient Reference Values are an important set of values used extensively by nutritionists, dietitians and other health professionals to provide advice to consumers on the consumption of nutrients and the foods that contain them.

They are also used throughout the food industry to promote consumption of specific foods on the basis that they are an important source of particular nutrients. This trend was initiated by the opportunity presented to cereal manufacturers of having large packaging to communicate such messages. However, the use of NRVs in the promotion of food has extended to fresh foods such as beef, chicken, pork, dairy, vegetables and fruits through the use of tools beyond simple inclusion on packaging (such as product information sheets, promotional pamphlets, electronic media advertising, websites).

In the process of developing the NRVs, there are some major transitions relevant to the promotion of seafood. Firstly, there is for the first time a recommendation for the consumption of omega-3 fatty acids. Secondly, the NRVs include specific recommendations for physiological factors such as pregnancy, lactation (breastfeeding), gender and age, making the use of NRVs in the promotion of food more complex. Thirdly, the NRVs have been expanded to include the following terms, to reflect a range of contexts in which nutrient recommendations are made (adapted from the Food and Nutrition Board: Institute of Medicine)[2]. The following definitions are integral components of the NRVs:

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EAR (Estimated Average Requirement)

A daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group.

RDI (Recommended Dietary Intake)

The average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 per cent) healthy individuals in a particular life stage and gender group.

AI (Adequate Intake)

(used when an RDI cannot be determined)

The average daily nutrient intake level based on observed or experimentally-determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate.

EER (Estimated Energy Requirement)

The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of defined age, gender, weight, height and level of physical activity, consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.

UL (Upper Level of Intake)

The highest average daily nutrient intake level likely to pose no adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects increases.

The definitions and contexts of these terms are outlined in the following table.

Definitions used in relation to Australian NRVs

Nutrient Reference Value	**For individuals:**	**For groups:**
Estimated Average Requirement (**EAR**)	Use to examine the probability that usual intake is inadequate	Use to estimate the prevalence of inadequate intakes within a group
Recommended Dietary Intake (**RDI**)	Usual intake at or above this level has a low probability of inadequacy	Do not use to assess intakes of groups
Adequate Intake (**AI**)	Usual intake at or above this level has a low probability of inadequacy. When the AI is based on median intakes of healthy populations, this assessment is made with less confidence	Mean usual intake at or above this level implies a low prevalence of inadequate intakes. When the AI is based on median intakes of healthy populations, this assessment is made with less confidence
Upper Level of Intake (**UL**)	Usual intake above this level may place an individual at risk of adverse effects from excessive nutrient intake	Use to estimate the percentage of the population at potential risk of adverse effects from excessive nutrient intake

These recommendations are for healthy people and may not meet the specific nutritional requirements of individuals with various diseases or conditions, pre-term infants, or people with specific genetic profiles. They are designed to assist nutrition and health professionals assess the dietary requirements of individuals and groups. They may also be used by public health nutritionists, food legislators and the food industry for dietary modelling and/or food labelling and food formulation[3].

There is also a more comprehensive approach to recommendations for specific age, gender and physiological status (eg. Pregnancy) groups. The aforementioned

expansion of the NRVs present enhanced opportunities to promote the consumption of seafood in the context of a healthful diet.

In relation to advice about seafood consumption, the two most relevant figures are EAR (the daily nutrient level meeting the requirements of half the healthy individuals of a designated age and gender group) and RDI (the average daily dietary intake sufficient to meet requirements for most (97%) of the population. Estimates in this report have been calculated to address these two requirements.

The release of the new NRVs in Australia has generated substantial communication initiatives across the range of food categories, and it is important that Seafood as a category has a voice in this process. The purpose of this document is to develop a knowledge base which places various seafood products in the context of these new nutrition recommendations. This base can then be subsequently used by the seafood industry to incorporate into nutrition and health communication initiatives promoting the consumption of seafood by Australian consumers, in the context of a healthful diet.

4. Need

Seafood has long been acknowledged as the richest natural source of long chain omega-3 (LC n-3) oils in the Australian diet. There is extensive evidence that diets containing defined amounts of LC n-3 are protective against a range of chronic diseases including coronary heart disease, diabetes and hypertension.

Several other recent developments have focussed further attention on LC n-3 content of foods. Firstly, here has been a concerted effort by the processed food industry to develop new products, and LC n-3 oils are an ingredient that has been incorporated into a wide range of food products. Secondly, there is a tendency for consumers to prefer food based fortification to nutrient supplements to achieve recommended intakes.

Most significant of recent developments has been the establishment of the Australian Nutrient Reference Values (NRVs) 2006, which provide guidelines for intake of nutrients, not just to prevent deficiency, but to address chronic disease risk. For the first time, recommendations for intake of LC n-3 oils has been established for the Australian population.

There is now a plethora of food products on the Australian market which have been fortified with LC n-3 oils, and there is a risk that if consumers are not well-informed, such foods will be consumed in preference to the only viable natural source: Seafood. This risk is intensified if seafood is recognised only for its LC n-3 oil content, rather than as a high quality food containing a range of essential nutrients.

This report addresses the need to confirm seafood as a rich natural source of LC n-3 oils and, importantly, other key nutrients.

5. Objectives

1. To develop products arising form the project that can be used in Seafood Industry publications and distributed to the wider media

2. To develop substantiated data form the project that can be used in a future rewrite of the FRDC "What's so Healthy about Seafood"

3. To review the NH&MRC NRVs and associated material as they relate to seafood

4. To interpret the information arising from the NHMRC NRV's report and the proceedings from the Seafood for Life and ISSFAL Conferences to rewrite in an easy to read and understandable format

6. Methods

Phase I: Identification of key nutrients for which Seafood is a "good" source

The first phase in this process is to identify key nutrients for which seafood could be considered a good source. The aim of this process was to identify nutrients for which the corresponding NRVs could be met by consuming reasonable amounts of seafood. This comprised the following steps:

- Selection of a sample of 20 seafood species commonly consumed in Australia
- Identification of nutrient contents of edible portions of each species from a range of data sources
- Calculation of amounts of each species required to be consumed for all nutrients having an NRV (EAR and RDI) for the full range of categories (life stage and gender).
- Identification of key nutrients for which seafood is a rich source

The first set of nutrients to be considered were the essential fatty acids (ie. Oils): omega-3 and omega-6 fatty acids, and long-chain omega-3 fatty acids (predominantly EPA - eicosapentanoic acid and DHA - docosahexanoic acid).

Essential fatty acids are those which cannot be synthesised *de novo* (ie. from scratch) by the body, and must be consumed as part of the diet. In the case of omega-3 oils, long-chain omega-3 (LC n-3) oils can be manufactured by the body from shorter chained omega-3 oils such as alpha-linolenic acid (found in foods such as linseed). However, this conversion is quite slow, and it is much more efficient to consume the long-chain omega-3 oils (EPA and DHA) directly from the diet from sources such as seafood.

Phase II: Assessment related to amounts the edible portions of specific seafood species required to meet NRVs

Nutrients identified as having particular potential in relation to seafood supplying a significant proportion of NRV requirements in phase I (above) were collated in relation to 20 popular species of seafood. This phase focused on the EAR and RDI for adult men as a reference point. This report can also be used as a guide to deriving requirements for other life stages and gender, depending on the marketing objective.

Key nutrients for which some seafood species are likely to be rich sources were incorporated into the same process as that used for the essential fatty acids in Appendix 3, using the RDIs and EARs outlined in tables 3 and 4, respectively. Species-specific information on vitamin and mineral content of Australian seafood is scant, with extensive information only on the following species (by virtue of their importance as indigenous foods):

- *Cassidula angulifera*, Shellfish, Flesh Cooked
- *Cherax albidus*, Cray Fish, Flesh
- *Monodonta labio*, Shellfish, Flesh
- *Nerita lineata*, Shellfish, Flesh
- *Telescopium telescopium*, Shellfish, Flesh
- *Terebralia sulcata*, Shellfish, Flesh

For general calculations of nutrient intakes, compositional information from NUTTAB Australian Food Composition Database[4] (the official Australian food composition dataset) was restricted to Gemfish (*Rexea solandri*) and Aquacultured Milkfish (*Chanos chanos*), upon which nutrient intake from fish for the Australian population have been generalised in the background documentation of the NRVs. This is also evident in calculations for long-chain omega-3 intake in the NRV document[1].

7. Results/Discussion

Phase I: Identification of key nutrients for which Seafood is a "good" source

Table 1 summarises the RDI's for essential fatty acids (omega-6 and omega-3) oils according to age, gender and life stage. The maximum requirement is for adult males and this value has been used as the basis for subsequent calculations.

Table 1: Nutrient Reference Values (RDI) for Essential fatty acids.

	18:2(n-6) (in grams)	18:3(n-3) (in grams)	LC omega 3 (in mg)
Boys and girls			
1-3 yr	5	0.5	40
4-8 yr	8	0.8	55
Boys			
9-13 yr	10	1	70
14-18 yr	12	1.2	125
Girls			
9-13 yr	8	0.8	70
14-18 yr	8	0.8	85
Adults			
Man	13	1.3	160
Woman	8	0.8	90
Pregnancy			
14-18 yr	10	1	110
19-50 yr	10	1	115
Lactation			
14-18 yr	12	1.2	140
19-50	12	1.2	145

(LC: Long-chain omega-3 fatty acids)

Appendix 3 outlines the contents of essential fatty acids of each of a range of seafood species. These values were derived from composition data on Australian seafood[5]. In particular, the long-chain omega-3 content of each species was calculated by adding amounts of EPA, DPA and DHA. Subsequently within each table, the amounts of the various fish species required to be consumed to meet RDI requirements have been calculated.

Long-chain omega-3 oils comprise a special category of nutrient within the context of the NRVs. The general approach to RDI calculations is to arrive at appropriate population intakes which will **prevent deficiency** in a large proportion of the population. However, the NRV document also makes further recommendations for long-chain omega-3 oil consumption on the basis of **optimal health** in relation to coronary heart disease risk. In essence, the NRV document proposes an NHMRC Suggested Dietary Target (SDT) of the 90th percentile intake of long-chain omega-3 oils in the diet, being 600mg and 400mg per day for men and women, respectively. This corresponds to the 1999 Heart Foundation recommendation of 430-570mg per day.

Considering this target, a standard 150g serve of the following fish species would meet the daily requirement for long-chain omega-3 oils:

For Men and Women:

- Gemfish (Rexea solandri)
- Salmon Atlantic (Salmo salar)
- Smooth oreo (Pseudocyttus maculatus)
- Blue mussel

For women only:

- Sea Mullet (*Mugil Cephalus*)
- Patagonian toothfish (*Dissostichus eleginoides*)
- Spikey Oreo (*Noecyttus rhomboidalis*)
- Silver Perch (*Bidyanus bidyanus*)
- Blue Mackerel (*Scomber australasicus*)
- Westem Blue Groper (*Achoerodus goudlii*)
- Threadfin Emperor (*Lethrinus genivittatus*)
- Black Oreo (*Allocyttus niger*)
- Spanish Mackerel (*Scomberomorous commerson*)
- Sydney Rock Oyster
- Commercial Scallop
- Arrow Squid

The aforementioned NHMRC targets for long-chain omega-3 intake translate to 4200mg and 2800mg per week for men and women, respectively. The ability of the above seafood species to supply long-chain omega-3 oils is affected by both serving size and frequency, an increase in both representing a substantial increase in the ability of these foods to supply the SDT for long-chain omega-3 oils. The following Table summarises the potential for seafood consumption to achieve the SDTs, through calculating the effect of changes in serving size and frequency on supply of Long-chain omega-3 oils. Given that there are 21 meal opportunities per week, a recommendation of seafood four times per week is an achievable objective.

