Section 1

Introduction to the Community Intervention to Increase Seafood Consumption (CIISC) project
1.0 Background

It is estimated that nine in 10 Australians have at least one risk factor for cardiovascular disease (CVD), 3.5 million have a form of cancer, up to two million are living with diabetes and over 60% are considered overweight or obese. Together these conditions account for the majority of the burden of disease in Australia with the highest prevalence being in lower socioeconomic areas (up to 2.3 times higher than that of high income areas) and in indigenous populations. Research has shown that a healthy diet, that includes regular seafood consumption, is one of the major protective factors against these conditions. There is also a growing body of evidence showing that specific types of seafood have a positive effect on conditions such as dementia, allergies, overweight and obesity, asthma, depression and bipolar disorders.1-5

Establishing regular fish consumption as a healthy, cost effective option for families has the potential to impact upon their short and long-term health. It may also act to prevent the development of common lifestyle conditions (such as diabetes or coronary heart disease) by establishing seafood consumption habits in the early years of life. There is some published research in this area, and most particularly from an Australian perspective, various Retail Sale and Consumption of Seafood reports funded by the Fisheries Research Development Corporation (FRDC). However there had been little work completed on the development, implementation and evaluation of coordinated and specific educational and training resources across a number of sectors (e.g. school curriculum from primary through to vocational sectors, point of sale resources for consumers, condition-specific resources and information for health professionals) to encourage regular seafood consumption.

1.1 Consultation process

An extensive consultation process was conducted throughout the research project. A number of key stakeholders and experts that could potentially add value to the project were recruited at the onset of the project. As required, members were asked to comment on aspects of the project relevant to their areas of expertise and/or experience. Key collaborators on the project were: the Western Australian Fishing Industry Council (WAFIC); Naturalist Marine Discovery Research Centre, Department of Fisheries; Flinders University; University of South Australia; University of the Sunshine Coast; Heart Foundation; Cancer Council; Diabetes Australia; Arthritis Australia; Omega 3 Centre; Western Australian Health Department; Technical and Further Education (TAFE) institutions; Seafood Services Australia (SSA), Seafood Experience Australia (SEA), the WA General Practitioner (WAGP) Network; City of Mandurah; people across all sectors of the seafood industry and those with expertise relevant to the development of education resources. These extensive collaborative links added considerable value to the research outcomes and were fundamental to the success of such a comprehensive project.

1.2 Needs assessment

There was a need to overcome the barriers to seafood consumption, particularly those cited in the general seafood consumption6 and the peri-natal seafood consumption studies conducted in Perth, Western Australia.7 Establishing regular seafood consumption as a healthy, cost effective dietary option has the potential to impact upon short and long-term health, both in the general population and in those with specific health conditions.

1.3 Aim

This study aimed to develop strategies to increase seafood consumption by targeting specific sectors of the population (e.g. school-aged children, families, women of childbearing age), trainees within the seafood industry, and groups with specific health conditions (e.g. those that evidence shows respond to nutrition therapies). The outcome measure of success of the project was an increase in seafood consumption with concomitant increases in value for the seafood industry.
1.4 Level of Impact

The condition/sector educational resources were developed in user-friendly formats/programs to meet the needs of specific target groups and to ensure maximum uptake. For example, health condition specific resources are in formats that facilitate discussion between general practitioners and clients to promote consumption of seafood as part of a healthy diet. Resources for schools were developed in line with existing curriculum frameworks across a range of disciplines and piloted through existing and relevant educational programs.

1.5 Project objectives

The objectives of the project were:

- To conduct a systematic review and gap analysis to:
  a. inform the development of industry guidelines around health messages and seafood, and
  b. identify research gaps and priorities in seafood health benefits research;
- To develop, implement and evaluate a series of targeted seafood health benefits communication resources for educational institutions, health professionals and their clients, seafood consumers and members of the seafood industry;
- To develop and evaluate a seafood health benefits skills set for incorporation into relevant vocational training packages administered through TAFE institutions; and
- To trial and evaluate the seafood health benefits communication resources developed in a single community to determine whether seafood consumption in that community is significantly altered through access to the developed resources.

The project followed a participatory action research model with each stage of the research informing the previous stages, thus ensuring the outcomes were relevant to the end users.

1.6 Stages of the Community Intervention to Increase Seafood Consumption (CIISC) Project

The CIISC project included a number of stages that culminated in the community intervention:

- Review of published literature relating to seafood consumption and human health, plus identification of organisations, institutions and spokespersons that currently provide information on seafood and health including their level of credibility (Section 2);
- Development of industry guidelines for seafood health and nutrition messages to summarise the regulations and guidelines to consider when using health and nutrition to promote seafood on food labels and in advertising material (Section 3);
- Critical review of relevant resources available to General Practitioners and Allied Health Professionals relating to seafood and nutrition (Section 4);
- Development of ‘Seafood and your Health’ booklets for specific health conditions that can be used by health professionals to assist clients within a 5 - 10 minute consultation (Section 4);
- Supermarket and media audit of health messages relating to seafood (Section 5);
- Development of point of sale seafood and health messages (Section 5);
- Development of educational resources for primary, secondary and vocational institutions (Section 6);
- Implementation and analysis of a cross-sectional community-based survey on seafood purchasing and consumption behaviours (Section 7);
- Discussion of communication strategies to promote the community intervention (Section 8);
- Evaluation of the CIISC community intervention (Section 9); and
- Formulation of recommendations based on the outcomes of the CIISC project (Section 10).
Section 2

Literature review
2.0 Introduction

The first stage of this project consisted of a review of the most up-to-date evidence around the health benefits of regular seafood consumption. The results of the review formed the basis of the CIISC intervention.

2.1 Objectives of the review of evidence

The review of published literature pertaining to seafood consumption and human health had the following objectives:

1. Review the latest evidence of health benefits associated with seafood consumption by condition;
2. Identify the work that has been done on how communication of health benefits can and does change consumer behaviour, particularly those in the target groups (young people, older people, pregnant women and health condition specific sectors);
3. Identify the barriers to and drivers for the use of seafood benefits information;
4. Identify current communication material used to disseminate health benefits information to target groups, and consider the strengths and weaknesses of these; and
5. Identify the appropriate delivery frameworks for health benefits information and detail any specific requirements for these.

In addition to the review of published literature, an organisational review was conducted to complete the investigation and identify opportunities for collaboration and co-funding. The objectives of this second phase of the review were to:

1. Identify which organisations, institutions and spokespeople are currently providing information on seafood health benefits and the level of credibility of those organisations and institutions;
2. Undertake an initial assessment of organisations, institutions and spokespeople capacities and relevance to the seafood industry; and
3. Assess the availability of trained people to develop resources and to deliver health benefits information to the target audiences.

Results of the review of published literature are presented in Section 2.3 and the organisational review in Section 2.4.

2.2 Methodology

A comprehensive search was conducted utilising the following databases: Archive of Life Sciences; Proquest; PubMed; Science Direct; Taylor and Francis; The Cochrane Collaboration; Web of Knowledge; Web of Science; and Wiley Interscience.

Other sources of information were: national and international seafood-based databases; seafood industry websites or databases; major national and international academic libraries; electronic sources of information (e.g. Google, Google Scholar, international websites); Departments of Health within Australia; and educational institutions.

2.3 Literature review results

Key findings from published studies are presented in summary form by health condition.

2.3.1 Alzheimer's Disease

*What we know:*

- Research has revealed that a diet high in fish, nuts, salad dressings, poultry, tomatoes, fruit, cruciferous and dark green leafy vegetables is strongly associated with a lower risk of Alzheimer's Disease (AD).¹
- Reduced risk of dementia is thought to be associated with consumption of the marine sourced omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).⁸
Post-mortem examinations have revealed that the brains of persons with AD contain less DHA in the grey matter of the frontal lobe and hippocampus.9

Large population based studies consistently reveal that omega-3 fatty acids retard cognitive decline over time.10

Dietary omega-3 fatty acids are shown to be beneficial in correcting high levels of omega-6 fatty acids in the brains of normal subjects thereby reducing the potential of damage to the brain.8

Promotion of the evidence in order to induce an increase in consumption of sustainable seafood within a healthy diet has the potential to significantly reduce the human and public health burden of AD for the future.11

What we need to know:

The influence of nutrients, foods and dietary behaviors on cognitive decline should be explored to identify preventative strategies that can be implemented to delay onset or slow decline.

2.3.2 Asthma and allergies

What we know:

Recent research suggests that eating fish and seafood during pregnancy may protect some children from asthma.12, 13

Fish consumption in the first year of life is associated with a reduced risk of asthma and allergic rhinitis in childhood.2

Epidemiological studies of Australian school children reveal that children who eat fish more than once a week have one third the risk of airway hyper-responsiveness compared with children who do not eat fish regularly.14, 15

Regular consumption of fresh, oily fish is associated with a reduced risk of asthma and airway diseases.13, 16

Fish sticks consumption during pregnancy significantly increased asthma risk in children (odds ratio 2.04). This negative outcome is thought to be associated with the trans fat content of the processed fish sticks.12

What we need to know:

Future research is needed to investigate the protective mechanisms associated with eating fish and seafood during pregnancy.

The protective link between common childhood allergies and seafood consumption (both maternal and child) should be investigated further.