Table 2: Amounts of Long-chain Omega-3 oils supplied per week, according to frequency and serving size

Seafood Species	150g 2/week	150g 4/week	250g 2/week	250g 4/week
Gemfish	629	1258	1048	2097
Salmon Atlantic	905	1810	1508	3017
Smooth oreo	696	1392	1160	2320
Blue mussel	602	1204	1003	2007
SeaMullet	428	856	713	1427
Patagonian toothfish	458	916	763	1527
Spikey Oreo	555	1110	925	1850
Silver perch	490	980	817	1633
Blue Mackerel	803	1606	1338	2677
Westem blue groper	690	1380	1150	2300

Threadfin emperor	482	964	803	1607
Black oreo	792	1584	1320	2640
Spanish mackerel	557	1114	928	1857
Sydney rock oyster	470	940	783	1567
Commercial scallop	450	900	750	1500
Arrow Squid	540	1080	900	1800

Vitamins and Minerals

Key nutrients for which some seafood species are likely to be rich sources were incorporated into the same process as that used for the essential fatty acids in Appendix 3, using the RDIs and EARs outlined in tables 3 and 4, respectively. Species-specific information on vitamin and mineral content of Australian seafood is scant, with extensive information only on the following species (by virtue of their importance as indigenous foods):

- *Cassidula angulifera*, Shellfish, Flesh Cooked
- *Cherax albidus*, Cray Fish, Flesh
- *Monodonta labio*, Shellfish, Flesh
- *Nerita lineata*, Shellfish, Flesh
- *Telescopium telescopium*, Shellfish, Flesh
- *Terebralia sulcata*, Shellfish, Flesh

For general calculations of nutrient intakes, compositional information from NUTTAB Australian Food Composition Database[4] was restricted to Gemfish (*Rexea solandri*) and Aquacultured Milkfish (*Chanos chanos*), upon which nutrient intake from fish for the Australian population are generalised. This is also evident in calculations for long-chain omega-3 intake in the NRV document[1].

Table 5 adds another category of NRV – Adequate Intake (AI), which provides a guide for intake for those nutrients for which no specific RDI has been attributed.

Table 3: Recommended Dietary Intake (RDI) values for Trace elements and vitamins with potential to promote seafood consumption.

	Iron (mg)	Zinc (mg)	Selenium (mcg)	Vita B12 (mcg)
Boys and girls				
1-3 yr	9	3	25	0.9
4-8 yr	10	4	30	1.2
Boys				
9-13 yr	8	6	50	1.8
14-18 yr	11	13	70	2.4
Girls				
9-13 yr	8	6	50	1.8
14-18 yr	15	7	60	2.4
Adults				
Man	8	14	70	2.4
Woman	8	8	60	2.4
Pregnancy				
14-18 yr	27	10	65	2.6
19-50 yr	27	11	65	2.6
Lactation				
14-18 yr	10	11	75	2.8
19-50	9	12	75	2.8

Table 4: Estimated Average Requirement (EAR) values for Trace elements and vitamins with potential to promote seafood consumption.

	Iron (mg)	Zinc (mg)	Selenium(mcg)	Vita B12 (mcg)
Boys and girls				
1-3 yr	2.5	3	20	0.7
4-8 yr	3	4	25	1
Boys				
9-13 yr	5	6	40	1.5
14-18 yr	11	13	60	2
Girls				
9-13 yr	5	6	40	1.5
14-18 yr	6	7	50	2
Adults				
Man	12	14	60	2
Woman	6.5	8	50	2
Pregnancy				
14-18 yr	8.5	10	55	2.2
19-50 yr	9	11	55	2.2
Lactation				
14-18 yr	9	11	65	2.4
19-50	10	12	65	2.4

Table 5: Nutrient Reference Values (AI) for Trace elements and vitamins with potential to promote seafood consumption.

	Copper (mg)	Vit E (mg)
Boys and girls		
1-3 yr	0.7	5
4-8 yr	1	6
Boys		
9-13 yr	1.3	9
14-18 yr	1.5	10
Girls		
9-13 yr	1.1	8
14-18 yr	1.1	8
Adults		
Man	1.7	10
Woman	1.2	7
Pregnancy		
14-18 yr	1.2	8
19-50 yr	1.3	7
Lactation		
14-18 yr	1.4	12
19-50	1.5	11

Seafood has been identified as important sources of selenium, iodine, omega-3 oils, Vitamin B12 and Vitamin D in the elderly European populations[6, 7].

Iodine

Whilst there is little species-specific information on contents of Iodine, seafood as a general commodity is recognised as one of the major sources of iodine, in conjunction with dairy products and iodised salt[8]. The combination of public health interventions to reduce table salt consumption, the use of non-iodised salt by food manufacturers in the mainland states of Australia, and the decline in the iodine content of milk, have led to concerns about iodine content in Australia. Clearly, the role of seafood as a major source of iodine has become more prominent given this environment.

Phase II: Assessment related to amounts the edible portions of specific seafood species required to meet NRVs

Nutrients identified as having particular potential in relation to seafood supplying a significant proportion of NRV requirements in phase I were collated in relation to 20 popular species of seafood. This phase focused on the EAR and RDI for adult men as a reference point. This report can also be used as a guide to deriving requirements for other life stages and gender, depending on the marketing objective.

For fish, omega-3 fatty acids and Selenium were identified as nutrients supplied in nutritionally significant amounts in relation to the new NRVs. For shellfish, long chain omega-3 fatty acids, zinc, copper and selenium were identified. Thus, these nutrients have been incorporated for analysis in Appendices 4 and 5.

A summary of key information from Appendices 3-5 are outlined in tables 6 to 9.

Table 6: Amount of edible portion of seafood species required to meet NRV for long-chain omega-3.

	John Dory (Zeus faber)	Gemfish (Rexea solandri)	SeaMullet (Mugil Cephalus)	Golden Trevally (gnathanodon speciosus)	Patagonian toothfish (Dissostichus	Spikey Oreo (Noecyttus rhomboidalis)	Orange Roughy (hoplosptethus atlanticus)	Salmon Atlantic (Salmo salar)	Silver perch (bidyanus bidyanus)	Blue Mackerel (Scomber australasicus)	Westem blue groper (Achoerodus goudlii)	Butter fish (Scatophagus multifasciatus)	Threadfin emperor (Lethrinus genivittatus)	Black oreo (Allocyttus niger)	Spanish mackerel (Scomberomorous	Smooth oreo (Pseudocyttus maculatus)	Mud crab	Sydney rock oyster	Blue mussel	Surf clam	Arrow Squid	Commercial scallop	Eastern king prawn
Boys and girls																							
1-3 yr	24	10	14	29	13	11	294	7	12	7	9	58	12	8	11	9	47	13	10	83	11	13	27
4-8 yr	33	13	19	40	18	15	404	9	17	10	12	80	17	10	15	12	65	18	14	114	15	18	37
Boys																							
9-13 yr	42	17	25	51	23	19	514	12	21	13	15	102	22	13	19	15	82	22	17	145	19	23	48
14-18 yr	76	30	44	91	41	34	919	21	38	23	27	183	39	24	34	27	147	40	31	259	35	42	85
Girls																							
9-13 yr	42	17	25	51	23	19	514	12	21	13	15	102	22	13	19	15	82	22	17	145	19	23	48
14-18 yr	52	20	30	62	28	23	625	14	26	16	18	124	26	16	23	18	100	27	21	176	24	28	58
Adults																							
Man	97	38	56	116	52	43	1176	27	49	30	35	234	50	30	43	35	188	51	40	331	44	53	109
Woman	55	21	32	65	29	24	661	15	28	17	20	132	28	17	24	19	106	29	22	186	25	30	61
Pregnancy																							
14-18 yr	67	26	39	80	36	30	808	18	34	21	24	161	34	21	30	24	129	35	27	228	31	37	75
19-50 yr	70	27	40	83	38	31	845	19	35	21	25	168	36	22	31	25	135	37	29	238	32	38	78
Lactation																							
14-18 yr	85	33	49	101	46	38	1029	23	43	26	30	205	44	27	38	30	165	45	35	290	39	47	95
19-50	88	35	51	105	47	39	1066	24	45	27	32	212	45	27	39	31	171	46	36	300	40	48	99

Table 7: Amount of edible portion of seafood species required to meet NRV for Selenium

	SeaMullet (Mugil Cephalus)	Salmon Atlantic (Salmo salar)	Butter fish (Scatophagus multifasciatus)	Spanish mackerel (Scomberomorous commerson)	Arrow squid	Mud crab	Sydney rock oyster	Blue mussel	Surf clam	Commercial scallop
Boys and girls										
1-3 yr	68	68	68	68	56	66	32	56	103	113
4-8 yr	82	82	82	82	67	80	39	67	124	135
Boys										
9-13 yr	137	136	136	136	112	133	65	112	206	225
14-18 yr	192	191	191	191	156	187	91	156	288	315
Girls										
9-13 yr	137	136	136	136	112	133	65	112	206	225
14-18 yr	164	164	164	164	134	160	78	134	247	270
Adults										
Man	192	191	191	191	156	187	90	156	288	315
Woman	164	164	164	164	134	160	78	134	247	270
Pregnancy										
14-18 yr	178	178	178	178	145	173	84	145	268	293
19-50 yr	178	178	178	178	145	173	84	145	268	293
Lactation										
14-18 yr	205	205	205	205	167	200	97	167	309	338
19-50	205	205	205	205	167	200	97	167	309	338

Table 8: Amount of edible portion of seafood species required to meet NRV for Vitamin B12

	Salmon Atlantic (Salmo salar)	Butter fish (Scatophagus multifasciatus)	Spanish mackerel (Scomberomorous commerson)	Arrow squid	Mud crab	Sydney rock oyster	Blue mussel	Surf clam	Commercial scallop
Boys and girls									
1-3 yr	22	36	29	53	8	4	6	1	45
4-8 yr	31	52	42	76	11	6	8	2	65
Boys									
9-13 yr	47	78	63	115	17	9	13	3	98
14-18 yr	63	105	83	153	22	13	17	4	130
Girls									
9-13 yr	47	78	63	115	17	9	13	3	98
14-18 yr	63	105	83	153	22	13	17	4	130
Adults									
Man	63	105	83	153	22	13	17	4	130
Woman	63	105	83	153	22	13	17	4	130
Pregnancy									
14-18 yr	69	115	92	169	24	14	18	4	143
19-50 yr	69	115	92	169	24	14	18	4	143
Lactation									
14-18 yr	75	126	100	184	27	15	20	5	156
19-50	75	126	100	184	27	15	20	5	156

Table 9: Amount of edible portion of seafood species required to meet ERA for Selenium

	SeaMullet (Mugil Cephalus)	Salmon Atlantic (Salmo salar)	Butter fish (Scatophagus multifasciatus)	Spanish mackerel (Scomberomorous commerson)	Arrow squid	Mud crab	Sydney rock oyster	Blue mussel	Surf clam	Commercial scallop
Boys and girls										
1-3 yr	55	55	55	55	45	54	26	44	82	90
4-8 yr	69	69	69	69	56	67	33	56	103	113
Boys										
9-13 yr	110	110	110	110	89	107	52	89	165	180
14-18 yr	164	164	164	164	134	160	78	134	247	270
Girls										
9-13 yr	110	110	110	110	89	107	52	89	165	180
14-18 yr	137	137	137	137	112	134	65	112	206	225
Adults										
Man	164	164	164	164	134	160	78	134	247	270
Woman	137	137	137	137	112	134	65	112	206	225
Pregnancy										
14-18 yr	151	151	151	151	123	147	71	123	226	248
19-50 yr	151	151	151	151	123	147	71	123	226	248
Lactation										
14-18 yr	178	178	178	178	145	174	84	145	268	293
19-50	178	178	178	178	145	174	84	145	268	293

Food Composition Data Issues

Australia has good quality species-specific information on the fat/oil content of seafood. The database developed by CSIRO[5] has emerged as a highly valuable tool in placing seafood in the context of the NRVs for essential fatty acids. Unfortunately, the quality of food composition data for other nutrients for which seafood is a good source, are not well-developed in terms of providing species-specific information of the local product. In this case, species-specific data from American (USDA) sources have been used. Where information on particular species was not available (eg. Commercial scallop, Mud crab, Arrow squid, Sydney rock oyster, Surf clam), imputed data from a similar species were used.

Such assumptions can lead to large variations in calculated amounts required to meet NRV requirements. For example, the following compares USDA with Australian data on nutrient contents of cooked scallop (all values per 100g):

Nutrient	**USA - USDA[9]**	**Australia - NUTTAB[4]**
Iron (mg)	3.0	1.2
Zinc (mg)	3.0	4.1
Selenium (mcg)	27.9	25.0
Copper (mg)	0.3	0.038
Vitamin B12 (mcg)	1.3	2.1

As can be seen with the above comparison, the extent and direction of the differences are inconsistent, with higher vitamin B12 and zinc, but lower iron, selenium and copper in the Australian (NUTTAB) analyses.

In the Australian food composition tables[4], there are only two fish species nominated (Milkfish and Gemfish). In the case of selenium, the content for steamed milkfish, which contained 36.8 micrograms/100g[4], approximated the values reported for a range of fish species in the USDA data. However, if the value for steamed Gemfish was used (82.7 micrograms/100g), then the amounts required to meet NRVs will be about half these values. The absence of species-specific compositional information is problematic for such calculations.

There are some sporadic reports of data on the composition of Australian seafood from surveillance studies. For example, Selenium, copper and zinc levels have been measured in *Mugil cephalus* (mullet)[10], however such studies involved local, geographically restricted sampling and were conducted in the context of environmental contamination, and levels were determined in dry weight and not necessarily related to the concept of “edible portion”, which is usual for food composition studies.

8. Benefits and adoption

Appendices 3 to 5 provide the raw data from which the conclusions and recommendations in this report are drawn. Additionally, the data in these appendices are formatted to enable use as individual reference sheets for the development of promotional material based on the ability of individual seafood species to provide sufficient nutrients to meet Australian Nutrient Reference Values.

9. Further Development

From the findings in this report, certain gaps in scientific information about seafood were encountered. In response to these, and to facilitate the promotion of the health benefits of seafood, it would be advantageous for the fishing industry to:

- advocate for the inclusion of identification of specific fish species in the next Australian National Nutrition Survey (which is currently under development by the Federal Government)
- Develop species-specific compositional information on seafood, especially for key nutrients such as zinc, selenium, iodine, vitamin D and copper.
- Consider a focus on seafood as an important Iodine source in view of decreased consumption of iodised salt and progressively decreasing iodine content in dairy foods
- Recommend to consumers the consumption from a broad range of seafood species, to maximise health benefits.
- Extend the “eat seafood twice a week” message to 4 times per week
- Consider research into serving size recommendations for the Australian population
- Clarify the optimal frequency of seafood consumption (small amount daily, every three days, twice weekly, 8 times/month)

10. Planned outcomes

Planned outcomes include a greater ability for seafood marketers to highlight the health benefits of seafood consumption, particularly in relation to the role of seafood in assisting Australians to achieve the intake levels for several important nutrients recommended in the NHMRC NRVs.

This will be achieved by assisting marketers to access information on the NRVs, both through this report and the “Plain Talk on NRVs & Seafood” statement attached to this report. (This document will be completed and widely distributed to marketers -- via direct communication, via the Seafood Seafood Services and SEA websites, and via media release -- when this report has received final approval.

A video / DVD will also be produced (within the funding allocation already allocated for this project: ie, from within the current budget, without extra funding), featuring an interview with Dr Somerset and other relevant footage, and based on the “Plain Talk …” document. Again, this can be made available via the SSA website, and also sent direct to marketers who are prepared to meet a charge of less than $3/copy to cover reproduction costs.

Planned outcomes also include greater recognition by Australians of the importance of consuming seafood for good health, and a subsequent trend to eating more seafood more often.

These outcomes will be encouraged by actions including: publicity in the general and industry media from distribution of the “Plain Talk …” document; direct interaction with consumers by retailers in particular; and display of the NRV video in those retail and similar outlets with a television screen for entertaining and informing customers while waiting in the shop.

11. Conclusion

The health benefits of consuming adequate amounts of seafood are well-established in the literature, and have been confirmed recently in national and international scientific meetings[11,12]. The importance of various nutrients for which seafood is a rich source are reflected in the Nutrient Reference Values for Australians. Through the evaluation of Australian seafood in the context of the 2006 NRVs, the following conclusions and recommendations have been identified:

Practical advice for nutrient intake

- At a serving size of 150g, seafood is clearly an excellent source of dietary long chain omega-3 oils. If this serving size were increased, seafood would be enhanced further as a viable omega-3 source
- Australian consumers can meet the NRVs for long chain omega-3 oils entirely from the consumption of certain species of seafood without the necessity of consuming either omega-3 supplements or foods artificially fortified with omega-3 oils
- Due to large variations between seafood species in terms of nutrient content, it is prudent to advise consuming a variety of seafood rather than favouring specific species individually.
- The omega-3 requirements of individuals can also be met by combining seafood consumption with foods which are artificially enriched with omega-3 oils.
- Seafood is not just a good source of omega-3 oils: Amounts of seafood which are commonly consumed can meet the NRVs for certain other nutrients such as Selenium, Zinc, Copper, Iodine and Vitamin B12, nutrients which are often lacking in foods which are artificially enriched with omega-3 oils

Specific information on nutrient content of seafood

- Of the 20 seafood species included in this analysis, all (except Orange Roughy) were good sources of long chain omega-3 oils and Selenium
- All species except Sea Mullet were good sources of Vitamin B12
- Sydney Rock Oyster, Mud Crab and Arrow Squid were good sources of copper
- Sydney Rock Oyster was a comprehensive source of Iron, Zinc, Selenium, Copper and Vitamin B12

General issues

- There are substantial gaps in species-specific information on the composition of seafood, especially in critical nutrients such as zinc, selenium, iodine, vitamin D and copper.

- Recommendations on consumption of seafood should be extended to four times per week to meet the NHMRC Suggested Dietary Target for long-chain omega-3 intake.
- The NRV publication also recognises seafood as a major source of protein in the Australian diet

12. References

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10. Kirby J, Maher W and Harasti D. Changes in selenium, copper, cadmium, and zinc concentrations in mullet (Mugil cephalus) from the southern basin of Lake Macquarie, Australia, in response to alteration of coal-fired power station fly ash handling procedures. Arch Environ Contam Toxicol 2001; 41: 171-81.
11. International Society for the Study of Fatty Acids and Lipids (ISSFAL) Proceedings. 7th International Congress. Cairns, Australia. 2006.
12 "Seafood for Life" International Workshop, Seafood Services Australia. Cairns, 2006.

Appendix 1: Intellectual Property

No Intellectual Property issues have been identified.

Appendix 2: Staff

Mr Scott Bowerman. Manager, Seebee Productions
Ms Laurence Chicoulaa. Project Manager, Gluconeogenesis

Appendix 3: Consumption levels of selected seafood species required to meet RDI's for essential fatty acids (omega-6 and omega-3 oils).

These tables outline the contents of essential fatty acids of each of a range of seafood species derived from Australian species-specific composition data[5]. Subsequently within each table, the amounts of the various fish species required to be consumed to meet RDI requirements have been calculated. Figures outlined in bold indicate amounts which are feasible in terms of standard serving sizes.

Note: In the example of John Dory, below, an amount of 86.9g of this fish contains enough long-chain omega-3 oil to meet the daily requirement RDI for this nutrient. However, an unachievable amount (118 kg) would be required, for example, to meet the RDI for 18:3(n-3). For simplicity, only quantities which are considered to be feasible amounts of usual consumption are included in the Appendices.

John Dory (*Zeus faber*)

Content of essential fatty acids

LC omega 3 mg/100g	185
18:3(n-3) g/100g	0.0011
18:2(n-6) g/100g	0.0026

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**24**	**417**
4-8 yr	**33**	**303**
Boys		
9-13 yr	**42**	**238**
14-18 yr	**76**	**132**
Girls		
9-13 yr	**42**	**238**
14-18 yr	**52**	**192**
Adults		
Man	**97**	**103**
Woman	**55**	**182**
Pregnancy		
14-18 yr	**67**	**149**
19-50 yr	**70**	**143**
Lactation		
14-18 yr	**85**	**118**
19-50	**88**	**114**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Gemfish (*Rexea solandri*)

Content of essential fatty acids

LC omega 3 mg/100g	419
18:3(n-3) g/100g	0.005
18:2(n-6) g/100g	0.032

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**10**	**1000**
4-8 yr	**13**	**769**
Boys		
9-13 yr	**17**	**588**
14-18 yr	**30**	**333**
Girls		
9-13 yr	**17**	**588**
14-18 yr	**20**	**500**
Adults		
Man	**38**	**263**
Woman	**21**	**476**
Pregnancy		
14-18 yr	**26**	**385**
19-50 yr	**27**	**370**
Lactation		
14-18 yr	**33**	**303**
19-50	**35**	**286**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

SeaMullet (*Mugil Cephalus*)

Content of essential fatty acids

LC omega 3 mg/100g	285
18:3(n-3) g/100g	0.001
18:2(n-6) g/100g	0.0043

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**14**	**714**
4-8 yr	**19**	**526**
Boys		
9-13 yr	**25**	**400**
14-18 yr	**44**	**227**
Girls		
9-13 yr	**25**	**400**
14-18 yr	**30**	**333**
Adults		
Man	**56**	**179**
Woman	**32**	**313**
Pregnancy		
14-18 yr	**39**	**256**
19-50 yr	**40**	**250**
Lactation		
14-18 yr	**49**	**204**
19-50	**51**	**196**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Golden Trevally (*Gnathanodon speciosus*)

Content of essential fatty acids

LC omega 3 mg/100g	138
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.0023

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**29**	**345**
4-8 yr	**40**	**250**
Boys		
9-13 yr	**51**	**196**
14-18 yr	**91**	**110**
Girls		
9-13 yr	**51**	**196**
14-18 yr	**62**	**161**
Adults		
Man	**116**	**86**
Woman	**65**	**154**
Pregnancy		
14-18 yr	**80**	**125**
19-50 yr	**83**	**120**
Lactation		
14-18 yr	**101**	**99**
19-50	**105**	**95**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Patagonian toothfish (*Dissostichus eleginoides*)

Content of essential fatty acids

LC omega 3 mg/100g	305.6
18:3(n-3) g/100g	0.003
18:2(n-6) g/100g	0.054

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**13**	**769**
4-8 yr	**18**	**556**
Boys		
9-13 yr	**23**	**435**
14-18 yr	**41**	**244**
Girls		
9-13 yr	**23**	**435**
14-18 yr	**28**	**357**
Adults		
Man	**52**	**192**
Woman	**29**	**345**
Pregnancy		
14-18 yr	**36**	**278**
19-50 yr	**38**	**263**
Lactation		
14-18 yr	**46**	**217**
19-50	**47**	**213**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Spikey Oreo (*Noecyttus rhomboidalis*)

Content of essential fatty acids

LC omega 3 mg/100g	370
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.017

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**11**	**909**
4-8 yr	**15**	**667**
Boys		
9-13 yr	**19**	**526**
14-18 yr	**34**	**294**
Girls		
9-13 yr	**19**	**526**
14-18 yr	**23**	**435**
Adults		
Man	**43**	**233**
Woman	**24**	**417**
Pregnancy		
14-18 yr	**30**	**333**
19-50 yr	**31**	**323**
Lactation		
14-18 yr	**38**	**263**
19-50	**39**	**256**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Orange Roughy (*Hoplosptethus atlanticus*)

Content of essential fatty acids

LC omega 3 mg/100g	13.66
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	294	**34**
4-8 yr	404	**25**
Boys		
9-13 yr	514	**19**
14-18 yr	919	**11**
Girls		
9-13 yr	514	**19**
14-18 yr	625	**16**
Adults		
Man	1176	**9**
Woman	661	**15**
Pregnancy		
14-18 yr	808	**12**
19-50 yr	845	**12**
Lactation		
14-18 yr	1029	**10**
19-50	1066	**9**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Salmon Atlantic (*Salmo salar*)