Further evidence is needed to support the association between eating fish and seafood and reduced prevalence and severity of asthma among asthma sufferers.

Investigation of the physiological function of the major nutrients found in various types of seafood and identification of those that impact on the risk of asthma is warranted.17, 18

The relationship between the increased risk of asthma and trans fats should be investigated further. Clear delineations need to be made between those seafood products that have positive benefits and any that do not.

2.3.3 Cognitive development (including behavioural issues and ADHD)

What we know:

DHA and EPA are essential to foetal and neonatal brain development and maturation. Fatty acids accumulate expressly during periods of rapid brain growth and development occurring between gestation and the first year of life. Foetal accretion of omega-3s is notably high during the last trimester of pregnancy.19, 20

Thirteen per cent of school-aged children in Australia have been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). Significant co-morbidities include mood and impulsivity disorders, oppositional defiant disorder, obsessive compulsive disorder and depression. 60% of symptoms or difficulties remain throughout life.21, 22

There is limited evidence for seafood, fish oil or supplements in the management of attention disorders such as ADHD. However the evidence that is available is promising.23-27 A diet high in omega-3s, for instance, has shown marked improvement in behaviours in children with ADHD.21, 22

The onset of 75% of all mental disorders occurs prior to 25 years of age. Fourteen per cent of adolescents in Australia are living with a mental health disorder.28 Adolescents may have the additional compounding concerns of: poor diet (high in meats, sugars, fats, and salt); adverse socioeconomic conditions; increased screen time; risky health behaviours; alcohol misuse; smoking and risky sexual behaviours.29
Strongest evidence relating to the benefits of a diet high in omega-3s is associated with depression, behavioural problems, mood and impulsivity disorders. Research has shown that low levels of red blood cell DHA have a positive correlation with clinical depression scores in children with juvenile bipolar depression.

Emerging evidence strongly shows that adequate levels of omega-3s in early development and into adulthood may prevent aggression and hostility.

**What we need to know:**

- Treatment and/or prevention of attention disorders (including ADHD) in children and adults with omega-3s either through fish consumption and/or supplements warrants further attention.
- Nutritional trials with children who have behavioural issues should include a high intake of marine sourced omega-3s.

### 2.3.4 Cardiovascular disease

**What we know:**

- Fish intake is beneficial to heart health. One serve of fish per week reduces the risk of coronary heart disease (CHD) and stroke. Two or more serves of fish each week provide increased protection against all cardiovascular diseases (CVD).
- The benefits of eating fish depend on the type of fish meal prepared. Broiled or baked fish are better than fried fish; fried fish is not associated with a lower risk of ischemic heart disease. Differentiation of fish meal types is noted by some researchers. Consumption of non-fried fish containing omega-3s, for instance, is associated with a lower odds ratio of atherosclerosis.
- Regular consumption of omega-3s may decrease cholesterol levels.
- Consumption of fish is associated with beneficial structural changes in veins and arteries.
- Regular consumption of fish and omega-3s found in fish and seafood can lower blood pressure levels.
- Consumption of omega-3s is associated with a reduced risk of CVD, cardiac events (heart attack) and mortality. For people with pre-existing coronary disease, increasing fish consumption or fish oil supplementation is associated with reduced coronary mortality.
- Fish consumption is associated with a reduced risk of death from stroke and all-cause ischemic heart disease (blockage of the arteries) in both men and women. Even consumption of fish as little as one to three times per month may reduce the risk of ischemic stroke.
- Fish and/or omega-3s consumption is associated with lower inflammatory markers indicating lower risk of CHD. These benefits are particularly pronounced when consumed in the form of fish rather than in supplement form (0.6g of omega-3 per day).
- Fish and seafood are preferred sources of the marine sourced omega-3s, DHA and EPA, as the body processes them more efficiently (compared with supplements and planty-based omega-3s).
- Although evidence clearly shows that fish intake provides greater benefits than supplements such as fish oil, supplements may be beneficial to those who cannot or do not eat seafood.
- Fish oil supplements and EPA/DHA enriched concentrates need to ensure accurate content claims, oxidative stability, negligible levels of environmental contaminants, the appropriate accompanying presence of physiological anti-oxidants, plus other factors.
- Despite knowledge of the benefits of fish oil and favourable attitudes toward nutritional therapy, family physicians infrequently recommend fish oils to CVD patients.