Content of essential fatty acids

LC omega 3 mg/100g	603
18:3(n-3) g/100g	0.015
18:2(n-6) g/100g	0.067

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**7**	**1429**
4-8 yr	**9**	**1111**
Boys		
9-13 yr	**12**	**833**
14-18 yr	**21**	**476**
Girls		
9-13 yr	**12**	**833**
14-18 yr	**14**	**714**
Adults		
Man	**27**	**370**
Woman	**15**	**667**
Pregnancy		
14-18 yr	**18**	**556**
19-50 yr	**19**	**526**
Lactation		
14-18 yr	**23**	**435**
19-50	**24**	**417**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Silver perch (*Bidyanus bidyanus*)

Content of essential fatty acids

LC omega 3 mg/100g	326
18:3(n-3) g/100g	0.038
18:2(n-6) g/100g	0.34

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**12**	**833**
4-8 yr	**17**	**588**
Boys		
9-13 yr	**21**	**476**
14-18 yr	**38**	**263**
Girls		
9-13 yr	**21**	**476**
14-18 yr	**26**	**385**
Adults		
Man	**49**	**204**
Woman	**28**	**357**
Pregnancy		
14-18 yr	**34**	**294**
19-50 yr	**35**	**286**
Lactation		
14-18 yr	**43**	**233**
19-50	**45**	**222**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Blue Mackerel (*Scomber australasicus*)

Content of essential fatty acids

LC omega 3 mg/100g	535
18:3(n-3) g/100g	0.01
18:2(n-6) g/100g	0.038

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**7**	**1429**
4-8 yr	**10**	**1000**
Boys		
9-13 yr	**13**	**769**
14-18 yr	**23**	**435**
Girls		
9-13 yr	**13**	**769**
14-18 yr	**16**	**625**
Adults		
Man	**30**	**333**
Woman	**17**	**588**
Pregnancy		
14-18 yr	**21**	**476**
19-50 yr	**21**	**476**
Lactation		
14-18 yr	**26**	**385**
19-50	**27**	**370**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Westem blue grouper (*Achoerodus goudlii*)

Content of essential fatty acids

LC omega 3 mg/100g	460
18:3(n-3) g/100g	0.018
18:2(n-6) g/100g	0.037

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**9**	**1111**
4-8 yr	**12**	**833**
Boys		
9-13 yr	**15**	**667**
14-18 yr	**27**	**370**
Girls		
9-13 yr	**15**	**667**
14-18 yr	**18**	**556**
Adults		
Man	**35**	**286**
Woman	**20**	**500**
Pregnancy		
14-18 yr	**24**	**417**
19-50 yr	**25**	**400**
Lactation		
14-18 yr	**30**	**333**
19-50	**32**	**313**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Butter fish (*Scatophagus multifasciatus*)

Content of essential fatty acids

LC omega 3 mg/100g	68.4
18:3(n-3) g/100g	0.041
18:2(n-6) g/100g	0.02

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	58	**172**
4-8 yr	80	**125**
Boys		
9-13 yr	102	**98**
14-18 yr	183	**55**
Girls		
9-13 yr	102	**98**
14-18 yr	124	**81**
Adults		
Man	234	**43**
Woman	132	**76**
Pregnancy		
14-18 yr	161	**62**
19-50 yr	168	**60**
Lactation		
14-18 yr	205	**49**
19-50	212	**47**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Threadfin emperor (*Lethrinus genivittatus*)

Content of essential fatty acids

LC omega 3 mg/100g	321
18:3(n-3) g/100g	0.0042
18:2(n-6) g/100g	0.0042

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**12**	**833**
4-8 yr	**17**	**588**
Boys		
9-13 yr	**22**	**455**
14-18 yr	**39**	**256**
Girls		
9-13 yr	**22**	**455**
14-18 yr	**26**	**385**
Adults		
Man	**50**	**200**
Woman	**28**	**357**
Pregnancy		
14-18 yr	**34**	**294**
19-50 yr	**36**	**278**
Lactation		
14-18 yr	**44**	**227**
19-50	**45**	**222**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Black oreo (*Allocyttus niger*)

Content of essential fatty acids

LC omega 3 mg/100g	528
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.035

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**8**	**1250**
4-8 yr	**10**	**1000**
Boys		
9-13 yr	**13**	**769**
14-18 yr	**24**	**417**
Girls		
9-13 yr	**13**	**769**
14-18 yr	**16**	**625**
Adults		
Man	**30**	**333**
Woman	**17**	**588**
Pregnancy		
14-18 yr	**21**	**476**
19-50 yr	**22**	**455**
Lactation		
14-18 yr	**27**	**370**
19-50	**27**	**370**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Spanish mackerel (*Scomberomorous commerson)*

Content of essential fatty acids

LC omega 3 mg/100g	371
18:3(n-3) g/100g	0.013
18:2(n-6) g/100g	0.032

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**11**	**909**
4-8 yr	**15**	**667**
Boys		
9-13 yr	**19**	**526**
14-18 yr	**34**	**294**
Girls		
9-13 yr	**19**	**526**
14-18 yr	**23**	**435**
Adults		
Man	**43**	**233**
Woman	**24**	**417**
Pregnancy		
14-18 yr	**30**	**333**
19-50 yr	**31**	**323**
Lactation		
14-18 yr	**38**	**263**
19-50	**39**	**256**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Smooth oreo (*Pseudocyttus maculatus*)

Content of essential fatty acids

LC omega 3 mg/100g	464
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.024

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**9**	**1111**
4-8 yr	**12**	**833**
Boys		
9-13 yr	**15**	**667**
14-18 yr	**27**	**370**
Girls		
9-13 yr	**15**	**667**
14-18 yr	**18**	**556**
Adults		
Man	**35**	**286**
Woman	**19**	**526**
Pregnancy		
14-18 yr	**24**	**417**
19-50 yr	**25**	**400**
Lactation		
14-18 yr	**30**	**333**
19-50	**31**	**323**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Mud crab

Content of essential fatty acids

LC omega 3 mg/100g	85
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.026

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**47**	**213**
4-8 yr	**65**	**154**
Boys		
9-13 yr	**82**	**122**
14-18 yr	**147**	**68**
Girls		
9-13 yr	**82**	**122**
14-18 yr	**100**	**100**
Adults		
Man	**188**	**53**
Woman	**106**	**94**
Pregnancy		
14-18 yr	**129**	**78**
19-50 yr	**135**	**74**
Lactation		
14-18 yr	**165**	**61**
19-50	**171**	**58**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Sydney rock oyster

Content of essential fatty acids

LC omega 3 mg/100g	313
18:3(n-3) g/100g	0.012
18:2(n-6) g/100g	0.052

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**13**	**769**
4-8 yr	**18**	**556**
Boys		
9-13 yr	**22**	**455**
14-18 yr	**40**	**250**
Girls		
9-13 yr	**22**	**455**
14-18 yr	**27**	**370**
Adults		
Man	**51**	**196**
Woman	**29**	**345**
Pregnancy		
14-18 yr	**35**	**286**
19-50 yr	**37**	**270**
Lactation		
14-18 yr	**45**	**222**
19-50	**46**	**217**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Blue mussel

Content of essential fatty acids

LC omega 3 mg/100g	401
18:3(n-3) g/100g	0.008
18:2(n-6) g/100g	0.009

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**10**	**1000**
4-8 yr	**14**	**714**
Boys		
9-13 yr	**17**	**588**
14-18 yr	**31**	**323**
Girls		
9-13 yr	**17**	**588**
14-18 yr	**21**	**476**
Adults		
Man	**40**	**250**
Woman	**22**	**455**
Pregnancy		
14-18 yr	**27**	**370**
19-50 yr	**29**	**345**
Lactation		
14-18 yr	**35**	**286**
19-50	**36**	**278**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart. References:
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Surf clam

Content of essential fatty acids

LC omega 3 mg/100g	48.3
18:3(n-3) g/100g	0.0003
18:2(n-6) g/100g	0.001

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	83	**120**
4-8 yr	114	**88**
Boys		
9-13 yr	145	**69**
14-18 yr	259	**39**
Girls		
9-13 yr	145	**69**
14-18 yr	176	**57**
Adults		
Man	331	**30**
Woman	186	**54**
Pregnancy		
14-18 yr	228	**44**
19-50 yr	238	**42**
Lactation		
14-18 yr	290	**34**
19-50	300	**33**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart. References:
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Arrow Squid

Content of essential fatty acids

LC omega 3 mg/100g	360
18:3(n-3) g/100g	0
18:2(n-6) g/100g	0.0023

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**11**	**909**
4-8 yr	**15**	**667**
Boys		
9-13 yr	**19**	**526**
14-18 yr	**35**	**286**
Girls		
9-13 yr	**19**	**526**
14-18 yr	**24**	**417**
Adults		
Man	**44**	**227**
Woman	**25**	**400**
Pregnancy		
14-18 yr	**31**	**323**
19-50 yr	**32**	**313**
Lactation		
14-18 yr	**39**	**256**
19-50	**40**	**250**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart. References:
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Commercial scallop

Content of essential fatty acids

LC omega 3 mg/100g	300
18:3(n-3) g/100g	0.0047
18:2(n-6) g/100g	0.0054

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**13**	**769**
4-8 yr	**18**	**556**
Boys		
9-13 yr	**23**	**435**
14-18 yr	**42**	**238**
Girls		
9-13 yr	**23**	**435**
14-18 yr	**28**	**357**
Adults		
Man	**53**	**189**
Woman	**30**	**333**
Pregnancy		
14-18 yr	**37**	**270**
19-50 yr	**38**	**263**
Lactation		
14-18 yr	**47**	**213**
19-50	**48**	**208**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart. References:
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Eastern king prawn

Content of essential fatty acids

LC omega 3 mg/100g	147
18:3(n-3) g/100g	0.0019
18:2(n-6) g/100g	0.0076

Quantity of fish necessary to achieve the Corresponding RDI in grams

	LC omega 3	Percentage RDI per 100g
Boys and girls		
1-3 yr	**27**	**370**
4-8 yr	**37**	**270**
Boys		
9-13 yr	**48**	**208**
14-18 yr	**85**	**118**
Girls		
9-13 yr	**48**	**208**
14-18 yr	**58**	**172**
Adults		
Man	**109**	**92**
Woman	**61**	**164**
Pregnancy		
14-18 yr	**75**	**133**
19-50 yr	**78**	**128**
Lactation		
14-18 yr	**95**	**105**
19-50	**99**	**101**

References: Nichols PD, Virtue P, Mooney BD et al, Seafood the Good Food. The oil (fat) content and composition of Australian commercial fishes, shellfishes and crustaceans. 1998, CSIRO Marine Research: Hobart. References:
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Appendix 4: Consumption levels of selected seafood species required to meet RDI's for key vitamins and minerals

Recommended Dietary Intakes for key vitamins and minerals: The following tables outline the amounts of specified seafood required to meet RDI for a range of nutrients for which seafood is recognised as being a good source. Since there is little Australian species-specific data on the content of these nutrients, other food composition data sources have been used. These are noted for each example. (* denotes levels of consumption in excess of levels likely to be consumed)

SeaMullet (*Mugil Cephalus*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	1.02
	Zinc mg/100g	0.52
	Selenium mcg/100g	36.5
	Vitamin E mg/100g	1
	Copper mg/100g	0.051
	Vitamin B12mcg/100g	0.22

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium
Boys and girls	
1-3 yr	**68**
4-8 yr	**82**
Boys	
9-13 yr	**137**
14-18 yr	**192**
Girls	
9-13 yr	**137**
14-18 yr	**164**
Adults	
Man	**192**
Woman	**164**
Pregnancy	
14-18 yr	**178**
19-50 yr	**178**
Lactation	
14-18 yr	**205**
19-50	**205**

Percentage of RDI contained per 100g edible portion

	Selenium
Boys and girls	
1-3 yr	147
4-8 yr	122
Boys	
9-13 yr	73
14-18 yr	52
Girls	
9-13 yr	73
14-18 yr	61
Adults	
Man	52
Woman	61
Pregnancy	
14-18 yr	56
19-50 yr	56
Lactation	
14-18 yr	49
19-50	49