**What we need to know:**

- Regular fish intake is protective against all CVD and is also beneficial to those with pre-existing CVD. Guidelines that outline what a healthy diet, protective against CVD at a population level looks like are urgently required.
- Population-based dietary guidelines for those who are at higher risk of developing CVD and other lifestyle conditions such as diabetes, hypertension and arthritis are also required.
- Evidence is mounting regarding problems associated with the composition and variability of over-the-counter omega-3 supplements. Further research is needed to assess the health impact of commonly available supplements in relation to: accuracy of health claims; variability of fillers used; possible contaminants; stability over time; properties of common components; shelf life and interactions with various medications and herbal preparations.
2.3.5 Cancer

What we know:

- High fish intake has been associated with significantly reduced risk of ovarian and colorectal cancer.54, 55
- High level evidence supports fish consumption as protective in reducing the risk of prostate and lung cancers in males.56-60
- Epidemiological studies assessing the benefits of fish and seafood consumption associated with the risk of lung, prostate, breast, colorectal, ovarian, pancreatic, skin (basal cell carcinoma), stomach and esophageal cancer, and non-Hodgkin lymphoma show promising results.23, 58, 61-65

What we need to know:

- More evidence is needed to link the health benefits of fish and marine omega-3s to particular types of cancer.58
- More research is needed around the mechanisms by which fish consumption appears to protect against lung cancer.60
- Animal experiments have shown marine sourced omega-3s (EPA and DHA) slow the growth rate of breast and prostate cancer cells in vitro. However, the impact of a high intake of EPA and/or DHA on the risk of these cancers or other hormone-dependent cancers in humans is unclear and needs further investigation.58
- Guidelines for diets protective against various types of cancer are required.

2.3.6 Cystic fibrosis

What we know:

- Regular intake of omega-3s may provide some benefits for people with cystic fibrosis with relatively few adverse effects.66

What we need to know:

- More research is needed to determine whether or not there is a significant therapeutic effect of omega-3s to further assess the influence of disease severity, dosage and duration of treatment.
- Results are required to support treatment decisions for people with or affected by cystic fibrosis.

2.3.7 Diabetes

What we know:

- Regular fish consumption should be considered as part of a healthy diet for diabetic management.67, 68
- Physical activity, a Body Mass Index (BMI) lower than 25, and a Mediterranean diet characterised by high levels of fruit, vegetables, carbohydrates that are low Glycaemic Index (GI) or high fibre, and 30-35% total fat (high in monounsaturated fatty acids and omega-3s and low in saturated fat) appear to be preventative for type 2 diabetes.69, 70
- Regular fish consumption is strongly associated with positive management of triglyceride levels in individuals with diabetes and helps the kidneys to function more efficiently in patients with type 1 diabetes.67
- A higher intake of oily fish also has a positive effect on triglyceride levels in type 2 diabetes, although researchers note an accompanying slight but significant increase in low-density lipoprotein (LDL) cholesterol.71
- A significant reduction in type 2 diabetes has been associated with high fish and seafood consumption. A lower risk of albuminuria, an indicator of damage to the kidneys, has been identified with higher levels of fish consumption.72
- In healthy subjects, moderate levels of fish oil supplementation do not modulate insulin sensitivity or secretion. Fish oil has been found to impair glucose tolerance in individuals with high phospholipid omega-6:omega-3 ratios. Fish oil supplementation for these individuals should either be avoided or accompanied by decreased omega-6 dietary intake.73

What we need to know:

- Mixed results of previous research raise the need for further investigations on the link between fish consumption, omega-3 intake and risk of diabetes.74 The background diet of subjects needs to be closely considered.
- Evidence is needed on the levels of regular fish (seafood) consumption that provides the best protection against developing or managing the various forms of diabetes, across the lifespan.
- Further evidence around the positive impact of regular fish consumption on the management of diabetes is needed.
### 2.3.8 Gender-specific conditions

#### 2.3.8.1 Men

- CHD is the most common underlying cause of death for Australian men, accounting for 18.5% of male deaths.\(^7\)
- An inverse relationship exists between fish consumption and death from CHD in men. Men who consume 35g or more of fish daily are identified as having a relative risk of death from CHD and myocardial infarction of 0.62 and 0.56 respectively.\(^6\)
- Fish consumption in men is also strongly linked to the risk of incident cardiac heart failure (CHF). Consumption of broiled or baked fish one or two times a week is associated with greatly reduced risk factors: 20% lower risk of CHF, 36% of coronary death and 17% in total mortality.\(^1\)
- There is some research indicating omega-3s may have a role in the conversion of androgen precursors in males to active metabolites, thus producing a protective effect against prostate cancer.\(^7\)
- Strong evidence exists for a reduced risk of prostate cancer and lower lung cancer mortality in men who consume a high seafood diet (independent of cigarettes, animal fat minus fish fat, and vegetable and fruit consumption).\(^7\)
- Increased consumption of seafood has been shown to confer protection against the development of esophageal cancer in males aged 45 years and older in large population-based studies.\(^7\)\(^8\)
- Dietary intake of omega-3s is a factor in the production and function of normal spermatozoa.\(^8\) Positive associations have been identified between high DHA concentrations in ejaculate and spermatozoa motility.\(^8\)\(^2\)\(^3\)
- Men are less likely to consume seafood as a main protein source.\(^8\) The influence of males on eating habits within the family unit should be considered in any intervention to increase regular seafood consumption.\(^8\)
- In Australia, around 70% of men aged 35-44 years are overweight or obese.\(^8\) Several studies have identified that overweight men tend to underestimate their weight and are less likely to attempt weight loss.\(^8\)\(^5\)
- Fish and seafood form a valuable part of a healthy diet and present a low fat, high quality protein source also contributing omega-3s, iodine and selenium. Weight reduction among overweight younger men has been associated with the inclusion of fish as part of an energy-restricted diet.\(^5\)

#### 2.3.8.2 Women

- Cross-national studies support recommendations that women of childbearing age should ingest at least 200mg of DHA per day.\(^9\)
- Pregnant and lactating women have greater nutritional requirements and as such may be at greater risk of nutrient deficiencies which may consequently increase their risk of depression.\(^5\)
- At least 340g of seafood should be ingested weekly during pregnancy for beneficial effects on child development.\(^9\)
- Depression is consistently responsible for the greatest burden of disease in women across low-, middle- and high-income countries.\(^9\)
- Frequent fish consumption has been associated with a decreased risk of depression.\(^9\) It is estimated that the global disease burden of postpartum depression potentially attributable to low levels of omega-3s is 65.5%.\(^9\)
- Adequate DHA concentration in breast milk has a strong negative correlation with postpartum depression rates.\(^9\)
- High intake of sea fish is independently associated with greater bone mass and lower osteoporosis risk in women, especially those consuming more than 250g per week of seafood.\(^9\)\(^6\)
- Post-menopausal women who consumed fish experienced a significantly reduced risk of breast cancer when compared with red meat consumers, indicating reduced risk in older women who prefer fish as a primary protein source to the exclusion of red meat.\(^9\)
What we need to know:

- We need to know the real risk of potential exposure to pollutants such as methylmercury through fish and seafood. More research is needed to determine safe levels of exposure and the source/s of exposure e.g. local fish/seafood, imported fish/seafood.98
- Further investigation into exposure levels of imported seafood and regulatory food standards relating to exposure of seafood to pollutants is required.
- Gender differences in the metabolism and physiological effect of seafood and associated nutrients need to be further explored. Of particular interest are gender-specific health conditions.

2.3.9 Healthy ageing

What we know:

- Seniors can gain significant health benefits from the consumption of 3.5g-4.0g of omega-3s each week.99, 100 Oily fish such as sardines, salmon and farmed rainbow trout provide enough omega-3s in one 150g serve to meet the recommended weekly intake.
- As CVD is the leading cause of death in Australia, seafood intake can play a vital role in preserving life. One to two serves of oily fish per week provides significant protection against health conditions such as CVD, particularly ischemic stroke,101 arthritis and some cancers, with the strongest evidence for older women.102
- Recent research suggests that marine sourced omega-3s may prevent or delay age-related hearing loss (presbycusis). Consumption of at least two servings of fish per week significantly reduced the risk of hearing loss.103, 104
- Regular fish and seafood consumption may reduce the likelihood of age-related macular degeneration (AMD) with the odds of AMD 51% lower in the highest quartile of fish intake compared to the lowest quartile. Many studies support significant protective effects of a diet high in seafood.105-109
- There is evidence that dietary DHA may reduce the progression of periodontal disease in older people.110
- Intake of omega-3 rich seafood is linked to increased dispositional optimism in the elderly, and has, in some long term studies, been linked to reduced depression.111-113
- DHA is a catalyst for the slowing of early stage progression of dementia.114, 115
- Seafood is a rich source of both calcium and vitamin D, important bone-building micronutrients.
- A diet high in oily fish may aid in the prevention of vitamin D deficiency, and as such, vitamin D rich seafood can play an important role in the maintenance of bone mineral density as people age. Reduced sun exposure, an increased requirement of vitamin D, and a reduced capacity to synthesize provitamin D3 in skin and to hydroxylate vitamin D3 in kidneys in older people106 underpins the need for high-quality, bioavailable vitamin D. Seafood is the best dietary source of vitamin D, and is second only to the sun.
- Commonly consumed, affordable sources of seafood such as Australian salmon and silver perch contain more than double the recommended daily intake of vitamin D in a 150g serve.117, 118
- Loss of calcium through urinary excretion is of concern for bone health in seniors. Evidence is emerging showing lower fracture rates and higher bone mineral density (BMD) with the consumption of adequate levels of calcium rich, high protein seafood. This may be due to increased intestinal absorption, which negates the impact of urinary excretion. When calcium and vitamin D intake is adequate, dietary protein at moderate levels is beneficial to total body BMD particularly for seniors. Seafood is a good source of calcium, vitamin D and protein, therefore can favourably contribute to BMD.119-122

What we need to know:

- Further promotion of a diet high in seafood for healthy ageing should be a priority.
- Development of low cost, nutrition-rich seafood meals should also be a priority given the significant increase in the aged population worldwide.