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Salmon Atlantic (*Salmo salar*)

Compositional Data (Farmed, Raw) (data derived from USDA[9])	Iron mg/100g	0.36
	Zinc mg/100g	0.4
	Selenium mcg/100g	36.5
	Copper mg/100g	0.25
	Vitamin B12mcg/100g	3.18

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	**68**	**22.0**
4-8 yr	**82**	**31.4**
Boys		
9-13 yr	**136**	**47.1**
14-18 yr	**191**	**62.8**
Girls		
9-13 yr	**136**	**47.1**
14-18 yr	**164**	**62.8**
Adults		
Man	**191**	**62.8**
Woman	**164**	**62.8**
Pregnancy		
14-18 yr	**178**	**69.1**
19-50 yr	**178**	**69.1**
Lactation		
14-18 yr	**205**	**75.4**
19-50	**205**	**75.4**

Percentage of RDI contained per 100g edible portion

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	147	455
4-8 yr	122	318
Boys		
9-13 yr	73	212
14-18 yr	52	159
Girls		
9-13 yr	73	212
14-18 yr	61	159
Adults		
Man	52	159
Woman	61	159
Pregnancy		
14-18 yr	56	145
19-50 yr	56	145
Lactation		
14-18 yr	49	133
19-50	49	133

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Butterfish (*Scatophagus multifasciatus*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	0.5
	Zinc mg/100g	0.77
	Selenium mcg/100g	36.5
	Copper mg/100g	0.054
	Vitamin B12mcg/100g	1.9

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	**68**	**36**
4-8 yr	**82**	**52**
Boys		
9-13 yr	**136**	**78**
14-18 yr	**191**	**105**
Girls		
9-13 yr	**136**	**78**
14-18 yr	**164**	**105**
Adults		
Man	**191**	**105**
Woman	**164**	**105**
Pregnancy		
14-18 yr	**178**	**115**
19-50 yr	**178**	**115**
Lactation		
14-18 yr	**205**	**126**
19-50	**205**	**126**

Percentage of RDI contained per 100g edible portion

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	147	278
4-8 yr	122	192
Boys		
9-13 yr	73	128
14-18 yr	52	95
Girls		
9-13 yr	73	128
14-18 yr	61	95
Adults		
Man	52	95
Woman	61	95
Pregnancy		
14-18 yr	56	87
19-50 yr	56	87
Lactation		
14-18 yr	49	79
19-50	49	79

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Spanish mackerel (*Scomberomorous commerson*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	0.44
	Zinc mg/100g	0.49
	Selenium mcg/100g	36.5
	Vitamin E mg/100g	0.69
	Copper mg/100g	0.055
	Vita B 12 mcg/100g	2.4

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	68	**29.1**
4-8 yr	**82**	**41.6**
Boys		
9-13 yr	**136**	**62.5**
14-18 yr	**191**	**83.3**
Girls		
9-13 yr	**136**	**62.5**
14-18 yr	**164**	**83.3**
Adults		
Man	**191**	**83.3**
Woman	**164**	**83.3**
Pregnancy		
14-18 yr	**178**	**91.6**
19-50 yr	**178**	**91.6**
Lactation		
14-18 yr	**205**	**100**
19-50	**205**	**100**

Percentage of RDI contained per 100g edible portion

	Selenium	Vitamin B12
Boys and girls		
1-3 yr	147	344
4-8 yr	122	240
Boys		
9-13 yr	73	160
14-18 yr	52	120
Girls		
9-13 yr	73	160
14-18 yr	61	120
Adults		
Man	52	120
Woman	61	120
Pregnancy		
14-18 yr	56	109
19-50 yr	56	109
Lactation		
14-18 yr	49	100
19-50	49	100

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Mud crab

Compositional Data (data for Blue crab, Raw) (data derived from USDA[9])	Iron mg/100g	0.74
	Zinc mg/100g	3.54
	Selenium mcg/100g	37.4
	Copper mg/100g	0.669
	Vitamin B12mcg/100g	9

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Zinc	Selenium	Copper	Vitamin B12
Boys and girls				
1-3 yr	**84**	**66**	**104**	**7.7**
4-8 yr	**112**	**80**	**149**	**11.1**
Boys				
9-13 yr	**169**	**133**	**194**	**16.6**
14-18 yr	**367**	**187**	**224**	**22.2**
Girls				
9-13 yr	**169**	**133**	**164**	**16.6**
14-18 yr	**197**	**160**	**164**	**22.2**
Adults				
Man	**395**	**187**	**254**	**22.2**
Woman	**225**	**160**	**179**	**22.2**
Pregnancy				
14-18 yr	**282**	**173**	**179**	**24.4**
19-50 yr	**310**	**173**	**194**	**24.4**
Lactation				
14-18 yr	**310**	**200**	**209**	**26.6**
19-50	**338**	**200**	**224**	**26.6**

Percentage of RDI contained per 100g edible portion

	Zinc	Selenium	Copper	Vitamin B12
Boys and girls				
1-3 yr	119	152	96	1299
4-8 yr	89	125	67	901
Boys				
9-13 yr	59	75	52	602
14-18 yr	27	53	45	450
Girls				
9-13 yr	59	75	61	602
14-18 yr	51	63	61	450
Adults				
Man	25	53	39	450
Woman	44	63	56	450
Pregnancy				
14-18 yr	35	58	56	410
19-50 yr	32	58	52	410
Lactation				
14-18 yr	32	50	48	376
19-50	30	50	45	376

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Sydney rock oyster

Compositional Data (data for Pacific oyster, Raw) (data derived from USDA[9])	Iron mg/100g	5.11
	Zinc mg/100g	16.62
	Selenium mcg/100g	77
	Copper mg/100g	1.576
	Vitamin B12mcg/100g	16

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Iron	Zinc	Selenium	Copper	Vitamin B12
Boys and girls					
1-3 yr	176	**18**	**32**	**45**	**4**
4-8 yr	195	**24**	**39**	**64**	**6**
Boys					
9-13 yr	156	**36**	**65**	**83**	**9**
14-18 yr	215	**78**	**91**	**96**	**13**
Girls					
9-13 yr	156	**36**	**65**	**70**	**9**
14-18 yr	293	**42**	**78**	**70**	**13**
Adults					
Man	156	**84**	**90**	**108**	**13**
Woman	156	**48**	**78**	**76**	**13**
Pregnancy					
14-18 yr	528	**60**	**84**	**76**	**14**
19-50 yr	528	**66**	**84**	**83**	**14**
Lactation					
14-18 yr	195	**66**	**97**	**89**	**15**
19-50	176	**72**	**97**	**96**	**15**

Percentage of RDI contained per 100g edible portion

	Iron	Zinc	Selenium	Copper	Vitamin B12
Boys and girls					
1-3 yr	57	556	313	222	2500
4-8 yr	51	417	256	156	1667
Boys					
9-13 yr	64	278	154	120	1111
14-18 yr	47	128	110	104	769
Girls					
9-13 yr	64	278	154	143	1111
14-18 yr	34	238	128	143	769
Adults					
Man	64	119	111	93	769
Woman	64	208	128	132	769
Pregnancy					
14-18 yr	19	167	119	132	714
19-50 yr	19	152	119	120	714
Lactation					
14-18 yr	51	152	103	112	667
19-50	57	139	103	104	667

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Blue mussel

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	3.95
	Zinc mg/100g	1.6
	Selenium mcg/100g	44.8
	Vitamin E mg/100g	0.55
	Copper mg/100g	0.094
	Vitamin B12mcg/100g	12

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Iron	Selenium	Vitamin B12
Boys and girls			
1-3 yr	228	**55.8**	**5.8**
4-8 yr	253	**7**	**8.3**
Boys			
9-13 yr	203	**112**	**12.5**
14-18 yr	278	**156**	**16.6**
Girls			
9-13 yr	203	**112**	**12.5**
14-18 yr	380	**134**	**16.6**
Adults			
Man	203	**156**	**16.6**
Woman	203	**134**	**16.6**
Pregnancy			
14-18 yr	684	**145**	**18.3**
19-50 yr	686	**145**	**18.3**
Lactation			
14-18 yr	253	**167**	**20**
19-50	228	**167**	**20**

Percentage of RDI contained per 100g edible portion

	Iron	Selenium	Vitamin B12
Boys and girls			
1-3 yr	44	179	1724
4-8 yr	40	1429	1205
Boys			
9-13 yr	49	89	800
14-18 yr	36	64	602
Girls			
9-13 yr	49	89	800
14-18 yr	26	75	602
Adults			
Man	49	64	602
Woman	49	75	602
Pregnancy			
14-18 yr	15	69	546
19-50 yr	15	69	546
Lactation			
14-18 yr	40	60	500
19-50	44	60	500

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Surf clam

Compositional Data (data for Clam, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	13.98
	Zinc mg/100g	1.37
	Selenium mcg/100g	24.3
	Vitamin E mg/100g	0.31
	Copper mg/100g	0.344
	Vitamin B12mcg/100g	49.44

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Iron	Selenium	Copper	Vitamin B12
Boys and girls				
1-3 yr	64	**102**	203	**1.4**
4-8 yr	72	**123**	291	**2.0**
Boys				
9-13 yr	57	**205**	378	**3.0**
14-18 yr	79	**288**	436	**4.0**
Girls				
9-13 yr	57	**205**	320	**3.0**
14-18 yr	107	**247**	320	**4.0**
Adults				
Man	57	**288**	494	**4.0**
Woman	57	**247**	349	**4.0**
Pregnancy				
14-18 yr	193	**267**	349	**4.4**
19-50 yr	193	**267**	378	**4.4**
Lactation				
14-18 yr	72	**309**	407	**4.8**
19-50	64	**309**	436	**4.8**

Percentage of RDI contained per 100g edible portion

	Iron	Selenium	Copper	Vitamin B12
Boys and girls				
1-3 yr	156	98	49	7143
4-8 yr	139	81	34	5000
Boys				
9-13 yr	175	49	26	3333
14-18 yr	127	35	23	2500
Girls				
9-13 yr	175	49	31	3333
14-18 yr	93	40	31	2500
Adults				
Man	175	35	20	2500
Woman	175	40	29	2500
Pregnancy				
14-18 yr	52	37	29	2273
19-50 yr	52	37	26	2273
Lactation				
14-18 yr	139	32	25	2083
19-50	156	32	23	2083

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Arrow Squid

Compositional Data (Data for squid, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	0.68
	Zinc mg/100g	1.53
	selenium mcg/100g	44.8
	Vitamin E mg/100g	1.2
	Copper mg/100g	1.89
	Vitamin B12mcg/100g	1.3

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium	Copper	Vitamin B12
Boys and girls			
1-3 yr	**55**	**37**	**53**
4-8 yr	**66**	**53**	**76**
Boys			
9-13 yr	**111**	**69**	**115**
14-18 yr	**156**	**79**	**153**
Girls			
9-13 yr	**111**	**58**	**115**
14-18 yr	**133**	**58**	**153**
Adults			
Man	**156**	**90**	**153**
Woman	**133**	**63**	**153**
Pregnancy			
14-18 yr	**145**	**64**	**169**
19-50 yr	**145**	**69**	**169**
Lactation			
14-18 yr	**167**	**74**	**184**
19-50	**167**	**79**	**184**

Percentage of RDI contained per 100g edible portion

	Selenium	Copper	Vitamin B12
Boys and girls			
1-3 yr	182	270	189
4-8 yr	152	189	132
Boys			
9-13 yr	90	145	87
14-18 yr	64	127	65
Girls			
9-13 yr	90	172	87
14-18 yr	75	172	65
Adults			
Man	64	111	65
Woman	75	159	65
Pregnancy			
14-18 yr	69	156	59
19-50 yr	69	145	59
Lactation			
14-18 yr	60	135	54
19-50	60	127	54

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Commercial scallop

Compositional Data (scallop, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	0.29
	Zinc mg/100g	0.95
	selenium mcg/100g	22.2
	Copper mg/100g	0.053
	Vitamin B12mcg/100g	1.53

Quantity of fish (in grams) necessary to achieve the Corresponding RDI in grams

	Selenium	Vitamin E	Vitamin B12
Boys and girls			
1-3 yr	113	**45**	**53**
4-8 yr	135	**65**	**76**
Boys			
9-13 yr	225	**98**	**115**
14-18 yr	315	**130**	**153**
Girls			
9-13 yr	225	**98**	**115**
14-18 yr	270	**130**	**153**
Adults			
Man	315	**130**	**153**
Woman	270	**130**	**153**
Pregnancy			
14-18 yr	293	**143**	**169**
19-50 yr	293	**143**	**169**
Lactation			
14-18 yr	338	**156**	**184**
19-50	338	**156**	**184**

Percentage of RDI contained per 100g edible portion

	Selenium	Vit E	Vitamin B12
Boys and girls			
1-3 yr	88	222	189
4-8 yr	74	154	132
Boys			
9-13 yr	44	102	87
14-18 yr	32	77	65
Girls			
9-13 yr	44	102	87
14-18 yr	37	77	65
Adults			
Man	32	77	65
Woman	37	77	65
Pregnancy			
14-18 yr	34	70	59
19-50 yr	34	70	59
Lactation			
14-18 yr	30	64	54
19-50	30	64	54

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Appendix 5: Consumption levels of selected seafood species required to meet the Estimated Average Requirement (EAR) for key vitamins and minerals.