2.3.10 Inflammatory conditions

What we know:

- Evidence shows that fish intake is beneficial in the management of inflammatory diseases.123, 124
- Dietary intake of omega-3 fatty acids is associated with lower levels of inflammation.125
- Moderate to high intake of fish appears to be protective against rheumatoid arthritis (RA). An increase of 30g oily fish (8g fat/ 100g fish) consumption per day has been associated with a 49% risk reduction of RA.126
Dietary fish oil supplementation has demonstrable benefits for RA and other inflammatory conditions (e.g. bowel disease and immunoglobulin A nephropathy) and may also reduce pharmacological dosages required to treat RA.\textsuperscript{127}

Ingestion of omega-3 fatty acid supplements has consistently shown improvement in joint tenderness and the amount of morning stiffness in those with RA.\textsuperscript{123, 127}

Fish oil is currently used as an adjuvant to approved medications for arthritis and studies support its efficacy in conjunction with non-steroidal anti-inflammatory drugs (NSAID). While consumption of fish and fish oil does not prove efficacious in all cases, some individuals have been able to discontinue or reduce NSAID therapy while continuing fish oil ingestion.\textsuperscript{127-129}

What we need to know:

Further research is needed to confirm that fish intake is beneficial to the prevention and management of inflammatory diseases.

Improving consumer understanding of the ratio of omega-3 and omega-6 fatty acids is important and its absence from the materials reviewed should be addressed in future health promotional materials.

The continued, unqualified promotion of ALA sources as efficacious sources needs to be addressed, and further study of this issue would be beneficial as this misconception may lead RA sufferers to dismiss the therapeutic effects of omega-3 fatty acids after doses of ALA fail to result in positive outcomes.

Confusion between cod liver oil and fish oil, and consumer concerns about vitamin A toxicity (cod liver oil is a rich source of vitamin A) need to be clarified.

2.3.11 Maternal health

What we know:

Maternal nutrition is important to foetal brain development.\textsuperscript{130}

Seafood is an excellent source of omega-3 fatty acids, which are essential for optimum foetal neural development.\textsuperscript{91}

High levels of fish intake during pregnancy have been associated with longer gestation, increased birth weight and lower hypertension during pregnancy.\textsuperscript{131-135}

Fish and seafood are potential sources of exposure to pollutants such as methylmercury that may adversely affect pregnancy outcomes. Thus, advising pregnant women about fish consumption requires consideration of potential risks as well as benefits.\textsuperscript{131,136} Not enough women of childbearing age are consuming adequate fish for health benefits.\textsuperscript{137}

The beneficial effects on child development of maternal seafood intake of more than 340g per week were found in a United States study. This suggests that advice to limit seafood consumption could actually be detrimental. These results show that risks from the loss of nutrients were greater than the risks of harm from exposure to trace contaminants in 340g seafood eaten weekly.\textsuperscript{91, 138}

Higher maternal fish consumption has been linked to higher child developmental scores at 18 months, and improved performance on language and visual motor skills.\textsuperscript{134, 135}

What we need to know:

We need to understand the real risk of potential exposure to pollutants such as methylmercury through fish and seafood. More research is needed to determine safe levels of exposure and the source/s of exposure (e.g. local fish/seafood, imported fish/seafood).\textsuperscript{98}

Further investigation into exposure levels of imported seafood and regulatory food standards relating to exposure of seafood to pollutants is required.

2.3.12 Mental health

What we know:

Fish consumption is significantly associated with higher self-reported mental health status.\textsuperscript{139, 140}

A mean daily intake of 10g of seafood is linked to lower prevalence of poor cognitive performance.\textsuperscript{141}

There are significant negative correlations between worldwide fish consumption and rates of depression (including post-partum), bipolar disorder and suicidal ideation.\textsuperscript{139, 142-144}

Fish intake has been shown to have a negative association with depressed mood, risk of recurrent depressive episodes and depressive symptoms.\textsuperscript{145-147}
A growing body of evidence suggests a protective effect of omega-3 fatty acids against dementia. Intake of at least one fish serve per week reduces the risk of Alzheimer’s Disease.

What we need to know:

- Further research is needed to establish a significant association between fish consumption and its effect on mental health and cognitive impairment.
- Further research is needed to establish a strong positive association between fish and seafood consumption and mood disorders.
- Research into the protective properties of seafood consumption in childhood and adolescence on prevention, behaviour management, delay to onset and reductions in severity of mental health conditions is required.
- Research that provides estimates of omega-3s required to offer protection against cognitive decline and delay of onset of Alzheimer’s and/or dementia are required. Recommendations to slow cognitive decline are also required.
- Evidence of a therapeutic effect on general mental wellbeing would contribute to a population level campaign promoting the benefits of fish and seafood consumption.

2.3.13 What are the health risks associated with eating fish and seafood?

What we know:

- A balance of risk-benefit in relation to the consumption of fish and seafood is recommended in the literature, as well as taking into consideration meal size and frequency of consumption.
- Guidelines are available to assist people to make informed choices about the types and amount of seafood they ingest based on higher omega-3 content and low mercury concentrations.
- Levels of dioxins and other pollutants in fish are low, and potential carcinogenic and other effects are outweighed by potential benefits of fish intake and should have little impact on choices or consumption of seafood.
- Fish low in mercury and high in omega-3s are recommended. Light tuna has relatively low levels of mercury, and other fish, such as wild and farmed salmon and shrimp, contain very low levels of mercury.
- Fish containing the highest amounts of omega-3s in the United States (US) are farmed trout, farmed Atlantic salmon, Coho salmon, toothfish, Copper River salmon and sockeye salmon.
- Women of childbearing age should consult regional advisories for locally caught freshwater fish. The benefits of modest fish intake, excepting a few selected species, also outweigh risks.
- Women who are pregnant, may become pregnant or are breastfeeding, as well as very young infants should avoid fish with higher mercury content. Consumption of fish and seafood should not, however, be avoided altogether as it is the predominant source of omega-3s, which are essential for optimum foetal neural development.
- Advances have made biomonitoring a cost-effective public health tool for helping federal, state and local health agencies develop optimal dietary guidance.

What we need to know:

- There is very little information available about actual dangers of mercury levels in seafood from Australian waters.
- More research is required on the nutritional security of fish and seafood in Australian waters. This should include guidelines for consumption of seafood.
- Evidence based guidelines on the amount of fish that Australian pregnant women and infants can safely eat are required.

2.3.14 Consumer attitudes towards fish and seafood consumption

What we know:

- Perceived cost, freshness, quality, availability, ease of use, and confidence in preparation were considered to be the main influences in consumer choice of fish and seafood products. Quality is perceived by appearance and odour.
- Taste is identified as the most important driver for eating fish, followed closely by perceived health benefits. Bones and price influenced purchase type but not intention to purchase.
- Eating fish in compliance with health recommendations is higher among women and increases with increasing age. The presence of children in the household is associated with lower fish consumption.
The influence of family members (particularly husbands or partners) impacts upon the likelihood of the serving fish and seafood, and the types of products served.\textsuperscript{175, 176}

Lower income is positively associated with lower fish consumption. Higher education is linked with a higher intention to eat fish but has no effect on how often fish is actually eaten.\textsuperscript{174}

Odours common to fish and seafood are often a deterrent to consumption. These are often related to bacteria.\textsuperscript{177}

Fresh fish and seafood are preferred to alternative products including processed, smoked, canned and frozen products.\textsuperscript{173} Packaged fresh fish is often perceived by heavy fish purchasers as inferior to fresh fish and by infrequent fish purchasers as having all the issues associated with fresh fish.\textsuperscript{178}

Plain fresh frozen fillets are sometimes rejected as they are perceived as grey, lifeless, anonymous and basic. They are associated with factories and processing.\textsuperscript{178}

Fish is often perceived to be tasteless and preparation of sauces imposes extra cost. Consumers often fry fish in batter or butter which reduces the healthful effects on disease and conflicts with the health guidelines.\textsuperscript{178}

The highly processed product varieties (battered and crumbed fish, and fish in sauce dishes) are often popular among families and perceived as easy and convenient to cook. However, they are perceived to be made from poor quality fish, less healthy due to the cooking techniques associated with them (e.g. deep frying), and lacking in variety.\textsuperscript{178}

Strategies directed at parents and children should include experimental ‘hands-on’ components to encourage experimentation, particularly focussing on ease of preparation and the variety of lower cost seafood available.\textsuperscript{176}

\textit{What we need to know:}

- The influence of the male within the family unit on attitudes towards seafood consumption should be researched further.
- Interventions seeking to promote seafood (particularly fish) as an integral part of a healthy diet should be investigated further and should address existing negative attitudes and beliefs around cost, storage and preparation of seafood.