Estimated Average Requirement: The following tables outline the amounts of specified seafood required to meet EAR for a range of nutrients for which seafood is recognised as being a good source. Only those nutrients which had been found in Phase I to be in high concentrations in some seafood were considered. Food composition data source and assumptions used in these calculations are as for Appendix 2

SeaMullet (*Mugil Cephalus*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	1.02
	Zinc mg/100g	0.52
	Selenium mcg/100g	36.5

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium
Boys and girls	
1-3 yr	**55**
4-8 yr	**68**
Boys	
9-13 yr	**110**
14-18 yr	**164**
Girls	
9-13 yr	**110**
14-18 yr	**137**
Adults	
Man	**164**
Woman	**137**
Pregnancy	
14-18 yr	**151**
19-50 yr	**151**
Lactation	
14-18 yr	**178**
19-50	**178**

Percentage of EAR contained per 100g edible portion

	Selenium
Boys and girls	
1-3 yr	182
4-8 yr	147
Boys	
9-13 yr	91
14-18 yr	61
Girls	
9-13 yr	91
14-18 yr	73
Adults	
Man	61
Woman	73
Pregnancy	
14-18 yr	66
19-50 yr	66
Lactation	
14-18 yr	56
19-50	56

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Salmon Atlantic (*Salmo salar*)

Compositional Data (Farmed, Raw) (data derived from USDA[9])	Iron mg/100g	0.36
	Zinc mg/100g	0.4
	Selenium mcg/100g	36.5

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium	Vita B12
Boys and girls		
1-3 yr	**55**	**28**
4-8 yr	**68**	**38**
Boys		
9-13 yr	**110**	**57**
14-18 yr	**164**	**75**
Girls		
9-13 yr	**110**	**57**
14-18 yr	**137**	**75**
Adults		
Man	**164**	**75**
Woman	**137**	**75**
Pregnancy		
14-18 yr	**151**	**82**
19-50 yr	**151**	**82**
Lactation		
14-18 yr	**178**	**88**
19-50	**178**	**88**

Percentage of EAR contained per 100g edible portion

	Selenium	Vita B12
Boys and girls		
1-3 yr	182	357
4-8 yr	147	263
Boys		
9-13 yr	91	175
14-18 yr	61	133
Girls		
9-13 yr	91	175
14-18 yr	73	133
Adults		
Man	61	133
Woman	73	133
Pregnancy		
14-18 yr	66	122
19-50 yr	66	122
Lactation		
14-18 yr	56	114
19-50	56	114

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Butterfish (*Scatophagus multifasciatus*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	0.5
	Zinc mg/100g	0.77
	Selenium mcg/100g	36.5

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium	Vita B12
Boys and girls		
1-3 yr	**55**	**47**
4-8 yr	**68**	**63**
Boys		
9-13 yr	**110**	**95**
14-18 yr	**164**	**126**
Girls		
9-13 yr	**110**	**95**
14-18 yr	**137**	**126**
Adults		
Man	**164**	**126**
Woman	**137**	**126**
Pregnancy		
14-18 yr	**151**	**137**
19-50 yr	**151**	**137**
Lactation		
14-18 yr	**178**	**147**
19-50	**178**	**147**

Percentage of EAR contained per 100g edible portion

	Selenium	Vita B12
Boys and girls		
1-3 yr	182	213
4-8 yr	147	159
Boys		
9-13 yr	91	105
14-18 yr	61	79
Girls		
9-13 yr	91	105
14-18 yr	73	79
Adults		
Man	61	79
Woman	73	79
Pregnancy		
14-18 yr	66	73
19-50 yr	66	73
Lactation		
14-18 yr	56	68
19-50	56	68

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Spanish mackerel (*Scomberomorous commerson*)

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	0.44
	Zinc mg/100g	0.49
	Selenium mcg/100g	36.5

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium	Vita B12
Boys and girls		
1-3 yr	**55**	**38**
4-8 yr	**68**	**50**
Boys		
9-13 yr	**110**	**75**
14-18 yr	**164**	**100**
Girls		
9-13 yr	**110**	**75**
14-18 yr	**137**	**100**
Adults		
Man	**164**	**100**
Woman	**137**	**100**
Pregnancy		
14-18 yr	**151**	**108**
19-50 yr	**151**	**108**
Lactation		
14-18 yr	**178**	**117**
19-50	**178**	**117**

Percentage of EAR contained per 100g edible portion

	Selenium	Vita B12
Boys and girls		
1-3 yr	182	263
4-8 yr	147	200
Boys		
9-13 yr	91	133
14-18 yr	61	100
Girls		
9-13 yr	91	133
14-18 yr	73	100
Adults		
Man	61	100
Woman	73	100
Pregnancy		
14-18 yr	66	93
19-50 yr	66	93
Lactation		
14-18 yr	56	85
19-50	56	85

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Mud crab

Compositional Data	Iron mg/100g	0.74
	Zinc mg/100g	3.54
(data for Blue crab, Raw) (data derived from USDA[9])	Selenium mcg/100g	37.4

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Zinc	Selenium	Vita B12
Boys and girls			
1-3 yr	85	**53**	**10**
4-8 yr	113	**67**	**13**
Boys			
9-13 yr	169	**107**	**20**
14-18 yr	367	**160**	**27**
Girls			
9-13 yr	169	**107**	**20**
14-18 yr	198	**134**	**27**
Adults			
Man	395	**160**	**27**
Woman	226	**134**	**27**
Pregnancy			
14-18 yr	282	**147**	**29**
19-50 yr	311	**147**	**29**
Lactation			
14-18 yr	311	**174**	**31**
19-50	339	**174**	**31**

Percentage of EAR contained per 100g edible portion

	Zinc	Selenium	Vita B12
Boys and girls			
1-3 yr	118	189	1000
4-8 yr	88	149	769
Boys			
9-13 yr	59	93	500
14-18 yr	27	63	370
Girls			
9-13 yr	59	93	500
14-18 yr	51	75	370
Adults			
Man	25	63	370
Woman	44	75	370
Pregnancy			
14-18 yr	35	68	345
19-50 yr	32	68	345
Lactation			
14-18 yr	32	57	323
19-50	29	57	323

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Sydney rock oyster

Compositional Data	Iron mg/100g	5.11
	Zinc mg/100g	16.62
(data for Pacific oyster, Raw) (data derived from USDA[9])	Selenium mcg/100g	77

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Iron	Zinc	Selenium	Vita B12
Boys and girls				
1-3 yr	49	**18**	**26**	**6**
4-8 yr	59	**24**	**32**	**8**
Boys				
9-13 yr	98	**36**	**52**	**11**
14-18 yr	215	**78**	**78**	**15**
Girls				
9-13 yr	98	**36**	**52**	**11**
14-18 yr	117	**42**	**65**	**15**
Adults				
Man	235	**84**	**78**	**15**
Woman	127	**48**	**65**	**15**
Pregnancy				
14-18 yr	166	**60**	**71**	**16**
19-50 yr	176	**66**	**71**	**16**
Lactation				
14-18 yr	176	**66**	**84**	**18**
19-50	196	**72**	**84**	**18**

Percentage of EAR contained per 100g edible portion

	Iron	Zinc	Selenium	Vita B12
Boys and girls				
1-3 yr	204	556	385	1667
4-8 yr	169	476	313	1250
Boys				
9-13 yr	102	278	192	909
14-18 yr	47	127	128	667
Girls				
9-13 yr	102	278	192	909
14-18 yr	85	233	154	667
Adults				
Man	43	116	128	667
Woman	79	217	154	667
Pregnancy				
14-18 yr	60	164	141	625
19-50 yr	57	156	141	625
Lactation				
14-18 yr	57	156	119	556
19-50	51	139	119	556

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Blue mussel

Compositional Data (Raw) (data derived from USDA[9])	Iron mg/100g	3.95
	Zinc mg/100g	1.6
	Selenium mcg/100g	44.8

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Iron	Selenium	Vita B12
Boys and girls			
1-3 yr	63	**45**	**8**
4-8 yr	76	**56**	**10**
Boys			
9-13 yr	127	**89**	**15**
14-18 yr	278	**134**	**20**
Girls			
9-13 yr	127	**89**	**15**
14-18 yr	152	**112**	**20**
Adults			
Man	304	**134**	**20**
Woman	165	**112**	**20**
Pregnancy			
14-18 yr	215	**123**	**22**
19-50 yr	228	**123**	**22**
Lactation			
14-18 yr	228	**145**	**23**
19-50	253	**145**	**23**

Percentage of EAR contained per 100g edible portion

	Iron	Selenium	Vita B12
Boys and girls			
1-3 yr	159	222	1250
4-8 yr	132	179	1000
Boys			
9-13 yr	79	112	667
14-18 yr	36	75	500
Girls			
9-13 yr	79	112	667
14-18 yr	66	89	500
Adults			
Man	33	75	500
Woman	61	89	500
Pregnancy			
14-18 yr	47	81	455
19-50 yr	44	81	455
Lactation			
14-18 yr	44	69	435
19-50	40	69	435

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Surf clam

Compositional Data (data for Clam, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	13.98
	Zinc mg/100g	1.37
	Selenium mcg/100g	24.3

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Iron	Se	Vita B 12
Boys and girls			
1-3 yr	18	82	**2**
4-8 yr	21	103	**2**
Boys			
9-13 yr	36	165	**4**
14-18 yr	79	247	**5**
Girls			
9-13 yr	36	165	**4**
14-18 yr	43	206	**5**
Adults			
Man	86	247	**5**
Woman	46	206	**5**
Pregnancy			
14-18 yr	61	226	**5**
19-50 yr	64	226	**5**
Lactation			
14-18 yr	64	267	**6**
19-50	72	267	**6**

Percentage of EAR contained per 100g edible portion

	Iron	Selenium	Vita B12
Boys and girls			
1-3 yr	556	122	5000
4-8 yr	476	97	5000
Boys			
9-13 yr	278	61	2500
14-18 yr	127	40	2000
Girls			
9-13 yr	278	61	2500
14-18 yr	233	49	2000
Adults			
Man	116	40	2000
Woman	217	49	2000
Pregnancy			
14-18 yr	164	44	2000
19-50 yr	156	44	2000
Lactation			
14-18 yr	156	37	1667
19-50	139	37	1667

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Arrow Squid

Compositional Data (Data for squid, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	0.68
	Zinc mg/100g	1.53
	Selenium mcg/100g	44.8