\textbf{2.3.15 Marketing and advertising}

\textit{What we know:}

- Modern marketing techniques, in particular advertising, have a strong influence on food choice.\textsuperscript{177}
- Many consumers obtain health information regarding seafood from the media.\textsuperscript{175}
- A health benefit message may increase consumers intention to eat fish by a greater amount than a health risk message may lower their intention.\textsuperscript{179}
- More consumers recall hearing positive messages regarding fish consumption than negative messages.\textsuperscript{175}
- Food advertising to children predominantly features Snack foods/fast foods and confectionery. Advertising campaigns often use themes that promote grazing, denigrate core foods and include exaggerated health claims.\textsuperscript{180}
- Changing the food advertising environment within children’s television viewing time to an environment where nutritious foods are promoted and less healthful foods unrepresented would lead to the normalisation and reinforcement of healthy eating.\textsuperscript{181}

\textit{What we need to know:}

- More research is required to inform a comprehensive social marketing campaign to promote the regular inclusion of fish and or seafood in the diet of Australian families.

\textbf{2.3.16 Health literacy}

\textit{What we know:}

- Almost half of Australians do not have adequate health literacy to understand health information and instructions.\textsuperscript{182}
- Internationally, health literacy levels are similar to those in Australia. In the US, 28.7% of parents have been identified as having basic or below basic health literacy,\textsuperscript{183} while 30% of Taiwanese adults have marginal or inadequate health literacy despite over 20% of the population possessing tertiary qualifications.\textsuperscript{184}

\textit{What we need to know:}

- The challenge for public health professionals transpires in communicating complicated and evolving scientific knowledge with simple and straightforward messages that have widespread availability.
2.4 Seafood health benefits communication strategic review

2.4.1 Capacity needs

Having completed an extensive review of the literature including the latest scientific evidence of health benefits associated with seafood consumption and consumer motivations, a review of corporate and organisational resources and capacity was conducted. The objectives of this second phase of the review were to:

1. Identify which organisations, institutions and spokespeople are currently providing information on seafood health benefits and the level of credibility of those organisations and institutions;

2. Undertake an initial assessment of organisations, institutions and spokespeople capacities and relevance to the seafood industry; and

3. Assess the availability of trained people to develop resources and to deliver health benefits information to the target audiences.

The strategic review generated large amounts of information. Tables 4.1 to 4.9 in Section 4 - Appendices provide information sourced sorted by health condition. Table 4.10 provides a comprehensive list of websites associated with all resources reviewed.

2.4.2 Summary of information provided

- Many relevant organisations reviewed did not provide any advice on the health benefits of seafood; furthermore, little information was available from most health and food agencies.

- When information was provided, messages were generally similar. The most common messages referred to omega-3s and health benefits (high in protein, vitamins and minerals) and usually recommended two serves of fish per week. Some messages related fish to: slimming; specific health benefits of vitamins and minerals (e.g. iodine); and the omega-3 levels in different fish types. The balance between risks and benefits associated with mercury levels in fish was reported.

- A particular source of information was usually discussed; however, the actual reference details were rarely given. While reliable resource references were not numerous, the most common Australian references were:
  a. What's so Healthy About Seafood: A Guide for Seafood Marketeers published by the Fisheries Research and Development Corporation (FRDC);185
  b. The Australian Dietary Guidelines;186, 187
  c. The National Health and Medical Research Council (NHMRC); and
  d. Food Standards Australia and New Zealand (FSANZ).

- It appeared very little information on the health benefits of seafood was included in training packages/curriculum at a primary, secondary and technical level. However, it is noteworthy that there is considerable scope to include such information in already developed competencies and curricula. The research does indicate that a single reference point for seafood health benefits (updated frequently) may be advantageous.

- Few simple pamphlets or educational materials were available for point of sale (except FRDC’s What’s so Healthy About Seafood).

- Cooking demonstrations (live and telecast) and formal cooking classes are extremely popular in Australia. However, little research has been conducted assessing the effectiveness of these modes of communication on short or long-term changes to healthy eating.
2.5 Summary

This systematic review of published literature has sought to provide an overview of the best available evidence around seafood consumption and human health. It is expected there will be a number of reports and publications that have not been included as they are either not substantiated by evidence or have not included references to support the comments therein.

The evidence presented clearly shows significant health benefits of the regular consumption of seafood as part of a healthy diet. There is also substantial evidence supporting a diet high in seafood to prevent or manage chronic lifestyle conditions such as arthritis, nutrition-related cancers, cardiovascular diseases, diabetes and obesity. Emerging but significant evidence supports the ingestion of seafood or fish oil in the management of mental health conditions including behaviour management associated with conditions such as ADHD.

It would appear from the evidence available that most people would benefit from the ingestion of at least two serves of seafood (particularly those high in omega-3s) each week. There is also good evidence indicating a positive association with increased seafood consumption in the prevention and management of chronic health conditions in both men and women.