Quantity of fish (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium	Vita B12
Boys and girls		
1-3 yr	**45**	**69**
4-8 yr	**56**	**92**
Boys		
9-13 yr	**89**	**138**
14-18 yr	**134**	**184**
Girls		
9-13 yr	**89**	**138**
14-18 yr	**112**	**184**
Adults		
Man	**134**	**184**
Woman	**112**	**184**
Pregnancy		
14-18 yr	**123**	**200**
19-50 yr	**123**	**200**
Lactation		
14-18 yr	**145**	**215**
19-50	**145**	**215**

Percentage of EAR contained per 100g edible portion

	Selenium	Vita B12
Boys and girls		
1-3 yr	222	145
4-8 yr	179	109
Boys		
9-13 yr	112	72
14-18 yr	75	54
Girls		
9-13 yr	112	72
14-18 yr	89	54
Adults		
Man	75	54
Woman	89	54
Pregnancy		
14-18 yr	81	50
19-50 yr	81	50
Lactation		
14-18 yr	69	47
19-50	69	47

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Commercial scallop

Compositional Data (scallop, mixed species, Raw) (data derived from USDA[9])	Iron mg/100g	0.29
	Zinc mg/100g	0.95
	Selenium mcg/100g	22.2

Quantity of seafood (in grams) necessary to achieve the Corresponding EAR in grams

	Selenium	Vita B12
Boys and girls		
1-3 yr	90	**59**
4-8 yr	113	**78**
Boys		
9-13 yr	180	**118**
14-18 yr	270	**157**
Girls		
9-13 yr	180	**118**
14-18 yr	225	**157**
Adults		
Man	270	**157**
Woman	225	**157**
Pregnancy		
14-18 yr	248	**170**
19-50 yr	248	**170**
Lactation		
14-18 yr	293	**183**
19-50	293	**183**

Percentage of EAR contained per 100g edible portion

	Selenium	Vita B12
Boys and girls		
1-3 yr	111	169
4-8 yr	88	128
Boys		
9-13 yr	56	85
14-18 yr	37	64
Girls		
9-13 yr	56	85
14-18 yr	44	64
Adults		
Man	37	64
Woman	44	64
Pregnancy		
14-18 yr	40	59
19-50 yr	40	59
Lactation		
14-18 yr	34	55
19-50	34	55

References: U.S. Department of Agriculture and Agricultural Research Service, USDA National Nutrient Database for Standard Reference, Release 20. 2007.
National Health and Medical Research Council, Nutrient Reference Values for Australia and New Zealand. 2006, Commonwealth of Australia: Canberra.

Appendix 6: Background media statement related to placing seafood in the context of the NRVs: *Plain Talk About NRVs and Seafood*

The resources in Appendices 6 and 7 comprise statements specifically related to this report, the first of which has been released previously and is available on the Seafood Services Australia website:

http://www.seafood.net.au/news/news.item.php?pid=238

Included in Appendix 7 is a position statement from the Heart Foundation, which forms the basis of national recommendations for the consumption of seafood by Australians. This statement is available at:

www.heartfoundation.org.au/Professional_Information/Lifestyle_Risk/

Media Statement: Plain Talk About NRVs and Seafood

Seafood suppliers can improve the health of the average Australian by encouraging greater consumption of seafood.

Australians should be eating seafood at least twice a week for optimum health -- and four times a week or more is even better.

That's the straightforward advice of nutrition expert Dr Shawn Somerset, following a study of how seafood fits into Australian Government recommendations for healthy eating.

Dr Somerset, Senior Lecturer in Human Nutrition at Griffith University, has been studying the role of seafood in meeting the latest guidelines on healthy eating from the Australian Government's National Health & Medical Research Council (NHMRC).

Dr Somerset said seafood is an excellent source of high-quality protein and other essential nutrients as well, including omega-3, iodine and selenium, plus Vitamin B12, zinc and copper.

Eating a wide variety of seafood on a regular basis -- ideally, at four of each week's average 21 meals -- makes a major contribution to meeting the Australian Government's recommended intake of several nutrients.

He said that a switch to eating more seafood was a practical, cost-effective way of significantly improving the health of the average Australian.

The health benefits of seafood are well established and internationally-recognised, particularly in relation to heart health," Dr Somerset said. "A switch to seafood and away from other less nutritionally valuable foods could significantly extend lifespan and quality of life for many Australians."

Dr Somerset has recommended eating a variety of fish and other seafood at least twice a week, and, ideally, four times a week or more.

He has also recommended portions of 200 to 250 grams rather than the standard portion of 150 grams.

"Eating fish or other seafood twice a week should be the minimum consumption level simply to avoid deficiencies in essential nutrients such as Omega-3 fat and iodine," Dr Somerset said.

"However, to achieve optimum nutrition, I would recommend at least four meals per week of 200 to 250-gram portions of fish or other seafood. This is achievable, considering there are 21 meal opportunities every week.

"Potentially, this would make an enormous improvement to the health of the Australian community, given that surveys indicate that presently only 25% of Australians eat seafood an average of even once a week."

Dr Somerset said seafood could make a very significant contribution to achieving the NHMRC recommendations for healthy eating.

“Seafood is a high-quality protein source and relatively low in fat. Its protein comes at the cost of fewer calories than most other meats, and so is beneficial in weight-reduction diets in particular, something very relevant now that obesity levels are causing such concern to health authorities in Australia.

“Also, seafood is a prime source of essential nutrients, particularly Omega-3 oils, iodine and selenium, and is also rich in zinc, calcium and Vitamin B12.

“Research suggests that many Australians, particularly children, are deficient in iodine, and, in the case of zinc, the NHMRC itself has described it as ‘borderline for adequacy in the community’. Seafood is an excellent source for both: all seafood in the case of iodine and Oysters in particular for zinc.”

Dr Somerset said that, in 2006, the NHMRC introduced new Nutrient Reference Values (NRVs), a set of recommendations for population intakes of nutrients based on the best scientific information available.

“These were an extension of the 1991 Recommended Dietary Intakes but involved key changes. These changes included addition of an expanded set of nutrient intake reference categories and an increase in the range of nutrients for which reference values were provided.

“For the first time, the NHMRC has formally recommended specific intakes of the essential Omega-3 fatty acids (oils), which make up the largest component in fish oil. The levels required to avoid deficiencies in Omega-3s can be achieved by eating two or three meals of 200 to 250 grams each of most types of seafood each week.

“This will also supply much of the average weekly requirements for other nutrients, such as selenium, iodine, zinc, copper and Vitamin B12.”

However, Dr Somerset said eating seafood more frequently would confer further benefits.

“The NHMRC went further than simply recommending the minimum average daily amounts of nutrients like Omega-3 fatty acids by also making recommendations on nutrient intakes to reduce chronic disease risk.

“Here, the NHMRC’s typical recommendation was to replace what it called ‘nutrient-poor, energy-dense foods and drinks’ -- in other words, foods low in nutrients but high in calories -- with vegetables, fruit, wholegrain cereals and lean protein like seafood.

“To optimise the disease-fighting benefits of Omega-3 oils, the NHMRC recommended average daily intakes of 610mg for men and 430mg for women, which are three to four times the minimum daily intakes recommended.

“That may seem like a lot to Australians at present but it is only half the average Omega-3 intake of the Japanese, and their high seafood consumption and consequent Omega-3 levels is attributed as the major reason for their comparatively low levels of heart problems.

“Here, it means eating varieties of fish with higher-than-average oil content -- fish like Swordfish, the Mackerels, Australian Sardines, Australian Herrings, Mullet, Tailor and Atlantic salmon -- and probably eating seafood four times or more a week. It can be included for lunch, even breakfast, as well as making up the centerpiece of evening meals.

“Consumers may find it helpful to talk to a specialist seafood retailer and to consult the publication *Seafood the Good Food*, published by CSIRO, which lists the oil content of seafood varieties sold in Australia.

“One simple thing to do, and this deserves to be emphasised, is to eat a wide variety of seafood and to eat it often.”

Dr Somerset has been studying how Australian fish and other seafood fit into the context of the new NRVs. Specifically, he has prepared calculations for a range of popular fish and other seafood that estimate the amounts of each required to meet the nutrient reference values (NRVs) for a range of nutrients.

It is intended as a guide upon which evidence-based communication about the health benefits of fish and other seafood can be derived. It is not intended to be a promotional vehicle in itself.

“This analysis confirms that the NRVs for long-chain Omega-3 oils can be met by the consumption of many forms of seafood. Further, many

seafood species can also be considered as rich sources of selenium, for example, and the NRVs for zinc and copper can be met by regular consumption of shellfish, like Oysters, Crabs, etcetera.

“However, there are still many gaps in our knowledge of the composition of seafood and this should be taken into account when referring to individual seafood species in relation to NRVs.”

Dr Somerset said his study had provided a number of conclusions:

- fish and other seafood are clearly a viable source of dietary long chain Omega-3 oils;
- Australian consumers can meet the NRVs for long chain Omega-3 oils entirely from the consumption of certain species of fish and other seafood without the necessity of consuming either Omega-3 supplements or foods artificially fortified with Omega-3 oils;
- feasible levels of consumption of fish and other seafood can meet the NRVs for certain other nutrients, such as selenium, zinc, copper, iodine and Vitamin B12;

- there are substantial gaps in species-specific information on the composition of fish and
- other seafood, especially in critical nutrients such as zinc, selenium, iodine and copper; and fish and other seafood are a major source of protein in the Australian diet.

Dr Somerset has recommended that the seafood industry:

- advocate the inclusion of identification of specific fish species in the next Australian National Nutrition Survey (which is currently under development by the Federal Government);
- develop species-specific compositional information on fish and other seafood, especially for key nutrients such as zinc, selenium, iodine and copper;
- consider a focus on fish and other seafood as an important Iodine source in view of decreased consumption of iodised salt and progressively decreasing iodine content in dairy foods; and
- recommend consumers eat a wide variety of fish and other seafood species.

FURTHER INFORMATION: Dr Shawn Somerset 0407 642 872

Notes

- Dr Shawn Somerset is a Senior Lecturer in Human Nutrition within the Nutrition Unit, School of Health Sciences, Griffith University. He is a qualified dietitian, with a PhD from the University of Queensland and a Postgraduate Diploma in Nutrition & Dietetics from the University of Sydney. Previously, he has worked in the Queensland Departments of Health and Primary Industries & Fisheries, and has worked as a consultant to food industry in Australia and France. His major interests are food system analysis, nutrition-industry inter-sectoral collaboration and liaison, and coronary heart disease prevention.
- The Australian Government's National Health & Medical Research Council (NHMRC) is Australia's peak body for supporting health and medical research; for developing health advice for the Australian community, health professionals and governments; and for providing advice on ethical behaviour in health care and in the conduct of health and medical research.
- *Seafood the Good Food* outlines the oil content and composition of 189 Australian seafood species. Each species page lists the common name, scientific name and an image. There is a summary box of oils, oil class and fatty acids, as well as fatty acid nomenclature and portion. A second publication, *Seafood the Good Food II*, expands on the first volume by examining factors that may influence the good oils that are present in seafood including how seafood is produced and how it is prepared for consumption. It also outlines the oil content and composition of an additional 79 seafood species not covered in Volume I. Both books are available on the website of Seafood Services Australia: http://www.seafood.net.au

Appendix 7: Background statement related to placing seafood in the context of the NRVs: *Heart Foundation recommends two to three fish meals every week*

The Heart Foundation has recommended Australians eat seafood two to three times a week for cardiovascular health.

Although this recommendation is not related to the Australian Government recommendations regarding Nutrient Reference Values, it further strengthens the case for seafood consumption at a considerably higher level than the current average consumption of seafood here.

Furthermore, the Heart Foundation has said all Australian governments should encourage greater consumption of fish and also should encourage doctors to promote fish consumption amongst patients at risk of coronary heart disease.

The Heart Foundation recommendations can be read in conjunction with the NHMRC NRV recommendations to provide seafood consumers with a more detailed suite of information on the health benefits of seafood, and so encourage increased consumption of seafood.

The Heart Foundation has released an official position statement entitled *Fish, fish oils, Omega-3 polyunsaturated fatty acids and cardiovascular health*.

The Heart Foundation says the position statement was developed to provide recommendations to the general population and health professionals.

In addition, the statement provides cautions on the consumption of fish with high and medium methylmercury content.

The statement said one of the Heart Foundation's duties was to advocate for change within the food industry and from governments.

Recommendations

The Heart Foundation makes the following recommendations with respect to fish, fish oils and Omega-3 polyunsaturated fatty acids (N-3 PUFA) to improve the cardiovascular health of all Australians.

Fish that live in cold water are rich in N-3 PUFA — particularly docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA) and docosapentaenoic acid (DPA). Alpha-linolenic acid (ALA) is a plant-based N-3 PUFA that has many health benefits but does not benefit cardiovascular health as well as marine N-3 PUFA.

The Heart Foundation says that pregnant or breastfeeding women, women planning pregnancy, and children should:

1. Follow the recommendations for the adult Australian population.

2. Not exceed recommended doses of fish and fish oil supplements.
3. Follow the advice from Food Standards Australia & New Zealand on mercury in fish.

To lower their risk of coronary heart disease (CHD), all Australians should:

1. Consume about 500 mg per day of combined DHA and EPA through a combination of the following:

- two or three serves (150g serve) of oily fish per week
- fish oil capsules or liquid
- food and drinks enriched with marine N-3 PUFA.

2. Consume at least 2g per day of ALA.

3. Follow government advice on fish consumption regarding local safety issues.

4. Discuss healthy eating and concerns about nutrition with an Accredited Practising Dietitian or a doctor.

Health professionals should advise adult Australians with documented coronary heart disease (CHD) to:

1. Consume about 1,000 mg per day of combined DHA and EPA through a combination of the following:

- two or three serves (150g serve) of oily fish per week
- fish oil capsules or liquid
- food and drinks enriched with marine N-3 PUFA.

2. Consume at least 2g per day of ALA.

3. Follow government advice on fish consumption regarding local safety issues.

4. Discuss healthy eating and concerns about nutrition with an Accredited Practising Dietitian or a doctor.

Health professionals should advise adult Australians with elevated triglycerides (TG) to take fish oil capsules or liquid and marine N-3 PUFA enriched foods and drink as first-line therapy by:

• starting with a dose of 1,200 mg per day of DHA and EPA, and, if appropriate,
• increasing the dose to 4,000 mg per day of DHA and EPA and checking their patient's response every 3 to 4 weeks when the dose is changed, until target TG levels are reached.

Rationale

The Heart Foundation says the consumption of fish, fish oils and N-3 PUFA is associated with a reduced risk of cardiovascular disease (CVD). However, since the Heart Foundation's report *Review of the relationship between dietary fat and cardiovascular disease* was published in 1999, new findings have been published in Australia and internationally regarding the benefits of, and cautions about, consuming N-3 PUFA.

The World Health Organisation recommends an intake of one to two servings of fish (where each serving is deemed as providing 200 to 500 mg/week DHA and EPA) as protective against CHD and stroke.

In 2006, the National Health & Medical Research Council (NHMRC) issued *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes,* which recommended an intake of combined DHA, EPA and DPA of 610 mg/day for men and 430 mg/day for women to prevent chronic disease.

To consolidate the extensive literature on fish, fish oils and N-3 PUFA, and to explore the international recommendations regarding their cardiovascular health benefits, a literature review was conducted on behalf of the Heart Foundation by Associate Professor David Colquhoun* and Antonio Ferreira-Jardim**.

The Heart Foundation encourages governments to:

1. Recommend that Australians consume fish and fish oils.
2. Commit to collecting data on the Australian population's dietary intake (including of N-3 PUFA) through a regular national nutrition survey.
3. Include fish oil capsules and liquid in the Pharmaceutical Benefits Scheme to help health professionals to prescribe them to people who have CHD.
4. Support professional development for doctors that includes advice on fish and fish oil consumption for those with, and at risk of, CHD.
5. Support sustainable fishing practices and healthy, sustainable marine ecosystems.
6. Monitor levels of methylmercury and dioxins in Australian fish.

To encourage the consumption of fish and fish oils by the Australian population, the food industry should:

1. Develop a variety of foods that are enriched with N-3 PUFA.
2. Promote fish and seafood that come from sustainable sources.
3. Retain marine oils where possible during the processing of fish and seafood.

The review aimed to:

• determine the extent of the association between the consumption of fish, fish oils and N-3 PUFA and the reduction in CHD mortality
• determine the extent of the association between the consumption of fish, fish oils and N-3 PUFA and serum TG levels
• derive population-based recommendations for the consumption of fish, fish oils and N-3 PUFA to lower the risk of CHD and in the secondary prevention of CHD
• identify possible toxic risks associated with fish and fish oil consumption.

The findings and the levels of evidence of the scientific literature discussed in the Heart Foundation's review of evidence *Fish, fish oils, N-3 polyunsaturated fatty acids and cardiovascular health* are summarised below.

Summary of evidence

- Individuals with a higher intake of fish have a lower risk of CHD mortality, total CHD and total stroke.
- Consuming fish at least once a week is associated with a lower risk of total stroke and CHD mortality in the general population and in post-myocardial infarction (heart attack) patients.
- In secondary prevention, a diet with 2 g/day of ALA decreases the risk of CHD.
- In secondary prevention, 850 mg/day of marine N-3 PUFA supplementation reduces the risk of CHD mortality and 1,800 mg/day reduces major coronary events.
- In secondary prevention, there is conflicting evidence about the effects of marine N-3 PUFA supplementation on the risk of sudden death in patients.
- Marine N-3 PUFA supplementation of 1,000 to 4,000 mg/day decreases serum (triglyceride) TG levels by 25 to 30% and increases high-density lipoprotein (HDL) cholesterol levels by 1 to 3%. A dose
- relationship exists between intake of marine N-3 PUFA and decreased serum TG levels.
- Marine N-3 PUFA has an additive effect to statin*** therapy in decreasing serum TG levels and increasing HDL cholesterol.
- Consuming fish with high levels of methylmercury may result in long-term neurological damage. Gestational exposure to methylmercury may result in neurodevelopmental deficits.
- The consumption of oily fish twice a week promotes cardiovascular health without excessive exposure to mercury.
- There is inconclusive evidence to support a relationship between mercury exposure and the incidence of CVD.
- Fish oil capsules available in Australia have zero or near zero methylmercury content. Fish oil capsules in Australia contain very low levels of dioxins (polychlorinated biphenyl (PCB)).

Australian recommendations

The average N-3 PUFA intake of Australians has been estimated at 246 mg/day comprising 75, 71 and 100 mg/day from EPA, DPA and DHA respectively.
Seafood is by far the richest source of N-3 PUFA in the diet.
The NHMRC has recently published Nutrient Reference Values, which include recommendations for intake of ALA, DHA, EPA and DPA for the first time.
Adequate intake values were set as follows:

- ALA: 1.3 g/day for men and 0.8 g/day for women
- DHA+EPA+DPA: 160 mg/day for men and 90 mg/day for women.

An upper limit for children, adolescents and adults was set at 3,000 mg/day for DHA, EPA and DPA. No upper limit was set for ALA because there is no known level at which adverse effects occur.
To prevent chronic disease, dietary intakes for DHA, EPA and DPA have been set at what is known as the current 90th centile in the population, values that are known to be safe and to provide potential benefit.
The suggested dietary target to reduce chronic disease is 610 mg/day for men and 430 mg/day for women.

Mechanisms for action

Fish and fish oils are thought to decrease the risk of CHD through several possible mechanisms, including:

- altering the lipid composition of cell membranes
- decreasing blood levels of TG
- increasing the level of HDL
- improving heart rate variability and lowering heart rate
- increasing the threshold for ventricular fibrillation
- anti-platelet effects that decrease the risk of thrombosis
- improving endothelial function
- decreasing some inflammatory responses
- lowering blood pressure
- decreasing plasma leptin levels.

Fatty acids, particularly marine N-3 PUFA, are incorporated into cell membranes, and increasing the amount of PUFA in the membrane increases its fluidity and deformability.

There is a dose-response relationship between intake of marine N-3 PUFA and reduction in blood TG level. The higher the baseline TG level, the greater the response. In individuals with extremely high TG levels, N-3 PUFA supplementation may lower TG level by 50%.
Intake of marine N-3 PUFA is positively correlated with HDL levels. Animal and in vitro studies show that intake of marine N-3 PUFA increases the number of receptors for, and turnover of, HDL.

Marine N-3 PUFA significantly decreases chylomicron levels and size, which improves their clearance.

Supplementation does not appear to alter the levels of total cholesterol or low-density lipoprotein (LDL) if the TG level is not high.

Marine N-3 PUFA modulates the activities of several enzymes involved in carbohydrate and lipid metabolism. These changes lead to decreased TG synthesis and increased mitochondrial beta-oxidation, with a subsequent decrease in the formation of very LDL cholesterol.

Marine N-3 PUFA have an additive effect when combined with lipid-lowering medication such as statins. Combined treatment decreases TG level, increases HDL level, and redistributes LDL particle size to a less dense (less atherogenic) form beyond the response to statin only.

Marine N-3 PUFA supplementation inhibits nuclear transcription factor kB, a key transcription factor in cytokine gene expression, cellular adhesion and inflammation. Supplementation decreases cytokine and nitric oxide production by macrophages, and release of inflammatory markers and cytokines in response to mitogenic and inflammatory stimuli.

Elevated plasma leptin level is independently associated with CVD risk. Marine N-3 PUFA supplementation inhibits leptin gene expression in an animal model, and a diet rich in fish and marine N-3 PUFA is associated with low plasma leptin level independent of body fat content. Marine N-3 PUFA has a mild anti-platelet effect but does not affect bleeding time.

Future research

The Heart Foundation recommends further research in the following areas:

- Large, high quality randomised controlled trials that measure the cardiovascular outcomes in individuals given dietary advice to increase their consumption of marine N-3 PUFA. These trials need long-term follow-up.
- Exploration of the Omega-3 Index (the percentage of EPA and DHA in red blood cells), which is considered an emerging risk factor.
- Human trials to quantify the effect of high-dose marine N-3 PUFA on heart rate variability.
- High-quality randomised controlled trials that measure the benefits of ALA on cardiovascular health. It is not clear whether ALA prevents recurrent coronary events although there are trends suggesting that this may be the case.

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** University of Queensland, Core Research Group, Brisbane, Australia.
*** Statins are drugs prescribed to reduce cholesterol.

Note: For a full copy of the Heart Foundation position statement, go to the Heart Foundation website at

www.heartfoundation.org.au/Professional_Information/Lifestyle_Risk/ or telephone for heart health information on 1300 36 27 87.

To encourage greater consumption of seafood, the Heart Foundation website also has questions & answers about fish and fish oil, fish recipe sheets, fish eating plans, and a table of recommended fish and seafood and their Omega-3 content.

Further reading:

1. National Heart Foundation of Australia: Review of evidence: *Fish, fish oils, N-3 polyunsaturated fatty acids and cardiovascular health: a review of the evidence*, NHFA, 2008.

2. Colquhoun D, Ferreira-Jardim A, Udell T and Eden B: “Fish, fish oils, N-3 polyunsaturated fatty acids and cardiovascular health”. *Heart, lung and circulation*. (2008.).

Also see:
http://www.heartfoundation.org.au/Professional_Information/Lifestyle_Risk/Nutrition/Pages/default.aspx

Appendix 8: List of abbreviations

AI	Acceptable intake(related to NRVs)
ALA	Alpha-linolenic acid
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DHA	Docosahexaenoic Acid
EAR	Estimated Average Requirement (related to NRVs)
EPA	Eicosapentaenoic Acid
LC n-3 oils	Long chain omega-3 oils
NHMRC	National Health and Medical Research Council
NRV	Nutrient Reference Value
NUTTAB	Australian Food Composition Database
PUFA	Polyunsaturated Fatty Acid
RDI	Recommended Dietary Intake(related to NRVs)
SDT	Suggested Dietary Target (related to NRVs)
UL	Upper limit (related to NRVs)
USDA	United States Department of Agriculture